Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2016

Trends and benchmarking of livestock farms and veterinarians

September 2017




Preface

This is a copy of the report *Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2016* drawn up by the Netherlands Veterinary Medicines Institute (SDa). With this report, the SDa expert panel provides insight into the usage of antibiotics at Dutch livestock farms for the sixth consecutive year.

Once again, the patterns observed vary by livestock sector. While some livestock sectors continued to reduce their usage levels substantially in 2016, most livestock sectors recorded relatively minor reductions. This indicates that following the sharp declines recorded for the previous five years, usage levels have begun to stabilize for most livestock sectors. In certain livestock sectors, the number of livestock farms (systematically) exceeding the signaling and action thresholds is still considerable, showing these sectors still require attention. Results of the monitoring of antibiotic use in rabbits raised for food production are reported for the first time in 2016.

The end of 2016 saw the commencement of critical success factor (CSF) studies in three livestock sectors (the veal, poultry and pig farming sectors). These studies aim to identify the characteristics of livestock farms that have systematically recorded low usage levels over the past few years. The findings should benefit current high usage level farms, and the expectations for this special project are quite high. A similar study is being conducted among veterinarians. The results of the CSF studies are expected later this year and the SDa expert panel will consider the CSF findings when revising its benchmark thresholds.

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

Utrecht, May 2017

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Conclusions and recommendations

The SDa aspires for transparent and prudent usage of antibiotics in the Netherlands by continuously monitoring the amounts of antibiotics used in the veal, cattle, pig, broiler, turkey and meat rabbit farming sectors, surveying smaller animal sectors, assessing sales figures, and benchmarking usage levels of livestock farms and prescription patterns of veterinarians.

Developments in usage levels of monitored livestock sectors

In 2016, the broiler, turkey, veal and pig farming sectors managed to reduce their antibiotic use in terms of defined daily doses animal ($DDDA_{NAT}$) by 30.1%, 26.5%, 5.3% and 1.9%, respectively. The cattle farming sector as a whole recorded a minor increase (of 1.1%) in the amount of antibiotics used. Considering the cattle farming sector's low usage level, the SDa expert panel feels this minor increase was the result of natural variation.

Throughout the various livestock sectors, many livestock farms managed to consolidate or further reduce their low usage levels recorded in previous years. The livestock sectors that had recorded a $DDDA_{NAT}$ increase last year were able to change course in 2016 by reducing the amounts of antibiotics used. The steep decline recorded for the **broiler farming sector** is particularly remarkable. The rise in the use of slower growing breeds for the Dutch consumer market probably contributed to this development. This 2016 decline neutralized the usage level increase recorded for 2014, and resulted in a 72% reduction compared to the broiler farming sector's 2009 usage level. Another welcome development is the fact that in 2016, the **turkey farming sector** recorded its first substantial usage level reduction. The SDa expert panel hopes the turkey farming sector will continue this decline throughout 2017, as further reductions are still considered necessary within this sector. The reductions observed in the **pig farming sector** are modest, indicating antibiotic use at pig farms demands ongoing attention.

The **veal farming sector** recorded a 5.3% decline in the amount of antibiotics used compared with the 2015 level. Over the past four years, the veal farming sector's usage level has remained fairly stable.

Antibiotic use in the **dairy cattle farming sector** declined by 3.2%, while the **non-dairy cattle farming sector** recorded a 7% increase. When interpreting the findings for the cattle farming sector, its relatively low usage levels should be considered.

In 2016, the SDa started monitoring the amounts of antibiotics used in the **rabbit farming sector**. This livestock sector recorded a relatively high usage level ($DDDA_{NAT}$ value of 40.9). In 2011 and 2012, rabbit farms could voluntarily supply their usage data for monitoring by LEI Wageningen UR. The 2011 and 2012 usage levels turned out to be very high, with defined daily doses animal per animal-year (DD/AY) of 165 and 138, respectively, with outliers of 300 DD/AY. It is quite an achievement that the rabbit farming sector has managed to realize such a substantial usage level reduction over the past few years. In the years to come, the SDa will monitor whether this downward trend is going to continue, and benchmark thresholds for the rabbit farming sector will be agreed upon. The aim is not merely to reduce the rabbit farming sector's overall usage level, but also to reduce the use of second-choice antibiotics at rabbit farms. Third-choice antibiotics are only used sporadically in this livestock sector.

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

In most livestock sectors, the usage level reductions achieved over the past few years were associated with increasing relative contributions of first-choice antibiotics. In the broiler and turkey farming sectors, however, second-choice antibiotics accounted for increasingly higher proportions of overall antibiotic use. To fight the development and spread of resistant ESBL-producing organisms, the relative increase in the use of second-choice antibiotics should be addressed in the years to come. The SDa expert panel would like to see a further reduction in second-choice antibiotics' relative contribution to overall antibiotic use in the broiler and turkey farming sectors.

Third-choice antibiotics usage, specifically fluoroquinolones and third- and fourth-generation cephalosporins, was generally low in the monitored livestock sectors. However, fluoroquinolone use did increase slightly in the veal and turkey farming sectors, in absolute as well as relative terms. Most other livestock sectors recorded very low usage levels for third-choice antibiotics, with levels below 0.005 $DDDA_{NAT}$. Fluoroquinolone use in monitored livestock sectors (the rabbit farming sector included) rose from 125 kg in 2015 to 146 kg in 2016. This was mainly due to the veal and turkey farming sectors recording 5 kg and 11 kg increases, respectively. Fluoroquinolone use in poultry not subjected to SDa monitoring was high, with "unmonitored poultry farming subsectors" accounting for 103 kg. According to the Dutch poultry farming sector, this high number was mainly due to use in broiler parent stock and broiler grandparent stock, with parent stock at rearing farms and - to a lesser extent - parent stock at production farms contributing the most. Further examination and regulation efforts by the poultry farming sector therefore seem to be necessary to reduce the amount of fluoroquinolones used.

Aminoglycoside use in livestock sectors subject to SDa monitoring increased from 544 kg in 2015 to 651 kg in 2016 (784 kg if the rabbit farming sector is included). The cattle, veal and turkey farming sectors recorded higher aminoglycoside usage levels than last year, while the pig and broiler farming sectors recorded lower usage levels.

Use of polymyxins, including colistin, showed a steep 31% decline over the 2015-2016 period. Use of colistin monotherapy products also declined compared with the 2015 level. All monitored livestock sectors managed to keep their colistin use below 1 mg/PCU kg, the most stringent benchmark threshold proposed by the European Medicines Agency (EMA). The pig farming sector had been the number one colistin user in 2015, with a reported use of 1,243.7 kg, but it managed to reduce its colistin use by almost 30% in 2016, to 871.7 kg. The second-highest colistin user was the veal farming sector, which recorded a reduction of almost 64% by reducing its colistin use from 137.5 kg in 2015 to 49.7 kg in 2016. The reductions achieved by the turkey and broiler farming sectors were minimal (<5 kg). Last year, a (plasmid-mediated) type of colistin resistance that can be transferred between bacteria was identified as a cause for concern by the SDa expert panel, and this warrants further restriction of colistin use.

Quinolone use increased in the veal farming sector (by 20%), while the broiler and turkey farming sectors managed to reduce their quinolone use substantially (by 48% and 80%, respectively).

Sales figures

In 2016, sales of antibiotics in terms of kilograms of active substances dropped by 14.5% compared with the 2015 level. The amount of antibiotics used exceeded the amount sold in 2016. This was probably due to wholesalers and veterinary practices using antibiotics from stocks built up previously. The number of kilograms of active substances sold declined by 64.4% between 2009 (the government-specified reference year) and 2016.

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 a livestock farm falls within the target zone, the signaling zone, or the action zone and are based on the amounts of antibiotics used. The decline in mean antibiotic use observed for 2016 was associated with only a small number of livestock farms moving from the action zone to a lower usage level zone in most cases. The exception was the sharp decline of the number of broiler farms included in the action and signaling zones caused by a marked reduction in overall antibiotic use in the broiler farming sector.

The veal farming sector showed no prominent shift of farms from either the signaling- or action zone to the target zone compared to 2015. The veal farming sector was the livestock sector with the highest number of livestock farms recording signaling or action zone usage levels for three consecutive years. These veal farms have not made any significant progress over several years. This lack of progress underlines the importance of identifying critical success factors in the veal farming sector. The currently ongoing critical success factor study should result in a clear action plan describing the interventions to be implemented in this livestock sector.

The SDa expert panel has also calculated the 2016 Veterinary Benchmark Indicators (VBI) for individual veterinarians, 76% of veterinarians were included in the target zone based on their prescription patterns. Of the 1,280 veterinarians with recorded one-to-one relationships (with the veterinarians active in multiple livestock sectors having been included in the statistics more than once), 20 (1.6%) fell within the action zone. A VBI could be assigned to 1,186 veterinarians that were responsible for more than one livestock farm in 2016, of which 13 (1.1%) were included in the action zone. The expert panel feels it is necessary to identify the factors that may have caused these veterinarians to have such a high VBI. Approximately 22% of veterinarians were included in the signaling zone based on their prescription patterns. The proportion of veterinarians in the signaling zone varied: 48% (of 141 veterinarians in total) for the veal farming sector; 33% (of 9 veterinarians in total) for the turkey farming sector, 21% (of 268 veterinarians in total) for the pig farming sector, 19% (of 772 veterinarians in total) for the cattle farming sector, and 13% (of 90 veterinarians in total) for the broiler farming sector. 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. The SDa expert panel hopes the critical success factor study that is currently being conducted among veterinarians will facilitate such improvements.

Revision of the calculation and benchmarking methods

In 2017, the calculation method for the poultry farming sector will be revised. Poultry farms' defined daily doses animal will from then on be calculated based on the birds' body weight at the time of treatment rather than their standardized average body weight. The poultry farming sector hopes this change will enable more accurate benchmarking of poultry farms' antibiotic use. The SDa and the poultry farming sector have already agreed on the specifics of the new calculation method.

The calculation method for the veal farming sector will also be revised. In addition to basing $DDDA_F$ calculations on the calves' body weight at the time of treatment, usage levels will be calculated over 1.5-year periods rather than 1-year periods. Usage level data will, however, still be reported as the amounts of antibiotics used per year. The veal farming sector hopes these changes will enable more accurate benchmarking while also mitigating the effect of any year-to-year differences in the number of times a year veal farmers start with a new herd of calves on usage levels. This new calculation method can be implemented as soon as it has been fully specified and finalized.

From 2017 onwards the benchmarking method for the cattle farming sector will only include a signaling threshold. This is possible because of this livestock sector's low usage levels and minimal variation between individual cattle farms. Additionally, the proportion of cattle farms structurally recording high usage levels is small, which is why the cattle farming sector is not participating in the critical success factor studies. Once the new method has been implemented, cattle farms are required to take action to reduce the amount of antibiotics used if they have been included in the signaling zone two years in a row. Benchmarking of veterinarians active in the cattle farming sector will also be based on the signaling threshold.

Last year the SDa expert panel proposed several changes to the benchmarking method. Later this year the results of the critical success factor studies will become available. These studies are being conducted to identify the factors that set livestock farms with long-term low usage levels apart from livestock farms with long-term high usage levels. Prescription patterns of veterinarians are being evaluated in a similar manner. The findings of these studies will help guide the benchmark threshold revision process in late 2017.

The expert panel will discuss its revision of the benchmark thresholds with each of the monitored livestock sectors and new benchmark thresholds will be provided to all monitored livestock sectors in early 2018.

Every livestock sector, except the dairy cattle farming sector, still needs to step up its efforts in order to have all livestock farms record target zone usage levels. The expert panel feels the critical success factor studies will help these livestock sectors realize the intended improvements.

Terms and definitions

BCT	BrancheCodeTabel [a veterinary medicinal products database]
$DDDA_{NAT}$	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 unit of measurement 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. This parameter is used in other countries as well. It is similar to the parameter DDD per 1,000 person-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 unit of measurement 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 some older publications, this parameter was expressed in ADDD/Y.

$DDDA_{VET}$	The defined daily dose animal based on the antibiotic prescription pattern of a particular veterinarian in one of the livestock sectors. To determine the $DDDA_{VET}$, the first step is to calculate the total number of treatable kilograms for which a particular veterinarian prescribed antibiotics during a specific year (the overall number of treatable kilograms for all livestock farms that had a registered one-to-one relationship with this veterinarian in the year concerned). This number is then divided by the average number of kilograms of animal present based on all of the livestock farms that had a registered one-to-one relationship with the veterinarian concerned. The $DDDA_{VET}$ reflects a particular veterinarian's prescription pattern in absolute terms, and is used to identify inter-veterinarian variability in prescription patterns.
DDD_{VET}	The active substance-based defined daily dose for veterinary medicinal products. The DDD_{VET} is the assumed average dose administered to a particular type of livestock in Europe, in mg/kg body weight. This unit of measurement is used to determine DDD_{VET}/PCU values. In addition, calculating the DDD_{VET}/live weight value facilitates comparison with the $DDDA_{NAT}$ parameter.
EMA	European Medicines Agency
ESBL	Extended-Spectrum Beta-Lactamase
ESVAC	European Surveillance of Veterinary Antimicrobial Consumption
EUROSTAT	The statistical office of the European Union. 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).
PCU	Population Correction Unit, a parameter used by the European Medicines Agency representing the number of kilograms of animal in a particular livestock sector. The PCU is calculated using the number of animals present and the number of animals slaughtered in a particular livestock sector in a specific year. As a result, the PCU is more production driven than the denominator in the SDa's $DDDA_{NAT}$ calculations, which also

	represents the number of kilograms of animal in a particular livestock sector but is based solely on the average number of animals present in the year concerned.
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 antibiotic use. A veterinarian's VBI is based on the distribution of the RPRs of the livestock farms for which he or she is responsible.

Introduction

This is the sixth year for which the SDa publishes usage data. The layout of the current report is largely in line with that of the 2015 report, although certain sections of the current report contain additional data or are structured slightly differently. Detailed information on colistin use is provided this year. The appendices now include a special paragraph with data calculated in accordance with the European calculation method recently proposed and published by EMA as part of its ESVAC project.

The SDa has been monitoring the amounts of antibiotics used at Dutch livestock farms since 2011, by comparing livestock farms' usage levels to specific benchmark thresholds that have been defined for the various livestock sectors and the associated production categories and types of 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 enable 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 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.

Trends in usage and sales of antibiotics

The 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 farm-level delivery records for antimicrobial agents. The delivery records are transferred to the SDa through the databases of the various livestock sectors, and provide detailed information on the amounts of antibiotics used in each sector.
2. Sales figures recorded in the Dutch 'Branchecodetabel' (BCT) are provided to the SDa by FIDIN, the federation of the Dutch veterinary pharmaceutical industry. The BCT was accessed on April 12, 2017. 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 use in the various Dutch livestock sectors over several years. $DDDA_{NAT}$ data are 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 have reported all delivery record data for veal, pig and cattle farms to the SDa. As a result, the SDa was able to analyze $DDDA_{NAT}$ trends for these livestock sectors from 2012 onwards. As only part of the 2012 delivery record data for the broiler farming sector had been provided to the SDa, the SDa decided to estimate the broiler farming sector's 2012 usage levels based on the available 2012 data. Antibiotic use in the turkey farming sector has been reported on since 2013. Delivery record data for all rabbit farms have been included for the first time this year.

In order to determine the $DDDA_{NAT}$ values, the SDa required 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 2016*

Livestock sector	2012	2013	2014	2015	2016
Broiler farming sector	43,846	44,242	47,020	49,107	48,378
Turkey farming sector	4,962	5,046	4,763	5,178	4,572
Pig farming sector	710,688	710,802	704,937	706,025	686,638
Dairy cattle farming sector	924,600	958,200	966,000	1,030,200	1,076,400
Veal farming sector	156,602	159,547	158,828	156,751	164,890
Non-dairy cattle farming sector	597,900	573,800	649,000	649,800	600,100
Rabbit farming sector	872	830	860	1,004	948

** The 2012 and 2013 figures were provided by LEI Wageningen UR. 2014, 2015 and 2016 figures for the pig and cattle farming sectors were provided by EUROSTAT. Figures for the rabbit, veal and poultry farming sectors were provided by Statistics Netherlands (CBS).*

Developments in usage of antibiotics based on delivery record data

Usage data were provided by the various livestock sectors. In the event of livestock farms with high delivery record results, the data were rechecked. These farms represented only a small proportion of the total number of livestock farms. Some high delivery record results reflected errors in the data file. In those cases, the data were resubmitted.

The 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 2016. This was done for each type of livestock within the various livestock sectors in the Netherlands. This resulted in livestock sector-specific $DDDA_{NAT}$ values. The $DDDA_{NAT}$ values for the 2012-2016 period are included in Table 2.

In 2016, the **broiler farming sector** achieved a spectacular 30.1% $DDDA_{NAT}$ reduction. The rise in the use of slower growing breeds probably contributed to this steep decline. The critical success factor study, which is being conducted throughout the first half of 2017, aims to identify differences between livestock farms included in different benchmark zones based on their usage levels. This study should provide detailed information on the underlying factors contributing to this drop in $DDDA_{NAT}$.

The **turkey farming sector** also substantially reduced the amount of antibiotics used, by 26.5%. This sector's usage level is now lower than it has been over the past few years. The SDa hopes this downward trend will continue in the years to come.

In terms of $DDDA_{NAT}$, the **pig farming sector** continued its modest decline in the amount of antibiotics used by a further 1.9% reduction.

The cattle farming sector as a whole recorded a minor increase (of 1.1%) in the amount of antibiotics used. As of 2016, however, two cattle farming subsectors are distinguished for reporting purposes: the dairy cattle farming sector and the non-dairy cattle farming sector. Antibiotic use in the **dairy cattle farming sector** declined by 3.2%, while the **non-dairy cattle farming sector** recorded a 7.0% increase. The non-dairy cattle farming sector's low usage level should be considered when interpreting this 7.0% increase. For the time being, the SDa is not concerned by this rise in antibiotic use and considers it to be a normal fluctuation.

Just like for last year's report, CBS data on the number of animals were used to calculate $DDDA_{NAT}$ values for the **veal farming sector**. Overall use of antibiotics in this livestock sector decreased by 5.3% in 2016, following a similar rise in antibiotic use in the year before. Over the past four years, usage levels have fluctuated somewhat, with no substantial downward trend.

Antibiotic use in **rabbits** raised for food was monitored for the first time in 2016. With a $DDDA_{NAT}$ of almost 41, the rabbit farming sector's usage level qualifies as high. In 2011 and 2012, rabbit farms could voluntarily supply their antibiotic usage data for monitoring by LEI Wageningen UR. The usage levels observed for 2011 and 2012 turned out to be very high, with defined daily doses animal per animal-year (DD/AY) of 165 and 138, respectively, with outliers of 300 DD/AY.

Table 2. DDDA$_{NAT}$ figures for the 2012-2016 period, by livestock sector (broiler, turkey, pig, dairy cattle, veal, non-dairy cattle and rabbit farming sectors) and pharmacotherapeutic group

	Broiler farming sector					Turkey farming sector				Pig farming sector				
	2012	2013	2014	2015	2016	2013	2014	2015	2016	2012	2013	2014	2015	2016
Pharmacotherapeutic group														
1st-choice antibiotics	**7.80**	**6.91**	**5.51**	**4.24**	**2.74**	**22.47**	**19.87**	**21.17**	**13.46**	**10.39**	**7.42**	**7.45**	**6.97**	**6.88**
As a proportion of overall AB use	**42.23%**	**50.57%**	**34.97%**	**29.07%**	**26.87%**	**76.53%**	**64.63%**	**58.89%**	**50.95%**	**72.56%**	**74.46%**	**78.22%**	**77.10%**	**77.54%**
Amphenicols	*	*	*	*	*	0.02	*	*	0.00	0.06	0.09	0.17	0.18	0.24
Macrolides/lincosamides	1.11	0.44	0.35	0.48	0.25	3.07	2.12	1.98	1.18	0.93	0.71	0.92	0.78	0.82
Other	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Penicillins	2.10	2.05	2.12	1.20	0.70	5.86	5.80	4.49	3.70	0.33	0.52	0.61	0.57	0.58
Pleuromutilins	0.00	0.00	*	*	*	*	*	0.12	*	0.35	0.12	0.09	0.08	0.07
Tetracyclines	2.52	2.71	1.70	1.49	1.01	11.19	9.58	12.57	7.63	6.79	4.58	4.34	4.14	4.07
Trimethoprim/sulfonamides	2.07	1.71	1.34	1.07	0.78	2.33	2.37	2.01	0.95	1.92	1.40	1.33	1.20	1.10
2nd-choice antibiotics	**9.84**	**6.50**	**10.07**	**10.28**	**7.38**	**5.13**	**9.59**	**13.57**	**11.36**	**3.93**	**2.54**	**2.07**	**2.07**	**1.99**
As a proportion of overall AB use	**53.23%**	**47.60%**	**63.91%**	**70.45%**	**72.41%**	**17.46%**	**31.18%**	**37.76%**	**42.99%**	**27.43%**	**25.54%**	**21.76%**	**22.89%**	**22.45%**
Aminoglycosides	0.61	0.04	0.03	0.02	0.01	1.24	0.40	0.71	0.69	0.00	0.00	0.01	0.01	0.00
1st- and 2nd-gen. cephalosporins	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Quinolones	2.07	1.67	2.13	2.86	1.51	0.23	0.02	0.10	0.01	0.03	0.03	0.05	0.03	0.02
Fixed-dose combinations	0.55	0.36	0.06	0.11	0.05	*	*	*	*	0.27	0.10	0.05	0.04	0.03
Macrolides/lincosamides	*	*	*	*	*	*	*	*	*	0.46	0.31	0.17	0.25	0.26
Penicillins	5.73	4.35	7.80	7.23	5.78	3.48	9.09	12.13	10.05	2.58	1.66	1.45	1.36	1.39
Polymyxins	0.88	0.08	0.05	0.06	0.04	0.18	0.08	0.63	0.61	0.58	0.44	0.34	0.38	0.28
3rd-choice antibiotics	**0.84**	**0.25**	**0.18**	**0.07**	**0.07**	**1.76**	**1.29**	**1.20**	**1.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
As a proportion of overall AB use	**4.53%**	**1.83%**	**1.13%**	**0.48%**	**0.72%**	**6.01%**	**4.19%**	**3.34%**	**6.06%**	**0.01%**	**0.00%**	**0.02%**	**0.00%**	**0.00%**
3rd- and 4th-gen. cephalosporins	*	*	*	*	*	*	*	*	*	0.00	*	*	*	*
Fluoroquinolones	0.84	0.25	0.18	0.07	0.07	1.76	1.29	1.20	1.60	0.00	*	0.00	0.00	0.00
Overall antibiotic use	**18.48**	**13.66**	**15.76**	**14.59**	**10.19**	**29.36**	**30.74**	**35.94**	**26.42**	**14.32**	**9.96**	**9.52**	**9.03**	**8.87**

0.00 means use was below 0.005 DDDA$_{NAT}$ * means no use was reported ** means only bacitracin was used

Table 2 (continued)

	Dairy cattle farming sector					Veal farming sector					Non-dairy cattle farming sector					Rabbit farming sector
	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2016
Pharmacotherapeutic group																
1st-choice antibiotics	**1.91**	**2.47**	**2.39**	**2.27**	**2.23**	**20.21**	**18.15**	**18.23**	**18.99**	**17.94**	**0.94**	**1.14**	**0.95**	**0.86**	**0.91**	**30.92**
As a proportion of overall AB use	**47.06%**	**61.23%**	**72.56%**	**73.06%**	**74.03%**	**78.17%**	**84.41%**	**86.20%**	**86.09%**	**85.90%**	**68.64%**	**81.59%**	**82.60%**	**86.00%**	**84.95%**	**75.54%**
Amphenicols	0.04	0.05	0.06	0.06	0.06	1.23	1.23	1.52	1.63	1.59	0.07	0.11	0.10	0.10	0.11	0.00
Macrolides/lincosamides	0.05	0.05	0.09	0.09	0.06	3.42	3.49	3.53	3.70	3.35	0.09	0.19	0.18	0.15	0.15	1.07
Other	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	16.37**
Penicillins	1.19	1.72	1.62	1.50	1.52	0.19	0.41	0.43	0.42	0.48	0.07	0.09	0.09	0.09	0.10	*
Pleuromutilins	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1.38
Tetracyclines	0.43	0.42	0.39	0.37	0.35	12.61	10.87	10.66	11.01	10.47	0.55	0.59	0.47	0.42	0.44	10.49
Trimethoprim/sulfonamides	0.20	0.22	0.24	0.25	0.24	2.76	2.14	2.08	2.22	2.05	0.16	0.16	0.11	0.10	0.10	1.62
2nd-choice antibiotics	**2.09**	**1.55**	**0.90**	**0.83**	**0.78**	**5.33**	**3.33**	**2.90**	**3.04**	**2.92**	**0.41**	**0.26**	**0.20**	**0.14**	**0.16**	**9.76**
As a proportion of overall AB use	**51.52%**	**38.60%**	**27.30%**	**26.79%**	**25.83%**	**20.63%**	**15.47%**	**13.71%**	**13.80%**	**13.97%**	**29.97%**	**18.32%**	**17.36%**	**13.95%**	**15.01%**	**23.84%**
Aminoglycosides	0.00	0.00	0.00	0.01	0.01	0.81	0.53	0.34	0.19	0.23	0.03	0.02	0.01	0.01	0.01	9.66
1st- and 2nd-gen. cephalosporins	0.04	0.03	0.02	0.02	0.03	*	*	*	*	*	0.00	0.00	0.00	0.00	0.00	*
Quinolones	0.00	0.00	0.00	0.00	0.00	0.27	0.30	0.49	0.58	0.66	0.01	0.01	0.03	0.02	0.03	*
Fixed-dose combinations	1.30	1.01	0.48	0.42	0.38	0.42	0.09	0.01	0.00	0.00	0.14	0.08	0.04	0.03	0.03	*
Macrolides/lincosamides	0.02	0.01	0.01	0.01	0.01	0.49	0.35	0.19	0.18	0.19	0.04	0.03	0.02	0.01	0.02	0.01
Penicillins	0.67	0.48	0.38	0.37	0.34	2.61	1.69	1.71	1.91	1.77	0.15	0.10	0.09	0.07	0.06	*
Polymyxins	0.06	0.02	0.01	0.01	0.01	0.73	0.36	0.15	0.19	0.07	0.05	0.01	0.01	0.01	0.00	0.09
3rd-choice antibiotics	**0.06**	**0.01**	**0.00**	**0.00**	**0.00**	**0.31**	**0.03**	**0.02**	**0.02**	**0.03**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.25**
As a proportion of overall AB use	**1.42%**	**0.18%**	**0.14%**	**0.15%**	**0.14%**	**1.20%**	**0.12%**	**0.09%**	**0.11%**	**0.13%**	**1.40%**	**0.09%**	**0.04%**	**0.05%**	**0.05%**	**0.62%**
3rd- and 4th-gen. cephalosporins	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*	*	0.01	0.00	0.00	0.00	0.00	*
Fluoroquinolones	0.01	0.00	0.00	0.00	0.00	0.31	0.03	0.02	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.25
Overall antibiotic use	**4.06**	**4.03**	**3.30**	**3.11**	**3.01**	**25.85**	**21.50**	**21.15**	**22.05**	**20.88**	**1.37**	**1.40**	**1.15**	**1.00**	**1.07**	**40.93**

0.00 means use was below 0.005 $DDDA_{NAT}$ *** means no use was reported** **** means only bacitracin was used**

Usage of critically important antibiotics

In 2011, in light of an advisory report by the Health Council of the Netherlands, 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 antibiotic resistance. In this regard, Dutch policy deviates from the OIE List of Antimicrobial Agents of Veterinary Importance (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.

Over the past few years, all of the monitored livestock sectors managed to reduce the overall amount of antibiotics used. There has also been a shift in the relative contributions of first-, second- and third-choice antibiotics to overall antibiotic use. As a result of the implemented policy, all livestock sectors except the broiler and turkey farming sectors saw a rise in the relative contribution of first-choice antibiotics over the last years. The SDa expert panel is concerned about the relative contribution of second-choice antibiotics in the broiler and turkey farming sectors, which has gone up due in part to the launch of new amoxicillin-containing products. This is something to keep an eye on in the next few years, for instance by analyzing the poultry farming sector's database in order to assess the indications for which these antibiotics have been prescribed. As most second-choice antibiotics used are of critical importance with respect to the development and spread of resistant ESBL-producing organisms and the treatment of infections caused by these organisms, they are to be used prudently. The SDa expert panel would like to see a further reduction in second-choice antibiotics' contribution to overall antibiotic use.

In general, use of third-choice antibiotics has been low since the SDa introduced its zero-level benchmark threshold for this category of antibiotics. Third- and fourth-generation cephalosporins, for instance, are generally used very sparingly in the monitored livestock sectors. Fluoroquinolone use in monitored livestock sectors rose from 125 kg in 2015 to 146 kg in 2016. This was mainly due to the veal and turkey farming sectors recording 5 kg and 11 kg increases, respectively. Most other livestock sectors recorded very low usage levels for third-choice antibiotics, with levels below 0.005 $DDDA_{NAT}$. Fluoroquinolone use in poultry not subjected to SDa monitoring was high, with "unmonitored poultry farming subsectors" accounting for 103 kg. According to the poultry farming sector, this high number was mainly due to use in broiler parent stock and broiler grandparent stock, with parent stock at rearing farms and - to a lesser extent - parent stock at production farms contributing the most. Further examination and regulation efforts by the poultry farming sector therefore seem to be necessary in order to reduce the amount of fluoroquinolones used.

Aminoglycoside use increased from 544 kg to 651 kg. The cattle, veal and turkey farming sectors recorded higher aminoglycoside usage levels than the year before, while the pig and broiler farming sectors recorded lower usage levels.

Polymyxin use, which is limited to the use of colistin in food-producing livestock sectors, declined in 2016. Use of colistin monotherapy products declined sharply, and oral colistin/amoxicillin fixed-dose combinations were taken off the market. Colistin use in the turkey, veal, pig, cattle and broiler farming sectors dropped from 1,446 kg in 2015 to just 968 kg in 2016. The pig farming sector had been the number one colistin user in 2015, with a reported use of 1,244 kg, but it managed to bring its colistin use down to 872 kg in 2016. The second-highest colistin user was the veal farming sector, which recorded 137 kg in 2015 and 50 kg in 2016. The amount of colistin used in the cattle, turkey and broiler farmer sectors only decreased by about 18 kg, because these livestock sectors had already recorded low usage levels in 2015. They did, however, still manage to reduce their colistin use by about 30%.

Table 3 shows the amounts of colistin used (in $DDDA_{NAT}$) throughout the 2013-2016 period, as well as colistin's relative contribution to overall antibiotic use. The table clearly shows that colistin's relative $DDDA_{NAT}$ contribution is extremely limited, in most cases not even amounting to 1%. Only the pig and turkey farming sectors show slightly higher percentages.
Last year, a (plasmid-mediated) type of colistin resistance that can be transferred between bacteria was identified as a cause for concern by the SDa expert panel. This type of resistance warrants restriction of colistin use. Colistin use was already in decline in the past few years. This downward trend was supported by the fact that oral fixed-dose combinations have been taken off the market.

Table 4 shows how each livestock sector's colistin use relates to the 1 mg/PCU and 5 mg/PCU benchmark thresholds proposed by EMA (EMA 2016). The Population Correction Unit (PCU) represents the number of kilograms of animal per livestock sector. The PCU values have been determined using a calculation method proposed by EMA (for details on the PCU calculations, please refer to the section "Antibiotic use in monitored livestock sectors calculated using the EMA method" in the appendices). The PCU value for the rabbit farming sector is a rough estimate based on the number of rabbits at monitored rabbit farms and production cycle length. As a result, the PCU identified for the rabbit farming sector is associated with a higher degree of uncertainty.

Table 3. Mean overall antibiotic use and mean colistin use from 2013 to 2016, in $DDDA_{NAT}$

[*]Years in which the rabbit farming sector was not yet subjected to monitoring.

	2013				2014				2015				2016			
Livestock sector	**No. of farms**	**Overall anti-biotic use**	**Colistin use**	**Colistin use as a % of overall AB use**	**No. of farms**	**Overall anti-biotic use**	**Colistin use**	**Colistin use as a % of overall AB use**	**No. of farms**	**Overall anti-biotic use**	**Colistin use**	**Colistin use as a % of overall AB use**	**No. of farms**	**Overall anti-biotic use**	**Colistin use**	**Colistin use as a % of overall AB use**
Broiler farming sector	770	13.66	0.08	0.6%	798	15.76	0.05	0.3%	816	14.59	0.06	0.4%	849	10.19	0.04	0.4%
Turkey farming sector	48	29.36	0.18	0.6%	41	30.74	0.08	0.2%	40	35.94	0.63	1.8%	47	26.42	0.61	2.3%
Pig farming sector	6,588	9.96	0.44	4.5%	6,072	9.52	0.34	3.6%	5,824	9.03	0.38	4.2%	5,462	8.87	0.28	3.2%
Rabbit farming sector	-[1]	-	-	-	-[1]	-	-	-	-[1]	-	-	-	42	40.93	0.09	0.2%
Dairy cattle farming sector	18,005	4.03	0.02	0.5%	17,747	3.30	0.01	0.2%	17,737	3.11	0.01	0.2%	17,529	3.01	0.01	0.2%
Veal farming sector	2,125	21.50	0.36	1.7%	2,061	21.15	0.15	0.7%	1,978	22.05	0.19	0.8%	1,928	20.88	0.07	0.3%
Non-dairy cattle farming sector	13,645	1.40	0.01	0.9%	13,476	1.15	0.01	0.6%	12,971	1.00	0.01	0.7%	12,548	1.07	0.00	0.4%

Table 4. 2016 colistin use in mg/PCU, by livestock sector

Livestock sector	Colistin use in kg	PCU*	mg/PCU**
Broiler farming sector	6.8	366,184	0.019
Turkey farming sector	10.3	168,257	0.061
Pig farming sector	871.7	1,559,092	0.559
Dairy cattle farming sector	19.4	762,450	0.025
Veal farming sector	49.7	213,577	0.233
Non-dairy cattle farming sector	10.3	267,275	0.039
Cattle farming sector	29.7	1,029,725	0.029
Rabbit farming sector	0.24	3,398	0.069

** x 1000 kg; ** in mg/1000 kg*

Table 4 shows that each livestock sector's 2016 colistin use was below the most stringent EMA-proposed benchmark threshold of 1 mg/PCU. Colistin use in terms of mg/PCU was highest in the pig farming sector. This livestock sector did, however, manage to reduce its colistin use compared with the 2015 level, from 0.814 to 0.559 (2015 data are included in the appendices). This is in line with the $DDDA_{NAT}$-based reduction in the amount of colistin used. Detailed analyses (see appendices) of farm-level usage data and prescription patterns of individual veterinarians indicate that the amounts of colistin used are randomly distributed over the different livestock farms and veterinarians. No particular farms with persistently high usage levels can be identified.

In the veal farming sector, use of quinolones has steadily increased over the years (with a 20% increase over the 2015-2016 period). This appears to have been influenced by whether veal calves were treated with either aminoglycosides, polymyxins or quinolones, which all have similar indications. Consequently, aminoglycoside and polymyxin use should also be taken into account when aiming to reduce the amount of quinolones used. In the broiler and turkey farming sectors, quinolone use declined sharply in 2016 (by 48% and 80%, respectively), as did the amounts of aminoglycosides and polymyxins used.

Long-term developments in the amounts of antibiotics used in monitored livestock sectors

The SDa expert panel has analyzed long-term developments in the amounts of antibiotics used. By integrating LEI Wageningen UR and SDa data, it could calculate the reductions achieved over the 2009-2016 period in the veal, broiler, pig and dairy cattle farming sectors. This is the first time long-term developments for the turkey farming sector have been included in the SDa report (see Figure 1). As the SDa only started monitoring the rabbit farming sector's usage level in 2016, it could not yet identify any long-term developments for this livestock sector.

The veal farming sector managed to reduce in its usage level (in $DDDA_{NAT}$) by 38% between 2009 and 2016. Over the 2007-2016 period, it even achieved a 47% reduction. This decline has plateaued in the past four years, as indicated by minor upward and downward fluctuations. Usage data recorded for the various veal farming subsectors (see the benchmarking section in this report) support this finding.

Figure 1. Long-term developments in antibiotic use according to LEI Wageningen UR data (in DD/AY, as published in MARAN reports) and SDa data (in $DDDA_{NAT}$), based on a spline with 95% CI point estimates for each year. See the appendices for the computational basis. Purple: turkey farming sector; blue: veal farming sector; orange: broiler farming sector; light green: pig farming sector; dark green: dairy cattle farming sector. Due to its width, no confidence band is included for the turkey farming sector's fitted curve

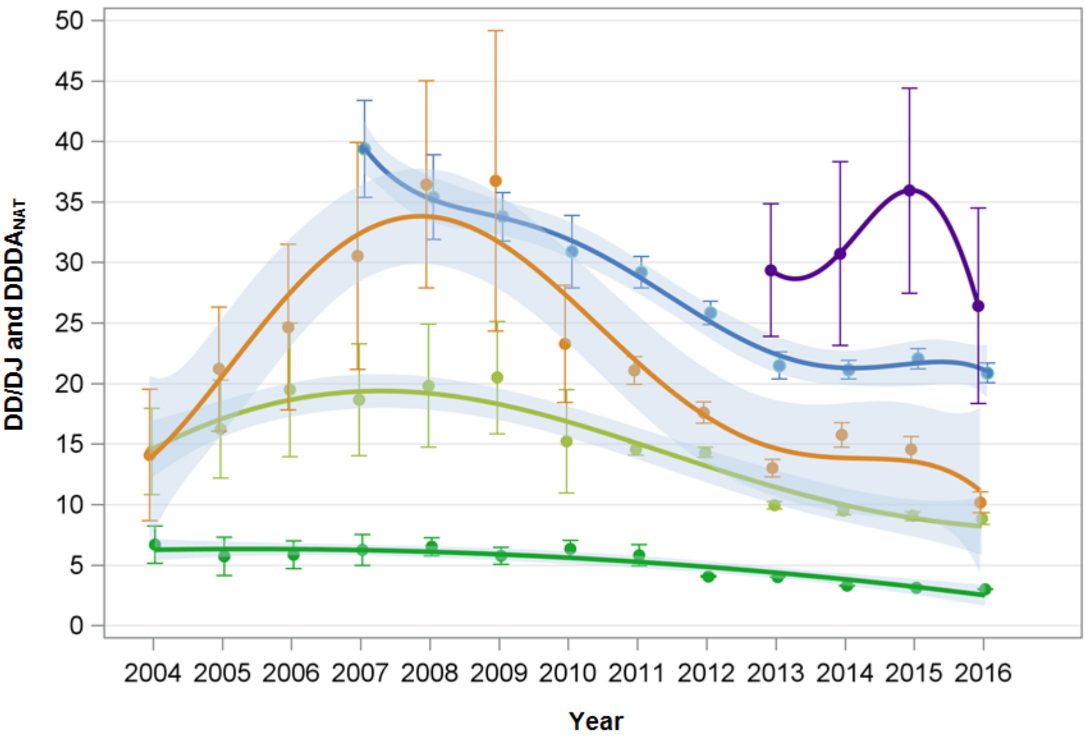


Table 5. Reductions in the amount of antibiotics used in agricultural livestock by year compared to 2009

	$DDDA_{NAT}$	Reduction from the 2009 level, in %						
Livestock sector	2009	2010	2011	2012	2013	2014	2015	2016
Broiler farming sector	36.76	37	43	52	65	57	60	72
Pig farming sector	20.51	26	29	30	51	54	56	57
Dairy cattle farming sector	5.78	-10	-1	30	30	43	46	48
Veal farming sector	33.80	9	14	24	36	37	35	38

For the entire observation period, veal and dairy cattle farming sector data have been adjusted for the dosage-related changes implemented in the "Diergeneesmiddelenstandaard" database in 2014. Turkey farming sector data have not been included in this table, as there was no 2009 usage level to which the more recent usage levels could be compared.

Between 2009 and 2016, the broiler and pig farming sectors achieved $DDDA_{NAT}$ reductions of 72% and 57%, respectively. This makes the broiler farming sector the first livestock sector to achieve a usage level reduction in excess of 70%. The dairy cattle farming sector's $DDDA_{NAT}$ reduction amounted to 48%. As a result of its impressive usage level reduction achieved in 2016, the turkey farming sector's 2016 usage level is lower than the levels recorded for 2013 and 2014. Its main focus should now be to continue this downward trend.

Distribution of the kilograms of antibiotics used over the various livestock sectors and overall antibiotic use in 2016 (mass balance)

Using all delivery data recorded by the livestock sectors, the total number of kilograms of active substances used within each livestock sector was calculated. Just like $DDDA_{NAT}$ values, the number of kilograms of veterinary medicinal products 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. The resulting figures for each livestock sector are shown in Table 6.

Sales figures were provided by FIDIN (BCT data as of April 12, 2017). They represent the number of kilograms of active substances sold. They are also reported by category of antibiotics (i.e. first-, second- or third-choice antibiotics) with further classification based on the main pharmacotherapeutic groups. Table 7 shows the number of kilograms of active substances sold.

Table 7 also includes all available data for unmonitored animal sectors. The amounts of antimicrobial agents used in unmonitored animal sectors have been estimated with varying levels of accuracy. The estimates included for some of these sectors are extrapolated survey data.

Unmonitored poultry farming subsectors: For the year 2016, the SDa obtained data on the use of antibiotics at rearing and production farms in the broiler supply chain, and data on the use of antibiotics at layer farms and farms earlier in the layer supply chain. This resulted in detailed information on the amounts of antibiotics used in the broiler and layer supply chains in 2016. The data were not categorized by subsector, as the recording format used by the SDa did not require such specification. Some types of poultry farms are exempt from having their antibiotic usage data recorded in the central registry used by the Dutch poultry farming sector (the "Centrale Registratie Antibiotica" or CRA), including duck, guinea fowl, ostrich and quail farms. As a result, these smaller poultry farming subsectors have not been included in the category "unmonitored poultry farming subsectors".
Mink farming sector: Using processing data from feed kitchens and veterinarians' individual prescriptions, the mink farming sector assessed the amounts of antibiotics used in 2013, 2014 and 2015.
Sheep and goat farming sectors: In 2011 and 2012, GD Animal Health surveyed veterinary practices in the Netherlands in order to assess the amounts of antibiotics used in sheep and goats. The SDa expert panel extrapolated these data to estimate the amounts used in the sheep and goat farming sectors as a whole.
Zoos: Seven zoo veterinarians granted access to their 2016 antibiotic procurement records. This enabled the SDa expert panel to estimate the amounts of antibiotics used in Dutch zoos.
Companion animal and horse sectors: Sales data enable identification of products that are only authorized for use in companion animals or horses. The amounts of antibiotics sold for use in companion animals or horses could be derived from these data and have been included in Table 7. Recently, the SDa surveyed Dutch veterinary practices providing veterinary care for horses and companion animals. It used the survey data to estimate the amounts of antibiotics with a multi-species indication that had been administered to horses and companion animals. For 2014, this

figure was estimated at approximately 2,500 kg (with use in horses accounting for 1,600 kg and use in companion animals accounting for 900 kg).
Approximately 10,000 kg of antimicrobial substances authorized for use in food-producing animals could be attributed to the unmonitored livestock sectors, in addition to approximately 4,500 kg of antibiotics only authorized for use in companion animals or horses. Of the approximately 10,000 kg of antimicrobial substances attributed to unmonitored livestock sectors, first- and third-choice antimicrobial agents turned out to account for over 80% and less than 1.5%, respectively, with second-choice antibiotics accounting for the rest.

In 2016, objectively measured use of antimicrobial agents (i.e. use in monitored livestock sectors, unmonitored poultry farming subsectors, and the companion animal and horse sectors) exceeded overall sales of these agents. In 2015, however, approximately 20,000 kg could not be accounted for. Stockpiling at wholesalers or veterinary practices may have contributed to this 2015 discrepancy. This explanation currently seems more plausible than it did last year, particularly considering the fact that in 2016 the number of kilograms used exceeded the number of kilograms sold.

However, direct comparisons of products sold and products used based on their EAN (European Article Number, a unique identifier for veterinary medicinal products and pack sizes) suggested that a proportion of the products used concerned packages that had been assigned new EAN barcodes several years ago. Veterinary practices in the Netherlands may have to be reminded to update the definition of veterinary medicinal products in their practice management systems as soon as a new EAN barcode is assigned, even if the RegNL registration code, substance, strength and pack size of the product concerned stay the same. This is necessary to ensure that supplied veterinary medicinal products are registered using the correct EANs.

Table 6. Distribution of antibiotic use in kg over the monitored livestock sectors, by pharmacotherapeutic group

Pharmacotherapeutic group	Broiler farming sector	Turkey farming sector	Pig farming sector	Dairy cattle farming sector	Veal farming sector	Non-dairy cattle farming sector	Rabbit farming sector	All livestock sectors combined
1st-choice antibiotics	**3,846**	**1,649**	**60,823**	**10,887**	**51,948**	**9,263**	**310**	**138,725**
As a proportion of overall AB use	**39.82%**	**66.92%**	**82.81%**	**86.12%**	**84.32%**	**85.96%**	**69.38%**	**81.10%**
Amphenicols	0	0	1,214	618	2,624	680	0	5,136
Macrolides/lincosamides	584	458	6,787	431	13,541	2,227	10	24,038
Other	0	0	0	0	0	0	88	88
Penicillins	562	283	5,082	3,367	558	359	0	10,211
Pleuromutilins	0	0	498	0	0	0	21	519
Tetracyclines	957	783	31,560	2,101	26,489	4,407	138	66,435
Trimethoprim/sulfonamides	1,743	125	15,683	4,369	8,735	1,589	54	32,298
2nd-choice antibiotics	**5,778**	**742**	**12,630**	**1,739**	**9,641**	**1,512**	**133**	**32,175**
As a proportion of overall AB use	**59.83%**	**30.11%**	**17.19%**	**13.76%**	**15.65%**	**14.03%**	**29.82%**	**18.81%**
Aminoglycosides	18	32	14	210	290	87	133	784
1st- and 2nd-gen. cephalosporins	0	0	0	28	0	0	0	29
Quinolones	729	1	211	2	1,966	351	0	3,258
Fixed-dose combinations	125	0	656	757	13	225	0	1,775
Macrolides/lincosamides	0	0	57	5	12	4	0	78
Penicillins	4,900	699	10,821	719	7,310	834	0	25,284
Polymyxins	7	10	872	19	50	10	0	968
3rd-choice antibiotics	**34**	**73**	**0**	**15**	**19**	**1**	**4**	**146**
As a proportion of overall AB use	**0.36%**	**2.97%**	**0.00%**	**0.12%**	**0.03%**	**0.01%**	**0.81%**	**0.09%**
3rd- and 4th-gen. cephalosporins	0	0	0	0	0	0	0	0
Fluoroquinolones	34	73	0	15	19	1	4	146
Overall antibiotic use	**9,658**	**2,464**	**73,453**	**12,641**	**61,608**	**10,776**	**447**	**171,047**

Table 7. Antibiotic use in monitored livestock sectors (combined), antibiotic use in unmonitored animal sectors and sales figures (gray: survey data)

	Monitored livestock sectors	Unmonitored animal sectors					Sales	
Year	Combined 2016	Unmonitored poultry farming subsectors 2016	Mink farming sector 2015	Sheep farming sector 2012	Goat farming sector 2012	Zoos 2016	Companion animal and horse sectors +survey data on products authorized for use in >1 species 2014	FIDIN data 2016
1st-choice antibiotics	**138,725**	**2,653**	3,042	142	484	**4**	**2,836**	**142,055**
As a proportion of overall AB use	**81.10%**	**83.57%**	88.60%	73.67%	63.10%	**48.56%**	**64.74%**	**80.80%**
Amphenicols	5,136	0	0	5	17	0	22	4,904
Fixed-dose combinations	0	0		0			434	434
Macrolides/lincosamides	24,038	818	19	2	0	0	104	22,995
Other	88	0					440	477
Penicillins	10,211	668	3	14	17	0	26	11,464
Pleuromutilins	519	5					0	636
Tetracyclines	66,435	703	2,047	94	265	1	645	62,122
Trimethoprim/sulfonamides	32,298	459	971	27	185	3	1,166	39,023
2nd-choice antibiotics	**32,175**	**418**	390	50	282	**4**	**1,533**	**33,427**
As a proportion of overall AB use	**18.81%**	**13.17%**	11.37%	25.77%	36.72%	**47.93%**	**34.99%**	**19.01%**
Aminoglycosides	784	4		0	55		29	1,033
1st- and 2nd-gen. cephalosporins	29	0		1	5	0	534	567
Quinolones	3,258	87		0	26	0	0	3,065
Fixed-dose combinations	1,775	1				4	1	2,342
Macrolides/lincosamides	78	0	0	1	2		0	88
Penicillins	25,284	272	390	47	195		967	25,260
Polymyxins	968	56					1	1,072
3rd-choice antibiotics	**146**	**103**	1	1	1	**0**	**12**	**331**
As a proportion of overall AB use	**0%**	**3.25%**	0.03%	0.56%	0.19%	**3.51%**	**0.28%**	**0.19%**
3rd- and 4th-gen. cephalosporins	0	0		0	1	0	1	1.68
Fluoroquinolones	146	103	1	1	1	0	11	329
Overall	**171,047**	**3,174**	3,433	193	767	**8**	**4,381**+2,500	**175,813**

Sector-level monitoring using the EMA method

Earlier this year, EMA published its *Draft Guidance on provision of data on antimicrobial use by animal species from national data collection systems*. The report sets out EMA's plans to start sector-level monitoring and reporting of antimicrobial use data. Antimicrobial use data would be reported in addition to sales data for European Union member states and several other countries in the European Economic Area (EMA, 2017). The EMA Draft Guidance assumes that countries will participate in this sector-level monitoring program on a voluntary basis. It identifies two potential monitoring models: monitoring based on data from a random selection of farms (sample survey model, similar to how MARAN used to collect data for LEI Wageningen UR's reports) and monitoring covering a whole animal production sector (census model). Data collected by means of the sample survey or census model would be expressed in defined daily doses for animals, by the parameter DDD_{VET}. This parameter is very similar to the DDDA parameter used in the Dutch "*Diergeneesmiddelenstandaard*" and by the SDa. The main difference between the DDD_{VET} and DDDA parameters is that the former is determined based on the active substance concerned, while the latter is determined for each veterinary medicinal product individually, based on the product information. The active substances and their DDD_{VET} values are listed on the EMA website.

The parameters used are not the only difference between the calculation method proposed by EMA and the one currently used by the SDa. In fact, the main difference concerns how the number of kilograms of animal are calculated. EMA proposes to calculate the number of kilograms of animal using publicly available statistics on the number of live and slaughtered animals. The SDa expert panel decided to perform an exploratory comparison of EMA's PCU method and the SDa method, using the 2016 data. A description of this exploratory comparison is included in the appendices. Initial results suggest that using EMA's PCU method rather than the SDa method would result in usage levels that are not as strongly correlated with the presence of resistant pathogens in the livestock sector concerned. The SDa expert panel will to examine the results in greater detail and will comment on its findings later this year.

Trend analysis based on national sales figures

Sales data

Of the overall amount of antibiotics sold in 2016 (BCT figures as of April 12, 2017), 97.3% could be traced back to antibiotic use in SDa-monitored livestock sectors (versus 88.7% in 2015). Sales of antibiotics in terms of kilograms of active substances dropped by 14.5% compared with the 2015 level, resulting in a 64.4% decline over the 2009-2016 period.

Developments in usage of antibiotics

The proportion of first-choice antibiotics continued to grow, from 80.2% of the overall number of kilograms sold in 2015 to 80.8% in 2016. Sales of most pharmacotherapeutic groups declined in line with overall sales, i.e. with about 15%. There were, however, several exceptions. Sales of third- and fourth-generation cephalosporins and tetracyclines recorded much steeper declines. On the other hand, sales of amphenicols, first- and second-generation cephalosporins, macrolides (both first- and second-choice antibiotics) and antibiotics classified as "other" went up slightly.

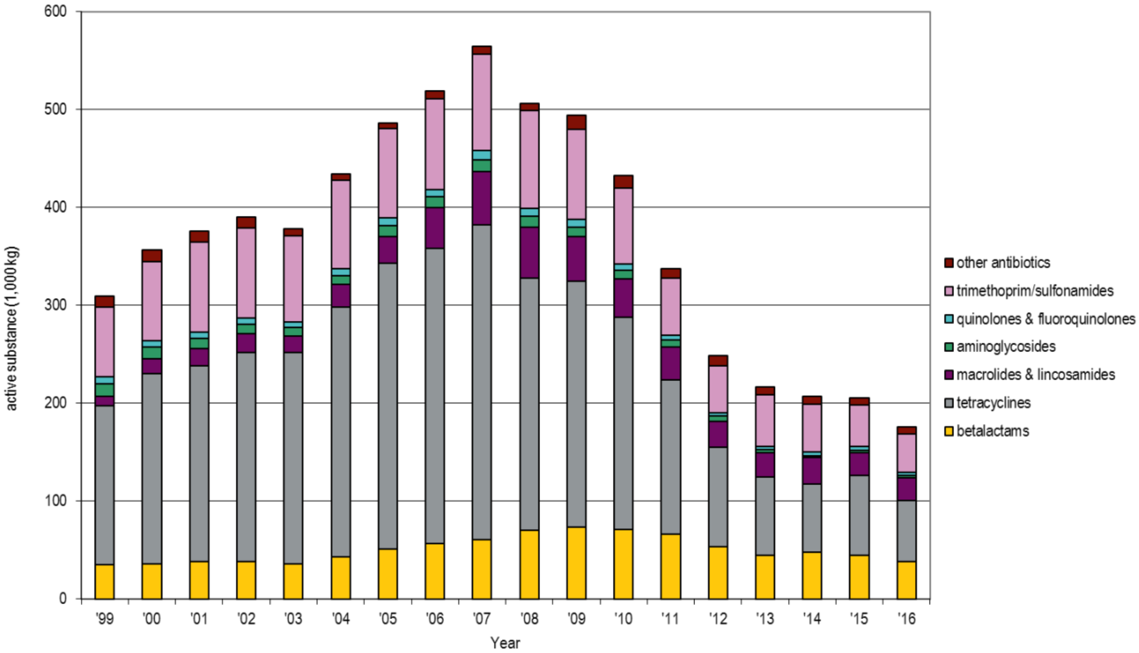
Third-choice antibiotics
Use of third- and fourth-generation cephalosporins declined over the 2015-2016 period, with 85% and 15%, respectively. Considering that third- and fourth-generation cephalosporins contributed 1.68 kg to the overall number of kilograms of antibiotics sold, the relative contribution of third-choice antibiotics remained unchanged, at 0.19%. Sales of cephalosporin substances in particular saw a drastic decline in 2016. This was supported by the fact that in 2016, two of the four cephalosporin substances could no longer readily, if at all, be obtained through regular channels. Two of the active substances can now only be used when they are imported from other EU countries. Although imported products should be included in recorded usage data, they are not included in sales figures. As a result, imports intended for use in unmonitored animal sectors will not be recorded at all. All fluoroquinolones recorded a decline in the number of kilograms sold. The 2016 data indicate a decline in topical application of fluoroquinolones in the form of ear ointments for companion animals.

Second-choice antibiotics
Use of first- and second-generation cephalosporins (primarily in companion animals) and second-choice macrolides increased in 2016. Increased use in companion animals will in part have been due to skin conditions being treated with these products rather than amoxicillin, in line with the formulary. Use of second-choice macrolides was still very limited, even though it increased from 50 kg in 2015 to 88 kg in 2016. Their use does, however, require attention, since their long half-lives mean treatment may consist of just a single injection. Compliance may therefore be an important consideration in the context of macrolide use. As yet, there is no consensus regarding the effects with regard to selection for resistant pathogens, but the risk of selection may be higher than is the case with intermittent administration of antibiotics.

First-choice antibiotics
In 2016, doxycycline accounted for 50.4% of the number of kilograms of tetracyclines, compared with 41.7% in 2015. Use of first-choice antibiotics declined by 24% over the 2015-2016 period and by far exceeded the 14.5% decline recorded for the overall number of kilograms of antibiotics sold. The distinct reduction recorded for tetracycline appears to have been a correction for the substantial rise reported for 2015.

The SDa expert panel considers the FIDIN procedure for obtaining sales data from members and non-members quite laborious. Sales data are collected by accessing the BCT database. All manufacturers affiliated with FIDIN and VetIndex are required to supply sales data at specified intervals. The data collection process is audited on an annual basis. Not all manufacturers are FIDIN members, however, and non-members supply antimicrobial sales data on a voluntary basis. The expert panel feels this sales data recording method might be too vulnerable as it is too dependent on the procedures in place at the manufacturers concerned. Once again, the figures had to be reevaluated and it turned out several corrections had been performed following initial data submission.

Figure 2. Developments in sales of antimicrobial agents between 1999 and 2016, 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 (see Table 8). Usage level distributions based on all livestock farms in a particular livestock sector can be found in the appendices. The distributions for many livestock sectors have clearly changed shape throughout the years. Although the proportion of livestock farms with low usage levels has increased over the years, long-tailed distributions indicate that a small number of farms still recorded high usage levels for 2016. Changes in the veal farming sector's usage level distributions, however, are generally less pronounced over the years.

Table 8. Annual defined daily doses animal ($DDDA_F$) for the poultry, pig, veal, cattle and rabbit farming sectors and the associated production categories and types of farms in 2016. Provided parameters are the mean, median (Med.), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	Production category/type of farm	n*	Mean	Med.	P75	P90
Poultry farming sector	Broiler farms	849	7.9	2.8	12.4	22.4
	Turkey farms	47	18.1	13.6	19.7	48.7
Pig farming sector	Sows/suckling piglets	1,919	3.5	2.3	4.7	8.1
	Weaner pigs	2,088	24.2	11.9	29.1	57.2
	Fattening pigs	4,701	4	1.7	5.7	10.1
Veal farming sector	White veal farms	857	23.7	23	29	35.6
	Rosé veal starter farms	240	83.9	83.2	100	111.6
	Rosé veal fattening farms	602	2.8	0.9	3.9	8.1
	Rosé veal combination farms	229	11.1	11.3	16.6	20.6
Cattle farming sector	Dairy cattle farms	17,529	2.1	2.1	2.9	3.7
	Rearing farms	435	0.8	0	0.1	1.3
	Suckler cow farms	9,067	0.6	0.1	0.7	1.9
	Beef farms	3,046	1.6	0	0.4	2.9
Rabbit farming sector		41	40.9	31.8	60.3	84.4

** In the case of the pig farming sector, n represents the number of farms with the indicated production category*

In 2016, the **broiler farming sector** substantially reduced 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 very positive development. However, there is still a relatively large amount of variation between individual broiler farms, as indicated by their usage level distribution (see appendices). A substantial number of broiler farms recorded zero-level use. The distribution for the broiler farming sector is relatively wide, with several peaks and a long tail. This should be addressed in the years to come, since the SDa expert panel would like to see a narrower distribution that is unimodal rather than multimodal in nature. As mentioned before, the transition of farms to slower growing breeds may have contributed to the heterogeneity observed in this livestock sector. The coming year should provide more insight into this matter, considering the results of the critical success factor studies are due later in 2017.

Antibiotic use in the **turkey farming sector** declined in 2016, although mean usage levels were still relatively high. There was a large amount of variation between individual turkey farms, in part due to the various types of farms within this livestock sector (rearing farms, fattening farms) and big differences in husbandry methods. The tail of the distribution, which represents turkey farms with high usage levels, is long and indicates that exceptionally high $DDDA_F$ values exceeding 50 $DDDA_F$ were a regular occurrence. The SDa expert panel already noted in 2014 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. This prompted the turkey farming sector to draw up its action plan "*Plan van aanpak antibioticagebruik kalkoensector 2016 – 2020*", which is currently being implemented. The decline in the amounts of antibiotics used achieved in 2016 could very well be the first sign of its successful implementation. The expert panel hopes the turkey farming sector can continue this favorable development in the years to come. The sector should strive for a larger proportion of turkey farms recording target zone usage levels and fewer farms recording exceptionally high usage levels.

As of 2016, benchmarking in the **pig farming sector** is performed based on the following three production categories: 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. Action zone usage levels occur far less frequently. Each production category includes a substantial number of pig farms with zero-level use.

Usage levels differed between specialized pig farms (farms with a single production category - i.e. either sows/suckling piglets, weaner pigs or fattening pigs - accounting for >90% of its pig population) and pig farms with several production categories. This is most obvious when comparing the median $DDDA_F$ values for the various production categories. Antibiotic use (mean and median values) in weaner pigs at specialized pig farms is higher and associated with a wider distribution (higher P90 value) characterized by a long tail. In the case of fattening pigs and sows/suckling piglets, differences between specialized and non-specialized farms are not as pronounced. The distinct difference observed for antibiotic use in weaner pigs was unexpected. A potential explanation might be that antibiotics administered to weaner pigs at non-specialized farms are in fact attributed to another production category in veterinarians' delivery records. Consequently, the expert panel urges the pig farming sector to reiterate the importance of checking whether the correct production category is specified each time antibiotics are recorded in the delivery records. Registration improvements are desirable to correctly derive new benchmark thresholds.

Table 9. Annual defined daily doses animal ($DDDA_F$) for specialized and non-specialized pig farms. Provided parameters are the mean, median (Med.) and 90th percentile (P90)

	Production category	n	Mean	Med.	P90
Specialized pig farms	Sows/suckling piglets	100	3.19	1.37	6.97
	Weaner pigs	139	29.66	17.28	65.09
	Fattening pigs	3,136	4.41	2.46	10.92
Non-specialized pig farms	Sows/suckling piglets	1,820	3.55	2.31	8.11
	Weaner pigs	1,954	23.79	11.35	57.00
	Fattening pigs	1,566	3.02	0.34	8.22

Compared with 2015, the **veal farming sector** saw a rise in the amounts of antibiotics used at 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 2015, but since this is not reflected in each of the distribution parameters, the impact of this development seems to be limited. Zero-level use is very rare amongst white veal farms and rosé veal starter farms, and did not increase in 2016. The distributions for veal farms are still relatively wide, with big $DDDA_F$ differences between high and low users. Furthermore, the distributions show that high $DDDA_F$ values were a very regular occurrence. Rosé veal fattening farms are the only veal farms with a narrow distribution and a substantial number of zero-level users. Nevertheless, the distribution for these veal farms still has an excessively long tail and shows that several rosé veal fattening farms still recorded excessively high usage levels for 2016. Although the distribution for rosé veal combination farms is narrower than the one for rosé veal starter farms, it is still relatively wide. Approximately 10% of rosé veal combination farms were zero-level users in 2016.

The expert panel once again wants to commend the cattle farming sector for continuing to reduce its antibiotic use despite it already being characterized by low usage levels and limited usage level variation between farms. In the **dairy cattle farming sector**, mean and median antibiotic use continued to decline in 2016. Although the amounts of antibiotics used in the **non-dairy cattle farming sector** went up the expert panel is not yet concerned by this. It considers these changes to be the result of natural fluctuations in antibiotic use.

In 2016, the SDa started monitoring the amounts of antibiotics used in the **rabbit farming sector**. LEI Wageningen UR had already surveyed a random selection of 37 rabbit farms in 2012. According to 2012 CBS data, the surveyed rabbit farms accounted for 88% of all breeding does. In 2012, the mean number of defined daily doses animal recorded was 133. Use of antibiotics in rabbits dropped by 69% over the 2012-2016 period, but is still relatively high. The maximum number of defined daily doses animal used at individual rabbit farms decreased from 333 to 140 (LEI Wageningen UR, 2014), although between-farm differences were still substantial in 2016. Even though the SDa expert panel is pleased that the rabbit farming sector realized such a steep decline in the amount of antibiotics used, it would like to see a narrower distribution with fewer outliers.

The benchmark thresholds for the various livestock farming sectors are listed in Table 10. No benchmark thresholds have yet been defined for the rabbit farming sector.

Table 10. Signaling and action thresholds for the various livestock sectors and the associated production categories and types of farms for 2016, based on DDDA$_F$ values

Livestock sector	Production category/type of farm	Signaling threshold	Action threshold
Poultry farming sector	Broiler farms	15	30
	Turkey farms*	19	31
Pig farming sector	Sows/suckling piglets	10	20
	Weaner pigs	22	60
	Fattening pigs	10	12
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
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 is based on the P80 value. The signaling thresholds for all other types of farms/production categories except fattening pigs refer to the P50 value minus 20%.*

Table 11 shows how livestock farms were distributed over the various benchmark zones. The livestock sectors have agreed with the SDa to not only address livestock farmers with action zone usage levels, but livestock farmers with structurally high usage levels who are included in the signaling zone as well. It is the livestock sectors' responsibility to implement the more stringent requirements.

The veal farming sector in particular has a high proportion of farms with signaling or action zone usage levels, ranging from 45% of rosé veal combination farms to 75% of rosé veal starter farms. It should be noted, however, that the signaling threshold was originally derived from the median DDDA$_F$ value (the median value minus 20%). The fact that there are still many livestock farms with signaling zone usage levels shows that the veal farming sector's usage level improvements have been limited. Apparently, more targeted measures are needed to reduce the amounts of antibiotics used in this livestock sector.

All other livestock sectors clearly succeeded in reducing their overall antibiotic use in 2016, indicated by a higher number of zero-level users and a larger proportion of livestock farms in the target zone. This development was associated with fewer farms recording signaling or action zone usage levels. Nevertheless, a number of farms appear to have underperformed in comparison to the other farms within their livestock sector. Practically all livestock sectors have long-tailed distributions, indicating there are still several livestock farms with action zone usage levels.

Table 11. Distribution of livestock farms over the various benchmark zones in 2016

Livestock sector	Production category/ type of farm	Target zone n (%)	Signaling zone n (%)	Action zone n (%)
Poultry farming sector	Broiler farms	690 (81%)	121 (14%)	38 (5%)
	Turkey farms	33 (70%)	6 (13%)	8 (17%)
Pig farming sector	Sows/suckling piglets	1,803 (94%)	100 (5%)	16 (1%)
	Weaner pigs	1,388 (67%)	506 (24%)	194 (9%)
	Fattening pigs	4,216 (90%)	157 (3%)	328 (7%)
Veal farming sector	White veal farms	429 (50%)	380 (44%)	48 (6%)
	Rosé veal starter farms	60 (25%)	151 (63%)	29 (12%)
	Rosé veal fattening farms	311 (52%)	195 (32%)	96 (16%)
	Rosé veal combination farms	125 (55%)	88 (38%)	16 (7%)
Cattle farming sector	Dairy cattle farms	16,434 (94%)	1,015 (6%)	80 (0%)
	Rearing farms	385 (89%)	19 (4%)	31 (7%)
	Suckler cow farms	7,314 (81%)	916 (10%)	837 (9%)
	Beef farms	2,548 (84%)	132 (4%)	366 (12%)

Table 12. Shifts in the proportion of livestock farms in the various benchmark zones between 2012 and 2016

Livestock sector	Production category/ type of farm	Target zone %					Signaling zone %					Action zone %				
	Year 20..	12	13	14	15	16	12	13	14	15	16	12	13	14	15	16
Poultry farming sector	Broiler farms	52	68	66	70	81	31	25	21	20	14	17	6	13	10	5
	Turkey farms	-	50	51	50	70	-	25	22	20	13	-	25	27	30	17
Pig farming sector	Sows/suckling piglets	56	66	72	85	94	24	24	19	11	5	20	11	8	4	1
	Weaner pigs	-	-	-	73	67	-	-	-	20	24	-	-	-	8	9
	Fattening pigs	77	83	86	90	90	16	6	6	3	3	7	11	8	7	7
Veal farming sector	White veal farms	33	49	48	46	50	50	41	44	46	44	17	10	8	9	6
	Rosé veal starter farms	36	39	33	21	25	48	48	56	63	63	16	13	11	16	12
	Rosé veal fattening farms	38	46	48	50	52	33	33	34	36	32	29	21	19	14	16
	Rosé veal combination farms	-	60	50	54	55	-	30	40	37	38	-	10	10	9	7
Cattle farming sector	Dairy cattle farms	56	55	91	93	94	40	42	8	6	6	4	3	1	1	0
	Rearing farms	81	83	84	85	89	3	6	6	6	4	16	11	9	9	7
	Suckler cow farms	82	80	84	80	81	8	6	6	10	10	10	14	9	10	9
	Beef farms	-	79	79	82	84	-	10	10	5	4	-	11	10	12	12

The distribution of livestock farms over the various benchmark zones (Table 11 and Table 12) corresponds quite well to the general trends indicated in the previous tables and figures, and the overall picture is similar to the situation in 2015. The only exceptions are the broiler and turkey farming sectors, in which the substantially lower usage levels recorded for 2016 have affected the poultry farms' distribution over the three benchmark zones. With regard to the other livestock sectors no major shifts occurred in 2016.

Of the livestock farms with 2014, 2015 and 2016 data available 1.8% stayed within the action zone throughout the 2014-2016 period (Table 13). The SDa expert panel is pleased to see such a small proportion of livestock farms with structurally high usage levels (action zone usage levels for at least three years in a row). The turkey farming sector is an exception in this respect, with approximately 17% of farms having recorded action zone usage levels for three consecutive years. It should be noted, however, that this percentage comprises just six turkey farms.

Throughout the 2014-2016 period 5.9% of livestock farms never left the signaling and action zones. With 27.8% and 27.6%, respectively, this proportion was substantially higher for turkey and veal farms. The proportion of farms remaining in the signaling and action zones for three consecutive years was particularly high for rosé veal starter farms (75%). It was also considerable for white veal farms (50%), and only marginally lower for rosé veal fattening farms and rosé veal combination farms (48% and 45%, respectively). These findings underline the importance of addressing long-term high users in addition to other livestock farms included in the signaling and action zones in order to further reduce antibiotic usage. Development of antibiotic resistance and associated spread of resistant bacteria are more likely to occur at farms structurally recording action or signaling zone usage levels. This is one of the reasons why the expert panel feels reduction efforts should focus more strongly on these livestock farms. In its report on associations between antibiotic use and antibiotic resistance, the SDa already warned that higher usage levels are associated with increased prevalence of resistant micro-organisms (SDa, 2016a).

Table 13. The proportion of livestock farms that stayed in the same benchmark zone throughout the 2014-2016 period, and the proportion of livestock farms that never left the signaling and action zones throughout the 2014-2016 period

Livestock sector	Production category/ type of farm	Number of livestock farms with available data for the 2014-2016 period	Livestock farms that stayed in the same benchmark zone(s) (%)			
			Target zone	Signaling zone	Action zone	Signaling zone/ action zone
Poultry farming sector	Broiler farms	756	52.6%	2.5%	1.9%	10.1%
	Turkey farms	36	41.7%	2.8%	16.7%	27.8%
Pig farming sector*	Sows/suckling piglets	1,840	64.1%	1.0%	0.1%	2.4%
	Fattening pigs	3,989	73.1%	0.1%	1.6%	2.9%
Veal farming sector	White veal farms	805	16.4%	12.0%	0.5%	21.2%
	Rosé veal starter farms	198	5.1%	32.3%	1.5%	54.5%
	Rosé veal fattening farms	522	23.8%	10.2%	2.1%	26.4%
	Rosé veal combination farms	143	32.9%	22.4%	0.0%	30.8%
Cattle farming sector	Dairy cattle farms	17,173	85.2%	1.1%	0.1%	1.8%
	Rearing farms	114	63.2%	0.0%	5.3%	9.6%
	Suckler cow farms	7,182	65.7%	1.4%	4.1%	11.2%
	Beef farms	2,517	71.6%	0.5%	8.3%	10.6%

* *Changes regarding the categorization of pigs and prescription of antibiotics have affected the accuracy of year-to-year comparisons.*

Benchmarking of veterinarians

The benchmarking method for veterinarians was introduced in March of 2014. All veterinarians can retrieve their VBI by accessing the quality management systems.

Last year, the number of veterinarians with whom livestock farms had a registered one-to-one relationship remained virtually the same (1,280 in 2016 vs. 1,298 in 2015). Veterinarians' VBI are livestock sector specific, which means that veterinarians active in more than one livestock sector are included in the statistics for each livestock sector in which they are active. Consequently, the sum of the number of veterinarians included for the different livestock sectors will exceed the number of unique veterinarians.

In 2016, most veterinarians (76.0%) had antibiotic prescription patterns that met the target zone criteria. The number of veterinarians within the action zone continued to decline, from 1.8% in 2015 to 1.6% (20 veterinarians) in 2016. Veterinarians included in the action zone are required to take action immediately in order to improve their prescription patterns.

The $DDDA_{VET}$ parameter reflects the average prescription pattern of a single veterinarian. It is determined based on the usage data of all livestock farms that have a registered one-to-one relationship with the veterinarian concerned. The $DDDA_{VET}$ enables comparison of individual veterinarians by quantifying differences in their average prescription patterns. In 2016, the mean $DDDA_{VET}$ value for veterinarians active in the broiler farming sector was approximately 8 (DDDA), although 10% of veterinarians had a $DDDA_{VET}$ value that was more than twice as high (P90 = 20 DDDA). There was little variation in the $DDDA_{VET}$ values of veterinarians active in the dairy cattle farming sector. On average they prescribed 2.26 DDDA with only 10% of them recording a prescription pattern characterized by a $DDDA_{VET}$ value higher than 2.84. More pronounced differences and markedly higher defined daily doses animal were recorded for veterinarians active in the veal farming sector.

Table 14. Annual defined daily doses animal ($DDDA_{VET}$) for veterinarians active in the broiler, turkey, pig, dairy cattle, veal and non-dairy cattle farming sectors, for 2016. Provided parameters are the mean, 50th percentile (median), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	n	Mean	Median	P75	P90
Broiler farming sector	90	8.04	5.12	10.65	20.00
Turkey farming sector	9	13.37	8.59	19.39	38.79
Pig farming sector	268	5.65	4.94	6.97	10.58
Dairy cattle farming sector	739	2.26	2.21	2.51	2.84
Veal farming sector	141	13.36	10.48	22.96	28.45
Non-dairy cattle farming sector	682	1.11	0.73	1.21	1.89

These differences directly affect the VBI and how the veterinarians are distributed over the benchmark zones. In 2016, the proportion of veterinarians with a VBI>0.30 (action zone) varied slightly between the various livestock sectors, with proportions of 1.0%, 1.1%, 2.2%, 3.6% and 22.2% being recorded for the cattle, pig, broiler, veal and turkey farming sectors, respectively. Due to the small number of turkey farms in the Netherlands the number of veterinarians active in this livestock sector was limited as well.

Although the overall proportion of veterinarians with a VBI in the signaling zone declined (22.5% in 2016 vs. 26.8% in 2015), it still represented a substantial group of veterinarians. The proportion of veterinarians included in the signaling zone differed between the various livestock sectors, with proportions of 13.3%, 19.3%, 21.3%, 33.3% and 47.5% being recorded for the broiler, cattle, pig, turkey and veal farming sectors, respectively.

In all livestock sectors except the cattle farming sector prescription pattern differences between individual veterinarians were still substantial, but smaller than several years earlier. The number of veterinarians who had a high VBI, despite only having been responsible for livestock farms with target or signaling zone usage levels, increased. This was due to the benchmark thresholds for livestock farms in some of the livestock sectors (i.e. the broiler and pig farming sectors) not properly representing the current $DDDA_F$ distribution for the livestock sectors concerned. If livestock farms within these livestock sectors record relatively low usage levels, a veterinarian could still be assigned a high VBI if there is a large amount of variation between the farms for which he or she is responsible. This is the result of substantial improvements in the amounts of antibiotics used without the benchmark thresholds having been adjusted accordingly. This issue will be resolved when the benchmark thresholds for livestock farms are revised at the end of 2017.

The proportion of veterinarians in the signaling zone recorded for the cattle farming sector is particularly surprising, given the small number of cattle farms with high usage levels. In this case the VBI is not in line with the actual situation. This is illustrated by Table 14 which shows the average prescription patterns of veterinarians expressed in $DDDA_{VET}$. The mean, median and P75 $DDDA_{VET}$ values for veterinarians active in the cattle farming sector are quite close together as a result of limited variation in their prescription patterns and cattle farms' low usage levels. The benchmarking methods for cattle farms and veterinarians active in the cattle farming sector should be revised before the end of 2017.

The SDa expert panel would like to advise the quality assurance body for veterinarians (Stichting Geborgde Dierenarts, SGD) to consider taking these findings into account when performing file assessments.

Table 15. 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

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		
	Target zone	Signaling zone	Action zone	Target zone	Signaling zone	Action zone
	≤0.10	(0.10<VBI≤0.30)	(VBI>0.3)	-	-	-
Broiler farming sector	62	11	1	14	1	1
Turkey farming sector	1	3	2	3	0	0
Pig farming sector	197	56	2	11	1	1
Veal farming sector	49	62	3	20	5	2
Cattle farming sector (veal farming sector not included)*	583	149	5	32	0	3
- Dairy cattle farming sector	621	81	0	34	1	2
- Non-dairy cattle farming sector	467	188	19	47	2	5

** The number of veterinarians active in the cattle farming sector as a whole (not including the veal farming sector) has been used to calculate the total number of veterinarians. Itemized data on the dairy and non-dairy cattle farming subsectors have only been included for the purpose of illustration. Besides, since many veterinarians are active in both cattle farming subsectors and the antibiotic use distributions for the two subsectors are quite different, the numbers included for the cattle farming sector as a whole (not including the veal farming sector) are not simply a sum of the numbers included for the dairy and non-dairy cattle farming sectors.*

Table 16. VBI for veterinarians active in the broiler, turkey, pig, dairy cattle, veal and non-dairy cattle farming sectors, for 2016. Provided parameters are the mean, 50th percentile (median), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	n	Mean	Median	P75	P90
Broiler farming sector	90	0.04	0.01	0.06	0.13
Turkey farming sector	6	0.24	0.14	0.45	0.60
Pig farming sector	268	0.06	0.05	0.09	0.13
Dairy cattle farming sector	739	0.05	0.04	0.06	0.09
Veal farming sector	114	0.13	0.13	0.19	0.24
Non-dairy cattle farming sector	674	0.08	0.05	0.12	0.20

Revision of the $DDDA_F$ calculation method and subsequent benchmark threshold adjustment

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 SDa expert panel as well as the livestock sectors have identified several bottlenecks and limitations, and the SDa is continuously looking for ways to improve its benchmarking method. Several livestock sectors have suggested ways to improve the calculation method, in particular to make sure production cycles are properly taken into account and to limit the occurrence of distorted DDDA figures caused by variations in how individual farms' livestock populations are made up. When changes are made to the calculation method, the benchmark thresholds have to be adjusted as well. *In general, these benchmark threshold adjustments are implemented irrespective of the general benchmark threshold revisions taking place later this year.* The changes implemented for the various livestock sectors can be summarized as follows:

The SDa and the **poultry farming sector** have agreed to record antibiotic use at broiler and turkey farms in terms of defined daily doses animal rather than treatment days from January 2017 onwards. The SDa supports the incorporation of a limited number of growth curves. In light of this, the poultry farming sector has drawn up an SOP detailing how the $DDDA_F$ values should be calculated. This SOP has already been approved by the SDa and is currently being integrated in the databases of the broiler and turkey farming sectors. From its next report onwards (the report on 2017 data, to be published in 2018), the SDa will use growth curves in its calculations, and it will adjust the benchmark thresholds for broiler and turkey farms accordingly. Table 17 compares the current and new calculation methods for the broiler and turkey farming sectors using the 2016 data.

Table 17. A comparison of annual defined daily doses animal ($DDDA_F$) calculated using the method based on standardized body weight (1 kg for broilers, 10.5 kg for turkey toms and 5.6 kg for turkey hens) and annual defined daily doses animal calculated using the new method based on body weight at the time of treatment. Provided parameters are the mean, median (Med.), 75th percentile (P75) and 90th percentile (P90)

Calculation method	Livestock sector	Type of farm	n	Mean	Med.	P75	P90
Standardized body weight	Poultry farming sector	Broiler farms	849	7.9	2.8	12.4	22.4
		Turkey farms	47	18.1	13.6	19.7	48.7
Body weight at time of treatment	Poultry farming sector	Broiler farms	849	9.6	4.8	12.7	22.4
		Turkey farms	47	27.4	18.8	34.2	72.8

In the case of the **broiler farming sector**, the $DDDA_F$ values turn out to be higher when calculated using body weight at the time of treatment. As the change in calculation method only has limited consequences for the overall distribution of broiler farms over the various benchmark zones, it does not require benchmark threshold adjustment. The change in calculation method could have substantial consequences for individual broiler farms, however, as it may result in them being included in another benchmark zone. The broiler farming sector is aware of this and will inform broiler farmers of the potential consequences when notifying them of their $DDDA_F$ values.

The SDa expert panel wants to consult with the **turkey farming sector** shortly to make sure new benchmark thresholds can be defined before the end of 2017. The current benchmark thresholds were defined when monitoring had just begun, but have turned out not to be realistic.

In 2016, a new method was introduced for calculating usage levels and associated benchmark thresholds for the **pig farming sector**. This method makes a distinction between three production categories: sows and suckling piglets, weaner pigs, and fattening pigs. Generally speaking, the implementation of the new calculation method went well. As of January 1, 2017, the signaling and action thresholds for antibiotic use in weaner pigs are 20 $DDDA_F$ and 40 $DDDA_F$, respectively, as set out in last year's SDa report (SDa 2016b).

There were indications of some inaccuracies regarding production category specification in the delivery records. The expert panel wants the quality management bodies to reiterate that the correct production category has to be specified each time antibiotics are recorded in the delivery records. In 2017, the SDa will examine the calculation method more closely.
Detailed analysis by the expert panel of the two quality management systems has revealed subtle differences in the usage patterns recorded, which may have been caused by minor differences between the calculation methods. Later this year, the expert panel will examine this matter further. This will require a detailed description of the calculation method concerned. The expert panel expects the pig farming sector to specify its calculation method in an SOP before the end of 2017. This SOP should be submitted to the SDa for approval.

In the **veal farming sector** substantial usage level fluctuations are a recurring issue sincethe frequency with which veal farmers start a new production cycle with a new herd of calves may vary from once to twice a year. The SDa and the veal farming sector have now agreed that as of January 2017 veal farms' usage levels will be calculated over 1.5-year periods. The results of these calculations will be used to determine an annual average for the amount of antibiotics used.
The SDa will also examine possibilities to incorporate growth curves for veal calves in the calculation method applied to individual veal farms. The veal farming sector will set out the calculation method in a SOP, which will be submitted to the SDa for approval. The expert panel aims to conclude the calculation method discussions before the benchmark threshold revision scheduled for the end of 2017.

The SDa and the **cattle farming sector** have agreed to implement a revised benchmarking method as of 2017. Due to its low usage levels, the cattle farming sector is not included in the critical success factor studies. The expert panel deems a benchmarking method only comprising a signaling threshold to be sufficient for the cattle farming sector, considering this sector's narrow distributions and the small number of cattle farms with structurally high usage levels. Based on these considerations, the following benchmark thresholds have been defined for the cattle farming sector:

Table 18. $DDDA_F$ benchmark thresholds for the cattle farming sector as of January 2017

Livestock sector	Type of farm	Signaling threshold	Action threshold
Cattle farming sector	Dairy cattle farms	6	Action is required if a cattle farm's usage level has exceeded the signaling threshold 2 years in a row.
	Rearing farms	2	
	Suckler cow farms	2	
	Beef farms	2	

From January 2017 onwards, the benchmarking method for **veterinarians** active in the cattle farming sector will be based on the signaling threshold. Later this year, the expert panel will determine whether the VBI cut-off values for this livestock sector need to be adjusted as well.
The cattle farming sector will specify the calculation method in an SOP, which will be submitted to the SDa for approval.

The SDa and the **rabbit farming sector** had talked about monitoring antibiotic usage data for several years, and this has resulted in the rabbit farming sector's inclusion in this year's SDa report. In the months to come, the SDa wants to consult with this livestock sector on benchmark thresholds, aiming to arrive at a set of initial pragmatic benchmark thresholds by the end of 2017.

The SDa expert panel has noticed discrepancies in how the parties involved 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 a minimal level of harmonization regarding the way in which farmers and veterinarians are notified of monitoring results in the years to come, but this should not affect the sector-specific nature of such notifications. Such harmonization efforts would preferably coincide with the introduction of new benchmark thresholds.

The new SDa benchmarking method

Keeping and producing livestock will always be accompanied by antibiotic use, however prudent veterinary antibiotic use is amongst others characterized by an accurate diagnosis and adequate, timely treatment of the affected animal. Unnecessary herd or flock treatment should be avoided. 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, 2016a). To enable quantification of prudent veterinary usage of antibiotics for each of the livestock sectors, the SDa is currently analyzing which factors contribute to high and low usage levels. These critical success factor analyses are necessary in order for livestock farmers to responsibly (i.e. without compromising animal welfare) continue reducing the amounts of antibiotics used.

Benchmark thresholds for livestock farms with usage levels indicating prudent veterinary usage of antibiotics
As noted in last year's report, several livestock sectors or subsectors have seen the emergence of usage patterns characterized by regular zero-level use, 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. For livestock sectors and subsectors characterized by such favorable usage patterns, the SDa expert panel could introduce benchmark thresholds that represent prudent usage of minimal amounts of antibiotics and would probably only require very sporadic further adjustments in the years to come. For the livestock farms in such livestock sectors or subsectors, the expert panel plans to only distinguish between target and signaling zone usage levels, which means it would only define signaling thresholds. If one of these livestock farms were to exceed its signaling threshold two years in a row, it should be required to take action, for instance by drawing up an additional farm-specific improvement plan aimed at bringing its antibiotic use in line with the desired usage level. This should be incorporated in the quality assurance system concerned.

Pragmatic benchmark thresholds
For all other livestock sectors and subsectors, it will take longer for their long-term benchmark thresholds to be implemented. This is due to their relatively wide and irregular distributions. Wide distributions with several irregularities (e.g. multiple peaks) indicate heterogeneity in terms of usage levels and a high degree of variation over time. The SDa expert panel cannot predict when favorable prescription patterns will be recorded and whether the livestock sectors and subsectors concerned will be sufficiently homogenous to enable implementation of long-term benchmark thresholds representing prudent veterinary usage of antibiotics.

With regard to these sectors and subsectors substantial efforts are expected and the level of aspiration is high. At the moment the expert panel can only define pragmatic benchmark thresholds for the livestock farms concerned, just like it has done in the previous years. In due time, when more homogenous usage patterns have emerged, these thresholds could be replaced by benchmark thresholds representing prudent veterinary usage of antibiotics. As long as pragmatic benchmark thresholds are being applied, the expert panel will continue distinguishing between the existing three benchmark zones (the target, signaling and action zones). By definition, pragmatic benchmark thresholds have to be revised after a number of years. The 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 have all livestock farm record target zone usage levels.

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 VBI. In its 2014 report, the SDa 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. This is one of the reasons for re-examining between-farm usage level variations and prescription pattern variations between individual veterinarians. On the other hand, the expert panel has noticed that occasionally individual veterinarians are assigned an incorrect high VBI. As the expert panel introduced new calculation methods for several livestock sectors last year, the benchmark thresholds for veterinarians should be adjusted accordingly. The expert panel has therefore decided to revise the benchmarking method used for veterinarians before the end of 2017. 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

Computational basis for Figure 1 – Long-term developments in antibiotic use

- Until 2010, defined daily doses animal were based on data reported by LEI Wageningen UR (DD/AY figures). From 2011 onwards, SDa-reported defined daily doses animal ($DDDA_F$ figures) 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, required for calculating the $DDDA_{NAT}$ figures, 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 A1. Numbers of agricultural livestock (x1,000) from 2004 to 2016 in the Netherlands, based on data provided by CBS (poultry and veal calves) and EUROSTAT (the other types of livestock)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
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	4,986
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	1,022
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	4,140
Other 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	1,733
Turkeys	1,238	1,245	1,140	1,232	1,044	1,060	1,036	990	827	841	794	863	762
Other 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	105,550
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	48,378
Veal calves	765	829	844	860	899	894	928	906	908	925	921	909	956
Other 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	3,353
With dairy cattle accounting for						1,562	1,518	1,504	1,541	1,597	1,610	1,717	1,794
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	1,040
Weaned meat rabbits	297	312	283	338	282	271	260	262	284	270	278	333	318
Breeding does	49	48	41	49	41	41	39	39	43	41	43	48	45

Table A2. Standardized average body weights used for determining the $DDDA_{NAT}$ figures, by livestock sector and production category

Livestock sector	Production category	Standardized body weight in kg*
Veal farming sector	Veal calves	172
Pig farming sector	Piglets (<20 kg)	10
	Sows	220
	Fattening pigs	70.2
	Other pigs	70
Broiler farming sector	Broilers	1
Turkey farming sector	Turkeys	6
Cattle farming sector	Dairy cattle	600
	Non-dairy cattle	500
Rabbit farming sector	Weaned meat rabbits	1.8
	Breeding does	8.4

* *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 A3. Standardized average body weights used by the SDa for determining the DDDA$_F$ figures, by livestock sector and production category

Livestock sector	Production category	Further specification	Age group	Standardized body weight in kg*
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	205
Pig farming sector	Sows/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	Until ready for slaughter	70
		Gilts	74 days - 7 months	70
Broiler farming sector	Conventional broilers		0-42 days	1
Turkey farming sector	Toms			10.5
	Hens			5.6
Cattle farming sector**	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
Rabbit farming sector	Breeding does/kits		>4 months and <4.5 weeks	8.4
	Weaned meat rabbits		4.5-12 weeks	1.8
	Replacement breeding does		12 weeks - 4 months	3.4

** Body weights (in kg) 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).*

*** 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).*

Table A4. 2015 colistin use in mg/PCU (with PCU in kg)

Livestock sector	Colistin use in kg	PCU	mg/PCU
Broiler farming sector	10.1	371,250,052	0.027
Turkey farming sector	12.1	191,098,915	0.063
Pig farming sector	1,243.7	1,527,209,130	0.814
Veal farming sector	137.5	203,768,600	0.675
Cattle farming sector	43	979,547,500	0.044

Table A5. Overall antibiotic and colistin use in the monitored livestock sectors from 2013 to 2016, in number of kilograms of active substances

	2013				2014				2015				2016			
Livestock sector	No. of farms	Overall antibiotic use	Colistin use	Colistin use as a proportion of overall AB use	No. of farms	Overall antibiotic use	Colistin use	Colistin use as a proportion of overall AB use	No. of farms	Overall antibiotic use	Colistin use	Colistin use as a proportion of overall AB use	No. of farms	Overall antibiotic use	Colistin use	Colistin use as a proportion of overall AB use
Broiler farming sector	770	15,294	13.6	0.1%	798	16,220	9.0	0.1%	816	13,886	10.1	0.1%	849	9,658	6.8	0.1%
Turkey farming sector	48	3,360	3.4	0.1%	41	3,092	1.3	0.0%	40	3,778	12.1	0.3%	47	2,464	10.3	0.4%
Pig farming sector	6,588	87,029	1,438.4	1.7%	6,072	82,380	1,124.9	1.4%	5,824	77,664	1,243.7	1.6%	5,462	73,453	871.7	1.2%
Rabbit farming sector													42	456	0.2	0.1%
Dairy cattle farming sector	18,005	13,091	75.3	0.6%	17,747	11,857	33.2	0.3%	17,737	12,484	24.3	0.2%	17,529	12,641	19.4	0.2%
Veal farming sector	2,125	65,181	275.4	0.4%	2,061	62,733	117.5	0.2%	1,978	63,616	137.5	0.2%	1,928	61,608	49.7	0.1%
Non-dairy cattle farming sector	13,645	14,673	33.9	0.2%	13,476	13,772	20.6	0.1%	12,971	11,098	18.8	0.2%	12,548	10,776	10.3	0.1%

Table A6. Mean antibiotic and colistin use from 2013 to 2016, in DDDA$_F$

Livestock sector		2013 AB use (all farms)	2013 Colistin use (all farms)	2013 Colistin use (farms that used colistin)	2014 AB use (all farms)	2014 Colistin use (all farms)	2014 Colistin use (farms that used colistin)	2015 AB use (all farms)	2015 Colistin use (all farms)	2015 Colistin use (farms that used colistin)	2016 AB use (all farms)	2016 Colistin use (all farms)	2016 Colistin use (farms that used colistin)
Broiler farming sector	n	770	770	11	798	798	10	816	816	13	849	849	10
	mean	11.78	0.05	3.30	13.31	0.05	4.15	12.2	0.06	3.97	7.91	0.05	3.89
	median	9.13	0.00	3.80	9.37	0	3.45	7.19	0	2.44	2.84	0.00	3.12
Turkey farming sector	n	48	48	10	41	41	6	40	40	10	47	47	4
	mean	21.90	0.15	0.72	22.37	0.04	0.3	25.89	0.45	1.78	18.10	0.31	3.68
	median	18.04	0.00	0.55	16.62	0	0.21	18.86	0	1.26	13.59	0.00	3.35
Pig farming sector	n	6,588	6,588	1,748	6,072	6,072	1,390	5,820	5,820	1,246	5,382	5,382	1,084
	mean	7.79	0.29	1.08	7.91	0.25	1.08	13.12	0.66	3.08	14.11	0.57	2.82
	median	4.03	0.00	0.24	4.11	0	0.28	4.41	0	0.67	4.74	0.00	0.58
Rabbit farming sector	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	41	41	2
	mean										40.94	0.05	1.01
	median										31.84	0.00	1.01
Dairy cattle farming sector	n	18,005	18,005	2,280	17,747	17,747	1,206	17,737	17,737	883	17,529	17,529	708
	mean	2.80	0.01	0.09	2.27	0	0.07	2.16	0	0.08	2.11	0.00	0.08
	median	2.79	0.00	0.04	2.19	0	0.03	2.08	0	0.04	2.06	0.00	0.05
Veal farming sector	n	2,125	2,125	461	2,002	2,002	414	1,978	1,978	422	1,928	1,928	251
	mean	30.35	0.40	1.83	23.44	0.18	0.85	23.43	0.18	0.85	23.18	0.07	0.54
	median	16.64	0.00	0.56	16.71	0	0.08	16.35	0	0.07	16.98	0.00	0.05
Non-dairy cattle farming sector	n	13,644	13,644	337	13,359	13,359	263	12,971	12,971	237	12,548	12,548	130
	mean	1.00	0.01	0.25	0.94	0	0.23	0.85	0.01	0.3	0.85	0.00	0.30
	median	0.00	0.00	0.04	0	0	0.04	0	0	0.07	0.00	0.00	0.06

Table A7. Overall amount of antibiotics and overall amount of colistin prescribed per veterinarian from 2013 to 2016, in DDDA$_{VET}$

Year	Livestock sector		Unweighted				Weighted based on the number of kilograms present at farms with which the veterinarians had a registered one-to-one relationship			
			Prescribed ABs	Prescribed colistin	Prescribed colistin as a proportion of all ABs prescribed	Prescribed colistin (veterinarians who prescribed colistin)	Prescribed ABs	Prescribed colistin	Prescribed colistin as a proportion of all ABs prescribed	Prescribed colistin (veterinarians who prescribed colistin)
2016	Broiler farming sector	n	90	90		7	90	90		7
		mean	8.04	0.02	0.2%	0.25	10.76	0.04	0.3%	0.21
		median	5.12	0.00	0.0%	0.29	9.99	0.00	0.0%	0.29
	Turkey farming sector	n	9	9		3	9	9		3
		mean	13.37	0.25	1.9%	0.74	20.13	0.47	2.3%	1.01
		median	8.59	0.00	0.0%	0.29	19.39	0.00	0.0%	1.78
	Pig farming sector	n	268	268		164	268	268		164
		mean	5.65	0.13	2.3%	0.21	8.51	0.27	3.1%	0.28
		median	4.94	0.01	0.3%	0.09	6.77	0.13	2.0%	0.15
	Dairy cattle farming sector	n	739	739		193	739	739		193
		mean	2.26	0.00	0.2%	0.01	2.30	0.00	0.2%	0.01
		median	2.21	0.00	0.0%	0.01	2.27	0.00	0.0%	0.01
	Veal farming sector	n	141	141		46	141	141		46
		mean	13.36	0.10	0.7%	0.09	21.31	0.07	0.3%	0.09
		median	10.48	0.02	0.2%	0.02	22.96	0.02	0.1%	0.03
	Non-dairy cattle farming sector	n	682	682		46	682	682		46
		mean	1.11	0.00	0.2%	0.03	1.28	0.00	0.3%	0.03
		median	0.73	0.00	0.0%	0.01	0.87	0.00	0.0%	0.01

Table A7. (continued)

Year	Livestock sector		Unweighted				Weighted based on the number of kilograms present at farms with which the veterinarians had a registered one-to-one relationship			
			Prescribed ABs	**Prescribed colistin**	**Prescribed colistin as a proportion of all ABs prescribed**	**Prescribed colistin (veterinarians who prescribed colistin)**	**Prescribed ABs**	**Prescribed colistin**	**Prescribed colistin as a proportion of all ABs prescribed**	**Prescribed colistin (veterinarians who prescribed colistin)**
2015	Broiler farming sector	n	85	85		8	85	85		8
		mean	11.34	0.06	0.5%	0.66	15.37	0.06	0.4%	0.25
		median	9.25	0.00	0.0%	0.26	14.43	0.00	0.0%	0.21
	Turkey farming sector	n	8	8		4	8	8		4
		mean	24.69	0.30	1.2%	0.61	31.33	0.55	1.8%	0.64
		median	19.42	0.17	0.9%	0.59	30.55	0.51	1.7%	0.51
	Pig farming sector	n	280	280		178	280	280		178
		mean	5.76	0.18	3.1%	0.28	9.10	0.39	4.2%	0.41
		median	4.86	0.04	0.9%	0.15	7.40	0.22	3.0%	0.26
	Dairy cattle farming sector	n	743	743		237				237
		mean	2.27	0.01	0.2%	0.02	2.34	0.01	0.3%	0.02
		median	2.24	0.00	0.0%	0.00	2.32	0.00	0.0%	0.00
	Veal farming sector	n	142	142		58	142	142		58
		mean	15.19	0.09	0.6%	0.21	22.42	0.18	0.8%	0.21
		median	11.67	0.00	0.0%	0.11	23.99	0.11	0.5%	0.15
	Non-dairy cattle farming sector	n	749	749		67	749	749		67
		mean	0.85	0.00	0.4%	0.04	1.22	0.01	0.5%	0.04
		median	0.54	0.00	0.0%	0.01	0.73	0.00	0.0%	0.01

Table A7. (continued)

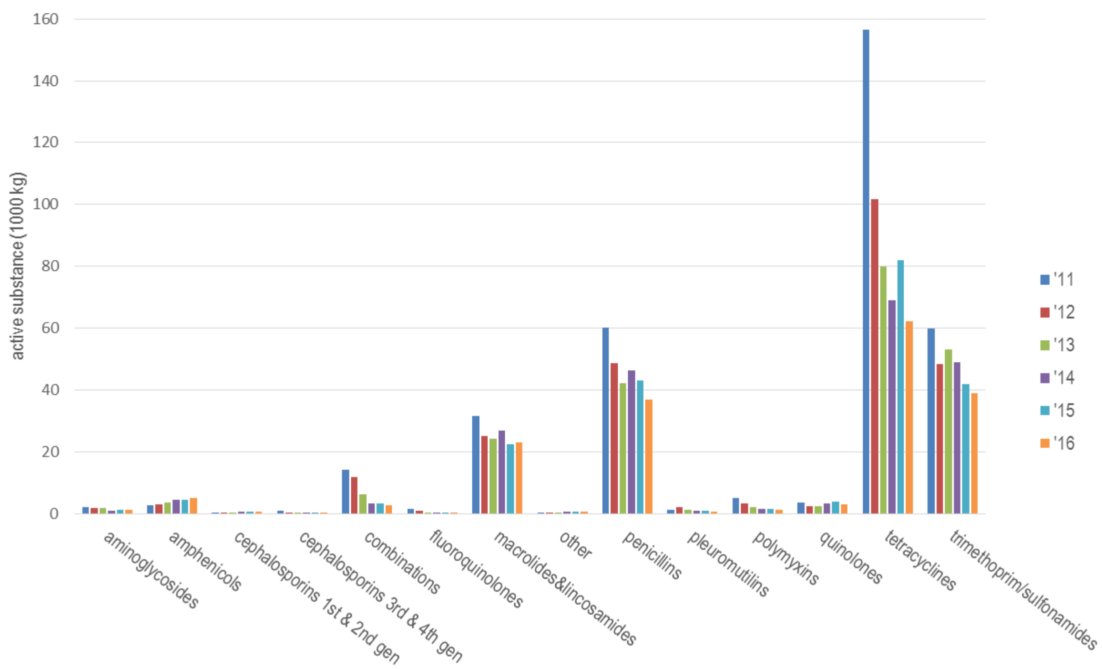
Year	Livestock sector		Unweighted				Weighted based on the number of kilograms present at farms with which the veterinarians had a registered one-to-one relationship			
			Prescribed ABs	Prescribed colistin	Prescribed colistin as a proportion of all ABs prescribed	Prescribed colistin (veterinarians who prescribed colistin)	Prescribed ABs	Prescribed colistin	Prescribed colistin as a proportion of all ABs prescribed	Prescribed colistin (veterinarians who prescribed colistin)
2014	Broiler farming sector	n	89	89		8	89	89		8
		mean	12.20	0.03		0.38	17.57	0.05	0.3%	0.24
		median	10.62	0.00		0.22	16.82	0.00	0.0%	0.18
	Turkey farming sector	n	NA	NA		NA	NA	NA		NA
		mean								
		median								
	Pig farming sector	n	285	285		193	285	285		193
		mean	5.95	0.17	2.9%	0.25	8.67	0.33	3.9%	0.35
		median	5.20	0.06	1.1%	0.12	7.72	0.20	2.5%	0.22
	Dairy cattle farming sector	n	752	752		317	752	752		317
		mean	2.51	0.01	0.3%	0.02	2.55	0.01	0.2%	0.01
		median	2.40	0.00	0.0%	0.00	2.44	0.00	0.0%	0.00
	Veal farming sector	n	135	135		53	135	135		53
		mean	13.48	0.08	0.6%	0.20	22.20	0.15	0.7%	0.20
		median	10.94	0.00	0.0%	0.10	22.94	0.07	0.3%	0.18
	Non-dairy cattle farming sector	n	741	741		89	741	741		89
		mean	0.91	0.00	0.5%	0.04	1.23	0.01	0.6%	0.04
		median	0.59	0.00	0.0%	0.01	0.72	0.00	0.0%	0.00

Table A7. (continued)

Year	Livestock sector		Unweighted				Weighted based on the number of kilograms present at farms with which the veterinarians had a registered one-to-one relationship			
			Prescribed ABs	**Prescribed colistin**	**Prescribed colistin as a proportion of all ABs prescribed**	**Prescribed colistin (veterinarians who prescribed colistin)**	**Prescribed ABs**	**Prescribed colistin**	**Prescribed colistin as a proportion of all ABs prescribed**	**Prescribed colistin (veterinarians who prescribed colistin)**
2013	Broiler farming sector	n	69	69		4	69	69		4
		mean	12.56	0.03	0.2%	0.45	14.35	0.09	0.6%	0.47
		median	12.24	0.00	0.0%	0.37	13.27	0.00	0.0%	0.32
	Turkey farming sector	n	NA	NA		NA	NA	NA		NA
		mean								
		median								
	Pig farming sector	n	271	271		211	271	271		211
		mean	6.67	0.38	5.7%	0.49	10.05	0.72	7.2%	0.74
		median	5.26	0.13	2.5%	0.24	9.40	0.43	4.6%	0.48
	Dairy cattle farming sector	n	687	687		459				459
		mean	2.90	0.01	0.4%	0.02	3.00	0.01	0.4%	0.01
		median	2.88	0.00	0.1%	0.01	2.98	0.00	0.2%	0.01
	Veal farming sector	n	164	164		53	164	164		53
		mean	12.27	0.20	1.6%	0.62	20.61	0.40	2.0%	0.49
		median	5.18	0.00	0.0%	0.31	0.93	0.01	0.8%	0.35
	Non-dairy cattle farming sector	n	699	699		133	699	699		133
		mean	0.93	0.01	0.8%	0.04	1.29	0.01	1.0%	0.04
		median	0.64	0.00	0.0%	0.01	0.82	0.00	0.0%	0.01

Sales figures for antibiotics, by class of antibiotics

Figure A1. Sales of antibiotics from 2011 to 2016, by class of antibiotics



Antibiotic use in monitored livestock sectors calculated using the EMA method

About the EMA method

Earlier this year, EMA published its Draft Guidance on provision of data on antimicrobial use by animal species from national data collection systems. The Draft Guidance sets out EMA's plans to start sector-level monitoring and reporting of antimicrobial use data. Antimicrobial use data would be reported in addition to sales data for European Union member states and several other countries in the European Economic Area (EMA 2017).

With the EMA method, data on antimicrobial use in pigs, cattle and broilers would be reported in sector-specific European Defined Daily Doses for animals (DDD_{VET}) and Defined Course Doses for animals (DCD_{VET}), which have been described in a special EMA document (EMA 2016). The EMA calculations would include a sector-specific Population Correction Unit (PCU) as the denominator, representing the number of kilograms of animal for the livestock sector concerned. The PCU differs from the denominator used by the SDa in its $DDDA_{NAT}$ calculations, due to several differences in how the two denominators are calculated. First of all, the EMA/ESVAC method and the SDa method do not use the same standardized weights per type of livestock. After all, the international standardized weights used in the EMA/ESVAC method have to account for between-country differences in animal weights, which necessitates compromises.

In addition, the SDa's $DDDA_{NAT}$ parameter actually represents the number of kilograms of animal at risk of being treated, while the proposed EMA parameter would represent the amount of meat produced in a particular livestock sector. This is due to the fact that the SDa denominator is based on the average number of animal places per year (animal-time) multiplied by the average body weight for the type of livestock concerned, while the EMA would use average weights to calculate the number of kilograms of animal produced. If meat production is limited, as is the case in the dairy cattle farming sector, the EMA parameter would be based on both meat production (i.e. the number of animals slaughtered) and the number of live animals (i.e. the number of kilograms of animal at risk of being treated). EMA to SDa parameter conversion and vice versa would be possible to a certain extent by adjusting for production cycle length. Table A8 lists the number of kilograms of animal and the PCU values for the various livestock sectors.

Differences observed between the dairy and non-dairy cattle farming sectors, for example, are primarily caused by average weight differences. With regard to the broiler farming sector, which is characterized by a high number of production cycles per year, the PCU value is approximately 7.5-fold higher than the number of kilograms of animal. This high live weight/PCU ratio is primarily the result of the number of production cycles per year. Due to their longer production cycles, the pig and veal farming sectors' ratios are lower, amounting to 2.3 and 1.3, respectively.

DDD_{VET}: The European equivalent of the DDDA parameter used in the Dutch *Diergeneesmiddelenstandaard*

Following the approach for assigning defined daily doses for human medicinal products, 2016 saw the development of a harmonized approach for the assignment of defined daily doses animal for antimicrobial veterinary medicinal products. Using all available European data on the use of antimicrobial veterinary medicinal products, each product's average daily dose was calculated for the various livestock sectors. The SDa expert panel performed two comparisons of the European DDD_{VET} values and its own $DDDA_{NAT}$ values in order to find out to what extent the calculation method used determines the resulting defined daily dose for animals.

Table A8. A comparison of the number of kilograms of live weight (x1,000 kg) calculated using the SDa method and the PCU (x1,000 kg) calculated using the EMA/ESVAC method, by livestock sector.

Livestock sector	EMA/ESVAC method	SDa method	Ratio
Veal farming sector	213,577	164,890	1.30
Dairy cattle farming sector	762,450	1,076,400	0.70
Non-dairy cattle farming sector	267,274	600,100	0.44
Pig farming sector	1,559,092	686,638	2.27
Broiler farming sector	366,184	48,378	7.57
Rabbit farming sector	-	948	-

For its first comparison, the expert panel calculated the defined daily doses animal entirely in accordance with the EMA/ESVAC method, by dividing the DDD_{VET} values by the PCU. For its second comparison, the expert panel divided the DDD_{VET} values by the number animal-years based on the situation in the Netherlands. The latter denominator is the denominator the SDa uses in its $DDDA_{NAT}$ calculations. It should be noted that CBS data rather than data from European data sources (EUROSTAT and TRACES) have been used as the basis for the PCU values, since European 2016 data were not yet available at the time.

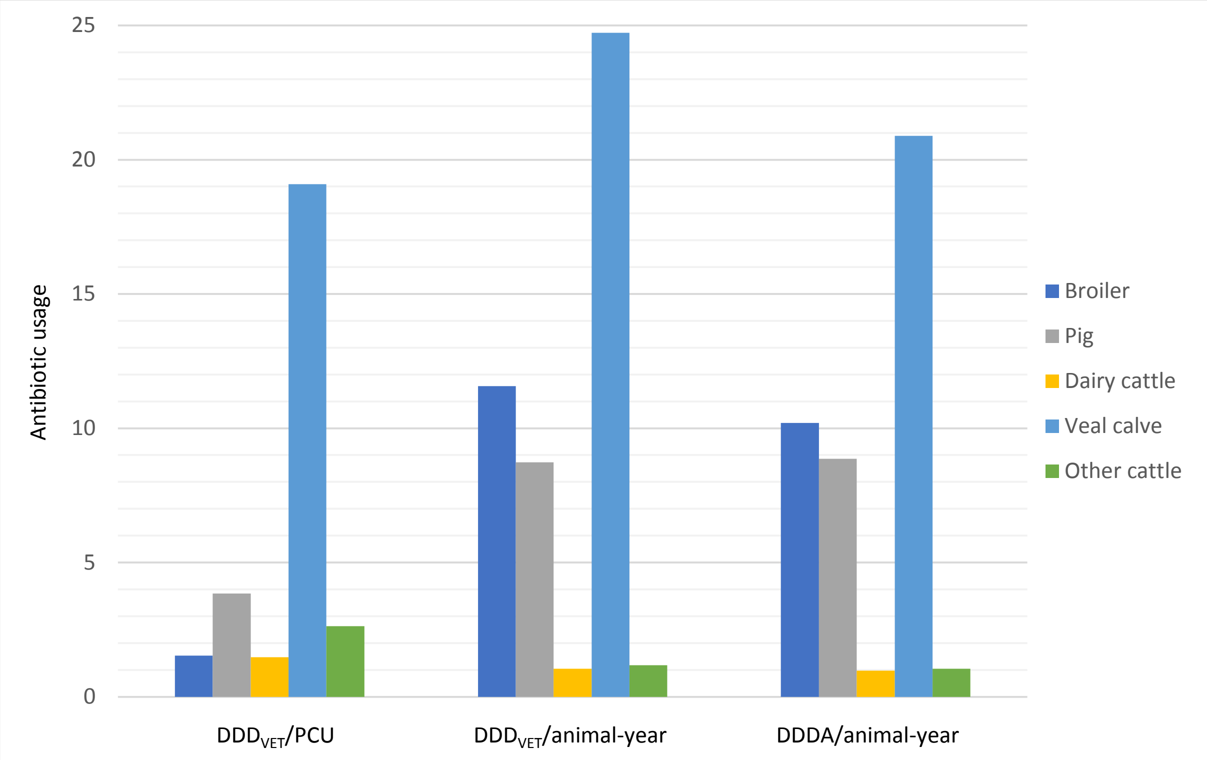
Differences between the DDD_{VET} and $DDDA_{NAT}$ values are mainly due to differences in how the calculation methods account for veterinary medicinal products with more than one active substance, fixed-dose combinations and trimethoprim/sulfonamides. According to the Dutch method, treatment with a fixed-dose combination accounts for just 1 DDDA, while the European method attributes 1 DDD_{VET} per active substance the product contains. Consequently, a single trimethoprim/sulfonamide combination would account for 2 DDD_{VET} (1 DDD_{VET} for trimethoprim and 1 DDD_{VET} for sulfonamide) using the European method, and for just 1 $DDDA_{NAT}$ using the Dutch method. The SDa is of the opinion that since the active substances in fixed-dose combinations are used simultaneously, they comprise a single exposure event. Administration of a fixed-dose combination affects intestinal bacteria differently compared to subsequent administration of the individual active substances. Since trimethoprim/sulfonamide combinations are used in all livestock sectors, each livestock sector's usage level is affected by this DDD_{VET}/$DDDA_{NAT}$ discrepancy. Such discrepancies are not only observed for trimethoprim/sulfonamide combinations, however, but for all aminoglycoside/penicillin combinations (used in cattle and pigs) and lincomycin/spectinomycin combinations (only used in poultry) as well.

For some veterinary medicinal products, dosing differences also result in discrepancies between the Dutch and European values. Oral neomycin doses for pigs and broilers in the Netherlands are markedly lower than the corresponding European average doses, resulting in the DDD_{VET} values for oral neomycin products being lower than the $DDDA_{NAT}$ values. In the Netherlands, parenteral amoxicillin and ampicillin doses in particular exceed the European average doses for these products, while oral amoxicillin and ampicillin doses are lower than the European average doses. As a result, the turkey and pig farming sectors' DDD_{VET} values for second-choice penicillins are lower than their $DDDA_{NAT}$ values, while the dairy cattle, veal and non-dairy cattle farming sectors' DDD_{VET} values for second-choice penicillins exceed their $DDDA_{NAT}$ values.

It is also worth noting that intrauterine and mastitis products have not been included in the DDD_{VET} calculations. To avoid substantial discrepancies between the Dutch and European values for the dairy cattle farming sector, intrauterine and mastitis products have also been excluded from the $DDDA_{NAT}$ calculations the SDa performed for its comparison.

Any discrepancies in the pig farming sector seem to balance each other out, with the overall $DDDA_{NAT}$/animal-year and DDD_{VET}/animal-year values being almost identical. The discrepancies amount to less than 10% for the turkey farming sector, and to 10-20% for the broiler and veal farming sectors (with the $DDDA_{NAT}$ value being lower than the DDD_{VET} value in all three livestock sectors). The discrepancies in systemic antibiotic use for the dairy and non-dairy cattle farming sectors amount to approximately 10% (with the $DDDA_{NAT}$ value being lower than the DDD_{VET} value).

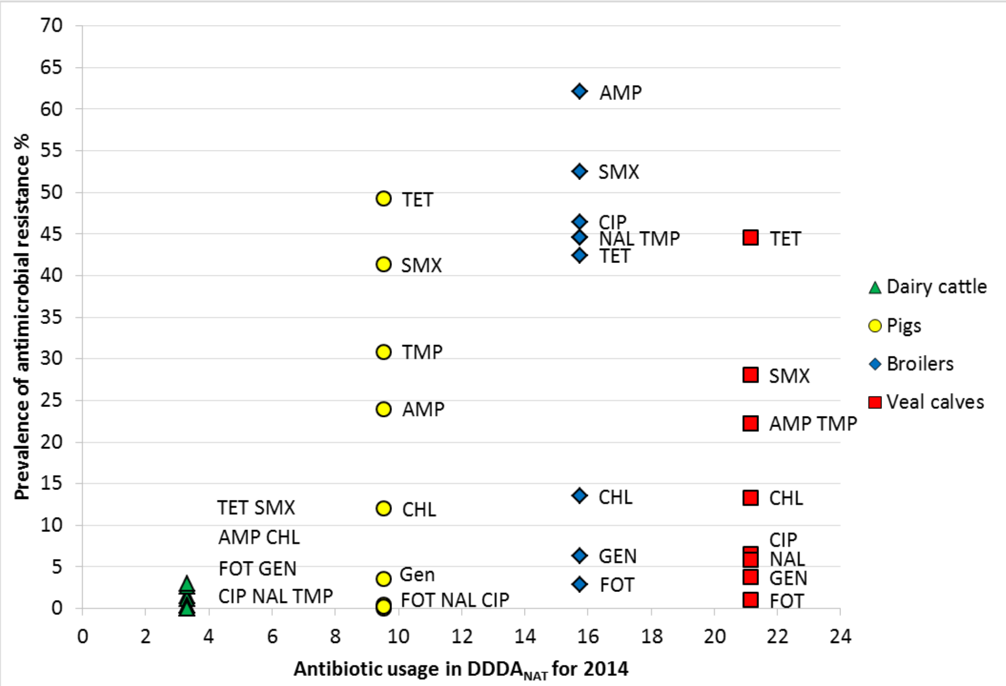
Figure A2. DDD_{VET}/PCU (the EMA/ESVAC antibiotic use parameter), DDD_{VET}/animal-year (numerator in accordance with the EMA/ESVAC method and denominator in accordance with the SDa method) and DDDA/animal-year (numerator and denominator in accordance with the SDa method, resulting in the SDa parameter $DDDA_{NAT}$) based on 2016 data



The usage pattern calculated using the EMA/ESVAC denominator (the PCU) is completely different from the usage patterns calculated using the SDa denominator, while substituting the SDa numerator (DDDA) for the EMA/ESVAC numerator (DDD_{VET}) does not markedly affect the overall picture. Apparently, the findings primarily depend on how the denominator is calculated. The expert panel is concerned by the fact that the usage pattern resulting from the EMA/ESVAC method does not seem to correlate as clearly with the resistance patterns observed for the various livestock sectors. Prevalence of resistant strains is highest in the three meat-producing livestock sectors (i.e. the veal, poultry and pig farming sectors) and lowest in the dairy cattle farming sector. This is illustrated by Figure A3, which is based on MARAN data and has been published in a previous SDa report. The graph gives an idea of the prevalence of resistant *E. coli* in the four livestock sectors.

Generally speaking, prevalence and $DDDA_{NAT}$ levels are related, albeit with a certain amount of variation between the various types of antibiotic resistance. Given that the DDD_{VET}/PCU value recorded for the veal farming sector is very high while the DDD_{VET}/PCU values for the other livestock sectors are relatively low, the expert panel is questioning whether the DDD_{VET}/PCU actually is the parameter best suited to accurately represent livestock sectors' usage levels and the one most strongly correlated with the prevalence of resistant strains from an epidemiological point of view. Further analyses should determine whether or not it is.

Figure A3. Ranking of four monitored livestock sectors based on overall antibiotic use (x-axis) and antibiotic-specific resistance in 2014, adapted from previously reported data (Dorado Garcia et al. 2016). Types of antibiotic resistance: AMP ampicillin; TET tetracycline; SMX sulfamethoxazole; TMP trimethoprim; CIP ciprofloxacin; NAL nalidixic acid; CHL chloramphenicol; FOT cefotaxime; GEN gentamicin



The Dutch livestock sectors can rest assured that no changes to the monitoring method will be necessary if they are to start providing sector-level antibiotic use data to EMA in the future.

Table A9. Tabular overview of the DDD_{VET}/PCU, DDD_{VET}/animal-year and DDDA/animal-year (=$DDDA_{NAT}$) comparisons for the various livestock sectors

	Broiler farming sector			Turkey farming sector		Pig farming sector		
Pharmacotherapeutic group	DDD_{VET}/ PCU	DDD_{VET}/ animal-year	DDDA/ animal-year	DDD_{VET}/ animal-year	DDDA/ animal-year	DDD_{VET}/ PCU	DDD_{VET}/ animal-year	DDDA/ animal-year
1st-choice antibiotics*	**0.53**	**4.03**	**2.74**	**16.12**	**13.46**	**3.04**	**6.91**	**6.88**
As a proportion of overall AB use	**34.84%**	**34.84%**	**26.87%**	**57.72%**	**50.95%**	**79.13%**	**79.13%**	**77.54%**
Amphenicols	0.00	0.00	*	0.00	*	0.08	0.18	0.24
Macrolides/lincosamides	0.03	0.24	0.25	1.28	1.18	0.36	0.81	0.82
Penicillins	0.09	0.68	0.70	3.64	3.70	0.25	0.57	0.58
Pleuromutilins	0.00	*	*	*	*	0.03	0.07	0.07
Tetracyclines	0.17	1.32	1.01	10.71	7.63	1.52	3.46	4.07
Trimethoprim/sulfonamides	0.24	1.78	0.78	0.49	0.95	0.80	1.81	1.10
2nd-choice antibiotics*	**0.99**	**7.47**	**7.38**	**10.21**	**11.36**	**0.80**	**1.82**	**1.99**
As a proportion of overall AB use	**64.55%**	**64.55%**	**72.41%**	**36.55%**	**42.99%**	**20.87%**	**20.87%**	**22.45%**
Aminoglycosides	0.00	0.00	0.01	0.20	0.69	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	0.00	0.00	*	0.00	*	0.00	0.00	*
Quinolones	0.14	1.08	1.51	0.01	0.01	0.01	0.02	0.02
Fixed-dose combinations	0.01	0.09	0.05	0.00	*	0.04	0.08	0.03
Macrolides/lincosamides	0.00	0.00	*	0.00	*	0.18	0.41	0.26
Penicillins	0.83	6.28	5.78	9.56	10.05	0.43	0.97	1.39
Polymyxins	0.00	0.03	0.04	0.44	0.61	0.15	0.34	0.28
3rd-choice antibiotics*	**0.01**	**0.07**	**0.07**	**1.60**	**1.60**	**0.00**	**0.00**	**0.00**
As a proportion of overall AB use	**0.61%**	**0.61%**	**0.72%**	**5.73%**	**6.06%**	**0.00%**	**0.00%**	**0.00%**
3rd- and 4th-gen. cephalosporins	0.00	0.00	*	0.00	*	0.00	0.00	*
Fluoroquinolones	0.01	0.07	0.07	1.60	1.60	0.00	0.00	0.00
Overall	**1.53**	**11.57**	**10.19**	**27.93**	**26.42**	**3.84**	**8.73**	**8.87**

* Pharmacotherapeutic group classification (i.e. first-, second- and third-choice antibiotics) in accordance with the Dutch method.

Table A9. (continued)

	Dairy cattle farming sector (ABs for intramammary or Intrauterine use not included)			Veal farming sector			Non-dairy cattle farming sector (ABs for intramammary or intrauterine use not included)		
Pharmacotherapeutic group	**DDD_{VET}/ PCU**	**DDD_{VET}/ animal-year**	**DDDA/ animal-year**	**DDD_{VET}/ PCU**	**DDD_{VET}/ animal-year**	**DDDA/ animal-year**	**DDD_{VET}/ PCU**	**DDD_{VET}/ animal-year**	**DDDA/ animal-year**
1st-choice antibiotics	**1.33**	**0.95**	**0.87**	**15.07**	**19.51**	**17.94**	**2.14**	**0.95**	**0.89**
As a proportion of overall AB use	**90.33%**	**90.33%**	**90.13%**	**78.93%**	**78.93%**	**85.90%**	**81.28%**	**81.28%**	**85.20%**
Amphenicols	0.06	0.04	0.06	0.95	1.22	1.59	0.20	0.09	0.11
Macrolides/lincosamides	0.04	0.03	0.05	2.94	3.81	3.35	0.39	0.17	0.15
Penicillins	0.22	0.15	0.26	0.20	0.26	0.48	0.10	0.05	0.08
Pleuromutilins	0.00	*	0.00	0.00	*	*	0.00	*	0.00
Tetracyclines	0.34	0.24	0.27	8.40	10.88	10.47	1.06	0.47	0.43
Trimethoprim/sulfonamides	0.67	0.47	0.24	2.58	3.34	2.05	0.39	0.17	0.10
2nd-choice antibiotics	**0.14**	**0.10**	**0.09**	**4.00**	**5.18**	**2.92**	**0.49**	**0.22**	**0.15**
As a proportion of overall AB use	**9.34%**	**9.34%**	**9.47%**	**20.97%**	**20.97%**	**13.97%**	**18.68%**	**18.68%**	**14.75%**
Aminoglycosides	0.01	0.01	0.01	0.07	0.09	0.23	0.01	0.01	0.01
1st- and 2nd-gen. cephalosporins	0.00	0.00	0.00	0.00	0.00	*	0.00	0.00	0.00
Quinolones	0.00	0.00	0.00	0.66	0.85	0.66	0.09	0.04	0.03
Fixed-dose combinations	0.05	0.04	0.04	0.00	0.00	0.00	0.06	0.03	0.03
Macrolides/lincosamides	0.01	0.01	0.01	0.09	0.12	0.19	0.02	0.01	0.02
Penicillins	0.06	0.04	0.03	3.12	4.05	1.77	0.28	0.13	0.06
Polymyxins	0.01	0.01	0.01	0.06	0.07	0.07	0.01	0.01	0.00
3rd-choice antibiotics	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.03**	**0.00**	**0.00**	**0.00**
As a proportion of overall AB use	**0.33%**	**0.33%**	**0.40%**	**0.10%**	**0.10%**	**0.13%**	**0.03%**	**0.03%**	**0.05%**
3rd- and 4th-gen. cephalosporins	0.00	0.00	0.00	0.00	0.00	*	0.00	0.00	0.00
Fluoroquinolones	0.00	0.00	0.00	0.02	0.02	0.03	0.00	0.00	0.00
Overall	**1.48**	**1.05**	**0.97**	**19.09**	**24.72**	**20.88**	**2.63**	**1.17**	**1.04**

Table A10. Standardized average body weights used for determining the PCU figures in accordance with the EMA method, by animal category (source: ESVAC population correction unit template): http://www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00)

Animal category	Specification	Standardized body weight in kg
Broilers	Slaughtered broiler	1
Turkeys	Slaughtered turkey	6.5
Pigs	Slaughtered pig	65
	Living sow	240
Cattle	Living or slaughtered cow	425
	Slaughtered heifer	200
	Slaughtered bullock/bull	425
	Slaughtered calf/young cattle	140
Sheep and goats	Slaughtered sheep/goat	20
	Living sheep	75
Horses	Living horse	400
Rabbits	Slaughtered rabbit	1.4
Import/export		
Broilers	Slaughtered broiler	1
Turkeys	Slaughtered turkey	6.5
Pigs	Slaughtered pig	65
	Fattening pig	25
Cattle	Slaughtered bovine	425
	Fattening bovine	140
Sheep and goats	Slaughtered sheep	20
	Fattening sheep	20
	Slaughtered goat	20
	Fattening goat	20

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Antibiotic use in $DDDA_F$ at poultry farms

Broiler farms

Number of broiler farms: 849
Number of broiler farms with $DDDA_F$=0: 312
Number of broiler farms that used third- and fourth-generation cephalosporins: 0
Number of broiler farms that used fluoroquinolones: 44

Table A11. Antibiotic use in $DDDA_F$ at broiler farms from 2013 to 2016

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
2016	849	7.9	2.8	12.4	22.4

Figure A4. $DDDA_F$ frequency distribution for 849 broiler farms in 2016

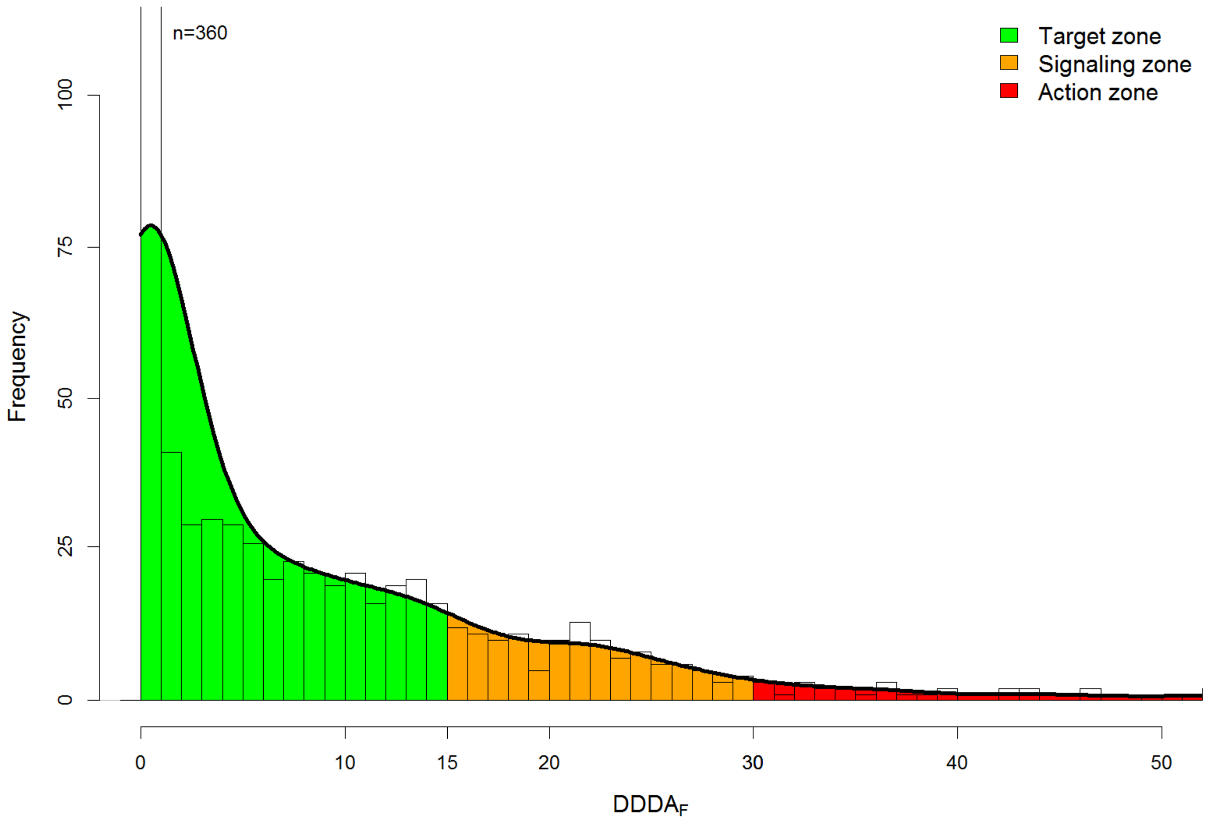

Table A12. Antibiotic use in $DDDA_F$ at broiler farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$ Median	P75	Mean
1st choice	Macrolides/lincosamides	Oral	767	0.00	0.00	0.16
1st choice	Penicillins	Oral	736	0.00	0.00	0.67
1st choice	Tetracyclines	Oral	654	0.00	0.00	0.97
1st choice	Trimethoprim/sulfonamides	Oral	473	0.00	0.93	0.74
2nd choice	Aminoglycosides	Oral	847	0.00	0.00	0.00
2nd choice	Quinolones	Oral	687	0.00	0.00	1.11
2nd choice	Fixed-dose combinations	Oral	826	0.00	0.00	0.03
2nd choice	Penicillins	Oral	510	0.00	5.09	4.14
2nd choice	Polymyxins	Oral	839	0.00	0.00	0.05
3rd choice	Fluoroquinolones	Oral	805	0.00	0.00	0.05

Antibiotic use in DDDA$_F$ at broiler farms, with DDDA$_F$ values based on body weight at the time of treatment, in accordance with the new calculation method for the poultry farming sector introduced in 2017.

Figure A5. DDDA$_F$ frequency distribution for 849 broiler farms in 2016 (based on body weight at time of treatment)

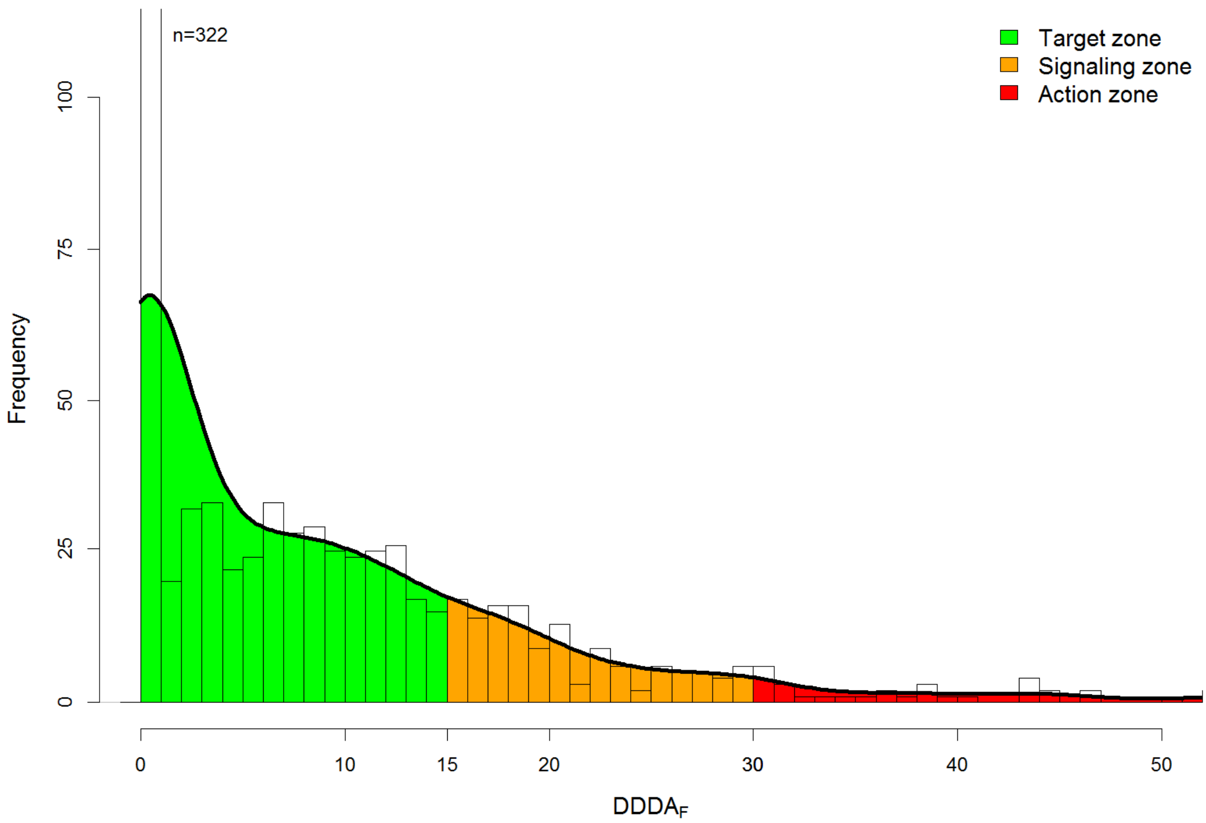

Table A13. The distribution of broiler farms over the various benchmark zones in 2016

Calculation method*	Target zone n (%)	Signaling zone n (%)	Action zone n (%)
Standardized body weight	690 (81%)	121 (14%)	38 (5%)
Body weight at time of treatment	675 (80%)	131 (15%)	43 (5%)

* DDDA$_F$ values based on either standardized body weight or body weight at the time of treatment

Turkey farms

Number of turkey farms: 47
Number of turkey farms with $DDDA_F$=0: 6
Number of turkey farms that used third- and fourth-generation cephalosporins: 0
Number of turkey farms that used fluoroquinolones: 24

Table A14. Antibiotic use in $DDDA_F$ at turkey farms from 2013 to 2016

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
2016	47	18.1	13.6	19.7	48.7

Figure A6. $DDDA_F$ frequency distribution for 47 turkey farms in 2016

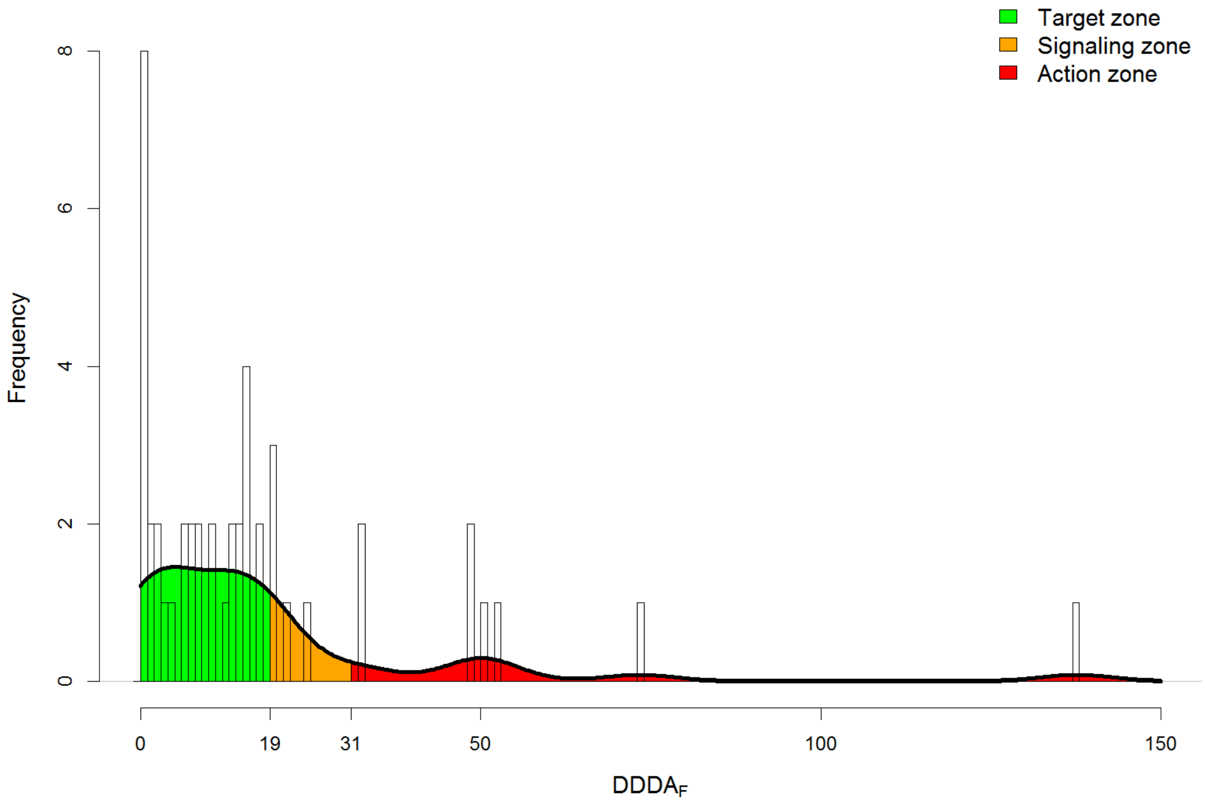

Table A15. Antibiotic use in $DDDA_F$ at turkey farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Macrolides/lincosamides	Oral	17	0.28	1.18	1.00
1st choice	Penicillins	Oral	23	0.31	1.74	2.33
1st choice	Tetracyclines	Oral	18	2.73	8.51	4.94
1st choice	Trimethoprim/sulfonamides	Oral	35	0.00	0.58	0.68
2nd choice	Aminoglycosides	Oral	37	0.00	0.00	0.32
2nd choice	Quinolones	Oral	46	0.00	0.00	0.02
2nd choice	Penicillins	Oral	15	2.32	7.51	7.23
2nd choice	Polymyxins	Oral	43	0.00	0.00	0.31
3rd choice	Fluoroquinolones	Oral	23	0.08	1.39	1.27

Antibiotic use in DDDA$_F$ at turkey farms, with DDDA$_F$ values based on body weight at the time of treatment, in accordance with the new calculation method for the poultry farming sector introduced in 2017.

Figure A7. DDDA$_F$ frequency distribution for 47 turkey farms in 2016 (based on body weight at time of treatment)

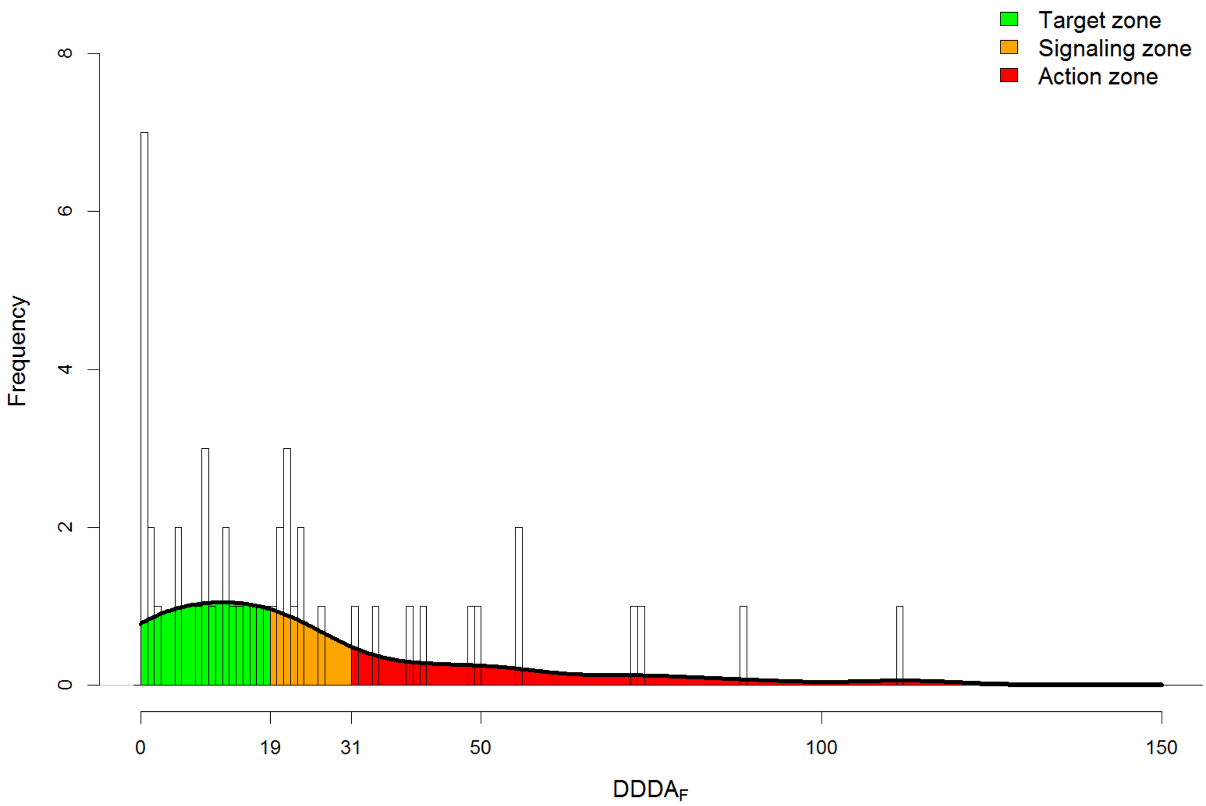

Table A16. The distribution of turkey farms over the various benchmark zones in 2016

Calculation method*	Target zone n (%)	Signaling zone n (%)	Action zone n (%)
Standardized body weight	33 (70%)	6 (13%)	8 (17%)
Body weight at time of treatment	24 (51%)	10 (21%)	13 (28%)

* DDDA$_F$ values based on either standardized body weight or body weight at the time of treatment

Antibiotic use in $DDDA_F$ at pig farms

Farms with sows and suckling piglets

Number of farms with sows and suckling piglets: 1,919
Number of farms with sows and suckling piglets with $DDDA_F$=0: 92
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: 7

Table A17. Antibiotic use in $DDDA_F$ at farms with sows and suckling piglets

Year	n	Mean	Median	P75	P90
2015	2,109	5.4	3.1	6.8	12.8
2016	1,919	3.5	2.3	4.7	8.1

Figure A8. $DDDA_F$ frequency distribution for 1,919 farms with sows and suckling piglets in 2016

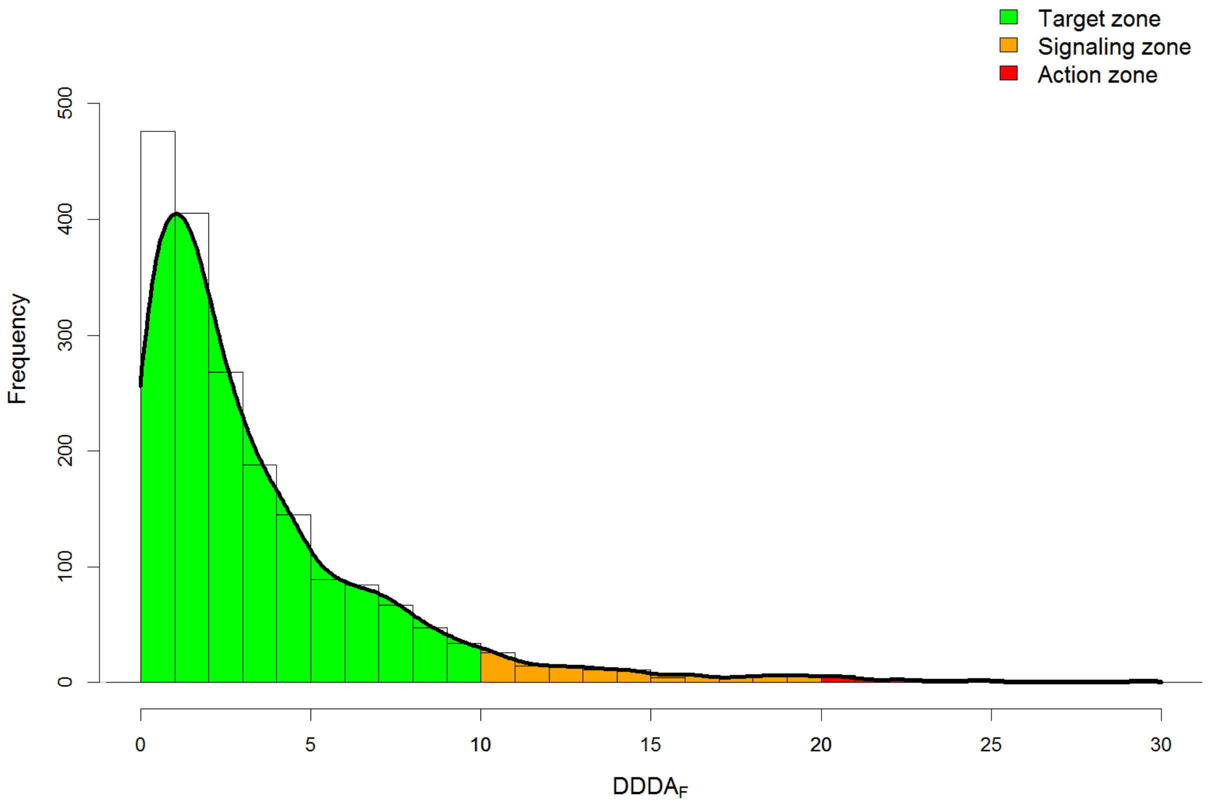

Table A18. Antibiotic use in DDDA$_F$ at farms with sows and suckling piglets in 2016, by pharmacotherapeutic group and route of administration

				DDDA$_F$		
Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with DDDA$_F$=0	Median	P75	Mean
1st choice	Amphenicols	Oral	1,914	0.00	0.00	0.00
1st choice	Amphenicols	Parenteral	1,429	0.00	0.02	0.15
1st choice	Macrolides/lincosamides	Oral	1,732	0.00	0.00	0.12
1st choice	Macrolides/lincosamides	Parenteral	1,714	0.00	0.00	0.02
1st choice	Penicillins	Parenteral	291	0.47	1.09	0.81
1st choice	Pleuromutilins	Oral	1,894	0.00	0.00	0.03
1st choice	Pleuromutilins	Parenteral	1,848	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	1,356	0.00	0.52	0.84
1st choice	Tetracyclines	Parenteral	772	0.05	0.34	0.36
1st choice	Trimethoprim/sulfonamides	Oral	1,489	0.00	0.00	0.29
1st choice	Trimethoprim/sulfonamides	Parenteral	713	0.06	0.29	0.27
2nd choice	Aminoglycosides	Oral	1,913	0.00	0.00	0.00
2nd choice	Quinolones	Oral	1,907	0.00	0.00	0.02
2nd choice	Fixed-dose combinations	Oral	1,903	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	1,732	0.00	0.00	0.02
2nd choice	Macrolides/lincosamides	Parenteral	1,602	0.00	0.00	0.18
2nd choice	Penicillins	Oral	1,681	0.00	0.00	0.18
2nd choice	Penicillins	Parenteral	1,103	0.00	0.16	0.15
2nd choice	Polymyxins	Oral	1,694	0.00	0.00	0.05
2nd choice	Polymyxins	Parenteral	1,453	0.00	0.00	0.04
3rd choice	Fluoroquinolones	Parenteral	1,912	0.00	0.00	0.00

Weaner pig farms

Number of weaner pig farms: 2,088
Number of weaner pig farms with $DDDA_F$=0: 272
Number of weaner pig farms that used third- and fourth-generation cephalosporins: 0
Number of weaner pig farms that used fluoroquinolones: 5

Table A19. Antibiotic use in $DDDA_F$ at weaner pig farms in 2016

Year	n	Mean	Median	P75	P90
2015	2,276	19.6	7.6	24.4	52.2
2016	2,088	24.2	11.9	29.1	57.2

Figure A9. $DDDA_F$ frequency distribution for 2,088 weaner pig farms in 2016

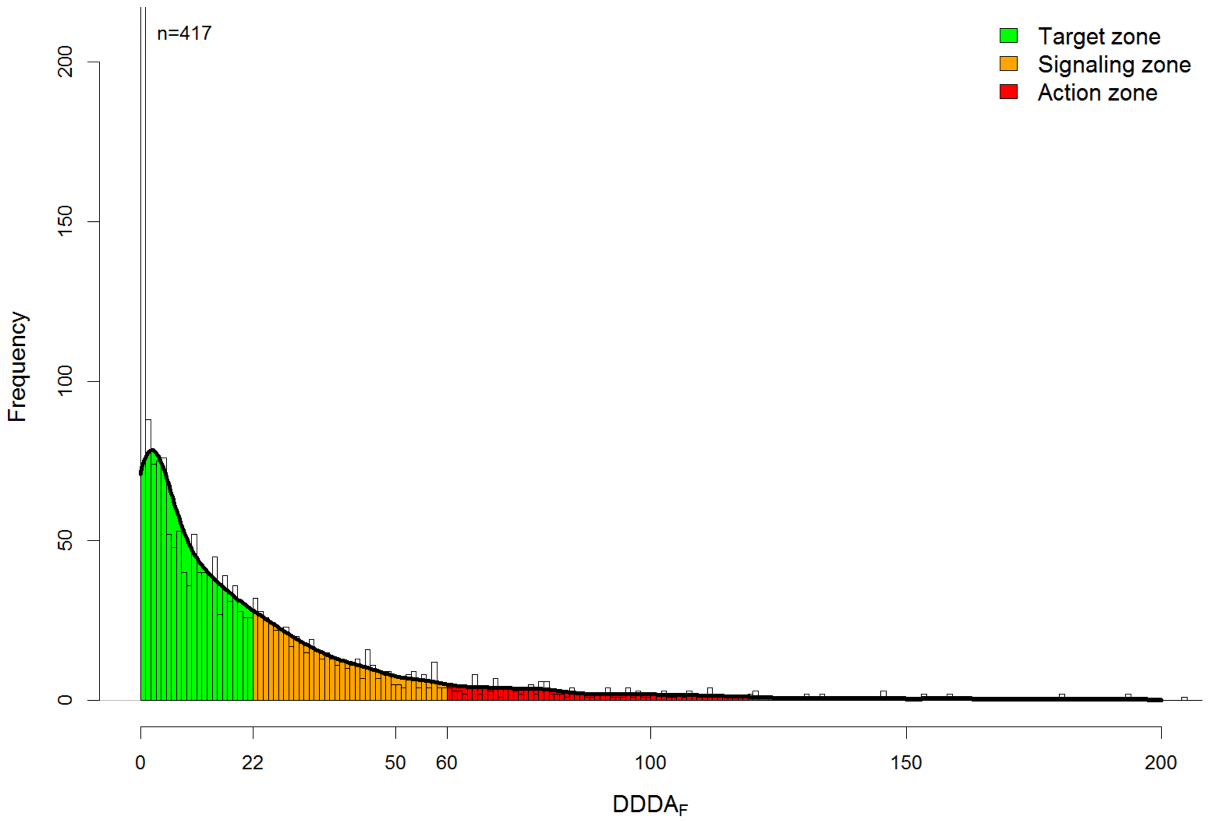

Table A20. Antibiotic use in $DDDA_F$ at weaner pig farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$ Median	P75	Mean
1st choice	Amphenicols	Oral	2,078	0.00	0.00	0.00
1st choice	Amphenicols	Parenteral	1,684	0.00	0.00	0.35
1st choice	Macrolides/lincosamides	Oral	1,800	0.00	0.00	0.72
1st choice	Macrolides/lincosamides	Parenteral	1,984	0.00	0.00	0.02
1st choice	Penicillins	Oral	2,087	0.00	0.00	0.00
1st choice	Penicillins	Parenteral	1,027	0.05	0.83	0.80
1st choice	Pleuromutilins	Oral	2,051	0.00	0.00	0.11
1st choice	Pleuromutilins	Parenteral	2,060	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	1,098	0.00	9.53	8.11
1st choice	Tetracyclines	Parenteral	1,448	0.00	0.19	0.92
1st choice	Trimethoprim/sulfonamides	Oral	1,246	0.00	3.17	3.69
1st choice	Trimethoprim/sulfonamides	Parenteral	1,734	0.00	0.00	0.09
2nd choice	Aminoglycosides	Oral	2,080	0.00	0.00	0.00
2nd choice	Quinolones	Oral	2,078	0.00	0.00	0.02
2nd choice	Fixed-dose combinations	Oral	2,066	0.00	0.00	0.06
2nd choice	Fixed-dose combinations	Parenteral	1,933	0.00	0.00	0.02
2nd choice	Macrolides/lincosamides	Parenteral	1,728	0.00	0.00	1.01
2nd choice	Penicillins	Oral	1,447	0.00	3.44	6.50
2nd choice	Penicillins	Parenteral	1,293	0.00	0.34	0.47
2nd choice	Polymyxins	Oral	1,599	0.00	0.00	1.21
2nd choice	Polymyxins	Parenteral	1,705	0.00	0.00	0.13
3rd choice	Fluoroquinolones	Parenteral	2,083	0.00	0.00	0.00

Pig fattening farms

Number of pig fattening farms: 4,701
Number of pig fattening farms with $DDDA_F$=0: 1,019
Number of pig fattening farms that used third- and fourth-generation cephalosporins: 0
Number of pig fattening farms that used fluoroquinolones: 5

Table A21. Antibiotic use in $DDDA_F$ at pig fattening farms in 2016

Year	n	Mean	Median	P75	P90
2015	5,072	4.1	1.6	5.4	10.2
2016	4,701	4.0	1.7	5.7	10.1

Figure A10. $DDDA_F$ frequency distribution for 4,701 pig fattening farms in 2016

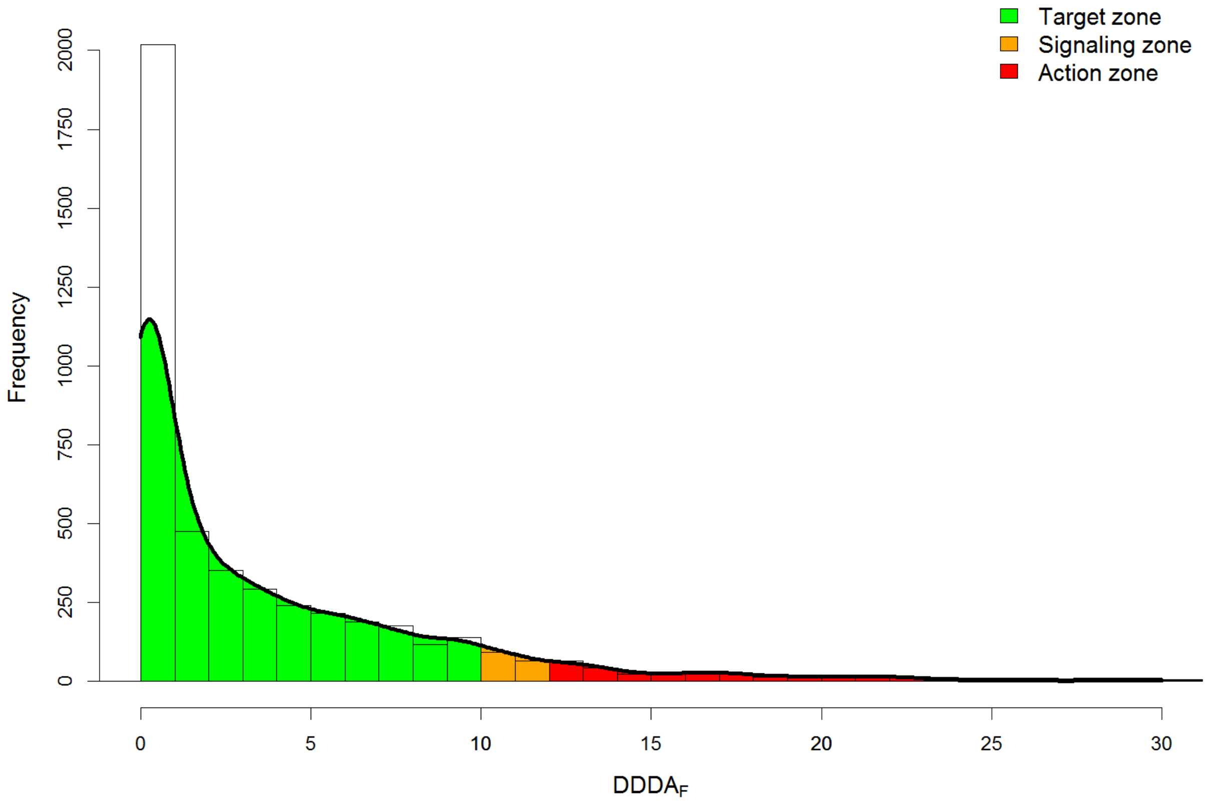

Table A22. Antibiotic use in $DDDA_F$ at pig fattening farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$ Median	P75	Mean
1st choice	Amphenicols	Oral	4,696	0.00	0.00	0.00
1st choice	Amphenicols	Parenteral	3,580	0.00	0.00	0.14
1st choice	Macrolides/lincosamides	Oral	3,631	0.00	0.00	0.64
1st choice	Macrolides/lincosamides	Parenteral	4,063	0.00	0.00	0.02
1st choice	Penicillins	Parenteral	1,720	0.10	0.34	0.28
1st choice	Pleuromutilins	Oral	4,585	0.00	0.00	0.05
1st choice	Pleuromutilins	Parenteral	4,489	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	2,701	0.00	2.60	2.09
1st choice	Tetracyclines	Parenteral	2,425	0.00	0.17	0.20
1st choice	Trimethoprim/sulfonamides	Oral	3,692	0.00	0.00	0.42
1st choice	Trimethoprim/sulfonamides	Parenteral	4,624	0.00	0.00	0.00
2nd choice	Quinolones	Oral	4,696	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Oral	4,687	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	4,599	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	4,657	0.00	0.00	0.01
2nd choice	Penicillins	Oral	4,542	0.00	0.00	0.06
2nd choice	Penicillins	Parenteral	4,207	0.00	0.00	0.01
2nd choice	Polymyxins	Oral	4,606	0.00	0.00	0.02
2nd choice	Polymyxins	Parenteral	4,590	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	4,699	0.00	0.00	0.00

Antibiotic use in $DDDA_F$ at veal farms

White veal farms

Number of white veal farms: 857
Number of white veal farms with $DDDA_F$=0: 5
Number of white veal farms that used third- and fourth-generation cephalosporins: 0
Number of white veal farms that used fluoroquinolones: 77

Table A23. Antibiotic use in $DDDA_F$ at white veal farms from 2011 to 2016

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
2016	857	23.7	23.0	29.0	35.6

Figure A11. $DDDA_F$ frequency distribution for 857 white veal farms in 2016

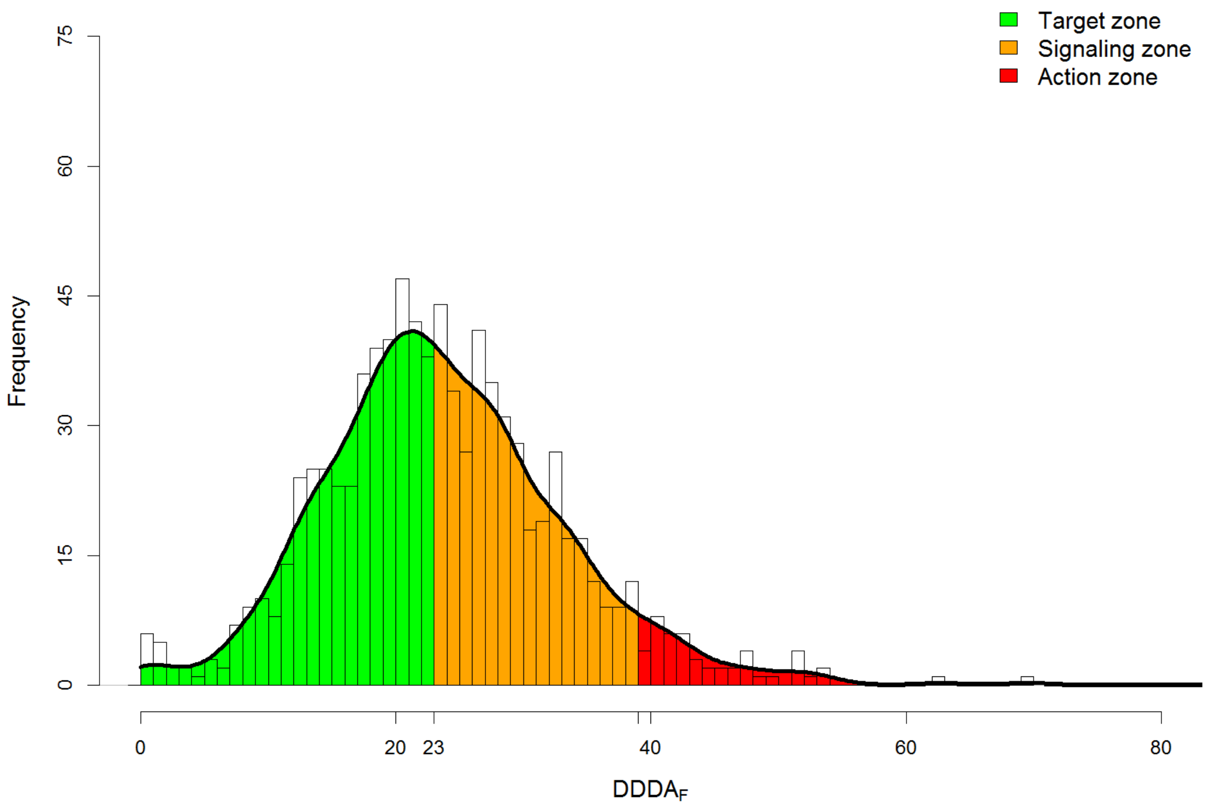

Table A24. Antibiotic use in $DDDA_F$ at white veal farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	9	1.13	1.75	1.35
1st choice	Macrolides/lincosamides	Oral	43	3.93	4.83	3.77
1st choice	Macrolides/lincosamides	Parenteral	213	0.05	0.16	0.16
1st choice	Penicillins	Intramammary for dry cow therapy	855	0.00	0.00	0.00
1st choice	Penicillins	Parenteral	53	0.36	0.70	0.54
1st choice	Tetracyclines	Oral	15	11.41	15.72	12.28
1st choice	Tetracyclines	Parenteral	682	0.00	0.00	0.02
1st choice	Trimethoprim/sulfonamides	Oral	405	0.15	2.99	1.78
1st choice	Trimethoprim/sulfonamides	Parenteral	181	0.05	0.12	0.10
2nd choice	Aminoglycosides	Oral	488	0.00	0.04	0.19
2nd choice	Aminoglycosides	Parenteral	476	0.00	0.09	0.08
2nd choice	Quinolones	Oral	656	0.00	0.00	0.88
2nd choice	Fixed-dose combinations	Parenteral	816	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	377	0.05	0.25	0.17
2nd choice	Penicillins	Intramammary	853	0.00	0.00	0.00
2nd choice	Penicillins	Oral	313	0.40	3.85	2.18
2nd choice	Penicillins	Parenteral	179	0.07	0.14	0.10
2nd choice	Polymyxins	Oral	803	0.00	0.00	0.08
2nd choice	Polymyxins	Parenteral	729	0.00	0.00	0.01
3rd choice	Fluoroquinolones	Oral	853	0.00	0.00	0.03
3rd choice	Fluoroquinolones	Parenteral	781	0.00	0.00	0.00

Rosé veal starter farms

Number of rosé veal starter farms: 240
Number of rosé veal starter farms with $DDDA_F$=0: 1
Number of rosé veal starter farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal starter farms that used fluoroquinolones: 16

Table A25. Antibiotic use in $DDDA_F$ at rosé veal starter farms from 2011 to 2016

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
2016	240	83.9	83.2	100	111.6

Figure A12. $DDDA_F$ frequency distribution for 240 rosé veal starter farms in 2016

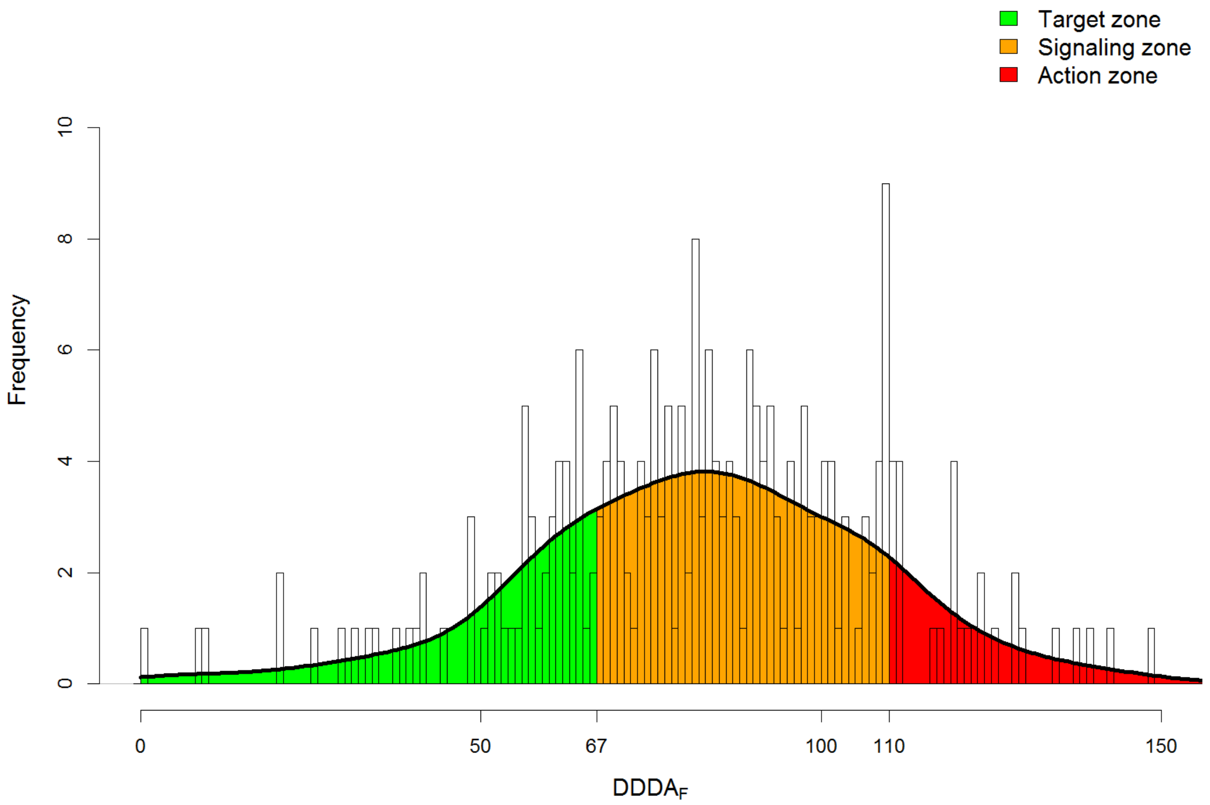

Table A26. Antibiotic use in $DDDA_F$ at rosé veal starter farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	1	6.07	9.68	7.68
1st choice	Macrolides/lincosamides	Oral	11	17.05	20.62	15.93
1st choice	Macrolides/lincosamides	Parenteral	47	0.27	0.75	0.66
1st choice	Penicillins	Parenteral	14	1.28	2.28	1.85
1st choice	Tetracyclines	Oral	3	42.09	51.96	42.25
1st choice	Tetracyclines	Parenteral	173	0.00	0.07	0.25
1st choice	Trimethoprim/sulfonamides	Oral	68	6.73	13.58	9.35
1st choice	Trimethoprim/sulfonamides	Parenteral	49	0.27	0.60	0.61
2nd choice	Aminoglycosides	Oral	158	0.00	0.13	0.62
2nd choice	Aminoglycosides	Parenteral	121	0.00	0.39	0.30
2nd choice	Quinolones	Oral	195	0.00	0.00	0.94
2nd choice	Fixed-dose combinations	Parenteral	224	0.00	0.00	0.01
2nd choice	Macrolides/lincosamides	Parenteral	122	0.00	1.05	0.75
2nd choice	Penicillins	Oral	153	0.00	1.64	2.08
2nd choice	Penicillins	Parenteral	63	0.16	0.45	0.32
2nd choice	Polymyxins	Oral	232	0.00	0.00	0.25
2nd choice	Polymyxins	Parenteral	196	0.00	0.00	0.02
3rd choice	Fluoroquinolones	Oral	237	0.00	0.00	0.02
3rd choice	Fluoroquinolones	Parenteral	227	0.00	0.00	0.01

Rosé veal fattening farms

Number of rosé veal fattening farms: 602
Number of rosé veal fattening farms with $DDDA_F$=0: 71
Number of rosé veal fattening farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal fattening farms that used fluoroquinolones: 4

Table A27. Antibiotic use in $DDDA_F$ at rosé veal fattening farms from 2011 to 2016

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
2016	602	2.8	0.9	3.9	8.1

Figure A13. $DDDA_F$ frequency distribution for 602 rosé veal fattening farms in 2016

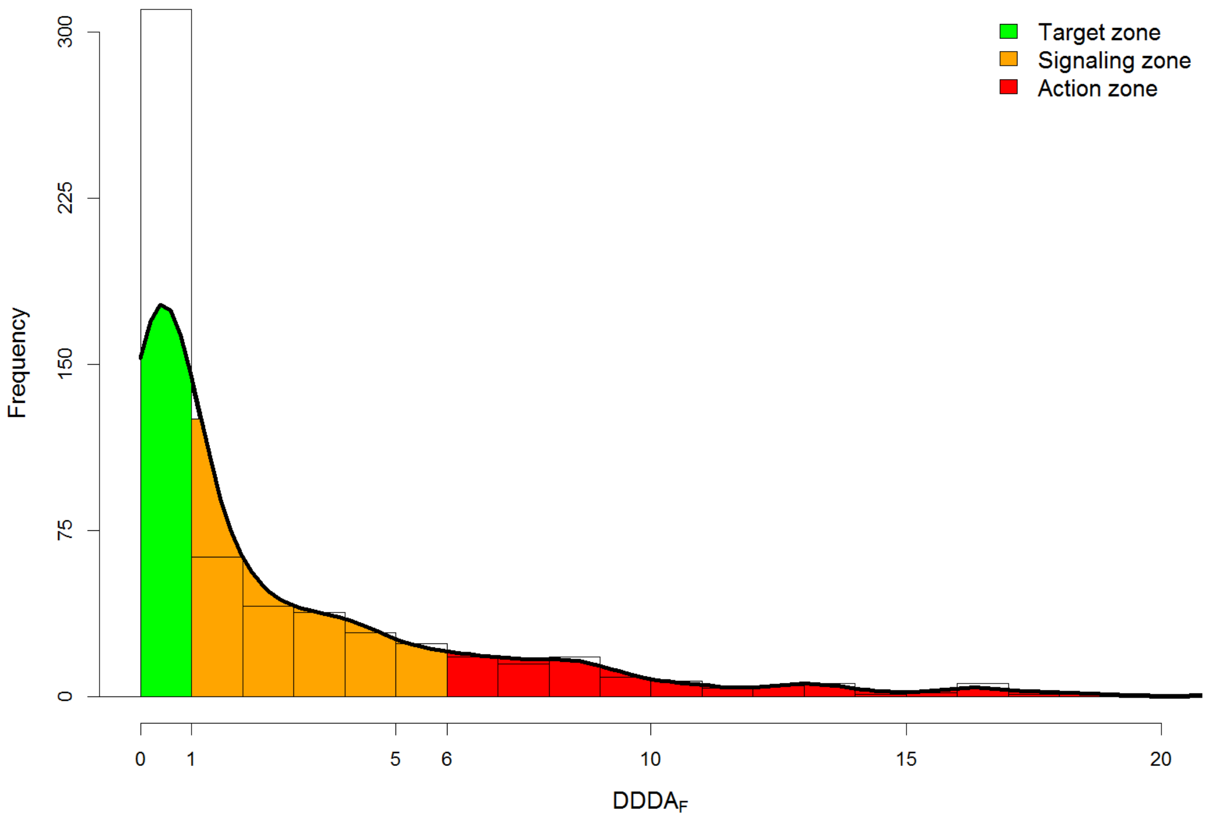

Table A28. Antibiotic use in $DDDA_F$ at rosé veal fattening farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	112	0.33	0.62	0.47
1st choice	Macrolides/lincosamides	Oral	574	0.00	0.00	0.05
1st choice	Macrolides/lincosamides	Parenteral	477	0.00	0.00	0.03
1st choice	Penicillins	Intramammary for dry cow therapy	601	0.00	0.00	0.00
1st choice	Penicillins	Parenteral	296	0.02	0.19	0.15
1st choice	Tetracyclines	Oral	403	0.00	1.93	1.46
1st choice	Tetracyclines	Parenteral	532	0.00	0.00	0.02
1st choice	Trimethoprim/sulfonamides	Oral	471	0.00	0.00	0.51
1st choice	Trimethoprim/sulfonamides	Parenteral	503	0.00	0.00	0.01
2nd choice	Aminoglycosides	Oral	599	0.00	0.00	0.00
2nd choice	Aminoglycosides	Parenteral	597	0.00	0.00	0.00
2nd choice	Quinolones	Oral	601	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	585	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	465	0.00	0.00	0.10
2nd choice	Penicillins	Oral	599	0.00	0.00	0.00
2nd choice	Penicillins	Parenteral	459	0.00	0.00	0.02
2nd choice	Polymyxins	Oral	601	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	598	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	598	0.00	0.00	0.00

Rosé veal combination farms

Number of rosé veal combination farms: 229
Number of rosé veal combination farms with $DDDA_F$=0: 26
Number of rosé veal combination farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal combination farms that used fluoroquinolones: 11

Table A29. Antibiotic use in $DDDA_F$ at rosé veal combination farms from 2011 to 2016

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
2016	229	11.1	11.3	16.6	20.6

Figure A14. $DDDA_F$ frequency distribution for 229 rosé veal combination farms in 2016

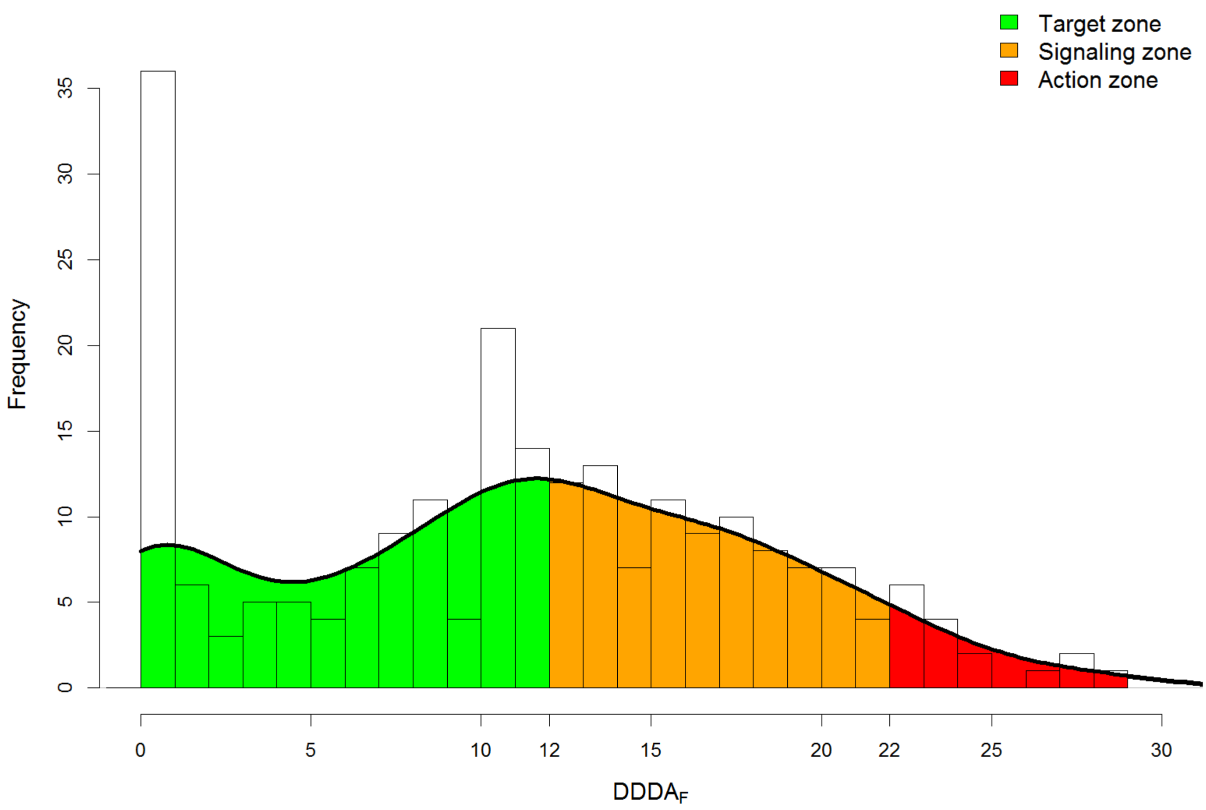

Table A30. Antibiotic use in $DDDA_F$ at rosé veal combination farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	31	1.15	1.76	1.30
1st choice	Macrolides/lincosamides	Oral	67	1.55	2.59	1.57
1st choice	Macrolides/lincosamides	Parenteral	94	0.02	0.11	0.11
1st choice	Penicillins	Parenteral	58	0.19	0.46	0.42
1st choice	Tetracyclines	Oral	48	5.23	8.32	5.39
1st choice	Tetracyclines	Parenteral	180	0.00	0.00	0.03
1st choice	Trimethoprim/sulfonamides	Oral	93	0.52	2.20	1.32
1st choice	Trimethoprim/sulfonamides	Parenteral	106	0.01	0.06	0.08
2nd choice	Aminoglycosides	Oral	173	0.00	0.00	0.07
2nd choice	Aminoglycosides	Parenteral	152	0.00	0.03	0.06
2nd choice	Quinolones	Oral	205	0.00	0.00	0.11
2nd choice	Fixed-dose combinations	Parenteral	209	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	113	0.01	0.25	0.18
2nd choice	Penicillins	Oral	159	0.00	0.15	0.34
2nd choice	Penicillins	Parenteral	90	0.03	0.09	0.07
2nd choice	Polymyxins	Oral	226	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	202	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	227	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	220	0.00	0.00	0.00

Antibiotic use in $DDDA_F$ at cattle farms

Dairy cattle farms

Number of dairy cattle farms: 17,529
Number of dairy cattle farms with $DDDA_F$=0: 244
Number of dairy cattle farms that used third- and fourth-generation cephalosporins: 274
Number of dairy cattle farms that used fluoroquinolones: 1,241

Table A31. Antibiotic use at dairy cattle farms from 2012 to 2016, presented as overall antibiotic use (A), use of dry cow (intramammary) antibiotics (B), use of mastitis injectors (C), and use of oral antibiotics in calves (D)

A **Overall antibiotic use, 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
2016	17,529	2.1	2.1	2.9	3.7

B **Use of dry cow (intramammary) antibiotics, in $DDDA_F$ (animals >2 years of age)**

n	Mean	Median	P75	P90
17,529	1.2	1.1	1.8	2.4

C **Use of mastitis injectors, in $DDDA_F$ (animals >2 years of age)**

n	Mean	Median	P75	P90
17,529	0.6	0.5	0.8	1.3

D **Use of oral antibiotics in calves, in $DDDA_F$ (animals <56 days of age)**

n	Mean	Median	P75	P90
17,529	3.1	0.0	0.0	6.7

Figure A15. DDDA$_F$ frequency distribution for 17,529 dairy cattle farms in 2016

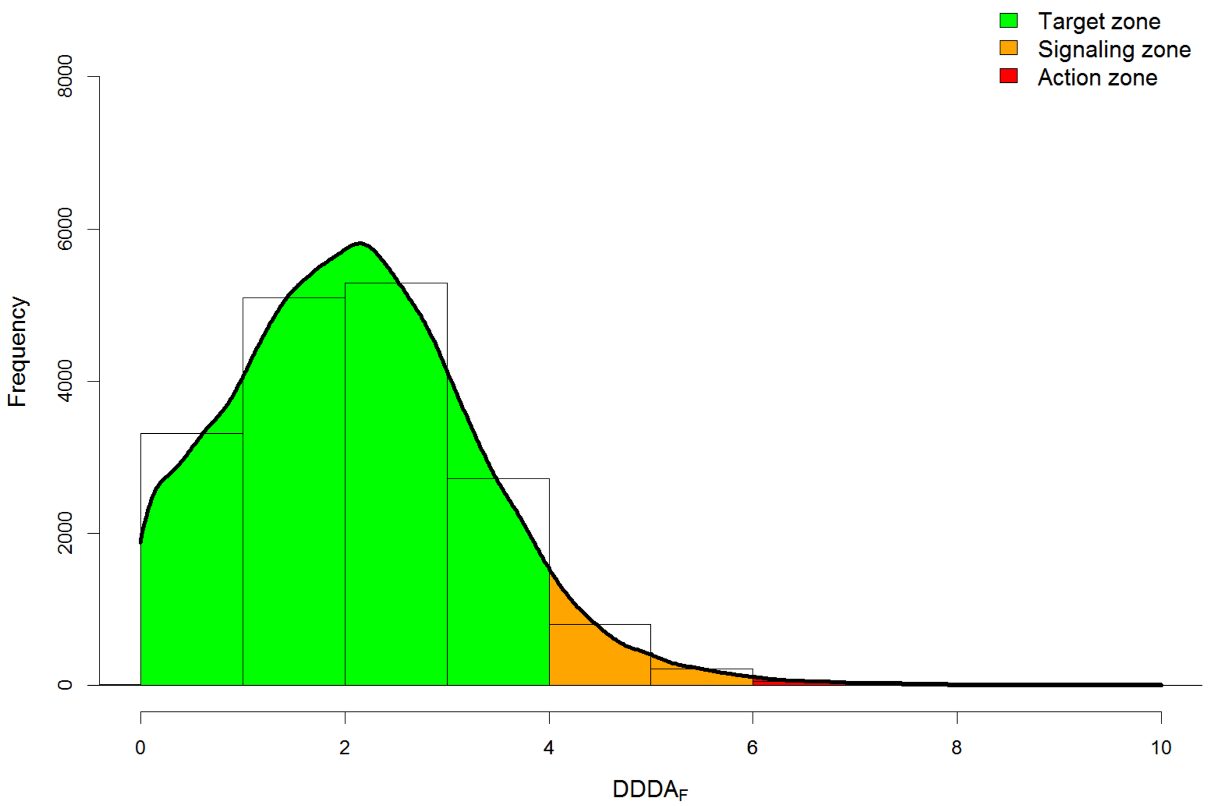

Table A32. Antibiotic use in $DDDA_F$ at dairy cattle farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	9,424	0.00	0.05	0.03
1st choice	Macrolides/lincosamides	Intramammary	17,295	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Oral	17,509	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Parenteral	12,852	0.00	0.01	0.04
1st choice	Penicillins	Intramammary for dry cow therapy	3,305	0.85	1.36	0.88
1st choice	Penicillins	Parenteral	3,651	0.11	0.26	0.19
1st choice	Tetracyclines	Oral	16,956	0.00	0.00	0.01
1st choice	Tetracyclines	Parenteral	3,235	0.11	0.24	0.17
1st choice	Tetracyclines	Intrauterine	7,468	0.02	0.10	0.06
1st choice	Trimethoprim/sulfonamides	Oral	15,660	0.00	0.00	0.01
1st choice	Trimethoprim/sulfonamides	Parenteral	3,110	0.10	0.22	0.16
2nd choice	Aminoglycosides	Oral	16,296	0.00	0.00	0.00
2nd choice	Aminoglycosides	Parenteral	17,263	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intramammary	16,204	0.00	0.00	0.01
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	12,710	0.00	0.01	0.01
2nd choice	Quinolones	Oral	17,526	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Intramammary	7,885	0.05	0.32	0.21
2nd choice	Fixed-dose combinations	Intramammary for dry cow therapy	17,081	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Oral	17,522	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	11,134	0.00	0.03	0.03
2nd choice	Macrolides/lincosamides	Parenteral	15,858	0.00	0.00	0.01
2nd choice	Penicillins	Intramammary	5,207	0.15	0.35	0.24
2nd choice	Penicillins	Intramammary for dry cow therapy	17,488	0.00	0.00	0.00
2nd choice	Penicillins	Oral	17,473	0.00	0.00	0.00
2nd choice	Penicillins	Parenteral	12,035	0.00	0.02	0.02
2nd choice	Polymyxins	Oral	17,203	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	17,135	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Intramammary	17,264	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Parenteral	17,511	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	17,528	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	16,289	0.00	0.00	0.00

Suckler cow farms

Number of suckler cow farms: 9,067
Number of suckler cow farms with $DDDA_F$=0: 4,314
Number of suckler cow farms that used third- and fourth-generation cephalosporins: 4
Number of suckler cow farms that used fluoroquinolones: 80

Table A33. Antibiotic use in $DDDA_F$ at suckler cow farms from 2012 to 2016

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
2016	9,067	0.6	0.1	0.7	1.9

Figure A16. $DDDA_F$ frequency distribution for 9,067 suckler cow farms in 2016

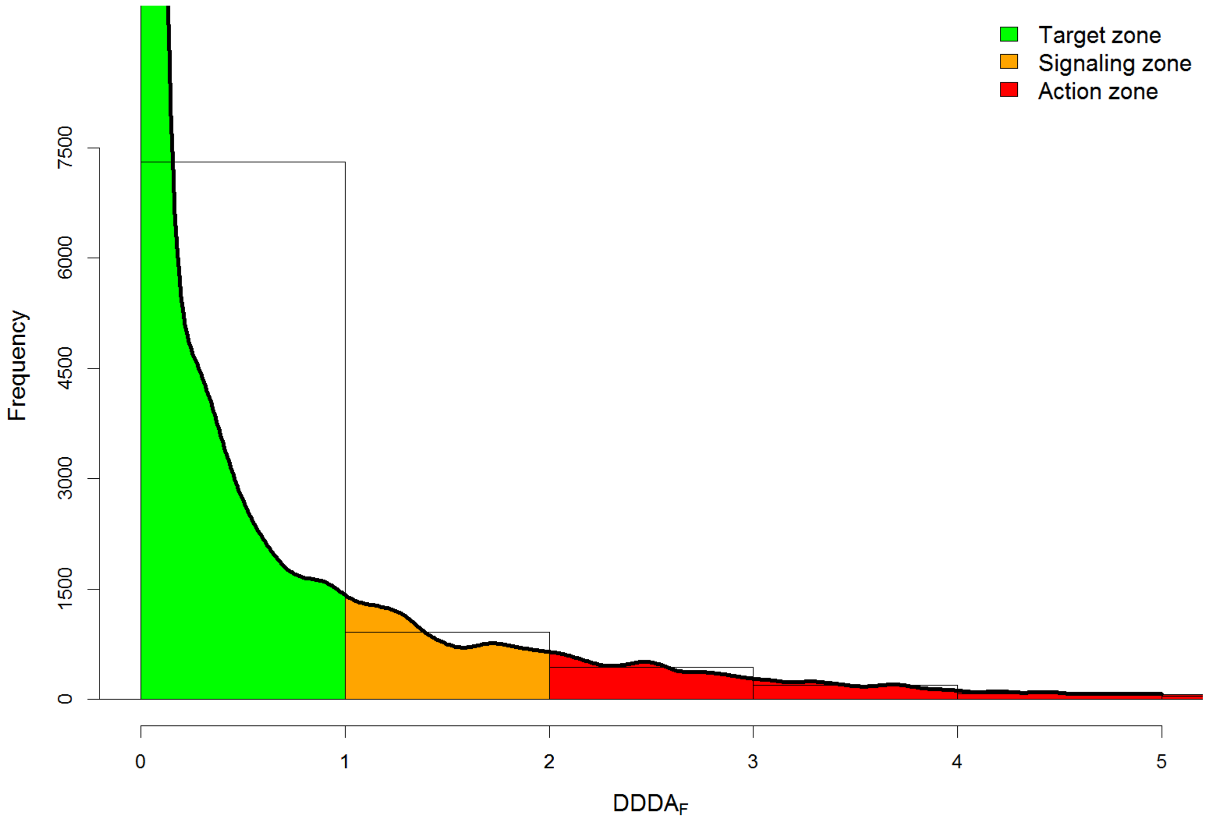

Table A34. Antibiotic use in $DDDA_F$ at suckler cow farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	7,588	0.00	0.00	0.04
1st choice	Macrolides/lincosamides	Oral	9,063	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Parenteral	8,714	0.00	0.00	0.01
1st choice	Penicillins	Intramammary for dry cow therapy	8,793	0.00	0.00	0.04
1st choice	Penicillins	Parenteral	6,622	0.00	0.06	0.19
1st choice	Tetracyclines	Oral	8,985	0.00	0.00	0.01
1st choice	Tetracyclines	Parenteral	7,484	0.00	0.00	0.06
1st choice	Tetracyclines	Intrauterine	7,450	0.00	0.00	0.04
1st choice	Trimethoprim/sulfonamides	Oral	8,896	0.00	0.00	0.01
1st choice	Trimethoprim/sulfonamides	Parenteral	7,885	0.00	0.00	0.03
2nd choice	Aminoglycosides	Oral	9,025	0.00	0.00	0.00
2nd choice	Aminoglycosides	Parenteral	9,020	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intramammary	9,031	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	8,955	0.00	0.00	0.00
2nd choice	Quinolones	Oral	9,065	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Intramammary	8,876	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Intramammary for dry cow therapy	9,061	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	7,619	0.00	0.00	0.12
2nd choice	Macrolides/lincosamides	Parenteral	8,661	0.00	0.00	0.01
2nd choice	Penicillins	Intramammary	8,745	0.00	0.00	0.01
2nd choice	Penicillins	Intramammary for dry cow therapy	9,064	0.00	0.00	0.00
2nd choice	Penicillins	Oral	9,051	0.00	0.00	0.00
2nd choice	Penicillins	Parenteral	8,193	0.00	0.00	0.03
2nd choice	Polymyxins	Oral	9,053	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	9,003	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Intramammary	9,066	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Parenteral	9,064	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	8,987	0.00	0.00	0.00

Rearing farms

Number of rearing farms: 435
Number of rearing farms with $DDDA_F$=0: 315
Number of rearing farms that used third- and fourth-generation cephalosporins: 0
Number of rearing farms that used fluoroquinolones: 2

Table A35. Antibiotic use in $DDDA_F$ at rearing farms from 2013 to 2016

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
2016	435	0.8	0.0	0.1	1.3

* 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 435 rearing farms in 2016

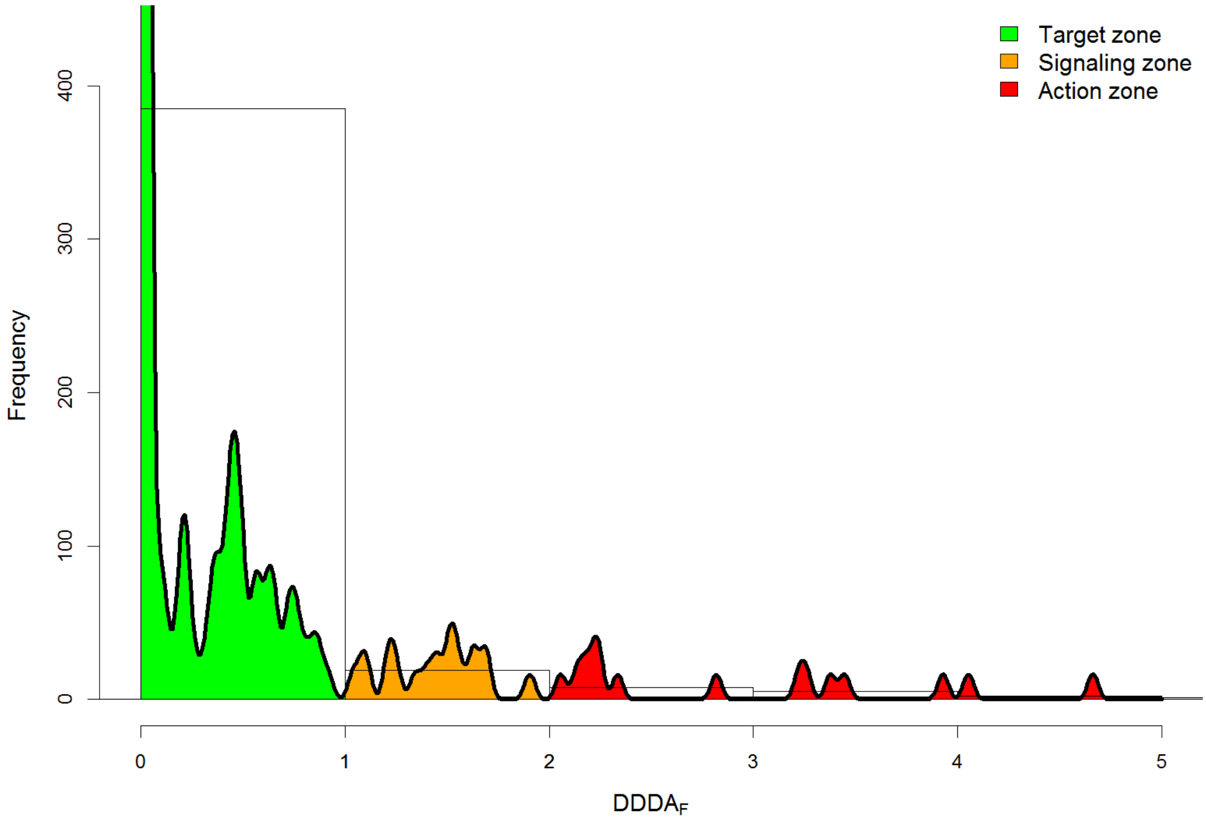

Table A36. Antibiotic use in $DDDA_F$ at rearing farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$ Median	P75	Mean
1st choice	Amphenicols	Parenteral	365	0.00	0.00	0.15
1st choice	Macrolides/lincosamides	Oral	428	0.00	0.00	0.09
1st choice	Macrolides/lincosamides	Parenteral	416	0.00	0.00	0.01
1st choice	Penicillins	Parenteral	386	0.00	0.00	0.10
1st choice	Tetracyclines	Oral	417	0.00	0.00	0.27
1st choice	Tetracyclines	Parenteral	414	0.00	0.00	0.06
1st choice	Tetracyclines	Intrauterine	433	0.00	0.00	0.00
1st choice	Trimethoprim/sulfonamides	Oral	430	0.00	0.00	0.01
1st choice	Trimethoprim/sulfonamides	Parenteral	400	0.00	0.00	0.02
2nd choice	Aminoglycosides	Oral	431	0.00	0.00	0.01
2nd choice	Aminoglycosides	Parenteral	434	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	434	0.00	0.00	0.00
2nd choice	Quinolones	Oral	434	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Intramammary	433	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	427	0.00	0.00	0.01
2nd choice	Macrolides/lincosamides	Parenteral	414	0.00	0.00	0.04
2nd choice	Penicillins	Intramammary	433	0.00	0.00	0.01
2nd choice	Penicillins	Parenteral	423	0.00	0.00	0.01
2nd choice	Polymyxins	Oral	434	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	433	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	433	0.00	0.00	0.00

Beef farms

Number of beef farms: 3,046
Number of beef farms with $DDDA_F$=0: 1,963
Number of beef farms that used third- and fourth-generation cephalosporins: 1st choice
Number of beef farms that used fluoroquinolones: 28

Table A37. Antibiotic use in $DDDA_F$ at beef farms from 2013 to 2016

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
2016	3,046	1.6	0.0	0.4	2.9

* Rearing and beef 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 3,046 beef farms in 2016

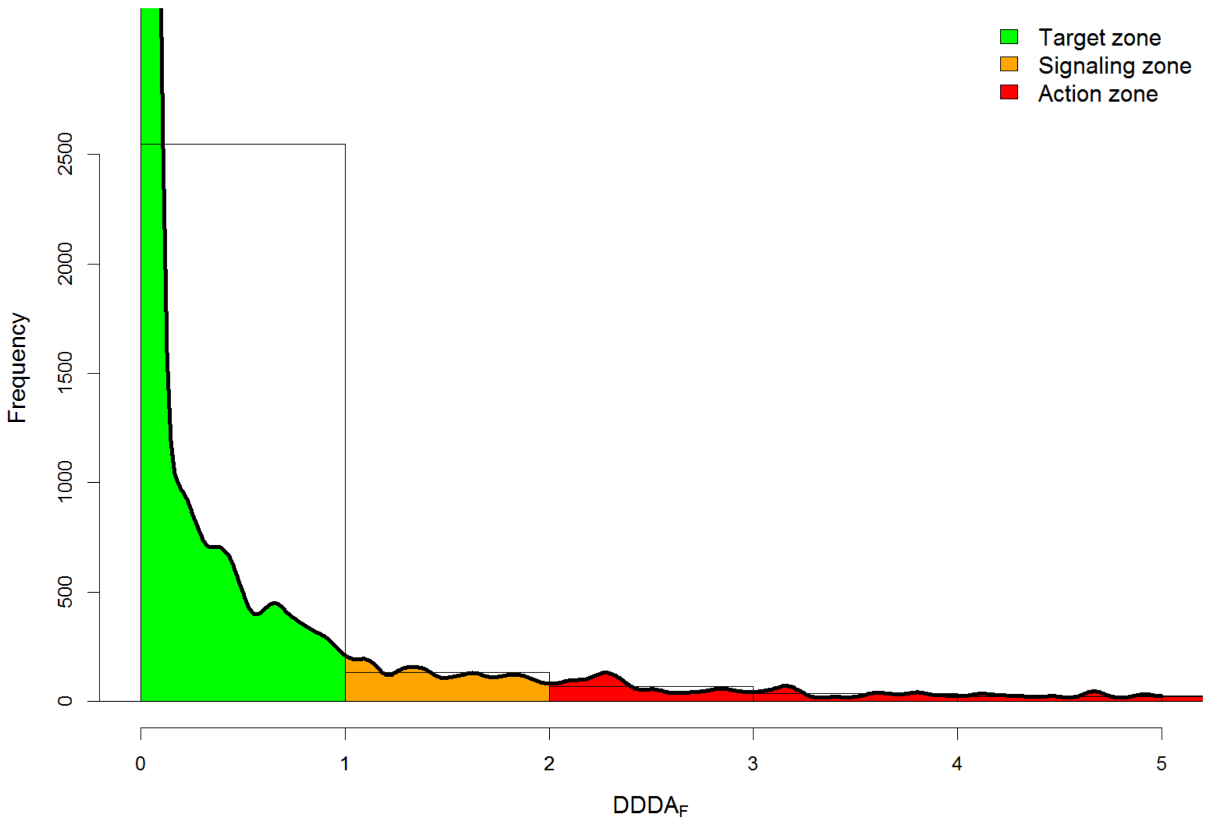

Table A38. Antibiotic use in $DDDA_F$ at beef farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$ Median	P75	Mean
1st choice	Amphenicols	Parenteral	2,332	0.00	0.00	0.19
1st choice	Macrolides/lincosamides	Oral	2,820	0.00	0.00	0.24
1st choice	Macrolides/lincosamides	Parenteral	2,774	0.00	0.00	0.01
1st choice	Penicillins	Intramammary for dry cow therapy	3,026	0.00	0.00	0.01
1st choice	Penicillins	Parenteral	2,430	0.00	0.00	0.10
1st choice	Tetracyclines	Oral	2,755	0.00	0.00	0.59
1st choice	Tetracyclines	Parenteral	2,735	0.00	0.00	0.04
1st choice	Tetracyclines	Intrauterine	2,916	0.00	0.00	0.01
1st choice	Trimethoprim/sulfonamides	Oral	2,860	0.00	0.00	0.15
1st choice	Trimethoprim/sulfonamides	Parenteral	2,683	0.00	0.00	0.03
2nd choice	Aminoglycosides	Oral	2,959	0.00	0.00	0.01
2nd choice	Aminoglycosides	Parenteral	2,998	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	3,042	0.00	0.00	0.00
2nd choice	Quinolones	Oral	3,001	0.00	0.00	0.03
2nd choice	Fixed-dose combinations	Intramammary	3,033	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Intramammary for dry cow therapy	3,044	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Oral	3,045	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	2,855	0.00	0.00	0.03
2nd choice	Macrolides/lincosamides	Parenteral	2,790	0.00	0.00	0.03
2nd choice	Penicillins	Intramammary	3,024	0.00	0.00	0.00
2nd choice	Penicillins	Intramammary for dry cow therapy	3,045	0.00	0.00	0.00
2nd choice	Penicillins	Oral	2,961	0.00	0.00	0.06
2nd choice	Penicillins	Parenteral	2,746	0.00	0.00	0.01
2nd choice	Polymyxins	Oral	3,036	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	3,006	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Parenteral	3,045	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	3,045	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	3,019	0.00	0.00	0.00

Antibiotic use in $DDDA_F$ at rabbit farms

Rabbit farms

Number of rabbit farms: 41
Number of rabbit farms with $DDDA_F$=0: 4
Number of rabbit farms that used third- and fourth-generation cephalosporins: 0
Number of rabbit farms that used fluoroquinolones: 8

Table A39. Antibiotic use in $DDDA_F$ at rabbit farms

Year	n	Mean	Median	P75	P90
2016	41	40.9	31.8	60.3	84.4

Figure A19. $DDDA_F$ frequency distribution for 41 rabbit farms in 2016

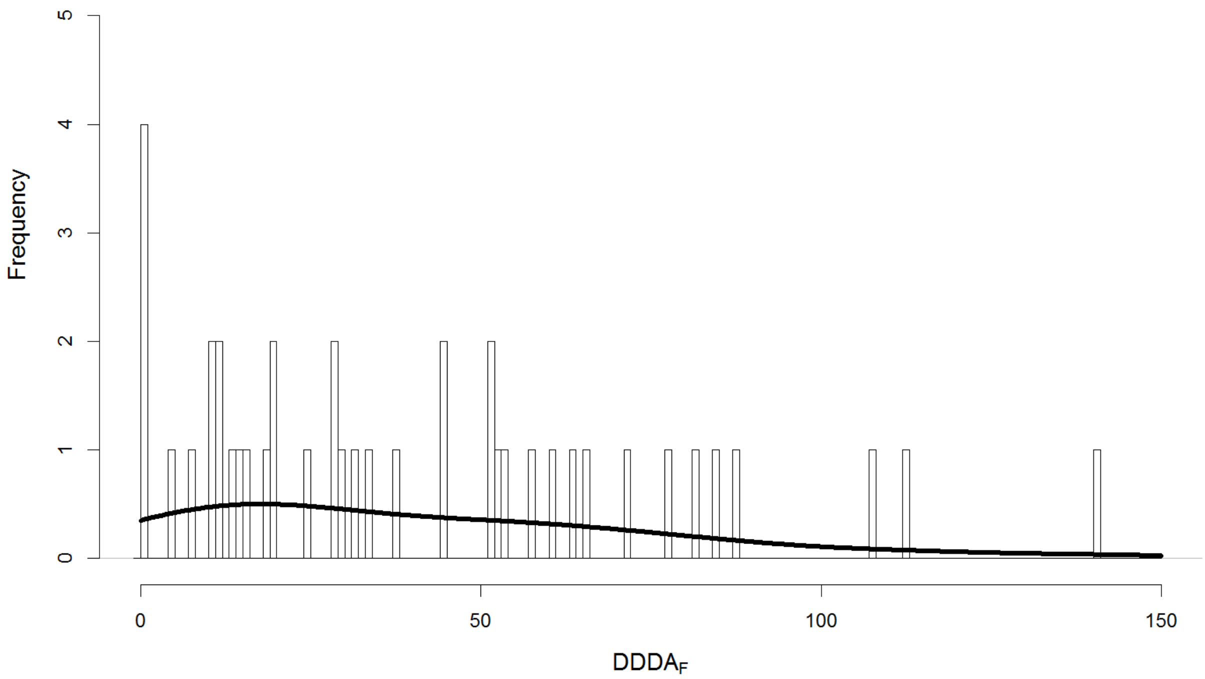

Table A40. Antibiotic use in DDDA$_F$ at rabbit farms in 2016, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with DDDA$_F$=0	DDDA$_F$ Median	P75	Mean
1st choice	Macrolides/lincosamides	Oral	34	0.00	0.00	0.87
1st choice	Macrolides/lincosamides	Parenteral	40	0.00	0.00	0.01
1st choice	Other	Oral	10	7.65	26.36	18.46
1st choice	Pleuromutilins	Oral	29	0.00	1.35	1.51
1st choice	Tetracyclines	Oral	18	3.38	8.38	9.18
1st choice	Tetracyclines	Parenteral	25	0.00	0.81	0.86
1st choice	Trimethoprim/sulfonamides	Oral	31	0.00	0.00	1.28
2nd choice	Aminoglycosides	Oral	17	2.95	13.44	8.46
2nd choice	Macrolides/lincosamides	Parenteral	40	0.00	0.00	0.01
2nd choice	Polymyxins	Oral	40	0.00	0.00	0.05
3rd choice	Fluoroquinolones	Oral	33	0.00	0.00	0.25

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Trends and benchmarking of livestock farms and veterinarians
SDa/1151/2017