Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2014

Trends and benchmarking of livestock farms and veterinarians

September 2015

(revision October 2015)

   

Preface

This is a copy of the SDa report 'Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2014'. With this report, the SDa expert panel provides insight into the usage of antibiotics at Dutch livestock farms for the fourth consecutive year. The report also contains information on veterinarians' prescription patterns over a three-year period. Following analyses of the data, the SDa decides on benchmarking methods for livestock farmers and veterinarians, in order to promote prudent usage of antibiotics in the Dutch livestock sector.

Over the past few years, the Dutch livestock sector as a whole has managed to achieve significant reductions in the amounts of antibiotics used. In 2014, these reductions appeared to have levelled off in most of the individual livestock sectors. As a result, the SDa expert panel is planning new initiatives in order to shift the focus from reducing the usage of antibiotics to actually reducing antibiotic resistance.

I would like to take this opportunity to thank each and every one who contributed to this report by submitting usage data. Every year the SDa expert panel is presented with new challenges that need to be addressed. We would not have been able to address these challenges properly without the efforts of all of our members and researchers.

Utrecht, September 2015

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Conclusions and recommendations

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

Developments in usage levels of monitored livestock sectors and developments in sales figures
In 2014, only the cattle farming sector still managed to achieve a distinct reduction (of 19.7%) in its usage of antibiotics in terms of defined daily doses animal ($DDDA_{NAT}$). This reduction was due to changes in the amounts of antibiotics used at dairy cattle farms. It is a significant achievement that a livestock sector characterized by low usage levels and only minor variation in usage levels between individual farms, still managed to further reduce its usage of antibiotics.
The other livestock sectors showed smaller reductions (of 4.4% in the pig farming sector and 1.6% in the veal farming sector) or even increases (of 21.1% in the broiler farming sector and 4.9% in the turkey farming sector) compared to their 2013 usage data. Contrary to the findings of the expert panel, the poultry farming sector reported a reduction in its usage level in terms of treatment days for the 2013-2014 period. The expert panel thinks this discrepancy is the result of shifts in the usage of particular products that occurred in 2014. Such shifts would have affected trends based on $DDDA_{NAT}$ data and trends based on the number of treatment days differently, with the latter of the two representing the calculation method used by the livestock sector itself. In the opinion of the expert panel, harmonization of the calculation methods is required, and the generally accepted $DDDA_{NAT}$ -based method proposed by the SDa and the European Medicines Agency (EMA) should be used.

Looking at the data from all of the monitored livestock sectors together, the steep downward trend in antibiotic usage that was seen in the previous years came to a halt in 2014. In terms of $DDDA_{NAT}$, 2013 and 2014 usage levels were similar. In terms of the $DDDA_{NAT}$ weighted based on the number of kilograms of animal weight per livestock sector, overall usage declined by 13.5%. However, this reduction was largely due to the reduction achieved in the cattle farming sector. It therefore presents a somewhat rosy picture of the developments in the three other livestock sectors.

The following long-term trends were identified for the different livestock sectors. The veal farming sector achieved a 37.4% reduction in the usage of antibiotics (in $DDDA_{NAT}$) over the 2009-2014 period. Compared to 2007, the year that as a result of implemented policies marked the beginning of the downward trend, the veal farming sector managed to reduce its usage of antibiotics (in $DDDA_{NAT}$) by 46.3%.
Sow/piglet farms, pig fattening farms and broiler farms achieved a $DDDA_{NAT}$-based reduction of 56.2%, 49.9% and 57.1%, respectively, over the 2009-2014 period. For the dairy farming sector, DDDA data based on average doses used were not available. As a result, no long-term trends were calculated for this sector.

Overall sales of antibiotics for veterinary use (in number of kilograms) decreased by 4.5% compared to the 2013 figure. In the 2012-2013 period, the reduction in the number of kilograms of antibiotics

sold was almost three times as high. It should be noted however, that the 2013 sales figures registered by the Federation of the Dutch Veterinary Pharmaceutical Industry (FIDIN) turned out to contain some errors. These have since been corrected. The actual reduction achieved over the 2009-2013 period is therefore 56.2% (instead of the 57.7% reduction previously reported). In terms of the number of kilograms of active substances sold, overall usage of antibiotics decreased by 58.1% between 2009 and 2014. The year 2009 is the government-specified reference year.
The delivery records for 2014 were converted to the amounts of antibiotics prescribed (in kilograms of active substances). For the 2013-2014 period, calculations based on delivery records found a 4.0% overall reduction in the number of kilograms of active substances used, for all monitored livestock sectors together.

Developments in the usage of antibiotics that are of critical importance for public health
Usage in agricultural livestock of antibiotics that are of critical importance for public health (i.e. third- and fourth-generation cephalosporins and fluoroquinolones) still showed a slight decline in 2014. For these antibiotics, usage levels based on sales figures are quite similar to the usage levels based on delivery records.

Usage of third- and fourth-generation cephalosporins in the monitored livestock sectors decreased to less than 0.5 kilograms. In unmonitored sectors, however, usage of third- and fourth-generation cephalosporins increased, from 13 to 14 kilograms. Approximately 18% of this could be attributed to usage in companion animals. The unmonitored sectors are responsible for approximately 97% of the total amount of third- and fourth-generation cephalosporins used.
Usage of fluoroquinolones in the monitored livestock sectors decreased by approximately 25%, from 225 to 168 kilograms. Overall usage of fluoroquinolones increased slightly in the 2013-2014 period. Unmonitored usage of fluoroquinolones represented 60% of overall usage, with usage in companion animals accounting for an estimated 7%. The remaining 53% is thought to have occurred in categories of animals that were not subjected to monitoring.

Usage of aminoglycosides decreased in most of the livestock sectors. The veal, cattle and poultry farming sectors achieved a 47%, 30% and 41% reduction, respectively. The pig farming sector, however, showed a 10% increase.

Usage of polymyxins also decreased in most of the livestock sectors, with reductions of 16%, 58% and 49% for the pig, veal and cattle farming sectors, respectively. Usage of polymyxins did, however, increase in the poultry farming sector by 14%.

It is not entirely clear which unmonitored sectors use antibiotics that are of critical importance for public health. The expert panel feels that the usage of such antibiotics should be fully accounted for, and should be reduced even further, if possible. It also feels that in smaller sectors, farms should be subjected to spot checks in order to estimate the amounts of antibiotics used in these sectors. Low-usage sectors do not require continuous recording and monitoring. For these sectors, estimations based on intermittent assessments should suffice. The frequency of any reassessments should be guided and updated by the assessment results. Usage of critical antibiotics in companion animals and horses will be assessed this year, by assessing a representative sample of veterinary practices.

Benchmarking 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's usage level falls within the target zone, the signaling zone, or the action zone.

The slight decrease in mean antibiotic use that was seen in 2014, was associated with a small number of livestock farms moving from the action zone to lower usage level zones. The improvement plans required to be implemented by livestock farms in the action zone, apparently no longer result in a further reduction of the amount of antibiotics used. The movement of livestock farms from the signaling zone to the target zone also seems to be coming to a halt in several livestock sectors, particularly in the broiler and veal farming sectors.

There were 1,211 veterinarians for whom the Veterinary Benchmark Indicator (VBI) could be calculated. Almost 60% of veterinarians fell within the target zone based on their prescription patterns. The proportion of veterinarians with a VBI over 0.3 and therefore being assigned to the action zone, was 3.3%. The expert panel feels it is necessary to find out why these veterinarians had such a high VBI. If necessary, measures should be taken to quickly improve their prescription patterns, so that they will be in line with those of their fellow veterinarians. Approximately 37% of veterinarians were assigned to the signaling zone based on their prescription patterns. Veterinarians active in the veal, broiler and pig farming sectors in particular contributed to the high percentage of veterinarians in the signaling zone.

Measures to be taken in the short term

The fact that the downward trend in antibiotic usage seen in previous years is now levelling off, requires further assessment. Looking at data from the European Medicines Agency (EMA 2014), the Netherlands has moved from high-level usage of antibiotics in veterinary medicine to an average level of usage over the past few years. The value of comparisons like this one is of course limited by structural differences between the livestock sectors of the various EU member states. The steep downward trend coming to a halt does, however, mark the beginning of a new era, according to the expert panel.

Over the coming years, livestock farms and veterinarians in the action and signaling zones should be the main focus when trying to further reduce the usage of antibiotics in the Dutch livestock sector. The expert panel has the opinion that further reductions can still be achieved if targeted measures are implemented for the livestock farms and veterinarians included in the signaling and action zones. Analysis of available data shows that there is still a substantial amount of variation in the usage levels of individual livestock farms and in veterinarians' prescription patterns within the various livestock sectors. Usage level variations may have been due to differences in how the livestock farms are managed and differences regarding hygiene, vaccination policies and structural organizational aspects. Prescription patterns of individual veterinarians will also have contributed to the differences that were identified. However, not much is known about what causes variations in veterinarians' prescription patterns.

When the benchmarking method was introduced, 25% of livestock farms fell within the action zone. The veal, poultry and pig farming sectors still have about 10% of high users, even though the action thresholds for these livestock sectors were already implemented in 2012. Livestock farms in the action zone apparently are relatively slow in reducing their usage levels. The current improvement plans drawn up for action zone livestock farms therefore seem to be insufficient in helping livestock farms move into the target zone. The expert panel strongly believes that a $DDDA_F$ level meeting the action zone criteria represents an unacceptably high level of antibiotic use.
As a result, the livestock sectors should do more to reduce the usage of antibiotics at action zone livestock farms as quickly as possible. In order to reduce the usage levels, livestock sectors should implement new initiatives that are able to generate results in the short term.

A large proportion of livestock farms are currently in the signaling zone. Most livestock farms within the signaling zone have not yet been required to take additional measures. Until now, broiler farms were the only livestock farms that also had to draw up an action plan if they fell within the signaling zone. To facilitate a further reduction in the usage of antibiotics, it is a logical step to require additional efforts from all signaling zone livestock farms and their veterinarians. It is therefore worth considering to require all livestock farms in the signaling zone to draw up improvement plans.

The expert panel found that there is still a substantial amount of variation between the prescription patterns of individual veterinarians. With the current VBI action threshold, a veterinarian's prescription pattern is required to deviate considerably to be classified as too high. This means the benchmarking method for veterinarians is quite conservative compared to the method used for livestock farms. Consequently, it is necessary to better align the two benchmarking methods. In the short term, this means lowering the action and signaling thresholds for the Veterinary Benchmark Indicator. The expert panel will provide its recommendations regarding this matter later this year.

Research to substantiate additional measures
It is necessary to change the way in which livestock farms in the signaling and action zones are encouraged to reduce their usage levels in the next few years.

- More detailed analysis of available usage data is required in order to identify the distinctive characteristics of low-usage livestock farms and high-usage livestock farms. This should enable the identification of success factors that will make it possible to further reduce the amounts of antibiotics used. Such detailed analysis requires additional information on livestock farm-specific characteristics that can subsequently be linked to usage-level data. The success factors identified in this manner can be used as the basis for targeted improvement plans for the livestock farms concerned.
- The expert panel strongly encourages comparative research into underlying factors that might explain the differences between veterinarians with high prescription patterns and veterinarians with low prescription patterns.
- Research is required to help clarify what defines 'prudent' usage. The practicability of current formularies is limited by legal aspects regarding the marketing authorizations of

veterinary prescription drugs. Ideally, formularies and guidelines on evidence-based, prudent usage of antibiotics should be integrated. The expert panel feels there is a clear need to amend the formularies in such a way as to leave room for recommendations on the choice of treatment, dosing and treatment duration that are more explicitly geared towards resistance prevention.

- Scenario analyses should be used to estimate the effects that certain sector-wide measures will have on the usage of antibiotics and on the presence of resistant micro-organisms. Such analyses could produce realistic projections for livestock sector interventions, and provide the information necessary to select the measures that will generate the biggest reductions in the amounts of antibiotics used.

Innovation is one of the hallmarks of the Dutch livestock sector. Improving animal health and further reducing the usage of antibiotics are topics that deserve to be added to the innovation agendas of the various livestock sectors. The Dutch livestock sector will only be able to further reduce its usage levels if it makes reduced usage of antibiotics a precondition for further innovation in the livestock sector. This means assessments will have to be performed to determine the implications of technical innovations for usage levels.

Benchmarking and antimicrobial resistance

Monitoring and pragmatic benchmarking of the amounts of antibiotics used have certainly paid off in the past few years. However, application of the current benchmarking method can only go so far. So now, the expert panel is looking for better substantiated benchmark thresholds. It wants the new benchmark thresholds also to be related to the presence of resistant bacteria in the various livestock sectors. To this end, it will work with the Central Veterinary Institute to analyse the national resistance monitoring data. Following analysis of these data, new benchmark thresholds will be proposed in the autumn of 2015. Since the issue of antimicrobial resistance differs per individual livestock sector, this new approach is likely to give rise to sector-specific benchmarking methods.

Terms and definitions

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.
$DDDA_{NAT}$	The 'Defined Daily Dose Animal' based on national antibiotic usage data. It is determined by first calculating the total number of treatable kilograms within a particular livestock sector for a specific year, and then dividing this number by the average number of kilograms of animal present within the livestock sector concerned. This measure is used to determine the amount of antibiotics used within a particular livestock sector, irrespective of the various types of livestock farms within the livestock sector concerned and any differences between these livestock farms. The $DDDA_{NAT}$ is used in other countries as well. It is similar to the parameter DDD per 1000 patient days used in human medicine when multiplied by 1000/365. 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. It is determined by first calculating the total number of treatable kilograms at a particular livestock farm for a specific year, and then dividing this number by the average number of kilograms of animal present at the livestock farm concerned. It reflects the amount of antibiotics used at a particular livestock farm, and is used for benchmarking individual livestock farms. This is the measure used by the SDa since 2011 (see the Standard Operating Procedure *'Berekening van de DDD/J voor antimicrobiële middelen door de SDa' [SDa method for calculating the DDDA/Y for antimicrobial agents]*). The $DDDA_{F}$ data of all individual livestock farms within a particular livestock sector are used to determine the mean and the median (*unweighted*, i.e. with all livestock farms contributing equally). The *weighted* mean of the $DDDA_{F}$ (with weighting based on the value of the denominator, i.e. the number of kilograms of animal) is equal to the mean $DDDA_{NAT}$ based on all livestock farms within the livestock sector considered. The $DDDA_{F}$ is expressed in DDDA/animal year. In previous 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.
Animal years	The cumulative number of days of animals' presence in a particular year, divided by 365. This parameter is used because most agricultural livestock have a life expectancy of less than one year. When referring to usage data for individual animals, sometimes usage levels are expressed in DDDA/animal place over a particular period of time rather than in DDDA/animal year.
ESVAC	European Surveillance of Veterinary Antimicrobial Consumption.
EMA	European Medicines Agency
Mass balance	An equation for comparing the reported amount (in kilograms, kg) of an active substance sold with the amount (in kg) of the active substance used according to delivery data reported by veterinarians (delivery records).
RPR	Relative Prescription Ratio. The amount of antibiotics used at a particular livestock farm ($DDDA_{F}$) divided by the action threshold applicable to the livestock farm concerned.
VBI	Veterinary Benchmark Indicator. A veterinarian's VBI expresses the probability that livestock farms for which the veterinarian concerned is responsible will fall within the action zone for livestock farms based on their usage of antibiotics. A veterinarian's VBI is based on the distribution of his or her RPRs.

Introduction

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

- report on developments in the usage of antibiotics in the Dutch livestock sector;
- define benchmark thresholds;
- compare the collected data with sales figures for antibiotics;
- benchmark livestock farms and veterinarians.

Once analysed, the data will also show whether an individual livestock farm's or veterinarian's usage of antibiotics has been persistently high or low for several years in a row.

This is the fourth year for which the SDa publishes usage data. The layout of the current report is largely in line with that of the 2013 report, although certain sections of the current report contain additional information. This report is, however, structured slightly differently, because the findings gave rise to new questions that needed answering and because new challenges were identified in 2014.

Last year, the SDa expert panel consulted with the various livestock sectors about adjusting the calculation methods used. Detailed information on the changes can be found in the final sections of this report. The report also refers to changes to the foundation of the benchmark thresholds. At the end of 2015, the expert panel will discuss its recommendations regarding this matter with the Dutch authorities and the various livestock sectors.

The 2013 report included several figures showing long-term trends based on LEI and SDa data. Some of these figures, e.g. figures representing trends in the veal farming sector, have been adjusted to reflect the fact that average doses rather than maximum doses are now being used in calculations. In addition, sector-specific trends have been fitted for all of the livestock sectors. As a result, the figures now clearly show, based on all information available, to what extent the individual livestock sectors have managed to change their usage levels over the past few years. This information is also relevant because the same data are used to analyse the association between usage data and the resistance data collected by the Central Veterinary Institute. This will be reported on later this year.

In the final section of the report, the expert panel also suggests how to deal with the usage of antibiotics in sectors that are currently not subjected to monitoring.

Trends in the usage and sales of antibiotics

Two reporting methods are used to analyse developments in the usage and sales of antibiotics. Usage of antimicrobial agents is assessed based on all delivery records for antimicrobial agents at livestock farms. These data are transferred to the SDa through the databases of the various livestock sectors.

Sales figures are provided by the Federation of the Dutch Veterinary Pharmaceutical Industry (FIDIN). Differentiation of sales figures according to livestock sector is only possible for a very small number of products, while delivery record data obviously are differentiated by livestock sector.

For each of the livestock sectors, the annual overall number of defined daily doses animal for the entire livestock sector ($DDDA_{NAT}$) is determined, based on all of the delivery records and the average number of kilograms of animal present within the livestock sector concerned. The $DDDA_{NAT}$ has been selected as the general trend indicator for antibiotic consumption within the various Dutch livestock sectors over several years. This parameter is similar to the ones suggested by the European Medicines Agency as part of the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) project, and is in line with the MARAN data previously reported by the Agricultural Economic Institute (LEI). From 2012 onwards, the livestock sectors (except for the broiler and turkey farming sectors) have reported all delivery records data to the SDa. This means that $DDDA_{NAT}$ trends for these livestock sectors can be analysed from 2012 onwards. Only part of the 2012 delivery record data for the broiler farming sector were provided. The 2012 usage levels for the broiler farming sector were therefore estimated based on the available 2012 data. 2013 was the first year in which data on the usage of antibiotics in the turkey farming sector were reported, which means that multi-year data are now also available for this sector. For determination of the $DDDA_{NAT}$, data on the number of animals present in the Netherlands are required. Data from Statistics Netherlands (CBS, Centraal Bureau voor de Statistiek) and EUROSTAT are used to this end.

Number of animals and 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 2014*

Livestock sector	2012	2013	2014
Pig farming sector	710,688	710,802	704,937
Turkey farming sector	4,962	5,046	4,763
Broiler farming sector	43,846	44,242	47,020
Veal farming sector (EUROSTAT)	162,056	176,882	161,884
Veal farming sector (Statistics Netherlands)	156,602	159,547	158,828
Cattle farming sector	1,522,500	1,532,000	1,615,000

** 2012 and 2013 figures provided by LEI; 2014 figures derived from EUROSTAT data, except for the poultry farming sector data. The latter were provided by Statistics Netherlands; the source of veal farming sector data is shown in the table.*

The Statistics Netherlands data were compared to information on the numbers of animals provided by the livestock sectors. This information was then used to calculate the average live weight present (in kilograms). For none of the livestock sectors do the differences between the 2013 and 2014 figures exceed 8%. The production figure for the veal farming sector in particular was slightly higher in 2013 than in the other years. In the event of substantial differences between European and national figures, the Dutch data are used. The same method is used by the EMA (ESVAC project). Such differences between European and Dutch figures were seen in the veal farming sector. For the veal farming sector, analyses with Statistics Netherlands data on the live weight of agricultural livestock in the Netherlands and analyses with EUROSTAT data were performed. The expert panel will look into the reasons for the data discrepancies. At the end of 2015, it will decide whether to use the Statistics Netherlands or the EUROSTAT data for all of the livestock sectors.

Developments in the usage of antibiotics between 2013 and 2014 based on delivery record data

First, the delivery records 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 2, the results were then linked to the average number of kilograms of animal present in 2014 (for the veal and poultry farming sectors Statistics Netherlands data were used, and for the other livestock sectors EUROSTAT data were used). This was done for each type of livestock within the various livestock sectors in the Netherlands. This resulted in livestock sector-specific $DDDA_{NAT}$ figures. The $DDDA_{NAT}$ figures for the 2012-2014 period are included in the table below.

In terms of $DDDA_{NAT}$, the pig farming sector achieved a 4.4% reduction in the usage of antibiotics. Compared to 2013, usage of polymyxins decreased by 16%, while usage of aminoglycosides increased by 10%.

As indicated before, data from Statistics Netherlands were used to calculate the changes in $DDDA_{NAT}$ for the veal farming sector. There were several reasons for using the Statistics Netherlands data. The 2013 data provided by EUROSTAT and Statistics Netherlands turned out to be very different. For the veal farming sector, the number of kilograms EUROSTAT reported for 2013 was substantially higher than the numbers reported for 2012 and 2014. However, the data reported by Statistics Netherlands showed little variation. This resulted in different outcomes when trend analysis was performed using the Statistics Netherlands data. Further inspection revealed that LEI has not always used EUROSTAT data in the past, and that the EMA (ESVAC project) opts to use national animal data in the event of discrepancies between European and national figures. Moreover, the data provided by Statistics Netherlands turned out to be more in keeping with the results reported for individual livestock farms (see the section on benchmarking livestock farms), i.e. the numbers of animals reported by the various livestock sectors and the kilograms of live animal weight estimated based on those numbers. According to the Statistics Netherlands data, the veal farming sector achieved a small, 1.6% reduction in the usage of antibiotics. The veal farming sector data provided by Statistics Netherlands result in the following $DDDA_{NAT}$ figures for the years 2012, 2013 and 2014: 25.85, 21.50 and 21.15, respectively (i.e. a 16.8% reduction and a 1.6% reduction, respectively). This means that according to the Statistics Netherlands figures, the usage levels are still declining to some extent.

Table 2. DDDA$_{NAT}$ data for the 2012-2014 period, by livestock sector (pig, veal, cattle, broiler and turkey farming sectors) and pharmaco-therapeutic group.

	Livestock sector														
	Pig farming sector			Veal farming sector			Cattle farming sector			Broiler farming sector			Turkey farming sector		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
Number of livestock farms with delivery records	6,425	6,588	6,072	2,175	2,125	2,002	32,254	31,650	31,106	732	770	798	-	48	41
Amphenicols	0.06	0.09	0.17	1.23	1.23	1.52	0.05	0.07	0.08	*	*	*		0.02	*
Aminoglycosides	0.00	0.00	0.01	0.81	0.53	0.34	0.01	0.01	0.01	0.58	0.03	0.03		1.24	0.40
1st- and 2nd-generation Cephalosporins	*	*	*	*	*	*	0.02	0.02	0.01	*	*	*		*	*
3rd- and 4th-generation Cephalosporins	0.00	0.00	*	0.00	0.00	0.00	0.03	*0.00	0.00	*	*	*		*	*
Quinolones	0.03	0.03	0.05	0.27	0.30	0.49	0.00	*0.00	0.01	1.97	1.65	2.13		0.23	0.02
Combinations of antibiotics	0.27	0.10	0.05	0.42	0.09	0.01	0.85	0.66	0.30	0.52	0.37	0.06		*	*
Fluoroquinolones	0.00	0.00	0.00	0.31	0.03	0.02	0.01	*	0.00	0.80	0.24	0.18		1.76	1.29
Macrolides/lincosamides	1.39	1.02	1.09	3.91	3.84	3.72	0.09	0.12	0.14	1.06	0.31	0.35		3.55	2.12
Penicillins	2.91	2.18	2.05	2.80	2.11	2.15	1.22	1.45	1.27	7.46	6.34	9.91		9.34	14.89
Pleuromutilins	0.35	0.12	0.09	*	*	*	*	*	*	0.00	0.00	*		*	*
Polymyxins	0.58	0.44	0.34	0.73	0.36	0.15	0.05	0.02	0.01	0.84	0.08	0.05		0.18	0.08
Tetracyclines	6.79	4.58	4.34	12.61	10.87	10.66	0.48	0.48	0.42	2.40	2.52	1.70		11.19	9.58
Trimethoprim/sulphonamides	1.92	1.40	1.33	2.76	2.14	2.08	0.18	0.20	0.19	1.97	1.46	1.34		1.80	2.37
Other	*	*	*	*	*		*	*	*	*	*	*		*	*
Total	**14.32**	**9.96**	**9.52**	**25.85**	**21.50**	**21.15**	**3.00**	**3.04**	**2.44**	**17.60**	**13.01**	**15.76**		**29.31**	**30.74**

0.00 means usage was below 0.005 DDDA$_{NAT}$; * means no usage was reported. An empty cell means no data were available.

The data provided by EUROSTAT, however, would result in the following $DDDA_{NAT}$ figures for 2012, 2013 and 2014: 24.98, 19.39 and 20.75, respectively. These data indicate a steeper decline (of 22.4%) between 2012 and 2013, and an increase (of 7%) between 2013 and 2014. The decrease in $DDDA_{NAT}$ over the three-year period is similar for both data sets.
Compared to 2013, usage of polymyxins and aminoglycosides decreased by 58% and 47%, respectively.

The cattle farming sector achieved an overall reduction in the usage of antibiotics of 19.7%. This is quite impressive, since usage levels in the cattle farming sector were low to begin with. In the cattle farming sector, usage of polymyxins decreased by 49% and usage of aminoglycosides by 30% between 2013 and 2014 (usage of antibiotics for dry-cow therapy is addressed on page 20).

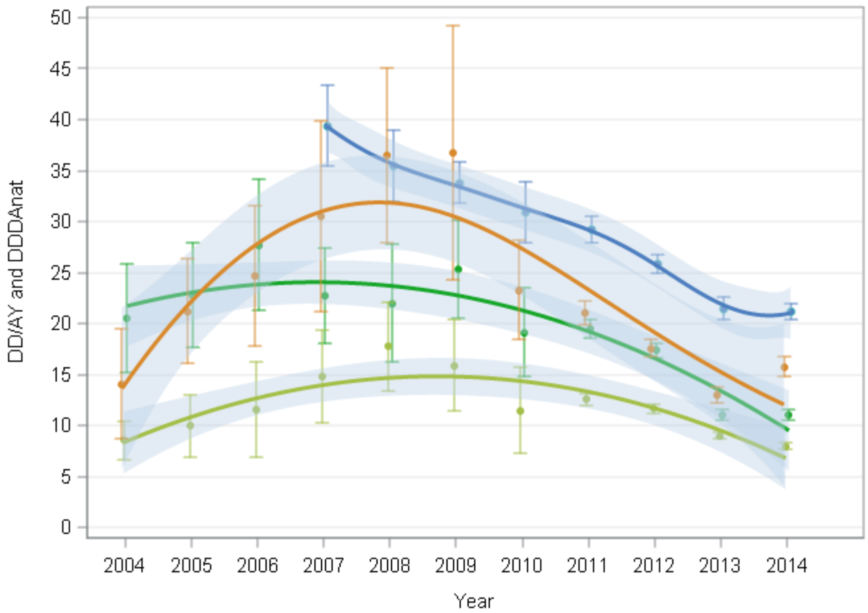
The broiler farming sector showed an increase in $DDDA_{NAT}$-based usage levels. Overall usage in $DDDA_{NAT}$ increased by 21.1% in the 2013-2014 period. The increase may have been due to the fact that administration of subclinical doses of lincomycin/spectinomycin combinations during the first week of life was being phased out, combined with usage in older animals of two medicinal products that were launched in 2013 and the sector-reported increase in treatment weight (GD Animal Health/AVINED, 2015). According to calculations by the expert panel, lincomycin/spectinomycin combinations accounted for just 2% in terms of DDDA, while accounting for 30% in terms of treatment days in 2013. For these calculations, the expert panel assumed administration of lincomycin/spectinomycin combinations at a 25% dose in broilers of 200 g. In 2014, usage of lincomycin/spectinomycin combinations decreased by 85% (85 deliveries in 2014 vs. 643 deliveries in 2013). This decrease reduced the livestock sector's overall usage by 1.7% in terms of DDDA and by 28% in terms of treatment days.
The increased use of products containing amoxicillin (an 80% increase in terms of DDDA) resulted in a 23% increase in overall usage in terms of DDDA. Assuming these products are predominantly administered to older animals weighing 1500 g (rather than 1000 g, the set standard weight), this would imply a 23/1.5=15% increase in treatment days. Combination of these data with those on the decreased usage of lincomycin/spectinomycin combinations shows a 28-15=13% *decrease* in the number of treatment days, but a 23-1.7=21% *increase* in usage in terms of DDDA. These calculations are based on plausible assumptions regarding the doses used and the moment of administration of the particular products concerned, but cannot be verified by the expert panel. Further analysis is required to determine whether these developments in usage patterns can fully explain the increased usage of antibiotics identified by the expert panel.
The 2012 usage levels for the poultry farming sector were recalculated. This had to be done since initially, only the number of treatment days (and no delivery records) were reported. The usage levels presented in this report were initially based on delivery records representing about 60% of the amount of antibiotics used in 2012, and subsequently converted to DDDA figures using the ratio treatment days in 2012:treatment days in 2013 (for 2013, treatment days as well as delivery records were reported).
In the 2013-2014 period, usage of polymyxins increased by 14%, while usage of aminoglycosides decreased by 41%.

Usage of antibiotics in the turkey farming sector increased by 4.9% (in terms of $DDDA_{NAT}$). In absolute terms, this qualifies as a high usage level. The turkey farming sector did, however, achieve a 27% reduction in usage of fluoroquinolones ($DDDA_{NAT}$).
Usage of fluoroquinolones in the poultry sector still requires special attention according to the expert panel. This sector should strive to limit its usage as much as possible until it reaches a level similar to the usage levels of the other livestock sectors.
Compared to 2013, the sector managed to reduce its usage of polymyxins by 75%. Usage of aminoglycosides decreased by 68% in the 2013-2014 period.

Collectively, the monitored livestock sectors recorded a negligible $DDDA_{NAT}$-based increase, of 0.00017% (general mean). When using the figures weighted based on the number of kilograms of animal within the various livestock sectors, the livestock sectors subjected to monitoring achieved a 13.5% reduction in terms of $DDDA_{NAT}$. However, the weighted mean is greatly affected by the reduction in usage levels achieved in the cattle farming sector, which means the developments in the other livestock sectors may come across as more positive than they actually were.

The expert panel analysed the long-term developments in the usage of antibiotics. By integrating LEI and SDa data, it could calculate the reductions achieved over the 2009-2014 period for the various livestock sectors. The LEI data for the veal farming sector were adjusted in order to account for the fact that calculations are now based on average doses. By using the currently available data, the expert panel was able to show sector-specific trends over a longer period of time as accurately as possible. The results are set out in Figure 1.

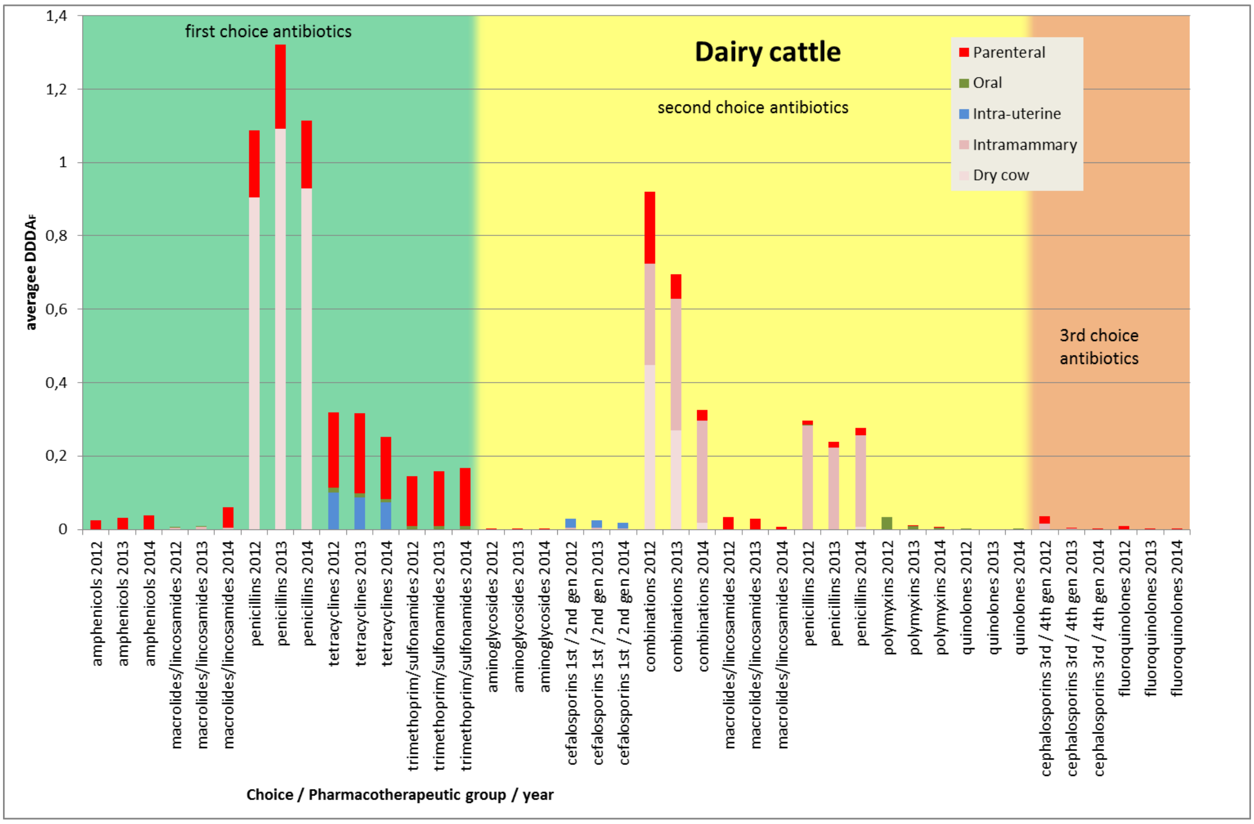
Figure 1. Long-term developments in the usage of antibiotics according to LEI WUR data (as published in MARAN reports) (in DD/AY) and SDa data (in $DDDA_{NAT}$), based on a spline (curve) with 95% CI point estimates for each year. See the appendices for details on the calculation methods used for deriving the figures and to see sector-specific figures. Veal farming sector (blue), poultry farming sector (orange), sow/piglet farms (dark green), pig fattening farms (light green).



The veal farming sector achieved a 37.4% reduction in the usage of antibiotics (in $DDDA_{NAT}$) over the 2009-2014 period. Compared to the 2007 level, usage in terms of $DDDA_{NAT}$ decreased by 46.3%. Sow/piglet farms, pig fattening farms and broiler farms achieved $DDDA_{NAT}$-based reductions of 56.2%, 49.9% and 57.1%, respectively, over the 2009-2014 period. Since the LEI data for the dairy farming sector have not been recalculated using the new (average) doses, no multi-year calculation is provided for this sector.

Additional assessment took place to analyse the usage of antibiotics for dry-cow therapy (intramammary antibiotics) in the dairy farming sector.

Figure 2. Distribution of the usage of antibiotics in the dairy farming sector over several years, by 1st-, 2nd- and 3rd-choice antibiotics and pharmacotherapeutic group.



The cattle farming sector data for 2012 and 2013 clearly show a shift from the use of primarily second- and third-choice antibiotics towards usage of primarily first- and second-choice antibiotics, while recorded overall usage was similar for both years ($DDDA_{NAT}$ of 2.97 and 3.04, respectively). The most notable change in 2013 was the shift from combinations of antibiotics towards first-choice penicillins. This shift was the result of changes in the use of antibiotics for dry-cow therapy, partly because of issues with the availability of several dry-cow (intramammary) antibiotics.
Overall sales and usage of dry-cow antibiotics decreased by 30% in 2014, which resulted in an overall DDDA for dry-cow antibiotics of 0.95. It is possible that to some extent, so-called teat sealants were used instead of dry-cow antibiotics. Teat sealants do not contain antibiotics. At the time this

development took place, the Royal Dutch Society for Veterinary Medicine (KNMvD) published its guideline on the application of selective dry-cow therapy (*'Selectief droogzetten'*). Furthermore, the mastitis-related DDDA dropped by 10%. The SDa thinks it would be wise to assess whether animal welfare is properly taken into account, to make sure the reduction targets do not cause livestock farmers to withhold treatment from animals that actually need it.

In addition to the rise in selective dry-cow therapy, limited availability of penethamate (used in injectables for mastitis and dry-cow injectors) also contributed to the steep decline in the usage of penicillins. For injectables in particular, this resulted in a partial shift towards usage of macrolides.

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

Usage data were provided by the various livestock sectors. Using all delivery records recorded by the livestock sectors, the total number of *kilograms of active substances* used within the individual livestock sectors was calculated in order to enable completion of the mass balance (an equation for comparing the FIDIN-provided number of kilograms of an active substance sold with the reported number of kilograms of the active substance used in the monitored livestock sectors). Total usage according to delivery records amounted to 190,055 kg, while total sales amounted to 207,012 kg. Collectively, compared to 2013, the monitored livestock sectors still managed to achieve a 4.5% reduction in usage of antibiotics in terms of the number of kilograms of active substances used according to the delivery records.

This highly specified division of antibiotics into pharmacotherapeutic groups is also used when reporting on usage in terms of treatable kilograms. It is a more detailed specification than the one used for sales figures reporting.

According to the sector-specific databases, the number of times an antibiotic was prescribed in 2014 amounted to a total of 806,854. These antibiotics were prescribed for 40,011 livestock farms in total. These data were based on delivery records from 6,072 pig farms (in the event of closed-loop farming, a distinction was made between the section with sows/piglets and the section with fattening pigs), 2,002 veal farms, 798 broiler farms, 41 turkey farms, and 31,106 cattle farms.

For livestock farms with high delivery data, the data were rechecked. In a number of cases the high delivery data reflected high doses that were caused by errors in the data file. In those cases, the data were resubmitted

Table 3. Distribution of the usage of antibiotics in kg over the various livestock sectors, overall usage and sales figures in 2014, by group of antibiotics.

Group	Usage according to delivery records Pig farming	Veal farming	Cattle farming	Broiler farming	Turkey farming	Total	Sales figures
Amphenicols	907	2,417	1,280	0	0	4,604	4,354
Aminoglycosides	44	358	99	83	13	597	839
1st- and 2nd-gen. Cephalosporins	0	0	19	0	0	19	545
3rd- and 4th-gen. Cephalosporins	0	0.01	0.46	0	0	0.47	14
Quinolones	485	1,393	327	1,003	1.00	3,208	3,379
Combinations of antibiotics	780	36	1,044	306	0	2,166	3,269
Fluoroquinolones	1.19	12	12	82	61	169	415
Macrolides/lincosamides	7,692	13,746	3,353	834	629	26,254	26,954
Other	0	0	0	0	0	0	502
Penicillins	15,680	7,325	5,416	9,576	1,170	39,168	46,406
Pleuromutilins	704	0	0	0	0	704	863
Polymyxins	1,079	116	52	9	1.32	1,257	1,416
Tetracyclines	35,679	28,737	8,208	1,526	901	75,050	69,052
Trimethoprim/sulphonamides	19,331	8,593	5,818	2,801	315	36,858	49,004
Total	82,380	62,733	25,629	16,220	3,092	190,055	207,012

Trend analysis based on national sales figures

Sales figures were provided by FIDIN. They represent the number of kilograms of active substances sold, and are reported for the main pharmacotherapeutic groups. In 2014, sales of antibiotics for veterinary use in general showed just a small decline (Figure 3). For the second year in a row, usage of tetracyclines seemed to exceed the amounts sold substantially. This was reason for the expert panel to examine the sales figures in greater detail. The 2013 sales figures reported by FIDIN turned out to contain some errors that had led to discrepancies. Several veterinary antimicrobial agents authorized for use in companion animals, turned out not to have been reported in 2013. These agents were, however, reported in 2014.

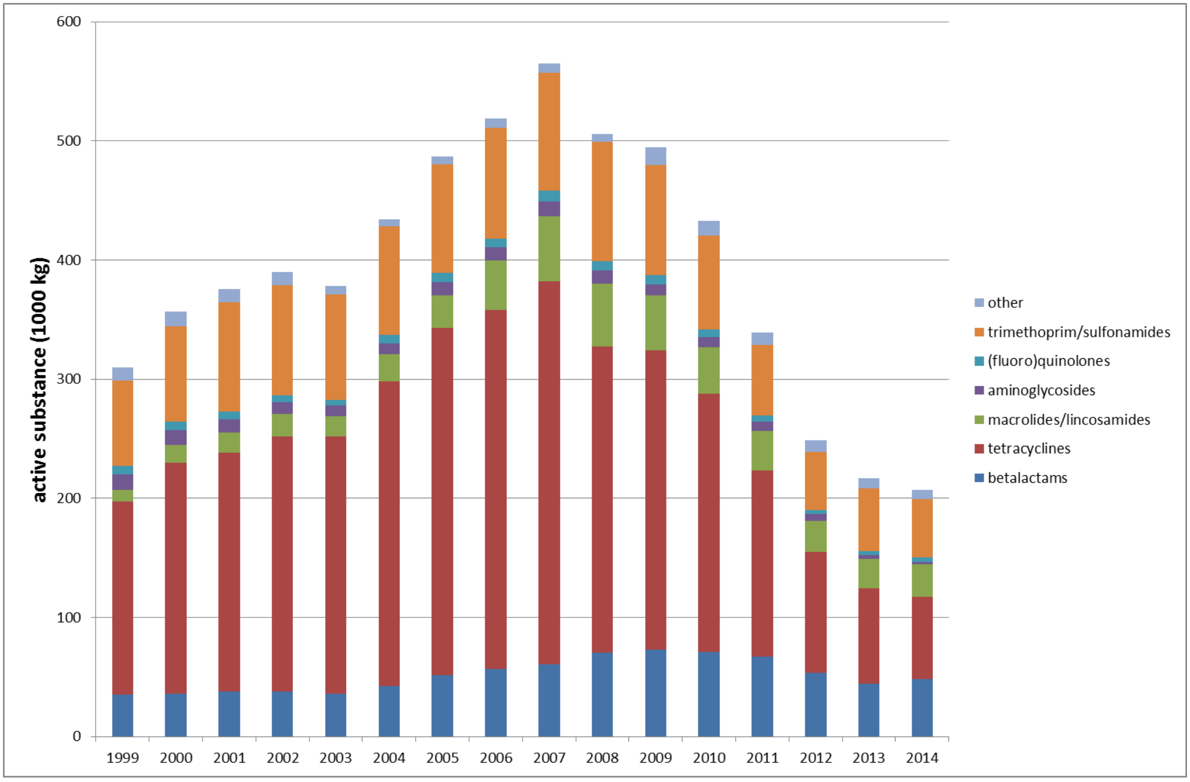
Furthermore, some of the product codes used in the reporting process had been mixed up (this error did not occur in 2012 and was corrected for the years 2013 and 2014). The application of incorrect product codes had led to underreporting of the amounts of first- and second-generation cephalosporins and metronidazole (by an estimated 900 kg in total) and tetracyclines (by an estimated 7,435 kg). The 2013 sales figures for tetracyclines have since been corrected, resulting in an actual reduction achieved over the 2009-2013 period of 56.2% (instead of the previously reported 57.7% reduction). The 2014 sales figure shows a 58.1% reduction compared the sales figure for 2009 (the year used as the reference year by the Dutch government). Compared to 2013, the sales figure shows a modest decline of about 4.5%, meaning that the steep decline seen in the past few years is leveling off. The sales figures therefore confirm the trends shown by the delivery record data.

Comparison of sales figures and veterinarians' delivery record data

In order to explain discrepancies between the amounts of antibiotics consumed according to delivery record data and the sales figures for antibiotics (provided by FIDIN), both data sources were inspected. For the 2014 data, the main differences between the recorded number of kilograms of active substances sold and the recorded number of kilograms consumed could be attributed to:

1. Cephalosporins (of the first, second, third and fourth generation). Of all cephalosporins used, 97% are used outside of the monitored livestock sectors. Of the increase in sales seen for first- and second-generation cephalosporins, 450 kg is attributable to a product authorized for use in companion animals that was not recorded in 2013. Usage of third- and fourth-generation cephalosporins in the monitored livestock sectors continued to decline. In the cattle farming sectors, usage decreased to less than 0.5 kilograms in 2014. Compared to the 2013 level, total sales increased by 1 kg, from 13 to 14 kg. Several products can be attributed to a particular type of animal based on the target species for which they are indicated according to their marketing authorization. This way, 18% of the cephalosporins used in unmonitored sectors can be attributed to companion animals. It is currently not possible to determine which animals accounted for the remaining 82%.
2. Fluoroquinolones. In 2014, usage in the monitored livestock sectors was 25% lower than in 2013, while overall sales increased by 9 kg. Unmonitored sectors accounted for 60% of the fluoroquinolones used. Products exclusively authorized for use in companion animals accounted for 7% of the total amount of fluoroquinolones used (27.5 kg). The remaining 53% were fluoroquinolones that were authorized for use in food-producing animals but used in unmonitored sectors. It is currently unclear in which target species they were used.
3. The pharmacotherapeutic group referred to as 'Other'. The antibiotics included in this group were not used in the monitored livestock sectors. Usage of other antibiotics amounted to 500 kg in total. This group includes metronidazole, a product exclusively authorized for use in companion animals. This product was not recorded in 2013. The other product included in this group is bacitracin, which is authorized for use in rabbits.
4. Substantial usage (25-30% of the total number of kilograms) in unmonitored sectors did not only occur in the pharmacotherapeutic group referred to as 'Other', but also applied to trimethoprim/sulphonamide combinations, combinations of multiple antibiotics and aminoglycosides (13,491 kg in total).
5. Many of the penicillins are authorized for use in several target species, including companion animals.

Figure 3. Developments in sales of antimicrobial agents between 1999 and 2014, in number of kilograms of active substances sold (x1000) (source: FIDIN), by main pharmacotherapeutic group in 2014.*



*The 2013 figures were corrected after some errors were identified in 2015, and they therefore deviate from the 2013 figures included in the 2013 SDa report.

6. Products exclusively authorized for use in companion animals accounted for 5,000 kg of the antimicrobial agents sold.
7. Following correction of a recording error regarding a product (explained in the section 'Trend analysis based on national sales figures'), the difference between recorded usage and recorded sales of tetracyclines in 2013 (with usage exceeding sales) turned out to be just 2% rather than the 13% difference found initially. The corrected 2014 figures still resulted in a 9% difference. This was most likely due to the relatively strong decline (of 8%) in usage levels for this pharmacotherapeutic group, which probably has led to stockpiling.

The SDa expert panel is of the opinion that the recording of sales figures and the recording of delivery records both have benefits as well as shortcomings as a method for monitoring usage of antibiotics at a national and livestock sector level. For the four main livestock sectors, the two recording methods (taking their individual shortcomings into account) can be deemed to be largely consistent regarding the 2014 figures.

Benchmarking livestock farms

When determining the defined daily dose animal at the farm level, the expert panel uses the parameter $DDDA_F$. For the veal farming sector, the 2014 $DDDA_F$ figures were based on average doses, while maximum doses had been used in previous years. The 2013-2014 period showed some minor shifts in mean and median antibiotic use in the veal farming sector. The P75 and P90 (i.e. the DDDA levels below which 75% and 90% of individual farms' DDDA figures, respectively, will be found) also did not change substantially, which means the tails of the distributions are still present.

In the pig farming sector, mean antibiotic use and in particular median antibiotic use decreased. This was to be expected considering the decrease over the 2013-2014 period referred to previously. The P75 and P90 showed a similar rate of decline. This means that, as intended, the tails of the distributions have also moved towards a slightly lower usage level.

The broiler farming sector showed an increase in both mean and median antibiotic use in terms of the calculated DDDA figures. The P75 and P90 both increased by about 30%. This means that the variability between individual broiler farms is on the increase again. This is a highly undesirable development, which demands further investigation by the broiler farming sector.

Median antibiotic use at turkey farms decreased slightly compared to the 2013 level, while the P75 and P90 were higher than in 2013. Apparently, the variability between individual turkey farms also increased, although these changes were not as pronounced as those seen in the broiler farming sector. The high usage levels and minor improvements mean that additional measures are required for the turkey farming sector.

Table 4. Annual defined daily doses animal ($DDDA_F$) for the four main livestock sectors and the various types of farms in 2014. Provided parameters are the mean, median (50th percentile), 75th percentile (P75) and 90th percentile (P90).

Livestock sector	Type of farm	N	Mean	Median	P75	P90
Veal farming sector	White veal farms	864	24.51	23.43	31.03	37.80
	Rosé veal starter farms	260	79.64	77.67	97.24	113.93
	Rosé veal fattening farms	663	3.40	1.18	4.55	9.50
	Rosé combination farms	215	12.95	12.01	17.10	21.91
Pig farming sector	Sow/piglet farms	2,487	9.34	4.86	10.81	19.97
	Pig fattening farms	4,905	5.06	2.39	6.79	11.80
Poultry farming sector	Broiler farms	798	13.31	9.37	19.68	34.60
	Turkey farms	41	22.37	16.62	33.98	45.25
Cattle farming sector	Dairy cattle farms	17,747	2.27	2.19	3.04	3.89
	Rearing farms	474	1.38	0.00	0.25	1.80
	Suckler cow farms	9,588	0.70	0.10	0.70	2.00
	Beef farms	3,297	1.71	0.00	0.47	4.37

In the dairy farming sector, mean and median antibiotic use continued to decline, and the P75 and P90 were also lower than they were in 2013. It is a significant achievement that a livestock sector characterized by low usage levels and only minor variation in usage levels between individual farms, still managed to further reduce its usage of antibiotics. Usage in the other cattle farming sectors remained stable.

Table 5. Signaling and action thresholds for the various livestock sectors and types of farms for 2014, based on the DDDA$_F$.

Livestock sector	Type of farm	Signaling threshold	Action threshold
Veal farming sector	White veal farms	23	39
	Rosé veal starter farms	67	110
	Rosé veal fattening farms	1	6
	Rosé combination farms	12	22
Pig farming sector	Sow/piglet farms	10	22
	Pig fattening farms	10	13
Poultry farming sector	Broiler farms	15	30
	Turkey farms*	19	31
Cattle farming sector	Dairy cattle farms	4**	6
	Rearing farms	1	2
	Suckler cow farms	1	2
	Beef farms	1	2

* see the 2013 SDa report; ** the signaling threshold for the dairy farming sector was based on the P80. The signaling threshold for all other livestock sectors except the pig fattening sector, refers to the P50 minus 20%.

Table 6. Distribution of livestock farms over the various benchmark zones in 2014.

Livestock sector	Type of farm	Target zone n (%)	Signaling zone n (%)	Action zone n (%)
Veal farming sector	White veal farms	414 (48%)	382 (44%)	68 (8%)
	Rosé veal starter farms	85 (33%)	146 (56%)	29 (11%)
	Rosé veal fattening farms	316 (48%)	223 (34%)	124 (19%)
	Rosé combination farms	107 (50%)	87 (40%)	21 (10%)
Pig farming sector	Sow/piglet farms	1,799 (72%)	480 (19%)	208 (8%)
	Pig fattening farms	4,209 (86%)	311 (6%)	385 (8%)
Poultry farming sector	Broiler farms	528 (66%)	168 (21%)	102 (13%)
	Turkey farms	21 (51%)	9 (22%)	11 (27%)
Cattle farming sector	Dairy cattle farms	16,190 (91%)	1,394 (8%)	163 (1%)
	Rearing farms	399 (84%)	30 (6%)	45 (9%)
	Suckler cow farms	7,613 (79%)	985 (10%)	990 (10%)
	Beef farms	2,689 (82%)	166 (5%)	442 (13%)

The distribution of livestock farms over the various benchmark zones (Table 6) is in line with the general trends indicated in the previous tables and figures. Except for the dairy cattle farming sector, none of the livestock sectors showed any major developments. The modest developments that did occur, however, are in line with the presence of modest changes in mean and median antibiotic use. The dairy farming sector managed to achieve a steep reduction in the proportion of farms within the signaling zone (8% in 2014 versus 42% in 2013). This achievement was the result of adjustment of the signaling threshold and more selective application of dry-cow therapy. Although the action threshold remained the same, the proportion of farms within the action zone also decreased (1% in 2014 versus 3% in 2013).

It is a positive development that the proportion of veal farms in the action zone decreased in the 2013-2014 period and is now similar to the proportions recorded for the other livestock sectors. However, no further reduction in the number of signaling zone farms was found for the various types of veal farms. The relatively high proportion of veal farms that fall within the signaling zone therefore remains cause for concern and requires additional measures to be taken. It should be noted that the benchmark thresholds for veal farms were not adjusted to take account of the new calculation method (which is based on average doses rather than on maximum doses). This could have contributed to the decreasing number of farms that moved from the signaling and action zones into the target zone. However, a similar tendency was already seen in 2013. It may therefore be assumed that the application of a calculation method based on average doses could only have had a limited effect on the benchmarking results. As a revision of the benchmark thresholds was already foreseen for late 2015, the SDa expert panel decided not to adjust the thresholds in 2014, as it deems it undesirable to change the benchmark thresholds multiple times in a short period of time.

Table 7. Shifts in the proportion of livestock farms in the various benchmark zones in the 2012-2014 period.

Livestock sector	Type of farm	Target zone %			Signaling zone %			Action zone %		
Year		2012	2013	2014	2012	2013	2014	2012	2013	2014
Veal farming sector	White veal farms	33	49	48	50	41	44	17	10	8
	Rosé veal starter farms	36	39	33	48	48	56	16	13	11
	Rosé veal fattening farms	38	46	48	33	33	34	29	21	19
	Rosé combination farms	-	60	50	-	30	40	-	10	10
Pig farming sector	Sow/piglet farms	56	66	72	24	24	19	20	11	8
	Pig fattening farms	77	83	86	16	6	6	7	11	8
Poultry farming sector	Broiler farms	52	68	66	31	25	21	17	6	13
	Turkey farms	-	50	51	-	25	22	-	25	27
Cattle farming sector	Dairy cattle farms	56	55	91	40	42	8	4	3	1
	Rearing farms	81	83	84	3	6	6	16	11	9
	Suckler cow farms	82	80	84	8	6	6	10	14	9
	Beef farms	-	79	79	-	10	10	-	11	10

The number of broiler farms in the action zone increased in 2014. The broiler farming sector will therefore be requested to determine the reasons for this change in usage levels. Usage levels for turkey farms are high. Compared to the year 2013, when the benchmark thresholds were determined based on the median and P75 figures for turkey farms, the proportion of farms in the action zone increased slightly in 2014 (from 25% to 27%). Measures should be taken to reduce the proportion of farms that fall within the action zone and to bring it in line with the proportions recorded for the other livestock sectors. The turkey farming sector is therefore requested to draw up an action plan on how to reduce its usage of antibiotics over the next few years.

When looking at the data for all of the livestock sectors collectively, the proportion of farms in the action zone has decreased substantially over the past years. Nevertheless, the aim for 2015 should be not to exceed the action threshold at all. In the opinion of the expert panel, a further reduction in the usage of antibiotics will require more detailed analysis of the available usage data in order to identify the distinctive characteristics of low-usage livestock farms and high-usage livestock farms. Such detailed analysis requires additional information on livestock farm-specific characteristics that can subsequently be linked to usage-level data. The necessary information will have be collected through random sampling. The success factors identified in this manner can be used as the basis for targeted improvement plans for the livestock farms concerned. In addition, scenario analyses could be performed to estimate the effects that new sector-wide measures will have on the usage of antibiotics.

Benchmarking veterinarians

The benchmarking method for veterinarians was introduced in March of 2014 and was based on prescription data recorded in 2012. The 2013 benchmarking results were published last year. At that time, veterinarians were not provided with their personal scores, since the sector-specific databases were not yet equipped to report results for individual veterinarians. Veterinarians could, however, calculate their personal Veterinary Benchmark Indicator (VBI) by using a simple online calculator using information on the amount of antibiotics used at each of the farms with which they had a registered one-to-one relationship. Veterinarians active in the veal farming sector now have direct access to their VBI scores, through a dedicated web portal. Veterinarians active in the poultry or dairy farming sector are sent their latest VBI results on a quarterly basis. Veterinarians active in the pig farming sector do not yet have access to their VBI scores. Later in 2015, veterinarians should have access to VBI scores for every livestock sector. Due to the reasons described above, the expert panel expects the effects of the VBI's implementation only to become apparent later in 2015.

Differences in prescription patterns of veterinarians are made transparent by determining the $DDDA_{VET}$ for every single veterinarian. The SDa uses this parameter together with the VBI in order to define the average prescription pattern of a particular veterinarian. The table below shows the mean $DDDA_{VET}$ and the 10th, 25th, 75th and 90th percentiles for all veterinarians within a particular livestock sector. For the turkey farming sector, the data required for determining veterinarian-specific usage levels in terms of $DDDA_{VET}$ or VBI (registered one-to-one relationships) were not provided. The extent of the difference between veterinarians with a high prescription pattern and those with a low prescription pattern was assessed by determining the ratios P90:P10 and P75:P25.

Table 8. Distribution of veterinarians' $DDDA_{VET}$ figures in 2014, by livestock sector.

Livestock sector	N	Mean	P10	P25	P75	P90	P75:P25	P90:P10
Veal farming sector	135	12.3	0.8	3.2	21.3	25.4	6.7	33.1
Pig farming sector	285	7.0	1.7	3.4	9.0	12.1	2.6	7.0
Broiler farming sector	89	12.2	0.0	4.2	18.8	25.7	4.5	-
Cattle farming sector	790	2.3	1.3	1.8	2.6	3.1	1.4	2.4

According to the table above, the veterinarians in the cattle farming sector show the lowest level of variation. The $DDDA_{VET}$ of the 10% of veterinarians with the highest prescription patterns is 2.4 times higher than the $DDDA_{VET}$ of the 10% of veterinarians with the lowest prescription patterns (P90:P10). In the pig and veal farming sectors, the P90:P10 ratios amount to 7 and approximately 33, respectively. As far as the ratio recorded for the veal farming sector is concerned, it should be taken into account that this livestock sector includes various types of farms, which vary substantially in the amounts of antibiotics used. These variations may have affected the $DDDA_{VET}$ figures reported for the veal farming sector as a whole. Veterinarians' $DDDA_{VET}$ figures in part depend on their portfolio of livestock farms and on how the livestock farms are distributed over the various livestock sectors.

The P90:P10 ratio for the broiler farming sector could not be included, since the P10 was 0. For the three livestock sectors for which the P90:P10 ratio could be included, the P75:P25 figures show a similar trend. The P75:P25 value recorded for the broiler farming sector is halfway between the ratios recorded for the pig and veal farming sectors. The distribution of $DDDA_{VET}$ figures indicates that even after the introduction of a specific benchmarking method for veterinarians, the prescription patterns of veterinarians still show quite a substantial amount of variation, except for those relating to the cattle farming sector.

When comparing the 2014 figures with those for 2013, some remarkable shifts can be identified. The number of veterinarians with whom livestock farms had a registered one-to-one relationship, decreased from 1,529 to 1,291. The decrease in the number of veterinarians with whom multiple farms within a particular livestock sector had a one-to-one relationship was particularly pronounced in the veal and pig farming sectors. However, the number of veterinarians responsible for just one farm within a particular livestock sector also decreased. Whether the number of active veterinarians has actually decreased or whether the changes were caused by other underlying developments, cannot be determined with the currently available information.

Most veterinarians (59.7%) had prescription patterns that met the target zone criteria. In total, 3.3% of veterinarians had a VBI over 0.3, and therefore fell within the action zone. Five veterinarians were responsible for just one farm that was included in the action zone. As a result, the total proportion of veterinarians that fell within the action zone amounted to 3.4%. Those veterinarians are expected to take action immediately in order to change their prescription patterns. The proportion of veterinarians with a VBI>0.30 varied slightly between the various livestock sectors, with proportions of 2.4%, 2.6%, 4.9% and 6.7% being recorded for the pig, dairy, broiler and veal farming sectors, respectively. With 37% of all veterinarians with a VBI being included in the signaling zone, the number of veterinarians in this zone was high. Of the total number of veterinarians, 35% fell within the signaling zone. The proportion of veterinarians in the signaling zone varied between the various livestock sectors, with proportions of 32.0%, 37.0%, 39% and 50% being recorded for the cattle, broiler, pig and veal farming sectors, respectively.

Table 9. 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	Signaling	Action	Target	Signaling	Action
	≤0.10	(0.10<VBI≤0.30)	(VBI>0.3)	-	-	-
Veal farming sector	40	61	8	19	6	1
Pig farming sector	157	109	6	11	1	1
Broiler farming sector	33	28	4	14	2	0
Cattle farming sector	494	249	22	20	2	3

The previous sections have shown that approximately 10% of livestock farms had a usage level that exceeded the action threshold. A veterinarian's prescription pattern is only deemed to be too high if at least 30% of the livestock farms the veterinarian is responsible for have a usage level exceeding the action threshold. This was the case for 3.3% of veterinarians. This means that a VBI of 0.30 (30%) is a relatively conservative threshold when considering the proportion of livestock farms in the action zone this VBI represents (30% rather than the actual 10%). With the way in which the livestock farms are currently distributed over the various benchmark zones, a VBI of 0.3 therefore only slightly encourages veterinarians to improve their prescription patterns. It is necessary to better align the risks for livestock farmers and veterinarians to be included in the action zone. To this end, the VBI-related signaling and action thresholds should be lowered soon.

Developments regarding the monitoring and benchmarking processes

Revision of the method used to calculate the $DDDA_F$

The benchmarking method for livestock farms was finalized in 2012. Since its introduction, considerable experience has been gained in the benchmarking of livestock farms. Over the years, the expert panel as well as the livestock sectors have identified several bottlenecks and limitations. Several livestock sectors have suggested changes to the method used in order to make it possible to take better into account the various product cycles at certain farms and to reduce the occurrence of distorted DDDA figures caused by variations in how a population of agricultural livestock is made up. The expert panel itself also wanted to adjust several aspects of the method. In doing so, it wanted to solve several issues regarding data interpretation that had been identified, and make usage levels pertaining to certain groups of livestock (such as young stock) more transparent, for instance. These changes require a revision of the methods used. Since the autumn of 2014, the SDa expert panel has met with the various livestock sectors several times to discuss the method used to calculate the amounts of antibiotics used at individual farms. In most cases, these meetings have resulted in changes that will be implemented in the course of 2015. For some livestock sectors, the intended changes are clear but still require further specification of certain technical aspects. The changes to be implemented for the various livestock sectors can be summarized as follows:

- Pig farming sector: a 90-degree turn in the method used has been agreed. The benchmarking method will no longer categorize pig farms by type of farm (sow/piglet farms and pig fattening farms), but rather by animal category (sows/piglets, suckling pigs and fattening pigs). As a result, a single pig farm could be assigned a maximum of three benchmark scores, depending on the animal categories present at the farm concerned. As of this year, veterinarians prescribing antibiotics for pigs therefore have to record for which of the three animal categories the antibiotic was intended. The SDa and the pig farming sector have finalized all technical aspects regarding the calculation method to be used, and they will be set out in an SOP. The revised method is expected to better reflect the actual situation, better represent the number of animals included in the various categories, and take better into account the effects of the addition of new gilts. In 2015, the revised method will hopefully lead to a further reduction of the amounts of antibiotics used.

Table 10. Revised pig farming sector benchmark thresholds for 2015, by animal category (age group).

Age group	Signaling threshold	Action threshold
Sows/piglets	10	20
Suckler pigs	22	60
Fattening pigs	10	12

- Cattle farming sector: cattle farms are characterized by relatively low levels of antibiotic use. Although usage in young stock is slightly lower than usage in older cattle, this is not properly reflected by the current method. It was therefore decided to specify usage data by animal category, similar to the new categorization to be used for pig farms. The technical details are currently being finalized. The expert panel hopes to conclude the decision-making process somewhere in the summer of 2015.
- Veal farming sector: the veal farming sector wanted the SDa to enable herd-based benchmarking, since the number of herds present at a veal farm may vary from year to year. Such variations can cause fluctuations in a farm's usage levels over several years. Since the veal farming sector performs calculations based on growth curves, it asked the SDa to also use this approach in the SDa's benchmarking method. The expert panel does not want to use benchmarking periods shorter than one year, as would be required for herd-based benchmarking. As an alternative to herd-based benchmarking, the expert panel has suggested the introduction of a longer benchmarking period. The veal farming sector feels this might be an acceptable solution, so the technical aspects of this proposal are currently being specified. Using a benchmarking period of 1.5 years will affect the figures relating to mean antibiotic use and the distribution of usage data over the various farms. This means the benchmarking thresholds will have to be adjusted accordingly. The expert panel is not going to use DDDA calculations based on growth curves in its benchmarking method. The use of growth curves would require information on the moment of administration for every delivery record recorded. Should the moment of administration be recorded incorrectly, it would have a considerable effect on the calculated DDDA, and the expert panel feels this approach would be too susceptible to errors.
- Poultry farming sector: the poultry farming sector performs calculations based on growth curves and uses a method based on treatment days. Although DD/AY data are included in reports by the poultry farming sector, this parameter is not used in the actual calculations. The SDa expert panel feels that the poultry farming sector using a different approach by no means helps to increase the level of transparency within this sector. In fact, application of two different approaches causes confusion: analysis based on the SDa method and analysis of sector-specific data based on the number of treatment days showed different trends in the usage of antibiotics between 2013 and 2014. As mentioned above in relation to the veal farming sector, the expert panel is not going to use calculations based on growth curves. The reasons for this decision have already been explained in the paragraph above. The SDa also feels the poultry farming sector has to fully adopt the DDDA-based method commonly applied throughout Europe. This method is to be implemented at the sector level in the next few years. As part of the ESVAC project, several pilot projects are currently being initiated to monitor the usage of antibiotics at a sample of farms using a method similar to the one applied by the SDa.

During its discussions with the various livestock sectors, the SDa expert panel noticed discrepancies in how individual livestock sectors present their data to livestock farmers and nowadays veterinarians as well. Although the expert panel knows that the sectors may have well-founded reasons for presenting their figures in a particular manner, it feels it is essential that livestock farmers are always provided with the results of calculations based on the SDa's method. If the sector feels the need to do so, it should feel free to provide additional, more detailed information as well. If necessary, the expert panel will also strive to harmonize the way in which results are presented.

Usage of antibiotics in sectors not subjected to monitoring

In 2013, the expert panel found out that certain second- and third-choice antibiotics are used outside of the four livestock sectors that are subjected to monitoring. This was discovered when comparing sales figures to delivery record data recorded by veterinarians. Detailed information on the usage in unmonitored sectors is not available. The expert panel has therefore decided that monitoring should no longer be limited to the four livestock sectors that are currently being monitored. However, the expert panel feels there are different ways to extend its monitoring activities, and the type of monitoring should correspond to the extent of the usage within the sector concerned. The SDa expert panel therefore proposes two different scenarios:

- Usage in sectors with documented low-level usage (the expert panel has previously reported this to be the case for laying hens, for instance) could be assessed every three years based on a random sample of farms, in order to keep track of any developments. It is expected that this scenario would apply to farms with laying hens, ducks or sheep.
- In sectors with insufficient or no available information, spot checks should be performed at a random sample of farms. The findings could then be used to decide whether or not continuous monitoring is required. It was decided to subject the turkey farming sector to continuous monitoring as of 2013, and the rabbit farming sector will be subjected to continuous monitoring as of 2015. The latter sector is currently monitoring its farms on a voluntary basis. As of 2016, the SDa will manage the monitoring of rabbit farms. In other sectors, such as the goat farming sector, the extent of the usage of antibiotics should be assessed. The goat farming sector, which in terms of usage levels is comparable to the dairy farming sector, seems to be a likely candidate for continuous monitoring.

In addition to the livestock sectors mentioned above, there are several unmonitored sectors for which the amounts of antibiotics used can currently either only be estimated to some extent based on sales figures (e.g. companion animals, with certain veterinary prescription drugs being exclusively authorized for use in companion animals) or not be estimated in a reliable way at all (e.g. horses, fish, mink, pigeons and smaller categories of animals to which the human population could potentially be exposed on a regular basis, such as zoo animals and animals at children's farms). Exploratory studies (e.g. to determine point prevalence data) are the way to go for these animal populations. The prioritization of such exploratory studies should be based on both the level of direct contact that occurs between a particular category of animals and the human population, and the expected usage of antimicrobial agents in these animals.

Revision of the benchmark thresholds in late 2015

In 2011, the initial benchmark thresholds were based on LEI data from samples of farms. The thresholds were later adjusted based on the sector-wide analyses published by the SDa since 2012. Most of the adjusted benchmark thresholds were derived from the distribution of the annual DDDA figures for all livestock farms within the livestock sector or subsector concerned. The signaling and action thresholds were set at the 50th percentile and 75th percentile of this distribution, respectively, minus 20%. Apart from exceptions, the benchmark thresholds have not been revised since their implementation. However, benchmarking in its current form (i.e. with the current benchmark thresholds and the current method) is not what it used to be:

- $DDDA_F$-related benchmark thresholds are based on the distribution of usage data rather than on the association between usage of and resistance to antimicrobial agents. In order to obtain benchmark thresholds that are closely associated with the issue of antimicrobial resistance, new thresholds will be defined based on information on the development of resistance and the presence of resistant microorganisms. In this light, the expert panel is particularly interested in the recently published Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA) Report by the European Centre for Disease Prevention and Control (ECDC), the European Food Safety Agency (EFSA) and the EMA. This report was published in January of 2015 and explores associations between veterinary usage of antibiotics and the presence of resistant microorganisms in animals and humans by comparing the usage and resistance data of several countries. Since usage of antibiotics in the Netherlands has declined over a relatively short period of time, it might be possible to explore these associations at a more detailed level, by livestock sector and solely for the situation in the Netherlands. To this end, the SDa has taken steps to enable detailed analysis of the usage and resistance data published annually by the Central Veterinary Institute in its MARAN reports. This analysis will provide insight into sector-specific associations between usage of antibiotics and antibiotic resistance, and make it possible to quantify the effect of reduced usage levels on the presence of resistant microorganisms. Since the issue of antimicrobial resistance differs per individual livestock sector, this new approach is likely to give rise to sector-specific benchmarking methods. Considering the above, the SDa expert panel will provide recommendations for adjusting the foundation of its benchmark thresholds later in 2015. When preparing its recommendations, the expert panel will focus predominantly on the relationship between usage of antibiotics and the extent of the problem of antimicrobial resistance. The zero usage benchmark thresholds introduced for third- and fourth-generation cephalosporins and fluoroquinolones have generated impressive results in a short period of time and will continue to be used.
- The benchmarking method for veterinarians has not yet yielded substantial effects, since it took quite a lot of time to launch the method and to make sector-specific data accessible. An additional complication was the fact that due to reduced usage of antibiotics at farms, the current signaling and action thresholds for veterinarians (0.10 and 0.30, respectively) are not in line with the frequency with which the benchmark thresholds for livestock farms are exceeded. The benchmarking method used for veterinarians will be adjusted accordingly.

- In several livestock sectors (the pig and cattle farming sectors), the calculation methods used have caused or will cause individual livestock farms to be assigned multiple benchmark scores. The VBI method therefore has to be adjusted accordingly. Later in 2015, the expert panel will provide recommendations on how to deal with this matter. The expert panel will also shortly indicate how the benchmark thresholds for veterinarians can be adjusted in such a way as to bring the benchmarking method for veterinarians more in line with the benchmarking method for livestock farms.

The SDa expert panel spends considerable amounts of time checking and editing the data provided by the various livestock sectors. Better data management within the livestock sectors would make this process more efficient. In general, the expert panel does regard the data provided to be reliable, but in a number of cases a sector's data management has been considered to be too *ad hoc*. KPMG is currently investigating the reliability of the data and the quality assurance procedures used in veterinary practices and livestock sectors. Based on the findings of this inspection, at the end of 2015 the expert panel will provide recommendations on how data management and data transfer could be improved.

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Appendices

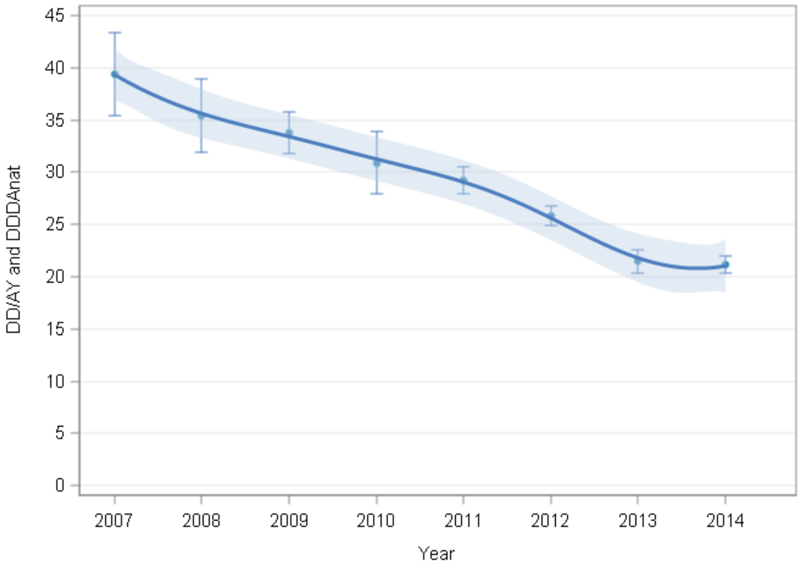
Trends in defined daily doses animal (in $DDDA_{NAT}$) by livestock sector

Table A1. $DDDA_{NAT}$ data for the two types of farms comprising the pig farming sector and for the dairy farming sector. These additional analyses were conducted to facilitate comparison with LEI WUR MARAN data.

	Livestock sector								
	Sow/piglet farms*			Pig fattening farms*			Dairy farming sector**		
Number of livestock farms with delivery records	2,338	1,345	2,487	4,628	5,378	4,905	18,053	18,005	17,747
Group	2012	2013	2014	2012	2013	2014	2012	2013	2014
Amphenicols	0.05	0.09	0.16	0.07	0.10	0.17	0.04	0.05	0.06
Aminoglycosides	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
1st- and 2nd-gen. cephalosporins	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.02
3rd- and 4th-gen. cephalosporins	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Quinolones	0.05	0.05	0.11	0.01	0.02	0.01	0.00	0.00	0.00
Fluoroquinolones	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Macrolides/lincosamides	1.57	0.97	0.87	1.24	1.07	1.26	0.07	0.06	0.10
Penicillins	5.14	3.44	3.48	0.99	1.06	0.74	1.86	2.19	2.01
Pleuromutilins	0.65	0.09	0.11	0.10	0.14	0.08	0.00	0.00	0.00
Polymyxins	1.07	0.79	0.63	0.17	0.14	0.08	0.06	0.02	0.01
Tetracyclines	6.14	3.69	3.84	7.35	5.36	4.69	0.43	0.42	0.39
Trimethoprim/sulphonamides	2.26	1.77	1.78	1.63	1.07	0.91	0.20	0.22	0.24
Combinations of multiple antibiotics	0.45	0.14	0.08	0.12	0.07	0.02	1.30	1.01	0.48
Other	-	-	-	-	-	-	-	-	-
Total	**17.39**	**11.03**	**11.08**	**11.68**	**9.02**	**7.96**	**4.06**	**4.03**	**3.33**

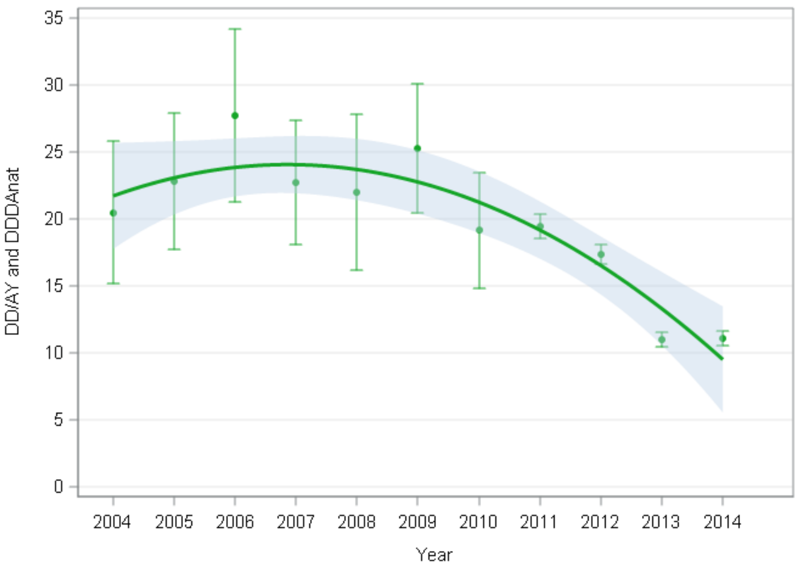
*Number of kilograms of animal estimated based on animal data provided by the pig farming sector.
**Number of kilograms of animal estimated based on data provided by EUROSTAT: 924,600, 958,200 and 966,000 x 1000 kg for the years 2012, 2013 and 2014, respectively.

Figure A1. Defined daily doses animal for the veal farming sector as reported by LEI WUR (2007-2010 data, in DD/AY) and the SDa (2011-2014 data, in $DDDA_{NAT}$).



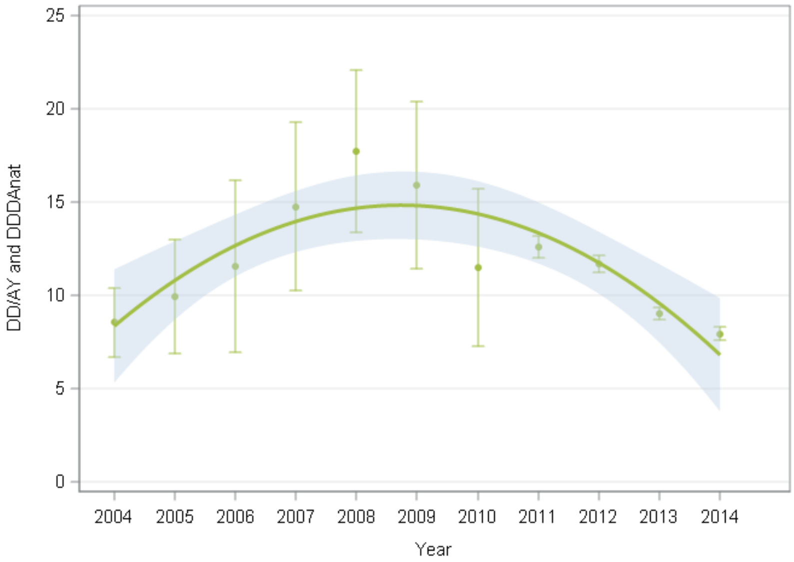
Point estimates (solid circles) with confidence intervals and trend (solid line). The trend was identified using a penalized B-spline routine with SAS PROG GPLOT (SAS Software). The $DDDA_{NAT}$ for 2011 was estimated using the 2011 $DDDA_F$:2012 $DDDA_F$ ratio (with weighting based on the average number of kilograms present at individual farms). Statistics Netherlands data were used to determine the total number of kilograms of animal present for the years 2011 to 2014, and the 95% confidence intervals were based on the corresponding confidence intervals for the $DDDA_F$ data weighted based on the kilograms of animal present at individual farms.

Figure A2. Defined daily doses animal for sow/piglet farms as reported by LEI WUR (2007-2010 data, in DD/AY) and the SDa (2011-2014 data, in $DDDA_{NAT}$).



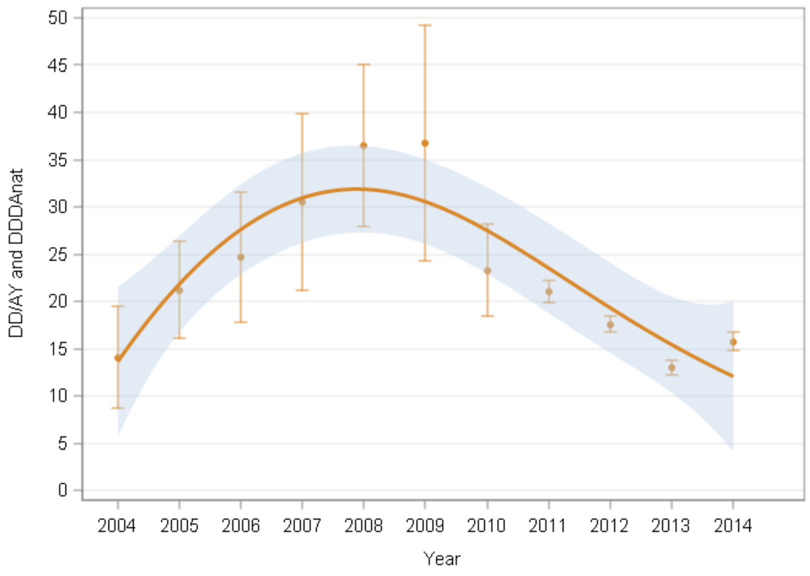
Point estimates (solid circles) with confidence intervals and trend (solid line). The trend was identified using a penalized B-spline routine with SAS PROG GPLOT (SAS Software).The $DDDA_{NAT}$ for 2011 was estimated using the 2011 $DDDA_F$:2012 $DDDA_F$ ratio (with weighting based on the average number of kilograms present at individual farms). EUROSTAT data were used to determine the total number of kilograms of animal present for the years 2011 to 2014, and the 95% confidence intervals were based on the corresponding confidence intervals for the weighted $DDDA_F$ data.

Figure A3. Defined daily doses animal for pig fattening farms as reported by LEI WUR (2007-2010 data, in DD/AY) and the SDa (2011-2014 data, in $DDDA_{NAT}$).



Point estimates (solid circles) with confidence intervals and trend (solid line). The trend was identified using a penalized B-spline routine with SAS PROG GPLOT (SAS Software).. The $DDDA_{NAT}$ for 2011 was estimated using the 2011 $DDDA_F$:2012 $DDDA_F$ ratio (with weighting based on the average number of kilograms present at individual farms). EUROSTAT data were used to determine the total number of kilograms of animal present for the years 2011 to 2014, and the 95% confidence intervals were based on the corresponding confidence intervals for the weighted $DDDA_F$ data.

Figure A4. Defined daily doses animal for the broiler farming sector as reported by LEI WUR (2007-2010 data, in DD/AY) and the SDa (2011-2014 data, in $DDDA_{NAT}$).



Point estimates (solid circles) with confidence intervals and trend (solid line). The trend was identified using a penalized B-spline routine with SAS PROG GPLOT (SAS Software). The $DDDA_{NAT}$ for 2011 was estimated using the 2011:2012 ratio in terms of treatment days (with weighting based on the number of animal days at individual farms). The $DDDA_{NAT}$ was estimated based on the number of treatment days in 2012, and on the 2013 ratio of the number of treatment days and the $DDDA_{NAT}$. Statistics Netherlands data were used to determine the total number of kilograms of animal present for the years 2011 to 2014, and the 95% confidence intervals were based on the corresponding confidence intervals for the weighted number of treatment days per year.

Number of animals in the Dutch livestock sector

Table A2. Number of agricultural livestock (x 1,000) in the Netherlands from 2002 to 2014 according to Statistics Netherlands data on the veal and poultry farming sectors and EUROSTAT data on the other livestock sectors.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Piglets (<20 kg)	4,225	3,896	4,300	4,170	4,470	4,680	4,555	4,809	4,649	4,797	4,993	4,920	5,116
Sows	1,140	1,052	1,125	1,100	1,050	1,060	1,025	1,100	1,098	1,106	1,081	1,095	1,106
Fattening pigs	3,913	3,934	3,850	3,830	4,040	4,010	4,105	4,099	4,419	4,179	4,189	4,209	4,087
Other types of pigs	1,876	1,883	1,865	1,900	1,660	1,960	2,050	2,100	2,040	2,021	1,841	1,789	1,765
Turkeys	1,451	1,112	1,238	1,245	1,140	1,232	1,044	1,060	1,036	990	827	841	794
Other types of poultry	102,200	80,120	86,776	94,220	93,195	94,479	98,184	98,706	102,585	98,253	96,268	98,587	103,944
Of which broilers account for	Un-known	50,937	50,127	54,660	42,289	44,262	44,496	41,914	43,352	44,358	43,285	44,748	47,020
Veal calves	692	748	775	813	824	860	913	886	921	919	940	1,026	939
Other types of cattle	3,088	2,986	2,984	2,933	2,849	2,960	3,083	3,112	3,039	2,993	3,045	3,064	3,230
Sheep	1,300	1,476	1,700	1,725	1,755	1,715	1,545	1,091	1,211	1,113	1,093	1,074	1,070

Sales figures for antibiotics, by class of antibiotics and by type of treatment

Figure A5. Sales of antibiotics in 2011, 2012, 2013 and 2014, by class of antibiotics.

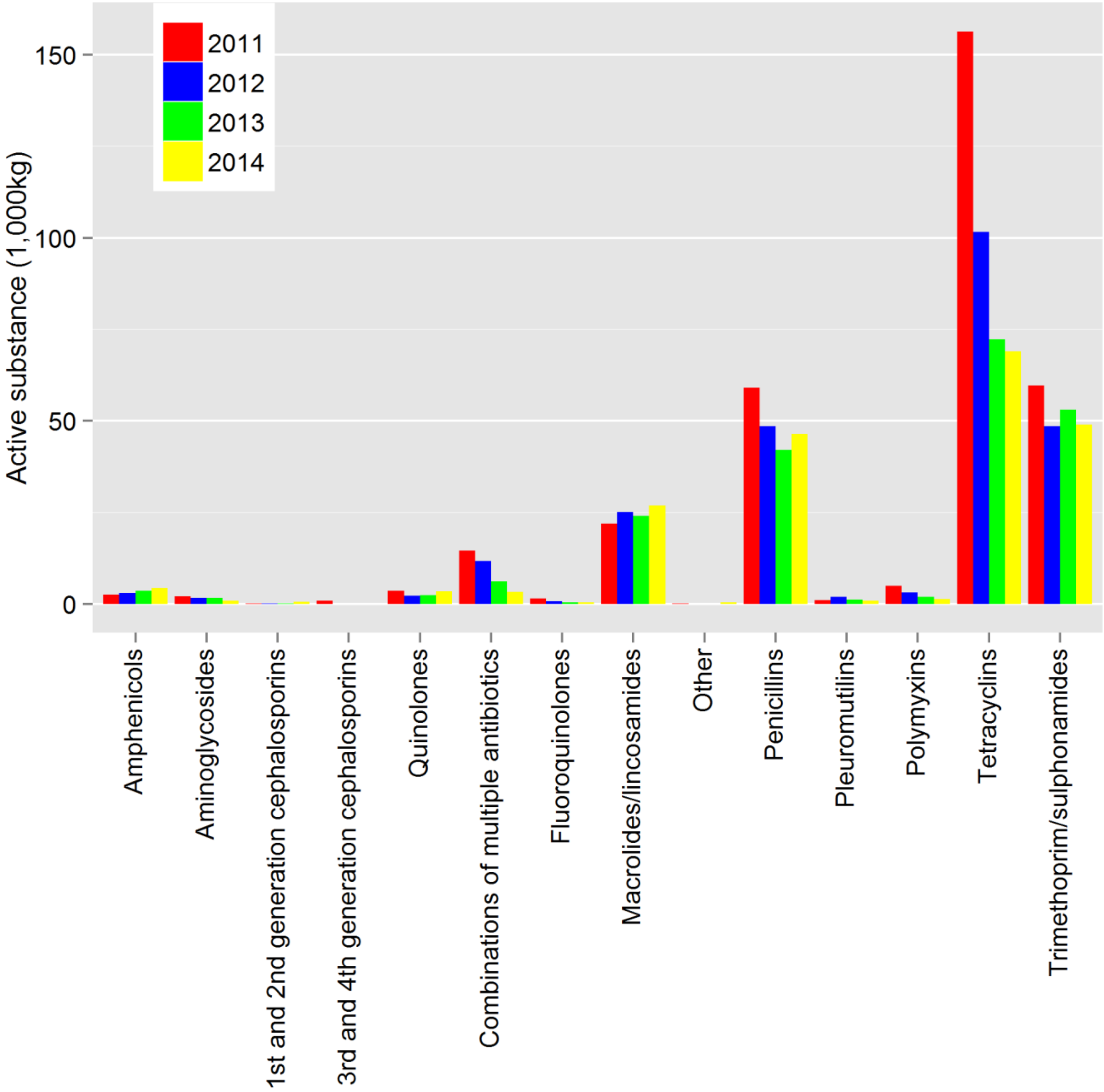
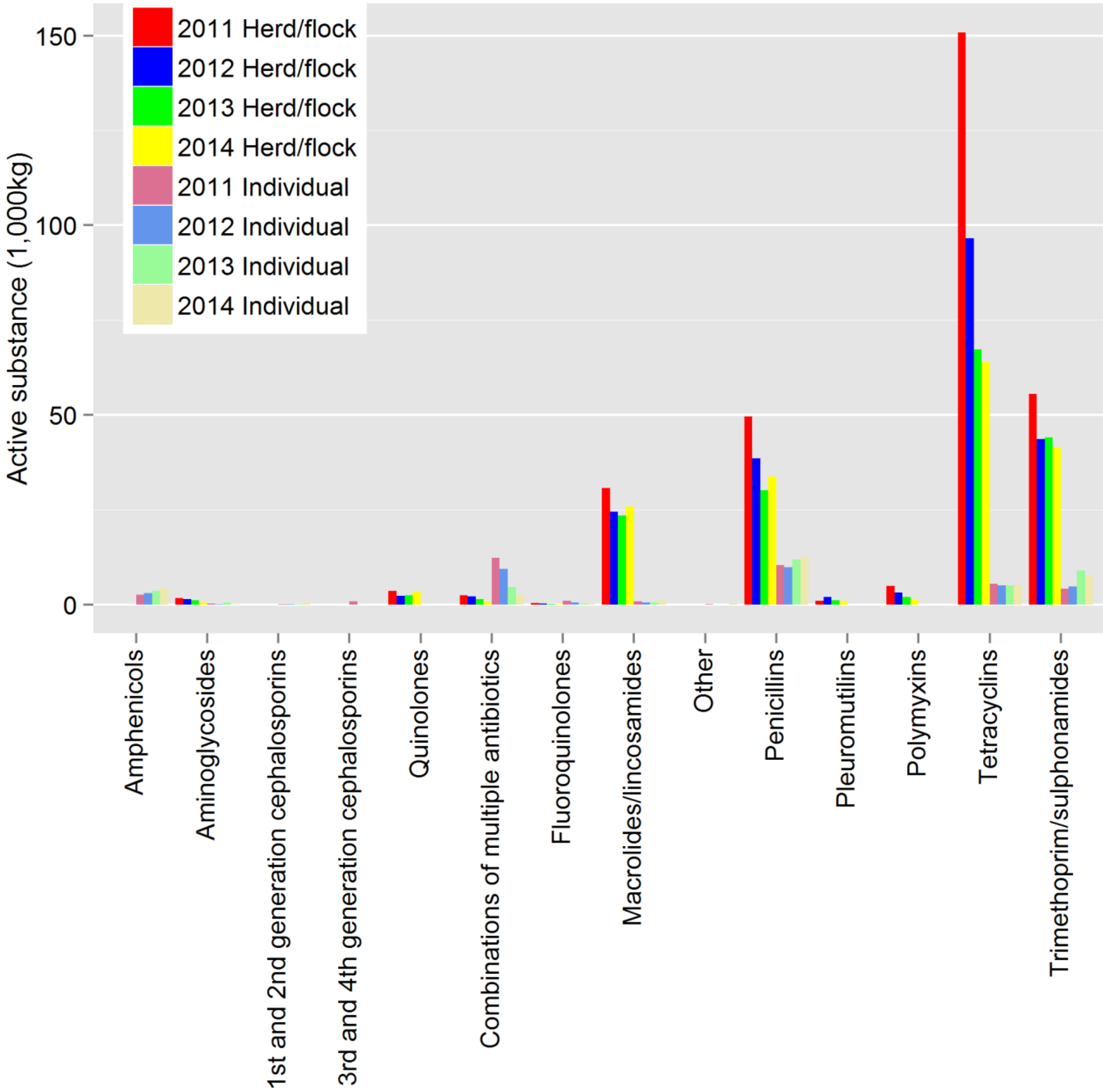


Figure A6. Sales of antibiotics used for flock/herd treatment or individual treatment in 2011, 2012, 2013 and 2014, by class of antibiotics.



Usage of antibiotics at farm level, by type of livestock farm

Table A3. Mean, median and 75th percentile of antibiotic usage (in $DDDA_F$) for the four main livestock sectors from 2011 to 2014, by type of livestock farm.

Livestock sector	**Type of farm**	**Number of livestock farms N**				**Mean**				**Median**				**P75**			
		2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014
Veal farming sector	White veal farms	934	904	862	864	41.1	33.6	31.4	24.5	33.2	30.7	26.2	23.43	44.9	40.1	35.0	31.0
	Rosé veal starter farms	207	189	264	260	120.0	97.5	115.6	79.6	94.4	84.2	80.9	77.7	127.8	107.1	102.2	97.2
	Rosé veal fattening farms	671	717	723	663	7.8	5,8	5.2	3.4	1.5	2.3	1.4	1.2	6.6	7.3	5.4	4.5
	Rosé combination farms	313	365	276	215	34.6	21.5	11.7	12.95	17.3	13.2	10.1	12.0	29.7	23.7	16.2	17.1
Pig farming sector	Sow/piglet farms	2,528	2,338	2,085	2,487	17.6	14.6	10.9	9.3	9.8	9.5	6.3	4.9	21.6	20.0	13.2	10.8
	Pig fattening farms	5,531	4,628	4,491	4,905	10.2	9.2	5.7	5.1	3.6	4.6	3.0	2.4	11.5	11.1	7.9	6.8
Poultry farming sector	Broiler farms	732	762	770	790	-	-	11.5	13.2	-	-	8.8	9.3	-	-	17.7	19.7
	Turkey farms	-	-	48	41	-	-	21.9	22.4	-	-	18.5	16.6	-	-	30.8	34.0
Cattle farming sector	Dairy cattle farms	-	18,053	18,005	17,747	-	2.9	2.8	2.3	-	2.7	2.8	2.2	-	3.8	3.7	3.0
	Rearing farms	-	2,274	472	474	-	2.7	1.1	1.4	-	0.0	0.0	0.0	-	0.1	0.2	0.2
	Suckler cow/beef farms	-	11,927	-	-	-	1.0	-	-	-	0	-	-	-	0.6	-	-
	Suckler cow farms	-	-	9,857	9,588	-	-	0.7	0.7	-	-	0.1	0.1	-	-	0.8	0.7
	Beef farms	-	-	3,316	3,297	-	-	1.8	1.7	-	-	0.0	0.0			0.6	0.5

Usage of antibiotics in $DDDA_F$ in veal calves

White veal calves

Number of white veal farms: 864
Number of white veal farms with $DDDA_F$ = 0: 7
Number of white veal farms that used third- and fourth- generation cephalosporins: 1
Number of white veal farms that used fluoroquinolones: 107

Table A4 Usage of antibiotics in $DDDA_F$ at white veal farms.

N	Mean	Median	P75	P90
864	24.5	23.4	31.0	37.8

Figure A7 Mean antibiotic use at white veal farms in 2011, 2012, 2013 and 2014, by ATCvet group (left) and by first-, second and third-choice products (right).

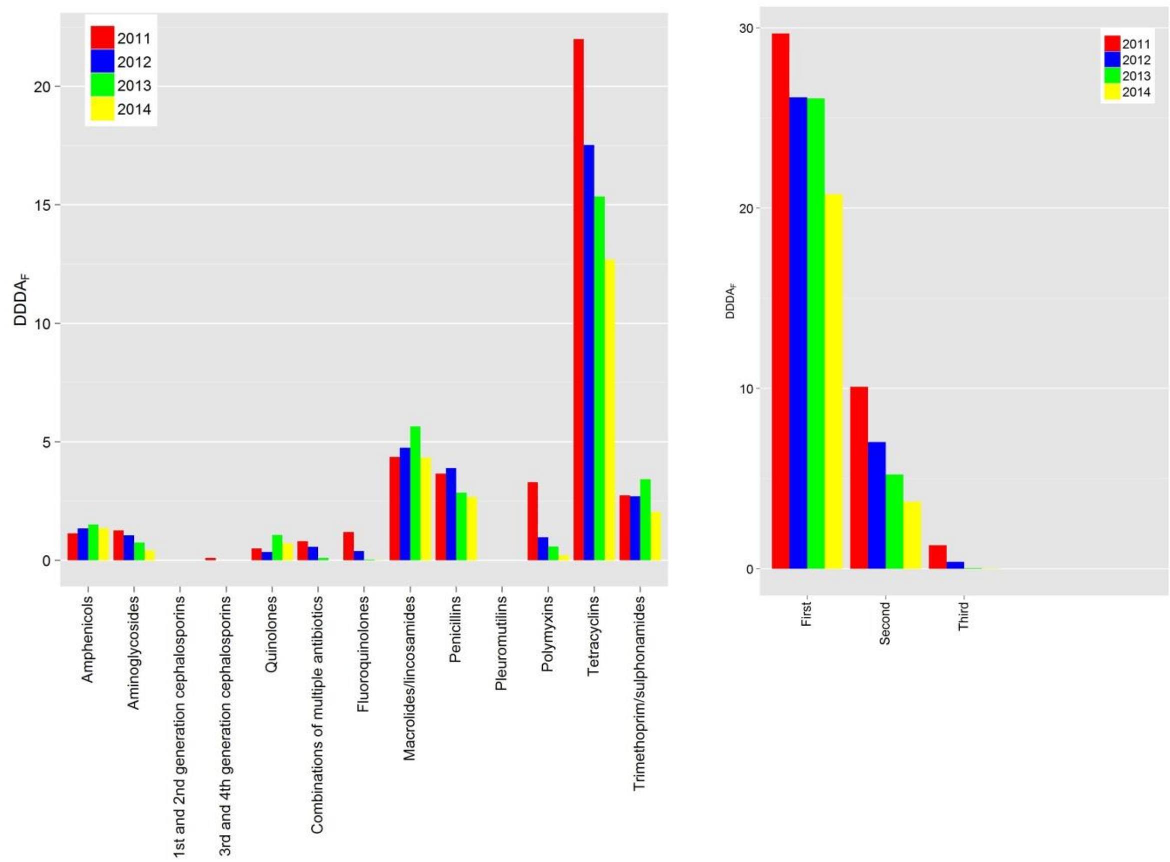


Table A5 Usage in $DDDA_F$ at white veal farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F$ = 0	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	864	0.00	0.00	0.00
amphenicols	Oral	864	0.00	0.00	0.00
amphenicols	Parenteral	12	1.23	1.74	1.37
aminoglycosides	Intramammary	864	0.00	0.00	0.00
aminoglycosides	Oral	707	0.00	0.00	0.36
aminoglycosides	Parenteral	527	0.00	0.07	0.07
3rd- and 4th-generation cephalosporins	Intramammary	864	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	864	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Parenteral	863	0.00	0.00	0.00
quinolones	Intramammary	864	0.00	0.00	0.00
quinolones	Oral	685	0.00	0.00	0.71
quinolones	Parenteral	864	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	864	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	864	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	791	0.00	0.00	0.01
fluoroquinolones	Intramammary	864	0.00	0.00	0.00
fluoroquinolones	Oral	855	0.00	0.00	0.02
fluoroquinolones	Parenteral	760	0.00	0.00	0.01
macrolides/lincosamides	Intramammary	864	0.00	0.00	0.00
macrolides/lincosamides	Oral	47	3.71	5.17	3.89
macrolides/lincosamides	Parenteral	78	0.27	0.61	0.44
penicillins	Intramammary	858	0.00	0.00	0.00
penicillins	Oral	322	0.30	3.56	2.09
penicillins	Parenteral	29	0.40	0.74	0.58
polymyxins	Intramammary	864	0.00	0.00	0.00
polymyxins	Oral	723	0.00	0.00	0.21
polymyxins	Parenteral	690	0.00	0.00	0.01
tetracyclines	Intramammary	864	0.00	0.00	0.00
tetracyclines	Oral	16	11.90	16.24	12.66
tetracyclines	Parenteral	653	0.00	0.00	0.03
trimethoprim/sulphonamides	Intramammary	864	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	346	0.58	3.04	1.94
trimethoprim/sulphonamides	Parenteral	146	0.06	0.14	0.10

Calves at rosé veal starter farms

Number of rosé veal starter farms: 260
Number of rosé veal starter farms with $DDDA_F$ = 0: 2
Number of rosé veal starter farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal starter farms that used fluoroquinolones: 18

Table A6 Usage of antibiotics in $DDDA_F$ at rosé veal starter farms.

N	Mean	Median	P75	P90
260	79.6	77.7	97.2	113.9

Figure A8 Mean antibiotic use at rosé veal starter farms in 2011, 2012, 2013 and 2014, by ATCvet group (left) and by first-, second and third-choice products (right).

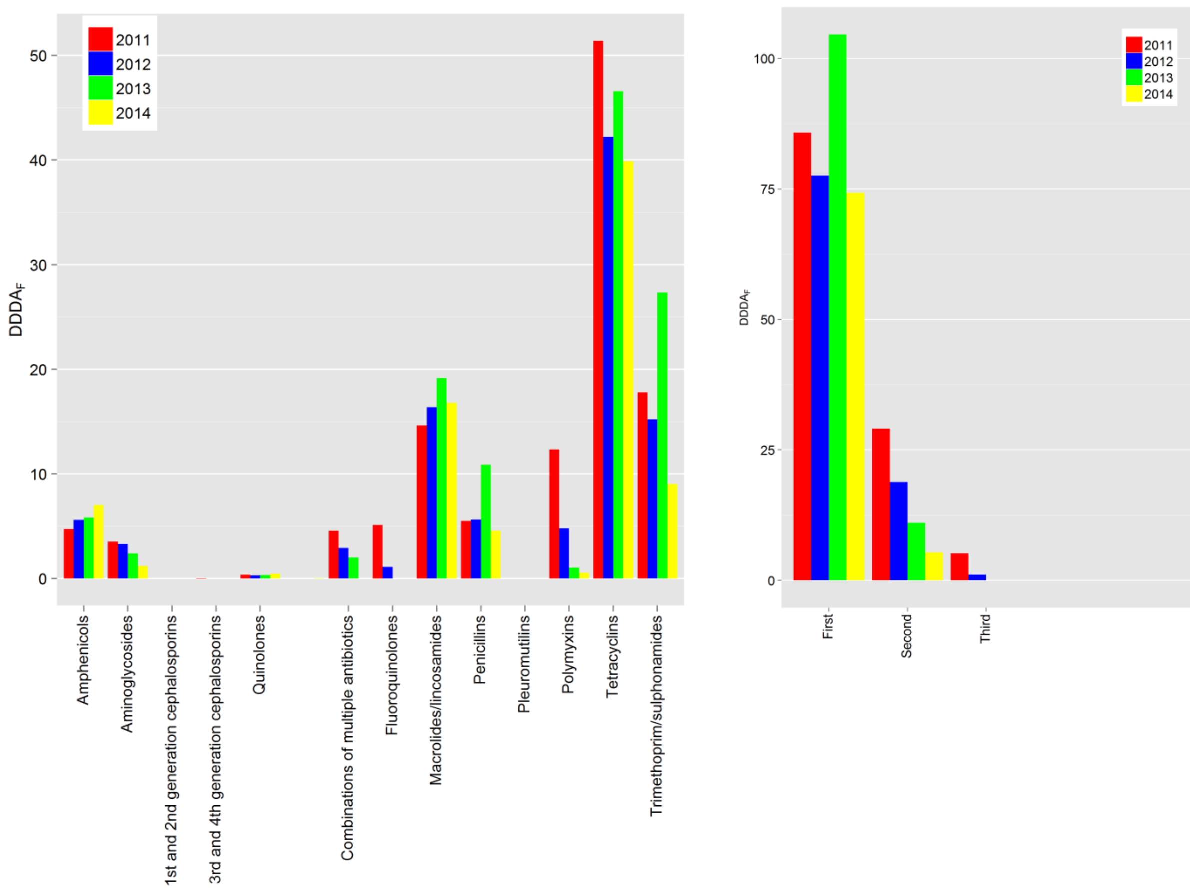


Table A7 Usage in $DDDA_F$ at rosé veal starter farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	$DDDA_F$ p75	$DDDA_F$ Mean
amphenicols	Intramammary	260	0.00	0.00	0.00
amphenicols	Oral	260	0.00	0.00	0.00
amphenicols	Parenteral	5	5.78	8.61	7.02
aminoglycosides	Intramammary	260	0.00	0.00	0.00
aminoglycosides	Oral	225	0.00	0.00	0.94
aminoglycosides	Parenteral	162	0.00	0.21	0.26
quinolones	Intramammary	260	0.00	0.00	0.00
quinolones	Oral	233	0.00	0.00	0.47
quinolones	Parenteral	260	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	260	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	260	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	234	0.00	0.00	0.06
fluoroquinolones	Intramammary	260	0.00	0.00	0.00
fluoroquinolones	Oral	259	0.00	0.00	0.01
fluoroquinolones	Parenteral	243	0.00	0.00	0.02
macrolides/lincosamides	Intramammary	260	0.00	0.00	0.00
macrolides/lincosamides	Oral	27	16.76	21.24	15.14
macrolides/lincosamides	Parenteral	36	0.98	2.00	1.64
penicillins	Intramammary	255	0.00	0.00	0.00
penicillins	Oral	158	0.00	1.95	2.12
penicillins	Parenteral	12	1.67	3.08	2.45
polymyxins	Intramammary	260	0.00	0.00	0.00
polymyxins	Oral	231	0.00	0.00	0.53
polymyxins	Parenteral	203	0.00	0.00	0.05
tetracyclines	Intramammary	260	0.00	0.00	0.00
tetracyclines	Oral	10	38.76	49.80	39.51
tetracyclines	Parenteral	188	0.00	0.06	0.35
trimethoprim/sulphonamides	Intramammary	260	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	69	6.53	14.21	8.54
trimethoprim/sulphonamides	Parenteral	56	0.26	0.67	0.51

Calves at rosé veal fattening farms

Number of rosé veal fattening farms : 663
Number of rosé veal fattening farms with $DDDA_F$ = 0: 83
Number of rosé veal fattening farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal fattening farms that used fluoroquinolones: 5

Table A8 Usage of antibiotics in $DDDA_F$ at rosé veal fattening farms.

N	Mean	Median	P75	P90
663	3.4	1.2	4.5	9.5

Figure A9 Mean antibiotic use at rosé veal fattening farms in 2011, 2012, 2013 and 2014, by ATCvet group (left) and by first-, second and third-choice products (right).

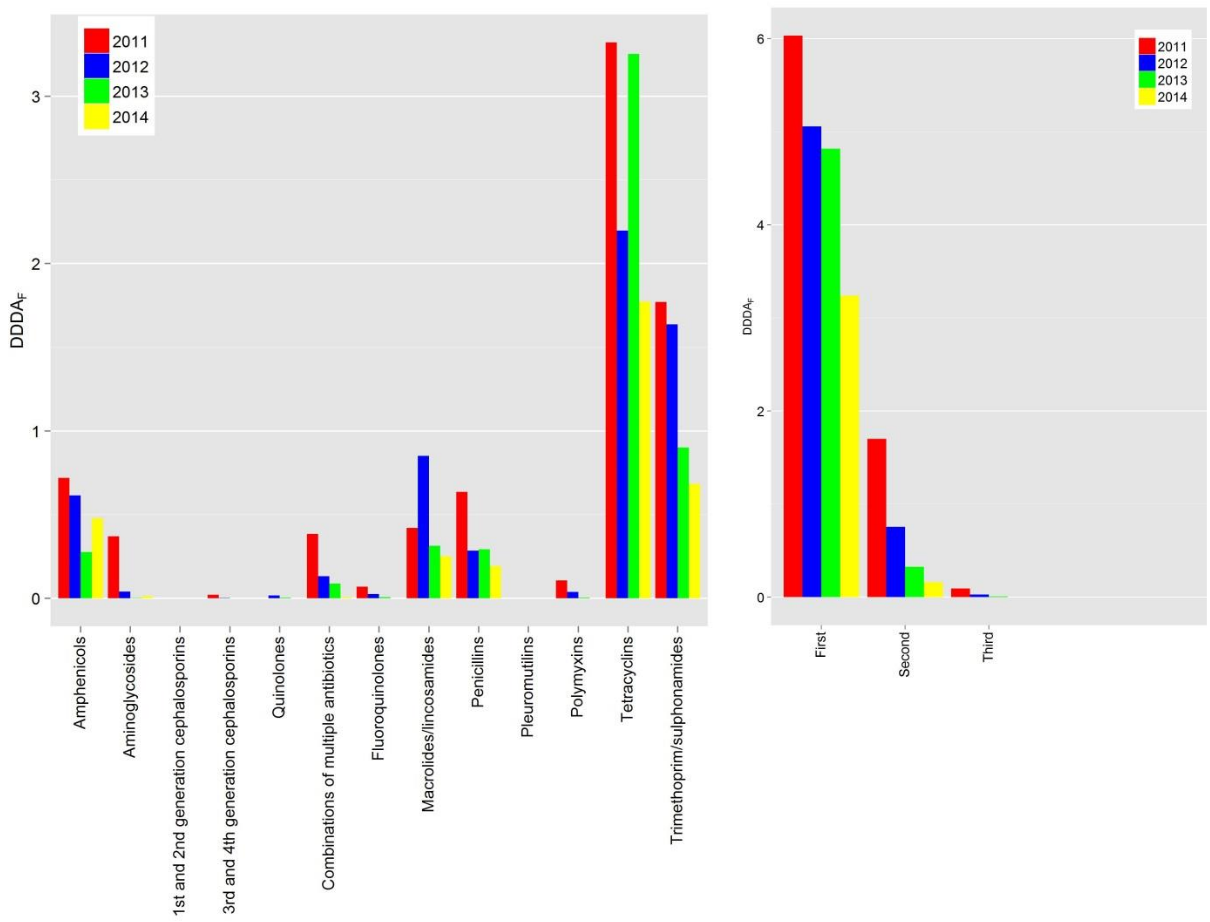


Table A9 Usage in $DDDA_F$ at rosé veal fattening farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	663	0.00	0.00	0.00
amphenicols	Oral	663	0.00	0.00	0.00
amphenicols	Parenteral	148	0.32	0.64	0.48
aminoglycosides	Intramammary	663	0.00	0.00	0.00
aminoglycosides	Oral	661	0.00	0.00	0.01
aminoglycosides	Parenteral	657	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intramammary	663	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	662	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Parenteral	663	0.00	0.00	0.00
quinolones	Intramammary	663	0.00	0.00	0.00
quinolones	Oral	663	0.00	0.00	0.00
quinolones	Parenteral	632	0.00	0.00	0.01
combinations of multiple antibiotics	Intramammary	663	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	663	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	658	0.00	0.00	0.00
fluoroquinolones	Intramammary	663	0.00	0.00	0.00
fluoroquinolones	Oral	622	0.00	0.00	0.11
fluoroquinolones	Parenteral	408	0.00	0.08	0.14
macrolides/lincosamides	Intramammary	663	0.00	0.00	0.00
macrolides/lincosamides	Oral	655	0.00	0.00	0.03
macrolides/lincosamides	Parenteral	281	0.06	0.20	0.16
penicillins	Intramammary	663	0.00	0.00	0.00
penicillins	Oral	661	0.00	0.00	0.00
penicillins	Parenteral	656	0.00	0.00	0.00
polymyxins	Intramammary	663	0.00	0.00	0.00
polymyxins	Oral	416	0.00	2.12	1.73
polymyxins	Parenteral	586	0.00	0.00	0.04
tetracyclines	Intramammary	663	0.00	0.00	0.00
tetracyclines	Oral	521	0.00	0.00	0.67
tetracyclines	Parenteral	575	0.00	0.00	0.01
trimethoprim/sulphonamides	Intramammary	663	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	663	0.00	0.00	0.00
trimethoprim/sulphonamides	Parenteral	148	0.32	0.64	0.48

Calves at rosé combination farms

Number of rosé combination farms: 215
Number of rosé combination farms with $DDDA_F$ = 0: 7
Number of rosé combination farms that used third- and fourth-generation cephalosporins: 0
Number of rosé combination farms that used fluoroquinolones: 13

Table A9 Usage of antibiotics in $DDDA_F$ at rosé combination farms.

N	Mean	Median	P75	P90
215	13.0	12.0	17.1	21.9

Figure A10 Mean antibiotic use at rosé combination farms in 2012, 2013 and 2014, by ATCvet group (left) and by first-, second and third-choice products (right).

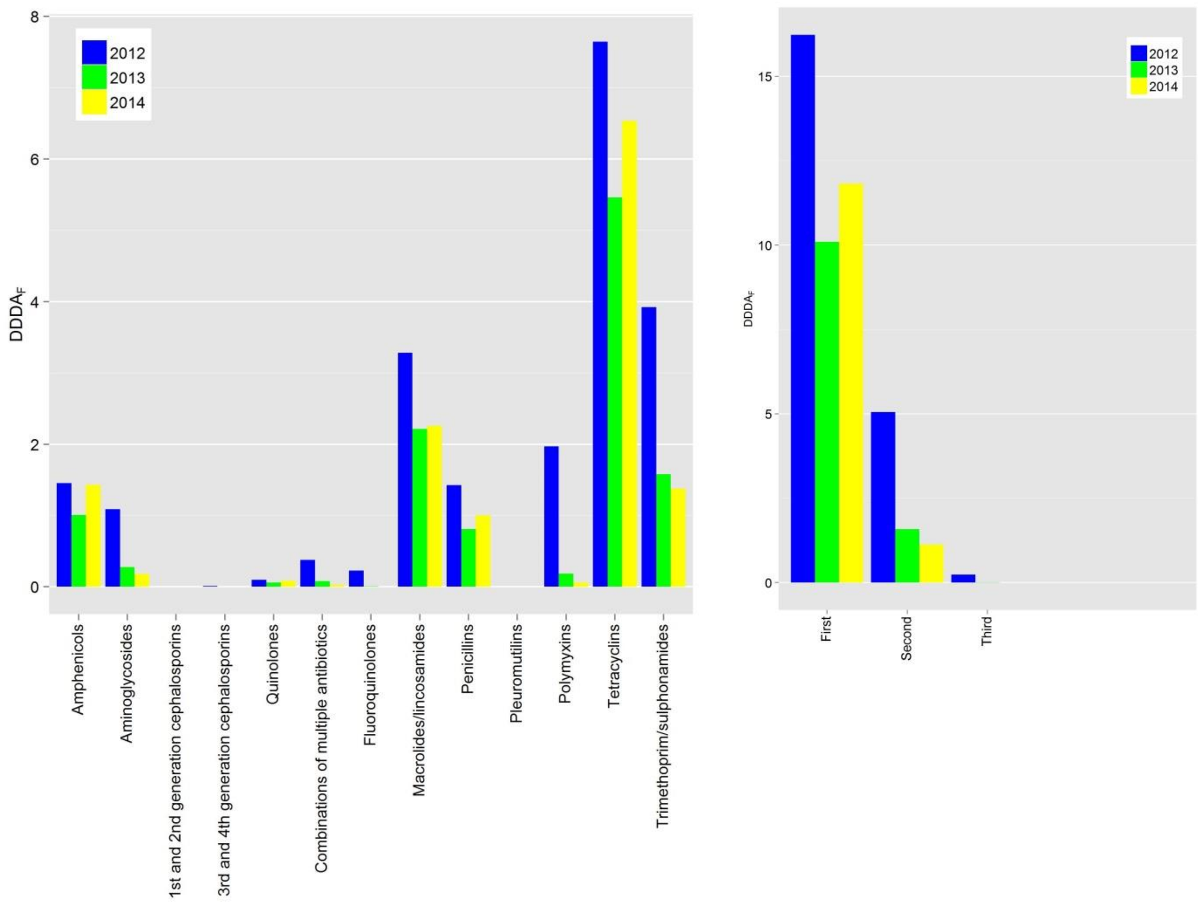


Table A11 Usage in $DDDA_F$ at rosé combination farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	215	0.00	0.00	0.00
amphenicols	Oral	215	0.00	0.00	0.00
amphenicols	Parenteral	12	1.15	1.91	1.43
aminoglycosides	Intramammary	215	0.00	0.00	0.00
aminoglycosides	Oral	190	0.00	0.00	0.12
aminoglycosides	Parenteral	154	0.00	0.02	0.07
quinolones	Intramammary	215	0.00	0.00	0.00
quinolones	Oral	198	0.00	0.00	0.08
quinolones	Parenteral	215	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	214	0.00	0.00	0.01
combinations of multiple antibiotics	Oral	215	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	182	0.00	0.00	0.02
fluoroquinolones	Intramammary	215	0.00	0.00	0.00
fluoroquinolones	Oral	213	0.00	0.00	0.00
fluoroquinolones	Parenteral	204	0.00	0.00	0.00
macrolides/lincosamides	Intramammary	215	0.00	0.00	0.00
macrolides/lincosamides	Oral	53	1.67	2.84	1.83
macrolides/lincosamides	Parenteral	43	0.21	0.48	0.42
penicillins	Intramammary	211	0.00	0.00	0.00
penicillins	Oral	135	0.00	0.28	0.45
penicillins	Parenteral	29	0.31	0.65	0.55
polymyxins	Intramammary	215	0.00	0.00	0.00
polymyxins	Oral	191	0.00	0.00	0.05
polymyxins	Parenteral	182	0.00	0.00	0.01
tetracyclines	Intramammary	215	0.00	0.00	0.00
tetracyclines	Oral	26	5.61	8.74	6.47
tetracyclines	Parenteral	146	0.00	0.04	0.06
trimethoprim/sulphonamides	Intramammary	215	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	84	0.68	2.00	1.30
trimethoprim/sulphonamides	Parenteral	74	0.03	0.08	0.08

Usage of antibiotics in $DDDA_F$ at cattle farms

Dairy cattle

Number of dairy cattle farms: 17,747
Number of dairy cattle farms with $DDDA_F$ = 0: 229
Number of dairy cattle farms that used third- and fourth-generation cephalosporins: 330
Number of dairy cattle farms that used fluoroquinolones: 1,247

Table A12 Usage of antibiotics at dairy cattle farms, presented as total usage (A), usage of dry-cow (intramammary) antibiotics (B), usage of mastitis injectors (C), and usage of oral antibiotics in calves (D).

A

Total usage, in $DDDA_F$				
N	**Mean**	**Median**	**P75**	**P90**
17,747	2.3	2.2	3.0	3.9

B

Usage of dry-cow (intramammary) antibiotics, in $DDDA_F$ (animals >2 years of age)				
N	**Mean**	**Median**	**P75**	**P90**
17,747	1.3	1.3	1.9	2.5

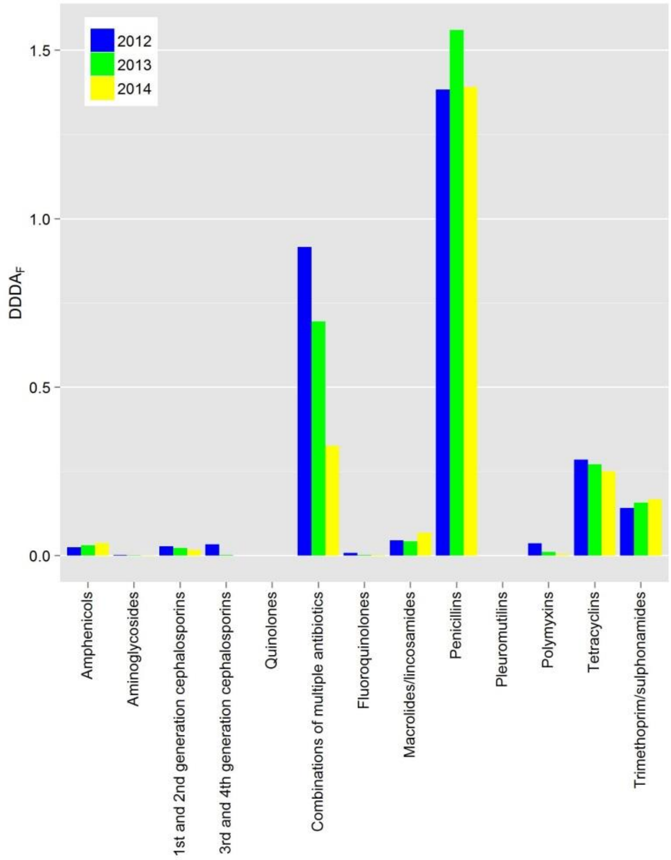
C

Usage of mastitis injectors, in $DDDA_F$ (animals > 2 years of age)				
N	**Mean**	**Median**	**P75**	**P90**
17,747	0.7	0.6	1.0	1.5

D

Usage of oral antibiotics in calves, in $DDDA_F$ (animals <56 days of age)				
N	**Mean**	**Median**	**P75**	**P90**
17,747	3.8	0.0	0.0	5.7

Figure A11 Mean antibiotic use at dairy cattle farms in 2012, 2013 and 2014, by ATCvet group (left) and by first-, second and third-choice products (right).



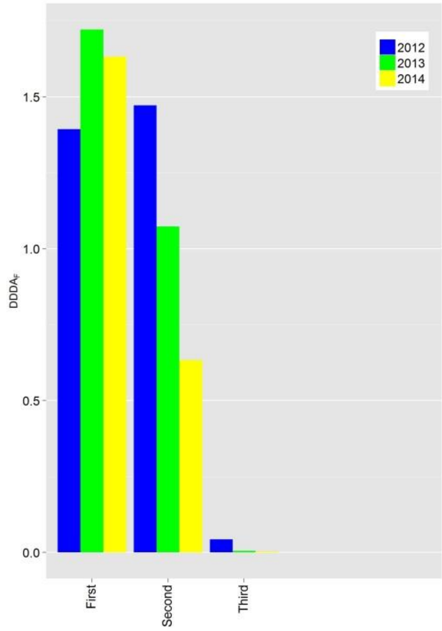


Table A13 Usage in $DDDA_F$ at dairy cattle farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	17747	0.00	0.00	0.00
amphenicols	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
amphenicols	Oral	17747	0.00	0.00	0.00
amphenicols	Parenteral	9720	0.00	0.05	0.04
amphenicols	Intrauterine	17747	0.00	0.00	0.00
aminoglycosides	Intramammary	17747	0.00	0.00	0.00
aminoglycosides	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
aminoglycosides	Oral	17507	0.00	0.00	0.00
aminoglycosides	Parenteral	17396	0.00	0.00	0.00
aminoglycosides	Intrauterine	17747	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intramammary	17574	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Oral	17747	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Parenteral	17747	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intrauterine	12293	0.00	0.01	0.01
3rd- and 4th-generation cephalosporins	Intramammary	17449	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Dry-cow (intramammary) antibiotic	17743	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	17747	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Parenteral	17703	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intrauterine	17747	0.00	0.00	0.00
quinolones	Intramammary	17747	0.00	0.00	0.00
quinolones	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
quinolones	Oral	17743	0.00	0.00	0.00
quinolones	Parenteral	17747	0.00	0.00	0.00
quinolones	Intrauterine	17747	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	7488	0.10	0.41	0.28
combinations of multiple antibiotics	Dry-cow (intramammary) antibiotic	16994	0.00	0.00	0.02
combinations of multiple antibiotics	Oral	17746	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	11621	0.00	0.03	0.03
combinations of multiple antibiotics	Intrauterine	17747	0.00	0.00	0.00
fluoroquinolones	Intramammary	17747	0.00	0.00	0.00
fluoroquinolones	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00

fluoroquinolones	Oral	17739	0.00	0.00	0.00
fluoroquinolones	Parenteral	16507	0.00	0.00	0.00
fluoroquinolones	Intrauterine	17747	0.00	0.00	0.00
macrolides/lincosamides	Intramammary	17445	0.00	0.00	0.01
macrolides/lincosamides	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
macrolides/lincosamides	Oral	17718	0.00	0.00	0.00
macrolides/lincosamides	Parenteral	11025	0.00	0.06	0.06
macrolides/lincosamides	Intrauterine	17747	0.00	0.00	0.00
penicillins	Intramammary	5627	0.14	0.37	0.25
penicillins	Dry-cow (intramammary) antibiotic	3304	0.93	1.42	0.94
penicillins	Oral	17583	0.00	0.00	0.00
penicillins	Parenteral	2906	0.13	0.29	0.21
penicillins	Intrauterine	17747	0.00	0.00	0.00
polymyxins	Intramammary	17747	0.00	0.00	0.00
polymyxins	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
polymyxins	Oral	16890	0.00	0.00	0.00
polymyxins	Parenteral	17362	0.00	0.00	0.00
polymyxins	Intrauterine	17747	0.00	0.00	0.00
tetracyclines	Intramammary	17747	0.00	0.00	0.00
tetracyclines	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
tetracyclines	Oral	16966	0.00	0.00	0.01
tetracyclines	Parenteral	3694	0.10	0.24	0.17
tetracyclines	Intrauterine	7111	0.03	0.11	0.07
trimethoprim/sulphonamides	Intramammary	17747	0.00	0.00	0.00
trimethoprim/sulphonamides	Dry-cow (intramammary) antibiotic	17747	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	15812	0.00	0.00	0.01
trimethoprim/sulphonamides	Parenteral	3193	0.10	0.21	0.16
trimethoprim/sulphonamides	Intrauterine	17747	0.00	0.00	0.00

Suckler Cows

Number of suckler cow farms: 9,588
Number of suckler cow farms with $DDDA_F$ = 0: 4,506
Number of suckler cow farms that used third- and fourth-generation cephalosporins: 4
Number of suckler cow farms that used fluoroquinolones: 90

Table A14 Usage of antibiotics in $DDDA_F$ at suckler cow farms

N	Mean	Median	P75	P90
9,588	0.7	0.1	0.7	2.0

Figure A12 Mean antibiotic use at suckler cow farms in 2012, 2013 and 2014, by ATCvet group (left) and by first-, second- and third-choice products (right).

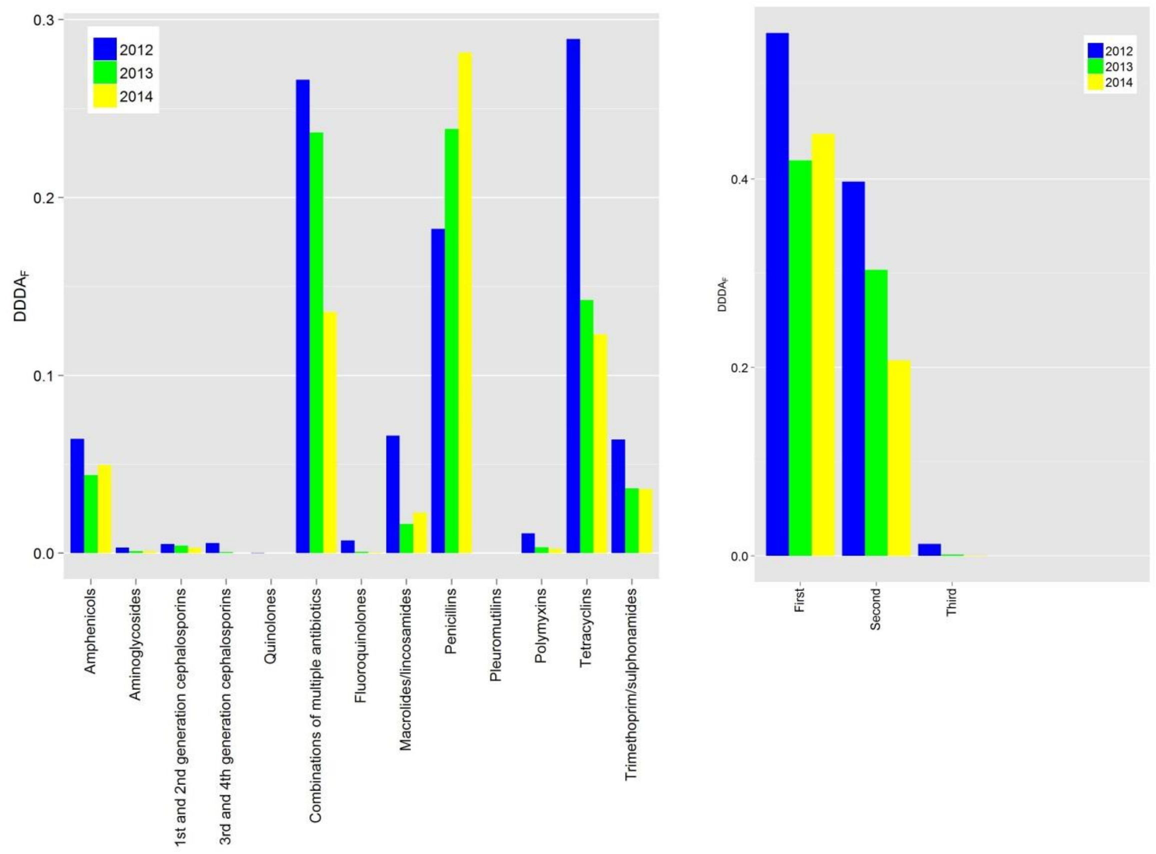


Table A15 Usage in $DDDA_F$ at suckler cow farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	9588	0.00	0.00	0.00
amphenicols	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
amphenicols	Oral	9588	0.00	0.00	0.00
amphenicols	Parenteral	7995	0.00	0.00	0.05
amphenicols	Intrauterine	9588	0.00	0.00	0.00
aminoglycosides	Intramammary	9588	0.00	0.00	0.00
aminoglycosides	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
aminoglycosides	Oral	9583	0.00	0.00	0.00
aminoglycosides	Parenteral	9541	0.00	0.00	0.00
aminoglycosides	Intrauterine	9588	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intramammary	9582	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Oral	9588	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Parenteral	9588	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intrauterine	9456	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intramammary	9586	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	9588	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Parenteral	9586	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intrauterine	9588	0.00	0.00	0.00
quinolones	Intramammary	9588	0.00	0.00	0.00
quinolones	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
quinolones	Oral	9587	0.00	0.00	0.00
quinolones	Parenteral	9588	0.00	0.00	0.00
quinolones	Intrauterine	9588	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	9341	0.00	0.00	0.01
combinations of multiple antibiotics	Dry-cow (intramammary) antibiotic	9563	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	9588	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	7920	0.00	0.00	0.12
combinations of multiple antibiotics	Intrauterine	9588	0.00	0.00	0.00
fluoroquinolones	Intramammary	9588	0.00	0.00	0.00
fluoroquinolones	Dry-cow (intramammary)	9588	0.00	0.00	0.00

	antibiotic				
fluoroquinolones	Oral	9586	0.00	0.00	0.00
fluoroquinolones	Parenteral	9500	0.00	0.00	0.00
fluoroquinolones	Intrauterine	9588	0.00	0.00	0.00
macrolides/lincosamides	Intramammary	9585	0.00	0.00	0.00
macrolides/lincosamides	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
macrolides/lincosamides	Oral	9583	0.00	0.00	0.00
macrolides/lincosamides	Parenteral	8914	0.00	0.00	0.02
macrolides/lincosamides	Intrauterine	9588	0.00	0.00	0.00
penicillins	Intramammary	9213	0.00	0.00	0.01
penicillins	Dry-cow (intramammary) antibiotic	9227	0.00	0.00	0.05
penicillins	Oral	9562	0.00	0.00	0.00
penicillins	Parenteral	6489	0.00	0.15	0.22
penicillins	Intrauterine	9588	0.00	0.00	0.00
polymyxins	Intramammary	9588	0.00	0.00	0.00
polymyxins	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
polymyxins	Oral	9495	0.00	0.00	0.00
polymyxins	Parenteral	9517	0.00	0.00	0.00
polymyxins	Intrauterine	9588	0.00	0.00	0.00
tetracyclines	Intramammary	9588	0.00	0.00	0.00
tetracyclines	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
tetracyclines	Oral	9496	0.00	0.00	0.01
tetracyclines	Parenteral	7865	0.00	0.00	0.07
tetracyclines	Intrauterine	7827	0.00	0.00	0.04
trimethoprim/sulphonamides	Intramammary	9588	0.00	0.00	0.00
trimethoprim/sulphonamides	Dry-cow (intramammary) antibiotic	9588	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	9379	0.00	0.00	0.01
trimethoprim/sulphonamides	Parenteral	8270	0.00	0.00	0.03
trimethoprim/sulphonamides	Intrauterine	9588	0.00	0.00	0.00

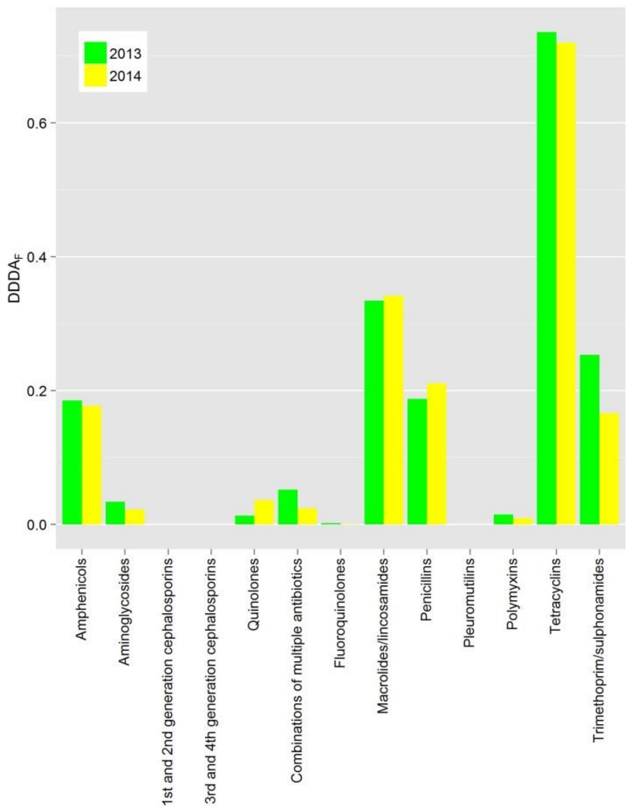
Beef Bulls

Number of beef farms: 3,297
Number of beef farms with $DDDA_F$ = 0: 2,078
Number of beef farms that used third- and fourth-generation cephalosporins: 2
Number of beef farms that used fluoroquinolones: 33

Table A16 Usage of antibiotics in $DDDA_F$ at beef farms

N	Mean	Median	P75	P90
3,297	1.7	0.0	0.5	4.4

Figure A13 Mean antibiotic use at beef farms in 2013 and 2014, by ATCvet group (left) and by first-, second- and third-choice products (right).



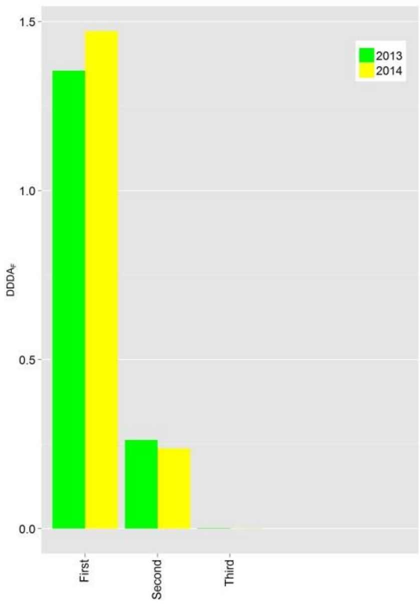


Table A17 Usage in $DDDA_F$ at beef farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F$ = 0	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	3297	0.00	0.00	0.00
amphenicols	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
amphenicols	Oral	3297	0.00	0.00	0.00
amphenicols	Parenteral	2463	0.00	0.02	0.18
amphenicols	Intrauterine	3297	0.00	0.00	0.00
aminoglycosides	Intramammary	3297	0.00	0.00	0.00
aminoglycosides	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
aminoglycosides	Oral	3268	0.00	0.00	0.02
aminoglycosides	Parenteral	3230	0.00	0.00	0.01
aminoglycosides	Intrauterine	3297	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intramammary	3296	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Oral	3297	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Parenteral	3297	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intrauterine	3291	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intramammary	3297	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Dry-cow (intramammary) antibiotic	3296	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	3297	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Parenteral	3296	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intrauterine	3297	0.00	0.00	0.00
quinolones	Intramammary	3297	0.00	0.00	0.00
quinolones	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
quinolones	Oral	3252	0.00	0.00	0.04
quinolones	Parenteral	3297	0.00	0.00	0.00
quinolones	Intrauterine	3297	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	3282	0.00	0.00	0.00
combinations of multiple antibiotics	Dry-cow (intramammary) antibiotic	3295	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	3297	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	3059	0.00	0.00	0.02
combinations of multiple antibiotics	Intrauterine	3297	0.00	0.00	0.00
fluoroquinolones	Intramammary	3297	0.00	0.00	0.00
fluoroquinolones	Dry-cow	3297	0.00	0.00	0.00

	(intramammary) antibiotic				
fluoroquinolones	Oral	3296	0.00	0.00	0.00
fluoroquinolones	Parenteral	3265	0.00	0.00	0.00
fluoroquinolones	Intrauterine	3297	0.00	0.00	0.00
macrolides/lincosamides	Intramammary	3297	0.00	0.00	0.00
macrolides/lincosamides	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
macrolides/lincosamides	Oral	3024	0.00	0.00	0.28
macrolides/lincosamides	Parenteral	2789	0.00	0.00	0.06
macrolides/lincosamides	Intrauterine	3297	0.00	0.00	0.00
penicillins	Intramammary	3275	0.00	0.00	0.00
penicillins	Dry-cow (intramammary) antibiotic	3269	0.00	0.00	0.01
penicillins	Oral	3178	0.00	0.00	0.09
penicillins	Parenteral	2452	0.00	0.01	0.11
penicillins	Intrauterine	3297	0.00	0.00	0.00
polymyxins	Intramammary	3297	0.00	0.00	0.00
polymyxins	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
polymyxins	Oral	3244	0.00	0.00	0.01
polymyxins	Parenteral	3236	0.00	0.00	0.00
polymyxins	Intrauterine	3297	0.00	0.00	0.00
tetracyclines	Intramammary	3297	0.00	0.00	0.00
tetracyclines	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
tetracyclines	Oral	2928	0.00	0.00	0.66
tetracyclines	Parenteral	2888	0.00	0.00	0.05
tetracyclines	Intrauterine	3133	0.00	0.00	0.01
trimethoprim/sulphonamides	Intramammary	3297	0.00	0.00	0.00
trimethoprim/sulphonamides	Dry-cow (intramammary) antibiotic	3297	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	3049	0.00	0.00	0.15
trimethoprim/sulphonamides	Parenteral	2864	0.00	0.00	0.02
trimethoprim/sulphonamides	Intrauterine	3297	0.00	0.00	0.00

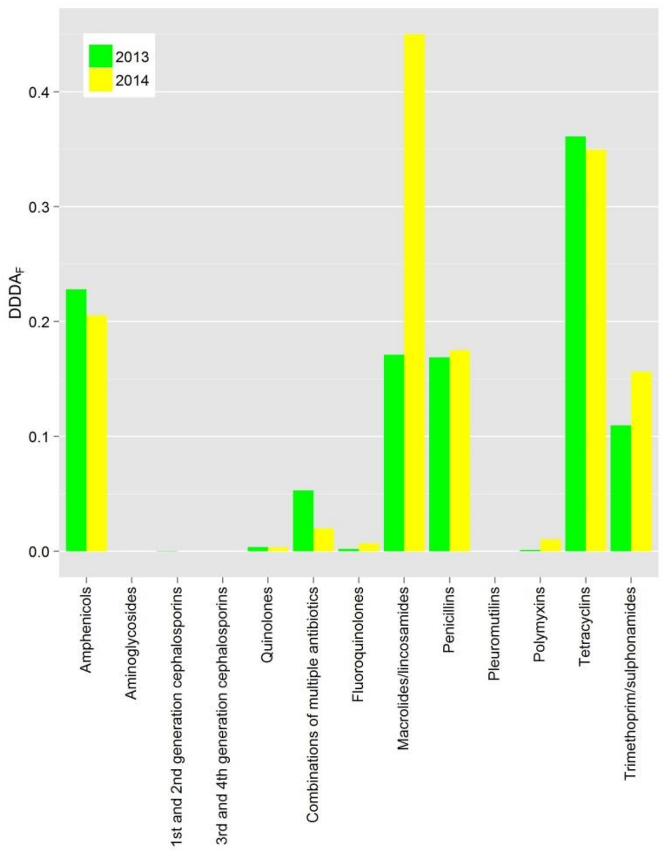
Rearing farms

Number of rearing farms: 474
Number of rearing farms with $DDDA_F$ = 0: 330
Number of rearing farms that used third- and fourth-generation cephalosporins: 0
Number of rearing farms that used fluoroquinolones: 5

Table A18 Usage of antibiotics in $DDDA_F$ at rearing farms

N	Mean	Median	P75	P90
474	1.4	0.0	0.2	1.8

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



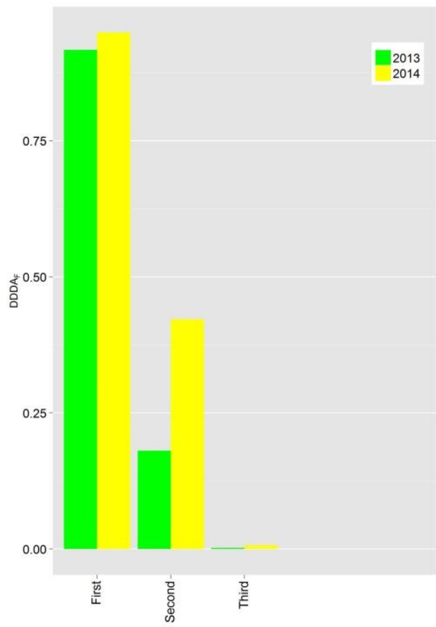


Table A19 Usage in $DDDA_F$ at rearing farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	474	0.00	0.00	0.00
amphenicols	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
amphenicols	Oral	474	0.00	0.00	0.00
amphenicols	Parenteral	388	0.00	0.00	0.21
amphenicols	Intrauterine	474	0.00	0.00	0.00
aminoglycosides	Intramammary	474	0.00	0.00	0.00
aminoglycosides	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
aminoglycosides	Oral	474	0.00	0.00	0.00
aminoglycosides	Parenteral	472	0.00	0.00	0.00
aminoglycosides	Intrauterine	474	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intramammary	474	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Oral	474	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Parenteral	474	0.00	0.00	0.00
1st- and 2nd-generation cephalosporins	Intrauterine	472	0.00	0.00	0.00
quinolones	Intramammary	474	0.00	0.00	0.00
quinolones	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
quinolones	Oral	473	0.00	0.00	0.00
quinolones	Parenteral	474	0.00	0.00	0.00
quinolones	Intrauterine	474	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	472	0.00	0.00	0.01
combinations of multiple antibiotics	Dry-cow (intramammary) antibiotic	473	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	474	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	454	0.00	0.00	0.01
combinations of multiple antibiotics	Intrauterine	474	0.00	0.00	0.00
fluoroquinolones	Intramammary	474	0.00	0.00	0.00
fluoroquinolones	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
fluoroquinolones	Oral	474	0.00	0.00	0.00
fluoroquinolones	Parenteral	469	0.00	0.00	0.01
fluoroquinolones	Intrauterine	474	0.00	0.00	0.00
macrolides/lincosamides	Intramammary	474	0.00	0.00	0.00
macrolides/lincosamides	Dry-cow (intramammary)	474	0.00	0.00	0.00

	antibiotic				
macrolides/lincosamides	Oral	464	0.00	0.00	0.07
macrolides/lincosamides	Parenteral	437	0.00	0.00	0.38
macrolides/lincosamides	Intrauterine	474	0.00	0.00	0.00
penicillins	Intramammary	472	0.00	0.00	0.00
penicillins	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
penicillins	Oral	472	0.00	0.00	0.02
penicillins	Parenteral	395	0.00	0.00	0.16
penicillins	Intrauterine	474	0.00	0.00	0.00
polymyxins	Intramammary	474	0.00	0.00	0.00
polymyxins	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
polymyxins	Oral	472	0.00	0.00	0.01
polymyxins	Parenteral	472	0.00	0.00	0.00
polymyxins	Intrauterine	474	0.00	0.00	0.00
tetracyclines	Intramammary	474	0.00	0.00	0.00
tetracyclines	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
tetracyclines	Oral	457	0.00	0.00	0.29
tetracyclines	Parenteral	442	0.00	0.00	0.06
tetracyclines	Intrauterine	474	0.00	0.00	0.00
trimethoprim/sulphonamides	Intramammary	474	0.00	0.00	0.00
trimethoprim/sulphonamides	Dry-cow (intramammary) antibiotic	474	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	460	0.00	0.00	0.13
trimethoprim/sulphonamides	Parenteral	439	0.00	0.00	0.02
trimethoprim/sulphonamides	Intrauterine	474	0.00	0.00	0.00

Usage of antibiotics in DDDA$_F$ at pig farms

Sows and Piglets

Number of sow/piglet farms: 2,487
Number of sow/piglet farms with DDDA$_F$ = 0: 290
Number of sow/piglet farms that used third- and fourth-generation cephalosporins: 0
Number of sow/piglet farms that used fluoroquinolones: 11

Table A20 Usage of antibiotics in DDDA$_F$ at sow/piglet farms

N	Mean	Median	P75	P90
2,487	9.3	4.9	10.8	20.0

Figure A15 Mean antibiotic use at sow/piglet farms in 2011, 2012, 2013 and 2014, by ATCvet group (left) and by first-, second- and third-choice products (right).

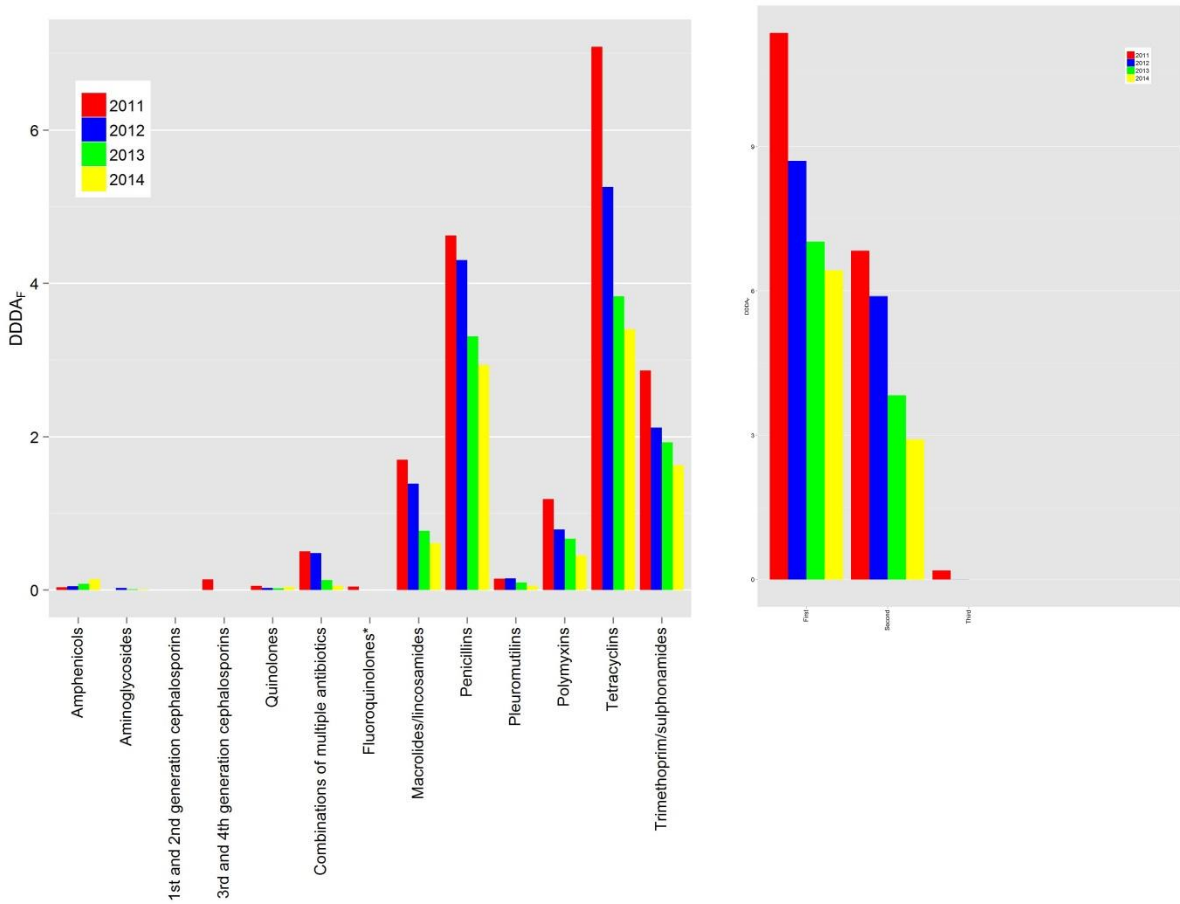


Table A21 Usage in $DDDA_F$ at sow/piglet farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F = 0$	$DDDA_F$ Median	p75	Mean
amphenicols	Intramammary	2487	0.00	0.00	0.00
amphenicols	Oral	2483	0.00	0.00	0.00
amphenicols	Parenteral	1786	0.00	0.05	0.14
aminoglycosides	Intramammary	2487	0.00	0.00	0.00
aminoglycosides	Oral	2476	0.00	0.00	0.01
aminoglycosides	Parenteral	2487	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intramammary	2487	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	2424	0.00	0.00	0.04
3rd- and 4th-generation cephalosporins	Parenteral	2487	0.00	0.00	0.00
quinolones	Intramammary	2487	0.00	0.00	0.00
quinolones	Oral	2458	0.00	0.00	0.02
quinolones	Parenteral	2059	0.00	0.00	0.04
combinations of multiple antibiotics	Intramammary	2487	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	2487	0.00	0.00	0.00
combinations of multiple antibiotics	Parenteral	2476	0.00	0.00	0.00
fluoroquinolones	Intramammary	2487	0.00	0.00	0.00
fluoroquinolones	Oral	2043	0.00	0.00	0.41
fluoroquinolones	Parenteral	1861	0.00	0.00	0.21
macrolides/lincosamides	Intramammary	2486	0.00	0.00	0.00
macrolides/lincosamides	Oral	1731	0.00	0.61	1.98
macrolides/lincosamides	Parenteral	375	0.64	1.28	0.96
penicillins	Intramammary	2487	0.00	0.00	0.00
penicillins	Oral	2427	0.00	0.00	0.05
penicillins	Parenteral	2415	0.00	0.00	0.00
pleuromutilines	Intramammary	2487	0.00	0.00	0.00
pleuromutilines	Oral	1750	0.00	0.09	0.41
pleuromutilines	Parenteral	1880	0.00	0.00	0.04
polymyxins	Intramammary	2487	0.00	0.00	0.00
polymyxins	Oral	1228	0.09	3.01	3.00
polymyxins	Parenteral	1016	0.05	0.34	0.40
tetracyclines	Intramammary	2487	0.00	0.00	0.00
tetracyclines	Oral	1247	0.00	1.27	1.45
tetracyclines	Parenteral	1016	0.04	0.21	0.18
trimethoprim/sulphonamides	Intramammary	2487	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	2424	0.00	0.00	0.04
trimethoprim/sulphonamides	Parenteral	2487	0.00	0.00	0.00

Pig fattening farms

Number of pig fattening farms: 4,905
Number of pig fattening farms with $DDDA_F$ = 0: 852
Number of pig fattening farms that used third- and fourth-generation cephalosporins: 0
Number of pig fattening farms that used fluoroquinolones: 8

Table A22 Usage of antibiotics in $DDDA_F$ at pig fattening farms

N	Mean	Median	P75	P90
4,905	5.1	2.4	6.8	11.8

Figure A16 Mean antibiotic use at pig fattening farms in 2011, 2012, 2013 and 2014, by ATCvet group (left) and by first-, second- and third-choice products (right).

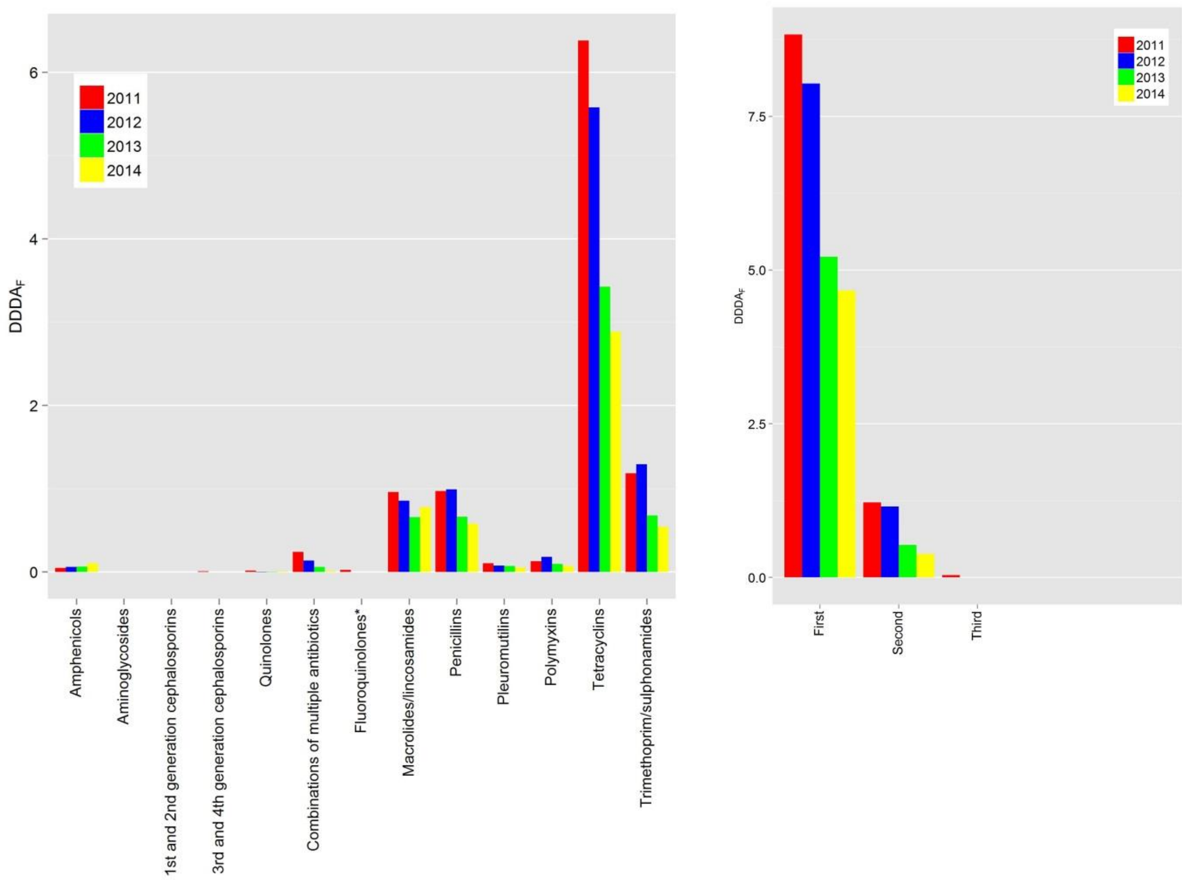


Table A23 Usage in $DDDA_F$ at pig fattening farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F$ = 0	$DDDA_F$ Median	$DDDA_F$ p75	$DDDA_F$ Mean
amphenicols	Intramammary	4905	0.00	0.00	0.00
amphenicols	Oral	4904	0.00	0.00	0.00
amphenicols	Parenteral	3909	0.00	0.00	0.11
aminoglycosides	Intramammary	4905	0.00	0.00	0.00
aminoglycosides	Oral	4905	0.00	0.00	0.00
aminoglycosides	Parenteral	4905	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Intramammary	4905	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Oral	4905	0.00	0.00	0.00
3rd- and 4th-generation cephalosporins	Parenteral	4905	0.00	0.00	0.00
quinolones	Intramammary	4905	0.00	0.00	0.00
quinolones	Oral	4890	0.00	0.00	0.01
quinolones	Parenteral	4905	0.00	0.00	0.00
combinations of multiple antibiotics	Intramammary	4905	0.00	0.00	0.00
combinations of multiple antibiotics	Oral	4887	0.00	0.00	0.01
combinations of multiple antibiotics	Parenteral	4694	0.00	0.00	0.01
fluoroquinolones	Intramammary	4905	0.00	0.00	0.00
fluoroquinolones	Oral	4905	0.00	0.00	0.00
fluoroquinolones	Parenteral	4897	0.00	0.00	0.00
macrolides/lincosamides	Intramammary	4905	0.00	0.00	0.00
macrolides/lincosamides	Oral	3813	0.00	0.00	0.75
macrolides/lincosamides	Parenteral	4236	0.00	0.00	0.03
penicillins	Intramammary	4905	0.00	0.00	0.00
penicillins	Oral	4671	0.00	0.00	0.25
penicillins	Parenteral	1543	0.13	0.38	0.32
Pleuromutilines	Intramammary	4905	0.00	0.00	0.00
Pleuromutilines	Oral	4787	0.00	0.00	0.05
Pleuromutilines	Parenteral	4732	0.00	0.00	0.00
polymyxins	Intramammary	4905	0.00	0.00	0.00
polymyxins	Oral	4655	0.00	0.00	0.07
polymyxins	Parenteral	4677	0.00	0.00	0.00
tetracyclines	Intramammary	4905	0.00	0.00	0.00
tetracyclines	Oral	2522	0.00	3.57	2.64
tetracyclines	Parenteral	2378	0.02	0.23	0.25
trimethoprim/sulphonamides	Intramammary	4905	0.00	0.00	0.00
trimethoprim/sulphonamides	Oral	3653	0.00	0.09	0.54
trimethoprim/sulphonamides	Parenteral	4805	0.00	0.00	0.00

Usage of antibiotics in DDDA$_F$ at poultry farms

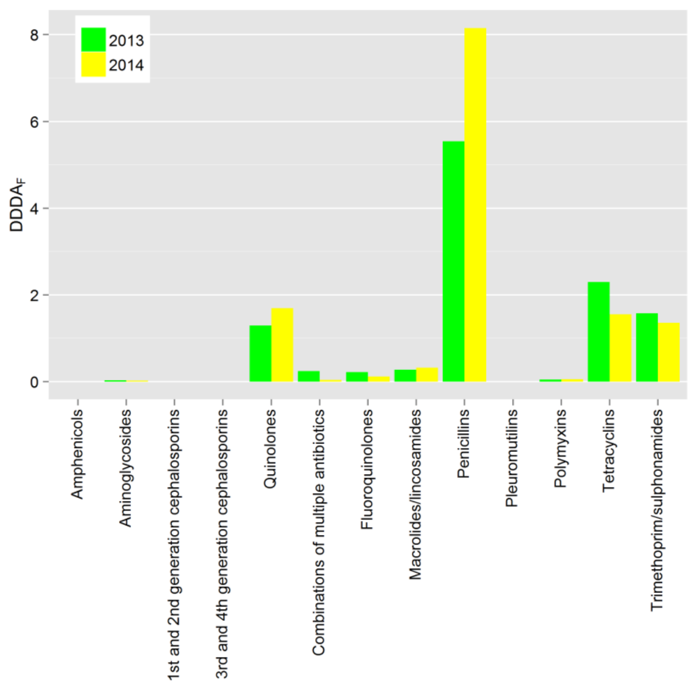
Broilers

Number of broiler farms: 798
Number of broiler farms with DDDA$_F$ = 0: 182
Number of broiler farms that used third- and fourth-generation cephalosporins: 0
Number of broiler farms that used fluoroquinolones: 73

Table A24 Usage of antibiotics in DDDA$_F$ at broiler farms

N	Mean	Median	P75	P90
798	13.3	9.4	19.7	34.6

Figure A17 Mean antibiotic use at broiler farms in 2013 and 2014, by ATCvet group (left) and by first-, second- and third-choice products (right).



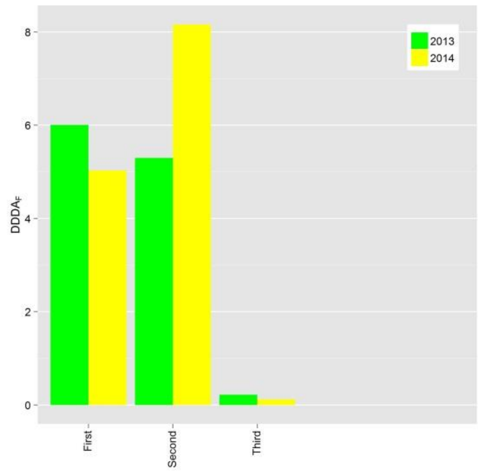


Table A25 Usage in $DDDA_F$ at broiler farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F$ = 0	$DDDA_F$ Median	p75	Mean
aminoglycosides	Oral	779	0.00	0.00	0.02
quinolones	Oral	600	0.00	0.00	1.72
combinations of multiple antibiotics	Oral	747	0.00	0.00	0.05
fluoroquinolones	Oral	717	0.00	0.00	0.12
macrolides/lincosamides	Oral	677	0.00	0.00	0.31
penicillins	Oral	307	4.16	12.54	8.00
polymyxins	Oral	780	0.00	0.00	0.05
tetracyclines	Oral	529	0.00	1.76	1.57
trimethoprim/sulphonamides	Oral	342	0.47	1.93	1.37

Turkeys

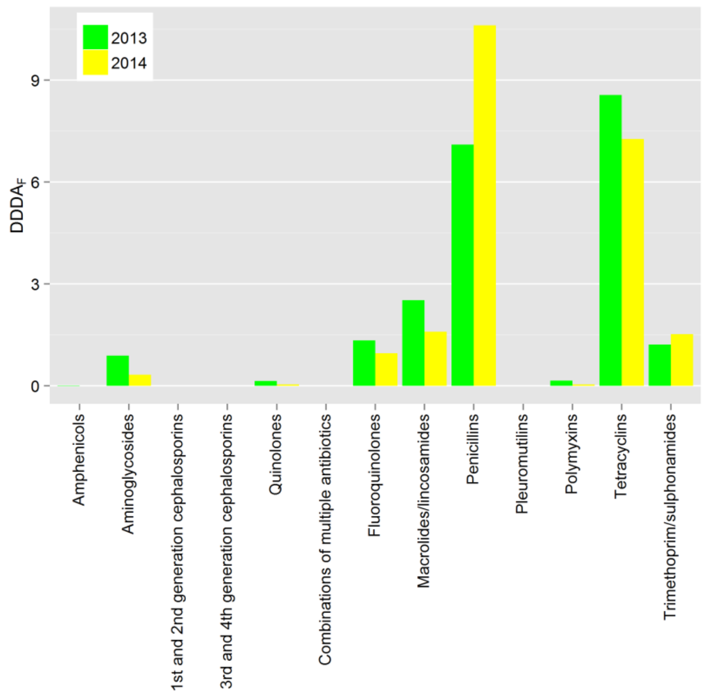
Broilers

Number of turkey farms: 41
Number of turkey farms with $DDDA_F$ = 0: 0
Number of turkey farms that used third- and fourth-generation cephalosporins: 0
Number of turkey farms that used fluoroquinolones: 28

Table A26 Usage of antibiotics in $DDDA_F$ at turkey farms

N	Mean	Median	P75	P90
41	22.4	16.6	34.0	45.3

Figure A18 Mean antibiotic use at turkey farms in 2013 and 2014, by ATCvet group (left) and by first-, second- and third-choice products (right).



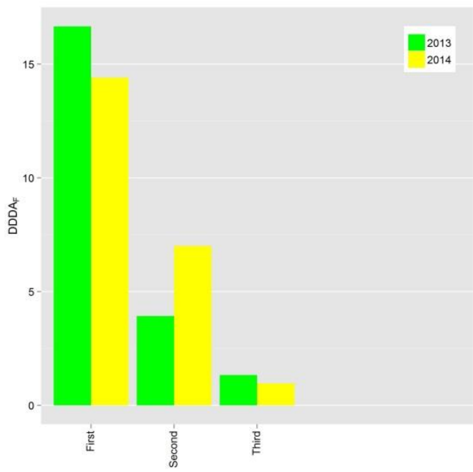


Table A27 Usage in $DDDA_F$ at turkey farms in 2014, by ATCvet group and route of administration.

ATCvet group	Route of administration	# farms with $DDDA_F$ = 0	$DDDA_F$		
			Median	p75	Mean
amphenicols	Oral	41	0.00	0.00	0.33
aminoglycosides	Oral	37	0.00	0.00	0.33
quinolones	Oral	39	0.00	0.00	0.04
fluoroquinolones	Oral	13	0.50	1.25	0.96
macrolides/lincosamides	Oral	7	0.83	2.41	1.60
penicillins	Oral	6	3.81	13.44	10.62
polymyxins	Oral	35	0.00	0.00	0.04
tetracyclines	Oral	6	5.08	10.25	7.26
trimethoprim/sulphonamides	Oral	20	0.37	2.18	1.52

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