Autoriteit Diergeneesmiddelen

Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2018

Trends and benchmarking of livestock farms and veterinarians

September 2019





Preface

This is a copy of the report *Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2018* drawn up by the Netherlands Veterinary Medicines Institute (SDa). With this report, the SDa expert panel provides insight into the usage of antibiotics at Dutch livestock farms for the eighth consecutive year.

Although new benchmark thresholds will be applied as of reporting year 2019, results in the current report are still based on the benchmarking method introduced in 2011. Details on the implementation of the new benchmark thresholds will be provided in next year's SDa report.

The objectives of the benchmark thresholds, however, will remain unchanged: discouraging unnecessary use of antibiotics, and showing livestock farmers and veterinarians how they perform in terms of the amounts of antibiotics used at their farms and in terms of their prescription patterns, respectively.

Utrecht, June 2019

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Contents

Conclusions and recommendations

Developments in usage of antibiotics in the monitored livestock sectors

In 2018, antibiotic use in terms of defined daily doses animal ($DDDA_{NAT}$ values) declined in the turkey farming sector (by 13.4%), the veal farming sector (by 5.4%), the dairy and non-dairy cattle farming sectors (by 0.4% and 1.7%, respectively) and the pig farming sector (by 0.4%).

The **broiler farming sector**, however, recorded a 26.3% increase in the amount of antibiotics used. Potential underestimation of the number of broilers by Statistics Netherlands (CBS) and an increase in broilers' age at the time of treatment may have contributed to the higher $DDDA_{NAT}$ value recorded for 2018. A discrepancy between the CBS data and data provided by the broiler farming sector suggests that CBS may have underestimated the number of animals present within the broiler farming sector in 2018. The data provided by the broiler farming sector are based on the Dutch government's livestock identification and registration (I&R) system, and form the basis for individual farms' $DDDA_F$ values. The broiler farming sector's mean $DDDA_F$ only rose by 2.9% in 2018. The SDa expert panel will examine the discrepancy between CBS-provided and sector-provided data on the number of broilers, and adjust the usage data if necessary.

The amount of antibiotics used in the **turkey farming sector** continued to decline substantially in 2018. The turkey farming sector has been subjected to SDa monitoring since 2013, and over the 2013-2018 period its antibiotic use has dropped by 40.6%

The 2018 decline recorded for the **veal farming sector** can be attributed to reductions in the amounts of antibiotics used at white veal farms, rosé veal starter farms and rosé veal fattening farms. Usage levels at rosé veal combination farms, however, increased slightly in 2018.

While the **pig farming sector** still managed to reduce the amount of antibiotics used, this reduction is leveling off. With a 0.4% reduction recorded for 2018, the downward trend is nearing the 0% level.

The **dairy cattle farming sector** and the **non-dairy cattle farming sector** both recorded a slight reduction in the amount of antibiotics used, of 0.4% and 1.7%, respectively. Over the past four years, usage levels in these livestock sectors have been consistently low, with values that are deemed to represent acceptable use of antibiotics.

The usage data recorded for the **rabbit farming sector** (i.e. meat rabbit farms) have fluctuated considerably throughout the years. These fluctuations may reflect suboptimal data quality. The SDa expert panel has asked the rabbit farming sector to address the causes of its usage data fluctuations and verify the data. In other livestock sectors, critical success factor studies were carried out in order to identify any points for improvement. While the rabbit farming sector could benefit from this kind of assessment, it would require a different approach due to the small number of farms that comprise this livestock sector. In contrast to the other livestock sectors, the rabbit farming sector's small number of farms does not allow for such quantitative analysis.

Sales figures

In 2018, sales of antibiotics in terms of kilograms of active substances amounted to 179,134 kg. The number of kilograms of active substances sold declined by 1.1% between 2017 and 2018. Between 2009 (the government-specified reference year) and 2018, sales declined by 63.8%. Close to 10% of the total number of kilograms of antibiotics sold could not be attributed to antibiotic use in the monitored livestock sectors or antibiotic use in companion animals/horses. This discrepancy exceeds those observed in previous years. The SDa expert panel wants to find out why such discrepancies between the numbers of kilograms sold and used occur. To this end, it proposes the following:

- Completeness and reliability assessment of provided sales figures, as the sales data provided by FIDIN have never been assessed for completeness and reliability.
- Assessment of antibiotic use in unmonitored sectors, since 2018's more prominent discrepancy between the amount of antibiotics sold and the recorded amount of antibiotics used may have been associated with increased use of antibiotics in unmonitored sectors.
- Inspection of the data recorded by veterinary practices and livestock sectors, to check whether all antibiotics recorded have been reported. To this end, the livestock sectors will be required to provide the SDa with all delivery record data and have the SDa expert panel perform the selection of antibiotics. This approach will facilitate compliance with the new Regulation (EU) 2019/6, which will apply from January 28, 2022 and has to be implemented in national law.

The SDa expert panel has already approached FIDIN about its intended completeness and reliability assessment of the provided sales figures.

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

Use of third-choice antibiotics remained low in most of the livestock sectors. Changes in livestock sectors' antibiotic use over the 2017-2018 period were generally not associated with substantial shifts in the relative contributions of first-, second- and third-choice antibiotics. The SDa expert panel is worried by the fact that colistin use went up in 2018. Colistin sales rose by 286 kg (29.7%), and this development was associated with all livestock sectors except the dairy cattle farming sector recording an increase in the amount of colistin used. These increases were most prominent in the pig farming sector and the "Other poultry farming subsectors" category, with 170 kg (22%) and 85 kg (106%), respectively. While the pig farming sector's overall colistin use did not exceed the benchmark thresholds defined by EMA as part of its European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) project, any increase in colistin use is undesirable. The SDa expert panel would like the livestock sectors concerned to explain why colistin use went up in 2018. Colistin use in laying hens did exceed the EMA benchmark threshold of 1 mg/PCU. In light of this finding, the SDa expert panel urges the layer farming sector to quickly reduce the amount of colistin used in laying hens.

Benchmarking of livestock farms

Over the past few years, one of the SDa expert panel's main goals has been to reduce the number of livestock farms with high antibiotic usage levels, and in particular those with persistently high usage levels. In support of this goal, it has been monitoring the percentages of farms with signaling or action zone usage levels. Its main findings based on the data recorded for 2018 are summarized below:

- In the turkey farming sector, usage of antibiotics at the 10% of turkey farms recording the highest $DDDA_F$ values decreased from 72.9 $DDDA_F$ in 2016 to 59.8 $DDDA_F$ in 2017 and 49.7 $DDDA_F$ in 2018. As a result, the turkey farming sector's usage level distributions have become less skewed, with shorter tails. Turkey farms' 2018 usage level appeared to be quite strongly correlated with their 2017 usage level (correlation coefficient of 0.85). This means the 2017 usage level of individual turkey farms was a predictor of their 2018 usage level, which suggests the presence of structural determinants of antibiotic use. This warrants further investigation, as such determinants could inform measures to further reduce the amounts of antibiotics used at turkey farms.
- The veal farming sector had the highest percentage of farms with a signaling or action zone usage level. It also had the highest percentage of farms with structurally high usage levels (i.e. a signaling or action zone usage level for three consecutive years). The number of veal farms included in the action zone decreased between 2017 and 2018. White veal farms in particular showed a steady decline in their median $DDDA_F$ value, in addition to a reduction in the number of farms recording above-median usage levels (usage levels included in the 75th or 90th percentile of the $DDDA_F$ distribution). Rosé veal starter farms' 2018 usage level appeared to be correlated with their 2017 usage level (correlation coefficient of 0.57), which suggests the presence of factors that result in structural usage level differences between individual farms. This warrants further investigation, as such factors could inform measures to further reduce the amounts of antibiotics used at these livestock farms.
- In 2017, the pig farming sector saw an undesirable rise in the percentage of farms with weaner pigs recording action zone usage levels, as a result of the introduction of new benchmark thresholds in 2016. 2018 saw a slight improvement in this respect, with farms with weaner pigs recording usage levels that were not quite as high (the mean $DDDA_F$ of the 10% of farms with the highest usage levels dropped from 52.9 in 2017 to 44.0 in 2018). The correlation coefficient for 2017 and 2018 antibiotic use at farms with weaner pigs is 0.74. This high degree of correlation indicates that their 2017 usage level was a predictor of their 2018 usage level. This suggests that there are structural usage level differences between individual farms with weaner pigs, and shows the necessity of addressing the amounts of antibiotics used at high usage level farms.

In all livestock sectors except the cattle farming sector (i.e. the dairy and non-dairy cattle farming sectors), several livestock farms recorded usage levels greatly exceeding their sector's mean $DDDA_F$ value. Generally speaking, there have been only minor changes in livestock sectors' antibiotic usage patterns and $DDDA_F$ values over the past few years. Only in rare cases did farms included in the signaling or action zone manage to achieve the usage level reductions the SDa had hoped for. Therefore, the SDa expert panel again urges the livestock sectors to address the amounts of antibiotics used at farms recording signaling or action zone usage levels. As livestock farms with

relatively high usage levels may promote emergence and spread of resistant bacteria, the livestock sectors should aim for a substantial reduction in the number of farms recording high $DDDA_F$ values, particularly those that have recorded high $DDDA_F$ values for several years. The SDa expert panel feels the implementation of its new benchmark thresholds will facilitate the identification of livestock farms with relatively high usage levels.

Benchmarking of veterinarians

For the majority of livestock sectors, the number of veterinarians included in the target zone has increased over the past few years as a result of the livestock farms reducing their usage levels. All of the livestock sectors except the veal farming sector have seen a steep decline in the number of veterinarians assigned to the signaling or action zone. Compared to other veterinarians, veterinarians active in the veal farming sector more frequently recorded prescription patterns consistent with the signaling or action zone. This was associated with the antibiotic usage patterns observed for veal farms. Over the 2013-2018 period, the veal farming sector has not shown any considerable improvements in the number of veterinarians included in the signaling or action zone based on their prescription patterns.

Introduction of new benchmark thresholds in 2019

2018 is the last reporting year for which livestock farms' antibiotic use is assessed using the SDa's "old" benchmarking method. In 2018, the SDa expert panel defined new benchmark thresholds, which will be applied as of the 2019 reporting year. The SDa report to be published in 2020 will be the first report to include findings based on the new benchmark thresholds. These thresholds should prompt the livestock sectors to take action in order to further reduce the number of farms with high usage levels, with the aim of increasing the percentage of farms with $DDDA_F$ values consistent with acceptable use of antibiotics.

The SDa's new benchmarking method is based on a single benchmark threshold (an action threshold) per type of farm or production category, which can either be a benchmark threshold representing acceptable use or a provisional benchmark threshold. If the action threshold is exceeded, the livestock farm is included in the action zone. A usage level below the action threshold results in the livestock farm being included in the target zone. Provisional benchmark thresholds have no long-term applicability and require regular reevaluation to assess whether a more stringent threshold can be introduced. Most of the livestock sectors seem to consider their new benchmark thresholds to be a distant goal, and they are trying to agree on an implementation period with the Ministry of Agriculture, Nature and Food Quality. The SDa expert panel wants its benchmarking approach to reduce the number of $DDDA_F$ outliers, including the aforementioned livestock farms with persistently high usage levels, and limit usage level fluctuations over time as much as possible. Consequently, it feels structural and/or more excessive benchmark threshold deviations should be met with stricter corrective measures, to be taken by the livestock sector concerned. A proportional approach like this would be particularly beneficial in the first years following the introduction of the new benchmark thresholds, as the livestock sectors will need some time to adjust to the new benchmarking method. In addition, the SDa expert panel feels the veal and rabbit farming sectors' $DDDA_F$ distributions show that these livestock sectors require across-the-board reductions in the amounts of antibiotics used.

Summary of old and new benchmark thresholds. Benchmark thresholds representing acceptable use will be valid from 2019 to 2024. Provisional benchmark thresholds will be valid for the 2019-2020 period

		Benchmark thresholds valid until the end of 2018		Benchmark thresholds valid as of 2019, with specification of the type of threshold	
Livestock sector	**Type of farm/ production category**	**Signaling threshold**	**Action threshold**	**Type of benchmark threshold**	**Action threshold**
Veal farming sector*	White veal farms	23	39	Provisional	23
	Rosé veal starter farms	67	110	Provisional	67
	Rosé veal fattening farms	1	6	Representing acceptable use	4
	Rosé veal combination farms	12	22	This category will cease to exist	
Pig farming sector	Sows/suckling piglets	10	20	Representing acceptable use	5
	Weaner pigs	20	40	Provisional	20
	Fattening pigs	10	12	Representing acceptable use	5
Poultry farming sector	Broiler farms	15	30	Representing acceptable use	8
	Turkey farms	19	31	Provisional	10¥
Rabbit farming sector	Rabbit farms			Provisional	**
Cattle farming sector	Dairy cattle farms	6§		Representing acceptable use	6
	Rearing farms	2§		Representing acceptable use	2
	Suckler cow farms	2§		Representing acceptable use	2
	Beef farms	2§		Representing acceptable use	2

* The benchmark thresholds are based on a 1.5-year period.
** No benchmark threshold can be determined based on the currently available data.
¥ The new benchmark threshold for turkey farms has yet to be agreed upon.
§ Threshold for inclusion in the signaling zone; cattle farms are included in the action zone if their usage level has exceeded the signaling threshold two years in a row.

New benchmark thresholds for veterinarians will be announced in the second half of 2019. Following analysis of the expected effects of the new benchmark thresholds for livestock farms, the SDa expert panel decided to also revise its benchmarking method for veterinarians. Implementation of the revised benchmarking method for veterinarians will require careful preparation.

Expansion of the SDa's monitoring process

Several new EU regulations on veterinary medicinal products must have been incorporated in Dutch law by 2022. The implementation of Regulation (EU) 2019/6 is most important in this respect, as this Regulation sets out rules regarding the placing on the market, manufacturing, import, export, supply, distribution, pharmacovigilance, control and use of veterinary medicinal products. As a result of the implementation of this Regulation, the SDa will have to expand its monitoring efforts as it will also have to monitor the use of antifungals, antiprotozoals, antivirals and topical antimicrobials (antimicrobials to be administered in the eyes or ears or on the skin) at livestock farms. At the moment, the SDa only monitors intramammary and intrauterine use of non-systemic antimicrobials. Implementation of his Regulation also means that in addition to data on the amounts of antimicrobials used in food-producing animal species, data will also have to be collected for other animals which are bred or kept, including animals kept by natural persons (e.g. companion animals).

Article 57 of the Regulation sets out several time limits for the implementation of this more extensive data collection and monitoring process. Within two years from January 28, 2022, data shall be collected for poultry (including turkeys), pigs and veal calves. Within five years from January 28, 2022, data shall be collected for all food-producing animals (including animals like dairy goats and lambs). Within eight years from January 28, 2022, data shall be collected for all animals which are bred or kept.

In the Netherlands, the SDa and the livestock sectors had, on their own accord, already taken steps to expand the number of livestock sectors being subjected to monitoring. The **rabbit farming sector** has been providing the SDa expert panel with antibiotic usage data since 2016. Although the **dairy goat farming sector** is not yet being monitored, it is taking steps to enable SDa monitoring. The SDa expert panel has urged this sector to make sure its monitoring system is ready for rollout by the end of 2019. While there is currently no obligation for the dairy goat farming sector to provide data on the amounts of antibiotics used, the SDa expert panel feels such an obligation would be warranted considering the growing number of dairy goats in the Netherlands and the sector's increasingly important role in the food industry. The **remaining livestock sectors or animal categories** (e.g. the sheep farming sector, horses and companion animals) are not yet subjected to regular monitoring, but are being monitored intermittently, once every three years. This will suffice until the data collection obligations set out in the new EU Regulation take effect.

Concluding remarks

In next year's report, the SDa expert panel will start applying its new benchmark thresholds. As they are lower than the current benchmark thresholds, some of the livestock sectors may see substantial changes in how the livestock farms and veterinarians are distributed over the respective benchmark zones. In order to avoid unpleasant surprises, the SDa expert panel advises the livestock sectors and veterinary organizations to prepare farmers and veterinarians by explaining the reasons for introducing the lower benchmark thresholds. The new benchmark thresholds are predominantly intended to reduce the amounts of antibiotics used at farms with relatively high usage patterns, which should result in $DDDA_F$ distributions with shorter tails and reduce the risk of selection and spread of resistant pathogens.

Terms and definitions

BCT	"Branchecodetabel", a veterinary medicinal products database used in the Netherlands.
$DDDA_F$	The defined daily dose animal used to express the amount of antibiotics used at a particular livestock farm. The $DDDA_F$ is determined by first calculating the total number of treatable kilograms at a particular livestock farm for a specific year, and then dividing this number by the average number of kilograms of animal present at the livestock farm concerned. It represents the amount of antibiotics used at a particular livestock farm, and is used for benchmarking individual livestock farms. This is the unit of measurement used by the SDa since 2011 (see the Standard Operating Procedure *Berekening van de DDD/J voor antimicrobiële middelen door de SDa* [SDa method for calculating the DDDA/Y for antimicrobial agents]). The $DDDA_F$ data of all individual livestock farms within a particular livestock sector are used to determine the sector's mean and median $DDDA_F$ values (*unweighted*, i.e. with all livestock farms contributing equally). Theoretically speaking, the weighted mean of the $DDDA_F$ (with weighting based on the value of the denominator, i.e. the number of kilograms of animal) is equal to the mean $DDDA_{NAT}$ based on all livestock farms within the livestock sector concerned. In practice, however, $DDDA_F$-$DDDA_{NAT}$ conversions are not possible, as the $DDDA_F$ and $DDDA_{NAT}$ denominators are based on different data sources. The $DDDA_F$ is expressed in DDDA/animal-year. In the initial SDa reports, the unit of measurement ADDD/Y was used.
$DDDA_{NAT}$	The defined daily dose animal used to express the amount of antibiotics used within a particular livestock sector in the Netherlands. The $DDDA_{NAT}$ is determined by first calculating the total number of treatable kilograms within a particular livestock sector for a specific year, and then dividing this number by the average number of kilograms of animal present within the livestock sector concerned. This unit of measurement is used to assess the amount of antibiotics used within a particular livestock sector, irrespective of the types of livestock farms or production categories included in the livestock sector concerned. When multiplied by 1,000/365, it is similar to the unit of measurement DDD per 1,000 person-days, which is used in human medicine. The $DDDA_{NAT}$ is expressed in DDDA/animal-year.

$DDDA_{VET}$	The defined daily dose animal used to express the antibiotic prescription pattern of a particular veterinarian in one of the livestock sectors for a particular year. To determine the $DDDA_{VET}$, the first step is to calculate the total number of treatable kilograms for which a particular veterinarian prescribed antibiotics during a specific year (the overall number of treatable kilograms for all livestock farms that had a registered one-to-one relationship with this veterinarian in the year concerned). This number is then divided by the average number of kilograms of animal present based on all of the livestock farms that had a registered one-to-one relationship with the veterinarian concerned. The $DDDA_{VET}$ reflects a particular veterinarian's prescription pattern in absolute terms, and is used to identify inter-veterinarian variability in prescription patterns.
DDD_{VET}	The active substance-based defined daily dose for veterinary medicinal products. The DDD_{VET} is the assumed average dose administered to a particular type of livestock in Europe, in mg/kg body weight. This unit of measurement is used to determine DDD_{VET}/live weight values, which facilitate comparison with $DDDA_{NAT}$ data.
EMA	European Medicines Agency
ESBL	Extended-Spectrum Beta-Lactamase
ESVAC	European Surveillance of Veterinary Antimicrobial Consumption
EUROSTAT	The statistical office of the European Union. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.
Mass balance	An equation for comparing the reported amount (in kilograms, kg) of an active substance sold with the amount (in kg) of the active substance used according to veterinarian-reported delivery data (delivery records).
PCU	Population Correction Unit, a unit of measurement for the number of kilograms of animal, used by the European Medicines Agency. The PCU is calculated using the number of animals slaughtered in a particular year (adjusted for imported and exported animals), unless the animals present within the livestock sector concerned are not kept for meat production, in which case the number of live animals is used (this mainly applies to dairy cattle). Consequently, depending on the livestock sector concerned, the PCU is a production-driven unit of measurement (more kilograms produced will result in a lower value), in contrast to the denominator in the SDa's $DDDA_{NAT}$ calculations, which is a unit of measurement for the number of kilograms of animal that is based solely on the average number of live animals present in the year concerned.

RPR	Relative Prescription Ratio, i.e. the amount of antibiotics used at a particular livestock farm (the farm's $DDDA_F$ value) divided by the action threshold applicable to the livestock farm concerned.
Treatable kilograms	The number of kilograms of a particular type of livestock that, according to the SPC, can be treated with a single packaging unit of the antibiotic concerned.
VBI	Veterinary Benchmark Indicator. A veterinarian's VBI expresses the probability that livestock farms for which the veterinarian concerned is responsible will fall within the action zone for livestock farms based on their antibiotic use. A veterinarian's VBI is based on the distribution of the RPRs of the livestock farms for which he or she is responsible.

Introduction

2018 is the eighth year for which the SDa publishes antibiotic usage data. The layout of the current report is largely in line with that of last year's report. The SDa has been monitoring the amounts of antibiotics used at Dutch livestock farms since 2011, by comparing livestock farms' usage levels to benchmark thresholds defined for a particular type of farm or production category in the livestock sector concerned. In the spring of 2014, the SDa also introduced and published a benchmarking method to be used for veterinarians.

Using data provided by the various livestock sectors, the SDa is able to:

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

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

The current report also addresses the new benchmark thresholds that will be applied as of the 2019 reporting year, as well as a number of other plans for the near future.

Trends in usage and sales of antibiotics

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

1. Usage of antibiotics is assessed based on all of the farm-level delivery records for antibiotics. The delivery records are transferred to the SDa through the databases of the various livestock sectors, and provide detailed information on the amounts of antibiotics used in each sector.
2. Sales figures are provided by FIDIN, the federation of the Dutch veterinary pharmaceutical industry. In the current report, the agents sold have been categorized in accordance with the Dutch "Branchecodetabel" (BCT) as at March 1, 2019. Differentiation of sales figures according to livestock sector was only possible for a small number of products.

For each of the livestock sectors, the annual overall number of defined daily doses animal for the entire livestock sector (in $DDDA_{NAT}$) has been determined, based on all of the delivery records and the average number of kilograms of animal present within the sector concerned. The $DDDA_{NAT}$ has been selected as the general trend indicator for antibiotic use in the various Dutch livestock sectors over several years. $DDDA_{NAT}$ data are in line with the MARAN data that used to be reported by the then Agricultural Economic Institute of Wageningen University & Research centre (LEI Wageningen UR, now Wageningen Economic Research). From 2012 onwards, all delivery record data pertaining to veal calves, cattle and pigs have been reported to the SDa by the respective livestock sectors. This has enabled the SDa to analyze $DDDA_{NAT}$ trends over the 2012-2018 period for the veal, cattle and pig farming sectors. As only part of the 2012 delivery record data for the broiler farming sector had been provided to the SDa, the SDa decided to estimate this livestock sector's 2012 antibiotic use based on the 2012 data that were available. Antibiotic use in the turkey farming sector has been reported on since 2013, and 2016 was the first year for which delivery record data for the rabbit farming sector were included in the SDa report. 2017 was the first year for which the SDa included itemized delivery record data for some of the other poultry farming subsectors (laying hen farms, rearing farms for laying hens, rearing farms for layer or broiler parent/grandparent stock, and production farms for layer or broiler parent/grandparent stock).

In order to determine the $DDDA_{NAT}$ values, the SDa had to obtain data on the numbers of animals present in the Netherlands. Data from Statistics Netherlands (CBS) and EUROSTAT were used to this end. For each type of livestock within the various livestock sectors, the number of kilograms of animal present in the Netherlands was calculated using the numbers of animals provided in Table A1 and Table A2 (included in the appendices). CBS data were used for the veal, poultry and rabbit farming sectors, and EUROSTAT data were used for the other livestock sectors.

In this report, "cattle farming sector" refers to dairy cattle and non-dairy cattle, and does not include veal calves. Consequently, the "cattle farming sector" and "veal farming sector" categories are mutually exclusive. This distinction is applied throughout this report.

Number of kilograms of animal present in the Netherlands

Table 1. Live weight (x1,000 kg) of agricultural livestock in the Netherlands from 2014 to 2018*

Livestock sector	2014	2015	2016	2017	2018
Broiler farming sector	47,020	49,107	48,378	48,237	41,789
Turkey farming sector	4,763	5,178	4,572	4,023	3,944
Pig farming sector	704,937	706,025	686,638	690,093	663,267
Dairy cattle farming sector	966,000	1,030,200	1,076,400	999,000	931,200
Non-dairy cattle farming sector	649,000	649,800	600,100	542,000	541,000
Veal farming sector	158,828	156,751	164,890	163,935	171,133
Rabbit farming sector	860	1,004	948	901	866

** Pig and cattle farming sector data were provided by EUROSTAT. Rabbit, veal and poultry farming sector data were provided by Statistics Netherlands (CBS).*

Live weight recorded for the broiler farming sector is markedly lower than in previous years, with a 13.4% decline compared to 2017. The lower weight affects the broiler farming sector's $DDDA_{NAT}$ values, the cause of this decline will be examined.

Developments in usage of antibiotics based on delivery record data

Antibiotic usage data were provided by the various livestock sectors. If large amounts of antibiotics were recorded for a particular livestock farm, the data were verified to check whether the provided information was correct. Only a small proportion of delivery records suggested the supply of large amounts of antibiotics. Some of the high delivery record results were due to errors in the data file. In those cases, the data were resubmitted. The delivery record data were used to determine the number of kilograms of animal treated for each of the livestock sectors. These numbers, together with the number of kilograms of animals present within the livestock sector concerned, enabled the SDa to obtain sector-specific $DDDA_{NAT}$ values. The $DDDA_{NAT}$ values for the 2014-2018 period are included in Table 2.

In 2018, antibiotic use in terms of defined daily doses animal ($DDDA_{NAT}$ values) declined in the turkey farming sector (by 13.4%), the veal farming sector (by 5.4%), the dairy and non-dairy cattle farming sectors (by 0.4% and 1.7%, respectively) and the pig farming sector (by 0.4%).

The **broiler farming sector**, however, recorded a 26.3% increase in the amount of antibiotics used. Potential underestimation of the number of broilers by Statistics Netherlands (CBS) and an increase in broilers' age at the time of treatment may have contributed to the higher $DDDA_{NAT}$ value recorded for 2018. A discrepancy between the CBS data and data provided by the broiler farming sector suggests that CBS may have underestimated the number of animals present within the broiler farming sector in 2018. The data provided by the broiler farming sector are based on the Dutch government's livestock identification and registration (I&R) system, and form the basis for individual farms' $DDDA_F$ values. The broiler farming sector's mean $DDDA_F$ only rose by 2.9% in 2018. As $DDDA_F$ calculations are growth-curve based, the resulting usage levels are adjusted for age/body weight at the time of treatment and type of breed. $DDDA_{NAT}$ calculations, on the other hand, are based on a standardized body weight of 1 kg for broilers. The SDa expert panel will examine the discrepancy

between CBS-provided and sector-provided data on the number of broilers, and adjust the usage data if necessary. In addition, it will monitor broiler's body weight at the time of treatment and try to find out whether the recorded increase was incidental or structural in nature.
The amount of antibiotics used in the **turkey farming sector** continued to decline substantially in 2018. The turkey farming sector has been subjected to SDa monitoring since 2013, and over the 2013-2018 period its antibiotic use has dropped by 40.6%
The 2018 decline recorded for the **veal farming sector** can be attributed to reductions in the amounts of antibiotics used at white veal farms, rosé veal starter farms and rosé veal fattening farms. Usage levels at rosé veal combination farms, however, increased slightly in 2018.
While the **pig farming sector** still managed to reduce the amount of antibiotics used, this reduction is leveling off. With a 0.4% reduction recorded for 2018, the downward trend is nearing the 0% level.
The **dairy cattle farming sector** and the **non-dairy cattle farming sector** both recorded a slight reduction in the amount of antibiotics used, of 0.4% and 1.7%, respectively. Over the past four years, usage levels in these livestock sectors have been consistently low, with values that are deemed to represent acceptable use of antibiotics.
The usage data recorded for the **rabbit farming sector** have fluctuated considerably throughout the years. These fluctuations may reflect suboptimal data quality. The SDa expert panel has asked the rabbit farming sector to address the causes of its usage data fluctuations and verify the data. In other livestock sectors, critical success factor studies were carried out in order to identify any points for improvement. While the rabbit farming sector could benefit from this kind of assessment, it would require a different approach due to the small number of farms that comprise this livestock sector. In contrast to the other livestock sectors, the rabbit farming sector's small number of farms does not allow for such quantitative analysis.

Table 2. $DDDA_{NAT}$ values for the 2014-2018 period, by livestock sector (broiler, turkey, pig, dairy cattle, non-dairy cattle, veal and rabbit farming sectors) and pharmacotherapeutic group

	Broiler farming sector					Turkey farming sector					Pig farming sector				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Pharmacotherapeutic group															
1st-choice antibiotics	**5.16**	**3.76**	**2.49**	**2.36**	**2.64**	**17.75**	**19.18**	**12.29**	**8.11**	**9.16**	**7.45**	**6.97**	**6.88**	**6.61**	**6.68**
As a proportion of overall AB use	**32.72%**	**25.79%**	**24.42%**	**25.08%**	**22.26%**	**57.73%**	**53.37%**	**46.49%**	**40.22%**	**52.46%**	**78.22%**	**77.10%**	**77.54%**	**75.99%**	**77.18%**
Amphenicols	*	*	*	*	*	*	*	*	*	*	0.17	0.18	0.24	0.25	0.25
Macrolides/lincosamides	*	*	*	*	*	*	*	*	*	*	0.92	0.78	0.82	0.76	0.77
Penicillins	2.12	1.20	0.70	0.59	0.51	5.80	4.49	3.70	1.64	2.22	0.61	0.57	0.58	0.55	0.68
Pleuromutilins	*	*	*	*	*	*	0.12	*	0.10	0.10	0.09	0.08	0.07	0.09	0.12
Tetracyclines	1.70	1.49	1.01	0.95	1.21	9.58	12.57	7.63	5.51	6.05	4.34	4.14	4.07	4.05	3.86
Trimethoprim/sulfonamides	1.34	1.07	0.78	0.82	0.92	2.37	2.01	0.95	0.86	0.79	1.33	1.20	1.10	0.90	1.01
2nd-choice antibiotics	**10.43**	**10.75**	**7.63**	**6.99**	**9.15**	**11.71**	**15.56**	**12.54**	**10.99**	**7.66**	**2.07**	**2.07**	**1.99**	**2.09**	**1.98**
As a proportion of overall AB use	**66.15%**	**73.73%**	**74.86%**	**74.34%**	**77.11%**	**38.08%**	**43.29%**	**47.45%**	**54.50%**	**43.92%**	**21.76%**	**22.89%**	**22.45%**	**24.01%**	**22.82%**
Aminoglycosides	0.03	0.02	0.01	0.03	0.02	0.40	0.71	0.69	0.05	0.00	0.01	0.01	0.00	0.01	0.03
Aminopenicillins	7.80	7.23	5.78	5.00	6.09	9.09	12.13	10.05	9.37	6.37	1.45	1.36	1.39	1.41	1.23
1st- and 2nd-gen. cephalosporins	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Quinolones	2.13	2.86	1.51	1.72	2.68	0.02	0.10	0.01	0.26	0.15	0.05	0.03	0.02	0.03	0.02
Fixed-dose combinations	0.06	0.11	0.05	0.01	0.02	*	*	*	*	*	0.05	0.04	0.03	0.02	0.02
Macrolides/lincosamides	0.35	0.48	0.25	0.20	0.29	2.12	1.98	1.18	1.30	1.14	0.17	0.25	0.26	0.37	0.37
Polymyxins	0.05	0.06	0.04	0.03	0.05	0.08	0.63	0.61	*	*	0.34	0.38	0.28	0.26	0.31
3rd-choice antibiotics	**0.18**	**0.07**	**0.07**	**0.05**	**0.07**	**1.29**	**1.20**	**1.60**	**1.06**	**0.63**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
As a proportion of overall AB use	**1.13%**	**0.48%**	**0.72%**	**0.58%**	**0.63%**	**4.19%**	**3.34%**	**6.06%**	**5.28%**	**3.62%**	**0.02%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
3rd- and 4th-gen. cephalosporins	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Fluoroquinolones	0.18	0.07	0.07	0.05	0.07	1.29	1.20	1.60	1.06	0.63	0.00	0.00	0.00	0.00	0.00
Overall antibiotic use	**15.76**	**14.59**	**10.19**	**9.40**	**11.87**	**30.74**	**35.94**	**26.42**	**20.16**	**17.45**	**9.52**	**9.03**	**8.87**	**8.70**	**8.66**

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

	Dairy cattle farming sector					Non-dairy cattle farming sector					Veal farming sector				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Pharmacotherapeutic group															
1st-choice antibiotics	**2.39**	**2.27**	**2.23**	**2.35**	**2.40**	**0.95**	**0.86**	**0.91**	**0.92**	**0.94**	**18.23**	**18.99**	**17.94**	**17.30**	**16.45**
As a proportion of overall AB use	**72.56%**	**73.06%**	**74.03%**	**76.94%**	**78.99%**	**82.60%**	**86.00%**	**84.95%**	**84.19%**	**86.67%**	**86.20%**	**86.09%**	**85.90%**	**85.90%**	**86.38%**
Amphenicols	0.06	0.06	0.06	0.05	0.05	0.10	0.10	0.11	0.11	0.10	1.52	1.63	1.59	1.44	1.36
Macrolides/lincosamides	0.09	0.09	0.06	0.05	0.05	0.18	0.15	0.15	0.16	0.14	3.53	3.70	3.35	3.43	3.28
Penicillins	1.62	1.50	1.52	1.69	1.76	0.09	0.09	0.10	0.11	0.10	0.43	0.42	0.48	0.46	0.44
Pleuromutilins	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Tetracyclines	0.39	0.37	0.35	0.32	0.32	0.47	0.42	0.44	0.45	0.53	10.66	11.01	10.47	10.35	10.08
Trimethoprim/sulfonamides	0.24	0.25	0.24	0.24	0.23	0.11	0.10	0.10	0.09	0.06	2.08	2.22	2.05	1.61	1.28
2nd-choice antibiotics	**0.90**	**0.83**	**0.78**	**0.70**	**0.64**	**0.20**	**0.14**	**0.16**	**0.17**	**0.14**	**2.90**	**3.04**	**2.92**	**2.80**	**2.57**
As a proportion of overall AB use	**27.30%**	**26.79%**	**25.83%**	**22.94%**	**20.88%**	**17.36%**	**13.95%**	**15.01%**	**15.72%**	**13.28%**	**13.71%**	**13.80%**	**13.97%**	**13.90%**	**13.50%**
Aminoglycosides	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.34	0.19	0.23	0.23	0.21
Aminopenicillins	0.38	0.37	0.34	0.31	0.29	0.09	0.07	0.06	0.08	0.06	1.71	1.91	1.77	1.75	1.68
1st- and 2nd-gen. cephalosporins	0.02	0.02	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	*	*	*	*	*
Quinolones	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.03	0.02	0.01	0.49	0.58	0.66	0.57	0.37
Fixed-dose combinations	0.48	0.42	0.38	0.34	0.29	0.04	0.03	0.03	0.04	0.03	0.01	0.00	0.00	0.01	0.00
Macrolides/lincosamides	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.03	0.19	0.18	0.19	0.23	0.29
Polymyxins	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.15	0.19	0.07	0.02	0.02
3rd-choice antibiotics	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.03**	**0.04**	**0.02**
As a proportion of overall AB use	**0.14%**	**0.15%**	**0.14%**	**0.11%**	**0.13%**	**0.04%**	**0.05%**	**0.05%**	**0.09%**	**0.05%**	**0.09%**	**0.11%**	**0.13%**	**0.19%**	**0.12%**
3rd- and 4th-gen. cephalosporins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*	*	*	*
Fluoroquinolones	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.04	0.02
Overall antibiotic use	**3.30**	**3.11**	**3.01**	**3.06**	**3.04**	**1.15**	**1.00**	**1.07**	**1.10**	**1.08**	**21.15**	**22.05**	**20.88**	**20.13**	**19.04**

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

	Rabbit farming sector		
	2016	2017	2018
Pharmacotherapeutic group			
1st-choice antibiotics	**30.92**	**24.22**	**32.66**
As a proportion of overall AB use	**75.54%**	**80.55%**	**74.75%**
Amphenicols	0.00	*	*
Macrolides/lincosamides	1.07	1.74	2.67
Other	16.37	12.36	16.55
Penicillins	*	*	0.00
Pleuromutilins	1.38	1.68	3.37
Tetracyclines	10.49	7.76	9.93
Trimethoprim/sulfonamides	1.62	0.69	0.13
2nd-choice antibiotics	**9.76**	**5.73**	**10.74**
As a proportion of overall AB use	**23.84%**	**19.05%**	**24.58%**
Aminoglycosides	9.66	5.73	10.22
Aminopenicillins	*	*	*
1st- and 2nd-gen. cephalosporins	*	*	*
Quinolones	*	*	*
Fixed-dose combinations	*	*	*
Macrolides/lincosamides	0.01	*	0.24
Polymyxins	0.09	*	0.28
3rd-choice antibiotics	**0.25**	**0.12**	**0.29**
As a proportion of overall AB use	**0.62%**	**0.41%**	**0.66%**
3rd- and 4th-gen. cephalosporins	*	*	*
Fluoroquinolones	0.25	0.12	0.29
Overall antibiotic use	**40.93**	**30.07**	**43.69**

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

Usage of first-, second- and third-choice antibiotics

In most livestock sectors, first-choice antibiotics accounted for over 75% of overall antibiotic use in 2018. The broiler and turkey farming sectors were the only livestock sectors with first-choice antibiotics accounting for less than 75% of overall antibiotic use (with 22% and 52%, respectively). The turkey farming sector was the only livestock sector in which the relative contribution of third-choice antibiotics exceeded the 1% level in 2018, with third-choice antibiotics accounting for 3.6% of overall antibiotic use. Changes in livestock sectors' antibiotic use over the 2017-2018 period were generally not associated with substantial shifts in the relative contributions of first-, second- and third-choice antibiotics. The contribution of second-choice antibiotics in the turkey farming sector, however, did show a sharp decline. This was associated with a rise in the relative contribution of first-choice antibiotics. Although use of second-choice antibiotics in the broiler farming sector appeared to have stabilized in previous years, it went back up in 2018. This is something to keep an eye on in the next few years. The sector should look into health management policies and the diagnostic processes and treatment options with respect to the most common bacterial infections in broilers. Diagnoses are already being recorded every time antibiotics are prescribed for poultry. Considering that administration of aminopenicillins is one of the drivers for selection of ESBL-producing Enterobacteriaceae, and administration of macrolides may lead to selection of macrolide-resistant *Campylobacter* species, these agents should be used prudently in order to reduce the risk of selection of resistant bacteria. The SDa expert panel continues to urge livestock farmers to limit their use of second-choice antibiotics as much as possible.

Use of colistin (the only polymyxin authorized for use in food-producing animals) went up in 2018, with the pig farming sector and the "Other poultry farming subsectors" category recording the most prominent increases. Their colistin use rose by 170 kg (22%) and 85 kg (106%), respectively, compared to 2017 usage levels. Just like last year, the SDa expert panel compared livestock sectors' colistin use with the EMA benchmark thresholds of 1 mg/PCU and 5 mg/PCU (EMA 2016). The Population Correction Unit (PCU) was used as the unit of measurement for the number of kilograms of animal, and the PCU values were determined using EMA's calculation method. As the PCU is based on the number of kilograms of animal produced, for a high-producing livestock sector like the broiler farming sector, colistin use in terms of mg/PCU will be relatively low compared with its $DDDA_{NAT}$ value. For each of the livestock sectors included in the table below, the amount of colistin used did not exceed the most stringent EMA benchmark threshold. The SDa expert panel also calculated the amount of colistin used in laying hens. As the ESVAC population correction unit template does not include standardized body weights for laying hens, laying hens were assumed to weigh 2-3 kg. This was deemed to be a realistic estimate for laying hens in the Netherlands. Estimates based on these body weights suggest colistin use in laying hens does exceed the 1 mg/PCU level. In light of this finding, the SDa expert panel urges the layer farming sector to quickly reduce the amount of colistin used in laying hens and to take appropriate measures to this end.

Table 3. Colistin use in mg/PCU from 2015 to 2018, by livestock sector

Livestock sector	2015	2016	2017	2018
Broiler farming sector	0.027	0.019	0.017	0.021
Pig farming sector	0.814	0.558	0.490	0.598
Dairy cattle farming sector	0.033	0.025	0.018	0.012
Non-dairy cattle farming sector	0.075	0.039	0.008	0.039
Veal farming sector	0.675	0.233	0.060	0.062

Following a steady increase from 2014 to 2016, use of quinolones in the veal farming sector declined in 2017 and even dropped below the 2014 level in 2018. Its aminoglycoside use remained stable, and it managed to keep its polymyxin use at the low level first recorded for 2017. In 2018, quinolone use in the broiler farming sector rose above the sector's 2014 level. Its use of fluoroquinolones went back up to the level recorded for 2016 and 2015. Use of aminoglycosides and polymyxins fell substantially in the turkey farming sector and remained low in the broiler farming sector.

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

Similar to previous years, the SDa expert panel has combined LEI Wageningen UR and SDa data in order to analyze long-term developments in antibiotic use (see Figure 1) and calculate the reductions achieved over the 2009-2018 period in the veal, broiler, pig and dairy cattle farming sectors. Table 4 shows the $DDDA_{NAT}$ reductions from the levels recorded for 2009, the government-specified reference year. The **veal farming sector** reduced its antibiotic use (in $DDDA_{NAT}$) by 44% between 2009 and 2018, and by 52% over the 2007-2018 period. Considering the relatively small 6.4% reduction achieved between 2013 and 2017, the 5.4% decline recorded for 2018 is a considerable improvement. The SDa expert panel hopes this will be followed by a further decline that will move the veal farming sector closer to a $DDDA_{NAT}$ value consistent with acceptable use.
The **turkey farming sector** has recorded steep declines for the past three years. The SDa expert panel hopes the sector will be able to continue this trend in the years to come.

Figure 1. Long-term developments in antibiotic use according to LEI Wageningen UR data (in DD/AY, as published in MARAN reports, until 2010) and SDa data (in $DDDA_{NAT}$, from 2011 onwards), as splines with point estimates and corresponding 95% confidence intervals for each year. See the appendices for the computational basis. With regard to the broiler farming sector, please take account of the denominator data considerations mentioned earlier in this report. Purple: turkey farming sector; blue: veal farming sector; orange: broiler farming sector; light green: pig farming sector; dark green: dairy cattle farming sector

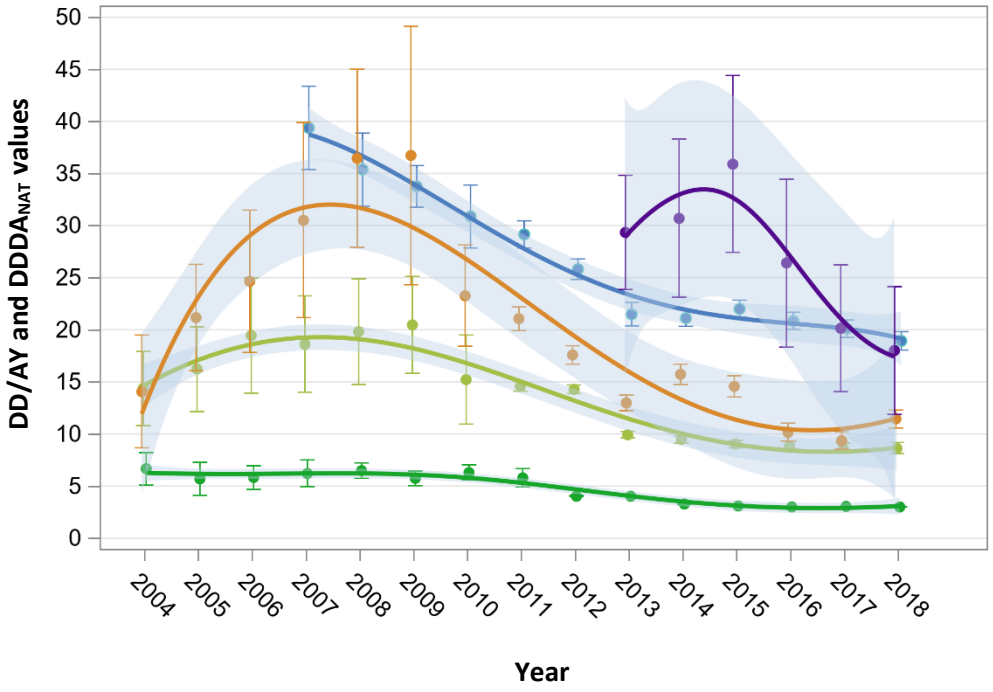


Table 4. Reductions in the amount of antibiotics used in agricultural livestock, compared to 2009 levels

	$DDDA_{NAT}$	Reduction from the 2009 level, in %								
Livestock sector	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Broiler farming sector	36.76	37	43	52	65	57	60	72	74	68
Pig farming sector	20.51	26	29	30	51	54	56	57	58	58
Dairy cattle farming sector	5.78	-10	-1	30	30	43	46	48	47	47
Veal farming sector	33.80	9	14	24	36	37	35	38	40	44

All veal and dairy cattle farming sector data relating to the observation period have been adjusted for the dosage-related changes implemented in the "Diergeneesmiddelenstandaard" database in 2014. Turkey and rabbit farming sector data have not been included in this table, as there were no 2009 usage data with which to compare the more recent usage data.

2018 data on amounts of antibiotics used (by livestock sector and for all livestock sectors combined) and amounts of antibiotics sold

Using all delivery data recorded by the livestock sectors, the total number of kilograms of active substances used within each livestock sector was calculated. Just like $DDDA_{NAT}$ data, the numbers of kilograms of veterinary medicinal products used in the various livestock sectors are reported for each category of antibiotics (i.e. first-, second- and third-choice agents), and further specified by pharmacotherapeutic group. The numbers of kilograms used in the various livestock sectors are shown in Table 5.

In 2011, the WVAB (the veterinary working group for antimicrobial policy of the Royal Dutch Society for Veterinary Medicine (KNMvD)) decided that the WHO's rationale for classifying macrolides as critically important antibiotics (the fact that they are known to select for macrolide-resistant *Campylobacter* species in animals) does apply to the poultry farming sector but not to the other livestock sectors. This is why in the poultry farming sector all macrolides are classified as second-choice antibiotics, while in the other livestock sectors only particular macrolides (long-acting injectables which are not authorized for use in poultry) are classified as second-choice antibiotics. Sales data on the macrolides that are regarded as first-choice antibiotics in most livestock sectors but as second-choice antibiotics in the poultry farming sector, do not allow for categorization by livestock sector. This is why in Table 5 every kg of macrolides used in the poultry farming sector has been recorded under first-choice antibiotics.

In addition to delivery record data on the amounts of antibiotics used, Table 5 also includes the numbers of kilograms sold. The sales figures were provided by FIDIN. Since certain products are exclusively authorized for use in companion animals and/or horses, the SDa expert panel was able to estimate how many of the kilograms recorded for a particular pharmacotherapeutic group must have been intended for companion animals and/or horses. It has included these estimates in a separate column.

Other poultry farming subsectors

Just like last year, the SDa expert panel obtained data on the amounts of antibiotics used at laying hen farms, rearing farms for laying hens, rearing farms for layer or broiler parent/grandparent stock, and production farms for layer or broiler parent/grandparent stock. From now on, these layer and broiler farming subsectors are subjected to SDa monitoring. Minor poultry farming subsectors such as the duck, guinea fowl, ostrich and quail farming sectors, are exempt from having their antibiotic usage data recorded in the central registry used by the Dutch poultry farming sector (the "Centrale Registratie Antibiotica" or CRA), and have not contributed to the data in the "Other poultry farming subsectors" column in Table 5.

Table 5. Antibiotic use in kg (by livestock sector and for all livestock sectors combined) and sales figures for 2018, by pharmacotherapeutic group

	According to delivery records									According to sales figures	
Pharmacotherapeutic group	**Broiler farming sector**	**Turkey farming sector**	**Other poultry farming subsectors**	**Pig farming sector**	**Dairy cattle farming sector**	**Non-dairy cattle farming sector**	**Veal farming sector**	**Rabbit farming sector**	**All livestock sectors combined**	**Companion animal + horse sectors**	**Overall sales**
1st-choice antibiotics	**3,735**	**1,199**	**2,745**	**55,192**	**9,376**	**7,553**	**46,668**	**257**	**126,726**	**2,524**	**139,799**
As a proportion of overall AB use/sales	**39.37**	**73.64**	**79.52**	**82.21**	**84.37**	**87.32**	**84.31**	**64.87**	**80.61**	**60.63**	**78.04**
Amphenicols	0	0	0	1,274	459	533	2,332	0	4,598	23	4,405
Fixed-dose combinations	0	0	0	0	0	0	0	0	0	453	453
Macrolides/lincosamides	612	354	1,114	6,905	352	1,820	13,731	23	24,910	110	24,961
Other	0	0	0	0	0	0	0	81	81	448	533
Penicillins	357	146	605	4,820	3,135	323	545	0	9,931	44	10,463
Pleuromutilins	0	13	4	867	0	0	0	47	931	0	1,123
Tetracyclines	1,048	600	603	27,387	1,636	4,037	23,955	102	59,368	95	65,033
Trimethoprim/sulfonamides	1,718	86	419	13,938	3,795	840	6,104	5	26,906	1,350	32,828
2nd-choice antibiotics	**5,723**	**404**	**666**	**11,941**	**1,725**	**1,096**	**8,667**	**137**	**30,357**	**1,626**	**39,107**
As a proportion of overall AB use/sales	**60.31**	**24.83**	**19.28**	**17.79**	**15.52**	**12.67**	**15.66**	**34.50**	**19.31**	**39.06**	**21.83**
Aminoglycosides	50	1	0	143	239	49	291	136	909	22	1,277
1st- and 2nd-gen. cephalosporins	0	0	0	0	22	0	0	0	22	476	499
Quinolones	1,121	6	97	163	11	135	1,144	0	2,677	0	3,667
Fixed-dose combinations	43	0	0	547	543	181	7	0	1,320	1	1,568
Macrolides/lincosamides	0	0	0	84	4	5	20	0	113	0	117
Penicillins	4,501	397	403	10,069	898	717	7,190	0	24,175	1,126	30,731
Polymyxins	7	0	165	935	8	8	15	1	1,141	1	1,249
3rd-choice antibiotics	**30**	**25**	**41**	**0**	**12**	**1**	**16**	**3**	**128**	**13**	**229**
As a proportion of overall AB use/sales	**0.32**	**1.53**	**1.20**	**0.00**	**0.11**	**0.01**	**0.03**	**0.63**	**0.08**	**0.32**	**0.13**
3rd- and 4th-gen. cephalosporins	0	0	0	0	0	0	0	0	0	0	1
Fluoroquinolones	30	25	41	0	12	1	16	3	128	13	227
Overall	**9,488**	**1,628**	**3,452**	**67,133**	**11,113**	**8,650**	**55,350**	**397**	**157,211**	**4,163**	**179,134**

***** Although macrolides/lincosamides used in poultry are regarded as second-choice antibiotics, the amounts of macrolides/lincosamides used in the various poultry farming sectors have been recorded under first-choice antibiotics in order to facilitate comparison with sales figures, as sales figures cannot be categorized by livestock sector.

Trend analysis based on national sales figures

Sales data

Data on the amounts of antibiotics sold were provided by FIDIN on March 1, 2019.

Developments in sales of antibiotics

In 2018, the overall number of kilograms of antibiotics sold decreased by 1.1%. Just like the year before, the number of kilograms sold (179,134 kg) was relatively high compared with the estimated number of kilograms used (161,374 kg). This estimate is based on recorded use in monitored livestock sectors and on sales of products only authorized for use in companion animals and/or horses. The data reveal a discrepancy of about 10% (17,760 kg) between the numbers of kilograms sold and used. Survey data obtained several years ago suggest it is very likely that part of this discrepancy is the result of antibiotic use in unmonitored livestock sectors (the goat, sheep and mink farming sectors in particular) and of horses and companion animals being treated with products that are also authorized for use in livestock (estimated to amount to approximately 7,000 kg in total). This leaves an unattributable difference of about 10,000 kg between the numbers of kilograms sold and used in 2018. This discrepancy exceeds those observed in previous years. The SDa expert panel wants to find out why such discrepancies between the numbers of kilograms sold and used occur. To this end, it proposes the following:

- Completeness and reliability assessment of provided sales figures, as the sales data provided by FIDIN have never been assessed for completeness and reliability. The SDa expert panel has already approached FIDIN about its intended completeness and reliability assessment of the provided sales figures. It urgently wants to obtain clarity regarding the data quality.
- Assessment of antibiotic use in unmonitored sectors, since 2018's more prominent discrepancy between the amount of antibiotics sold and the recorded amount of antibiotics used may have been associated with increased use of antibiotics in unmonitored sectors.
- Inspection of the data recorded by veterinary practices and livestock sectors, to check whether all antibiotics recorded have been reported. To this end, the livestock sectors will be required to provide the SDa with all delivery record data and have the SDa expert panel perform the selection of relevant products. This approach will facilitate compliance with the new Regulation (EU) 2019/6, which will apply from January 28, 2022 and has to be implemented in national law.

Third-choice antibiotics

Hardly any third- and fourth-generation cephalosporins were used or sold in 2018. Overall sales amounted to just 1 kg. The monitored livestock sectors did not record any use of third- and fourth-generation cephalosporins. Several products included in this pharmacotherapeutic group are only authorized for use in companion animals and horses. Sales of these products amounted to 0.4 kg. The remaining 0.6 kg of third- and fourth-generation cephalosporins sold is not accounted for.
Sales of fluoroquinolones declined by 7.9%, from 247 kg in 2017 to 227 kg in 2018. Fluoroquinolone use in monitored livestock sectors was markedly lower than in 2017, and some of the livestock sectors (the turkey farming sector and the other poultry farming subsectors) even managed to halve the number of kilograms used. As a result of these developments, the number of kilograms sold that

could not be attributed to a particular sector rose to 87 kg, meaning 38% of third-choice antibiotics sold was not accounted for (versus 19% in 2017).

Second-choice antibiotics

Between 2017 and 2018, colistin sales rose by 286 kg (29.7%). Increases were recorded for all livestock sectors except the dairy cattle farming sector. The increases in colistin sales were most prominent in the pig farming sector and the "Other poultry farming subsectors" category, with 170 kg (22%) and 85 kg (106%), respectively.

Although quinolone use in the broiler farming sector went up, the number of kilograms used in all monitored livestock sectors combined declined. However, sales of quinolones increased in 2018. As a result (and similar to the development recorded for fluoroquinolones), the discrepancy between the number of kilograms sold and the number of kilograms used increased substantially, from 120 kg in 2017 to almost 1,000 kg in 2018. The SDa expert panel deems it necessary to look into the kilograms of quinolones that are not accounted for (close to 30% of the total number of kilograms sold). It has already approached FIDIN regarding this issue.

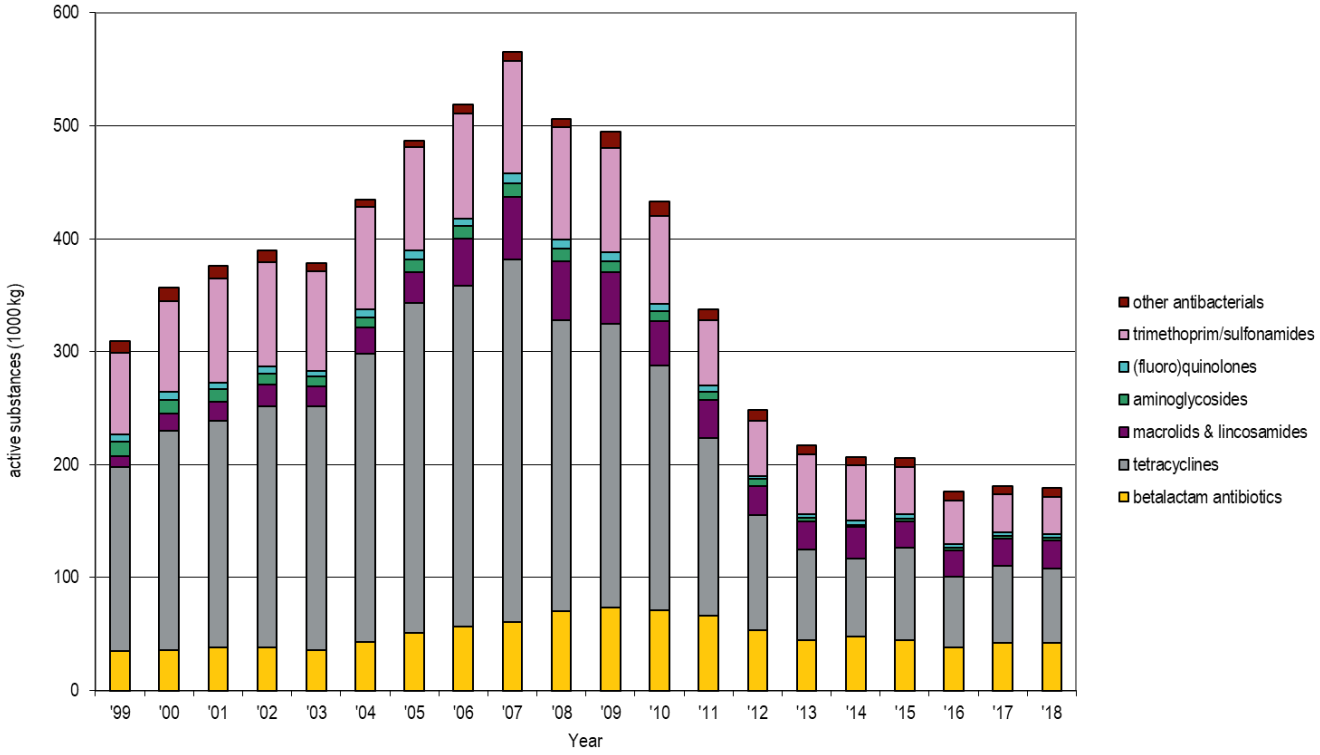
Both sales and use of aminoglycosides went up in 2018. In the monitored livestock sectors, they increased by 20% and 10%, respectively. Even though aminoglycoside use has fluctuated slightly over the past few years, it is clear that the discrepancy between the numbers of kilograms sold and used increased in 2018.

Use of injectable second-choice macrolides declined by 7 kg in 2018. This indicates a deviation from the trend observed in the years before, although the veal farming sector did record another increase. Given the risk of selection of resistant micro-organisms, decisions to administer these long half-life products should not be taken lightly. The SDa expert panel urges the veal farming sector to address the use of injectable second-choice macrolides.

First-choice antibiotics

Sales of pleuromutilins rose by over 45% between 2017 and 2018. Pleuromutilins are used in pigs, rabbits, turkeys and poultry species included in the "Other poultry farming subsectors" category. They are classified as first-choice antibiotics as this pharmacotherapeutic group does not yet include any antibiotics registered for human use. In February 2019, the Food and Drug Administration (FDA) accepted New Drug Applications for oral and intravenous formulations of a human medicine containing the pleuromutilin lefamulin. As lefamulin is specifically intended for the treatment of multi-drug resistant bacterial infections, pleuromutilins' status as first-choice antibiotics in veterinary medicine will have to be reassessed.

Figure 2. Developments in sales of antibiotics between 1999 and 2018, in number of kilograms of active substances sold (x1,000) (source: FIDIN), by main pharmacotherapeutic group



Benchmarking of livestock farms

Amounts of antibiotics used at livestock farms (in $DDDA_F$)

The SDa expert panel uses the $DDDA_F$ unit of measurement for expressing the defined daily dose animal at farm level. Most of the livestock sectors have seen the shape of their usage level distributions change considerably over the previous years. Although the proportion of livestock farms with low usage levels has increased over the years, the occurrence of long-tailed distributions indicates that farms with high usage levels are still a reality. The 2018 $DDDA_F$ distributions, which are based on all livestock farms in a particular livestock sector, can be found in the appendices. Most livestock sectors' usage level distributions are similar in shape to the 2017 distributions.

Table 6. 2018 annual defined daily doses animal ($DDDA_F$ values) for the broiler, layer, turkey, pig, veal, cattle and rabbit farming sectors and their respective production categories or types of farms. Provided parameters are the mean, median (Med.), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	Production category/type of farm	N	Mean	Med.	P75	P90
Broiler farming sector*	Broiler farms	834	10.6	5.1	14.5	26.7
	- Farms with conventional breeds	498	14.3	10.1	20.0	34.0
	- Farms with alternative breeds	475	3.6	0.0	4.9	10.6
	Rearing farms for parent stock	89	16.9	12.2	23.9	36.4
	Production farms for parent stock	196	2.7	0.0	3.8	8.4
	Rearing farms for grandparent stock	10	5.7	5.6	11.7	12.8
	Production farms for grandparent stock	19	3.0	0.0	7.1	9.4
Layer farming sector	Laying hen farms	844	1.6	0.0	0.8	6.1
	Rearing farms for laying hens	18	8.0	0.0	12.8	28.7
	Rearing farms for parent stock	176	2.3	0.0	2.7	5.8
	Production farms for parent stock	37	3.6	0.0	5.7	11.9
	Rearing farms for grandparent stock	2	0.0	0.0	0.0	0.0
	Production farms for grandparent stock	6	0.6	0.0	0.0	3.4
Turkey farming sector		38	20.9	11.6	24.1	49.7
Pig farming sector**	Sows/suckling piglets	1,780	3.8	2.1	4.5	8.6
	Weaner pigs	1,941	19.8	10.1	23.5	44.0
	Fattening pigs	4,323	3.9	1.8	5.4	9.9
Veal farming sector	White veal farms	855	20.1	19.3	24.6	30.0
	Rosé veal starter farms	256	79.9	79.3	96.1	115.6
	Rosé veal fattening farms	601	2.7	1.2	3.8	6.4
	Rosé veal combination farms	186	14.8	14.1	18.1	21.9
Cattle farming sector	Dairy cattle farms	16,499	2.1	2.1	2.9	3.8
	Rearing farms	544	1.0	0.0	0.0	1.4
	Suckler cow farms	8,932	0.6	0.0	0.6	1.8
	Beef farms	2,852	1.3	0.0	0.3	2.2
Rabbit farming sector		40	47.9	44.2	61.1	96.3

* The sum of the number of farms with conventional breeds and the number of farms with alternative breeds exceeds the N recorded for broiler farms in general, as some broiler farmers keep both conventional and alternative breeds.

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

For the subcategories “Farms with conventional breeds” and “Farms with alternative breeds” included in Table 6, N represents both specialized farms (i.e. broiler farms with only the indicated type of breeds) and non-specialized farms (i.e. broiler farms with both conventional and alternative breeds). Analysis of data from specialized farms alone (i.e. broiler farms with only conventional breeds and broiler farms with only alternative breeds) would have yielded similar results.

The SDa obtained usage data from 40 rabbit farms. In 2018, rabbit farms’ mean antibiotic use was 47.9 $DDDA_F$ (median: 44.2). This was substantially higher than the mean value recorded for 2017 (27.3 $DDDA_F$) and also exceeded the mean value recorded for 2016 (40.9 $DDDA_F$). The values recorded for the rabbit farming sector have fluctuated considerably throughout the years. These fluctuations may reflect suboptimal data quality. The SDa expert panel has asked the rabbit farming sector to address the causes of its usage data fluctuations and verify the data, as it wants to make sure the data provided for next year’s SDa report will be of sufficient quality.

As was the case in 2017, usage levels in the pig farming sector differed between specialized pig farms (farms with either sows/suckling piglets, weaner pigs or fattening pigs accounting for >90% of its pig population) and pig farms with several production categories. Mean and median $DDDA_F$ values recorded for weaner pigs at specialized pig farms exceeded those recorded for weaner pigs at non-specialized pig farms. There is no obvious explanation for this difference in usage levels, but it is conceivable that antibiotics administered at non-specialized pig farms are not always assigned to the correct production category. The SDa expert panel wants the pig farming sector to look into the reasons for these usage level differences.

Table 7. 2018 annual defined daily doses animal ($DDDA_F$ values) for specialized and non-specialized pig farms. Provided parameters are the mean, median (Med.) and 90th percentile (P90)

	Production category	N	Mean	Med.	P90
Specialized pig farms	Sows/suckling piglets	137	4.82	2.71	10.71
	Weaner pigs	151	27.38	17.03	60.14
	Fattening pigs	2,849	4.52	2.70	10.89
Non-specialized pig farms	Sows/suckling piglets	1,643	3.68	2.11	8.36
	Weaner pigs	1,790	19.15	9.36	43.40
	Fattening pigs	1,475	2.83	0.26	7.80

Distribution of livestock farms over the various benchmark zones

Table 9 shows how livestock farms were distributed over the various benchmark zones. Several livestock sectors had a large percentage of farms (in some cases over 90%) recording target zone usage levels for 2018. Many of these livestock sectors managed to reduce their overall antibiotic use in such a way that $DDDA_F$ values of 0 or slightly higher were a regular occurrence and a large number of farms were included the target zone. This development was associated with a drop in the number farms recording signaling or action zone usage levels. Nevertheless, a number farms appear to have underperformed in comparison to the other farms within their livestock sector. Virtually all livestock sectors have long-tailed 2018 usage level distributions, indicating there are still several livestock farms with action zone usage levels. The sector showing the most room for improvement in this

regard is the veal farming sector. This also becomes apparent when looking at the number of veal farms included in the signaling and action zones.

Table 8. 2018 signaling and action thresholds for the various livestock sectors and the associated production categories and types of farms, based on $DDDA_F$ values

Livestock sector	Type of farm/production category	Signaling threshold**	Action threshold
Broiler farming sector		15	30
Turkey farming sector*		19	31
Pig farming sector	Sows/suckling piglets	10	20
	Weaner pigs	20	40
	Fattening pigs	10	12
Veal farming sector	White veal farms	23	39
	Rosé veal starter farms	67	110
	Rosé veal fattening farms	1	6
	Rosé veal combination farms	12	22
Cattle farming sector	Dairy cattle farms	6	A usage level that has exceeded the signaling threshold two years in a row
	Rearing farms	2	
	Suckler cow farms	2	
	Beef farms	2	

* Please refer to the SDa report *Usage of Antibiotics in Agricultural Livestock in the Netherlands in 2013*.

** The signaling threshold for dairy cattle farms is based on the P80 value. The signaling thresholds for all other types of farms/production categories except fattening pigs refer to the P50 value minus 20%.

Table 9. Distribution of livestock farms over the various benchmark zones in 2018.

Livestock sector	Type of farm/production category	Target zone		Signaling zone		Action zone	
		N	%	N	%	N	%
Poultry farming sector	Broiler farms	632	76	134	16	68	8
	Turkey farms	25	66	4	11	9	24
Pig farming sector	Sows/suckling piglets	1,642	93	94	6	44	2
	Weaner pigs	1,365	70	345	18	232	12
	Fattening pigs	3,886	90	134	3	304	7
Veal farming sector	White veal farms	591	69	252	29	12	1
	Rosé veal starter farms	75	29	148	58	33	13
	Rosé veal fattening farms	290	48	243	40	68	11
	Rosé veal combination farms	72	39	96	52	18	10
Cattle farming sector	Dairy cattle farms	16,306	99	166	1	27	0
	Rearing farms	506	93	24	4	14	3
	Suckler cow farms	8,138	91	414	5	380	4
	Beef farms	2,550	89	105	4	197	7

The appendices to this year's report also illustrate the correlation between 2017 and 2018 usage levels in terms of $DDDA_F$. The correlation coefficients are generally low (r <0,50 for most of the livestock sectors), but the SDa expert panel did find a substantial degree of variation between the various livestock sectors. The most remarkable findings are described below:

- In the turkey farming sector, usage of antibiotics at the 10% of turkey farms recording the highest $DDDA_F$ values decreased from 72.9 $DDDA_F$ in 2016 to 59.8 $DDDA_F$ in 2017 and 49.7 $DDDA_F$ in 2018. As a result, the turkey farming sector's usage level distributions have become less skewed, with shorter tails. Turkey farms' 2018 usage level appeared to be quite strongly correlated with their 2017 usage level (correlation coefficient of 0.85). This means the 2017 usage level of individual turkey farms was a predictor of their 2018 usage level, which suggests the presence of structural determinants of antibiotic use. This warrants further investigation, as such determinants could inform measures to further reduce the amounts of antibiotics used at turkey farms.
- The veal farming sector had the highest percentage of farms with a signaling or action zone usage level. It also had the highest percentage of farms with structurally high usage levels (i.e. a signaling or action zone usage level for three consecutive years). The number of veal farms included in the action zone decreased between 2017 and 2018. White veal farms in particular showed a steady decline in their median $DDDA_F$ value, in addition to a reduction in the number of farms recording above-mean usage levels (usage levels included in the 75th or 90th percentile of the $DDDA_F$ distribution). Rosé veal starter farms' 2018 usage level appeared to be correlated with their 2017 usage level (correlation coefficient of 0.57), which suggests the presence of factors that result in structural usage level differences between individual farms. This warrants further investigation, as such factors could inform measures to further reduce the amounts of antibiotics used at these livestock farms.
- In 2017, the pig farming sector saw an undesirable rise in the percentage of farms with weaner pigs recording action zone usage levels, as a result of the introduction of new benchmark thresholds in 2016. 2018 saw a slight improvement in this respect, with farms with weaner pigs recording usage levels that were not quite as high: the mean $DDDA_F$ of the 10% of farms with the highest usage levels dropped from 52.9 in 2017 to 44.0 in 2018. The correlation coefficient for 2017 and 2018 antibiotic use at farms with weaner pigs is 0.74, indicating their 2017 usage level was a predictor of their 2018 usage level. This suggests that there are structural usage level differences between individual farms with weaner pigs, and shows the necessity of addressing the amounts of antibiotics used at high usage level farms.
- The degree of correlation in the broiler farming sector as a whole turned out to be low (r <0.30). This means there was no clear correlation between broiler farms' 2018 and 2017 usage levels. Both broiler farms with conventional breeds and broiler farms with alternative breeds had a correlation coefficient <0.30. Of the 815 broiler farms with available 2017 and 2018 data, 90 recorded usage levels exceeding the signaling threshold for both years.
- For dairy cattle and rearing farms, the SDa expert panel found remarkably strong correlations between 2017 and 2018 antibiotic usage levels. The high correlation coefficients for these types of farms may have been due primarily to structural between-farm differences in how the livestock populations are made up, and to a lesser extent to the presence of determinants of antibiotic use.

In all livestock sectors except the cattle farming sector (i.e. the dairy and non-dairy cattle farming sectors), several livestock farms recorded usage levels greatly exceeding their sector's mean $DDDA_F$ value. Generally speaking, there have been only minor changes in livestock sectors' antibiotic usage patterns and $DDDA_F$ values over the past few years. Only in rare cases did farms included in the signaling or action zone manage to achieve the usage level reductions the SDa had hoped for. Therefore, the SDa expert panel again urges the livestock sectors to address the amounts of antibiotics used at farms recording signaling or action zone usage levels. As livestock farms with relatively high usage levels may promote selection and spread of resistant bacteria, the livestock sectors should aim for a substantial reduction in the number of farms recording high $DDDA_F$ values, particularly those that have recorded high $DDDA_F$ values for several years. The SDa expert panel feels the implementation of its new benchmark thresholds will facilitate the identification of livestock farms with relatively high usage levels.

Introduction of new benchmark thresholds in 2019

2018 is the last reporting year for which livestock farms' antibiotic use is assessed using the SDa's "old" benchmarking method. In 2018, the SDa expert panel defined new benchmark thresholds, which will be applied as of the 2019 reporting year. The SDa report to be published in 2020 will be the first report to include findings based on the new benchmark thresholds. These thresholds should prompt the livestock sectors to take action in order to further reduce the number of farms with high usage levels, with the aim of increasing the percentage of farms with $DDDA_F$ values consistent with acceptable use of antibiotics.
The SDa's new benchmarking method is based on a single benchmark threshold (an action threshold) per type of farm or production category, which can either be a benchmark threshold representing acceptable use or a provisional benchmark threshold. If the action threshold is exceeded, the livestock farm is included in the action zone. A usage level below the action threshold results in the livestock farm being included in the target zone. Provisional benchmark thresholds have no long-term applicability and require regular reevaluation to assess whether a more stringent threshold can be introduced. Most of the livestock sectors seem to consider their new benchmark thresholds to be a distant goal, and they are trying to agree on an implementation period with the Ministry of Agriculture, Nature and Food Quality. The SDa expert panel wants its benchmarking approach to reduce the number of $DDDA_F$ outliers, including the aforementioned livestock farms with persistently high usage levels, and limit usage level fluctuations over time as much as possible. Consequently, it feels structural and/or more excessive benchmark threshold deviations should be met with stricter corrective measures, to be taken by the livestock sector concerned. A proportional approach like this would be particularly beneficial in the first years following the introduction of the new benchmark thresholds, as the livestock sectors will need some time to adjust to the new benchmarking method. In addition, the SDa expert panel feels the veal and rabbit farming sectors' $DDDA_F$ distributions show that these livestock sectors require across-the-board reductions in the amounts of antibiotics used.

New benchmark thresholds for veterinarians will be announced in the second half of 2019. Following analysis of the expected effects of the new benchmark thresholds for livestock farms, the SDa expert panel decided to also revise its benchmarking method for veterinarians. Implementation of the revised benchmarking method for veterinarians will require careful preparation.

Table 10. Summary of old and new benchmark thresholds. Benchmark thresholds representing acceptable use will be valid from 2019 to 2024. Provisional benchmark thresholds will be valid for the 2019-2020 period

		Benchmark thresholds valid until the end of 2018		**Benchmark thresholds valid as of 2019, with specification of the type of threshold**	
Livestock sector	**Type of farm/ production category**	**Signaling threshold**	**Action threshold**	**Type of benchmark threshold**	**Action threshold**
Veal farming sector*	White veal farms	23	39	Provisional	23
	Rosé veal starter farms	67	110	Provisional	67
	Rosé veal fattening farms	1	6	Representing acceptable use	4
	Rosé veal combination farms	12	22	This category will cease to exist	
Pig farming sector	Sows/suckling piglets	10	20	Representing acceptable use	5
	Weaner pigs	20	40	Provisional	20
	Fattening pigs	10	12	Representing acceptable use	5
Poultry farming sector	Broiler farms	15	30	Representing acceptable use	8
	Turkey farms	19	31	Provisional	10¥
Rabbit farming sector	Rabbit farms			Provisional	**
Cattle farming sector	Dairy cattle farms	6§		Representing acceptable use	6
	Rearing farms	2§		Representing acceptable use	2
	Suckler cow farms	2§		Representing acceptable use	2
	Beef farms	2§		Representing acceptable use	2

* The benchmark thresholds are based on a 1.5-year period.

** No benchmark threshold can be determined based on the currently available data.

¥ The new benchmark threshold for turkey farms has yet to be agreed upon.

§ Threshold for inclusion in the signaling zone; cattle farms are included in the action zone if their usage level has exceeded the signaling threshold two years in a row.

Table 11. Developments in the distribution of livestock farms over the various benchmark zones between 2014 and 2018

Livestock sector	Type of farm/ production category	% in target zone					% in signaling zone					% in action zone				
	Year 20..	14	15	16	17	18	14	15	16	17	18	14	15	16	17	18
Poultry farming sector	Broiler farms	66	70	81	76	76	21	20	14	16	16	13	10	5	8	8
	Turkey farms	51	50	70	64	66	22	20	13	16	11	27	30	17	20	24
Pig farming sector	Sows/suckling piglets	72	85	94	93	93	19	11	5	6	6	8	4	1	1	2
	Weaner pigs	-	73	66	69	70	-	20	24	16	18	-	8	9	15	12
	Fattening pigs	86	90	90	90	90	6	3	3	3	3	8	7	7	7	7
Veal farming sector	White veal farms	48	46	50	55	69	44	46	44	41	29	8	9	6	4	1
	Rosé veal starter farms	33	21	25	24	29	56	63	63	61	58	11	16	12	15	13
	Rosé veal fattening farms	48	50	52	42	48	34	36	32	43	40	19	14	16	15	11
	Rosé veal combination farms	50	54	55	46	39	40	37	38	43	52	10	9	7	11	10
Cattle farming sector*	Dairy cattle farms	91	93	94	99	99	8	6	6	0	1	1	1	0	0	0
	Rearing farms	84	85	89	91	93	6	6	4	8	6	9	9	7	1	1
	Suckler cow farms	84	80	81	92	91	6	10	10	8	8	9	10	9	0	1
	Beef farms	79	82	84	89	89	10	5	4	6	6	10	12	12	5	5

* The benchmarking method for the cattle farming sector was revised in 2017. See Table 8 for details.

Table 12. Distribution of livestock farms over the new benchmark zones that are to be introduced in 2019

Livestock sector	Type of farm/ production category	Target zone		Signaling zone		Action zone	
		N	%	N	%	N	%
Poultry farming sector	Broiler farms	492	59			342	41
	Turkey farms*	14	37			24	63
Pig farming sector	Sows/suckling piglets	1,391	78			389	22
	Weaner pigs	1,367	70			574	30
	Fattening pigs	3,157	73			1,166	27
Veal farming sector	White veal farms	591	69			264	31
	Rosé veal starter farms	75	29			181	71
	Rosé veal fattening farms	463	77			138	23
Cattle farming sector	Dairy cattle farms	16,306	99	166	1	27	0
	Rearing farms	506	93	24	4	14	3
	Suckler cow farms	8,138	91	414	5	380	4
	Beef farms	2,550	89	105	4	197	7

* The new benchmark threshold for turkey farms has yet to be agreed upon.

Benchmarking of veterinarians

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

The number of veterinarians with whom livestock farms had a registered one-to-one relationship in 2018 (1,241) was similar to the number recorded for 2017 (1,253). A veterinarian's VBI is livestock sector specific and can range from 0 to 1. The VBI reflects the probability of livestock farms with which the veterinarian has a one-to-one relationship recording action zone usage levels. For instance: A VBI of 0.22 indicates that 22% of the livestock farms with which the veterinarian concerned has a one-to-one relationship are included in the action zone. As the VBI is sector specific, a veterinarian active in various livestock sectors will be assigned several VBI scores.

Table 13. 2018 annual defined daily doses animal ($DDDA_{VET}$ values) for veterinarians active in the broiler, turkey, pig, dairy cattle, non-dairy cattle and veal farming sectors. Provided parameters are the mean, 50th percentile (median), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	N	Mean	Median	P75	P90
Broiler farming sector	86	8.50	8.58	11.99	17.09
Turkey farming sector	6	12.60	9.69	25.06	25.96
Pig farming sector	249	5.33	4.48	6.58	10.01
Dairy cattle farming sector	732	2.37	2.27	2.59	2.99
Non-dairy cattle farming sector	720	0.69	0.46	0.89	1.40
Veal farming sector	134	12.27	10.42	20.32	25.70

Table 14. Number of veterinarians per benchmark zone in 2018, by livestock sector; specified for veterinarians responsible for several farms per livestock sector and veterinarians responsible for a single farm per livestock sector

	Number of veterinarians with several farms per livestock sector who fall within the target, signaling or action zone based on their Veterinary Benchmark Indicator (VBI)			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		
Livestock sector	Target zone	Signaling zone	Action zone	Target zone	Signaling zone	Action zone
	≤0.10	(0.10<VBI≤0.30)	(VBI>0.3)	-	-	-
Broiler farming sector	50	23	3	9	1	0
Turkey farming sector	2	1	2	1	0	0
Pig farming sector	177	58	2	11	0	0
Dairy cattle farming sector	584	108	5	30	3	2
Non-dairy cattle farming sector	491	160	13	50	3	3
Veal farming sector	47	57	9	13	7	1

Veterinarians' distribution over the three benchmark zones basically parallels the distribution of livestock farms over the various benchmark zones. The number of veterinarians in the action zone is relatively small, but several livestock sectors are characterized by a substantial number of veterinarians being included in the signaling zone. It should be noted, however, that the livestock sectors' usage level distributions have changed significantly over the previous years, with a rise in the number of farms recording a $DDDA_F$ of 0 being the most prominent development. As a result, the VBI currently no longer sufficiently reflects veterinarians' prescription patterns. In response to this development, the SDa expert panel has prepared a new benchmarking method for veterinarians. The decision-making process regarding the implementation of this new method is expected to be finalized later this year.

Table 15. 2018 VBIs for veterinarians active in the broiler, turkey, pig, dairy cattle, non-dairy cattle and veal farming sectors. Provided parameters are the mean, 50th percentile (median), 75th percentile (P75) and 90th percentile (P90)

Livestock sector	**N**	**Mean**	**Median**	**P75**	**P90**
Broiler farming sector	86	0.07	0.04	0.12	0.18
Turkey farming sector	5	0.40	0.17	0.73	0.99
Pig farming sector	248	0.07	0.05	0.1	0.15
Dairy cattle farming sector	697	0.06	0.06	0.08	0.12
Non-dairy cattle farming sector	664	0.07	0.04	0.1	0.19
Veal farming sector	113	0.13	0.12	0.18	0.28

Revision of the antibiotic usage level calculation method

The benchmarking method for livestock farms was developed in 2012 and since its introduction, the SDa expert panel and the livestock sectors have identified several bottlenecks and limitations, which have led to the implementation of some improvements. Over the years, several livestock sectors have offered suggestions for improving the calculation method, in order to have it take account of the actual number of production cycles and to make DDDA estimates less susceptible to confounding due to variations in how individual farms' livestock populations are made up. The main changes that have been made to the sector-specific benchmarking processes are summarized below:

Poultry farming sector: As of January 2017, the poultry and turkey farming sectors determine livestock farms' antibiotic usage levels based on defined daily doses animal and body weight at time of treatment (growth curves).
Pig farming sector: Since 2015, pig farms are benchmarked according to production category, distinguishing between the following three categories: sows/suckling piglets, weaner pigs, and fattening pigs. As of January 1, 2017, the signaling and action thresholds applied for weaner pigs are 20 $DDDA_F$ and 40 $DDDA_F$, respectively.
Veal farming sector: Since January of 2017, the amounts of antibiotics used in the veal farming sector are calculated over 1.5-year periods. This should mitigate any usage level fluctuations resulting from year-to-year variations in the number of times new veal calves arrive at the farms. The 1.5-year data provided are used to determine an annual average for the amounts of antibiotics used. Incorporation of growth curves in the veal farming sector's $DDDA_F$ calculations is currently being considered and discussed. It has been decided to stop using rosé veal combination farms as a single reporting category. Rosé veal farms with both starter calves and fattening calves will have to itemize the amounts of antibiotics used based on the age of the calves to which the antibiotics are administered. This distinction between antibiotic use in starter calves and antibiotic use in fattening calves will support more precise monitoring of rosé veal combination farms, as they are a heterogeneous group with major between-farm differences in how the veal calf populations are made up.
Cattle farming sector: In 2017, the cattle farming sector saw the implementation of a revised benchmarking method, and the performance of this method will be evaluated in the second half of 2019.
Rabbit farming sector: This is the third SDa report with data on the amounts of antibiotics used in the rabbit farming sector. Prior to the rabbit farming sector's inclusion in the annual SDa reports, this livestock sector and the SDa had talked about usage level monitoring for years. There appear to be data quality issues that require urgent, targeted action by the rabbit farming sector. In the months to come, the SDa wants to decide on initial, provisional benchmark thresholds in consultation with the rabbit farming sector.

Plans for the near future

The new SDa benchmarking method

The SDa's new benchmarking method will be introduced in 2019. It is based on two different types of benchmark thresholds: benchmark thresholds representing acceptable use, and provisional benchmark thresholds. Benchmark thresholds that represent acceptable use of antibiotics will remain valid for years, while provisional benchmark thresholds will have to be adjusted more frequently. Although the "acceptable use" designation might be construed as a prescriptive value judgment, the SDa expert panel is aware that these benchmark thresholds will almost never be truly prescriptive in nature. After all, they always relate to low, acceptable usage levels within the context of a particular husbandry system. Benchmark thresholds representing acceptable use are used for livestock sectors whose antibiotic usage patterns are characterized by very low usage levels, limited variation between individual livestock farms in the amounts of antibiotics used, and limited usage level fluctuations over time. However, long-tailed $DDDA_F$ distributions might still be observed for some of these sectors, indicating the presence of a limited number of farms with high usage levels. The benchmark thresholds that represent acceptable use will probably require no or only minor adjustments in the years to come. As the sectors eligible for application of a benchmark threshold representing acceptable use are characterized by the absence of substantial structural between-farm differences, prescription patterns of the various veterinarians active within these sectors will show little variation as well.
Benchmark thresholds representing acceptable use are issued for five years. Their longer validity will create a sense of certainty about the targets livestock farmers are expected to meet. If a sector's antibiotic use continues to normalize, the sector will see a growing number of farms recording usage levels below its benchmark threshold. It should be noted, however, that application of benchmark thresholds representing acceptable use does not prohibit occasional peaks in the amounts of antibiotics used, for instance in the event of certain infections. They should, however, always be incidental in nature. As the vast majority of farms in livestock sectors eligible for a benchmark threshold representing acceptable use have already achieved low (i.e. target zone) usage levels, the SDa expert panel assumes these sectors will be able to strike a balance between optimizing animal health and limiting the amounts of antibiotics used.

Some of the livestock sectors still have relatively wide $DDDA_F$ distributions, indicative of substantial (structural) usage level and prescription pattern differences between individual livestock farms and veterinarians, respectively, and a relatively high degree of variation over time. For those livestock sectors, the SDa expert panel is not yet able to derive benchmark thresholds that represent acceptable use. In those cases, provisional benchmark thresholds are used. It is going to take some time before these livestock sectors will be eligible for application of a benchmark threshold representing acceptable use, as they still have to increase their efforts in order to reduce the amounts of antibiotics used. Benchmark thresholds for the types of farms or production categories in those livestock sectors currently can only be based on pragmatic considerations and will need adjusting after two to three years.

Action to be taken by livestock sectors in the event antibiotic usage levels exceed the sector's benchmark threshold

Even in livestock sectors with a very low mean $DDDA_F$ value and up to over 50% of farms recording a $DDDA_F$ value of 0, there are still several farms with usage levels amounting to tens of $DDDA_F$. As such outliers can be a decisive factor with regard to selection and spread of resistant micro-organisms, the SDa expert panel feels livestock sectors can no longer justify some of their farms repeatedly recording high usage levels. If a livestock sector's benchmark threshold is exceeded, its quality assurance body should ensure corrective measures are implemented and complied with. The SDa expert panel recommends the application of stricter measures in case of more excessive benchmark deviations, as it is in favor of a proportional approach in relation to corrective measures. A proportional approach like this would be particularly beneficial in the first years following the introduction of the new benchmark thresholds, as livestock farmers will need some time to adjust to the new benchmarking method. The objective of the SDa's benchmarking approach is to reduce the number of outliers in usage level distributions and limit usage level fluctuations over time as much as possible.

Benchmarking of veterinarians

The SDa expert panel intends to simplify its benchmarking method for veterinarians, and is currently discussing the matter with veterinary representatives. It has proposed the introduction of a new benchmarking method by 2020, which will be based on the $DDDA_{VET}$ unit of measurement. The $DDDA_{VET}$ is a more intuitive measure for veterinarians' prescription patterns and more in line with livestock farms' current antibiotic usage level distributions. In addition, the application of $DDDA_{VET}$ benchmark thresholds will be similar to the application of $DDDA_F$ benchmark thresholds. Consequently, as of 2020 veterinarians will be no longer be benchmarked by livestock sector (as is the case in the current VBI-based method), but by production category/type of farm. For example: In the current situation, a veterinarian active in the pig farming sector is assigned a single VBI score to benchmark his or her performance. As of 2020, this veterinarian will be assigned separate scores for the "Sows/suckling piglets", "Weaner pigs" and/or "Fattening pigs" production categories.

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

The SDa expert panel also used the European ESVAC method (with the DDD_{VET} unit of measurement) to determine the amounts of antibiotics used in 2018. The resulting DDD_{VET} data promote international transparency regarding the amounts of antibiotics used in agricultural livestock, as they enable third parties to compare the usage data for a particular type of livestock farm or production category in the Netherlands with usage data collected in another country (after adjusting for body weight, if necessary).

The numerator was calculated using European dosing data and represents the number of treatable kilograms within a particular livestock sector. The denominator was calculated according to the SDa method also used for determining $DDDA_{NAT}$ values, and represents the number of kilograms of animal present within the sector concerned. So to determine the denominator for a particular livestock sector, the relevant standardized average body weights as used by the SDa were multiplied by the number of animals present within the sector or production category concerned (these numbers are included in Table A1). The resulting values differ from the SDa's $DDDA_{NAT}$ values due to the application of antibiotic-specific conversion factors. $DDDA_{NAT}$ values are based on the veterinary medicinal product-specific dosages authorized in the Netherlands, while DDD_{VET} values are based on an average of the authorized dosages of the active substance concerned in several EU member states.

Table 16. Amounts of antibiotics used in 2017 and 2018 in terms of DDD_{VET}/animal-year, by livestock sector

	Broiler farming sector		Turkey farming sector		Pig farming sector		Dairy cattle farming sector		Non-dairy cattle farming sector		Veal farming sector	
Pharmacotherapeutic group	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
1st-choice antibiotics	**3.71**	**4.30**	**11.37**	**12.82**	**6.62**	**6.38**	**0.92**	**0.87**	**0.95**	**0.92**	**18.52**	**17.19**
As a proportion of overall AB use	**34.36%**	**32.19%**	**49.48%**	**60.76%**	**77.72%**	**77.73%**	**89.76%**	**88.69%**	**86.12%**	**88.58%**	**87.61%**	**88.07%**
Amphenicols	*	*	*	*	0.19	0.18	0.04	0.04	0.08	0.08	1.11	1.05
Macrolides/lincosamides	*	*	*	*	0.85	0.82	0.03	0.03	0.19	0.16	3.94	3.76
Penicillins	0.58	0.50	1.61	2.18	0.54	0.54	0.15	0.15	0.05	0.04	0.26	0.25
Pleuromutilins	*	*	0.14	0.14	0.10	0.13	*	*	*	*	*	*
Tetracyclines	1.27	1.67	9.20	10.14	3.42	3.12	0.22	0.21	0.48	0.54	10.61	10.06
Trimethoprim/sulfonamides	1.86	2.13	0.42	0.37	1.51	1.59	0.48	0.44	0.15	0.10	2.61	2.08
2nd-choice antibiotics	**7.03**	**8.98**	**10.54**	**7.65**	**1.90**	**1.83**	**0.10**	**0.11**	**0.15**	**0.12**	**2.59**	**2.31**
As a proportion of overall AB use	**65.15%**	**67.27%**	**45.89%**	**36.24%**	**22.28%**	**22.27%**	**9.97%**	**11.00%**	**13.81%**	**11.38%**	**12.23%**	**11.82%**
Aminoglycosides	0.03	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.09	0.09
1st- and 2nd-gen. cephalosporins	*	*	*	*	*	*	*	*	*	*	*	*
Quinolones	1.23	1.92	0.19	0.11	0.02	0.01	0.00	0.00	0.03	0.02	0.74	0.48
Fixed-dose combinations	0.02	0.03	*	*	0.03	0.02	0.04	0.02	0.03	0.02	0.01	0.00
Macrolides/lincosamides	0.19	0.25	1.40	1.23	0.53	0.53	0.01	0.01	0.01	0.02	0.14	0.19
Penicillins	5.53	6.73	8.95	6.30	1.01	0.90	0.05	0.07	0.07	0.06	1.59	1.53
Polymyxins	0.02	0.03	0.00	0.00	0.31	0.36	0.00	0.00	0.00	0.00	0.02	0.02
3rd-choice antibiotics	**0.05**	**0.07**	**1.06**	**0.63**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.02**
As a proportion of overall AB use	**0.49%**	**0.54%**	**4.63%**	**2.99%**	**0.00%**	**0.00%**	**0.27%**	**0.30%**	**0.07%**	**0.04%**	**0.16%**	**0.11%**
3rd- and 4th-gen. cephalosporins	*	*	*	*	*	*	0.00	0.00	*	*	*	*
Fluoroquinolones	0.05	0.07	1.06	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02
Overall antibiotic use	**10.78**	**13.35**	**22.98**	**21.11**	**8.52**	**8.21**	**1.03**	**0.98**	**1.10**	**1.04**	**21.15**	**19.52**

0.00 means use was below 0.005 $DDDA_{VET}$; * means no use was reported.

Implementation of new EU regulations, including Regulation (EU) 2019/6

Several new EU regulations on veterinary medicinal products must have been incorporated in Dutch law by 2022. The implementation of Regulation (EU) 2019/6 is most important in this respect, as this Regulation sets out rules regarding the placing on the market, manufacturing, import, export, supply, distribution, pharmacovigilance, control and use of veterinary medicinal products. As a result of the implementation of this Regulation, the SDa will have to expand its monitoring efforts as it will also have to monitor the use of antifungals, antiprotozoals, antivirals and topical antimicrobials (antimicrobials to be administered in the eyes or ears or on the skin) at livestock farms. At the moment, the SDa only monitors intramammary and intrauterine use of non-systemic antimicrobials. Implementation of his Regulation also means that in addition to data on the amounts of antimicrobials used in food-producing animal species, data will also have to be collected for other animals which are bred or kept, including animals kept in other sectors than food production (e.g. companion animals).

Article 57 of the Regulation sets out several time limits for the implementation of this more extensive data collection and monitoring process. Within two years from January 28, 2022, data shall be collected for poultry (including turkeys), pigs and veal calves. Within five years from January 28, 2022, data shall be collected for all food-producing animals (including animals like dairy goats and lambs). Within eight years from January 28, 2022, data shall be collected for all animals which are bred or kept, although no data will be collected from natural persons keeping companion animals. This means data on antimicrobial veterinary products used in companion animals will have to be collected from the party supplying the antimicrobials (the veterinarian or pharmacy).

Implementation of this Regulation may mean that in time, every veterinary practice will be required to use a practice management system (PMS) that supports transmission of prescription data. A national veterinary medicines database containing all of the up-to-date EAN barcode-related information required for a PMS would be helpful in this respect and development of such a database is currently being considered. Later this year, the SDa expert panel will publish a memorandum on the practical consequences of the implementation of the new EU regulations.

In the Netherlands, the SDa and the livestock sectors had, on their own accord, already taken steps to expand the number of livestock sectors being subjected to monitoring. The **rabbit farming sector** has been providing the SDa expert panel with antibiotic usage data since 2016. Although the **dairy goat farming sector** is not yet being monitored, it is taking steps to enable SDa monitoring. The SDa expert panel has urged this sector to make sure its monitoring system is ready for rollout by the end of 2019. While there is currently no obligation for the dairy goat farming sector to provide data on the amounts of antibiotics used, the SDa expert panel feels such an obligation would be warranted considering the growing number of dairy goats in the Netherlands and the sector's increasingly important role in the food industry. The remaining livestock sectors or animal categories (e.g. the sheep farming sector, horses and companion animals) are not yet subjected to regular monitoring, but are being monitored intermittently, once every three years. This will suffice until the data collection obligations set out in the new EU Regulation take effect.

References

Antibioticagebruik op konijnenbedrijven [Usage of antibiotics in the rabbit farming sector]. LEI Wageningen UR memorandum, January 2014. URL: http://www3.lei.wur.nl/antibiotica/documents/Antibioticagebruik_konijnensector.pdf. Last accessed on May 17, 2017.

Bokma-Bakker, M.H., van Riel, J.W., de Lauwere, C.C., Antonis, A.F.G., & Kluivers-Poodt, M. (2017). Onderzoek naar kritische succesfactoren voor een laag antibioticumgebruik bij vleeskalveren [A study to identify critical success factors for low antibiotic use in veal calves]. *Wageningen Livestock Research*, Report No 1068A.

Bokma-Bakker, M.H., Wiegel, J., Holstege, M.M.C., Kluivers-Poodt, M., de Lauwere, C.C., & Bouwstra, R.J. (2017). Onderzoek naar kritische succesfactoren voor een laag antibioticumgebruik bij vleeskuikens [A study to identify critical success factors for low antibiotic use in broilers]. *Wageningen Livestock Research*, Report No 1065A.

Dorado-García, A., Mevius, D. J., Jacobs, J. J., Van Geijlswijk, I. M., Mouton, J. W., Wagenaar, J. A., & Heederik, D. J. (2016). Quantitative assessment of antimicrobial resistance in livestock during the course of a nationwide antimicrobial use reduction in the Netherlands. *Journal of Antimicrobial Chemotherapy*, *71*(12), 3607-3619.

EMA 2016a. Updated advice on the use of colistin products in animals within the European Union: development of resistance and possible impact on human and animal health. London, 2016. URL: https://www.ema.europa.eu/en/documents/scientific-guideline/updated-advice-use-colistin-products-animals-within-european-union-development-resistance-possible_en.pdf

EMA 2016b. Defined daily doses for animals (DDDvet) and defined course doses for animals (DCDvet). URL: http://www.ema.europa.eu/docs/en_GB/document_library/Other/2016/04/WC500205410.pdf

EMA 2017. Draft guidance on provision of data on antimicrobial use by animal species from national data collection systems. URL: http://www.ema.europa.eu/ema/doc_index.jsp?curl=pages/includes/document/document_detail.jsp?webContentId=WC500224492&murl=menus/document_library/document_library.jsp&mid=0b01ac058009a3dc

van Hout, J. & Holstege, M. (2017). Analyse van het antibioticumgebruik over de periode 2013 t/m het 1ste halfjaar van 2016 & Karakteristieke eigenschappen van hoog- en laaggebruikende bedrijven met vleesvarkens [Analysis of antibiotic use from 2013 to mid-2016 & characteristics of pig fattening farms with high or low antibiotic use]. November 2017, Deventer, the Netherlands.

van Hout, J. & Holstege, M. (2017). Analyse van het antibioticumgebruik over de periode 2013 t/m het 1ste halfjaar van 2016 & Karakteristieke eigenschappen van hoog- en laaggebruikende varkensbedrijven met zeugen/biggen [Analysis of antibiotic use from 2013 to mid-2016 & characteristics of farms with sows/piglets with high or low antibiotic use]. November 2017, Deventer, the Netherlands.

MARAN 2017. Monitoring of Antimicrobial Resistance and Antibiotic Usage in Animals in the Netherlands in 2016. June 2017, Lelystad, the Netherlands.

Official Journal of the European Union 7.1.2019, L 4/1. REGULATION (EU) 2019/4 on the manufacture, placing on the market and use of medicated feed, amending Regulation (EC) No 183/2005 of the European Parliament and of the Council and repealing Council Directive 90/167/EEC.

Official Journal of the European Union 7.1.2019, L 4/24. REGULATION (EU) 2019/5 amending Regulation (EC) No 726/2004 laying down Community procedures for the authorization and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency, Regulation (EC) No 1901/2006 on medicinal products for paediatric use and Directive 2001/83/EC on the Community code relating to medicinal products for human use.

Official Journal of the European Union 7.1.2019, L 4/43. REGULATION (EU) 2019/6 on veterinary medicinal products and repealing Directive 2001/82/EC.

SDa 2012. Beschrijving van het antibioticumgebruik bij vleeskuikens, zeugen en biggen, vleesvarkens, en vleeskalveren in 2011 en benchmarkindicatoren voor 2012 [Information on usage of antibiotics in broilers, sows and piglets, fattening pigs and veal calves in 2011 and benchmark indicators for 2012]. SDa expert panel report, the Netherlands Veterinary Medicines Institute, Utrecht, the Netherlands. June 27, 2012.

SDa 2016. Association between antimicrobial use and the prevalence of resistant micro-organisms. SDa expert panel report, the Netherlands Veterinary Medicines Institute, Utrecht, the Netherlands. June 2016.

Appendices

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

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

Numbers of animals in the Dutch livestock sector

Table A1. Numbers of agricultural livestock (x1,000) from 2004 to 2018 in the Netherlands, based on data provided by CBS (poultry, veal calves, meat rabbits and goats) and EUROSTAT (the other types of livestock)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Piglets (<20 kg)	4,300	4,170	4,470	4,680	4,555	4,809	4,649	4,797	4,993	4,920	5,116	5,408	4,986	5,522	5,307
Sows	1,125	1,100	1,050	1,060	1,025	1,100	1,098	1,106	1,081	1,095	1,106	1,053	1,022	1,066	970
Fattening pigs	3,850	3,830	4,040	4,010	4,105	4,099	4,419	4,179	4,189	4,209	4,087	4,223	4,140	3,967	4,033
Other pigs	1,865	1,900	1,660	1,960	2,050	2,100	2,040	2,021	1,841	1,789	1,765	1,769	1,733	1,741	1,624
Turkeys	1,238	1,245	1,140	1,232	1,044	1,060	1,036	990	827	841	794	863	762	671	657
All poultry combined	86,776	94,220	93,195	94,479	98,184	98,706	102,585	98,253	96,268	98,587	103,944	107,743	105,550	105,184	96,986
With broilers accounting for	50,127	54,660	42,289	44,262	44,496	41,914	43,352	44,358	43,285	44,748	47,020	49,107	48,378	48,237	41,789
Veal calves	765	829	844	860	899	894	928	906	908	925	921	909	956	953	995
All cattle combined	2,984	2,933	2,849	2,960	3,083	3,112	3,039	2,993	3,045	3,064	3,230	3,360	3,353	3,082	2,634
With dairy cattle accounting for						1,562	1,518	1,504	1,541	1,597	1,610	1,717	1,794	1,665	1,552
Goats	282	292	310	324	355	374	353	380	397	413	431	470	500	533	588
Sheep	1,700	1,725	1,755	1,715	1,545	1,091	1,211	1,113	1,093	1,074	1,070	1,032	1,040	1,015	743
Weaned meat rabbits	297	312	283	338	282	271	260	262	284	270	278	333	318	300	291
Breeding does	49	48	41	49	41	41	39	39	43	41	43	48	45	43	41

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

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

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

Table A3. Standardized average body weights used by the SDa for determining the $DDDA_F$ values, by livestock sector and production category

Livestock sector	Production category	Further specification	Age group	Standardized body weight in kg[1]
Veal farming sector	Calves at white veal farms		0-222 days	160
	Calves at rosé veal starter farms		0-98 days	77.5
	Calves at rosé veal fattening farms		98-256 days	232.5
	Calves at rosé veal combination farms		0-256 days	205
Pig farming sector	Sows/suckling piglets	Sows (all females that have been inseminated), breeding boars and heat-check boars		220
		Suckling piglets	0-25 days	4.5
		Replacement gilts	7 months - 1st insemination	135
	Weaner pigs	Weaned piglets	25-74 days	17.5
	Fattening pigs/gilts	Fattening pigs	Until ready for slaughter	70
		Gilts	74 days - 7 months	70
Broiler farming sector[2]	Conventional broilers		0-42 days	n/a
Turkey farming sector[2]	Toms			n/a
	Hens			n/a
Cattle farming sector[3]	Dairy cattle		>2 years	600
	Heifers		1-2 years	440
	Yearlings		56 days - 1 year	235
	Calves (female)		<56 days	56.5
	Beef bulls		>2 years	800
	Beef bulls		1-2 years	628
	Beef bulls		56 days - 1 year	283
	Calves (male)		<56 days	79
Rabbit farming sector	Breeding does/kits		>4 months and <4.5 weeks	8.4
	Weaned meat rabbits		4.5-12 weeks	1.8
	Replacement breeding does		12 weeks - 4 months	3.4

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

[2] As of 2017, the body weights used for determining poultry farms' $DDDA_F$ value are based on the age of the animals at the time of treatment.

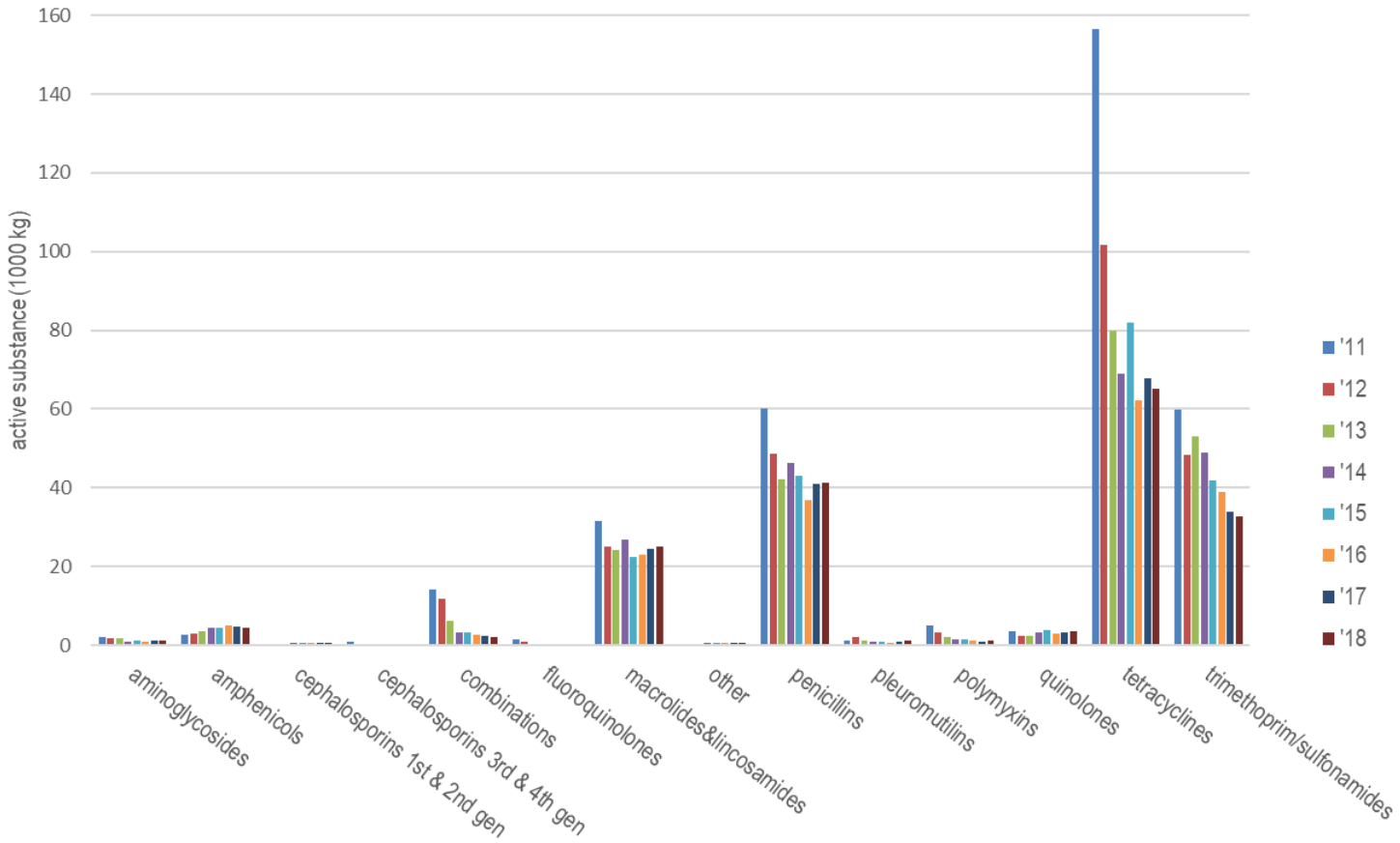
[3] Livestock farms in the cattle farming sector are categorized based on whether or not they produce milk. They are classified as either dairy cattle farms or non-dairy cattle farms. Non-dairy cattle farms include rearing farms (with <40% of cattle present being male and none of the animals being over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

Table A4. Standardized average body weights used for determining PCU values in accordance with the European Medicines Agency's approach, by animal category (source: ESVAC population correction unit template: http://www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00)

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

Sales figures for antibiotics, by pharmacotherapeutic group

Figure A1. Sales of antibiotics from 2011 to 2018, by pharmacotherapeutic group



Antibiotic use in $DDDA_F$ at broiler farms

All broiler farms combined

Number of broiler farms: 834
Number of broiler farms with $DDDA_F$=0: 280
Number of broiler farms that used third- and fourth-generation cephalosporins: 0
Number of broiler farms that used fluoroquinolones: 31

Table A5. Antibiotic use in $DDDA_F$ at broiler farms from 2016 to 2018*

Year	N	Mean	Median	P75	P90
2016	853	10.1	5.2	14.6	27.2
2017	852	10.3	4.4	14.4	27.1
2018	834	10.6	5.1	14.5	26.7

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A2. 2013 and 2018 $DDDA_F$ distributions for broiler farms, with 2018 $DDDA_F$ values based on standardized body weight

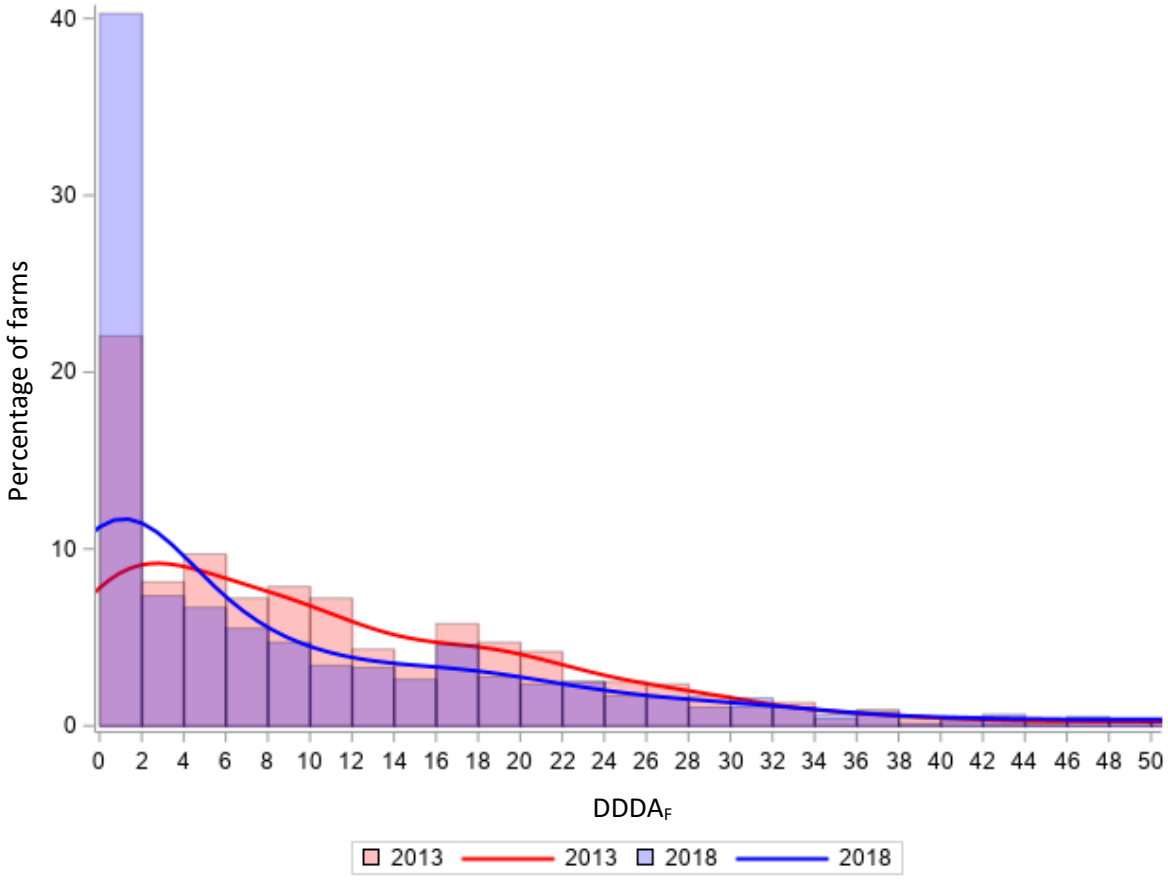


Figure A3. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.19. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

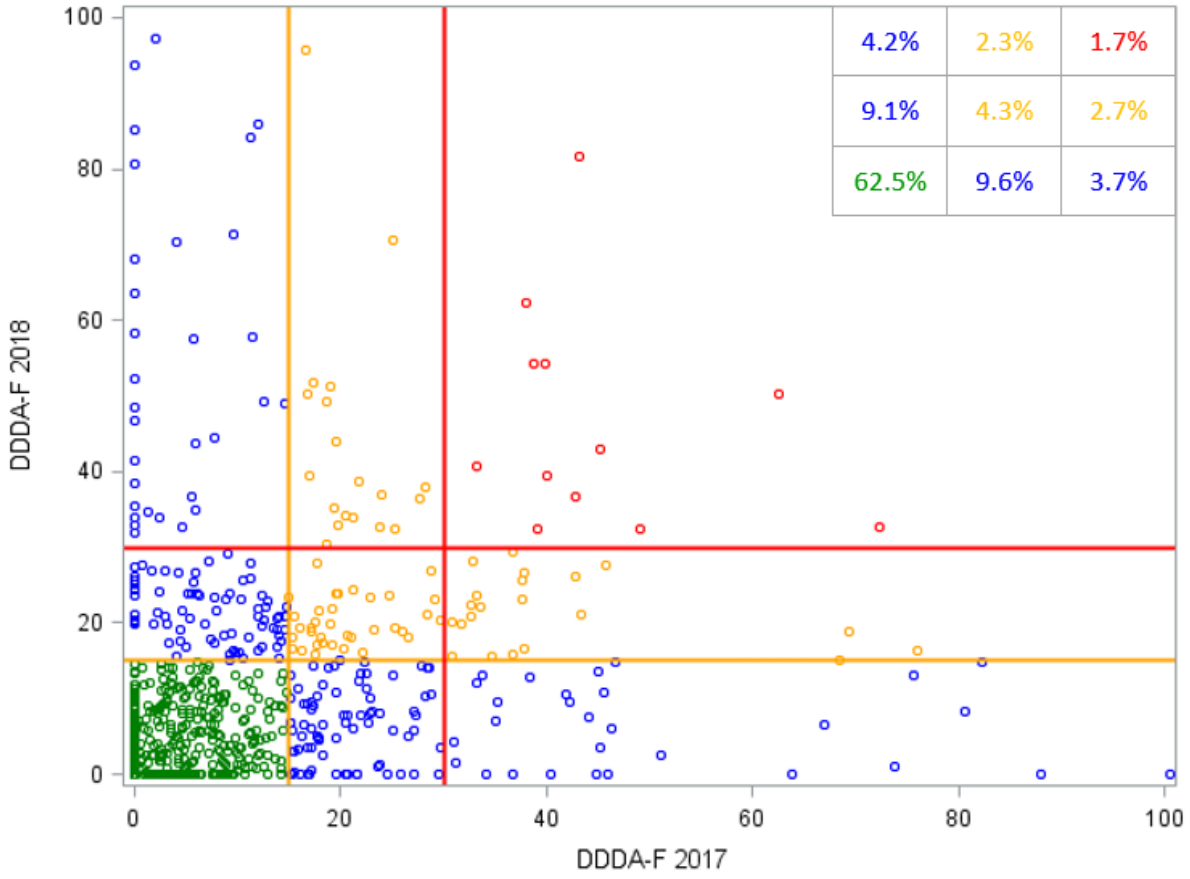


Table A6. Antibiotic use in $DDDA_F$ at broiler farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Penicillins	Oral	760	0.00	0.00	0.32
1st choice	Tetracyclines	Oral	624	0.00	0.27	1.31
1st choice	Trimethoprim/sulfonamides	Oral	453	0.00	4.02	2.88
2nd choice	Aminoglycosides	Oral	832	0.00	0.00	0.01
2nd choice	Quinolones	Oral	600	0.00	1.08	1.82
2nd choice	Fixed-dose combinations	Oral	821	0.00	0.00	0.16
2nd choice	Macrolides/lincosamides	Oral	751	0.00	0.00	0.20
2nd choice	Penicillins	Oral	463	0.00	4.02	3.62
2nd choice	Polymyxins	Oral	825	0.00	0.00	0.14
3rd choice	Fluoroquinolones	Oral	803	0.00	0.00	0.10

Broiler farms with conventional breeds

Number of broiler farms with conventional breeds: 498
Number of broiler farms with conventional breeds with $DDDA_F$=0: 105
Number of broiler farms with conventional breeds that used third- and fourth-generation cephalosporins: 0
Number of broiler farms with conventional breeds that used fluoroquinolones: 28

Table A7. Antibiotic use in $DDDA_F$ at broiler farms with conventional breeds from 2016 to 2018*

Year	N	Mean	Median	P75	P90
2016	570	12.3	8.5	17.5	29.7
2017	487	13.9	9.3	19.5	33.3
2018	498	14.3	10.1	20	34

* Only years for which similar $DDDA_F$ calculation methods were used have been included. The sum of the number of broiler farms with conventional breeds and the number of broiler farms with alternative breeds exceeds the N recorded for all broiler farms combined, as some broiler farmers keep both conventional and alternative breeds.

Figure A4. 2017 and 2018 $DDDA_F$ distributions for broiler farms with conventional breeds

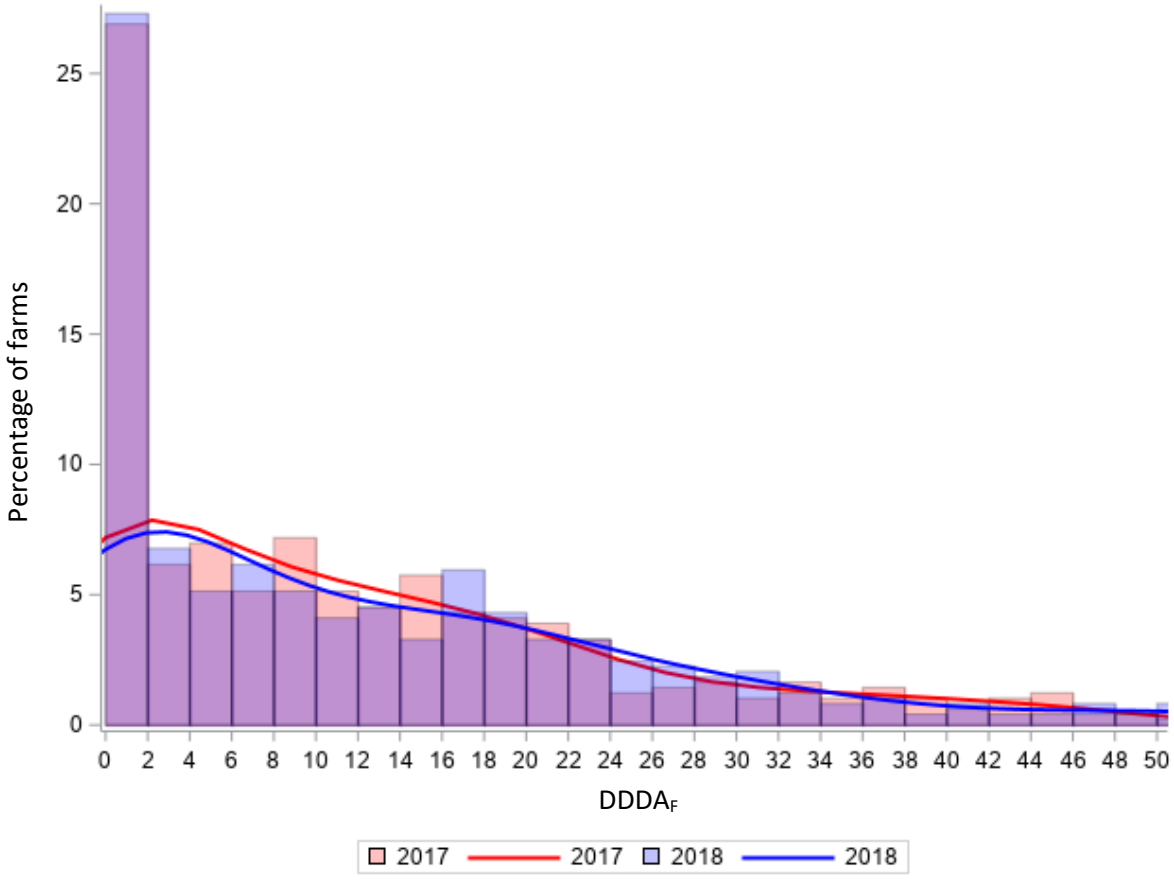


Figure A5. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.10. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

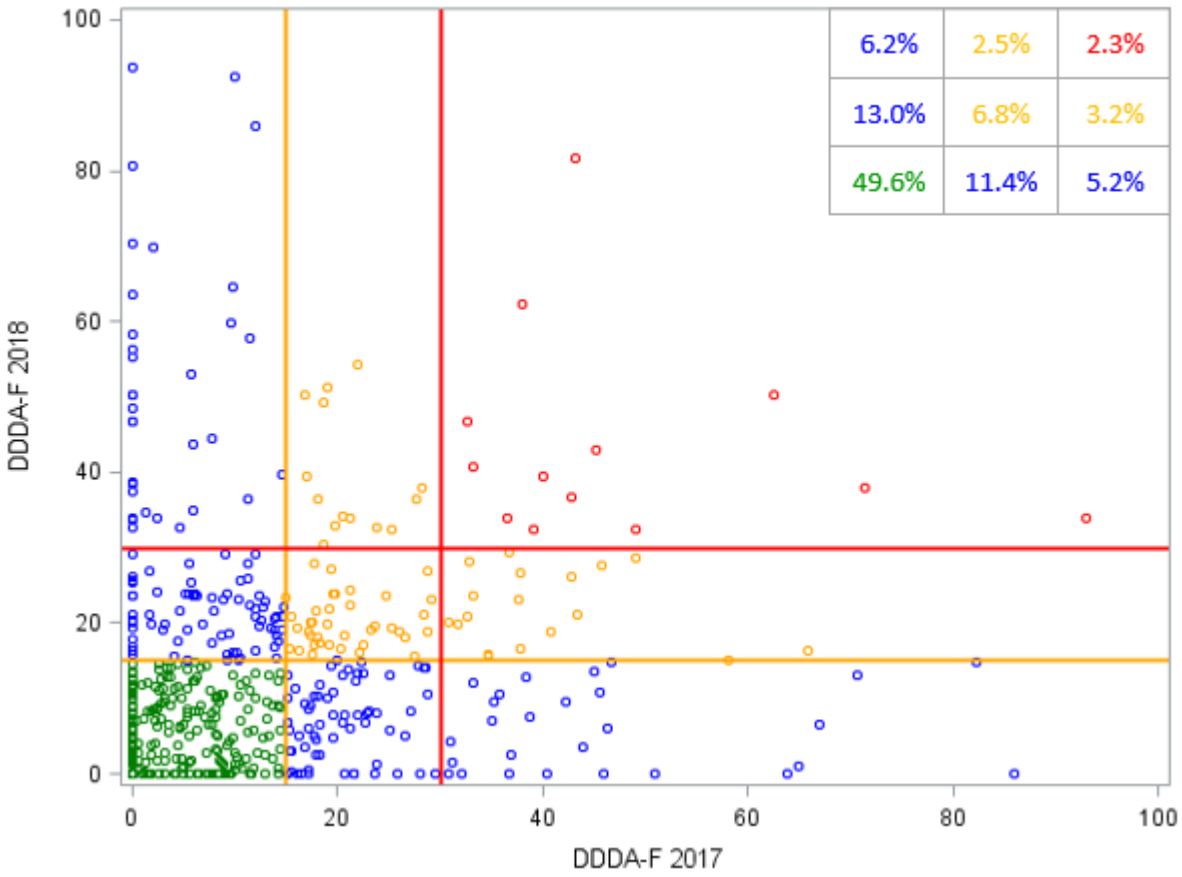


Table A8. Antibiotic use in $DDDA_F$ at broiler farms with conventional breeds in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Penicillins	Oral	442	0.00	0.00	0.41
1st choice	Tetracyclines	Oral	366	0.00	0.63	1.42
1st choice	Trimethoprim/sulfonamides	Oral	215	1.87	5.59	3.78
2nd choice	Aminoglycosides	Oral	496	0.00	0.00	0.02
2nd choice	Quinolones	Oral	331	0.00	1.96	2.26
2nd choice	Fixed-dose combinations	Oral	485	0.00	0.00	0.27
2nd choice	Macrolides/lincosamides	Oral	427	0.00	0.00	0.30
2nd choice	Penicillins	Oral	202	1.99	6.75	5.44
2nd choice	Polymyxins	Oral	490	0.00	0.00	0.23
3rd choice	Fluoroquinolones	Oral	470	0.00	0.00	0.16

Broiler farms with alternative breeds

Number of broiler farms with alternative breeds: 475
Number of broiler farms with alternative breeds with $DDDA_F$=0: 272
Number of broiler farms with alternative breeds that used third- and fourth-generation cephalosporins: 0
Number of broiler farms with alternative breeds that used fluoroquinolones: 3

Table A9. Antibiotic use in $DDDA_F$ at broiler farms with alternative breeds from 2016 to 2018*

Year	N	Mean	Median	P75	P90
2016	461	3.6	0.0	3.8	11.9
2017	493	4.1	0.0	5.0	12.6
2018	475	3.6	0.0	4.9	10.6

* Only years for which similar $DDDA_F$ calculation methods were used have been included. The sum of the number of broiler farms with conventional breeds and the number of broiler farms with alternative breeds exceeds the N recorded for all broiler farms combined, as some broiler farmers keep both conventional and alternative breeds.

Figure A6. 2017 and 2018 $DDDA_F$ distributions for broiler farms with alternative breeds

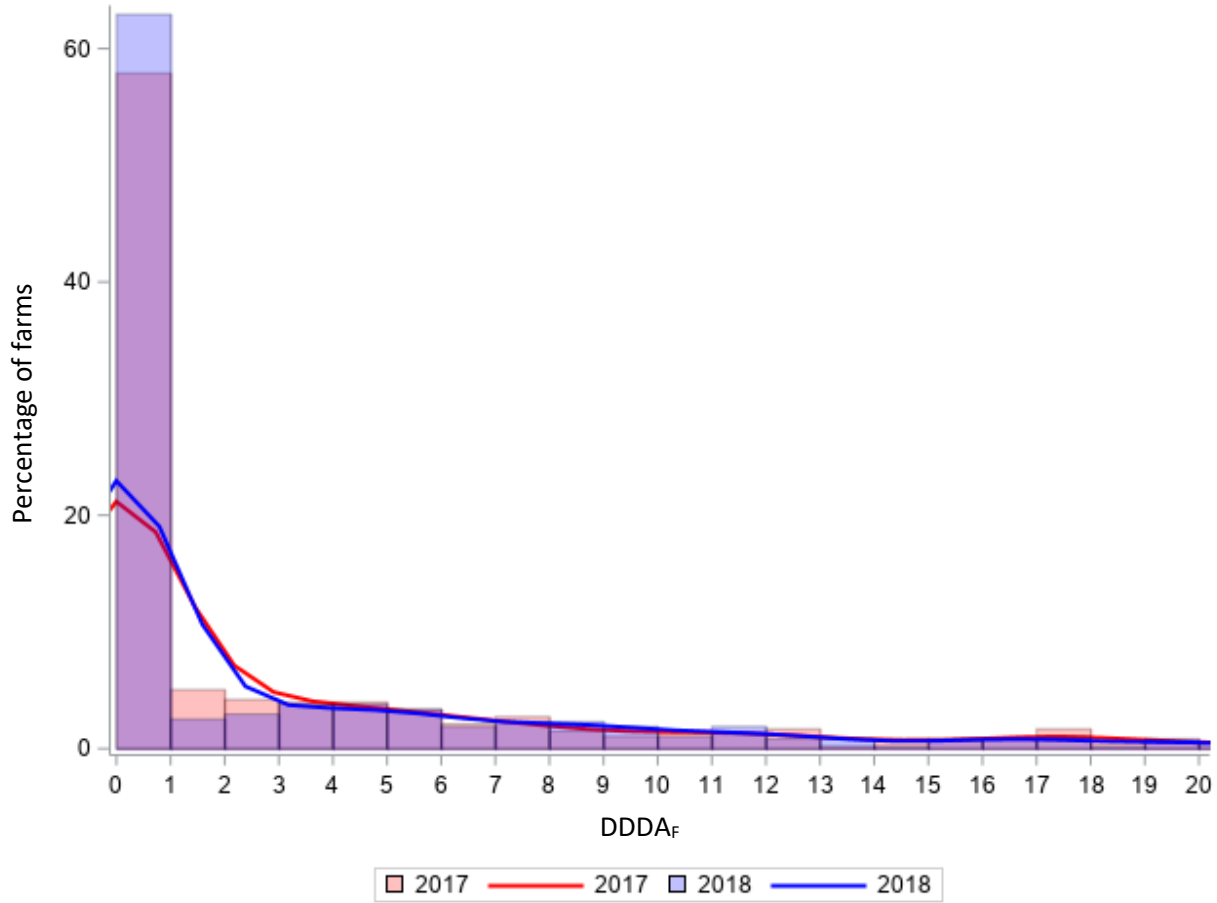


Figure A7. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.16. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

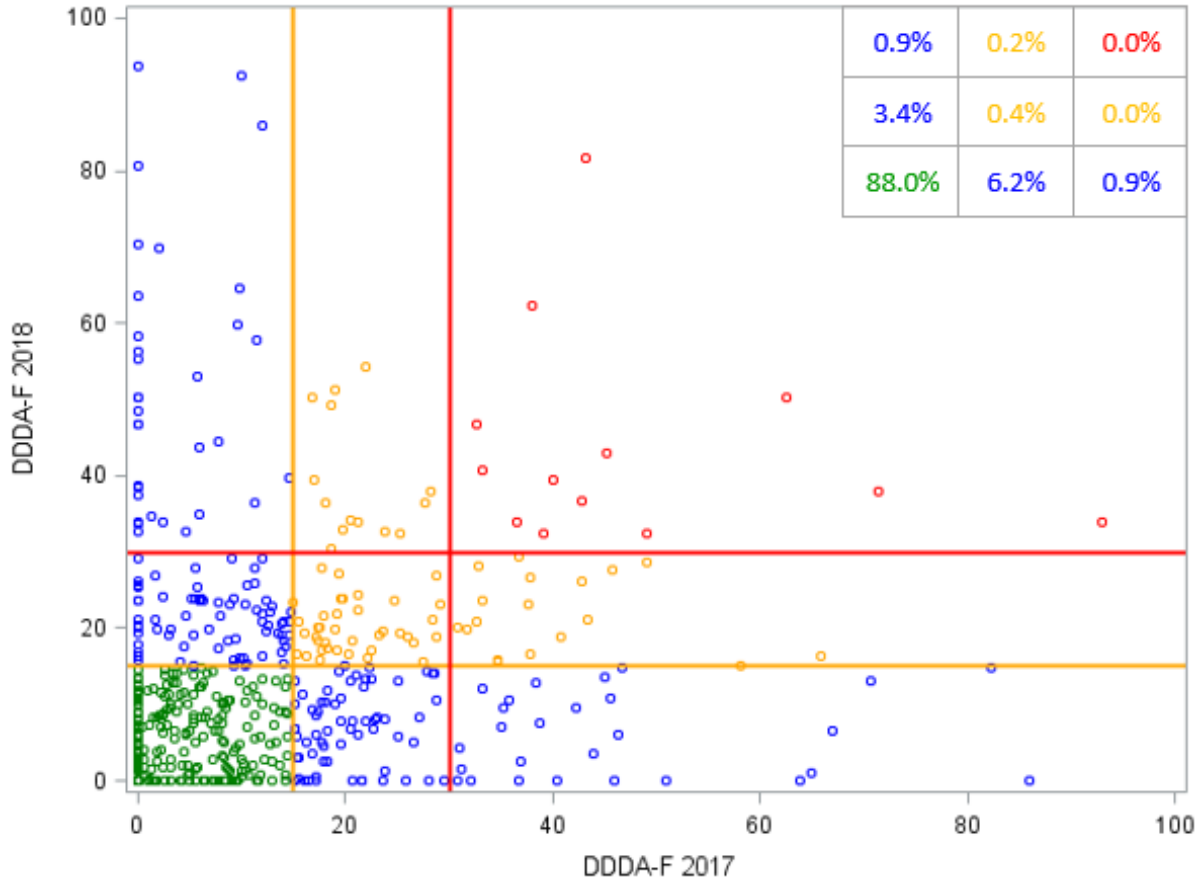


Table A10. Antibiotic use in $DDDA_F$ at broiler farms with alternative breeds in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Penicillins	Oral	457	0.00	0.00	0.13
1st choice	Tetracyclines	Oral	389	0.00	0.00	0.80
1st choice	Trimethoprim/sulfonamides	Oral	367	0.00	0.00	1.10
2nd choice	Quinolones	Oral	398	0.00	0.00	0.83
2nd choice	Macrolides/lincosamides	Oral	463	0.00	0.00	0.03
2nd choice	Penicillins	Oral	391	0.00	0.00	0.64
2nd choice	Polymyxins	Oral	474	0.00	0.00	0.01
3rd choice	Fluoroquinolones	Oral	472	0.00	0.00	0.01

Turkey farms

Number of turkey farms: 38
Number of turkey farms with $DDDA_F$=0: 2
Number of turkey farms that used third- and fourth-generation cephalosporins: 0
Number of turkey farms that used fluoroquinolones: 17

Table A11. Antibiotic use in $DDDA_F$ at turkey farms from 2016 to 2018*

Year	N	Mean	Median	P75	P90
2016	46	28.0	19.3	34.2	72.8
2017	45	18.7	10.4	25.5	59.8
2018	38	20.9	11.6	24.1	49.7

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A8. 2013 and 2018 $DDDA_F$ distributions for turkey farms, with 2018 $DDDA_F$ values based on standardized body weight

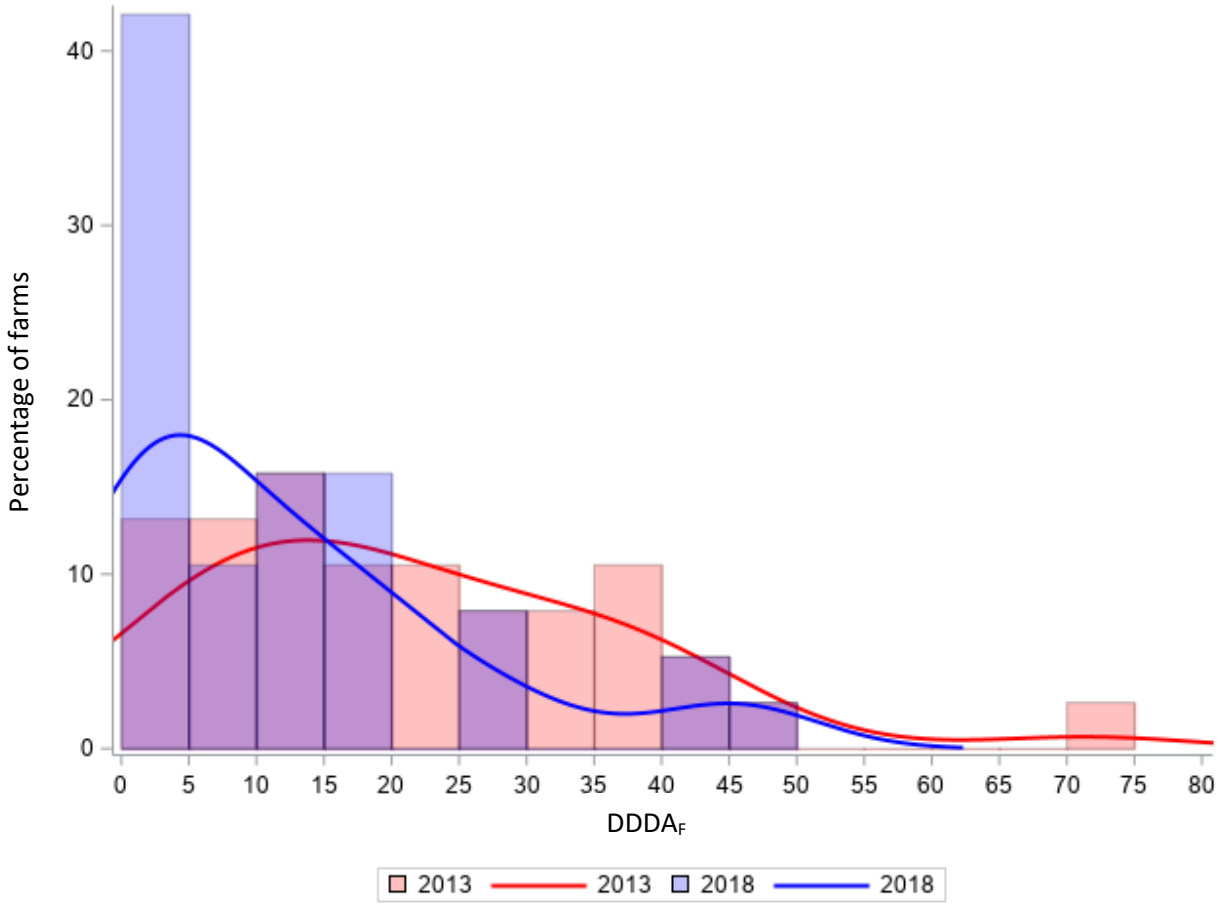


Figure A9. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.85. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

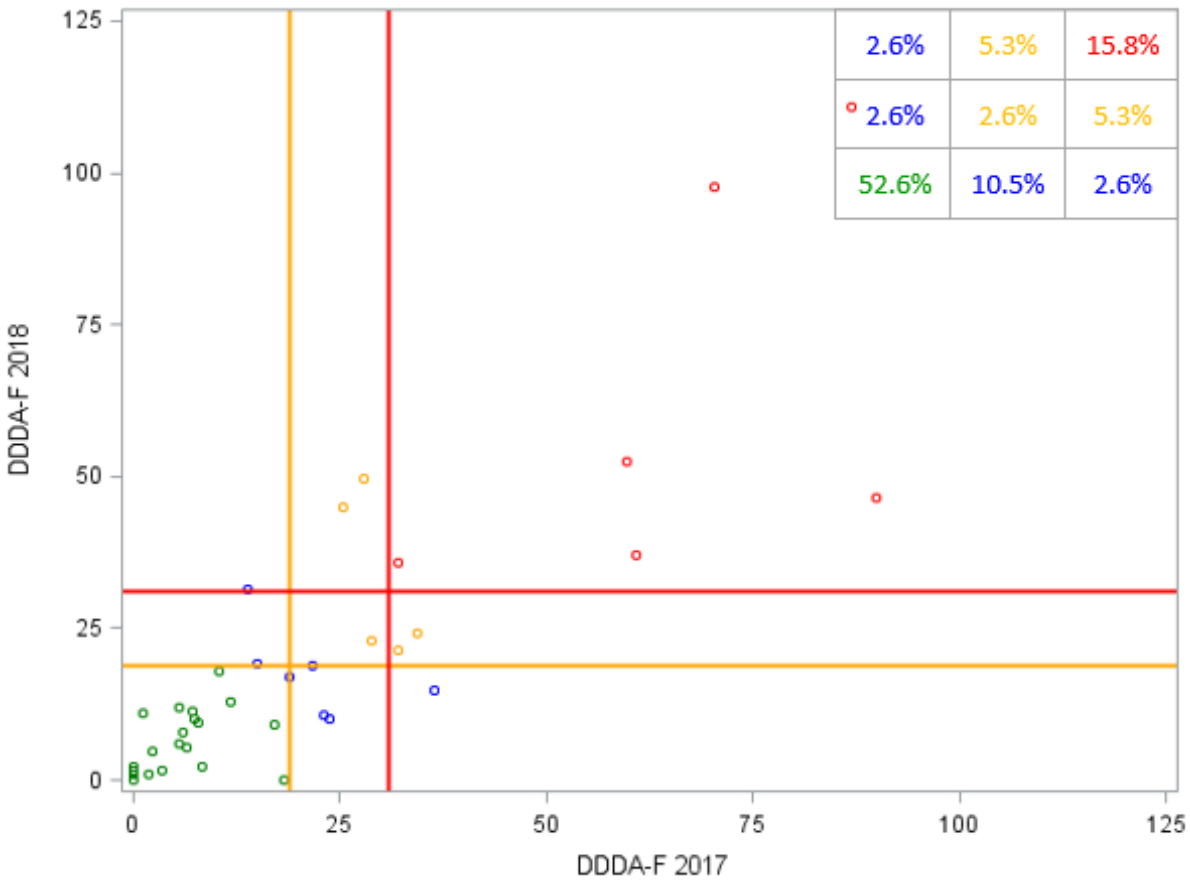


Table A12. Antibiotic use in $DDDA_F$ at turkey farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Penicillins	Oral	24	0.00	4.25	3.64
1st choice	Pleuromutilins	Oral	35	0.00	0.00	0.05
1st choice	Tetracyclines	Oral	8	3.61	8.56	4.96
1st choice	Trimethoprim/sulfonamides	Oral	29	0.00	0.00	1.48
2nd choice	Aminoglycosides	Oral	37	0.00	0.00	0.01
2nd choice	Quinolones	Oral	35	0.00	0.00	0.26
2nd choice	Macrolides/lincosamides	Oral	13	0.71	1.32	1.22
2nd choice	Penicillins	Oral	16	1.36	8.01	8.19
3rd choice	Fluoroquinolones	Oral	21	0.00	1.54	1.04

Antibiotic use in $DDDA_F$ at pig farms

Farms with sows and suckling piglets

Number of farms with sows and suckling piglets: 1,780
Number of farms with sows and suckling piglets with $DDDA_F$=0: 94
Number of farms with sows and suckling piglets that used third- and fourth-generation cephalosporins: 0
Number of farms with sows and suckling piglets that used fluoroquinolones: 5

Table A13. Antibiotic use in $DDDA_F$ at farms with sows and suckling piglets from 2015 to 2018*

Year	N	Mean	Median	P75	P90
2015	2,109	5.4	3.1	6.8	12.8
2016	1,919	3.5	2.3	4.7	8.1
2017	1,853	3.7	2.2	4.7	8.2
2018	1,780	3.8	2.1	4.5	8.6

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A10. 2015 and 2018 $DDDA_F$ distributions for farms with sows and suckling piglets

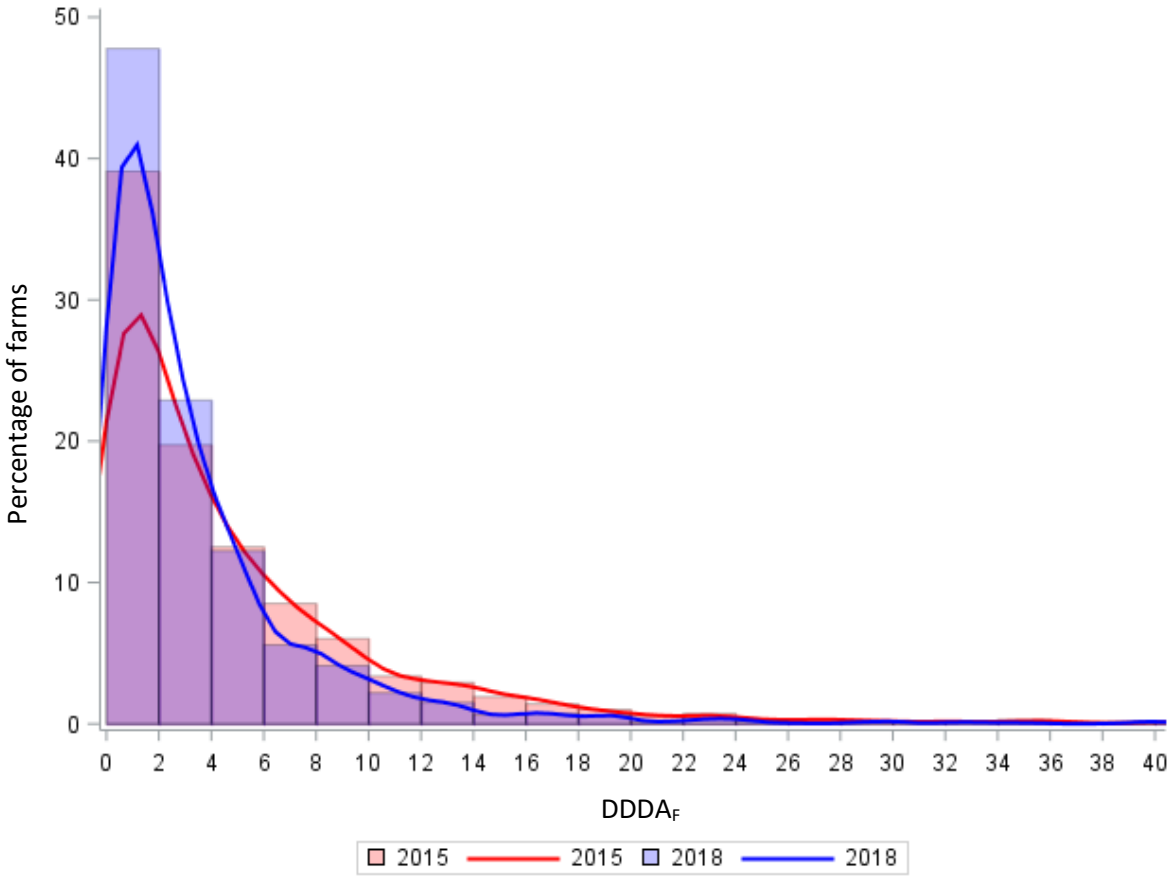


Figure A11. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.32. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

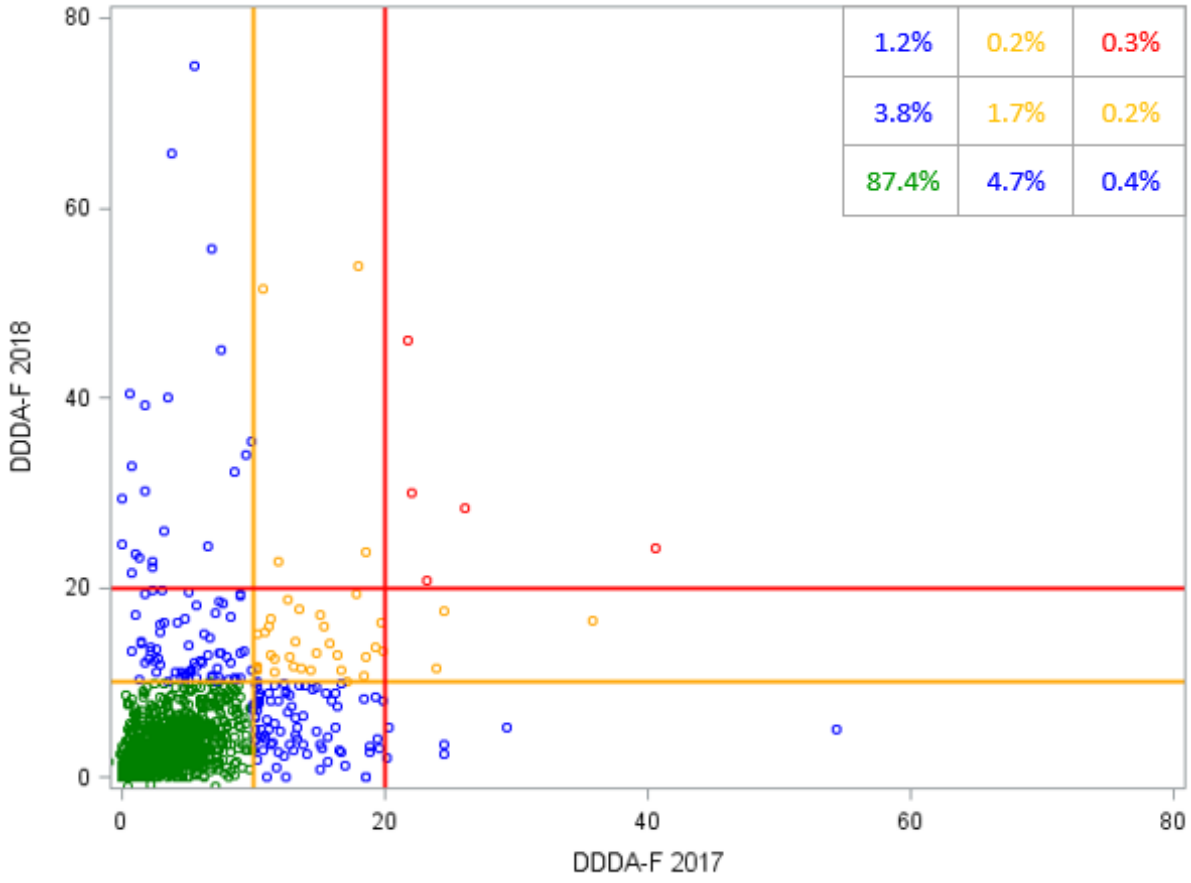


Table A14. Antibiotic use in $DDDA_F$ at farms with sows and suckling piglets in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Oral	1,779	0.00	0.00	0.00
1st choice	Amphenicols	Parenteral	1,264	0.00	0.07	0.20
1st choice	Macrolides/lincosamides	Oral	1,642	0.00	0.00	0.15
1st choice	Macrolides/lincosamides	Parenteral	1,602	0.00	0.00	0.01
1st choice	Penicillins	Parenteral	317	0.45	1.15	0.96
1st choice	Pleuromutilins	Oral	1,766	0.00	0.00	0.04
1st choice	Pleuromutilins	Parenteral	1,734	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	1,361	0.00	0.00	0.68
1st choice	Tetracyclines	Parenteral	740	0.06	0.37	0.58
1st choice	Trimethoprim/sulfonamides	Oral	1,504	0.00	0.00	0.20
1st choice	Trimethoprim/sulfonamides	Parenteral	691	0.05	0.27	0.23
2nd choice	Aminoglycosides	Oral	1,746	0.00	0.00	0.01
2nd choice	Aminoglycosides	Parenteral	1,778	0.00	0.00	0.00
2nd choice	Quinolones	Oral	1,766	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Parenteral	1,609	0.00	0.00	0.02
2nd choice	Macrolides/lincosamides	Parenteral	1,432	0.00	0.00	0.29
2nd choice	Penicillins	Oral	1,613	0.00	0.00	0.11
2nd choice	Penicillins	Parenteral	972	0.00	0.21	0.19
2nd choice	Polymyxins	Oral	1,635	0.00	0.00	0.04
2nd choice	Polymyxins	Parenteral	1,302	0.00	0.01	0.04
3rd choice	Fluoroquinolones	Parenteral	1,775	0.00	0.00	0.00

Farms with weaner pigs

Number of farms with weaner pigs: 1,941
Number of farms with weaner pigs with $DDDA_F$=0: 272
Number of farms with weaner pigs that used third- and fourth-generation cephalosporins: 0
Number of farms with weaner pigs that used fluoroquinolones: 4

Table A15. Antibiotic use in $DDDA_F$ at farms with weaner pigs from 2015 to 2018*

Year	N	Mean	Median	P75	P90
2015	2,276	19.6	7.6	24.4	52.2
2016	2,088	24.2	11.9	29.1	57.2
2017	2,037	21.7	10.6	25.5	52.9
2018	1,941	19.8	10.1	23.5	44.0

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A12. 2015 and 2018 $DDDA_F$ distributions for farms with weaner pigs

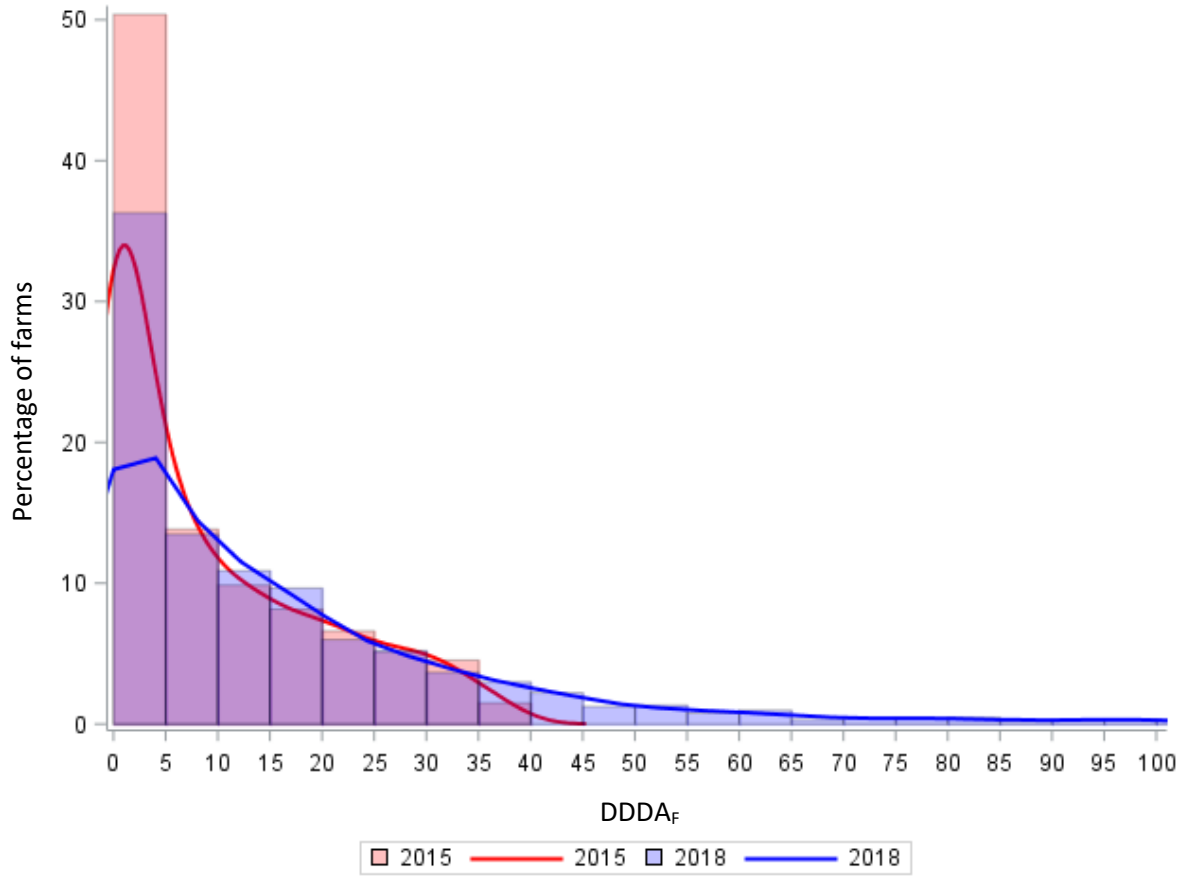


Figure A13. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.74. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

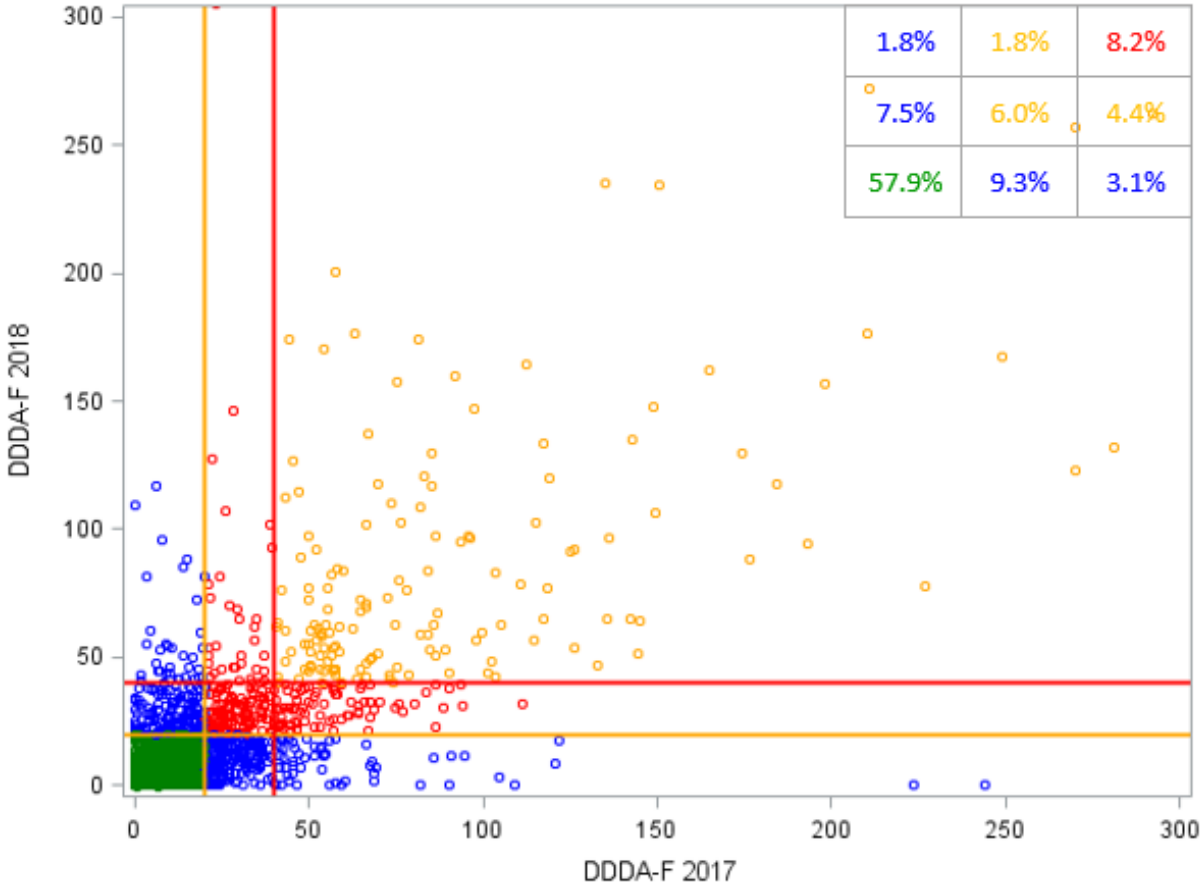


Table A16. Antibiotic use in $DDDA_F$ at farms with weaner pigs in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Oral	1,926	0.00	0.00	0.04
1st choice	Amphenicols	Parenteral	1,574	0.00	0.00	0.30
1st choice	Macrolides/lincosamides	Oral	1,738	0.00	0.00	0.51
1st choice	Macrolides/lincosamides	Parenteral	1,865	0.00	0.00	0.01
1st choice	Penicillins	Parenteral	1,088	0.00	0.67	0.93
1st choice	Pleuromutilins	Oral	1,912	0.00	0.00	0.11
1st choice	Pleuromutilins	Parenteral	1,920	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	1,069	0.00	7.14	6.30
1st choice	Tetracyclines	Parenteral	1,408	0.00	0.10	0.69
1st choice	Trimethoprim/sulfonamides	Oral	1,204	0.00	2.72	3.14
1st choice	Trimethoprim/sulfonamides	Parenteral	1,687	0.00	0.00	0.06
2nd choice	Aminoglycosides	Oral	1,889	0.00	0.00	0.15
2nd choice	Aminoglycosides	Parenteral	1,939	0.00	0.00	0.00
2nd choice	Quinolones	Oral	1,916	0.00	0.00	0.07
2nd choice	Fixed-dose combinations	Oral	1,939	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	1,824	0.00	0.00	0.02
2nd choice	Macrolides/lincosamides	Parenteral	1,577	0.00	0.00	0.93
2nd choice	Penicillins	Oral	1,399	0.00	1.98	4.74
2nd choice	Penicillins	Parenteral	1,206	0.00	0.37	0.47
2nd choice	Polymyxins	Oral	1,519	0.00	0.00	1.21
2nd choice	Polymyxins	Parenteral	1,569	0.00	0.00	0.11
3rd choice	Fluoroquinolones	Parenteral	1,937	0.00	0.00	0.00

Farms with fattening pigs

Number of farms with fattening pigs: 4,323
Number of farms with fattening pigs with $DDDA_F$=0: 1,004
Number of farms with fattening pigs that used third- and fourth-generation cephalosporins: 0
Number of farms with fattening pigs that used fluoroquinolones: 1

Table A17. Antibiotic use in $DDDA_F$ at farms with fattening pigs from 2015 to 2018*

Year	N	Mean	Median	P75	P90
2015	5,072	4.1	1.6	5.4	10.2
2016	4,701	4.0	1.7	5.7	10.1
2017	4,580	3.8	1.7	5.4	9.8
2018	4,323	3.9	1.8	5.4	9.9

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A14. 2015 and 2018 $DDDA_F$ distributions for farms with fattening pigs

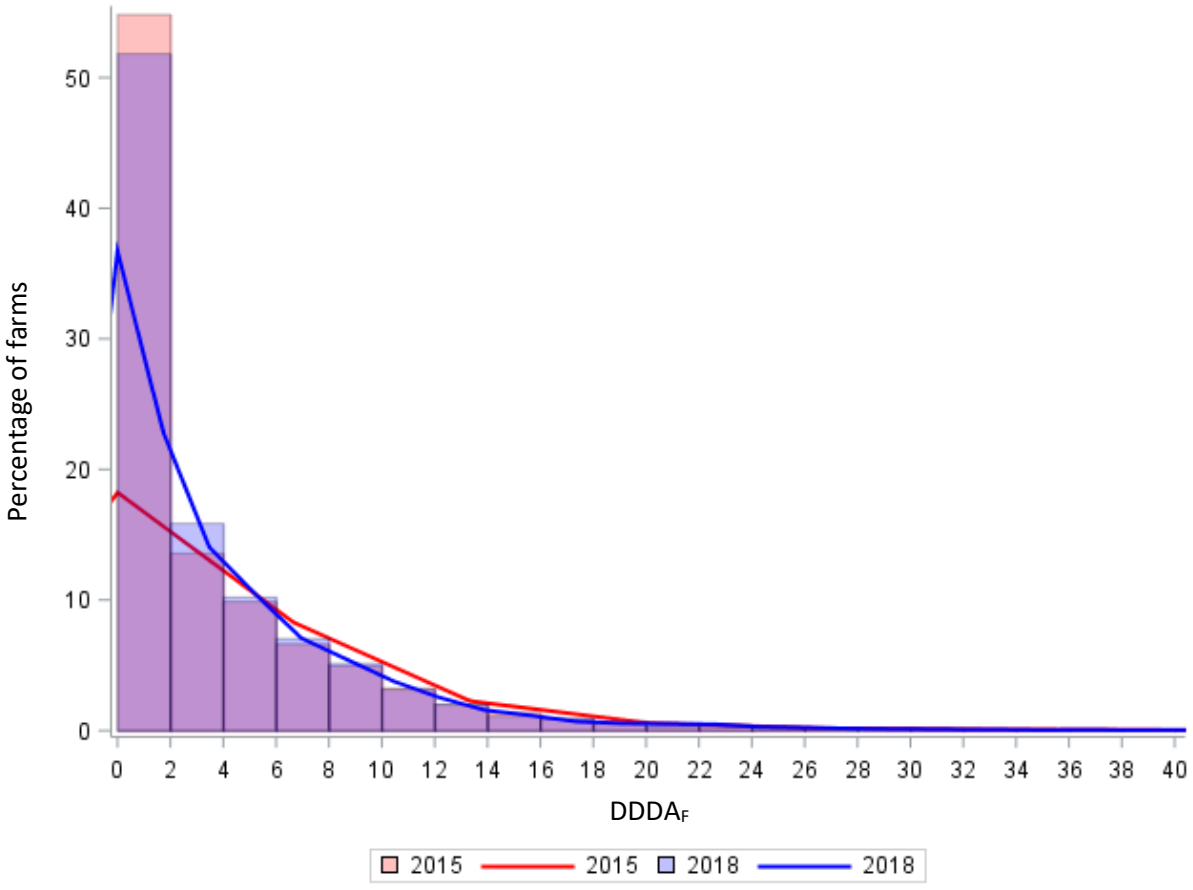


Figure A15. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.34. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

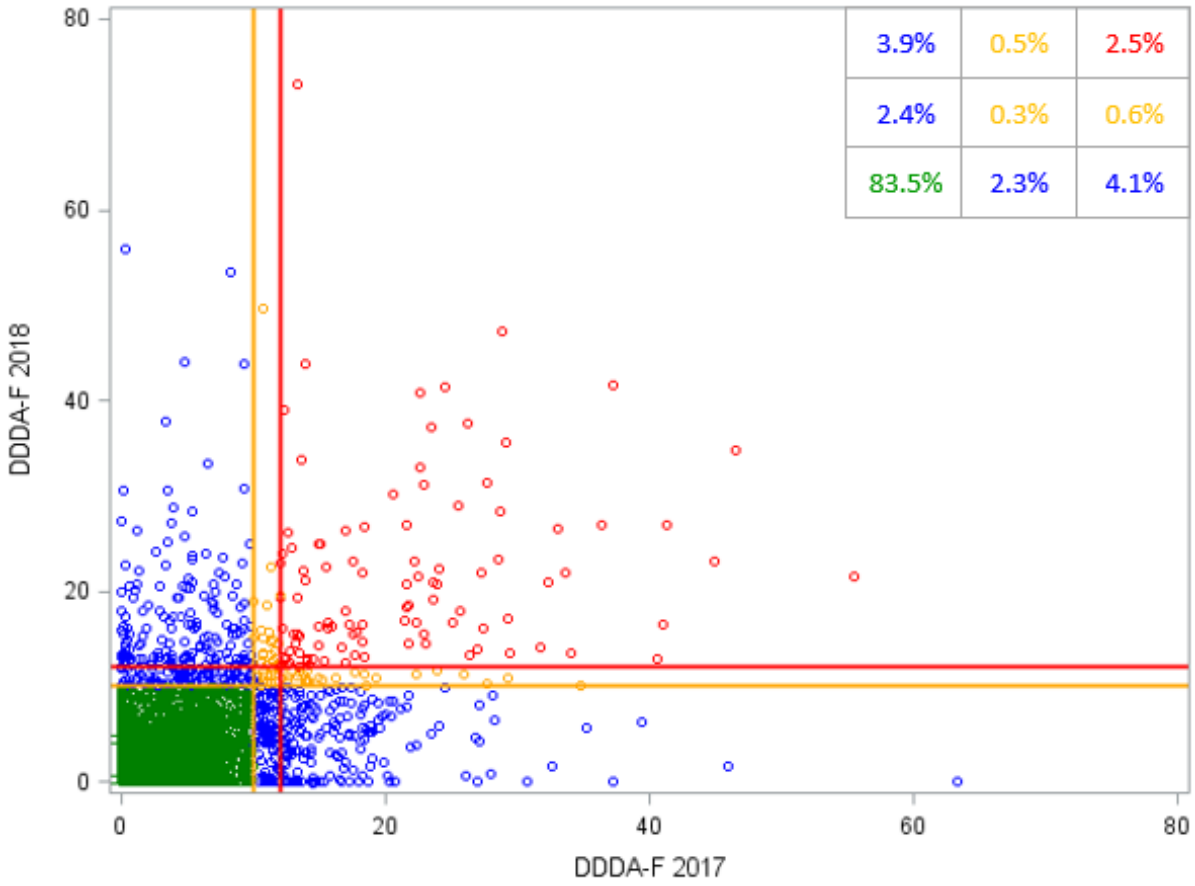


Table A18. Antibiotic use in $DDDA_F$ at farms with fattening pigs in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Oral	4,319	0.00	0.00	0.00
1st choice	Amphenicols	Parenteral	3,218	0.00	0.03	0.16
1st choice	Macrolides/lincosamides	Oral	3,258	0.00	0.00	0.72
1st choice	Macrolides/lincosamides	Parenteral	3,654	0.00	0.00	0.02
1st choice	Penicillins	Parenteral	1,699	0.08	0.34	0.37
1st choice	Pleuromutilins	Oral	4,238	0.00	0.00	0.05
1st choice	Pleuromutilins	Parenteral	4,153	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	2,558	0.00	2.29	1.89
1st choice	Tetracyclines	Parenteral	2,368	0.00	0.17	0.23
1st choice	Trimethoprim/sulfonamides	Oral	3,484	0.00	0.00	0.37
1st choice	Trimethoprim/sulfonamides	Parenteral	4,252	0.00	0.00	0.00
2nd choice	Aminoglycosides	Oral	4,320	0.00	0.00	0.00
2nd choice	Aminoglycosides	Parenteral	4,322	0.00	0.00	0.00
2nd choice	Quinolones	Oral	4,308	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	4,240	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	4,268	0.00	0.00	0.01
2nd choice	Penicillins	Oral	4,194	0.00	0.00	0.05
2nd choice	Penicillins	Parenteral	3,881	0.00	0.00	0.01
2nd choice	Polymyxins	Oral	4,245	0.00	0.00	0.03
2nd choice	Polymyxins	Parenteral	4,233	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	4,322	0.00	0.00	0.00

Antibiotic use in $DDDA_F$ at veal farms

White veal farms

Number of white veal farms: 855
Number of white veal farms with $DDDA_F$=0: 0
Number of white veal farms that used third- and fourth-generation cephalosporins: 0
Number of white veal farms that used fluoroquinolones: 119

Table A19. Antibiotic use in $DDDA_F$ at white veal farms from 2011 to 2018*

Year	N	Mean	Median	P75	P90
2011	934	41.1	33.2	44.9	57.8
2012	904	33.6	30.7	40.1	50.9
2013	862	31.4	26.2	35.1	45.2
2014	864	24.5	23.4	31.0	37.8
2015	855	25.1	24.3	31.7	38.3
2016	857	23.7	23.0	29.0	35.6
2017	838	23.0	22.2	27.0	33.1
2018	855	20.1	19.3	24.6	30.0

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A16. 2012 and 2018 $DDDA_F$ distributions for white veal farms

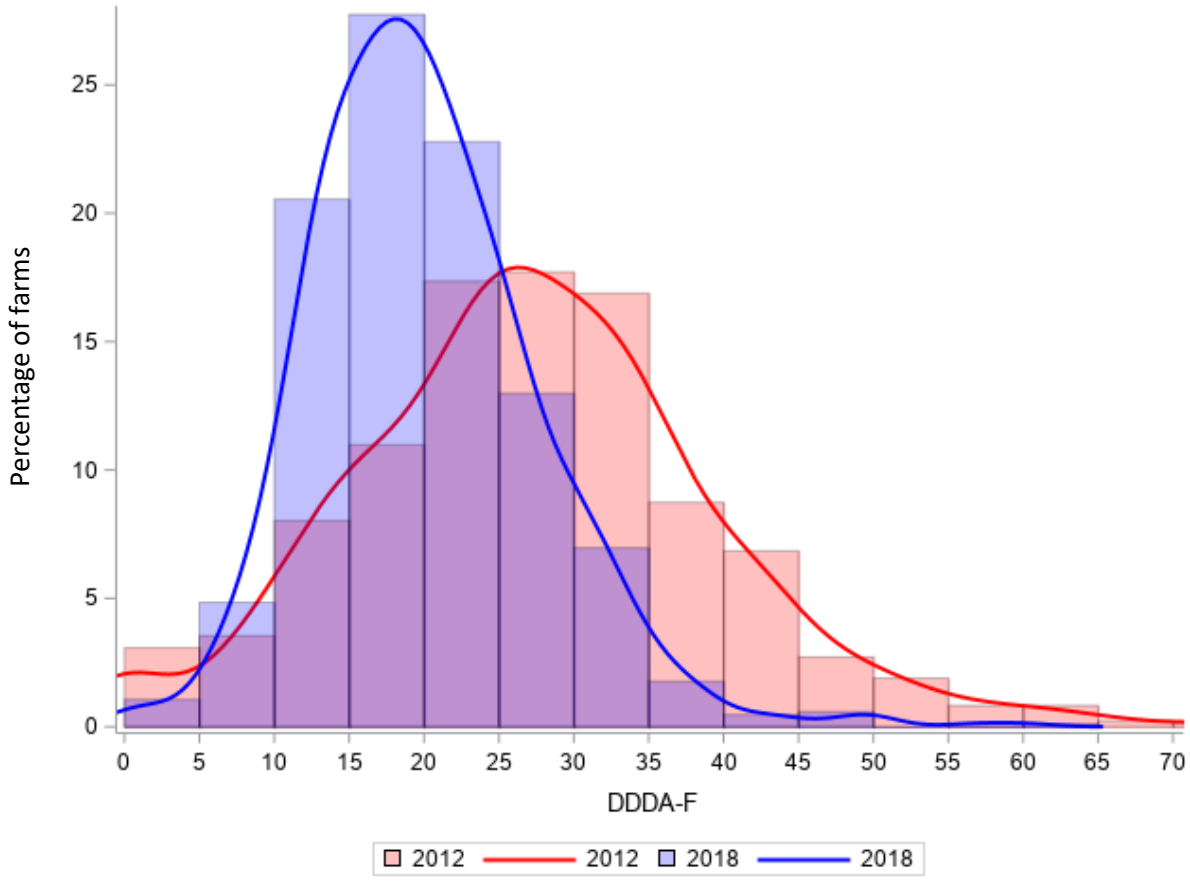


Figure A17. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.31. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

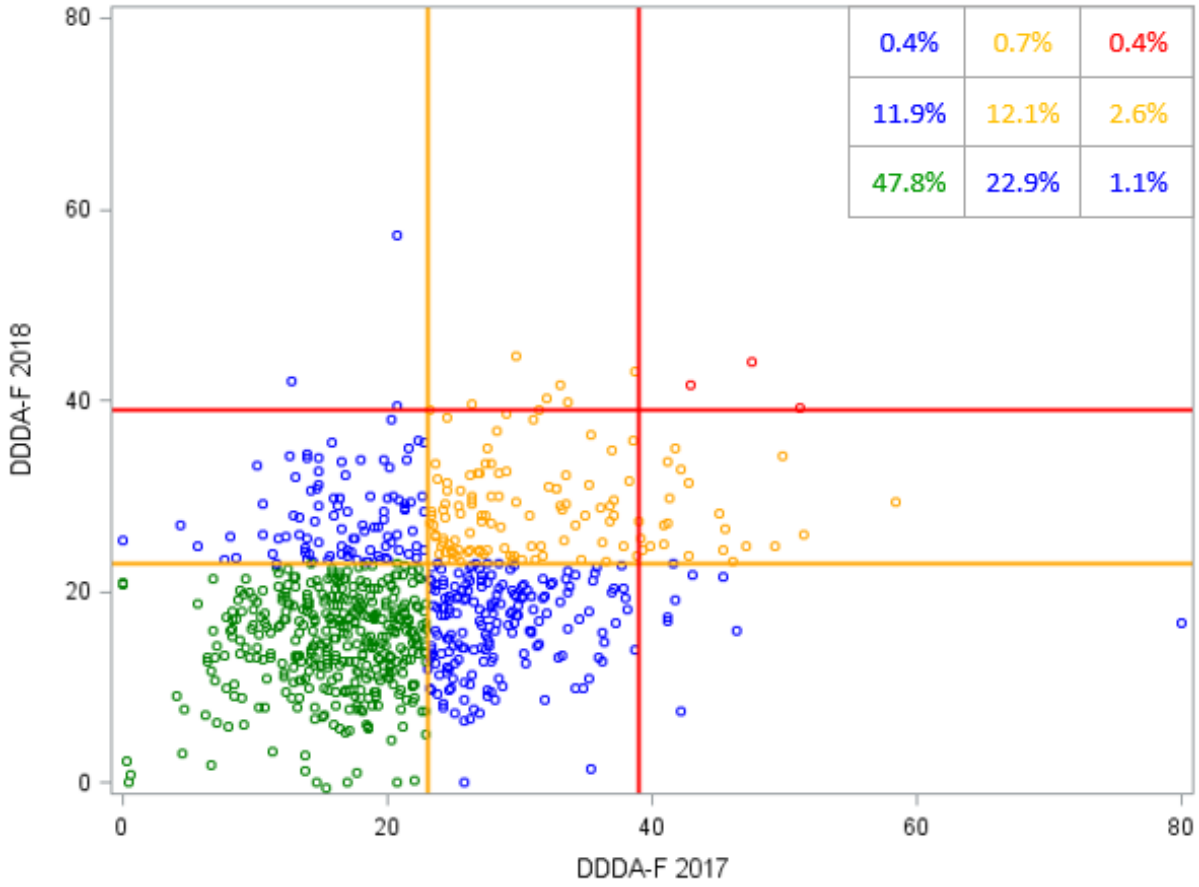


Table A20. Antibiotic use in $DDDA_F$ at white veal farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	9	0.89	1.32	1.04
1st choice	Macrolides/lincosamides	Oral	35	3.20	4.16	3.25
1st choice	Macrolides/lincosamides	Parenteral	245	0.02	0.10	0.13
1st choice	Penicillins	Parenteral	37	0.33	0.62	0.45
1st choice	Tetracyclines	Oral	5	10.31	13.55	10.78
1st choice	Tetracyclines	Parenteral	634	0.00	0.00	0.02
1st choice	Trimethoprim/sulfonamides	Oral	437	0.00	1.58	1.01
1st choice	Trimethoprim/sulfonamides	Parenteral	170	0.04	0.09	0.07
2nd choice	Aminoglycosides	Oral	365	0.01	0.05	0.17
2nd choice	Aminoglycosides	Parenteral	537	0.00	0.04	0.05
2nd choice	Quinolones	Oral	637	0.00	0.08	0.55
2nd choice	Fixed-dose combinations	Intramammary	854	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	795	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	239	0.12	0.30	0.21
2nd choice	Penicillins	Intramammary	853	0.00	0.00	0.00
2nd choice	Penicillins	Oral	251	0.68	2.96	1.89
2nd choice	Penicillins	Parenteral	139	0.07	0.13	0.10
2nd choice	Polymyxins	Oral	843	0.00	0.00	0.01
2nd choice	Polymyxins	Parenteral	786	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	835	0.00	0.00	0.04
3rd choice	Fluoroquinolones	Parenteral	749	0.00	0.00	0.01

Rosé veal starter farms

Number of rosé veal starter farms: 256
Number of rosé veal starter farms with $DDDA_F$=0: 1
Number of rosé veal starter farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal starter farms that used fluoroquinolones: 24

Table A21. Antibiotic use in $DDDA_F$ at rosé veal starter farms from 2011 to 2018*

Year	N	Mean	Median	P75	P90
2011	207	120.0	94.4	127.8	171.5
2012	189	97.5	84.2	107.1	143.1
2013	264	115.6	80.9	102.2	131.0
2014	260	79.6	77.7	97.2	113.9
2015	247	82.7	83.0	101.5	115.1
2016	240	83.9	83.2	100	111.6
2017	238	83.0	83.1	102.0	113.3
2018	256	79.9	79.3	96.1	115.6

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A18. 2012 and 2018 $DDDA_F$ distributions for rosé veal starter farms

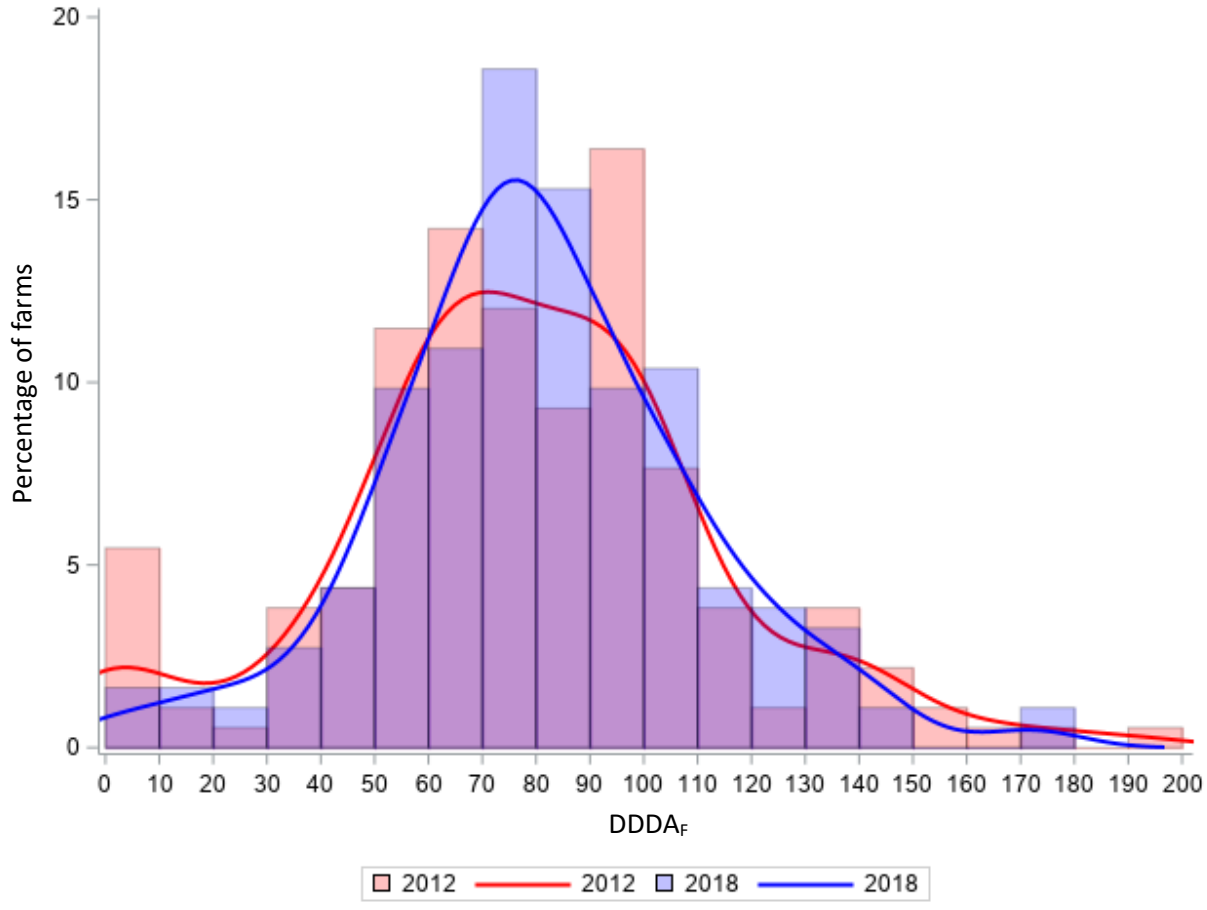


Figure A19. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.57. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

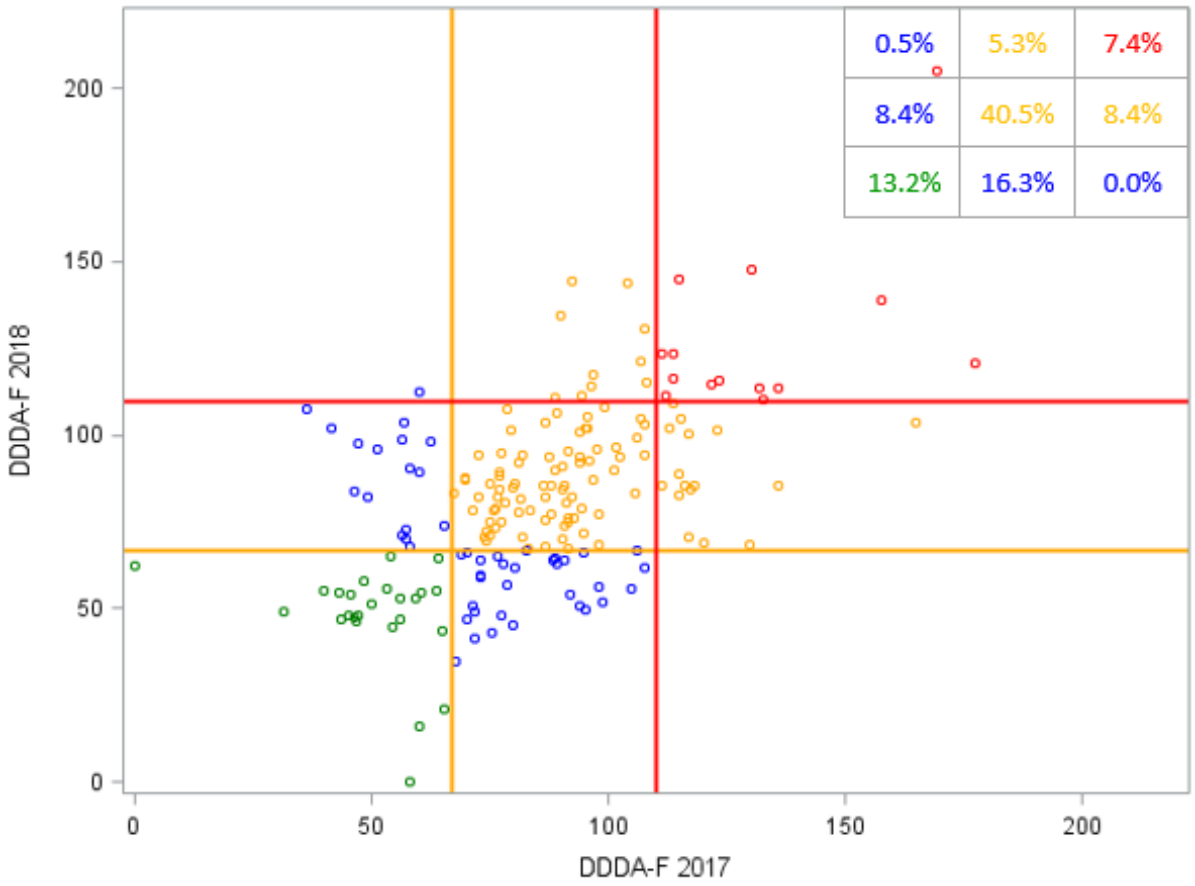


Table A22. Antibiotic use in $DDDA_F$ at rosé veal starter farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	4	5.41	8.75	6.70
1st choice	Macrolides/lincosamides	Oral	21	16.71	21.04	15.89
1st choice	Macrolides/lincosamides	Parenteral	69	0.14	0.42	0.68
1st choice	Penicillins	Intramammary for dry cow therapy	255	0.00	0.00	0.00
1st choice	Penicillins	Parenteral	23	1.18	2.00	1.73
1st choice	Tetracyclines	Oral	8	41.44	51.96	41.43
1st choice	Tetracyclines	Parenteral	199	0.00	0.00	0.13
1st choice	Trimethoprim/sulfonamides	Oral	84	3.79	9.01	6.01
1st choice	Trimethoprim/sulfonamides	Parenteral	74	0.15	0.43	0.41
2nd choice	Aminoglycosides	Oral	137	0.00	0.24	0.66
2nd choice	Aminoglycosides	Parenteral	132	0.00	0.41	0.38
2nd choice	Quinolones	Oral	209	0.00	0.00	0.65
2nd choice	Fixed-dose combinations	Parenteral	242	0.00	0.00	0.01
2nd choice	Macrolides/lincosamides	Parenteral	89	0.49	1.63	1.24
2nd choice	Penicillins	Intramammary for dry cow therapy	254	0.00	0.00	0.00
2nd choice	Penicillins	Oral	134	0.00	5.68	3.47
2nd choice	Penicillins	Parenteral	45	0.26	0.56	0.40
2nd choice	Polymyxins	Oral	255	0.00	0.00	0.03
2nd choice	Polymyxins	Parenteral	245	0.00	0.00	0.01
3rd choice	Fluoroquinolones	Oral	251	0.00	0.00	0.03
3rd choice	Fluoroquinolones	Parenteral	236	0.00	0.00	0.02

Rosé veal fattening farms

Number of rosé veal fattening farms: 601
Number of rosé veal fattening farms with $DDDA_F$=0: 56
Number of rosé veal fattening farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal fattening farms that used fluoroquinolones: 6

Table A23. Antibiotic use in $DDDA_F$ at rosé veal fattening farms from 2011 to 2018*

Year	N	Mean	Median	P75	P90
2011	671	7.8	1.5	6.6	14.5
2012	717	5.8	2.3	7.3	15.5
2013	723	5.2	1.4	5.4	10.8
2014	663	3.4	1.2	4.5	9.5
2015	638	2.7	1.0	4.0	7.3
2016	602	2.8	0.9	3.9	8.1
2017	580	3.0	1.6	4.1	7.8
2018	601	2.7	1.2	3.8	6.4

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A20. 2012 and 2018 $DDDA_F$ distributions for rosé veal fattening farms

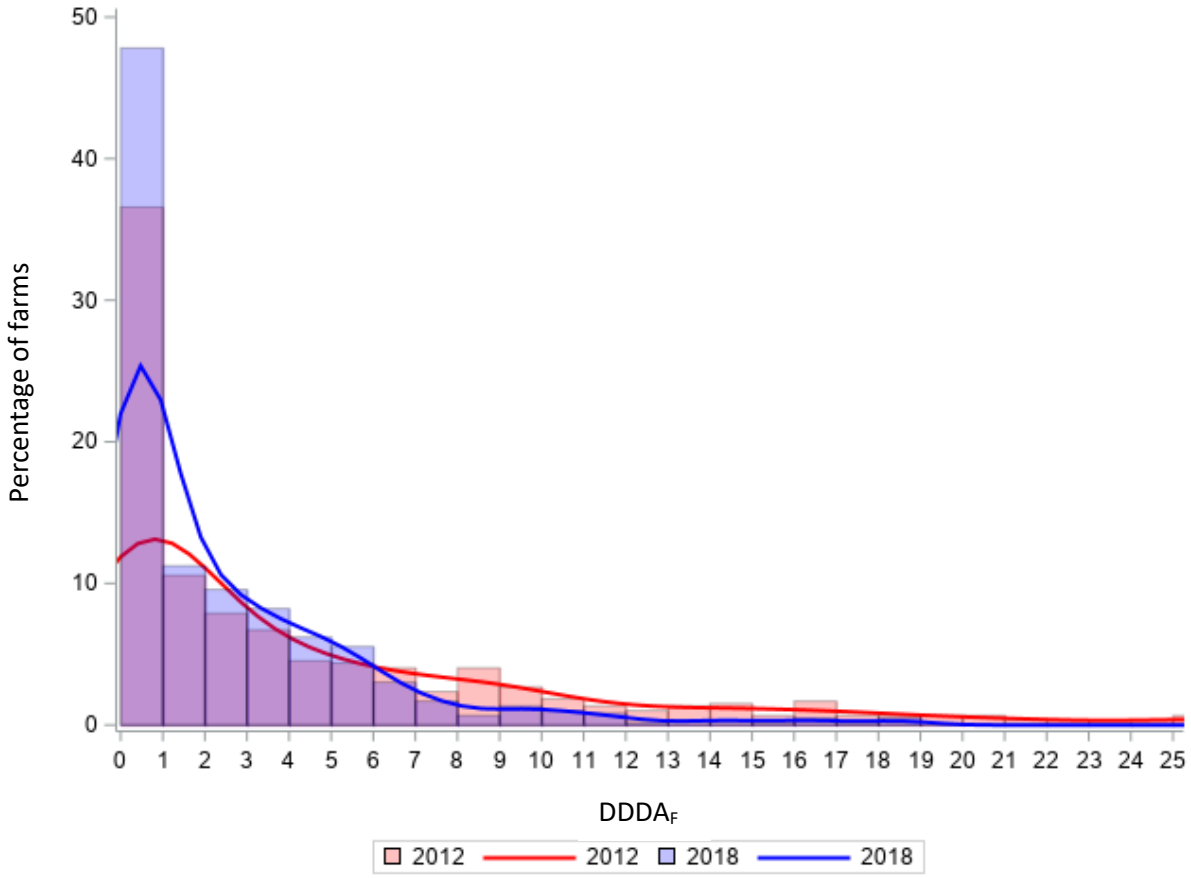


Figure A21. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.09. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

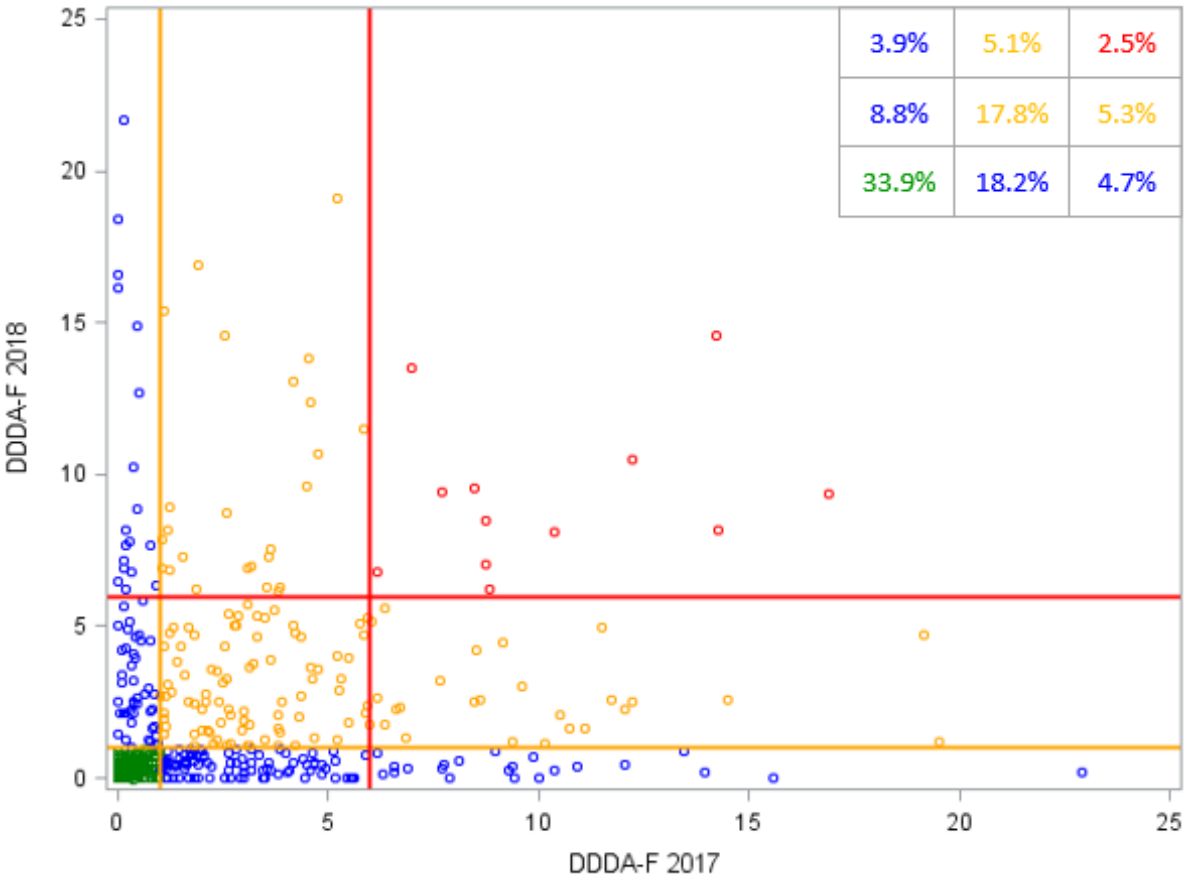


Table A24. Antibiotic use in $DDDA_F$ at rosé veal fattening farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	96	0.30	0.61	0.48
1st choice	Macrolides/lincosamides	Oral	577	0.00	0.00	0.03
1st choice	Macrolides/lincosamides	Parenteral	453	0.00	0.00	0.03
1st choice	Penicillins	Parenteral	248	0.05	0.17	0.14
1st choice	Tetracyclines	Oral	366	0.00	1.82	1.39
1st choice	Tetracyclines	Parenteral	536	0.00	0.00	0.02
1st choice	Trimethoprim/sulfonamides	Oral	477	0.00	0.00	0.45
1st choice	Trimethoprim/sulfonamides	Parenteral	506	0.00	0.00	0.01
2nd choice	Aminoglycosides	Oral	600	0.00	0.00	0.01
2nd choice	Aminoglycosides	Parenteral	595	0.00	0.00	0.01
2nd choice	Quinolones	Oral	600	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	580	0.00	0.00	0.00
2nd choice	Macrolides/lincosamides	Parenteral	415	0.00	0.07	0.12
2nd choice	Penicillins	Oral	597	0.00	0.00	0.01
2nd choice	Penicillins	Parenteral	408	0.00	0.02	0.03
2nd choice	Polymyxins	Parenteral	598	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	595	0.00	0.00	0.00

Rosé veal combination farms

Number of rosé veal combination farms: 186
Number of rosé veal combination farms with $DDDA_F$=0: 1
Number of rosé veal combination farms that used third- and fourth-generation cephalosporins: 0
Number of rosé veal combination farms that used fluoroquinolones: 14

Table A25. Antibiotic use in $DDDA_F$ at rosé veal combination farms from 2011 to 2018*

Year	N	Mean	Median	P75	P90
2011	313	34.6	17.3	29.7	45.7
2012	365	21.5	13.2	23.7	37.4
2013	276	11.7	10.1	16.2	23.8
2014	215	13.0	12.0	17.1	21.9
2015	238	11.8	11.2	16.2	21.4
2016	229	11.1	11.3	16.6	20.6
2017	212	12.8	12.6	17.3	22.6
2018	186	14.8	14.1	18.1	21.9

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A22. 2012 and 2018 $DDDA_F$ distributions for rosé veal combination farms

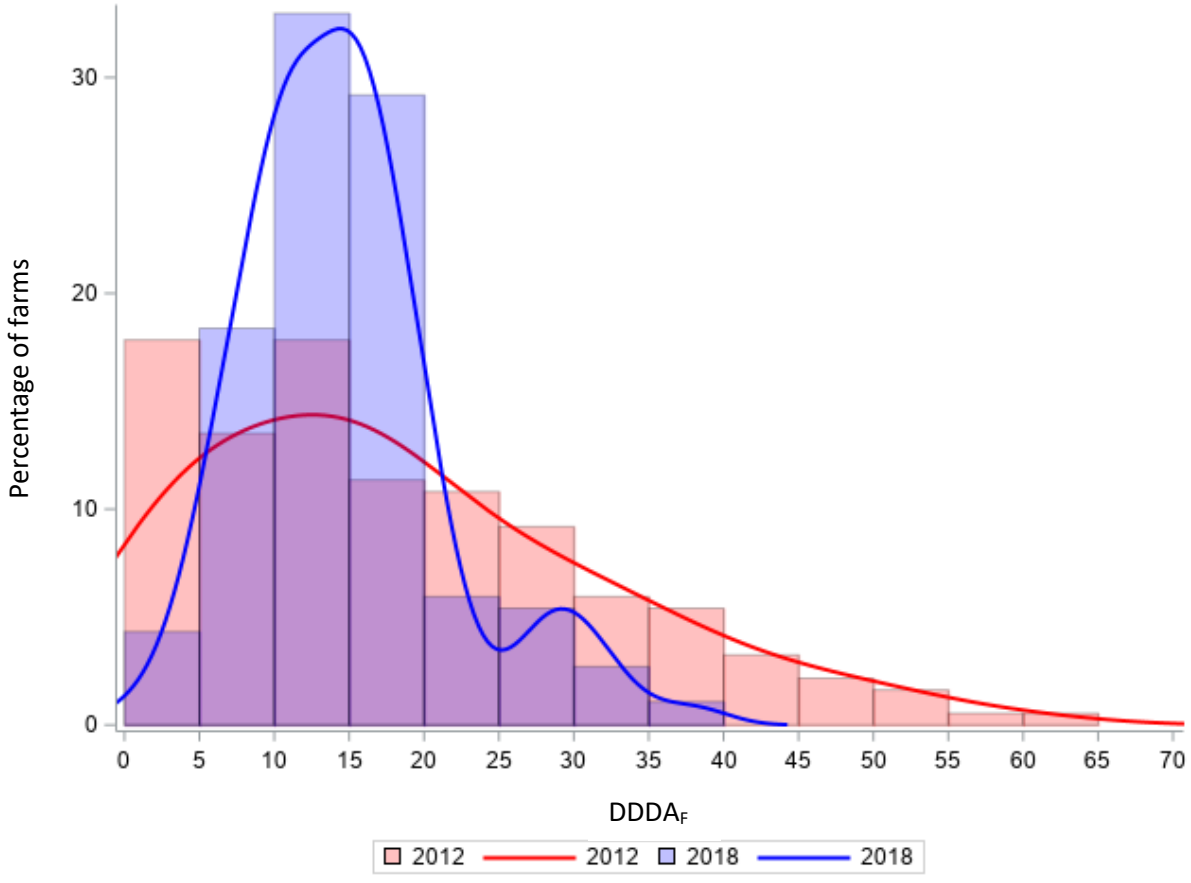


Figure A23. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.49. The orange and red lines represent the signaling and action thresholds, respectively. The table in the upper-right corner shows the percentage of farms for each of the fields

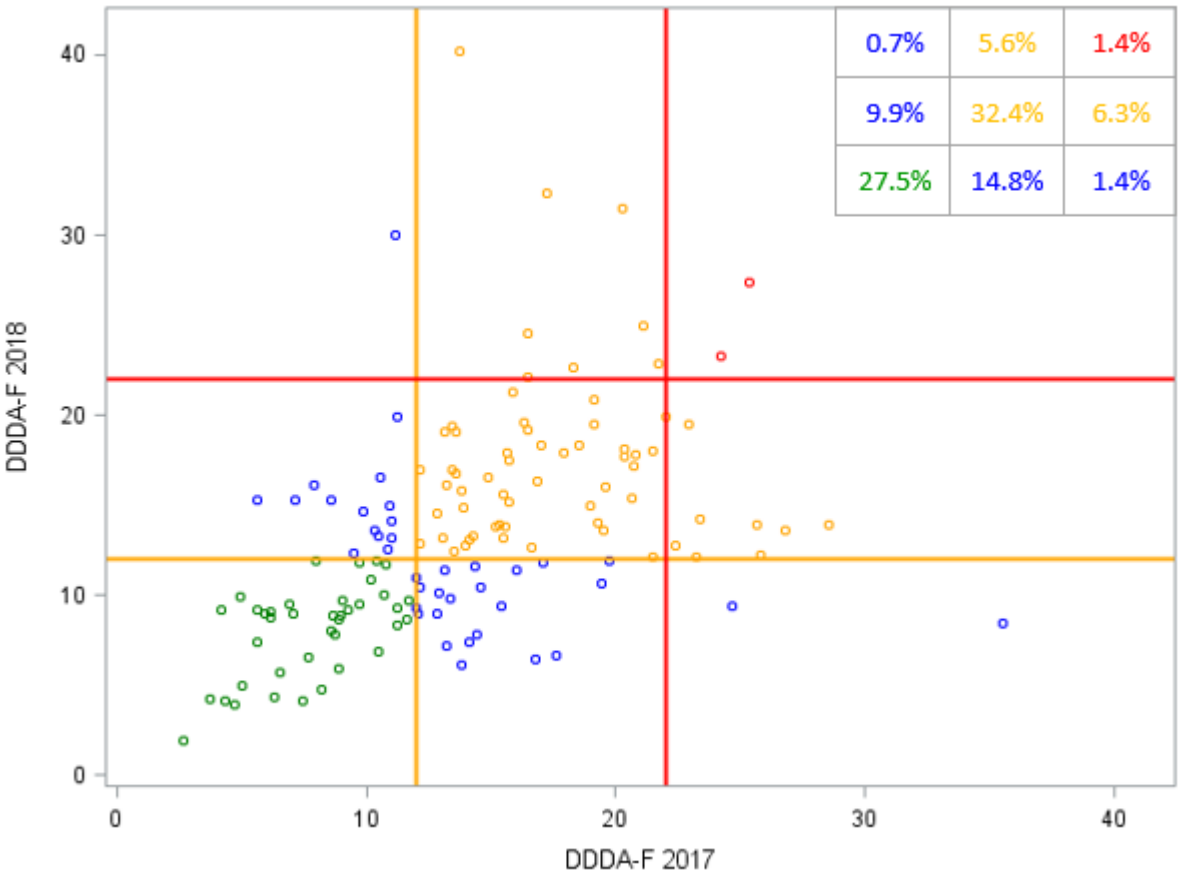


Table A26. Antibiotic use in $DDDA_F$ at rosé veal combination farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	2	1.30	1.90	1.55
1st choice	Macrolides/lincosamides	Oral	27	2.39	3.04	2.31
1st choice	Macrolides/lincosamides	Parenteral	62	0.02	0.07	0.19
1st choice	Penicillins	Parenteral	8	0.28	0.58	0.55
1st choice	Tetracyclines	Oral	5	7.50	9.56	7.79
1st choice	Tetracyclines	Parenteral	129	0.00	0.02	0.03
1st choice	Trimethoprim/sulfonamides	Oral	66	0.48	1.48	1.10
1st choice	Trimethoprim/sulfonamides	Parenteral	58	0.02	0.07	0.05
2nd choice	Aminoglycosides	Oral	104	0.00	0.04	0.10
2nd choice	Aminoglycosides	Parenteral	117	0.00	0.04	0.05
2nd choice	Quinolones	Oral	162	0.00	0.00	0.09
2nd choice	Fixed-dose combinations	Parenteral	164	0.00	0.00	0.01
2nd choice	Macrolides/lincosamides	Parenteral	43	0.20	0.46	0.36
2nd choice	Penicillins	Oral	109	0.00	0.35	0.42
2nd choice	Penicillins	Parenteral	28	0.06	0.13	0.12
2nd choice	Polymyxins	Oral	184	0.00	0.00	0.02
2nd choice	Polymyxins	Parenteral	178	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	184	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	173	0.00	0.00	0.01

Antibiotic use in $DDDA_F$ at cattle farms

Dairy cattle farms

Number of dairy cattle farms: 16,499
Number of dairy cattle farms with $DDDA_F$=0: 305
Number of dairy cattle farms that used third- and fourth-generation cephalosporins: 177
Number of dairy cattle farms that used fluoroquinolones: 903

Table A27. Antibiotic use at dairy cattle farms from 2012 to 2018, presented as overall antibiotic use (A), use of dry cow (intramammary) antibiotics (B), use of mastitis injectors (C), and use of oral antibiotics in calves (D)

A **Overall antibiotic use, in $DDDA_F$**

Year	N	Mean	Median	P75	P90
2012	18,053	2.9	2.7	3.8	4.9
2013	18,005	2.8	2.8	3.7	4.7
2014	17,747	2.3	2.2	3.0	3.9
2015	17,737	2.2	2.1	2.9	3.7
2016	17,529	2.1	2.1	2.9	3.7
2017	17,121	2.1	2.1	2.9	3.8
2018	16,499	2.1	2.1	2.9	3.8

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

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

N	Mean	Median	P75	P90
16,499	1.1	1.1	1.8	2.4

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

N	Mean	Median	P75	P90
16,499	0.6	0.5	0.9	1.4

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

N	Mean	Median	P75	P90
16,499	2.5	0.0	0.0	5.6

Figure A24. 2012 and 2018 $DDDA_F$ distributions for dairy cattle farms

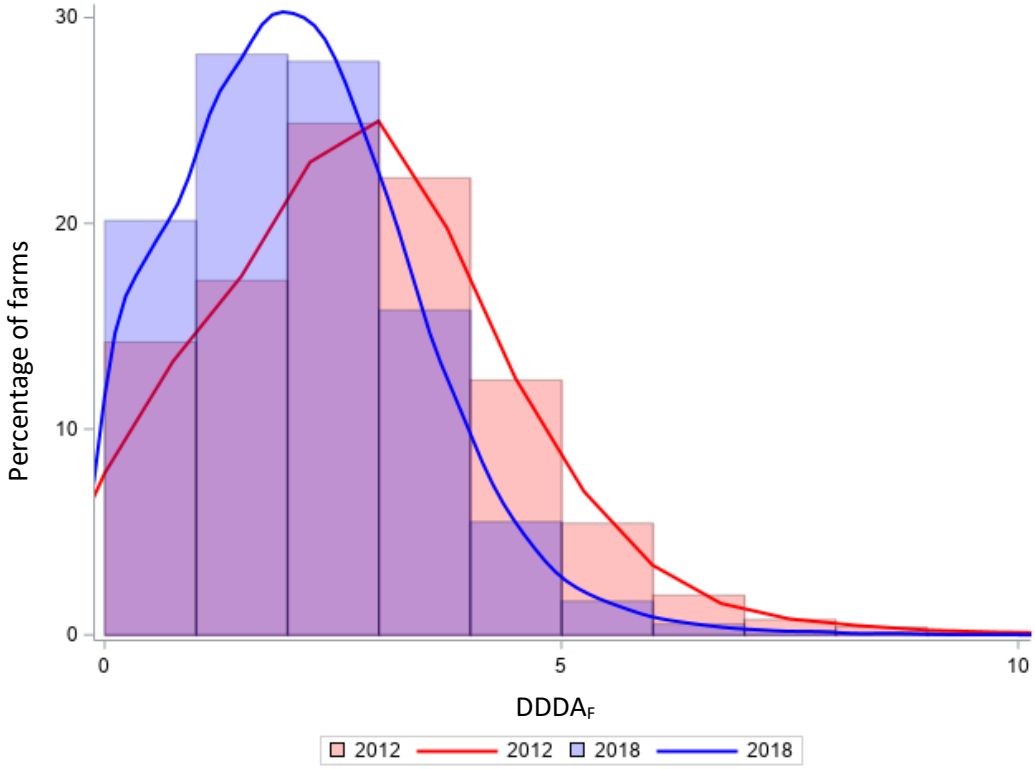


Figure A25. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.73. The orange line represents the signaling threshold. The table in the upper-right corner shows the percentage of farms for each of the fields

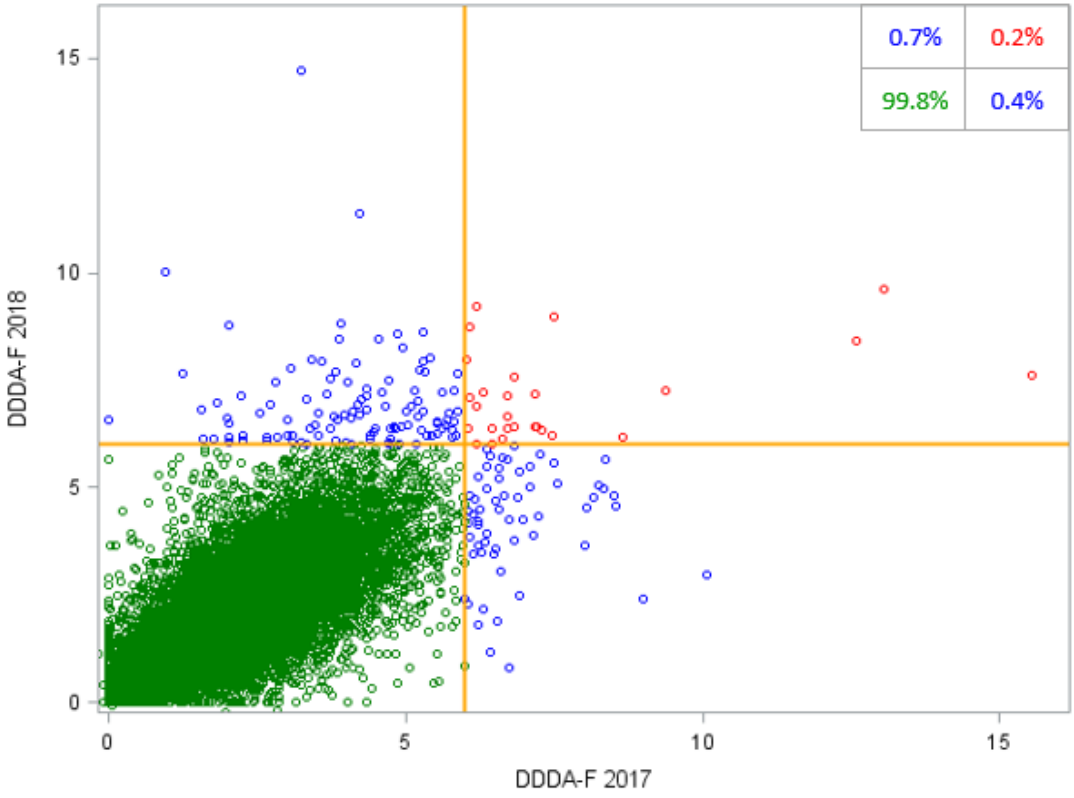


Table A28. Antibiotic use in $DDDA_F$ at dairy cattle farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	9,606	0.00	0.04	0.03
1st choice	Macrolides/lincosamides	Intramammary	16,488	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Oral	16,480	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Parenteral	12,401	0.00	0.00	0.04
1st choice	Penicillins	Intramammary	11,023	0.00	0.19	0.16
1st choice	Penicillins	Intramammary for dry cow therapy	3,536	0.83	1.40	0.89
1st choice	Penicillins	Parenteral	3,732	0.10	0.26	0.20
1st choice	Tetracyclines	Oral	16,167	0.00	0.00	0.00
1st choice	Tetracyclines	Parenteral	3,532	0.10	0.22	0.16
1st choice	Tetracyclines	Intrauterine	8,138	0.00	0.08	0.05
1st choice	Trimethoprim/sulfonamides	Oral	15,098	0.00	0.00	0.00
1st choice	Trimethoprim/sulfonamides	Parenteral	3,116	0.10	0.21	0.16
2nd choice	Aminoglycosides	Oral	14,891	0.00	0.00	0.01
2nd choice	Aminoglycosides	Parenteral	16,123	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intramammary	15,668	0.00	0.00	0.01
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	12,504	0.00	0.00	0.01
2nd choice	Quinolones	Oral	16,479	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Intramammary	8,753	0.00	0.22	0.16
2nd choice	Fixed-dose combinations	Intramammary for dry cow therapy	16,079	0.00	0.00	0.02
2nd choice	Fixed-dose combinations	Parenteral	12,658	0.00	0.00	0.02
2nd choice	Macrolides/lincosamides	Parenteral	14,839	0.00	0.00	0.01
2nd choice	Penicillins	Intramammary	6,094	0.09	0.27	0.18
2nd choice	Penicillins	Oral	16,498	0.00	0.00	0.00
2nd choice	Penicillins	Intramammary for dry cow therapy	16,490	0.00	0.00	0.00
2nd choice	Penicillins	Parenteral	9,344	0.00	0.05	0.04
2nd choice	Polymyxins	Oral	16,401	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	16,247	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Intramammary	16,332	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Intramammary for dry cow therapy	16,498	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Parenteral	16,482	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	16,498	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	15,596	0.00	0.00	0.00

Suckler cow farms

Number of suckler cow farms: 8,932
Number of suckler cow farms with $DDDA_F$=0: 4,573
Number of suckler cow farms that used third- and fourth-generation cephalosporins: 1
Number of suckler cow farms that used fluoroquinolones: 59

Table A29. Antibiotic use in $DDDA_F$ at suckler cow farms from 2012 to 2018*

Year	N	Mean	Median	P75	P90
2012	11,927	0.9	0.0	0.6	2.0
2013	9,857	0.7	0.1	0.8	2.2
2014	9,588	0.7	0.1	0.7	2.0
2015	9,305	0.6	0.1	0.7	2.0
2016	9,067	0.6	0.1	0.7	1.9
2017	9,351	0.5	0.0	0.6	1.7
2018	8,932	0.6	0.0	0.6	1.8

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A26. 2012 and 2018 $DDDA_F$ distributions for suckler cow farms (no probability density functions can be shown due to too little variation)

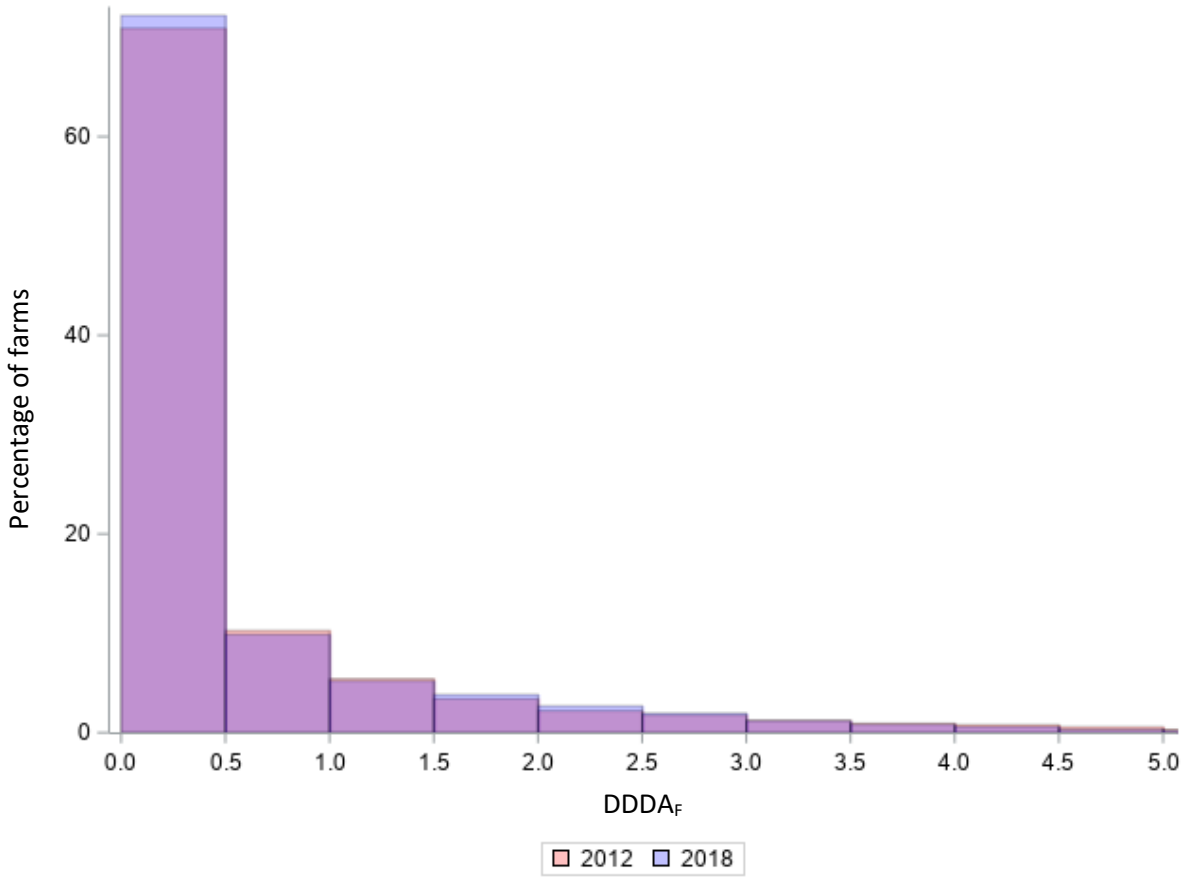


Figure A27. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.43. The orange line represents the signaling threshold. The table in the upper-right corner shows the percentage of farms for each of the fields

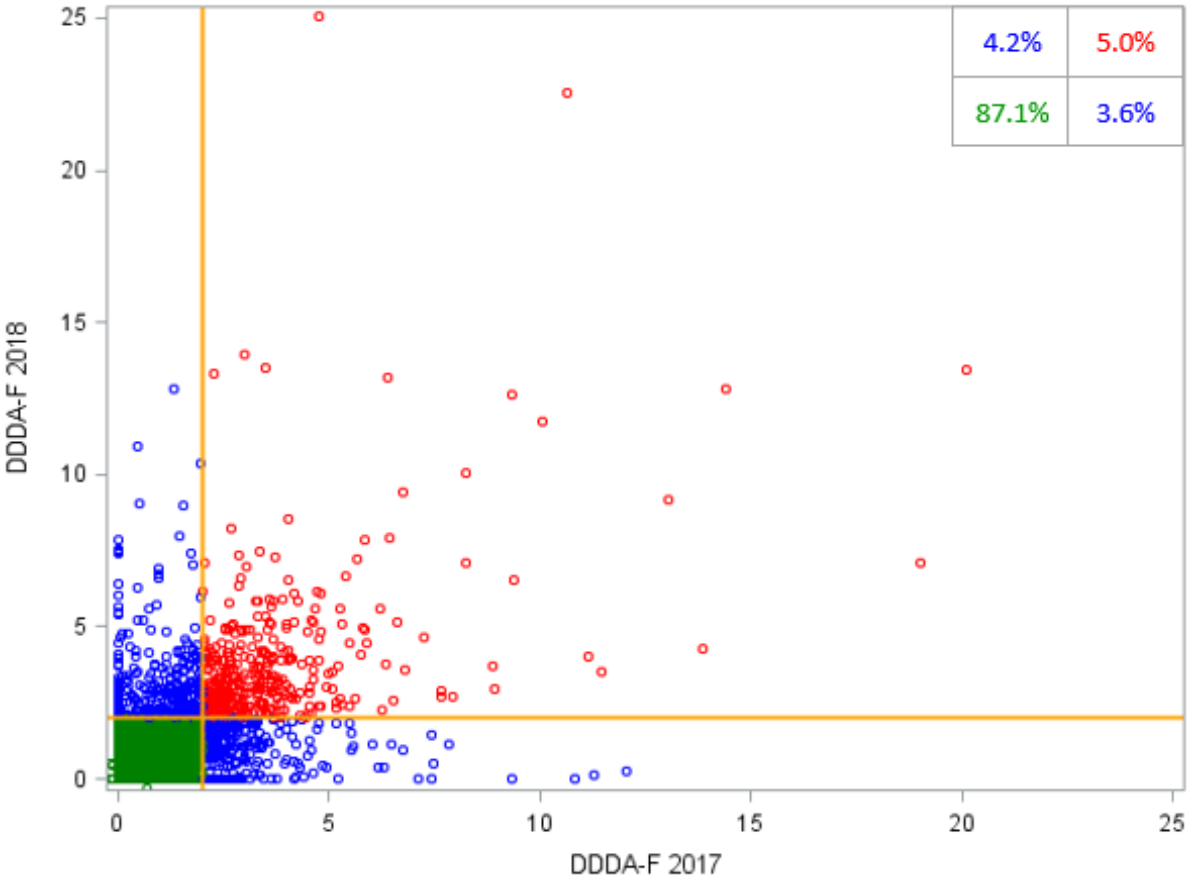


Table A30. Antibiotic use in $DDDA_F$ at suckler cow farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	7,685	0.00	0.00	0.04
1st choice	Macrolides/lincosamides	Intramammary	8,931	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Oral	8,927	0.00	0.00	0.00
1st choice	Macrolides/lincosamides	Parenteral	8,588	0.00	0.00	0.01
1st choice	Penicillins	Intramammary	8,859	0.00	0.00	0.01
1st choice	Penicillins	Intramammary for dry cow therapy	8,642	0.00	0.00	0.05
1st choice	Penicillins	Parenteral	6,616	0.00	0.04	0.19
1st choice	Tetracyclines	Oral	8,885	0.00	0.00	0.00
1st choice	Tetracyclines	Parenteral	7,491	0.00	0.00	0.09
1st choice	Tetracyclines	Intrauterine	7,588	0.00	0.00	0.03
1st choice	Trimethoprim/sulfonamides	Oral	8,796	0.00	0.00	0.00
1st choice	Trimethoprim/sulfonamides	Parenteral	7,889	0.00	0.00	0.02
2nd choice	Aminoglycosides	Oral	8,861	0.00	0.00	0.00
2nd choice	Aminoglycosides	Parenteral	8,869	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intramammary	8,906	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	8,824	0.00	0.00	0.00
2nd choice	Quinolones	Oral	8,931	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Intramammary	8,744	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Intramammary for dry cow therapy	8,917	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	7,888	0.00	0.00	0.08
2nd choice	Macrolides/lincosamides	Parenteral	8,496	0.00	0.00	0.03
2nd choice	Penicillins	Intramammary	8,635	0.00	0.00	0.01
2nd choice	Penicillins	Oral	8,926	0.00	0.00	0.00
2nd choice	Penicillins	Parenteral	7,810	0.00	0.00	0.05
2nd choice	Polymyxins	Oral	8,925	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	8,888	0.00	0.00	0.00
3rd choice	3rd- and 4th-gen. cephalosporins	Intramammary	8,931	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	8,930	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	8,874	0.00	0.00	0.00

Rearing farms

Number of rearing farms: 544
Number of rearing farms with $DDDA_F$=0: 409
Number of rearing farms that used third- and fourth-generation cephalosporins: 0
Number of rearing farms that used fluoroquinolones: 3

Table A31. Antibiotic use in $DDDA_F$ at rearing farms from 2013 to 2018*

Year	N	Mean	Median	P75	P90
2012**	-	-	-	-	-
2013	472	1.1	0.0	0.2	2.3
2014	474	1.4	0.0	0.2	1.8
2015	470	0.8	0.0	0.2	1.7
2016	435	0.8	0.0	0.1	1.3
2017	520	1.0	0.0	0.0	1.6
2018	544	1.0	0.0	0.0	1.4

* Only years for which similar $DDDA_F$ calculation methods were used have been included.
** Rearing and beef farms were grouped together for 2012, as the available data did not allow for categorization based on sex.

Figure A28. 2013 and 2018 $DDDA_F$ distributions for rearing farms (no probability density functions can be shown due to too little variation)

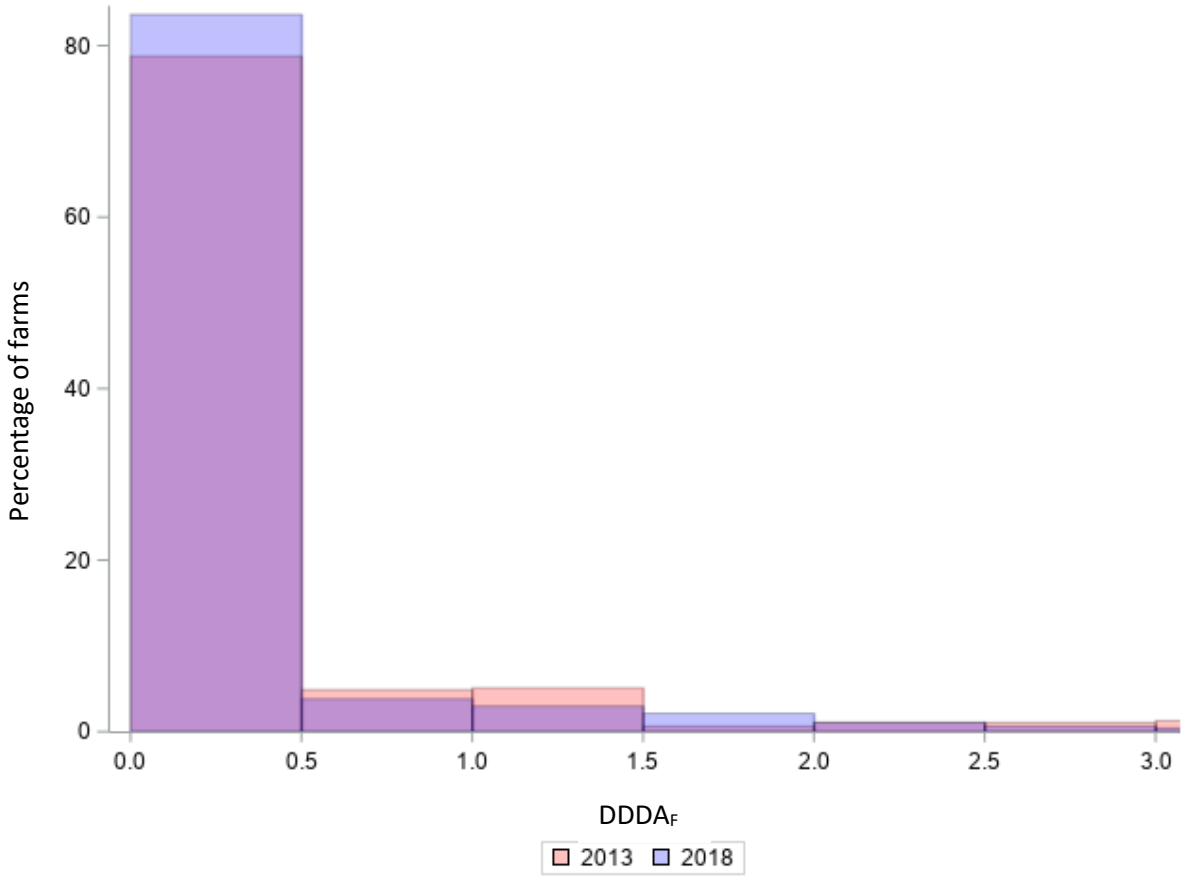


Figure A29. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.82. The orange line represents the signaling threshold. The table in the upper-right corner shows the percentage of farms for each of the fields

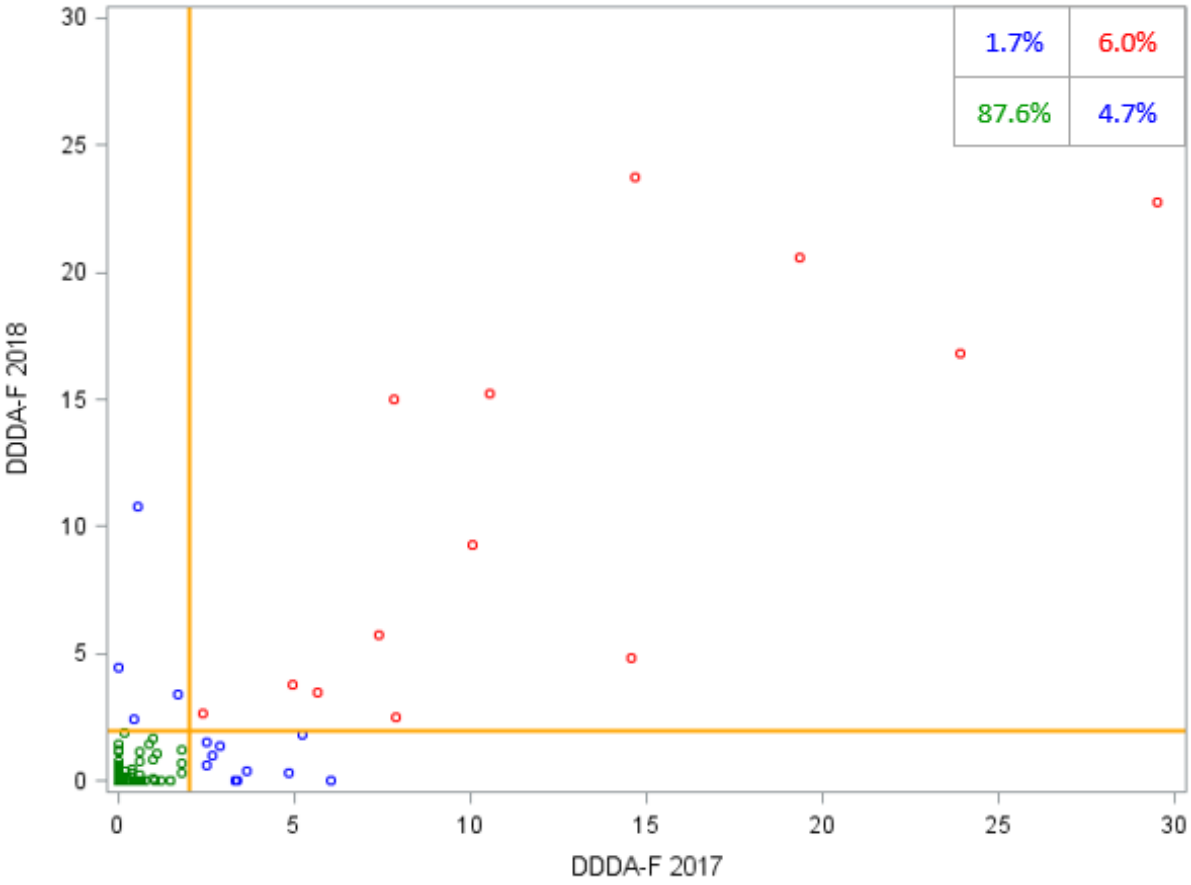


Table A32. Antibiotic use in $DDDA_F$ at rearing farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	461	0.00	0.00	0.13
1st choice	Macrolides/lincosamides	Oral	527	0.00	0.00	0.10
1st choice	Macrolides/lincosamides	Parenteral	518	0.00	0.00	0.01
1st choice	Penicillins	Parenteral	492	0.00	0.00	0.06
1st choice	Tetracyclines	Oral	517	0.00	0.00	0.49
1st choice	Tetracyclines	Parenteral	518	0.00	0.00	0.02
1st choice	Trimethoprim/sulfonamides	Oral	543	0.00	0.00	0.00
1st choice	Trimethoprim/sulfonamides	Parenteral	530	0.00	0.00	0.05
2nd choice	Aminoglycosides	Oral	512	0.00	0.00	0.04
2nd choice	Aminoglycosides	Parenteral	539	0.00	0.00	0.01
2nd choice	Quinolones	Oral	541	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Parenteral	542	0.00	0.00	0.01
2nd choice	Macrolides/lincosamides	Parenteral	538	0.00	0.00	0.00
2nd choice	Penicillins	Intramammary	513	0.00	0.00	0.04
2nd choice	Penicillins	Oral	543	0.00	0.00	0.00
2nd choice	Penicillins	Parenteral	536	0.00	0.00	0.05
2nd choice	Polymyxins	Oral	528	0.00	0.00	0.01
2nd choice	Polymyxins	Parenteral	543	0.00	0.00	0.01
3rd choice	Fluoroquinolones	Parenteral	541	0.00	0.00	0.00

Beef farms

Number of beef farms: 2,852
Number of beef farms with $DDDA_F$=0: 1,900
Number of beef farms that used third- and fourth-generation cephalosporins: 0
Number of beef farms that used fluoroquinolones: 19

Table A33. Antibiotic use in $DDDA_F$ at beef farms from 2013 to 2018*

Year	N	Mean	Median	P75	P90
2012**	-	-	-	-	-
2013	3,316	1.8	0.0	0.6	4.2
2014	3,297	1.7	0.0	0.5	4.4
2015	3,196	1.5	0.0	0.4	2.9
2016	3,046	1.6	0.0	0.4	2.9
2017	2,919	1.3	0.0	0.3	2.3
2018	2,852	1.3	0.0	0.3	2.2

* Only years for which similar $DDDA_F$ calculation methods were used have been included.
** Rearing and beef farms were grouped together for 2012, as the available data did not allow for categorization based on sex.

Figure A30. 2013 and 2018 $DDDA_F$ distributions for beef farms (no probability density functions can be shown due to too little variation)

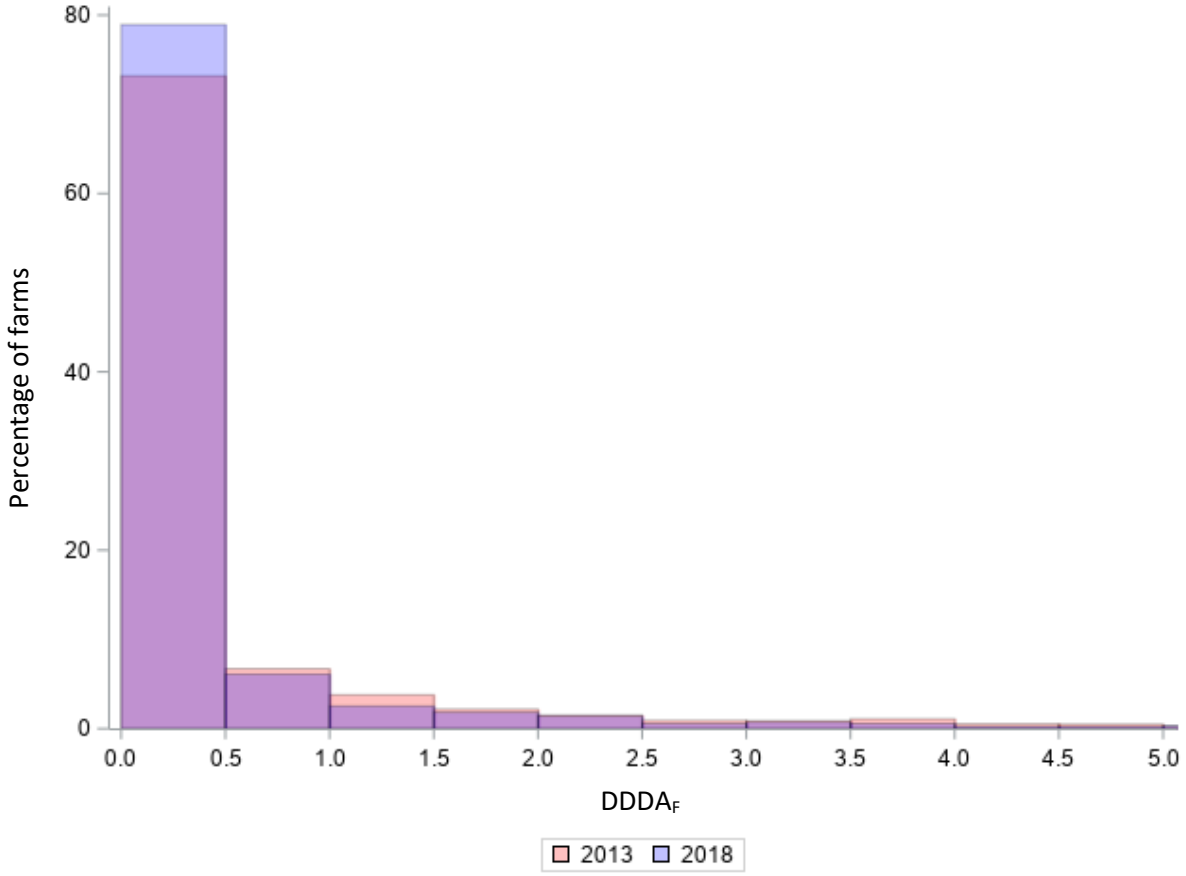


Figure A31. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.61. The orange line represents the signaling threshold. The table in the upper-right corner shows the percentage of farms for each of the fields

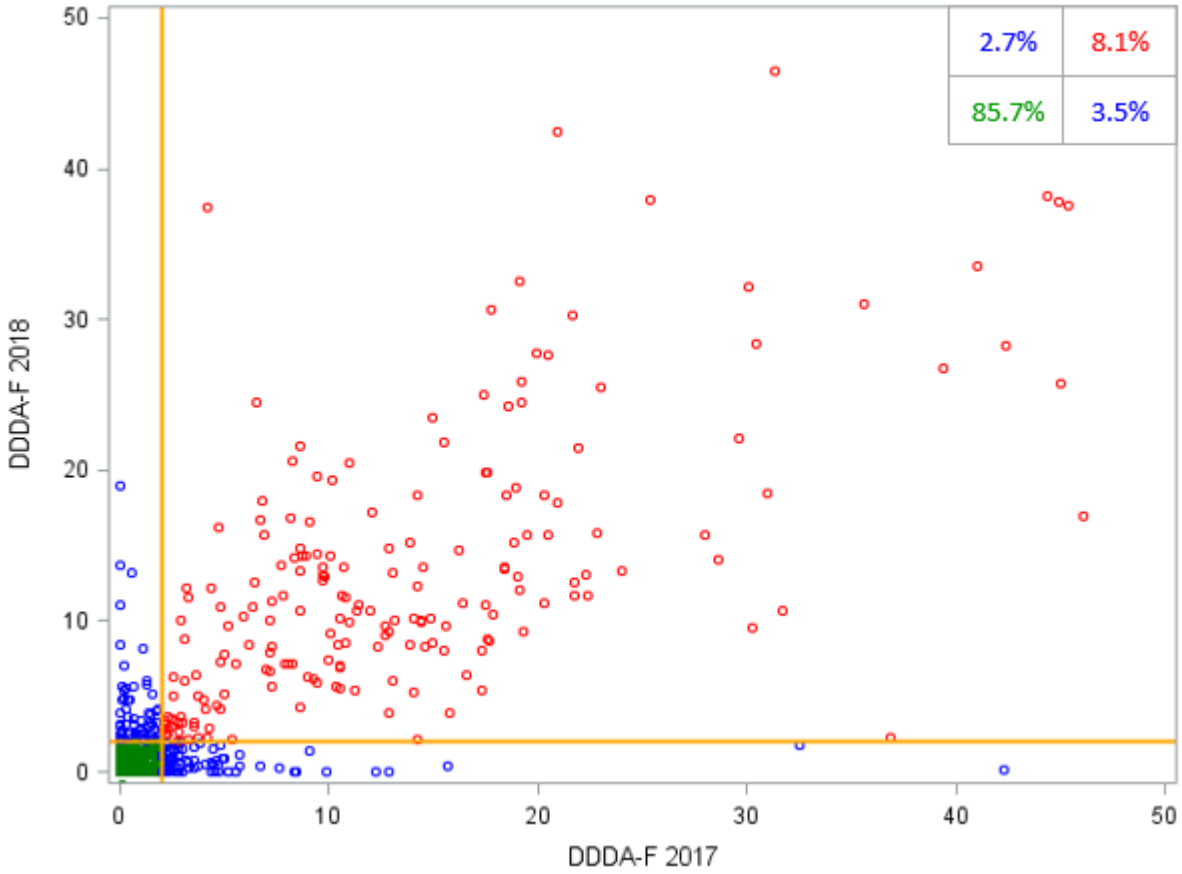


Table A34. Antibiotic use in $DDDA_F$ at beef farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Amphenicols	Parenteral	2,221	0.00	0.00	0.16
1st choice	Macrolides/lincosamides	Oral	2,690	0.00	0.00	0.18
1st choice	Macrolides/lincosamides	Parenteral	2,635	0.00	0.00	0.01
1st choice	Penicillins	Intramammary	2,850	0.00	0.00	0.00
1st choice	Penicillins	Intramammary for dry cow therapy	2,827	0.00	0.00	0.00
1st choice	Penicillins	Parenteral	2,308	0.00	0.00	0.10
1st choice	Tetracyclines	Oral	2,609	0.00	0.00	0.58
1st choice	Tetracyclines	Parenteral	2,544	0.00	0.00	0.04
1st choice	Tetracyclines	Intrauterine	2,751	0.00	0.00	0.01
1st choice	Trimethoprim/sulfonamides	Oral	2,749	0.00	0.00	0.08
1st choice	Trimethoprim/sulfonamides	Parenteral	2,578	0.00	0.00	0.01
2nd choice	Aminoglycosides	Oral	2,770	0.00	0.00	0.01
2nd choice	Aminoglycosides	Parenteral	2,811	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intramammary	2,851	0.00	0.00	0.00
2nd choice	1st- and 2nd-gen. cephalosporins	Intrauterine	2,850	0.00	0.00	0.00
2nd choice	Quinolones	Oral	2,839	0.00	0.00	0.01
2nd choice	Fixed-dose combinations	Intramammary	2,840	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Intramammary for dry cow therapy	2,851	0.00	0.00	0.00
2nd choice	Fixed-dose combinations	Parenteral	2,721	0.00	0.00	0.02
2nd choice	Macrolides/lincosamides	Parenteral	2,594	0.00	0.00	0.04
2nd choice	Penicillins	Intramammary	2,829	0.00	0.00	0.00
2nd choice	Penicillins	Oral	2,791	0.00	0.00	0.04
2nd choice	Penicillins	Parenteral	2,552	0.00	0.00	0.02
2nd choice	Polymyxins	Oral	2,851	0.00	0.00	0.00
2nd choice	Polymyxins	Parenteral	2,842	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Oral	2,851	0.00	0.00	0.00
3rd choice	Fluoroquinolones	Parenteral	2,834	0.00	0.00	0.00

Antibiotic use in $DDDA_F$ at rabbit farms

Rabbit farms

Number of rabbit farms: 40
Number of rabbit farms with $DDDA_F$=0: 2
Number of rabbit farms that used third- and fourth-generation cephalosporins: 0
Number of rabbit farms that used fluoroquinolones: 2

Table A35. Antibiotic use in $DDDA_F$ at rabbit farms from 2016 to 2018*

Year	N	Mean	Median	P75	P90
2016	41	40.9	31.8	60.3	84.4
2017	49	25.4	21.7	37.9	49.4
2018	40	47.9	44.2	61.1	96.3

* Only years for which similar $DDDA_F$ calculation methods were used have been included.

Figure A32. 2016 and 2018 $DDDA_F$ distributions for rabbit farms

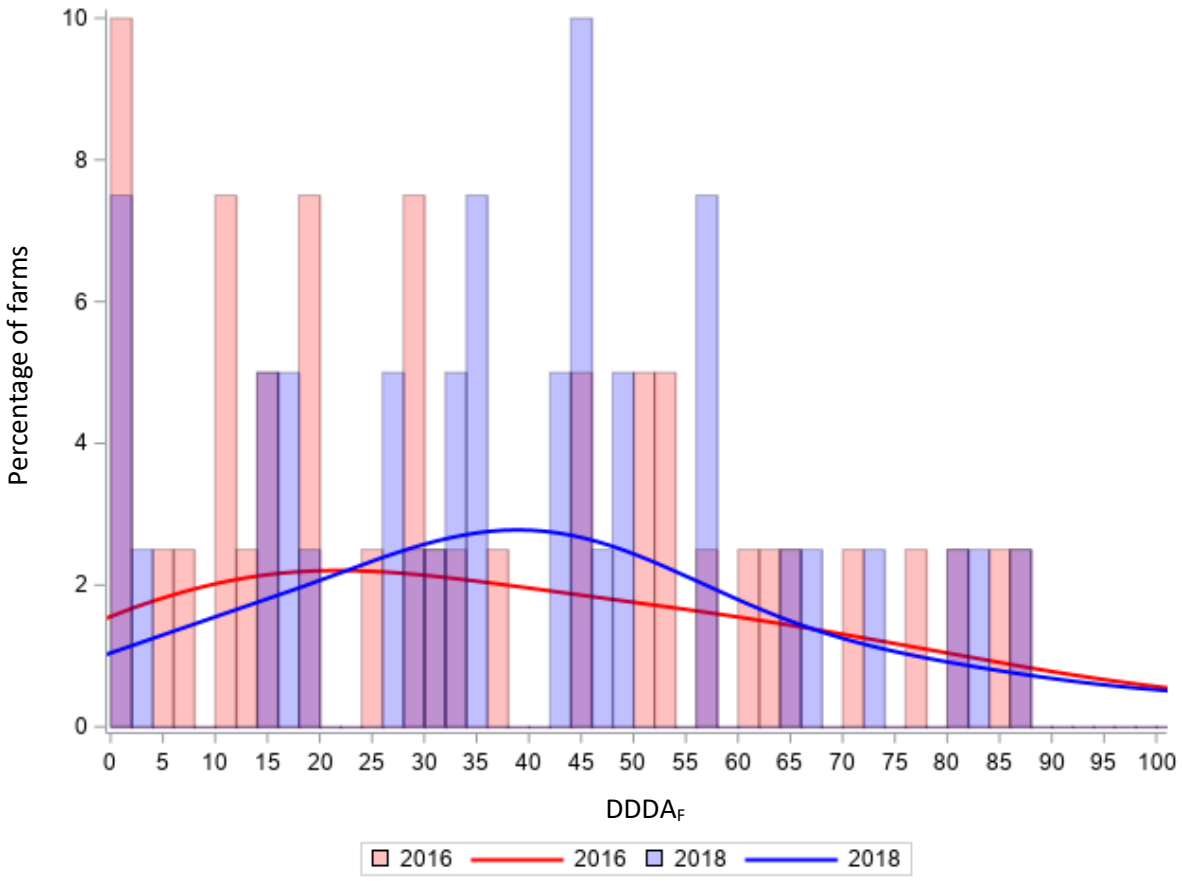


Figure A33. Scatter plot of 2017 and 2018 $DDDA_F$ values, with a correlation coefficient of 0.43

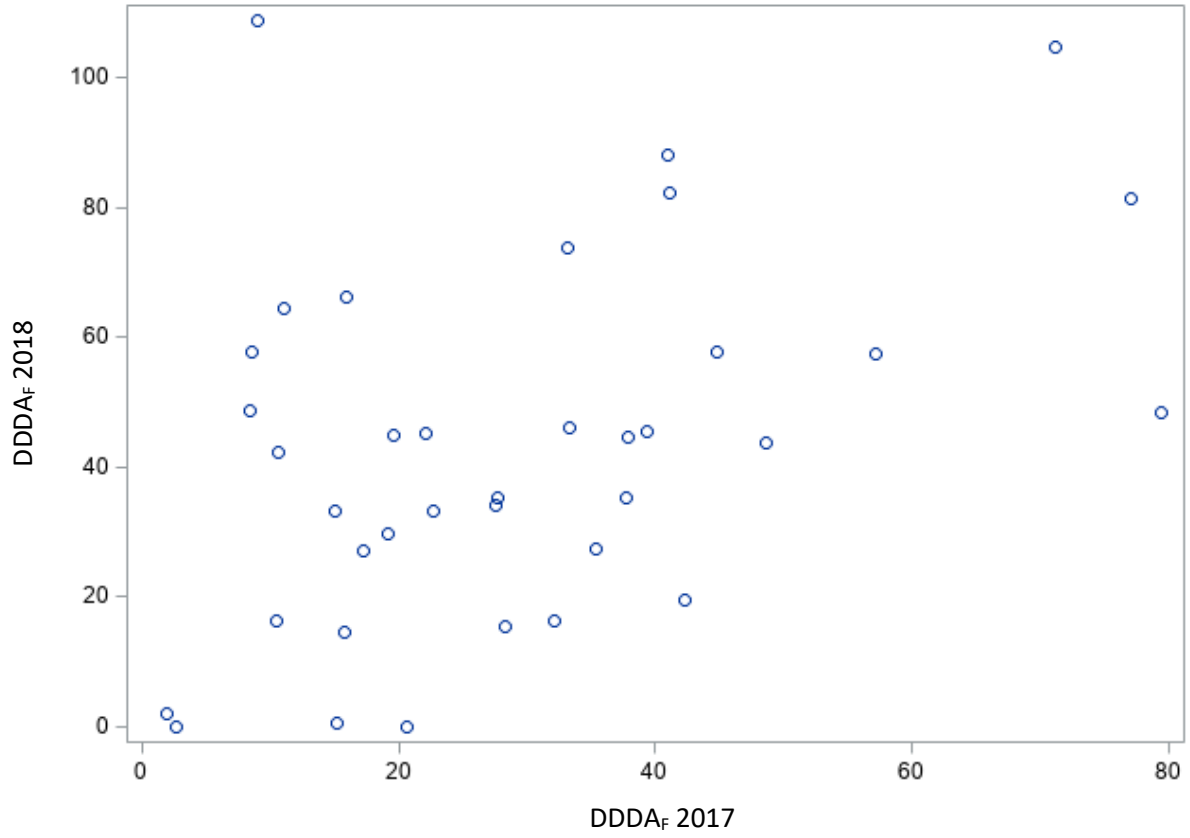


Table A36. Antibiotic use in $DDDA_F$ at rabbit farms in 2018, by pharmacotherapeutic group and route of administration

Category of antibiotics	Pharmacotherapeutic group	Route of administration	# of farms with $DDDA_F$=0	$DDDA_F$		
				Median	P75	Mean
1st choice	Macrolides/lincosamides	Oral	28	0.00	0.11	2.20
1st choice	Other	Oral	7	13.51	24.98	17.97
1st choice	Penicillins	Parenteral	39	0.00	0.00	0.00
1st choice	Pleuromutilins	Oral	19	0.79	5.54	3.73
1st choice	Pleuromutilins	Parenteral	39	0.00	0.00	0.00
1st choice	Tetracyclines	Oral	19	2.95	16.14	9.90
1st choice	Tetracyclines	Parenteral	19	0.11	0.92	1.06
1st choice	Trimethoprim/sulfonamides	Oral	34	0.00	0.00	0.22
1st choice	Trimethoprim/sulfonamides	Parenteral	39	0.00	0.00	0.01
2nd choice	Aminoglycosides	Oral	9	6.83	16.87	11.88
2nd choice	Macrolides/lincosamides	Parenteral	38	0.00	0.00	0.36
2nd choice	Polymyxins	Oral	38	0.00	0.00	0.26
3rd choice	Fluoroquinolones	Oral	37	0.00	0.00	0.32

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Trends and benchmarking of livestock farms and veterinarians
SDa/1153/2019
The Netherlands Veterinary Medicines Institute, 2019