Gives a higher administration of antibiotics a better herd performance in dairy cattle?

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Introduction

In the past decade a big discussion is raised about the use of antibiotics in livestock in the Netherlands. The main cause of this discussion is the increase of antibiotic-resistant bacteria. The fear that some antibiotics would be less or even not effective for ill people or animals became a big issue in the public debate. In 2008, 23 parties in the private industry in different livestock sectors signed an agreement to reduce the use of antibiotics in livestock [1]. One of the ingredients of the agreement was to impose one-to-one relationships between practicing veterinarians and farmers. So the farmers are only allowed to get their antibiotics prescribed at their linked veterinary practice. This rule is implemented by the sector since January 1st 2012. The one-to-one relation gives the opportunity to see the total amount of antibiotics the farmers use and makes the practicing veterinarians also partly responsible for the antibiotic use.

The use of antibiotics is thought to relate to herd performance indicators. This would mean that herd performance indicators should be better or worse when there are more antibiotics used. For example, when the agreement to reduce the use of antibiotics was made, people were afraid that the reduce in antibiotic use would cause an increase in percentage culled animals or percentage dead animals in the herd, because farmers would probably choose sooner to euthanize a cow instead of a treatment with antibiotics.

This study is aimed to see if there is a link between the use of antibiotics in 2011 and 2012 and to see if there is any link between the use of antibiotics and herd performance in dairy cattle.

Hypotheses

The study is divided in two main subjects: (1) the relation between the used antibiotics in 2011 and 2012 and (2) the relation between the use of antibiotics in 2012 and the herd performance in dairy cattle.

We expect that the use of antibiotics in 2012 is lower than in 2011, because the farmer and the veterinarian should be more aware of their use and should try to keep the antibiotic use as low as possible. At some farms, the use of antibiotics will be higher in 2012, as some farmers did not purchase all their antibiotics from one veterinarian in 2011 for example which has changed in 2012 due to the one-to-one relationships between practicing veterinarians and farmers.

With regard to the association between the use of antibiotics in 2012 and the herd performance we expect there will be a higher use of antibiotics on high producing herds, because they face more health issues or they use more antibiotics for e.g. dry cow therapy in order to prevent illness.

Material and methods

For this study we used data from the clients of 'de Universitaire landbouwhuisdierenpraktijk (ULP)'. The data about the use of antibiotics was collected from the AUV database. The use of antibiotics is expressed as animal daily dose per animal year (aDD/aY). ADD/aY is the total weight of treated animal in a year divided by the total mean weight of the herd in that year. The exact calculation of aDD/aY is in Appendix 1. The information about the herd performance indicators were collected from the Pir-DAP database(www.pir-dap.nl). The collection of the data and the analysis were done in Microsoft excel.

In the first part of the study, data from all the clients of the ULP from which the herd size, the antibiotic use of 2011 and 2012 and the route of administration was registered. These data were evaluated using basic descriptive statistics. The relationship between the use of antibiotics in 2011 and 2012 was analysed by using the R square.

For the second part of this study a selection of the clients of the ULP present in the Pir-DAP database was used. The relationship between the use of antibiotics in 2012 and several herd performance indicators were analysed using the R square.

All the data were checked and there were a few data removed from the dataset because they were unlikely outliers.

Results

At first, the data were checked for unlikely outliers. From 16 farmers were the data of aDD/aY in 2012 removed because they used less than 0,5 aDD/aY. The list of removed data is in Appendix 2.

The summary statistics of the aDD/aY and herd size are summarized in Table 1 to give a better view on the data used in this study.

Table 1: Summary statistics of the use of antibiotics in aDD/aY and the herdsize in 2011 and 2012.

	Mean	Median	Minimum	Maximum	n
Herdsize 2012	75	67	16	356	347
Herdsize 2011	75	69	16	336	347
aDD/aY 2012	3,9	3,9	0,5	9,4	330
aDD/aY 2011	4,2	4,2	0,0	14,5	346
In-/decrease in aDD/aY*	-0,5	-0,4	-7,6	4,5	330
Percentage in-/decrease*	20,3	-9,8	-82,6	1922,2	327

*Negative values are a decrease and positive values are an increase.

We found a moderate association between the aDD/aY in 2011 and 2012 (R^2=0,46,Figure 1). The mean aDD/aY in 2012 was lower than the use in 2011 with a mean of 3,9 and 4,4 aDD/aY respectively. The highest users of antibiotics used respectively 14,5 and 9,4 aDD/aY in 2011 and 2012. The analysis of the data shows that 61,2% of the farmers realized a decrease in aDD/aY in 2012 compared to the use in 2011. Only 9,4% of the farmers even realized a decrease of more than 2 aDD/aY. The mean decrease was 1,4 aDD/aY, with a range between 0 and 7,6 aDD/aY.

There was an increase in aDD/aY in 2012 in relation to 2011 in 38,8% of the farmers. Only a very small part of the farmers, 4,5%, had an increase of more than 2 aDD/aY. The mean increase was 1,0 aDD/aY with a range from 0 to 4,5 aDD/aY.

There is a mean increase of 20,3% in antibiotic use between 2012 and 2011 with a range between -82,6 and 1922,2% (n=327). This is the mean of the percentages calculated for individual farmers. This declares the positive value in the mean percentage in- and decrase while the absolute mean in- and decrease value is negative. In the group of farmers having an increase in antibiotic use was a mean increase of 96,2% with a range from 0,1 to 1922,2% (n=125). In this group were 18 farmers which more than doubled their antibiotic use in 2012 in comparison with 2011. In the group of farmers which had a decrease in antibiotic use was a mean decrease of 27,2% with a range from 0,4 to 82,6% (n=202).

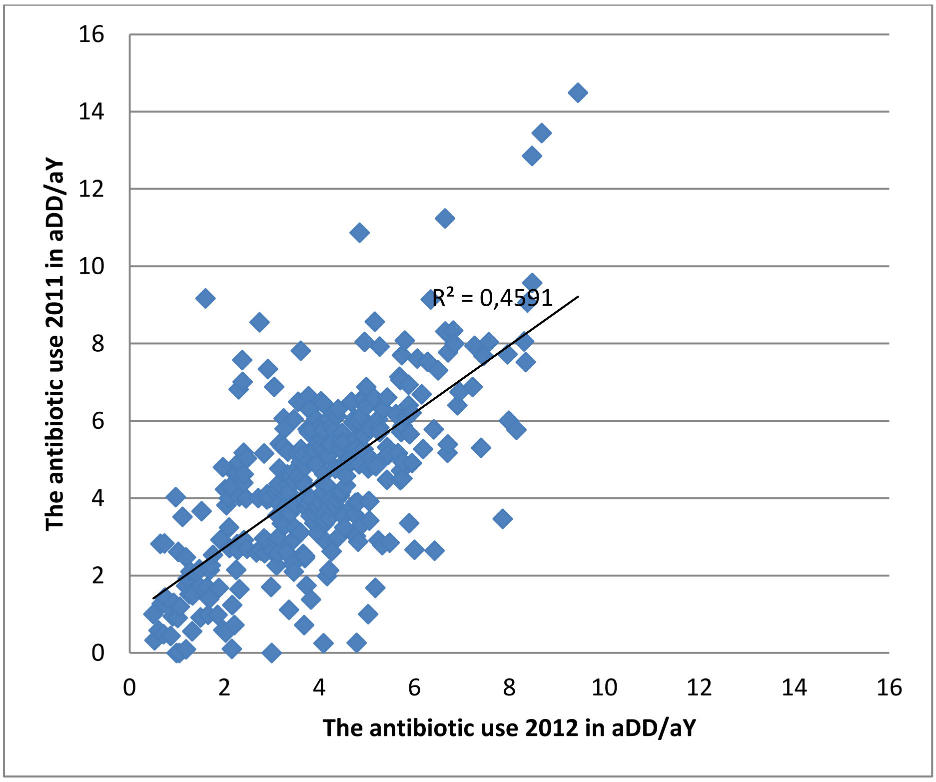

Figure 1: The relation between the antibiotic use in 2011 and 2012 in aDD/aY(n=330).

The mean decrease in aDD/aY of farms with different herd size is shown in figure 2. The group of farmers with 60 cows or less realized the biggest reduction of on average 0,85 aDD/Ay. The group of farmers with a herd size from 81 to 100 cows realized a reduction with a mean of 0,66 aDD/aY. The group of farmers with a herd size of more than 100 cows realized a reduction with a mean of 0,36 aDD/aY. The group of farmers with a herd size from 61 to 80 cows realized the smallest reduction with a mean of 0,05 aDD/aY.

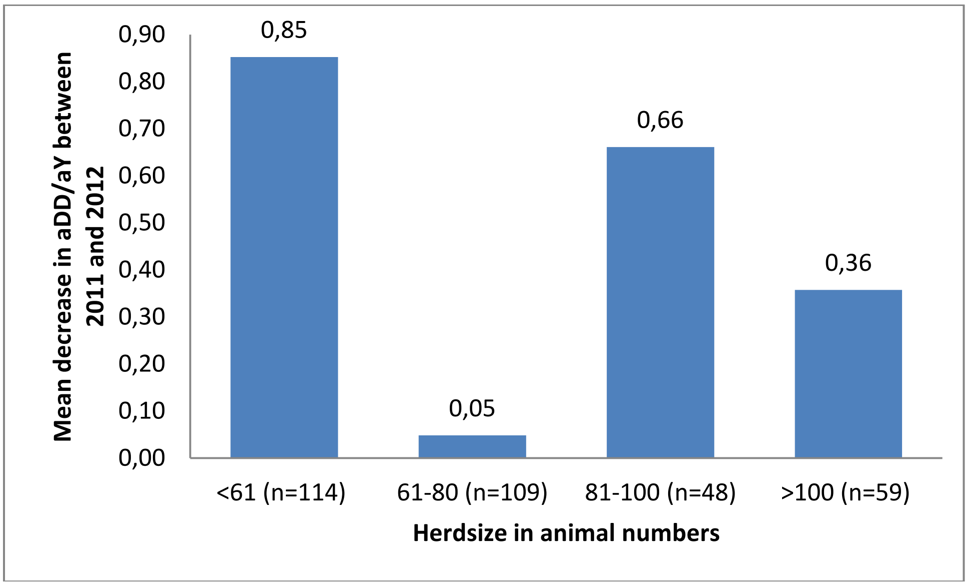

Figure 2: Comparison of the mean aDD/aY between different groups of farmers based on herd size.

The analysis also shows that intra mammary administered antibiotics responsible for the biggest part of aDD/aY. Ranking the routes of administration from high to low, results in the following: Dry cow therapy with a mean of 1,9 aDD/aY, mastitis treatment with a mean of 0,9 aDD/aY, per injection with a mean of 0,8 aDD/aY, per os with a mean of 0,4 aDD/aY and intra uterine with a mean of 0,1 aDD/aY. The other summary statistics of the routes of administration are in Table 2.

Table 2: Summary statistics of the routes of administration in aDD/aY.

Route of administration	Mean	Median	Minimum	Maximum	n
Dry cow therapy (intra mammary)	1,9	2,1	0,0	4,9	331
Mastitis treatment (intra mammary)	0,9	0,7	0,0	4,8	331
Per injection	0,8	0,7	0,0	3,5	331
Per os	0,4	0,0	0,0	14,4	331
Intra uterine	0,1	0,0	0,0	0,7	331

For the next results is the dataset with clients of the ULP which are in the Pir-Dap database used. There were 6 unlikely outliers removed having a percentage non return after first insemination of 100%. An overview of the removed data is in Appendix 2.
To have a better view on the different herd performance indicators, their summary statistics are shown in Table 3.

Table 3: Summary statistics from the used herd performance indicators.

Indicator	Mean	Median	Minimum	Maximum	n
BSK [3]	40,0	40,4	25,4	57,4	204
Netto output (NO) [2]	2080	2106	1124	2856	204
Bulk milk cell count	199	195	79	394	200
% cows with a high cell count	19,3	19	4	55	203
% new cows with a high cell count	8,5	8	3	20	203
Expected calving interval [4]	433	428	355	565	199
% non return after 1st insemination [4]	63,2	62,7	33,3	98,7	193
Mean age	4,93	4,83	3,50	9,50	204
Percentage culled animals	22,3	21	8	46	203
Age culled animals	6,25	6,17	3,50	11	203
Percentage dead animals	3,0	2,6	0	14,8	203

The association between the herd performance indicators and the aDD/aY was classified as weak to very weak for all indicators as R^2 values are all between 0,00 and 0,14. An overview is shown in Table 4.

Table 4: Associations between the used antibiotics in 2012 (aDD/aY) and different herd performance indicators.

Indicator	R^2	Interpretation
BSK [3]	0,11	Weak
NO [2]	0,14	Weak
Bulk milk cell count	0,05	Very weak
% cows with a high cell count	0,01	Very weak
% new cows with a high cell count	0,03	Very weak
Expected calving interval [4]	0,06	Very weak
% non return after 1st insemination [4]	0,02	Very weak
Mean age	0,01	Very weak
Percentage culled animals	0,00	Very weak
Age culled animals	0,00	Very weak
Percentage dead animals	0,01	Very weak

The figures 3 and 4 show the scatterplots of the relation between respectively the aDD/aY and percentage culled animals and the relation between the aDD/aY and percentage dead animals.

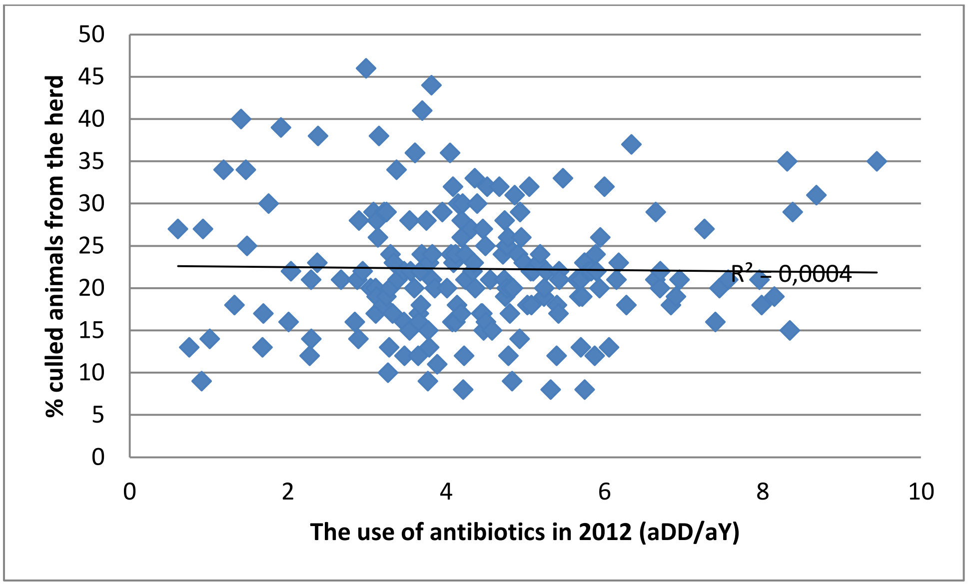

Figure 3: The relation between the use of antibiotics in 2012 (in aDD/aY) and the percentage culled animals (n=187).

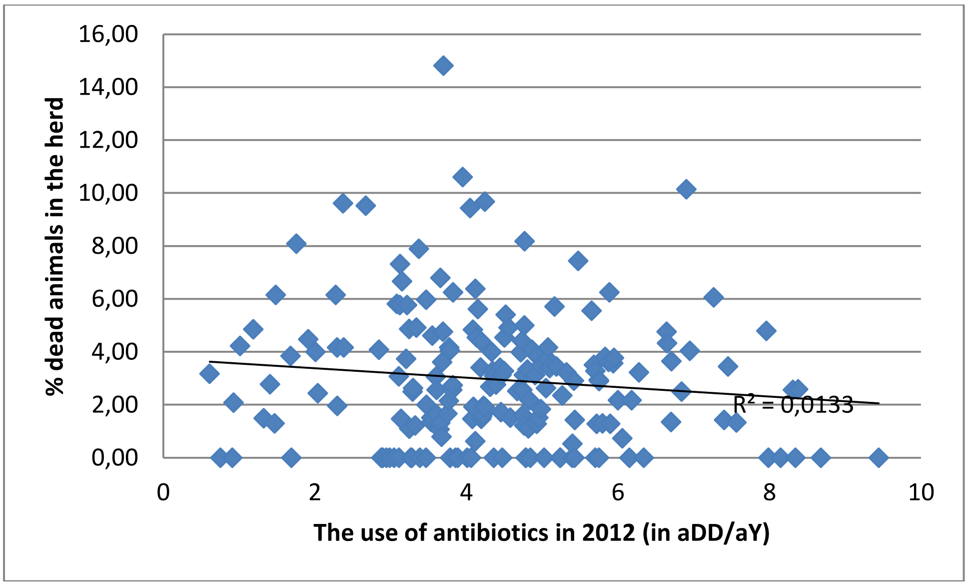

Figure 4: The relation between the use of antibiotics in 2012 (in aDD/aY) and the percentage dead animals in the herd (n=187).

There was a very weak correlation between the aDD/aY and percentage dead animals in the herd (R^2=0,01) and between the aDD/aY and the percentage culled animals from the herd (R^2=0,00). This was also the case when the aDD/aY for dry cow treatment or the aDD/aY for dry cow treatment and mastitis treatment are neglected (Table 5).

Table 5: The correlation between the total aDD/aY in 2012 without the aDD/aY for dry cow treatment and percentage culled and percentage dead in the herd (n=187). And the relation between the total aDD/aY in 2012 without the aDD/aY for dry cow- and mastitis treatment and the percentage culled and the percentage dead animals in the herd (n=187).

Antibiotic use	Indicator	R^2
The total aDD/aY without the aDD/aY for dry cow treatment	Percentage culled	0,00
	Percentage dead	0,06
The total aDD/aY without the aDD/aY for dry cow treatment and mastitis treatment	Percentage culled	0,00
	Percentage dead	0,00

The association between the intra mammary antibiotic use (dry cow- and mastitis treatment) and udder health indicators is provided in Table 6. For this purpose we used, bulk milk cell count, % cows with a high cell count and % new cows with a high cell count. These indicators correlated very weak with the antibiotics used for intra mammary treatment, combined and separate from each other.

Table 6: Cross table with the R^2 in the comparison of intra mammary treatment and udder health indicators (n=183).

Indicator/antibiotic treatment	Cell count in the milk tank	% cows with a high cell count	% new cows with a high cell count
Dry cow treatment	0,04	0,03	0,05
Mastitis treatment	0,00	0,00	0,00
Combination of dry cow- and mastitis treatment	0,04	0,01	0,04

Conclusions

We found a moderate association between the aDD/aY in 2011 and 2012. In this study 61,2% of the farmers realized a decrease in their use. When we group the farmers on herd size, the biggest mean decrease is found in the farmers with a herd size of 60 cows or less. This study shows that dry cow therapy is the biggest part in the antibiotic use of the farmers.

The hypothesis that there is a decrease in aDD/aY in 2012 with respect to 2011 is confirmed by the results of this study. We hypothesized that the aDD/aY of some farmers would increase because they have to buy their antibiotics at their registered practicing veterinarians in 2012 and they most likely bought most of their antibiotics at another veterinarian in 2011. This was confirmed in the study: 38,8% of the farmers increased in their aDD/aY in 2012 in comparison with 2011. From these farmers, were 18 who even more than doubled their antibiotic use in 2012 in comparison with 2011. Whether the reason for this increase could not be confirmed by this study. It is possible that there were other factors causing this increase, like more illness in the herd in 2012.

The correlation between the aDD/aY in 2012 and different herd performance indicators is weak to very weak, with a R^2 between 0,00 en 0,14. There was also a very weak correlation found between the percentage culled animals from the herd and the total aDD/aY without the aDD/aY for dry cow treatment or for dry cow- and mastitis treatment, both with a R^2 of 0,00. The correlation between the percentage dead animals in the herd and the total antibiotic use without the antibiotics used for dry cow treatment or for dry cow- and mastitis treatment was also very weak, with respectively a R^2 of 0,06 and 0,00. Even the relation between the use of intra mammary antibiotics and udder health indicators correlates very weak, with a R^2 between 0,00 and 0,05.

There is only a weak to very weak correlation found between the aDD/aY in 2012 and herd performance indicators, therefore the hypothesis that farms with better health indicators should use less antibiotics is not confirmed.

Discussion

The moderate link between the aDD/aY in 2011 and 2012 could be explained by the one-to-one relation between the farmer and the practicing veterinarians. In 2012 farmers are only allowed to buy their antibiotics at their registered practicing veterinarians, which makes it easier to monitor, and in some cases, reduce the antibiotic use. Besides the improved monitoring, farmers and veterinarians are more aware of the use of the antibiotics and the need to reduce it. The change in monitoring and awareness might have had such an influence that the correlation between the years became weak. The relation between the aDD/aY between 2012 and 2013 might be very interesting to give an answer to this problem, because there is no change in the monitoring and awareness of the antibiotic use.

We assume that the farmers which increased in their aDD/aY bought their antibiotics in 2011, a part of their total use or their total use, at another veterinarian. This could be a good argument in most of these cases, but there could be other factors influencing this group of farmers. They could have faced more health issues in 2012 than in 2011 or changed their management for dry cow treatment for example, which could have caused the increase in their aDD/aY.

The weak link between the aDD/aY and different herd performance indicators is probably a good sign. This weak link means that the herd performance indicators are not improving by using more antibiotics. This means that the reduce in aDD/aY should not affect the herd performance. For some of the herd performance indicators we could easily think of other factors which could influence the indicators more than the antibiotic use. For the BSK and NO it is imaginable that feed quality has a much bigger influence for example.

The relation between aDD/aY and the percentage culled animals from the herd and percentage dead animals in the herd is of special interest, as it is thought that a decrease in antibiotic use will increase the percentage culled animals from the herd or dead animals in the herd. Despite there has only a weak correlation been found between the aDD/aY and the percentage culled animals from the herd and percentage dead animals in the herd, there could be a breaking point. It is imaginable if there are too little antibiotics used, the percentage dead or culled animals in the herd will rise. Probably the reduction of antibiotic use in the Netherlands will not be decreased that far.

The very weak correlation between the use of intra mammary antibiotics and udder health indicators is notable. It is imaginable that there could be a relationship between intra mammary antibiotic use and udder health indicators, because mastitis treatment would be used for cows with a high cell count in the milk (caused by mastitis) and dry cow treatment should be lowering the udder health indicators by preventing mastitis. On the other hand farms with a lot of udder health problems might use more antibiotics, so causality is not easy to define. Even in these seemingly simple relationships there are more factors influencing the herd performance indicators.

In this study the aDD/aY of different farmers has been compared and there was no relation found in the aDD/aY in 2012 and the herd performance indicators. It should be interesting to study the relation between aDD/aY and herd indicators on one farm for more years. This study has not been done yet, but could provide another view on the relation between the aDD/aY and herd performance indicators.

In short, it may be concluded there are only weak correlations found between the use of antibiotics in aDD/aY and the herd performance indicators in this study. This is probably a good sign as reduction of antibiotics should not necessarily lead to worse herd performance indicators. The moderate correlation between the aDD/aY in 2011 and 2012 is notable and it should be interesting to study the relation between the aDD/aY in 2012 and 2013 as there is no change in monitoring and awareness of the antibiotic use.

References

1. SDA houdt dierenartsen en dierhouders een spiegel voor, J. Klein Haneveld, Tijdschrift voor Diergeneeskunde, Deel 137, Aflevering 7, 1 juli 2012, P438-441.
2. E-hoofdstukken CRV, E03 Netto opbrengst en lactatiewaarde, https://www.crv4all.nl/over-crv/documentatie/e-hoofdstukken/
3. E-hoofdstukken CRV, E04 Bedrijfsstandaardkoe (BSK), https://www.crv4all.nl/over-crv/documentatie/e-hoofdstukken/
4. E-hoofdstukken CRV, E13 Voortplanting, https://www.crv4all.nl/over-crv/documentatie/e-hoofdstukken/

Appendix 1: Calculation of animal daily dose / animal year (aDD/aY).

The calculation of animal daily dose / animal year is: *total kg treated animal* divided by *the total weight of the herd*.

To calculate *kg treated animal* there are a few assumptions made:

- The prescribed medicines are totally used on the herd
- The medicines are used by the prescriptions the producer tells in the instructions.

The calculation of the *kg treated animal* with an antibiotic is: the total amount of prescribed active substance of the antibiotic divided by the daily dose of the antibiotic.

The daily dose is an indicator for antibiotic use. One daily dose tells how many mg of an active substance is needed to treat one kg animal for one day and is based on the registered mean dose of an antibiotic for the most common disease in an animal species.

To calculate the *total kg treated animal* the *kg treated animal* needs to be calculated for every prescribed antibiotic. The *total kg treated animal* is the sum of the *kg treated animal* for the specific antibiotics.

For the calculation of the *total weight of the herd* is the mean of the present dairy cows used. In the calculation, the weight of a dairy cow is fixed at 600 kg.
The formula:

Total weight of the herd=mean of the present dairy cows*600

It is important to use the antibiotic data and the mean of present dairy cows from one year (and the same year) to calculate aDD/aY

1. Bijlage toelichting bij rapportage antibioticumgebruik bij rundvee, Concept mei 2011 http://www.melkveemagazine.nl/assets/files/pdf/melkvee-magazine/20110525/0113_001.pdf

Appendix 2: The data removed from the dataset.

The farmers using less than 0,5 aDD/aY in 2012 are removed from the dataset of aDD/aY 2012. The next table provides the removed data from the aDD/aY 2012 dataset.

Code	Name	aDD/aY 2012
Grot21	Groot A. de	0,0
Oudm207	Oudshoorn Melkveebedrijf VOF	0,0
Waah21	C. van der Waaij	0,0
LAAV172	J.J. van der Laan	0,1
KORG2	G.M. Korver	0,1
HEER31	VOF A. de Heer en N.J. Griffioen	0,1
SMIM22	A. Smit	0,1
GROS14	VOF BoerBert	0,1
CHAR82	K. Chardon	0,1
VERW13	R. Verlaan	0,2
HERO35A	C.W.H. den Hertog	0,2
GRIP44	W. Griffioen	0,3
VERL2	C.D. Verhoeff	0,3
GUNR27	Melkveehouderij Anton van der Gun	0,3
KOOV132	J.G.M. Kooijman	0,4
SPRK123	MTS Spruijt P. en Dijk H.A. van	0,4

There are also a few farmers removed from the % non return after first insemination dataset. These farmers had 100% non return, which is very unlikely. The next table provides the removed data from the % non return after first insemination dataset.

Code	Name	% nr after 1^{st} insemination
BOEH79	Boere W.J.P.	100
PEES9	Peek W.H.	100
SCHV174	A.T.M. van Schaik	100
VERK25	Verkroost H.F.	100
VERL20	Veehouderij A. Verhoef	100
VERO10	Verweij-Muller VOF	100