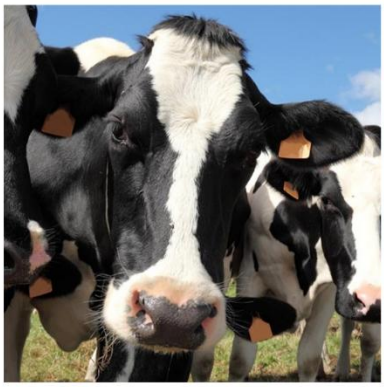
2024

Antimicrobial Use Report



Welsh Lamb and Beef Producers

Contents

Foreword

Welcome to the 4th annual Welsh Lamb and Beef Producers Antimicrobial Use Report. This report provides detailed analysis of antimicrobial use (AMU) in 5920 beef, sheep and dairy enterprises across Wales in 2024.

The 4th edition of the Welsh Lamb and Beef Producers (WLBP) Antimicrobial Use Report for 2024 provides a detailed summary of antimicrobial use (AMU) on 2643 beef, 2714 sheep and 563 dairy enterprises across Wales in 2024. Whilst this represents a small decrease (2.3%) in the total number of enterprises for which antimicrobial (AM) sales data were captured compared to the 2023 Report, this report still collates AMU data from a significant coverage of Welsh enterprises; 49% (~61,000) of the total beef stock, 55% (~1.8 million) of the total sheep stock and 50% (~96,000) of the total dairy stock which were assured under the Farm Assured Welsh Livestock (FAWL) Scheme in 2024.

Reporting AM sales records within the Welsh beef, sheep and dairy sectors provides key insights into the progress towards achieving and maintaining responsible AMU to reduce the emerging threat of antimicrobial resistance. Consistent with previous reports, total AMU by enterprise is presented, alongside AMU stratified by European Medicines Agency (EMA) category, AM class and by AM administration route. Monthly AM purchasing across each enterprise type and administration route is also presented, generating insights into potential seasonal variability in AM purchasing patterns.

Over 74,000 AM sales utilised in this report were captured and collated via the WLBP AMU Calculator, a novel reporting tool that produces accurate, standardised reports of AMU based on industry-agreed standards (CHAWG, 2020; SHAWG, 2019; ESVAC, 2021). Veterinary surgeons complete AMU calculations for enterprises under their care, which is a requirement for farmers as part of the FAWL assurance scheme. Veterinary surgeons review the AM sales data and assign purchased products to each herd or flock under their care, reporting on disposed quantities where necessary to achieve accurate AMU data.

Recent modifications to AMU reporting metrics adopted by the EU and UK include changes to animal weight calculations, resulting in higher weight estimates, and therefore lower AMU estimates (EMA, 2023). While it is hoped that extended data capture in the future will enable these new weight estimations to be used, methods used in this Report are consistent with previous Reports (see supplementary information for detailed methods). Readers should therefore consider that comparison between AMU reporting using different metrics is likely to be misleading.

While there is some overlap between members represented in the 2024 Report and previous years' Reports, it should be considered that the cohort of members represented in each Report varies from year to year. As such, directly comparing data between Reports is inappropriate given the characteristics and AMU profiles of farms represented are likely to vary substantially.

Contribution

This report and all supporting analyses were commissioned by WLBP and conducted independently by researchers at Bristol Veterinary School, University of Bristol, UK.

Analysis and report writing: Dr Caroline Best, Dr Elliot Stanton
Consultation: Professor Kristen Reyher, Professor Andrew Dowsey, Dr Judy Bettridge

Arwain DGC
Defnydd Gwrthficrobaidd Cyfrifol
Responsible Antimicrobial Use

Ariennir gan Lywodraeth Cymru
Funded by Welsh Government

WLBP's work on AMU forms an integral part of the award-winning **Arwain DGC** (Defnydd Gwrthficrobaidd Cyfrifol / Responsible Antimicrobial Use) programme, which is funded by the Welsh Government and led by Mentera.

For more information on the work of Arwain DGC, please go to:
https://rhaglenni.mentera.cymru/arwaindgc/en/home/

Contact

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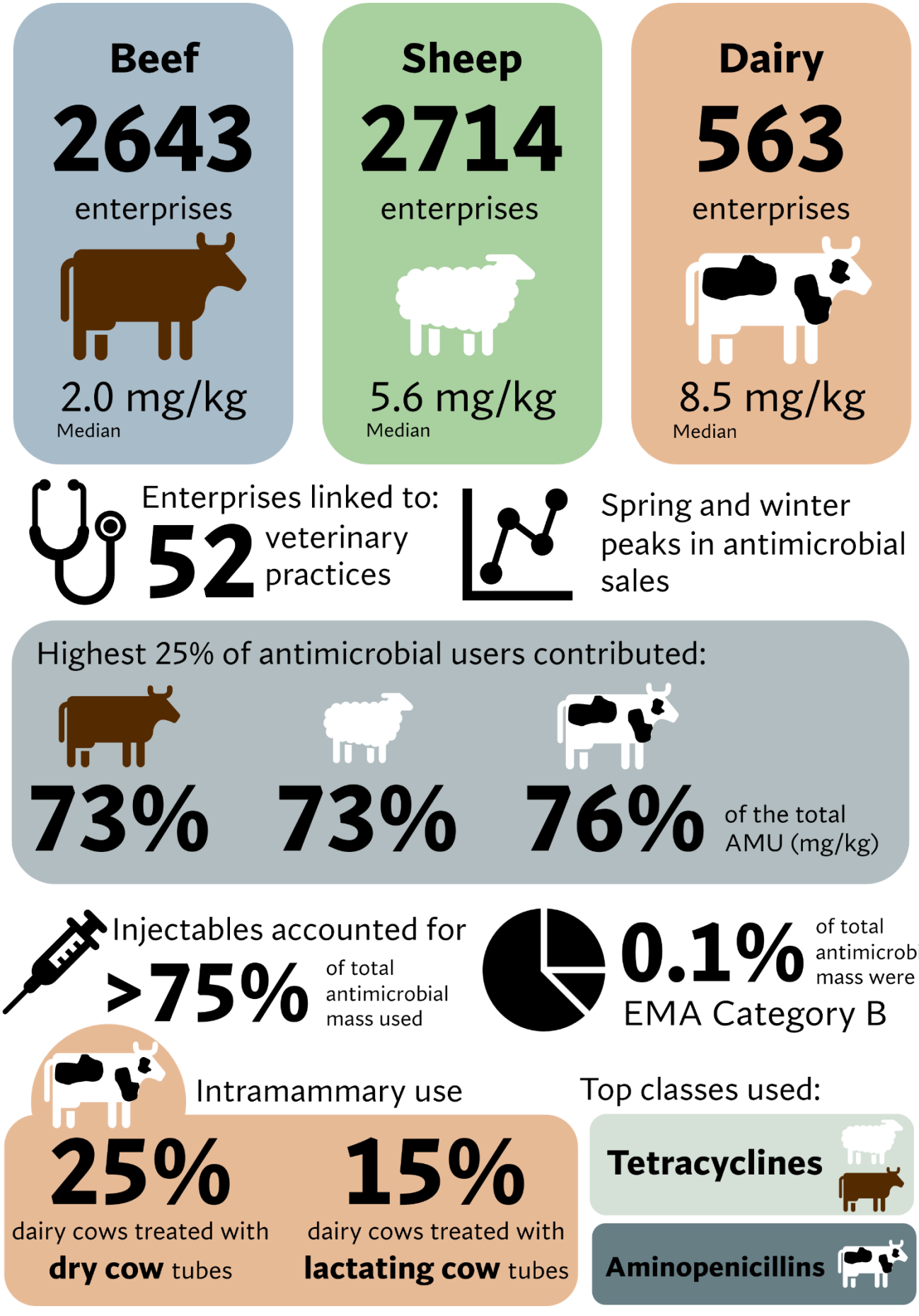
2024 AMU Report – at a glance



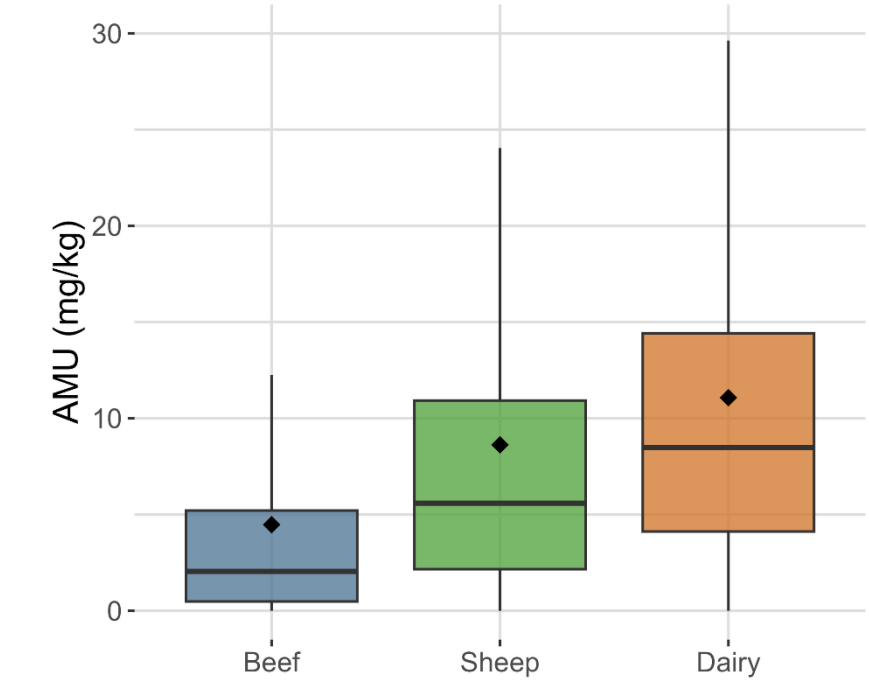
AMU by enterprise type

Using data submitted via the WLBP AMU Calculator, AMU in 2024 was calculated for 2643 beef, 2714 sheep and 563 dairy enterprises across Wales. Average enterprise-level AMU continues to be lowest within the beef sector and highest in the dairy sector.

AMU data were obtained from 2643 beef, 2714 sheep and 563 dairy enterprises for the 2024 calendar year (1st January to 31st December). This represents a reduction of 2% of beef, 2% of sheep and 3% of dairy enterprises contributing AMU data through the AMU Calculator, compared to peak numbers observed in 2023. Despite this, the number of beef, sheep and dairy enterprises reporting data through the AMU Calculator remains substantially higher in 2024 than in 2021, with the total number of enterprises reporting data increasing by 159% over these years. As per previous years, the 2024 AMU Report findings should not be directly compared to those of previous years as only 187 (3%) of enterprises in the 2024 dataset also provided data for all previous reports between 2021 and 2023.

Consistent with previous years' datasets, median AMU was highest in dairy (8.5 mg/kg*) and lowest in beef cattle (2.0 mg/kg*). Median sheep AMU sat roughly halfway between dairy and beef cattle at 5.6 mg/kg† (Figure 1). For the full methodology used to calculate AMU and why the median is chosen as an averaging method, see supplementary information.

Considerable variation was again observed in AMU mg/kg between individual enterprises in 2024. The highest 25% of AM users in beef, sheep and dairy enterprises contributed 73%, 73% and 76% of the total AMU in each sector, respectively. Figure 1 shows the distribution of AMU (with median and mean averages highlighted) to illustrate the substantial effect of enterprises with very high AMU on the enterprise average (see supplementary information on reporting average values).



		Beef	Sheep	Dairy
◆	Mean mg/kg	4.5	8.6	11.1
▬	Median mg/kg	2.0	5.6	8.5

Figure 1: Farm AMU (mg/kg) by enterprise type, 2024
Distribution of total annual AMU for all 2643 beef, 2714 sheep and 563 dairy enterprises in 2024. Fifth to 95th percentile are shown. Note: Topical antimicrobials are included in sheep mg/kg only. The methods used to create this graph are detailed in the supplementary information.

* mg/kg for beef and dairy enterprises was calculated using methodology defined by CHAWG (CHAWG, 2020)

† mg/kg for sheep enterprises was calculated using methodology defined by SHAWG (SHAWG, 2019)

AMU by EMA category

EMA Category B (Restrict) AM use by mass remains very low across enterprise types (<1%). Category C (Caution) AMs comprised 41% of AM mass in dairy, 34% in beef and 14% in sheep. A clear preference for Category D (Prudence) AMs was seen for all enterprise types.

The EMA categorises AMs into four categories, from A to D: Avoid, Restrict, Caution and Prudence (Figure 2). AMs are ranked according to the risk that their use in animals poses to public health through the possible development of AMR and the need to use them in veterinary medicine.

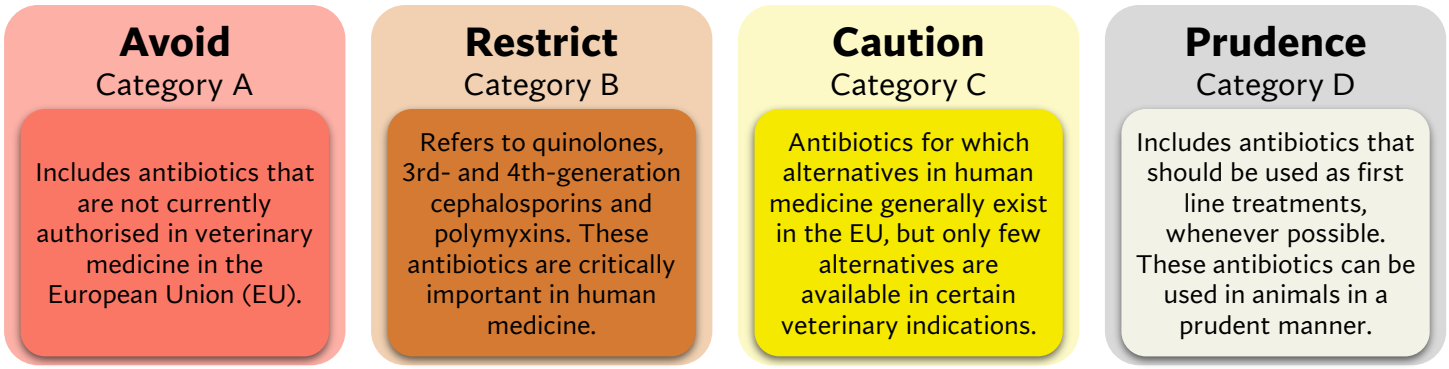


Figure 2: Definitions of EMA categories
Four categories of AMs, from A to D: Avoid, Restrict, Caution and Prudence (EMA, 2020).

Across enterprises, there was a preference for EMA Category D (Prudence) AMs which accounted for 66%, 86% and 59% of the total mass of AM ingredient used on beef, sheep and dairy enterprises, respectively (Figure 3). EMA Category C (Caution) AMs accounted for a lower proportion of total AM mass, representing 34%, 14% and 41% of total mass on beef, sheep and dairy enterprises, respectively. EMA Category B AMs represented just 0.2% of total AM mass on beef and dairy enterprises and <0.1% on sheep enterprises, which is important as these AMs are critically important in human medicine. Reassuringly, no enterprises recorded the use of any EMA Category A (Avoid) AMs.

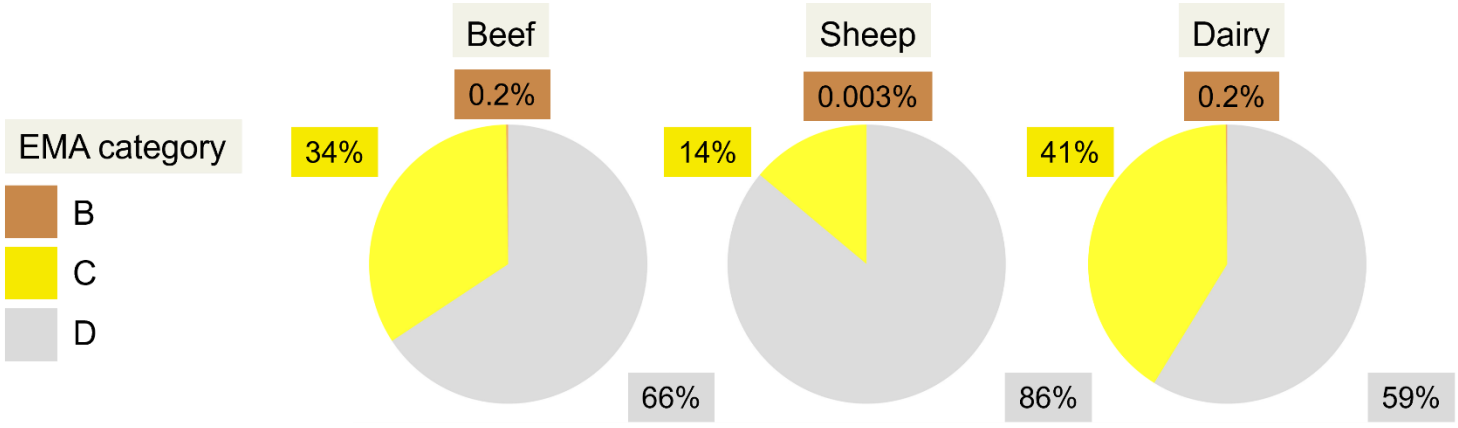


Figure 3: Proportion of AM ingredient used by enterprise type and EMA category, 2024
Proportion by mass of AM ingredient used for all 2643 beef, 2714 sheep and 563 dairy enterprises in 2024, split by AM category. Products with multiple different AM ingredients were placed into categories based on the AM ingredient in the formulation of highest EMA importance (EMA, 2020). See supplementary information for methodology.

AMU by class

Category D tetracyclines, aminopenicillins and penicillins were the most used AM classes by mass across all enterprise types. A wider range of AMs were used on beef and dairy enterprises, with aminoglycosides and macrolides making up the bulk of Category C AM use by mass.

The percentage of each AM class used by mass was analysed for 2643 beef, 2714 sheep and 563 dairy enterprises in 2024.

The breadth of AM classes used varied between enterprise types (Figure 4); most AM mass used by sheep enterprises was attributed to a select few AM classes, whereas use was spread across a much greater range of AM classes in beef and dairy enterprises.

In beef, five AM classes (tetracyclines, aminopenicillins, aminoglycosides, penicillins and macrolides) accounted for 81% of total AM use by mass.

In sheep, almost half (49%) of total AM use by mass was comprised of tetracyclines alone. Non-Category B beta-lactams (incl. penicillins and cephalosporins) accounted for a further 36% of total AM mass. Very low levels of spectinomycin (aminoglycoside; 1%) use were observed. Category C use mainly was comprised of aminoglycosides and macrolides, accounting for 11% of total AM mass used.

In dairy, 37% of total AM mass used was made up of non-Category B beta-lactams. By mass, aminoglycosides (excl. spectinomycin; 16%), sulfonamides (15%), tetracyclines (14%) and macrolides (12%) also represented relatively substantial proportions of total AMs used.

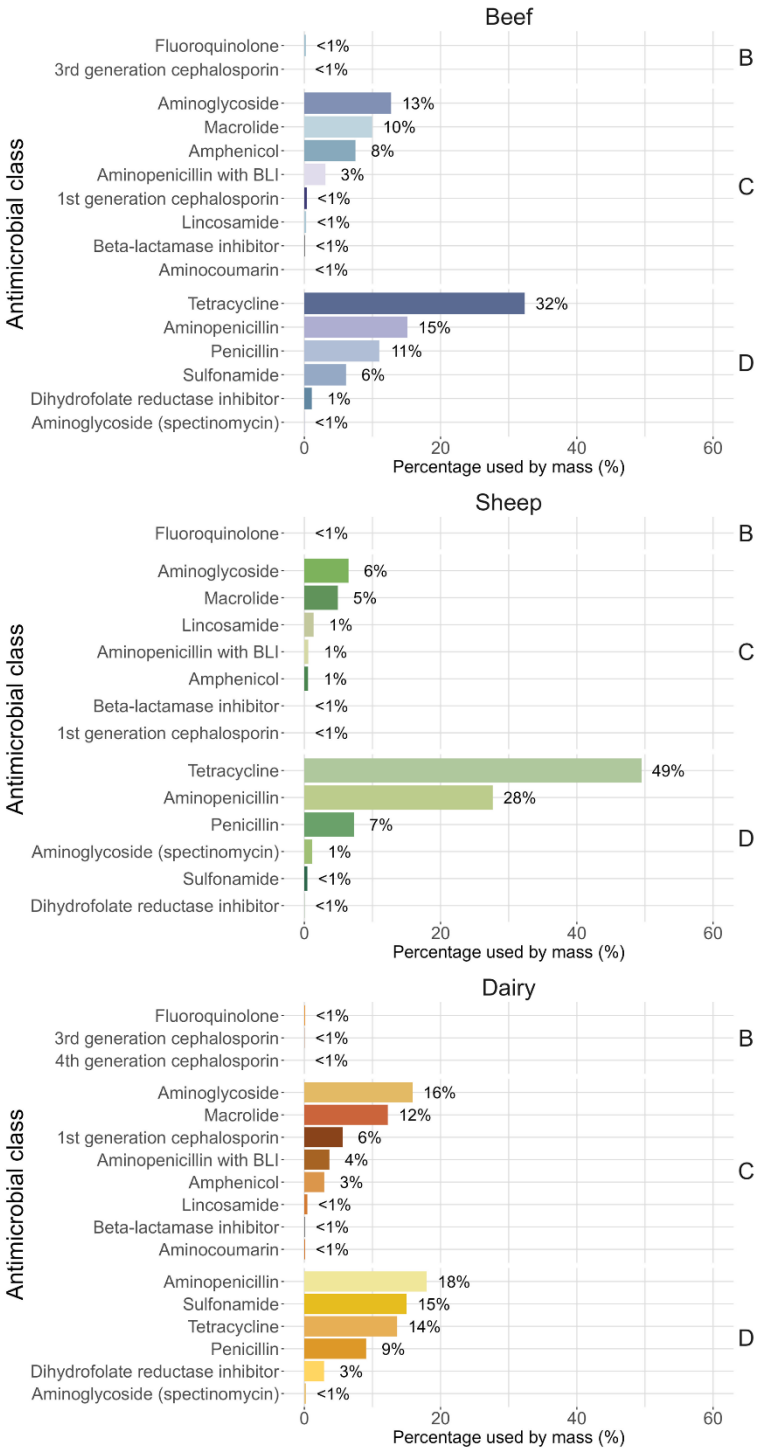


Figure 4: Proportion of AM classes used by enterprise type and EMA category, 2024
Proportion by mass of AM used for all 2643 beef, 2714 sheep and 563 dairy enterprises in 2024, split by AM class and AM category. See the supplementary information for details on the method used. BLI = Beta-lactamase inhibitor.

AMU by administration route

Injectables were the most common administration route when calculating by AM mass across all enterprise types. Following injectables, oral, spray and intramammary formulations were the next most common AM administration routes on beef, sheep and dairy enterprises, respectively.

The total mass of AMU by product administration route was analysed for 2643 beef, 2714 sheep and 563 dairy enterprises in 2024.

Unsurprisingly, given their high masses of active ingredient, injectable formulations, accounted for the majority of total AM mass used across all enterprise types (Figure 5). Injectables represented higher proportions of AM mass used in beef (90%) and sheep (88%) than in dairy (72%).

Intramammary AM products – used in the treatment of mastitis/udder infections – represented 15% of total AM mass used in dairy enterprises; as expected, smaller proportions were used in beef (1%) and sheep enterprises (<0.1%).

Topical sprays were most used by sheep enterprises, representing 8% of total AM mass, compared to beef and dairy enterprises where these products contributed 3% of total AM mass.

Oral formulation use (including powders, tablets and solutions) varied between enterprise types. Oral formulations accounted for 10% of total AM mass on dairy enterprises but lower proportions on beef (6%) and sheep (4%) enterprises.

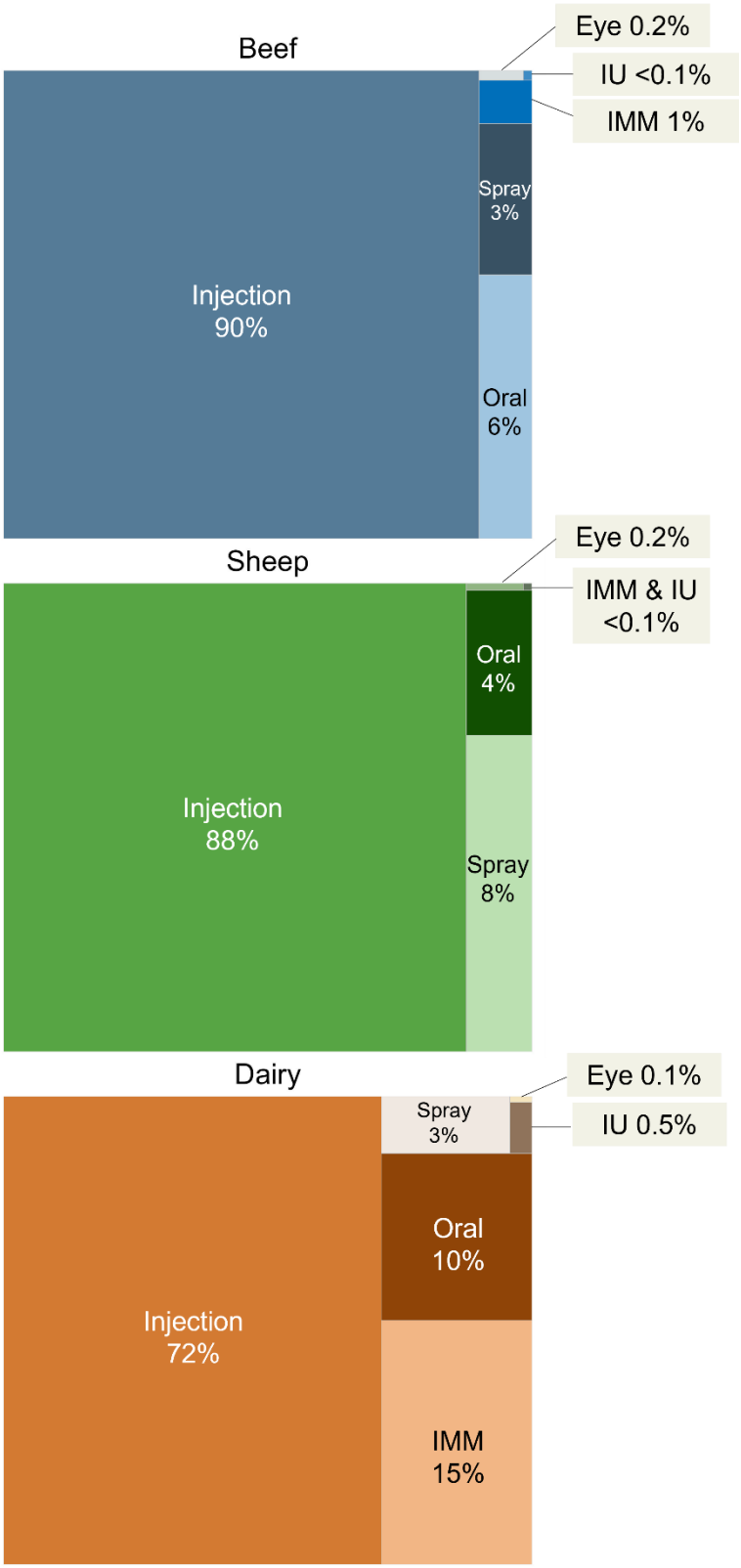


Figure 5: Proportion of AM products used by enterprise type and administration route, 2024
Proportion of AM by mass used for all 2643 beef, 2714 sheep and 563 dairy enterprises in 2024, split by administration route, as listed in the Veterinary Medicines Directorate's Summary of Product Characteristics for each AM product. See supplementary information for methodology. IU = intrauterine; IMM= intramammary

Intramammary use in dairy

On average, dairy herds in 2024 used more doses of AM products for dry cows than for lactating cows. On average, around 24% of cows were treated with dry cow intramammaries, whilst 18% were treated with lactating cow intramammaries.

The number of doses of intramammary (IMM) AM products used on the 563 dairy enterprises was analysed. A dose was defined as a course of treatment, which for a lactating cow therapy is defined as 3 IMM tubes and a dry cow therapy is 4 IMM tubes (CHAWG, 2020).

Of the 563 dairy enterprises, 76% reported at least one purchase of dry cow IMM therapy products and 82% reported at least one purchase of lactating cow IMM therapy products over the 2024 reporting period (Figure 6).

The average (median) number of IMM doses received per cow were 0.15 doses for IMM AM lactating cow therapy and 0.25 doses for AM dry cow therapy. Under the assumption that each treated cow received a single dose, on an average (median) enterprise, 15% of cows would have received a course of lactating cow therapy, and 1 in 4 (25%) cows would have received a course of dry cow therapy. For lactating cow IMM AM therapy, this likely represents an overestimate as a cow may have received multiple treatment courses throughout 2024.

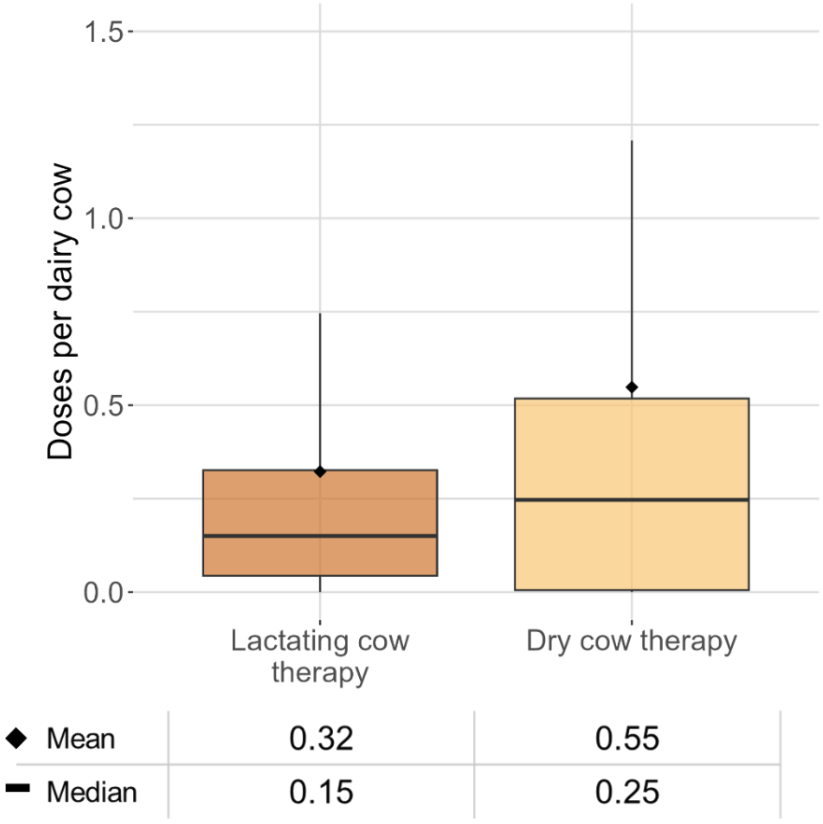


Figure 6: Doses of intramammary treatments used, 2024

Distribution of doses of lactating cow therapy and dry cow therapy AM intramammary treatments for all 563 dairy enterprises in 2024. 1 lactating cow dose = 3 tubes. 1 dry cow dose = 4 tubes. See supplementary information for methodology.

There is substantial variability in the number of doses of IMM treatments used on dairy enterprises. The 25% of enterprises using the highest number of doses used more than 0.33 doses of lactating cow therapy (33% of cows dosed) and 0.53 doses of dry cow therapy (53% of cows dosed). In contrast, the lowest 25% used less than 0.04 doses of lactating cow therapy (4% of cows dosed) and 0.008 doses of dry cow therapy (0.8% of cows dosed).

AM sales through the year by enterprise type

The average (median) mass of AMs sold across enterprise types varied throughout 2024. AM purchasing was generally greater in the spring months than in the summer months. In beef and dairy enterprises, AM purchasing increased again in the late autumn and winter months.

Mean monthly AM sales (mg/kg) were analysed for 2643 beef, 2714 sheep and 563 dairy enterprises in 2024. AMs are not necessarily used immediately at the point of purchase, so this analysis should be viewed as providing insight into variability in AM purchasing across enterprise types over the course of the year, rather than representing changes in AMU habits.

Distinct seasonal AM sales occurred for sheep enterprises, with increases in purchasing of AMs (in mg/kg) observed between January and March, before falling in April, and remaining at a lower level throughout the remainder of 2024 (Figure 7). Between January and March, mean monthly AM sales were 1.20 mg/kg compared to 0.56 mg/kg between April and December.

AM purchasing on dairy enterprises appeared marginally greater between January and March (mean: 1.09 mg/kg) than between April and October (mean: 0.74 mg/kg). AM purchases increased again in November and December (mean: 1.15 mg/kg).

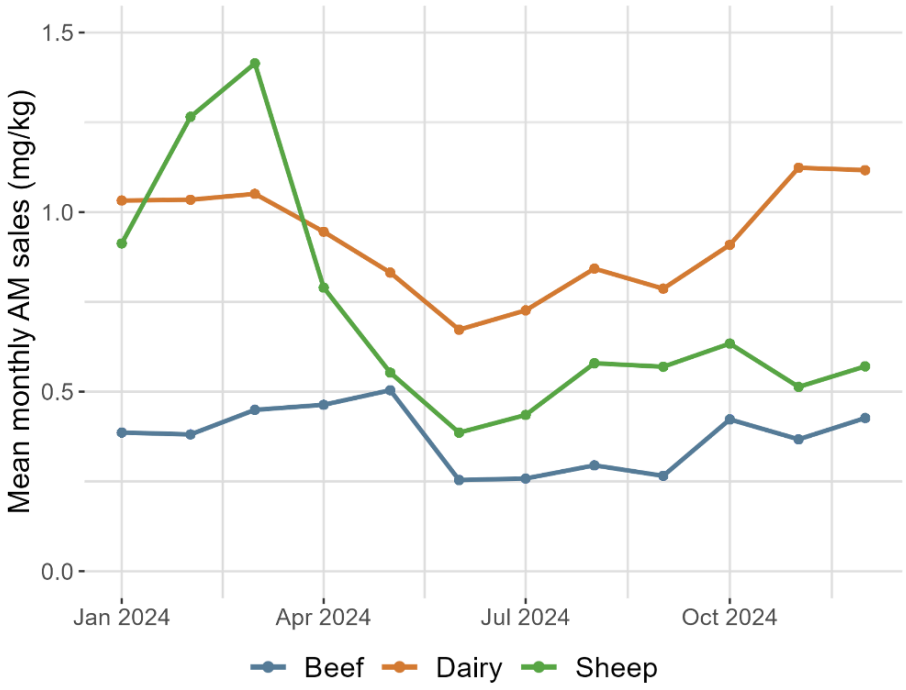


Figure 7: Mean monthly AM sales (mg/kg) by enterprise type, 2024

Mean monthly AM sales (AMU mg/kg) for all 2643 beef, 2714 sheep and 563 dairy enterprises in 2024. Note: Topicals are included in sheep mg/kg only. The methods used to create this graph are covered in the supplementary information.

Whilst beef enterprises appear to display less variability in mean AM purchasing throughout the year, greater proportional differences are observed than those on dairy enterprises. Here, average AMU for beef enterprises appeared lower between June and September (mean: 0.23 mg/kg), compared to the January and March (mean: 0.45 mg/kg) or October and December periods (mean: 0.42 mg/kg). This follows a broadly similar pattern to that observed on dairy enterprises, where purchasing decreased throughout the summer and early autumn.

As this analysis uses the mass-based metric, mg/kg, this seasonal variation is mostly driven by the purchase of injectables, as, in all enterprise types, these make up the majority of use by mass.

AM sales through the year by administration route

Some variability in the sale of AMs by administration route was observed. The clearest example of this occurred in sheep, where AM sales across each route of administration peaked in spring. AM sales by route of administration were more consistent on dairy enterprises.

Percentage change in AM sales by mass for each month – comparing monthly percentage of total AM mass to the expected amount (i.e. if AM purchasing was equal across all 12 months) – was analysed for 2643 beef, 2714 sheep and 563 dairy enterprises in 2024.

Monthly percentage change in AM sales by mass was then analysed by administration route for each enterprise type (Figure 8).

For beef enterprises, increased intrauterine (IU), intramammary (IMM) and oral AM purchasing occurred in the spring, with a second modest increase in oral AM purchasing occurring in December.

For sheep enterprises, AM purchasing was generally greatest in the spring. Here, higher than expected purchasing of AMs – of all administration routes – was observed between January and March. A second peak in sheep IMM purchasing occurred in July, although the absolute mass of IMM AMs purchased by sheep enterprises was very low. Intrauterine products were only purchased in February and March.

For dairy enterprises, sales of AMs with injectable, IU, oral and spray routes of administration were relatively stable throughout the year. For IMM Ams, purchasing peaked in November and December, whilst for eye formulations, sales peaked in April, September and November.

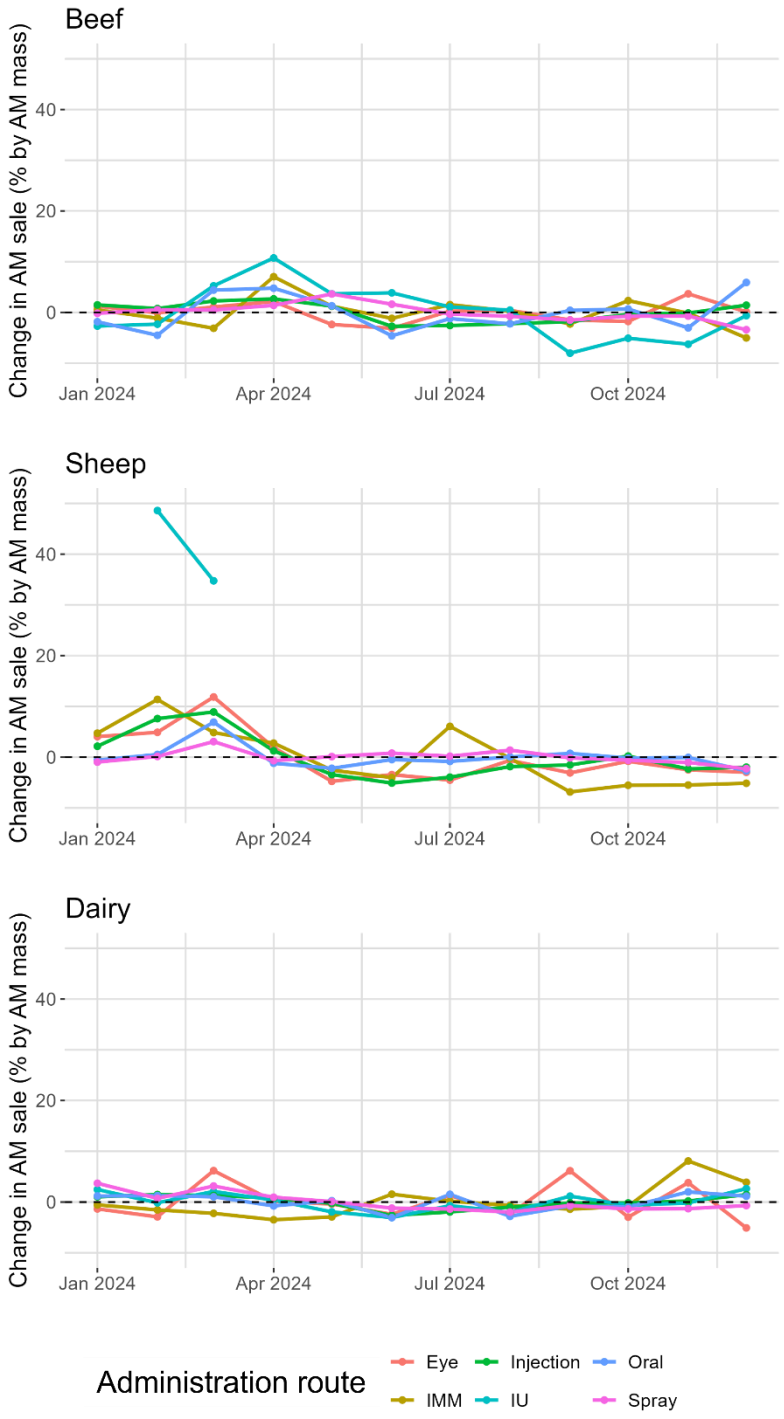


Figure 8: Monthly percentage change in AM sale by mass (mg) by enterprise type and administration route, 2024
Percentage change in AM sale by mass (mg) for all 2643 beef, 2714 sheep and 563 dairy enterprises in 2024, split by administration route. See supplementary information for methodology.

Supplementary information

Calculating AMU

Throughout this report, the metric milligrams per kilogram (mg/kg) is used to describe AMU.

Milligrams The total milligrams of active AM ingredient in the product. This is calculated using information from each product's Veterinary Medicine Directorate's (VMD) Summary of Product Characteristics[1] (SPC) Sales records for AM products sold to each farm are reviewed by the veterinary surgeon, who is able to assign products to a herd/flock (for mixed- or multi-enterprise farms) and detail if any product was disposed of (e.g. when a single dose from a multi-dose bottle was used). If product was disposed of, the corresponding milligrams of AM ingredient was then removed from the totals in this analysis. In some cases, exclusions or conversions were made:

- Clavulanic acid was removed from all analyses based on the AMU reporting recommendations (CHAWG, 2020; SHAWG, 2019; ESVAC, 2021).
- Where products are listed as pro-drugs, ESVAC conversion factors have been applied to calculate the milligrams of active moiety (ESVAC, 2021).
- Where products are listed using international units (IU), the ESVAC recommended conversion factor has been applied (ESVAC, 2021).
- Topical AM products (sprays and eye ointments) are excluded when quoting mean or median total use in a population (**Figure 1**) for dairy and beef herds, but are included for sheep flocks. This methodology follows the AMU reporting recommendations (CHAWG, 2020; SHAWG, 2019).

Kilograms The total kilograms of animals at risk of treatment in the herd/flock. These are calculated by WLBP from animal numbers either provided automatically or manually by farmers and veterinary surgeons when using the AMU Calculator. Tables S.1 - 3 below show the animal weights and reference the methodology used.

- In the case of beef:
    - 45% of herds were linked to the British Cattle Movement Service Cattle Tracing System and animal numbers were pulled automatically as opposed to using veterinary surgeon- or farmer-reported animal counts. These herds have a different method of calculating weights which aligns with ESVAC (ESVAC, 2021). Median AMU of these farms was 6.2 mg/kg.
    - 55% of beef herds relied on the veterinary surgeon/farmer entering animal counts and used the CHAWG simplified $mg/kg^{beef\ farm}$ metric (CHAWG, 2020). Median AMU of these farms was 5.4 mg/kg.

Limitations:

- For total kilograms of animal at risk of treatment, the two different methodologies explained above were used for beef herds. If one of these methodologies over- or under-estimates animal weight, the comparisons between these farms could be invalid.
- The mg/kg metric does not attempt to assign medicines to youngstock or adult cattle and therefore assumes that all animals on the farm were at risk of treatment. This may not accurately reflect how AMs are used (for example, intramammary tubes would not be used in non-lactating animals).

[1] VMD SPCs were accessed online via the VMD Product Information Database (www.vmd.defra.gov.uk/ProductInformationDatabase)

Table S.1: Beef weights

Count type	Herd type	Age group (years)	Sold for slaughter?	Sex	Time since arrival on farm (years)	WLBP AMU Calculator assigned weight (kg)	Method reference
Beef numbers manually entered by the veterinary surgeon	Beef fattening	<1	N	Mixed	<1	104	CHAWG simplified mg/kg$^{beef\ farm}$ metric[2]
		1 to 1.5	N	Mixed	<1	250	
		>1.5	N	Mixed	<1	144	
		1 to 1.5	N	Mixed	1 to 1.5	428	
		>1.5	N	Mixed	1 to 1.5	204	
		>1.5	N	Mixed	>1.5	146	
		<1	Y	Mixed	<1	28	
		1 to 1.5	Y	Mixed	<1	325	
		>1.5	Y	Mixed	<1	177	
		1 to 1.5	Y	Mixed	1 to 1.5	627	
		>1.5	Y	Mixed	1 to 1.5	403	
		>1.5	Y	Mixed	>1.5	199	
	Calf rearing	<1	N	Mixed	N/A	41	
		1 to 1.5	N	Mixed	N/A	323	
		>1.5	N	Mixed	N/A	482	
		<1	Y	Mixed	N/A	91	
		1 to 1.5	Y	Mixed	N/A	413	
		>1.5	Y	Mixed	N/A	680	
	Suckler	>1	N	Female	N/A	762	
		<1	N	Mixed	N/A	0	
		1 to 1.5	N	Mixed	N/A	266	
		>1.5	N	Mixed	N/A	453	
		<1	Y	Mixed	N/A	174	
		1 to 1.5	Y	Mixed	N/A	343	
		>1.5	Y	Mixed	N/A	655	
		<1	N	Female	N/A	367	
Beef numbers automatically sourced [1]	All	<1	N/A	Mixed	N/A	140	ESVAC PCU[3]
		1 - 2	N/A	Female	N/A	200	
		>1	N/A	Male	N/A	425	
		>2	N/A	Female	N/A	425	

1] Sourced from the British Cattle Movement Service.
2] CHAWG, 2020
3] ESVAC, 2021

Table S.2: Sheep weights

Count type	Description	WLBP AMU calculator assigned weight (kg)	Method reference
Flock numbers manually entered by the veterinary surgeon	Adult ewes put to the ram	75	SHAWG mg/kg$^{sheep\ farm}$ metric[1]
	Lambs sold as stores	20	
	Lambs sold for slaughter	20	
	Lambs sold for breeding or kept for breeding	20	

1] SHAWG, 2019

Table S.3: Dairy weights

Count type	Description	WLBP AMU calculator assigned weight (kg)	Method reference
Dairy numbers manually entered by the veterinary surgeon	Number of milking cows	425	ESVAC PCU2 – analogous to CHAWG mg/kg[3]
Dairy numbers automatically sourced [1]	Number of milking cows	425	

1] Sourced from the British Cattle Movement Service
2] ESVAC, 2021
3] CHAWG, 2020

Reporting average values

This report calculates the AMU in mg/kg for each farm in the WLBP AMU Calculator dataset and then describes these using averages to reflect the AMU of a typical farm in Wales. Averages are a way of summarising data by describing centrality. Two types of average, which have slightly different meanings, are used within this report:

Median: The median describes the middle value when data are ordered from least to greatest. It is equal to the 50th percentile of the dataset. 50% of the data lie below the median, and 50% above.

Mean: The arithmetic mean is calculated by totalling all values and dividing by the number of datapoints:

$$\text{Mean AMU} = \frac{Sum\ of\ all\ farms'\ AMU}{Number\ of\ farms}$$

The median is a more useful average to report when data are non-normally distributed. Enterprise AMU is often non-normally distributed due to the presence of outliers, especially enterprises with very high AMU. Where there are outliers with high AMU, the mean is expected to be larger than the median. An enterprise with lower than median AMU can consider themselves in the lower 50% of AMU users. The authors therefore recommend using median to report average AMU but provide mean AMU alongside this for comparison with other calculations.

Data displayed as boxplots (Figure 1 and 6)

The parts of the boxplot used in the report are explained in the diagram (Figure S.1). Farms whose use was less than the 5th or greater than 95th percentile are not shown on the plot, but their data were used to calculate the mean and median. If the mean is greater than the median, it indicates a 'long tail': a few enterprises which have very high use.

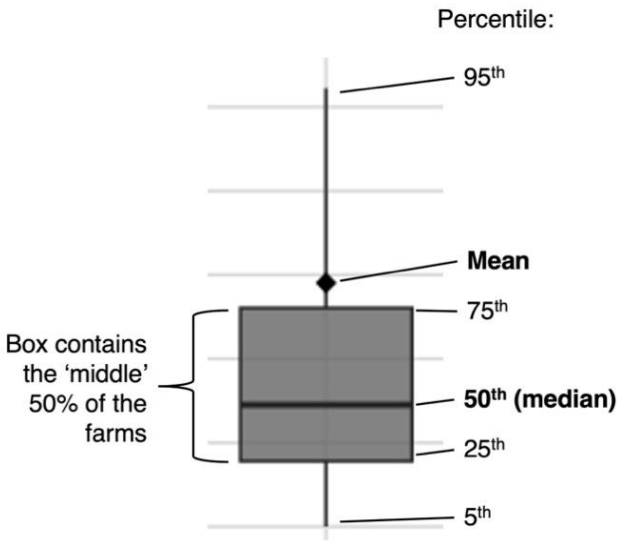


Figure S.1: Interpreting boxplots

Figure 3: Proportion of AM ingredient used by enterprise type and EMA category, 2024

Method: Products were grouped into EMA categories (EMA, 2020) based on the class of AM ingredients they contained. Products with multiple different AM ingredients were categorised according to the AM ingredient in the formulation with the highest EMA category.

Limitations: As this analysis is based on mass of AM ingredient, low-potency AMs such as tetracyclines contribute more to the total mass than high-potency AMs such as 3rd generation cephalosporins. Future reports aim to also report dose-based AMU metrics, such as DDDvet (ESVAC, 2016).

Figure 4: Proportion of AM classes used by enterprise type and EMA category, 2024

Method: AM ingredient was taken from the VMD SPC for each AM product. Proportion by mass (mg) of each class used was calculated.

Limitations: Same as limitations for Figure 3.

Figure 5: Proportion of AM product used by enterprise type and administration route, 2024

Method: Administration route was taken from the VMD SPC for each product, and the proportion by mass (mg) of each AM product used was calculated.

Limitations: The administration route listed on the SPC may not reflect the administration route used by the veterinary surgeon and farmer. For example, oral powders are sometimes used off-label in footbaths. Therefore, this analysis may not be indicative of the administration route used for each product.

Figure 6: Doses of intramammary treatments used, 2024

Method: Doses for dry cow and lactating cow AM-containing intramammary (IMM) products were calculated using methodology defined by CHAWG (CHAWG, 2020). For dry cow therapy: 1 dose = 4 tubes; for lactating cow therapy: 1 dose = 3 tubes (over the course of treatment, an average of 3 tubes are applied to one quarter). The following equation was used to calculate doses per cow for each dairy enterprise:

$$\text{Doses per cow} = \frac{Number\ of\ IMM\ doses}{Number\ of\ adult\ cows}$$

Limitations: These calculations assume the number of tubes used per course to be 4 (for dry cow therapy) and 3 (for lactating cow therapy), whereas a farmer or veterinary surgeon, in reality, may have used a different number of tubes.

Figure 7: Mean monthly AM sales (mg/kg) by enterprise type, 2024

Method: The date of AM transaction was used to group 2024 AM sales into months. The mean monthly AMU (mg/kg; see "Calculating AMU" for methodology) was calculated for each month for each enterprise type (beef, sheep, dairy).

Limitations: The date of AM transaction may not accurately represent the date of AM use, as farmers may store some AMs on farm for future use, so this analysis should be considered indicative of AM sales only.

Figure 8: Monthly percentage change in AM sale by mass (mg) by enterprise type and administration route, 2024

Method: The percentage of the 2024 total AM mass purchased in each month (i.e. relative increase or decrease in mass [mg] of AMs) by administration route and enterprise type was calculated using the following equation:

$$\text{Relative increase or decrease in AM sales by mass (mg)} = \frac{Total\ AM\ purchased\ that\ month\ (\frac{mg}{kg})}{Total\ AM\ purchased\ over\ year\ (\frac{mg}{kg})} x100$$

This was then compared to the expected amount (i.e. if AM was purchased equally across the whole year) and the difference was reported as the 'change in sale (% by AM mass)'. Values >0% indicate an increase in purchasing in those months, whereas values <0% indicate a decrease in purchasing.

Limitations: Same as limitations for Figure 7.

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