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A new vision for responsible antibiotic use

through data safeguarding and optimisation in the UK farm livestock sectors

Veterinary Schools Council

Food Industry Initiative on ANTIMICROBIALS

Contents

Foreword

The aim of this report is to highlight opportunities to improve antibiotic data collection, collation and use in UK farm animal sectors and, through this, to support responsible use of antibiotics.

The need and opportunities for centralised, national-level data on antibiotic use in the dairy, beef and sheep sectors are particular areas of focus within the report. However, opportunities to achieve more with data held by sectors which already report 90% or more of their antibiotic use, such as those in poultry, pig and aquaculture sectors, are also discussed.

An important question is 'why' do we need to do more with data? After all, the UK has been a global leader in driving farm antibiotic stewardship over the past decade. One answer is that new EU legislation mandating national data collection and collation by sector means we risk falling behind our European neighbours very quickly, reducing our competitiveness. It is also far easier to prove our commitment to critics if we are able to evidence our actions with data.

There are practical reasons too: farmers, veterinarians and government agencies are better placed to reduce antibiotic use and antimicrobial resistance (AMR) if they have more data on usage, the efficacy of and resistance to different antibiotics, and evolving best practice.

Lastly, there is the moral responsibility: AMR is already considered a 'slow-moving' pandemic and so much more can be done to mitigate it – mostly through driving responsible use, but also, for example, through modelling evolving diseases and resistance patterns. However, an effort to do these in any meaningful way requires accessible, transparent and reliable data.

These are compelling motives, and change will rely on collaboration between farmers and veterinarians, supportive supply chains, and – importantly – better sharing and utilisation of data. However, farmers have most to risk in sharing data beyond their immediately trusted groups: farmers often face unfair judgement and economic repercussions if their data are misused or misinterpreted. Veterinarians also have a role to play; as gatekeepers of antibiotics, they are in a strong position to reassure farmers of the benefits and safety of sharing data more widely. Despite this, both farmers and veterinarians need to trust that all actors within supply chains who might gain access to the information will respect data ownership and privacy.

This is why the Veterinary Schools Council sub-group on Antimicrobial Resistance (VSC-AMR) and the Food Industry Initiative on Antimicrobials (FIIA) have joined forces to compile this report. Within it, we recognise the need for clarity, mutual understanding, trust and leadership, especially among farmers, veterinarians and the supply chain.

Veterinary Schools Council sub-group on Antimicrobial Resistance &
Food Industry Initiative on Antimicrobials

There are a number of suggested actions arising from this report, but if a single 'take home message' can be highlighted, it is the manifold benefits of moving past the barriers and issues so we are no longer justifying why we cannot make progress but are problem-solving how we can. In this way, we believe UK farm livestock production has the potential to go from 'good' to 'great', and maintain its leading role in antibiotic stewardship through even better management, prevention and clinical excellence.

We thank the Agriculture and Horticulture Development Board (AHDB), the Veterinary Medicines Directorate (VMD), and others for their contributions towards the thinking on how to achieve this. We especially thank Catrina Prince from the VMD for her input to the illustrative scenarios of best practice in data gathering, analysis and presentation.

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Executive Summary

As part of its efforts towards fighting the global challenge of antimicrobial resistance (AMR), the UK livestock industry has made considerable strides in reducing, refining and replacing antibiotic use over the past 10 years, to have among the lowest antibiotic sales in Europe on a mg/kg basis. Furthermore, it has been largely able to demonstrate this through openly publishing product sales data. However, maintaining and reinforcing this leadership position, and making further progress towards 'responsible use', will mean addressing challenges around availability and utilisation of data.

One such challenge is variability in the availability of nationally collated antibiotic use or prescription data – as opposed to product sales data – which allows a more granular understanding of use in different livestock sectors. For example, while over 90% of such data in each of the UK poultry, pig and aquaculture sectors are collated and reported, 2023 was the first year any centrally collated data were reported for UK dairy, beef and sheep. Even so, these data covered just 28% of UK dairy cows and less than 10% of sheep and beef production.

These ruminant sectors are complex, lacking the opportunities and infrastructure which made it possible for the more integrated sectors to start reporting national-level antibiotic use/prescription data several years ago. Nonetheless, centralised, national-level data on antibiotic use and prescriptions would allow them to prove their claimed low levels of use, and significantly expand opportunities to benchmark, improve and report progress in a way that sales data, including products with authorisations for many different species, can never achieve. It would also create a level playing field with European dairy, beef and sheep producers who are either mandated now, or will be shortly, to collate these data each year.

A second challenge is how to make use of opportunities around data utilisation. If antibiotic use and prescription data included target conditions and effectiveness of treatment, this could be combined with disease and resistance surveillance data to help identify patterns. All UK sectors could benefit from exploring this further.

Despite these many advantages, barriers to data collection, collation and utilisation persist. In the cattle and sheep sectors, farmers (as primary data holders) have not always had adequate communication or consideration of their role, and this has impacted confidence and trust. There are other barriers, including technical (How can data practically be shared?), motivational (Who benefits and how?), and economic (Who pays, and where do commercial databases fit in?), which have hampered progress. Improved transparency around data sharing and permissions, better data 'literacy', clarity around the risks and benefits, incentives for data owners, and agreement on the end goal, would all help to address these barriers.

This report provides three recommendations to address the challenges around data.

1. **Enshrine common principles:** The UK farming industry, from farm to fork, should accept and adopt a set of key principles on data sharing and use as an industry standard.

2. **Understand barriers to data sharing:** A study of barriers to data sharing and use should be undertaken across the UK livestock and aquaculture sectors, and through the various supply chain levels, to identify where issues lie and how they can be overcome.

3. **Agree acceptable methods for publishing data:** The most appropriate data agreements and publishing methods, processes and bodies should be identified to improve confidence and reciprocity. This may require focus from a cross-industry group.

1. Introduction – the story so far

Antimicrobial-resistance (AMR) in bacteria is a natural phenomenon which occurs everywhere there are antibiotics. This includes in the environment (many antibiotics are derived from the soil) as well as in people, farm animals, pets and food. AMR can also be transferred between all of these through direct and indirect pathways. While AMR is a bacterium's natural response to a threat, and so can be found in pristine environments unrelated to human activity [1,2,3,4,5], the main driver of resistance is widely established as human manufacture and use of antibiotics across a range of applications.

AMR is now recognised as a critical threat to human and animal health. Around 130,000 tonnes of antibiotics are used globally every year[6], creating many opportunities for resistance to develop. In 2016, the O'Neill AMR Review[7]estimated there were 700,000 human deaths from drug-resistant infections in 2016, which would rise to 10 million by 2050 if unchecked. Despite considerable efforts in a number of countries, the latest Global Burden of Bacterial AMR in 2019 study[8] indicates this trajectory has already been exceeded, with an estimated 4.95 million deaths associated with AMR in 2019, 1.27 million of which were caused directly by AMR.

There is clear evidence that use of antibiotics (as a subset of antimicrobials and the main focus in this paper) in medical environments for the treatment of human disease is the leading cause of the growth in human AMR infection[9,10]. Despite this, AMR is a One Health issue crossing human, animal and environmental boundaries. Correlations between use of antibiotics in food-producing animals and human drug-resistant conditions are limited, and largely confined to foodborne pathogens (e.g. Campylobacter spp.[11]). Nonetheless, the transfer of resistance from animals to humans remains a risk. Furthermore, significant reductions in efficacy of some farm antibiotics due to AMR are now being recorded (e.g. spectinomycin, which is now delisted to treat E. coli infections in neonatal lambs[12]), underlining the importance of stewardship for the future of effective veterinary medicines. It is also possible that use on farms could contribute to the prevalence of resistance genes in our ecosystem with hitherto unknown ramifications for human medicine and the wider environment.

In the UK, the farming and veterinary response to the AMR threat has been to more than halve sales of antibiotics for food-producing animals on a voluntary basis since 2015[13]. This has resulted in the UK now having among the lowest sales of antibiotics for food-producing animals (on a national weight for weight basis) in Europe[14]. Despite this, data from 2021 show rates of reduction in sales have slowed, and quantities of products used within some livestock sectors remain unclear as the products are licensed across a number of different species.

The question is: where does the UK go from here? How can livestock sectors build on their achievements, define what responsible use of antibiotics means, and get better at disease prevention? How can they also instil confidence in the public that animal welfare and individual human and public health are promoted and protected? Unquestionably, information is key to answering these and many more questions. Yet efforts to improve access to data and analysis remain fraught with confusing terminology and unclear motives. Confidence in sharing data for analysis is low among farmers in many countries due to safeguarding concerns[15,16], which is understandable given their lack of direct control within most supply chains and the perceived risk of criticism, reduced opportunities or penalties.

In this paper, the Veterinary Schools Council sub-group on Antimicrobial Resistance (VSC-AMR) and the Food Industry Initiative on Antimicrobials (FIIA) – both significant proponents of the benefits of data collation and analysis – identify what quality antibiotic use and prescription data (referred to in this document as 'AMU' (antimicrobial use) data) in livestock look like, what improved data capture could achieve, where the risks and concerns lie, and what needs to be done to build confidence and engagement for the benefit of the UK livestock farming sectors.

2. What is 'Responsible Use'?

According to the Food and Agriculture Organization of the United Nations (FAO)[17], responsible use of antibiotics covers many different elements including:

- Prevention of infection through vaccination, good husbandry etc.
- Avoiding unnecessary use of antibiotics
- Avoiding use of antibiotics critical to humans wherever possible
- Using the right pharmaceutical
- Using antibiotics in a medically correct way
- Recording and feedback

Responsible use is not necessarily the same as zero use, and stakeholder communication should draw attention to the potential for perverse outcomes arising from overly focusing on absolute reductions in use, or on limiting choice of antibiotics at farm level. Responsible use is a matter that needs to be addressed on-farm by farmers and their veterinarians, and based on the specific circumstances and knowledge of the issues at play.

For this reason, responsible use is very hard to define. This challenge has been partially overcome in the past by using a common 'mantra' within the UK farming industry, first coined by the Responsible Use of Medicine in Agriculture (RUMA) Alliance, that responsible use is: *"As little as possible but as much as necessary"*.

While this was sufficient for many years, it has become clear that as the focus on antibiotic use has increased, so this definition needs to be more explicit and provide better direction. This is especially the case given the range of understandings of this simple statement among those within and outside farming. Furthermore, the prioritisation of products by importance to human health should be observed. Classifications are available from both the World Health Organization[18] and the European Medicines Agency (EMA)[19]. The UK's Veterinary Medicines Directorate (VMD) and RUMA both follow the advice of the EMA given it is more geographically appropriate and also balances human health priorities with those of animals.

Therefore, as an alternative, it is proposed that the following statement based on the specific elements articulated by the FAO and the spirit of the RUMA 'mantra' is considered for the UK farm veterinary context:

> *Responsible use of antibiotics is:*
>
> - *elimination of any unnecessary, irresponsible or inappropriate treatments, underpinned by effective disease prevention based on good animal husbandry and veterinary practice;*
>
> - *targeted and correctly dosed use of the most appropriate antibiotic for each situation, species and pathogen, with particular regard to European Medicine Agency classifications; and*
>
> - *administration according to established good practice, balancing disease management, animal husbandry and practicalities.*
>
> *The ideal scenario is therapeutic treatment of an individual animal (practical handling considerations accepted), giving rise to an expected response of disease resolution, with no need for any unplanned follow-up treatment. Any deviation from this should initiate a review to examine whether and how such a situation can be avoided in the future.*

3. A short history of farm antibiotic data collection and collation

Our ability to determine responsible use of antibiotics starts with data. Over the past decade, data on sales of antibiotics for food-producing animals has increased exponentially, with European countries in the vanguard. Denmark was the first to publish in 1996[20], collating antibiotic consumption and resistance data across farm animal, food and medical settings. Following this, a Danish government programme to target its pig sector was established, which successfully supported a c.25% reduction in use[21]. Data played a pivotal role in helping to develop optimal biosecurity protocols, identifying interventions and setting government-regulated targets. A case study compiled by the FAO catalogues Denmark's success in this area[22], identifying continuous analysis and feedback as drivers for change.

The Netherlands followed not long after, first publishing data on antibiotic sales for farm animals in 2002, with human data subsequently added[23]. In 2009 the Dutch government launched its programme to tackle AMU in pigs, veal calves, broilers and dairy cows. From 2009 to 2016, antibiotic sales fell by 64% through a regulatory-led approach including frequent veterinary visits and scrutiny of prescribing rates in each veterinary practice[24].

These are two early examples but, in general, European countries have been active in stewardship and this has been largely facilitated by data and benchmarking, particularly through the European Surveillance of Veterinary Consumption (ESVAC) group. ESVAC was responsible for defining the Population Correction Unit (PCU)[25] which acts as a proxy for the size of the animal population and has allowed data from different countries and across different species to be standardised and compared. In 2011, ESVAC released its first report on veterinary antibiotic sales between 2005 and 2009, and its latest report, released November 2023[14], showed that total sales in Europe had more than halved between 2011 and 2022.

In the UK, the Government's Veterinary Medicines Directorate (VMD) has been collating pharmaceutical sales figures since 1993. While this was voluntary at first, the submission of sales data became statutory in 2005. These data have been posted online since 2006, with the first UK Veterinary Antibiotic Resistance and Sales Surveillance report (VARSS) published in 2014, summarising data from 2009 to 2013). Since then, reports have been released annually[26] and have undoubtedly played a central role in the UK's success in halving sales since 2015[13].

While sales data are a useful gauge of responsible use, they can only signal the direction of travel at a macro level and do not – with a few exceptions – reveal use by sector or species due to many products holding multi-species licences.

In the UK, some sectors set out to address this lack of specific information by collating AMU data in their own species in order to understand their use of products as well as the contribution their sector was making to overall sales. This prompted other sectors to follow suit. The clearest example is the leadership of the British Poultry Council's (BPC) antibiotic stewardship programme. Starting in 2011, the poultry meat sector successfully gathered data relating to over 90% of production, and was the first to submit AMU figures to the VMD and have them published (see 2014 VARSS report)[27]. As more than half of antibiotics sold for food-producing animals in the UK are licensed for pig and poultry use only, publishing these data meant AMU in poultry meat production could be allocated to that sector, placing pressure on the laying hen and pig sectors to clarify their relative use of remaining sales.

Efforts were already underway in laying hens, with the British Egg Industry Council (BEIC) commencing AMU data collection in 2014 and releasing its findings for the first time in the VMD's 2016 VARSS report. Plans for a system to capture data for AMU in the UK pig sector were also proposed in 2014. The electronic Medicine Book-Pigs (eMB-Pigs)[28] was subsequently delivered through a collaboration between the VMD and the UK pig industry in April 2016, led and now funded by the Agriculture and Horticulture Development Board (AHDB) levy body. As data capture within eMB-Pigs grew, it became possible to understand patterns of use. Now, with AMU data for over 95% of annual UK pigmeat production captured through eMB-Pigs, the sector is able to evidence its consumption of antibiotics as a whole. It has recently demonstrated a reduction in AMU of three-quarters since 2015, and, importantly, supports individual producers to benchmark against peer groups, thus encouraging a veterinary-led approach to the concept of responsible use[29].

These developments prompted other UK food-producing animal sectors to look at ways to gather AMU data and publish these annually alongside interventions to improve stewardship. The result is UK farming can now provide AMU data for 90%+ of production in the poultry meat, laying hen, gamebird, salmon, trout and pig sectors, all supplied voluntarily to the VMD, with progress against a set of self-determined targets reported by RUMA[30]. The success of this voluntary, cross-industry-led approach has recently been documented in a case study published by the FAO[31], in which the trusted relationships across stakeholders – especially between farmers, veterinarians, and government – are identified as instrumental to sustained behaviour change and embedding positive practices.

However, significant challenges remain with centralised data collection in the key dairy, beef and sheep sectors in the UK. While these sectors are believed to use relatively low amounts of antibiotics on a mg/kg basis compared with some other sectors, they account for a relatively large percentage of the antibiotics administered to farm animals each year in the UK because these sectors comprise:

- More than half of all farms[32]
- Over 40% of farmgate value[32]
- Around two-thirds of the food-producing animal biomass[33].

One of the challenges with collecting AMU data from the dairy, beef and sheep sectors is there are far more farms than in the other sectors combined, and they tend to have more fragmented supply chains. Where sizeable datasets do exist within these sectors, they have, until recently, resided in different silos – for example, being held by specific consultancy groups or supply chains – and are sometimes released, but as aggregated data. However, some extremely successful initiatives to collect AMU data are in operation, particularly among the bigger dairy processors, and in Wales through Welsh Lamb and Beef Producers (WLBP) and their Farm Assured Welsh Livestock (FAWL) programme. Until recently, these have not been pooled with other datasets to cover a larger percentage of the national population in those sectors.

This is now changing with the advent of the Medicine Hub[34], developed and administered by the AHDB, which has created a pre-competitive platform through which these different datasets as well data from individual farms can be brought together. Medicine Hub was able to report data across contributing cattle and sheep farms in 2023 for the first time, covering AMU in 2022. This was mainly populated from pre-existing datasets, such as those held by WLBP, dairy processors and consultants, and direct supply groups for the main supermarkets.

Despite this, barriers to bringing data together in the cattle and sheep sectors remain considerable. Outside of direct or co-operative supply chains, there are few incentives for sharing, and the logistical challenges of communication and data transfer persist. Concerns also remain among farmers about how their data will be used and safeguarded.

At the same time, changes are happening apace in the EU as its new Veterinary Medicines Regulations (VMRs) now require national data on AMU to be collated and reported annually for cattle, pigs, chickens and turkeys by 2024, and other food-producing species including sheep and fish species by 2027[35]. In the UK's equivalent VMRs, proposed in 2023 and due to be finalised and passed as legislation in 2024 (correct at time of going to press), the collection of AMU data remains voluntary – albeit with the option to legislate if insufficient progress is made[36].

4. A vision for farm antibiotic data use

a) Introduction

In a 2016 blog, Professor Sir Ian Boyd, Chief Scientific Adviser at Defra 2016-2019, described some of the opportunities for 'open data' within agriculture[37]. These included providing a solution to global problems of food poverty and poor nutrition, precipitated as population increases and food production becomes more costly due to climate change and uncertainties about energy and fertiliser production. Simply allowing information to flow easily between those who have knowledge, and those who need it, would help understanding of disease challenges. It would also allow adaptation of farming methods to reduce impacts, as well as support farmers in finding markets for produce and getting paid, he said.

These are 'big picture' benefits of open data, but they are also relevant to AMU data and how those data translate into animal welfare, productivity, and environmental and reputational benefits, as outlined next.

b) The benefits of better data capture and use for farmers and veterinarians

Reputational impact

AMR of significance to human and animal health can emerge anywhere, and because of this, it will usually generate significant interest and concern. Indeed, tackling antibiotic resistance is a One Health initiative because everyone is affected.

Regardless of how well a sector is stewarding antibiotic use, without data and evidence to track this, both critics and advocates will rely on hearsay, anecdote and speculation. Therefore, collecting, collating and publishing AMU data is important for demonstrating transparency, which has reputational benefits for the industry through improved consumer confidence.

If a sector can provide data to demonstrate: a) its usage level and patterns; b) its track record – for example on responsible reductions, or low use of highest priority critically important antimicrobials for human medicine; and c) its commitment to adapt use if needed to respond to emerging AMR risks in animal and human health, it will inspire confidence in the sector's ability to take its AMR responsibilities seriously.

Improving analysis and decision making

Recording and benchmarking AMU enables trends and changes in use to be monitored and understood by veterinarians and farmers, which then supports informed stewardship decisions on farms.

In general, benchmarking data (i.e. *"…the comparison of one party's AMU with AMU in a pre-defined population of similar parties"*[38]) can change mindset and behaviour – highlighting potential for improvement[39,40], as well as validating skills and abilities[41]. Individual antibiotic data records are important in themselves, but are far more helpful when considered in context with others' data. Benchmarking AMU can take place within producer, discussion or supply chain groups, but these groups are often unrepresentative of the wider industry because of selection by geography, performance or attitude. Benchmarking within a centralised, national dataset provides an additional basis for analysis and comparison, is more likely to balance the effect of outliers, and broadens the scope for insight and improvement at farm, group or industry level.

c) The benefits of better data capture and use for supply chains and markets

Securing domestic markets

As other UK livestock sectors continue to publish national-level AMU data covering 90% or more of their population (Figure 1), so UK dairy, beef and sheep will come under increasing pressure to show similar engagement and transparency on this important public health issue.

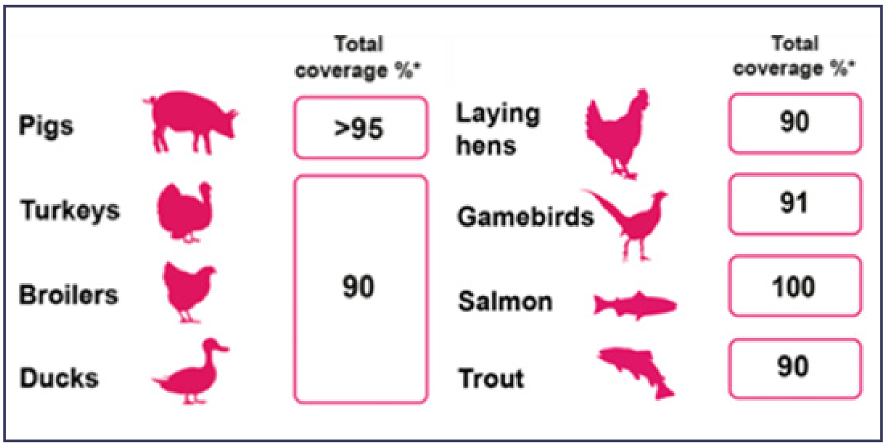

Figure 1: Current levels of AMU data capture, as summarised in the VARSS 2021 report[42]

(not depicted graphically in 2022 report)

The domestic challenges go further. Processors and retailers are under growing pressure from external groups to determine, report and compare AMU in their supply chains. A centralised, independently-run database collating data on behalf of the industry could provide aggregated (summary) data in a way that safeguards farmer identity – yet allows supply chain operators to meet customer expectations that use is monitored.

International competitiveness

As indicated in Section 3, the new EU VMRs include mandated collection and collation of AMU data. Many EU countries have been proactively preparing for the new regulations. Denmark and the Netherlands introduced mandatory data collection some time ago. In Belgium, data collection from veterinarians has been mandatory in veal, pigs and poultry since 2017; and in Spain and Italy, data collection in all livestock species has been mandatory since 2018 and 2019 respectively. Italy has gone a step further by developing systems that combine AMU data with other on-farm data to allow a standardised overview and benchmarking of farm practices.

With centralised collection of AMU data in UK cattle and sheep currently remaining voluntary (also explained in Section 3), these sectors risk falling behind. One consequence of this could be a competitive imbalance. For example, many beef supply chains source product from both the UK and Ireland; if Irish suppliers can provide data which UK suppliers cannot, sourcing from Ireland could become preferable. Alternatively, EU member states could plausibly demand trade equivalency from all their suppliers, leaving UK producers unable to meet data requirements for the beef, lamb and dairy products they wish to export to those countries. Similarly, countries to which both the UK and EU export could preferentially import from EU countries due to better provision of AMU data.

d) The benefits of better data capture and use for research

Disease surveillance and prevention

All data have value, but the amount of value can depend on how meaningful the data are. A dataset might have intrinsic worth because it supports certain insights, but datasets become far more valuable when linked and can explain and predict patterns. The most valuable data are those providing insights that can be used to make decisions or spur action[43].

Access to national-level data of sufficient detail should allow treatments for a range of conditions to be tracked. This in turn creates opportunities to understand treatment practices, disease prevalence or even emerging resistance where treatments prove ineffective. For example, significantly increased use of lincomycin or tiamulin over a specific year might indicate increased prevalence of swine dysentery, and switching to a different antibiotic could signify the emergence of resistance against these products.

This theoretical approach is being put to the test through recently-developed 'disease dashboards' from the Animal and Plant Health Agency (APHA)[44]. These aim to provide information on the results of clinical submissions for disease screening, although results need to be interpreted in light of number and type of submissions. Indications of disease incidence in pigs are currently being shared with the Pig Health & Welfare Council so they can be discussed in relation to AMU trends on eMB-Pigs.

In this way, improved data capture of on-farm AMU could improve interpretation of surveillance data on disease patterns or AMR prevalence from APHA, the Food Standards Agency or the VMD. Understanding patterns of treatment and resistance at point of administration could even reduce the incidence of disease in the first place and contain the spread of AMR.

Addressing efficiency and environmental impact

Better antibiotic data do not just support good practice in disease management. Prevention of disease reduces losses and improves performance, whether milk production, conception or growth rate efficiency. This, in turn, links to resource efficiency and greenhouse gas emissions, and therefore environmental impact and sustainability. It has been calculated that reductions in methane emissions of up to 30% are possible in cattle and sheep, starting with improved health and welfare, which also provides a foundation for breeding and feeding interventions[45]. As such, all these areas can be improved through the acquisition, interpretation and extrapolation of antibiotic data.

e) Risks of not sharing data

As many barriers as there are to sharing data, there are also risks to not sharing data. Refusing to openly share information can diminish trust, which has been described as *"…the ultimate currency in the relationship all institutions build with their stakeholders"*[46]. This includes the relationship between farming, its consumers and wider society. Therefore, transparency around AMU is important in building trust in a sector or food production system.

By helping to define targets across the UK farm livestock sectors and reporting on progress annually, RUMA's Targets Task Force[30] has introduced transparency. This in turn has led to more trusted relationships between UK farming and the regulator of veterinary medicines, the VMD. Trust has also been increased with the medical community – at least at a Governmental level – through former Chief Medical Officer Dame Sally Davies, who has praised the overall progress of UK farming in improving antibiotic stewardship.

Publishing data openly and being honest about progress demonstrates UK farming's accountability for its share of the AMR challenge. This has helped the industry manage criticism from campaign groups. For example, sector-wide transparency has prevented the issue of antibiotic use in farm livestock resurging into the type of crisis promised around 2015-2016, when use of antibiotics in livestock was held largely responsible for drug-resistant infections and the spread of resistance in human medicine.

5. Barriers and opportunities for better use of farm antibiotic data

Reasons for achieving the vision for AMU data laid out in Section 4 may sound compelling, but there are good reasons why progress has been slow and barriers still exist. A 2021 systematic review of 65 studies examining impediments to data sharing in general[47] suggested six categories of potential issues impeding 'data confidence': technical, motivational, economic, political, legal and ethical. Here, we apply these to the UK livestock industry, and examine the opportunities to overcome them.

a) Obstacles to data capture, use and data 'confidence'

Technical barriers

Lack of data collection and data preservation are two barriers relevant to livestock production, as well as restrictive data formats. Use of veterinary products and treatment of animals on farms must, by UK law, be recorded in a medicine book, and antibiotic products must be prescribed by a veterinarian. Hence, these data do exist – but not necessarily in formats that easily allow collection and collation at sector, regional or national level. Lack of rural broadband infrastructure limits electronic on-farm data capture[48], although cloud-based systems that allow offline capture and subsequent synching are becoming more prevalent; and lack of relevant training and technical understanding among farmers and veterinarians[48] is a further issue. This is why interfaces for data upload need to be intuitive, simple to access and time-efficient to ensure they facilitate rather than block participation.

Motivational barriers

Motivational barriers identified in the review included lack of incentive. A 2020 Kantar report[49] for UK government echoed this factor, finding that lack of emphasis on the benefits generated by data sharing is a key barrier to progress in data sharing projects. If financial and animal welfare benefits can motivate farmers to record antibiotic data[48], then a lack of these is likely to disincentivise. Overall, it seems the benefits of data collection and collation are often unclear to primary data holders. Moreover, perceived risks can be amplified due to confusion over terminology and poor communication about the project purpose. Good leadership setting out the benefits and opportunities to data holders can help drive engagement. Explaining risks, outlining mitigations and providing reassurance from those in authority can help allay primary producers' fears of data being used against them by supply chains and retailers. Anecdotal evidence from retailers supports this, where there has been initial reluctance around AMU data submission linked to a perception that data disappears into a 'black hole'. Subsequently, visibility of data and associated insight has driven engagement, suggesting that financial gain might be overemphasised as a motivational element.

Economic barriers

A key economic barrier identified in the review was lack of resources. In livestock production, more data mean more work, time and potentially financial investment for farmers, with unknown risk and return. At the most basic level of data capture and collation, there are questions over 'who pays' for the time and infrastructure required. Databases can be challenging to populate, but utilising the services of those with expertise in handling data can incur cost. With margins tight in many sectors, lack of funding for data upload has been a sufficient barrier to further engagement. Similarly, apps, application programming interfaces (APIs) or other technical solutions which could ease data upload need development investment. Until there is sufficient demand for such technologies, they are – unfortunately – unlikely to become part of standard livestock management programmes. Another economic barrier comes from those who have already invested in data collection and collation, who may be unwilling to share data for fear of losing a perceived commercial advantage.

Political barriers

Lack of trust and lack of guidelines, identified in the review, are barriers which resonate strongly with livestock farming. Data can illustrate progress and good practice – but they can also highlight challenges which are complex and open to misinterpretation. Credible concerns have been raised about AMU data falling into the wrong hands: these include the risk of information being misused or mismanaged, interpreted by those who are inexperienced or unqualified, analysed against inappropriate parameters, or exploited for external agendas. The politicising of this issue by campaign groups is a particular concern, where links are sought between antibiotic use and methods of production so as to support certain ideologies – e.g. an assumption that animals kept in 'high welfare' systems require fewer antibiotic treatments. Among farmers, this is arguably one of the more concerning aspects of data visibility.

Another example is the potential for supply chains to reward producers with low or zero use of antibiotics, irrespective of whether this represents responsible use. Such reliance on a single, overly simplified proxy for 'good' could risk animal welfare being unreasonably or unlawfully compromised with sick animals going untreated. This would be of particular concern if a perceived undesirable pattern of use in a farming business attracted financial penalties or 'de-listing' from a retail contract without an understanding of context. Equally, a period of high AMU could reflect an entirely legitimate and appropriate response to a disease outbreak, or persistent high use could be down to a failure of infrastructure, a situation that needs support to rectify, not penalties.

Those who stand to be penalised most by failures in data handling or safeguarding are farmers themselves. Farmers and their representatives recognise this. Such lack of trust often results in motives (from all sides) being questioned, with suspicion remaining firmly entrenched. This prevents the evolution of systems in which AMU data can be used to improve efficiency, performance and practices to create a better future for UK livestock industries. It therefore remains paramount that farmers feel comfortable and confident submitting data.

Legal barriers

Trust is often defined as a legal term, as the foundation of the word is in law and finance. Therefore, this explains why the review found that one of the major (so-called) legal barriers was lack of trust. Distrust was exacerbated by a poor understanding of terminologies, regulatory obligations and protocols. Education and information barriers to confident data capture and handling are evident in farming, where it is common to find data terms used incorrectly, for example, confusing 'anonymised' with 'aggregated' data. Interpretation of GDPR regulations, privacy and data permissions also vary depending on whether an optimistic or risk averse approach is taken. A common understanding of terminology and parameters will be important to build trust across the livestock sectors. As national data collation and reporting for AMU in farm species remains voluntary in the UK (as outlined in Section 3), this presents a challenge. However, the proposed VMRs contain provision for AMU data collection and collation to become a legal requirement if there is insufficient progress in voluntary reporting.

Ethical barriers

Data sharing has not always been fair and data holders can feel exploited in transactions where they receive little credit or benefit for their participation and hard work. Livestock farming is no stranger to this issue. It is fair and reasonable that those who submit data to a database should be able to obtain collated or analysed data back in order to use it for their own benchmarking and comparative ends, and/or trusted insight. Otherwise, there is likely to be insufficient incentive to participate in a voluntary scheme. Despite this, the way in which data reciprocity occurs, and its extent, is not necessarily clarified in advance, which has served to further diminish trust. FIIA has tried to address some of the trust concerns farmers have with the supply chain by publishing a Code of Conduct on Access to and Use of Industry Antibiotic Data, to which all FIIA members have agreed to abide[50]. Nonetheless, trust remain a key challenge.

b) Opportunities to improve confidence with data sharing and use

A growing body of research has examined factors that generate more positive attitudes toward data sharing among farmers and their support networks. The EU's Code of Conduct on agricultural data sharing by contractual agreement, published in 2019 by Copa-Cogeca[51], identified that farmers and agri-businesses were "more than willing to share data with each other and engage in a more open data mindset, but will only do so if the potential benefits and risks are made clear and when they can trust that these are settled in a proper and fair way through contractual agreements."

Transparency and responsibility were key to gaining trust, the Code stated, and engagement between stakeholders concerning the opportunities and challenges of data sharing was fundamental. A subsequent analysis of the Code carried out in 2021[52] argued that the extent to which a) information was understood by the more vulnerable party signing the contract – almost always the farmer – and b) responsibility was taken by the more powerful partner to provide that information, were both pivotal to fostering trust.

Themes of responsibility and trust are prominent in academic studies too. For example, it has been concluded that if 'smart' (i.e. technology and data-assisted) farming is to realise its potential, a number of issues concerning data sharing and permissions need to be addressed[53]. These include: understandable and transparent terms and conditions – especially who has access to the data, who derives benefits, and how privacy is managed; better awareness and data literacy to build confidence and improve data management practices; and open and transparent governance frameworks implemented by agricultural industries.

Open dialogue, education and awareness-raising along with good data governance have also been identified as essential to building trust in the adoption of smart farming systems[54]. With data, the distribution of benefits and risks between different actors in the agricultural sector is practically and symbolically important, and serves as yet another factor in a bigger power and information dynamic which is largely asymmetrical, favouring many in the supply chain but often not the farmer[55].

The benefits farmers receive from sharing data has been identified as an extremely important factor in the development of trust in a study examining perceptions of risk around smart farming in Ireland[56]. Farmers are more willing to share data if other farmers – or farmers in general – are the main ones to benefit[57], because farmers trust other farmers the most with their data. They also trust research institutes, but are least willing to share data if agribusiness and government benefit. The same study concluded that farmer co-operation over data was improved if farmers were engaged in a timely manner to ensure they were well informed of potential farm-level benefits, and if they were involved in data projects from the start as primary stakeholders.

Lastly, an important opportunity to increase confidence in sharing data would be to agree the more explicit definition of ‘responsible use’ recommended in Section 2. Agreeing and communicating this clearer definition would provide all stakeholders in the industry with a goal and shared purpose to improve collection and utilisation of data.

Together, these themes to improve willingness to share data can be summarised as: better transparency around data sharing and permissions; improved data ‘literacy’, communication and engagement; better distribution of risks and rewards of data sharing – especially ensuring farmers and other data owners benefit from sharing data; and a common understanding of what a goal of ‘Responsible Use’ represents.

6. Principles for securing better data outcomes

The analysis in previous sections lead to the following set of principles to secure better outcomes for utilisation and safeguarding of antibiotic data. These have been agreed by FIIA and VSC-AMR, and are recommended for general adoption.

a) General governing principles

Pivotal to improving confidence and engagement in centralised data is a clear articulation of the aspirations for those data, as well as protocols that are mutually agreed and understood.

1. Centralised databases should be developed by trusted and independent third parties so that they are able to gather preferably identifiable, but also anonymised, individual farm data as necessary, outside of commercial interests.

2. The primary goal is to establish national-level AMU data for that sector or species primarily for reputational purposes but potentially benchmarking too; other goals may be proposed and may change over time.

3. An ambition should be to release fully anonymised data for industry-promoting research, subject to formal assessment of the intended purpose.

4. An ambition should be to provide processors and retailers with aggregated (summary) AMU data for their supply chain in a way that safeguards farm identity, yet allows those supply chain operators to meet customer demands.

5. Individuals or organisations submitting data to centralised databases should expect reciprocity, meaning they should be able to receive aggregated information in return (in at least the same if not an improved format) to enhance and expand their own benchmarking activities, provided appropriate permissions and safeguards are in place.

6. Each farming sector should be ambitious and proactive in seeking to share aggregated AMU data, wherever considered 'safe' to do so for individual farmers and the UK farming industry as a whole, in the interests of transparency.

7. Stakeholders governing databases should be transparent, and decisions around when and what to publish or release as 'national aggregated or anonymised data' should rest with them. Where necessary, decisions to release information should be taken in collaboration with the VMD, interested sector groups and independent data experts.

8. Any aggregated or anonymised data released, published or shared must be done so with full context for the data provided including methodologies used, representativeness, coverage and potential bias (or otherwise), so as to avoid inappropriate comparisons.

9. Centralised datasets should never release identifiable data (where an individual farm or farmer might in any way be identified) without the express permission of the data holder (usually the farmer) and in line with data protection and privacy regulations.

10. Permissions given by individual farmers to share their data with third parties must be respected by data holders. These might include veterinarians, advisors, buyers, processors, retailers or membership organisations.

b) The need for individual farm data

There are a number of reasons why datasets which capture individual AMU records at farm or veterinary practice level are far preferable to those which simply add together pre-aggregated data. These reasons include: meeting regulatory needs; statistical robustness; effective use of data; and consistency of approach.

Regulatory needs

To calculate an industry-agreed mg/kg metric per species, the VMD requires information on use or prescription of each product alongside volume of sales and aggregated animal numbers for each farm providing data. This allows triangulation of AMU and sales data, but also the calculation of total antibiotic active ingredient for each product and other useful statistics. The collation of individual rather than aggregated records facilitates quality assurance of data, supports farm-level benchmarking, and shows distribution of AMU at a national level.

Statistical robustness

Aggregated data cannot be 'reconstituted' or validated with sufficient accuracy. For example, statistical means from aggregated datasets give no indication of the distribution of the data – a particular challenge given AMU data are widely recognised as having non-normal distributions. Median and interquartile ranges are less affected by outliers and are preferable to mean values, but cannot be combined with aggregated data from different data holders. Essentially, the statistical implications of bringing together aggregate data received from a number of datasets are complex, potentially producing spurious trends.

Analyses of datasets by academic researchers have also highlighted that groups collecting AMU data may not always calculate metrics in the same way. These calculations can be challenging and methodology has changed through the years – for example, variations in which of the data are included or omitted, varying formulae, and use of out-of-date conversion factors have all been identified and are risks to accepting aggregated datasets from different sources.

Effectiveness of data utilisation

Individual data records are necessary to understand the distribution of AMU within the national population of farms, and are therefore central to meeting the industry's sector-specific goals (set annually and facilitated by RUMA) in responsible antibiotic use. For example, experience with the electronic Medicine Book (eMB-Pigs) shows farm-level data can identify hotspots or explain trends in a way that is not possible using aggregated figures.

Both anonymised and identifiable individual data records have clear advantages over aggregated datasets. Anonymised farm-level data require no further legal permissions, as their capture is already compliant with UK-GDPR regulations on data protection. Collation of identifiable farm-level records for AMU allows de-duplication of data from different sources (e.g. bulk supply chain uploads, farm or veterinarian-entered data, farm software, devolved data exchange). Individual farm identifiers (actual or proxy) also enable the accurate comparison of year-on-year trends using the same sample or subsample of farms – for example, comparing spring block calving dairy herds, or finished pig production indoors.

Consistency of approach

The draft revised UK VMRs[36], discussed in Section 3, state that many sections of the veterinary medicines industry would benefit from closer harmonisation between British and EU regulatory frameworks. Amendments to the VMRs should therefore reflect EU changes where these are desirable and reduce divergence. Data on AMU per species in EU countries now requires information on products and animal biomass to be entered on to the new Antimicrobial Sales and Use Platform[58]. To ensure consistency with EU regulations (whether for trade, competition or comparison), the same information should be captured in the UK.

c) Robust and representative data

Representative samples

Collated data from samples of farms, herds or flocks within the national population are rarely representative. The size of a sample compared to the size of the population which it is selected to represent typically has an impact on the accuracy of a point value reported, such as an average (mean or median). When reporting estimates from a sample (not the whole population), it is also important to report the 95% confidence interval to give an estimation of the spread/ accuracy of an estimate. The 95% confidence interval indicates that if other samples were taken from the same population (in our case, a whole sector's AMU), we would expect the true estimate to be found within 95% of these intervals. A larger sample will make for a more precise estimate, with greater confidence that it is in the correct range. For example, a sample of 100 farms might have a median AMU of 20mg/kg, with a 95% confidence interval spanning 12-31mg/kg. A sample of 1,000 farms would have the same median, but will have more precise 95% confidence of 19-23mg/kg.

Even substantial AMU datasets are known to be skewed and cannot be assumed to be indicative of the whole. They are almost always convenience samples taken from a pre-existing group of farmers who are already – to a greater or lesser extent – engaged in terms of the value of information, which means they are inherently biased. This means they do not indicate an AMU value for the sector as a whole.

For instance, in the 2016 to 2019 VARSS reports[26], AMU data from large convenience samples representing between 30% and 34% of the national dairy herd were provided. Over these four years, mean AMU in those samples ranged from 26mg/kg (2016) to 17mg/kg (2017, 2018) to 22.5mg/kg (2019). There are various potential causes of the reported variation aside from differences in real sector-wide AMU. The 2019 report highlighted significant variation in the farms included in the samples each year. This meant that even though the numbers of animals included each year were equivalent to around a third of the UK dairy cow population, having different farms taking part could have influenced the averages reported. Indeed, when data from a smaller but more stable sample were reviewed over three of those years, there was far less variation in the mean from year to year (from 21.9mg/kg to 22.8mg/kg). This highlights the importance of interpreting any single statistic within the wider context of the dataset.

The distribution of AMU within samples of farms is a further factor as some farms use far more antibiotics than others. In a 2017 study of AMU on British dairy farms[59], it was determined that, among almost 300 farms in the study, the highest 25% of users were responsible for more than half of all the antibiotics used. In a 2017 study of over 200 sheep farms[60], a similar pattern could be seen where 80% of all AMU occurred in the highest-using 40% of flocks. It should be noted that a high level of antibiotic use in itself is not necessarily bad practice as it could be addressing a specific disease outbreak, or the veterinary elimination of a pathogen.

Despite challenges in obtaining sector-wide data, statistics from smaller samples have sometimes been incorrectly presented as 'industry data' in the media or press releases. Similarly, campaign groups might be tempted to compare AMU across different retail supply chains. However, the disparity in data availability, collection and methodologies across different supply chains may result in widely varying estimations of AMU between reported and true values for each sector and retailer in every measure. It is unlikely that any of these values will be representative, and trying to compare them will lead to spurious conclusions. Hence, when analysing even large samples, reports should clearly indicate that estimates of AMU should not be compared and the values presented are unlikely to represent the whole sector.

Sector-level AMU data

Sector-level AMU data refers to the amount of antibiotics prescribed and/or administered relative to a livestock or aquaculture sector. Sector-level data are important for monitoring trends within sectors and are derived differently by different sectors. For most major livestock sectors in the UK, national-level AMU data have been collected and provided to the VMD by the animal industries on a voluntary basis.

As mentioned previously, one sector's AMU figure will be calculated differently from another's (e.g. dairy, beef, salmon and poultry all collect information differently), and therefore it is inappropriate to compare AMU data from different sectors. It is also incorrect to compare AMU figures collected from individual farms or calculated as an average across several farms, against a national-level sector figure.

One reason a national sector target should not be interpreted as an individual farm-level target is that AMU will inevitably vary between individual farm types within a sector (e.g. a beef calf rearer compared with a calf finisher). Direct comparisons should avoided and caveats clearly stated where comparisons are made.

If comparing aggregate farm-level data (e.g. those collected by a processor or retailer) with published national figures is unavoidable, those making the comparison should present information taking into consideration the above principles for both samples. If differences between aggregate figures and national figures are described, this information should include commentary about the impact making such comparisons is likely to have on any conclusions drawn (i.e. that figures are not directly comparable and should be interpreted with care).

'National-level' data

At what point can it be claimed that sufficient high-quality data have been collated to determine a national AMU figure with reasonable confidence? For AMU data to be truly representative, they must be from a large enough and random sample within the population, or otherwise from 100% of the population. Both methods create a dataset representative of the national picture. However, collecting a large random sample or conducting a whole population census can be a time-consuming and expensive exercise, and is limited by data access and availability. Most AMU data are therefore collated from pre-existing datasets or through trade or assurance bodies that cover the vast majority of a particular sector. In most cases, this is a useful and pragmatic way of estimating AMU. The non-ruminant sectors reports of AMU data in the annual VARSS reports are collected in this way and all cover a minimum of 90% of the national population.

Due to the challenges in collecting and collating data from dairy, beef and sheep farms (outlined in Section 3), it is unlikely that 90% data coverage will be achieved in these UK sectors in the near future. Given this, at what stage should cattle and sheep data be considered sufficiently high quality to be presented alongside more 'nationally indicative' data from the aquaculture, pig and poultry sectors? We reported earlier in this section that data from 34% of the national dairy herd in a convenience sample reported in VARSS was found to be misleading, and noted that distribution in samples examining AMU are typically very skewed. It would therefore seem sensible to strongly caveat any datasets reported until the sample approaches 90% of the total population – or can be randomly collected. In the meantime, inclusion of smaller and appropriately caveated datasets for cattle and sheep, collated through the Medicine Hub as the national collection and collation platform, may incentivise other data holders to participate.

d) Best practice in data gathering, analysis and presentation

Principle 1: State the target population about which conclusions are to be drawn

Providing a target population definition is essential and will reduce the risk of incorrectly generalising results beyond the specific groups intended. A definition should also set clear thresholds for comparisons/trend monitoring within populations which will help identify selection bias, where certain groups are overrepresented or underrepresented in a sample (see below for more detail on these points). The target population definition should include:

- A specific population (e.g. all pigs raised for slaughter; all sheep flocks under the care of veterinary practice X; all commercial poultry farms supplying retailer Y)
- A geographic location (e.g. in the UK; in a 10km radius from Hereford; globally)
- A time boundary (e.g. in 2022; over the last decade; between May and June 2020)

Without a stated population definition, it is not possible to assess whether conclusions drawn from the data presented are valid.

Example 1: The importance of clearly defining a target population

A veterinarian practicing in South West England wants to better understand AMU in dairy herds. She has access to 20 dairy herds in the practice area, but only manages to collect AMU data from 19 of those herds for the previous calendar year. She uses the data from the 19 herds to calculate a mean average AMU of 15mg/kg (using the methodology outlined on the RUMA website). We might be very sceptical if this figure is reported as representing any of the following defined populations:

- *Dairy herds under the care of the neighbouring veterinary practice over the previous five years*
- *All dairy herds in the UK that year*

In contrast, if the figure is reported to represent the 20 herds in the veterinary practice area that year, we would have a lot more confidence that this was likely to be a true representation of those herds. However, it is impossible to make this judgement without the information contained within the population definition.

Principle 2: Define and state the sample coverage (number and percentage)

Once a population definition is established, it is possible to calculate the percentage of the population the sample covers. In some cases, where AMU is reported for every flock, herd or aquaculture site, this may be 100%. When defining the population as 'all the herds in the veterinary practice's area', for instance, as in Example 1, we could state that the herd coverage is 95% (n=19/20 herds). Alternatively, coverage could represent the % of animals (e.g. dairy cattle) existing in the area where data are collected, compared with the overall sample population (animals in that veterinarian's practice area).

Principle 3: Outline data selection method and data source

When presenting data, how the data have been selected should be stated, including from where they have been extracted or collected, and by whom. To report on Example 1, we might state: "Twenty farms under the care of one veterinarian and registered under CowCare Veterinary Practice in South West England were approached to join the study. Nineteen farms gave permission for their data to be shared. AMU data were collected by the study author from 19 farms using veterinary practice records." It is acceptable to provide this information in a report annexe or similar, depending on how the data are presented. Access to this information, however, should be straightforward and clear for readers.

Principle 4: Comment on any potential bias

There are several aspects that may affect the accuracy of an AMU figure (e.g. limited or selective sharing of AMU information or errors in measurement). For most purposes in collation of AMU data, selection bias is likely to be the most important factor. Selection bias occurs when the subjects (e.g. dairy cows or sheep) studied do not represent the target population about which conclusions are to be drawn. Bias may be known or unknown and may be measurable or unmeasurable. Example of potential sources of selection bias include:

- Over- or under-representation of certain farm types or farms with certain characteristics in the sample, as compared to the target population;
- Over- or under-representation of certain geographical areas in the sample, as compared to the target population;
- A higher proportion of farms from one processor or retailer included in the sample, as compared to the target population.

Example 2: Calculating AMU for beef animals destined for consumer products

Retailer X would like to understand AMU in the production of beef products they sell by calculating an aggregated figure. The retailer has a direct supply chain for 25% of their beef supply. They have 100% of AMU data from those finisher farms for the previous year, calculated at 7mg/kg. However, no AMU data are available to Retailer X from the rearer and grower farms where these animals previously resided. The other 75% of the retailer's beef is sourced through indirect supply chains, which includes an unspecified percentage of product from split carcases. Using this information, it would be correct to state: "One-quarter of the beef sold by Retailer X is finished on farms with an aggregated AMU of 7 mg/kg in the previous year." *Calculated using the 'farm-level' metric methodology described on the RUMA website[61].*

It would be important to clarify in any presentation of data that "Data were only available from farms in which animals spent a limited proportion of their adult lives, and antibiotic products used for these animals when they were on previous farms have not been accounted for. The figure presented therefore does not represent the lifetime total AMU per kg of animal produced, which is likely to be higher given that, for beef, antibiotics are more commonly administered in the rearing rather than finishing phases"[62].

Principle 5: Include details of any data pre-processing

When presenting data, any outliers or duplicates that have been removed from an original dataset should be clearly stated and explained. If outliers were removed, it is important to state the threshold for choosing such outliers; for duplicates, it is important to state the methodology used to identify duplicates. It is questionable to remove data from a whole dataset without clarifying why this was done.

Principle 6: Choose an appropriate metric and detail the methodology used

The many ways to measure and report AMU are appropriate for different purposes. For example, the PCU method used by ESVAC[25] for analysing sales data in food-producing animals allows comparisons across European countries across different years. In this method, however, only certain classes of livestock count towards the denominator biomass (e.g. AMU in beef cattle is only measured in terms of standardised weights for slaughter cattle). This works well for comparative reporting across countries but provides insufficient data at a farm level, and so would be appropriate for policymakers and international retailers to use, but less so for veterinarians working with individual farms.

The UK has developed and agreed benchmarking metrics within each UK farm sector in order to standardise AMU measurement for management purposes by farmers and their consultants, veterinarians or supply chains[61]. There are also bespoke methods/metrics that some consultancies or farms may choose to use to obtain a more granular picture of AMU in their operations[63]. FIIA members and the VSC-AMR agree that UK supply chains should report standardised industry-agreed metrics and methodologies in order to decrease confusion[61].

Principle 7: Do not compare 'apples with pears'

Within the datasets retailers are pressed to publish, there is often insufficient detail about methodology to gauge whether the same or differing methodologies are being used. Methodology can have a radical impact on the data reported, and calculations made using one method should not be compared with those calculated using another. Therefore, efforts should be made not to compare, explicitly or through implication, AMU figures which may differ in the metrics used, underlying sample and/or data collection.

Benchmarking – *"…the comparison of a party's AMU with AMU in a pre-defined population of similar parties"* [38] – is an important way to motivate farmers to reduce unnecessary use and share best practice. Collecting individual farm AMU data in a standardised format with appropriate permissions is crucial for AMU benchmarking, whether within eMB-Pigs or Medicine Hub, or among farmer groups, one or more veterinary practices or supply chains.

e) Best practice in sharing and interpretation of farm-level AMU data

Farmers should share any available farm AMU data – including benchmarking reports – with their veterinarian. In the absence of sector enterprise benchmarks, veterinarians and consultants may use sector-specific group reports (in identified or anonymised formats) to facilitate discussion with groups of clients.

When interpreting datasets made up of farm-level data, it is helpful to have information on the distribution of AMU within a sample; at a minimum, this should include the median, inter-quartile range and the full range of datapoints. Since AMU data are not normally distributed (most datasets show few farms using a high proportion of antibiotics, known as a 'right skew' of data), the median will provide a better indication than a mean of what average farms are using.

7. Conclusions and recommendations

The UK livestock farming sectors have made tremendous progress in monitoring and stewarding antibiotic use over the past decade. Despite this, progress is now stalling. It is likely that current activities have achieved as much as they can and new approaches will be needed to take ‘responsible use’ to the next level.

Part of this new approach is redefining what responsible use means so that it encompasses not only the decisions around using and administering antibiotics, but also reduces the need to use antibiotics in the first place. Meanwhile, veterinarians must continue to feel empowered and supported to use antibiotics as a treatment when warranted. In the world of unintended consequences, too firm a push back against any antibiotic use could result in newly trained cohorts of veterinarians becoming very reluctant to use any antibiotics at all. This could create ethical conflicts and serious challenges to animal health and welfare.

It is evident that use of data lies at the centre of solving many of these issues. From farm through to fork, there are significant opportunities for all in improved data sharing, ranging from reputation and trust to competitiveness. In particular, ensuring availability of national-level AMU data across all farm species, and utilising those data effectively to anticipate changing disease and resistance rates, would be game-changing from productivity and health and welfare perspectives.

A number of barriers to this vision persist, however. Some, such as a lack of confidence and incentive at farm level, may be exacerbated by both perceived and actual failures to share the benefits in previous projects. Others are more specific and concern technological, economic, legal or political barriers. It is likely that each individual sector and situation faces a unique set of barriers to improved use of data. VSC-AMR and FIIA make the following three recommendations as the first steps along a route to addressing these issues:

1. **Enshrine common principles:** The UK farming industry, from farm to fork, should accept and adopt the principles laid out in Section 6a (albeit with adjustments as necessary) as an industry standard.

2. **Understand barriers to data sharing:** A study of barriers to data sharing and use should be undertaken across the UK livestock and aquaculture sectors, and through the various supply chain levels, to identify where issues lie and how they can be overcome. Funding for this could potentially come from government with execution via a scientific research project.

3. **Agree acceptable methods for publishing data:** The most appropriate data agreements and publishing methods, processes and bodies should be identified to improve confidence and reciprocity. This may require a cross-industry group convened by the VMD, for example.

8. Glossary of terms

Aggregated Data: A combined dataset made up of a range of sources, meaning the individual data records are not singled out or identifiable

AHDB: Agriculture and Horticulture Development Board, the UK's biggest agricultural levy body

AMR: Antimicrobial resistance, often used to mean antibiotic resistance

AMU: Antimicrobial use, mostly used in relation to data; used in this context to cover both on-farm and prescription data

Anonymised Data: Data rendered anonymous by stripping it of any identifiable information. This makes it impossible to gain insights into the data originator, even by those who anonymised the data. Privacy laws do not apply to anonymised data as it is not personal

APHA: Animal and Plant Health Agency (UK Government)

API: Application Programming Interface that software uses to access data, server software or other applications, allowing two applications to 'talk to each other'. APIs communicate through a set of rules and act as intermediaries for specific tasks

Benchmarking: The comparison of a party's AMU with AMU in a pre-defined population of similar parties

BPC: British Poultry Council

DANMAP: Danish Integrated Antimicrobial Resistance Monitoring and Research Program

Data holder: The entity holding but not necessarily owning data; usually the holder of a dataset

Data originator: The original creator of data, who is often but not always the data owner.

Data provider: The entity providing data, who may be the data originator but can also be just an intermediate data holder who needs the owner's permission for any onward sharing

Data sharing: The practice of making data available to data users or third parties.

Data user: A natural or legal person that receives data from the data originator or data provider under an agreement with the data originator

EMA: European Medicines Agency

eMB-Pigs: The electronic Medicine Book for Pigs, a UK-wide service for the collection of data on antibiotic usage in the pig sector which was developed and is managed by the AHDB

ESVAC: European Surveillance of Veterinary Consumption groups, which produces comparative reports annually

FAO: Food and Agriculture Organization of the United Nations

FAWL: Farm Assured Welsh Livestock, an assurance programme from WLBP

GDPR: General Data Protection Regulation, a regulation on information privacy originating in the EU but now translated into UK-GDPR following the UK's exit from the EU

Identifiable data: Data containing information that allows (usually) an individual person to be identified, but in the context of this report, also allows an individual farm business to be identified

Medicine Hub: a pre-competitive platform through which different datasets of individual cattle and sheep farms can be collated and analysed; developed and administered by the AHDB

mg/kg: milligrams of antibiotic per kilogram of animal or fish weight, the most common metric for measuring antibiotic use in farm animals

PCU: Population Correction Unit which and takes into account the animal population as well as the estimated weight of each particular animal at the time of treatment with antibiotics

Pseudonymised data: A procedure where revealing or identifiable fields within a data record are replaced by artificial identifiers which render the data record less identifiable yet still allow its origins to be traced back by those with permission

Red Tractor: UK-wide farm assurance body

RUMA: Responsible Use of Medicines in Agriculture Alliance

SRUC: Scotland's Rural College

Stewardship: The conducting, supervising, or managing of (in this context) antibiotics and their use

VARSS: Veterinary Antibiotic Resistance and Sales Surveillance report produced annually by the Veterinary Medicines Directorate

VMD: Veterinary Medicines Directorate (UK Government), which regulates veterinary antibiotic sales and use

VMRs: Veterinary Medicine Regulations, the legislation governing antibiotic sales and use

WLBP: Welsh Lamb and Beef Producers, a farm assurance co-operative and antibiotic data holder

9. About VSC-AMR and FIIA

Veterinary Schools Council sub-group on AMR

The Veterinary Schools Council (VSC) is a membership organisation which represents the voices of world-leading veterinary schools across the UK, Ireland and the Netherlands. It engages in representative and policy work to ensure that the voice of veterinary schools is recognised for its expertise, innovation and commitment to the proper care of animals.

Guided by evidence-based research, VSC members work to promote innovative veterinary education and collaboration by facilitating the scientific underpinning of veterinary medicine and monitoring data as well as the spread of best practice. By recognising that the health and wellbeing of people, animals and the environment are interconnected, VSC's work aims to highlight the importance of veterinary research for the One Health agenda.

The Antimicrobial Resistance (VSC-AMR) group is one of six committees of the VSC. VSC-AMR looks at ways to utilise data currently held by veterinary schools to build the evidence base on the impact of AMR, and develop engagement with antimicrobial research being carried out in other disciplines. The group promotes antimicrobial research and raises veterinary student awareness of the importance of the appropriate prescribing of antibiotics.

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Food Industry Initiative on Antimicrobials

The Food Industry Initiative on Antimicrobials (FIIA) brings together 26 retailers, manufacturers, processors and food service companies to promote and support responsible AMU in livestock farming and aquaculture – taking collective action on AMR.

Activities are agreed by members, and these focus on collaborative working and co-ordination of initiatives. A key part of FIIA activities is promoting best practice in the health and welfare of animals in the UK food industry supply chain.

FIIA is led by a Strategic Board representing its members. The board defines the strategy and makes collective decisions on key commitments and actions.

The board has an independent chairperson, Sarah O'Brien, former Professor of Translational Agritechnology at Newcastle University. A smaller Steering Group maintains momentum and implements actions between meetings.

FIIA has agreed policies on Responsible Use of Antibiotics; Measurement of Antibiotic Data; and Access to and Use of Industry Antibiotic Data. It is the last of these that is relevant to this paper, as FIIA wishes to improve understanding of why data are important to all in the livestock farming industry and suggest ways to improve confidence in its handling.

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