EIP-AGRI Focus Group
Reducing antimicrobial use in poultry farming

STARTING PAPER - REPORT

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Introduction and background

The threat of antimicrobial resistance (AMR) and the need to act

The discovery of antimicrobials (AMs) revolutionised healthcare and prolonged life expectancy across the world. However, the miss-use of AMs in the last decades is reducing their effectiveness and creating multi-resistant micro-organisms, usually bacteria, for which we have no antibiotic treatment available. This is particularly relevant in human medicine. Without effective AMs there would be a significant increase in mortality rates, recovery times and economic costs of healthcare systems. Scientists estimate that if AMR continues to spread at current levels, by 2050 **10 million** people will die around the world from AMR related infections, more than the mortality due to cancer.

It is generally accepted that the use of AMs in animals contributes significantly to the threat of AMR in humans (1). Antimicrobial drugs are also widely used in animal health and are of vital importance in protecting animal health and welfare and the production of safe food (2). Thus, a one-health approach is needed, and all sectors must play their role in promoting a prudent use of AMs following the principle of "as little as possible, as much as needed".

The EU has always been the leader at a global level when it comes to tackling the issue of AMR. A good example is the ban of antimicrobial growth promoter (AGPs) in 2006. This ban effectively meant that all antimicrobials that were registered as feed additives (and did not need prescription) were not available anymore and all had to be used under medicine legislation (with prescription). An exception to this rule were some coccidiostats that were kept as feed additives. Unfortunately, the ban of AGP was not as successful as expected in reducing antimicrobial use (AMU) because it was followed by an increase of the use of therapeutic antibiotics, especially prophylactic in-feed antibiotics, and the total AMU was not reduced as much as expected. Thus, the next step was to promote a prudent use of therapeutic antibiotics.

Prudent AMU has been one of the goals promoted by the EIP-AGRI. The first action in this area was in the pig sector, the main user of AMs, by creating the **Focus Group on animal husbandry - Reduction of antibiotic use in the pig sector**. Now, following on this initiative, this focus group will analyse the situation in the poultry sector.

Objective / Scope of the Focus Group on reducing antimicrobial use in poultry farming

Considering the above, the tasks of this group are:

- Identify innovative hygienic and treatment practices (housing systems, feeding, heating, etc.) in order to reduce or even stop the use of AMs.
- Make an inventory of specific alternatives to AMs including vaccination, feeding approaches and breeding. Document good practices.
- List good practices on how to change attitudes, habits and the human behaviour of farmers, agri-advisers and veterinarians and on how to improve the dissemination of information.
- Analyse the economic implications (cost-benefit, risk, investment needs) of these alternative practices. Identify the financial parameters needed to evaluate and compare the economics of existing strategies and innovative solutions to reduce the use of antimicrobials.
- Propose potential innovative actions and ideas for Operational Groups in order to develop and explore (integrated) strategies to reduce the use of antimicrobials and protect health and welfare of livestock.
- Identify needs from practice and possible knowledge gaps which could be solved by further research.

Legislative context

Given the importance of the AMR challenge, the main international organisations involved in human and animal health and agriculture, OIE, WHO and FAO, decided to coordinate their efforts in a tripartite alliance

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(4) to maximise impact. They adopted the Global Action Plan on AMR (GAP) in 2015 and have harmonised recommendations for the implementation of National Action Plans in all countries (4).

The EU has been a pioneer in tackling the issue of AMR and its most recent action plan can be found in here (5). Then, the animal health law (6), a key output of the **Animal Health Strategy 2007-2013, "Prevention is better than cure"**, was proposed by the Commission in May 2013 to strengthen the enforcement of health and safety standards for the whole agri-food chain. This law sets out a better legal basis for monitoring animal pathogens resistant to AMs and promotes a more efficient detection and control of transmissible animal diseases.

The EU has also recently produced the new set of regulations 2019/4, 2019/5 and 2019/6 (7) governing veterinary medicinal products and medicated feed, which were published in the Official Journal of the EU in January 2019 and will come into force in January 2022. The main aim of the regulation on veterinary medicinal products is to reduce antibiotic use in food producing animals, especially prophylactic use. The regulation replaces Directive 2001/82/EC and harmonises the authorisation, distribution and pharmacovigilance systems for veterinary medicines across the EU. This new regulation includes the following provisions: 1) Antibiotics must not be applied routinely, 2) must not be used to compensate for poor hygiene, 3) inadequate animal husbandry, or 4) poor farm management, 5) must not be used for prophylaxis treatment (preventative treatment to healthy animals) except in exceptional circumstances, 6) cannot be used for metaphylaxis treatment except when the risk of spread of an infection or of an infectious disease in the group of animals is high and no other appropriate alternatives are available; 7) restriction applies for the use of certain types of antibiotics (critically important AMs, CIAs); 8) veterinary prescription should be based on clinical examination or other proper assessment; 9) are only valid for 5 days; and 10) are limited to the amount required for the treatment concerned.

Of special interest is the discussion about the use of coccidiostats. These products remained legally classified as feed additives in the EU after AGPs were moved into prescription drug categories regulated by the EMA. Although these are not drugs of importance in human medicine, this situation is being revisited now because its use is still routine in the EU. Coccidiosis is still a difficult disease to control in poultry production. The inclusion of this products as prescription drugs would mean that they would be also regulated by the new EU in-feed medicine regulation having an important impact for poultry producers. In the US these drugs are treated as AMs and antibiotic free production also exclude the use of coccidiostats. Increases in mortalities of 2-3% are often observed in this situation.

FG Challenge: The above-mentioned international organisations are active in the area of prudent use of AMs and AMR reduction. However, these are not the only ones. What other organisations are driving change in AMU and AMR at local, national and international level? What is the role of NGOs and the private sector?

Monitoring and Surveillance of AMU, a must do

No matter what actions are taken to reduce AMU, the collection of data is one of the first steps in any action plan. The level of development of the data collection system for AMU is very heterogeneous between countries all over the world as shown by the 3rd OIE Annual Report on AMU (8). In the EU, some countries have very good data on AMU, however, data at an EU level is only available based on sales by country in the reports of the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) project (9). The ESVAC project was started by the European Medicine Agency (EMA) in 2010 to develop a harmonised approach for the collection and reporting of data on AMU. Data on sales of veterinary AMs is reported by each member state using an excel template and the amounts of veterinary AMs sold are linked to the animal demographics in each country using a population correction unit (PCU) as a proxy for the size of the animal population (considering theoretical weight for each species and production stage). In the case of chickens and turkeys PCU considers 1kg and 6.5 kg of theoretical weight respectively.

The approach used by ESVAC so far, does not allow for species specific information. However, EMA launched in July 2018 a project for stratifying sales data of veterinary AMs by animal species. This will enable an approximate estimation of consumption by species allocating a proportion of the total sales to each species. Project ACTIING (10) is also collecting information on the different data collection systems in place in different countries, mostly EU, to collect AMU data at herd level.

Two aspects are very important when discussing AMU data collection. The first one is the level at which data is collected. There are important differences between the amounts of AMs that are prescribed, the amounts that are sold and the actual amount used at animal level. The disposal of antibiotics that were never used to treat animals is as important in terms of AMR as the AMs used for treatment. However, AMs prescribed but never reaching the farm inflate the figure on AMU and are misleading. The second important consideration for the monitoring and surveillance of AMU are the units used (11). The format of the units is normally:

amounts of AMs used / animals treated

where the numerator describes the actual amount used (eg. mg or g) or the dose used (eg. Defined Daily Dose) and the denominator describes defined animal units (eg. PCU used by ESVAC) or amounts of animal product produced (eg. Kg of meat). Each one of these units has advantages and disadvantages depending on the context. However, what is clear is that a common unit used across countries and species should be developed.

Antimicrobial use in the poultry sector

Chicken is on its way to become the most consumed meat in the world. For decades, the chicken industry has been the first animal production to meet consumer needs and preferences and, once again, it has been the fastest to respond to the need to reduce AMU. The first regions to act have been the EU, driven mostly by national governments with different approaches and levels of success, and the US, driven mostly by retailers and with 50% of the production already antibiotic free.

However, the poultry sector is one of the most diverse in terms of species and types of production and AMU is not known in most cases for poultry species other than chicken or for alternative production systems. According to FAO, in 2016, ducks accounted for 5% of the world's poultry population, turkeys for 2% and other poultry, such as geese and guinea fowl, made up the remaining 2%. For eggs, 8% of the eggs produced in the world came also from species other than chicken, especially in Asia. In terms of production systems, the new systems like free range or organic are more and more important in the EU and this represents completely different challenges for disease control and prudent AMU. There are, for example, 400 million laying hens in the EU with about 53% of them are kept in enriched cages, 27% in barn systems, 15% in free range and 5% are in organic holdings. Thus, the recommendations for prudent use resulting from this focus group will need to be detailed for the different production systems and species.

Species specific data is not available in all EU countries, however many countries like the Netherlands, Denmark or Finland have shown success stories on AMU reduction. If we look at the data from the Netherlands (figure 1) it can be seen how broiler production was one of the main users of AMs right after the ban of AGPs in 2006. However, after a peak in 2008-2009, the reduction in the use of AMs was very fast. On the other hand, the late inclusion of turkeys in the monitoring system shows how not all poultry sectors are at the same level of action when it comes to tackle AMU.

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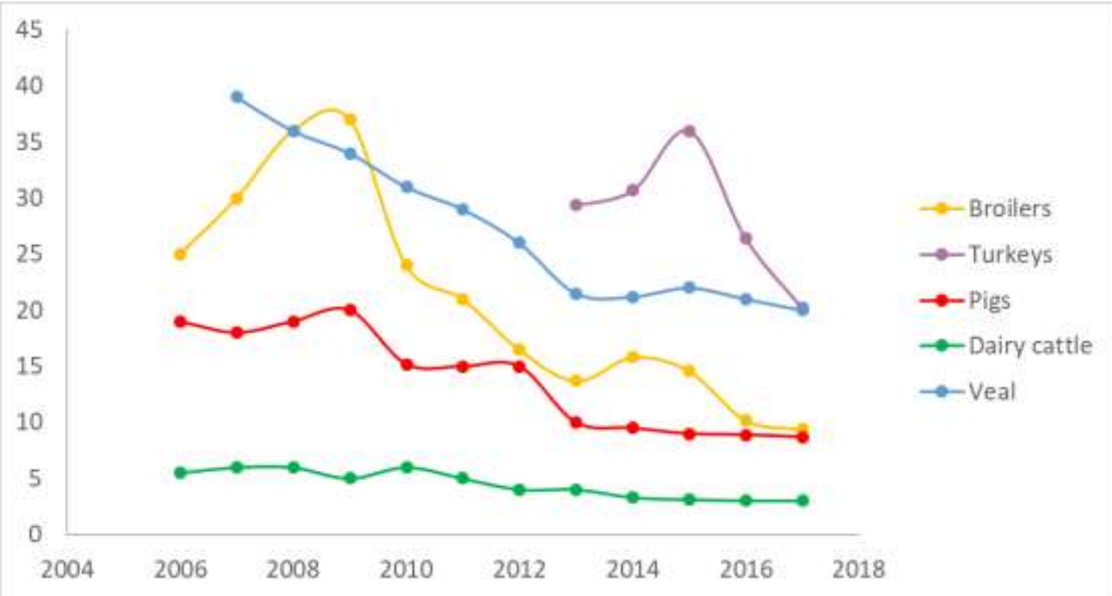

Figure 1. AMU for different species adapted from the report by LEI WUR-MAPAN (years 2007-2010) and by SDa (years 2011-2016) https://www.rivm.nl/bibliotheek/rapporten/2017-0056.pdf. The units of AMU are calculated as the total number of treatable kg within a livestock sector for a specific year divided by the average kg of animal present within the livestock sector concerned.

FG challenge: Public data on AMU in the poultry sector is still scarce despite there has been considerable progress in the reduction of AMU. What is the situation in your country? Is there public information available? What do you think is the contribution of other species and production systems in the different countries in the EU?

In order to discuss prudent AMU once we know the amounts used, it is important to understand the main issues that motivate AMU and how the treatment is carried out. Individual treatment in poultry production is rarely an option because the numbers of animals in a flock are often too high. Thus, in-feed or water medication of all the birds in a flock is common practice. Antimicrobial treatment is mostly related to bacterial and protozoal diseases that can be the primary cause of disease but often are secondary infections occurring during viral infections or non-infectious diseases related to inadequate husbandry. Most medication in poultry occurs around transport of day-old chicks or to counteract unspecific losses of productivity. The experience so far reducing the use of AMs has shown that these treatments may not always be needed or can be avoided by improving husbandry. However, there are always cases where infectious diseases happen even in the best conditions of production.

FG challenge: The main infectious diseases for which AMs are used in broilers include gastrointestinal disease (coccidiosis, necrotic enteritis and other dysbacteriosis), respiratory diseases (mainly E. coli secondary to viral infections), musculoskeletal diseases and septicemias/omphalitis. What are the main pathogens causing these diseases? This will be relevant for the development of vaccines. What would be the main or emerging causes on AM treatment in other species or new production systems?

Strategies to promote prudent AMU and to address AMR

The previous focus group on prudent use of antimicrobials in pigs (**Focus Group on animal husbandry - Reduction of antibiotic use in the pig sector**) departed from the description of strategies to address the issue of AMR given by the OIE and the European Commission. The strategies discussed by the group in the final report were summarised under the following key headings:

- Changing attitudes, habits and human behaviour (farmers, advisors and veterinarians) and improving the dissemination of information. This group included collection of information (monitoring and surveillance), legislation and education.
- Specific alternatives to antibiotics including mainly vaccination (regulated as medicine), nutrition (including feed additives; **https://ec.europa.eu/food/safety/animal-feed/feed-additives_en**) and breeding.
- General enhancement of animal health and welfare. This concerns disease elimination and reduction through improvement of biosecurity, management, husbandry, facilities, diagnostics and training of personnel, veterinarians and advisors.

The areas to be considered in poultry are similar but the details differ considerably based on the structure of the industry and particularities of the species. The following sections are a short review of the main issues and strategies used until now to reduce the use of antimicrobials in poultry production, mainly chickens in conventional production systems.

FG challenge: A very important aspect to consider in poultry, given its well-developed pyramid structure, is the practices that can be applied at farm level and the practices that can be applied at production chain level. Decisions taken at higher levels of the production chain affect directly the results in the lower levels and can make impossible the production of animals without AMs no matter how well trained and willing the farmer is. Which are the practices that need to be implemented at a production chain level and which at a farm level?

The social sciences approach: Changes in human behaviour and improving dissemination of information

There are 2 aspects to consider when it comes to social sciences and AMU; on one side the attitudes, behaviour and socio-eco framework explaining the use of AMs; on the other side the system of knowledge exchange.

It is important to bear in mind that AMs have been used in farming for decades creating habitual behavioural patterns which are socially and culturally ingrained. There is a need to identify specific behavioural patterns and understand the factors shaping these behaviours, as well as potential resistance to change. Although there is some work done, there is still an important knowledge gap in this area. Interdisciplinary approaches bringing together psychologists, sociologists, veterinarians, economists, welfare scientists among others will be needed.

In terms of the system of knowledge exchange, the poultry sector is quite diverse. A very significant part of chicken production is part of vertical integrations with very effective knowledge transfer structures but at the same time very secretive. This allows that one company has a good approach to produce antibiotic free chicken but keeps the information for themselves as a competitive advantage. At the same time, new production systems with a smaller scale can be very interactive groups with good knowledge exchange and collaboration but with less resources to develop new knowledge. The use of participatory learning and action methods has been shown to be the most effective approach in introducing new practices at farm level (12). The combination of these methodological approaches ensures a systematic and bottom-up approach to intervention design and enables learning from examples.

When discussing social aspect of the AMR challenge it is also important to consider the level at which the action is needed; region, country or producer/retailer level. The approach used by the EU, combining awareness campaigns and legislation has already been discussed in the introduction. At a national level, the measures that can be used by countries include actions to regulate the prescription, distribution and supply channels; taxes and other financial incentives; establishment of collaborations with livestock industry; or education and training actions for veterinarians, farmers and general public. The approach so far has been different between countries. Some countries like Denmark prefer action by legislation. Others like the

Netherlands prefer an approach by collaboration and raising awareness. In all cases countries should learn from previous experiences and adapt the actions to the characteristics of their production sector.

FG challenge: There is a need for interdisciplinary approaches and success stories in the use of social sciences to promote prudent use of AMs. We should prioritise the most urgent actions to enable farmers and veterinarians to be the change. What are the priorities to fill knowledge gaps? What are the best examples of success in changing attitudes and behaviours? What is the role of the lower levels of the production chain and the consumer in fostering change for prudent AMU?

Specific practices to reduce the AMU: vaccination, nutrition and breeding

Vaccination

Veterinary vaccines play an important role for animal and public health, animal welfare and food production and present no hazard to consumers of products from vaccinated animals. A vaccination program should prevent or reduce infectious disease and thus can reduce the need to use anti-microbials. Vaccines may also be used strategically in eradication programs accompanied by diagnostic tests. Chickens are particularly susceptible to bacterial and viral infections in their first 10–14 days of life (the brooding period) where they are developing their adaptive immune, digestive and thermoregulatory systems. Thus, most of the vaccines are focused in this period.

The vaccine market in poultry is well developed and vaccines have had already a positive impact on reducing the need for AMs. However, it is important to remark that vaccines are not a substitute for poor husbandry. Good husbandry is, in fact, a requirement to obtain an optimum result when using vaccines. Vaccines just stimulate the development of the immune response to a disease, but it is the animal the one that must develop the adequate immune response. This is often not possible for animals suffering stress affecting the immune function. Thus, use of vaccines with a suboptimal husbandry is often a waste of money. It is also important to consider all the technical issues that can be associated to vaccination failure like inadequate storage or application. Thus, dissemination of technical information to optimise the results of vaccination is as important as the vaccination itself. The vaccination program is something that the farmer should discuss with the veterinarian in an individual basis and always consider cost benefits aspects.

The needs for vaccination to reduce the use of AMs have been discussed by OIE (13) and EMA and EFSA (14). For bacteria, *E. coli* infections remain the main concerns. Autogenous vaccines (a vaccine prepared from cultures of microorganisms obtained from the farm to be immunised) are still widely used for *E. coli* infections due to the variable efficacy of current vaccines against the wide strain variation. Vaccines against colibacillosis can be improved to cover more strains. High AMU for Clostridium perfringens Type A (causing necrotic enteritis) is also common and passive immunity of broiler from vaccination of layers is short lived. Vaccines for *Ornithobacterium rhinotracheale* and *enterococci* are also needed, and treatment of secondary bacterial infections would be reduced with more effective vaccines against *coccidiosis* and *histomoniasis*. Viral infections contribute significantly to the runting and stunting syndrome (RSS), characterised by growth depression, decreased uniformity and poor economic performance (15). The multiplicity of agents involved in RSS makes it difficult to develop multivalent vaccines (vaccines designed to immunise against two or more microorganisms/strains) for these early infections of broilers. Alternatively, non-specific stimulation of the immune system of the young chicks (trained immunity) may potentially increase their resistance to the pathogens occurring in that critical period. Finally, *coccidia* vaccination has been used for years in poultry production systems with good results. It can help reduce anticoccidial resistance and replace field oocysts for some less pathogenic ones while stimulating bird immunity. Again, the success of coccidia vaccination programs is based on proper application of all the steps.

Nutrition and Gut health

When talking about gut health the focus is often on the control of pathogens like *coccidia, C. perfringens, or E. coli* which are the main ones observed when an intestinal problem is detected. However, in many cases this are the consequences, not the causes, of the problem. Chickens are much more sensitive to changes in parameters like pH, viscosity and dry matter in the gastrointestinal tract compared to other production species like pigs. This need for stability of the gut environment in chickens means that any deviation from the normal conditions will result in digestive problems.

Often, the cause of digestive disease is an unbalance of nutrients in the gut which changes the intestinal ecosystem and causes the proliferation of pathogen microbes causing inflammation. The unbalance of nutrients in the gut may be due to either wrong nutrient levels in the diet or suboptimal digestion. In this sense, it is important to clarify the difference between nutrition and feeding practices. In many occasions, diets are formulated with an optimal composition, and thus nutrients requirements are well covered, but the feeding practices may be inadequate, resulting in digestive disease. The communication between the farmer, the nutritionist, the mill and the veterinarian are key to minimise these issues.

Unfortunately, farmers don't have much control of the composition of their diets and rely on the nutritionist to make changes in the diet. At the same time, conflictive recommendations from the nutritionist and the veterinarian often result in inadequate treatment of digestive problems. If we add the need to react in a very short period to minimise loses, the use of AMs is often an easy solution. Thus, a clear protocol on nutrition and feeding, including in-feed antibiotic alternatives, play a very important role in the control of digestive disease. In the case of chickens, the main aspects that must be considered to keep a good gut health are:

- Adjusting dietary nutrients to the needs of the animal. Phase feeding, feeding several diets in successive periods of time to more closely match the animal's nutrient requirements, directly reduces undigested nutrients. Farmers need to understand nutrient requirements of their animals and make sure that they are not over/underfeeding important nutrients. Proper labelling is an important aspect.
- Using feed additives to optimise digestion and microbial environment. Phytase, carbohydrases, proteases and organic acids are especially effective in chickens and have important cost saving impact and improve productivity and gut microbiome. Prebiotics and probiotics (or combined as symbiotics) play an important role to reduce the use of AMs too. The concept of competitive exclusion was first used in poultry and it emphasises the role, not only of feed but of the environment in creating the right microbiome in poultry species. Monitoring microbial populations in farms is something that farmers could use more.
- Ensure ingredient quality and the right particle size and feed form. Importance of water quality is always underestimated.

Genetics/Breeding

Genetic selection reaches it maximum expression in chickens when it comes to growth rate and efficiency. However, these breeding criteria are sometimes not aligned with animal health and welfare, and selection for production traits may have resulted in animals with increased susceptibility to a range of infectious diseases. In fact, genetic lines with slower growth have been selected as a possible approach to reduce AMU in some cases.

Resistance (ability of the host to resist pathogens by preventing the pathogen from entering or by inhibiting replication) and tolerance (is the ability to minimise the damage caused by pathogen) may be genetically controlled (16, 17), and can complement existing interventions to control infectious diseases. To date the relative contribution of resistance and tolerance to infection outcome is poorly understood (18). Gene editing could potentially open a new option for genetics disease resistance.

FG challenge: This is a very general overview of the specific practices to reduce the use of AMs in poultry. Are there specific strategies missing that should be highlighted? What are the most successful in your opinion? What are the most promising? Do you think the same solutions used in conventional chickens can be used in other species and production systems?

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General improvement of health and welfare

It is generally accepted that reduction of stress contributes to welfare and health. Adjusting stocking density, temperature, air velocity, environmental NH_3, litter characteristics, light programs and relative humidity according to the age, phase of production, size of the birds and external environmental conditions is important. All these traits are highly interrelated and should not be used as single criteria for changes in barns but considered as a whole. With all poultry species environmental stress can alter their feed intake patterns, induce digestion problems and has also very severe effects on their immune system (19) leaving birds more susceptible to infectious agents. Inadequate husbandry can also result in non-infectious problems like feather pecking or pododermatitis that can induce secondary infections. Indeed, a general improvement of all these parameters is directly dependent on an adequate training and motivation of the farm staff although more and more these functions are being automatized with the use of precision livestock farming (PLF).

At a production chain level, breeder nutrition and management, together with incubation and hatching, are of extreme importance in poultry as, in many cases, issues in these phases will create problems further down in the production chain that cannot be solved. Egg shell quality, affecting oxygen availability and embryo development are the main characteristics affected by breeder management. Breeders are also a source of microbes and immunity to their progeny. Monitoring how biosecurity measures affect such transfer is important and new tools need to be developed in this area. Suboptimal incubation and poor access to feed and water for 48 h post-hatch cause problems with the development of the lymphoid tissue associated with the gut and general immunity.

Regular monitoring of the environmental and health and welfare status of each flock should be used to anticipate problems and adjust husbandry. Once an episode of clinical disease starts in a farm, AM treatment must be in place as soon as possible to minimise productive losses and mortality. Even if the required diagnostic tests are ordered to a lab, by the time the veterinarian gets the results it would be too late. The use of rapid on-farm diagnostic tests and PLF are very promising options in this area. There are more and more point-of-care diagnostic tools, like multiplex polymerase chain reaction, available at competitive prices. These tools should also include methods for pathogen antibiotic susceptibility testing. Ideally, we should develop technologies that enable economical, rapid on-farm diagnosis, so that veterinarians only prescribe antimicrobials when needed and can select the correct treatment. At the same time, PLF offers a great opportunity to use technology for early diagnostic based on unspecific environmental or clinical sign detection, e.g. coughing, movement, air quality measures.

FG challenge: Unspecific practices to reduce the use of AMs include a huge number of options. Prioritisation is needed and knowledge gaps need to be filled. What are the best approaches so far? What are the specific biosecurity measures that work best in each species and production system? What PLF and rapid diagnostics are already available at commercial level? Are there good guidelines and reference parameters available for the farmer? Is the information disseminated properly?

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Glossary

Alternative food animal production: farming practices that are different than those used in conventional farming. In this context, some systems have legally defined standards, such as 'organic production', while others are governed by private standards, such as 'label-rouge'.
Antimicrobial agent: a naturally occurring, semi-synthetic or synthetic substance that exhibits antimicrobial activity (kill or inhibit the growth of micro-organisms) at concentrations attainable in vivo. Anthelmintics and substances classed as disinfectants or antiseptics are excluded from this definition.
Antibiotic: generally used in the past to mean antimicrobials. However, it is now more often used to mean antibacterials and is understood by the public and professionals in this way. Almost exclusively now, when people talk about antibiotic resistance, they are talking about antibacterial resistance.
Antimicrobial resistance: resistance of a microorganism to an antimicrobial medicine to which it was originally sensitive. Resistant organisms (they include bacteria, fungi, viruses and some parasites) can withstand attacks by antimicrobial medicines, such as antibiotics, anti-fungals, antivirals, and antimalarials, so that standard treatments become ineffective and infections persist increasing risk of spread to others.
Growth promotion: administration of antimicrobial agents to animals only to increase the rate of weight gain or the efficiency of feed utilisation.
Metaphylaxis: antimicrobials are administered to clinically healthy animals belonging to the same flock or pen as animals that are already displaying clinical signs.
Monitoring: intermittent performance and analysis of routine measurements and observations, aimed at detecting changes in the environment or health status of a population.
Point-of-care testing: diagnostic testing at the time and place of patient care.
Poultry: domestic fowl, such as chickens, turkeys, ducks, and geese
Prophylaxis: antimicrobials are administered to a herd or flock of animals at risk of disease but not yet displaying clinical signs.
Surveillance: systematic ongoing collection, collation, and analysis of information related to animal health and the timely dissemination of information so that action can be taken

Abbreviations

AGP - Antibiotic Growth Promoter
AM - Antimicrobial
AMR - Antimicrobial Resistance
AMU - Antimicrobial Use
CIA - Critically Important Antimicrobial
EMA - European Medicines Agency
ESVAC - Europeans Surveillance of Veterinary Antimicrobial Consumption
FAO - Food and Agriculture Organisation
GAP - Global Action Plan on AMR
OIE - World Organisation for Animal Health
PCU - Population Correction Unit
PLF - Precision Livestock Farming
WHO – World Health Organisation

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4) https://www.who.int/antimicrobial-resistance/national-action-plans/en/
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Other links of interest:

EPRUMA: https://www.epruma.eu/
OIE AMR strategy: http://oie-antimicrobial.com/
WHO: https://www.who.int/antimicrobial-resistance/en/
FAO: http://www.fao.org/antimicrobial-resistance/en/
EFSA: https://www.efsa.europa.eu/en/topics/topic/antimicrobial-resistance
ECDC: https://ecdc.europa.eu/en/antimicrobial-resistance
Tripartite actions: http://www.oie.int/index.php?id=2413&L=3
Global Action Plan – GAP – on AMR: https://www.who.int/antimicrobial-resistance/global-action-plan/en/

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