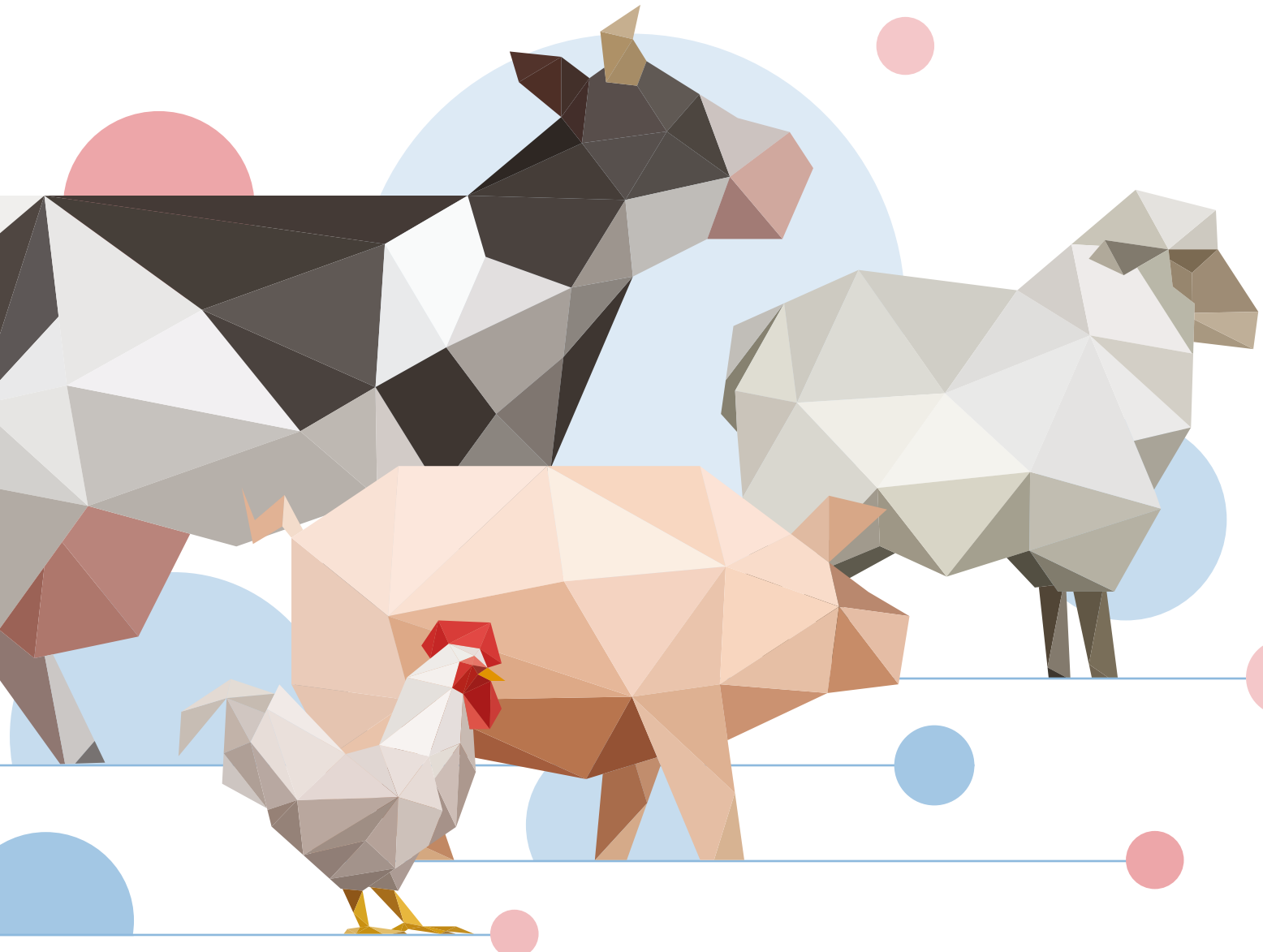
How Prevention Can Reduce the Need for Antibiotics

Pathways to Reduce the Need for Antimicrobials on Farms for Sustainable Agrifood Systems Transformation (RENOFARM)



Health for Animals
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Food and Agriculture Organization of the United Nations

HealthforAnimals

Rome, 2024

Contents

Foreword

In a world where global demands for food are continuously rising and challenges are becoming increasingly complex, the need for innovative solutions in agriculture and the food sector has never been more pressing. One of the most significant challenges we face today is the escalating threat of antimicrobial resistance (AMR). This global health crisis, if left unaddressed, could diminish decades of progress in healthcare and agriculture, endangering not only human well-being but also the sustainability of our agriculture production systems.

The use of antimicrobials in agriculture and food production has significantly contributed to improved animal welfare and safer production systems. However, overuse and misuse of these critical tools can have far-reaching consequences, which not only threaten human health but also undermine the long-term viability of our agrifood systems. FAO, in response to the above global challenges, has developed the FAO Action Plans on AMR 2016-2020 and 2021-2025. They provide strategic directions to guide FAO's efforts to support its member countries to implement sustainable practices that safeguard health, production and environment.

It is my privilege to introduce the FAO 10-year initiative to reduce the need for antimicrobials on farms for sustainable agrifood systems transformation (RENOFARM). This initiative is anchored in the latest FAO Action Plans on AMR, and responds to the calls made by the Global Leaders Group on AMR and FAO Committee on Agriculture's (COAG) Subcommittee on Livestock, in terms of "reducing the need for antimicrobial use in the food and agriculture sectors is essential for preserving the efficacy of antimicrobials and mitigating the risk of AMR rising from the agrifood sectors". Through the RENOFARM initiative, FAO will support agrifood producers to adopt good practices to reduce the need for antimicrobial use and preserve the efficacy of these life-saving medicines for future generations. By working with governments, agricultural producers, academic institutions, healthcare professionals, and consumers, FAO is leading the way in promoting responsible antimicrobial stewardship and tackling AMR risk in the agrifood systems.

As we embark on this journey, we must remember that the responsibility of curbing AMR does not fall on any one organisation or country alone. It is a collective duty that requires the cooperation of governments, industry stakeholders, researchers, and the public. FAO welcomes all stakeholders to join hands in the pursuit of a healthier, more sustainable world. This FAO-HealthforAnimals report presents many examples across the world on how joint, collaborative efforts from different stakeholders could make a difference.

I am encouraged by the shared vision to safeguard the health of our planet and its people, ensuring that antimicrobials remain effective tools for years to come. The RENOFARM initiative is a beacon of hope in this critical fight, and I am confident that it will light the path towards a brighter, more resilient future for the agrifood systems.

Thanawat Tiensin
Director of Animal Health and Production Division
FAO Rome

Executive Summary

Antimicrobials play an important role in veterinary medicine as in human medicine. These medicines, which include antibiotics, reduce suffering and mortality from common and costly animal diseases, while also lowering the risk of transfer and spread of these diseases among animals and people.

However, antimicrobial resistance (AMR) now poses a major threat to global health, food safety, and food security, making it an urgent "One Health" issue that impacts animals, people and planet. Overuse or misuse of antimicrobials contributes to bacterial resistance that brings with it significant consequences for animal health and, by implication, human health and the environment. Resistant strains of bacteria threaten an increase in animal suffering and losses, as well as a reduction in the effectiveness of antimicrobial treatments in both human and veterinary medicine.

Growing recognition of this "One Health" threat has inspired a shift towards more responsible antimicrobial use and stewardship. Global efforts have been coordinated in recent decades by the quadripartite of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the World Health Organization (WHO) and the World Organisation for Animal Health (WOAH). Under these auspices, initiatives such as the AMR Multi-Stakeholder Partnership Platform and the Global Leaders Group have helped operationalise the FAO Action Plan on Antimicrobial Resistance 2021-2025.

As a result, antimicrobial has fallen globally and in most major markets.[1] In the UK, for example, antimicrobial sales for livestock dropped by 59% between 2014 and 2022, with a 82% reduction in the use of highest-priority, critically important antimicrobials.[2] In the wider EU, use has fallen 53% since 2011, and up to 68% in large markets like Germany.[3,4] These reductions have occurred as use of prevention products, like vaccines, have dramatically risen.

However, to feed a rising population, the world must produce as much food in the next 30 years as in the last 10,000 years combined.[5] FAO-OECD analyses estimate that this will include increases in the production of animal-sourced foods, driven by growing consumption in lower-income regions where nutrition remains a challenge.[6] It is vital that

this production is done sustainably, which includes the responsible use of antimicrobials and greater adoption of disease prevention practices.

Prevention is the responsible path to reducing the need for antimicrobials to avoid generating an increase in untreated infections. A survey of veterinarians found 65 per cent state that simply raising animals without antibiotics would worsen animal health and welfare.[7] Antibiotics are the only medicines that can treat bacterial diseases, which means disease prevention is the most effective way to avoid the need for antimicrobials.

This report illustrates how governments, health professionals, veterinarians and food producers can work together to implement greater disease prevention tools, reducing the need for antimicrobials on farms and transitioning towards healthier and more sustainable agrifood systems. The evidence and solutions presented align with the Reduce the Need for Antimicrobials on Farms for Sustainable Agrifood Systems Transformation initiative (RENOFARM), coordinated by FAO, which aims to enroll 100 countries in the ten-year initiative.

The tools and practices that will allow for better disease prevention on farms, while reducing the use of antimicrobials, come in many forms. From vaccination to improved nutrition, biosecurity and digital technologies, many of these tools are widely available today, with significant evidence illustrating their effectiveness in reducing antimicrobial use while supporting improved health outcomes for animals and humans.

Despite this, the availability and use of both antimicrobials and alternative forms of prevention varies greatly around the world. By equipping all countries with better means of prevention, the world can more effectively achieve the goal of reduced antimicrobial use, while promoting more sustainable human and animal health. This report sets out examples of how practitioners have implemented improved preventative care, subsequently reducing the need for on-farm antimicrobial use, while also offering a model for how these tools can be taken up elsewhere. An overview of initiatives seeking to increase uptake and implementation of prevention on-the-ground is also provided.

Key terms[8]

Antimicrobials – a naturally occurring, semi-synthetic or synthetic substance that kills or inhibits the replication of microorganisms. The most common or known antimicrobials are 'antibiotics', which address bacteria.

Antimicrobial Resistance – the inherited or acquired characteristic of microorganisms to survive or proliferate in concentrations of an antimicrobial that would otherwise kill or inhibit them.

Optimized Use / Responsible Use – When animal antimicrobials are used only when necessary and prevention practices are maximized to reduce the incidence of disease.

Prevention – Use of approaches like vaccination and improved biosecurity to reduce the risk of bacterial infection in an animal, and therefore reduce the need for antimicrobial treatment.

Insights from the report include:

- **The rise of vaccinations in the Norwegian aquaculture industry in the 1980s-90s enabled a 99.8 percent reduction in antibiotic use compared to 1987 levels.** Aquaculture production grew in turn from 57,000 tons in 1987 to 1.6 million tons in 2022.
- **Better nutrition and internal health can boost animals' natural immunity, lessening the need for antimicrobials, improving health and food safety.** One U.S. broiler operation, for example, witnessed a nearly 25 percent reduction in processing plant carcass condemnations when shifting to an antibiotic free program.
- **Biosecurity measures can be implemented and improved, no matter the sophistication level of a market, to reduce antibiotic need.** This includes basic approaches such as foot washes for livestock, through to more high-tech approaches such as virtual fencing.
- **Modern genetic testing in livestock can reduce the risk of bacterial disease and antibiotic need.** For example, a study of U.S. dairy cows helped 'rank' cows, identifying those with superior genetics which can improve breeding decisions made by farmers to reduce reliance on antibiotics, methane emissions, and feed required.
- **Digital technologies are bolstering disease prevention efforts for animals worldwide.** For instance, a sound monitoring system in swine production to detect the respiratory health status of growing pigs has reduced antibiotic use due to more effective early intervention.
- **Non-medically important antimicrobials can be used to treat diseases in animals.** For certain diseases and situations, this approach can help reduce the need for medically important or critically important antimicrobials.

Part 1: Livestock health in the context of One Health

The health, wellbeing and productivity of livestock has a defining role within the One Health system that also encompasses human populations and the environment. Livestock health has direct implications for more than 1.5 billion people, who earn a living through raising and selling livestock, and who depend on animal-sourced foods for protein and nutrients.[9] Livestock health is also linked to agricultural emissions, particularly methane, and, in many parts of the world, the management of rangelands.

Preserving the efficacy of antimicrobial treatments is therefore fundamental to upholding livestock health and minimising the impact of animal diseases. Where bacterial disease remains prevalent, antimicrobials are the first and only line of defence. For example, the prevalence of bacterial livestock disease in some African countries can be as high as 40 per cent for brucellosis and 28 per cent for Q Fever.[10] Many of the economically damaging and neglected livestock diseases across Africa and Asia, such as Contagious Bovine Pleuropneumonia (CBPP), are bacterial and require antibiotic treatment.[11]

But the ongoing need for antimicrobial treatment must also be balanced against the risk of antimicrobial resistance and the potential impact this has for One Health outcomes for people, animals and the environment. Currently, levels of antimicrobial resistance in animals are often low or absent according to public data from developed markets. This success must be maintained to avoid a reduction in the effectiveness of treatments, which would increase mortality among people and animals. In animal agriculture, this would result in livestock losses that undermine the already precarious livelihoods, food security and prospects of hundreds of millions of the world's most vulnerable people. Allowing AMR to develop unchecked could result in GDP losses of up to five per cent, compared to the relatively low cost of disease prevention measures that reduce the need for antimicrobials.[12]

The challenge of managing antimicrobial resistance is made more complex by the current limitations of veterinary medicine in developing countries. The countries most affected

by bacterial diseases among livestock are also those with the most limited veterinary infrastructure and resources. In Asia-Pacific, the ratio of livestock animal units to veterinary professionals is 3,883 to 1 compared to 612 to 1 in Europe – a more than 6-fold difference.[13]

As of 2016, the veterinary workforce in Kenya was around a tenth of the human medical profession, at 2,000 professionals, of which more than half were focused on pets.[14] Additional veterinary experts are needed in developing markets to shift practices and increase the adoption of preventative tools.

Furthermore, there are no genuine alternatives to antibiotics, which are the only medicines to treat and cure bacterial infections. Developing new antibiotics is a costly and lengthy process, meaning that no new class of antibiotic has been developed for either human or animal use since the 1980s.[15]

Reducing the development of antimicrobial resistance without further jeopardising animal health thus requires both the responsible use of antimicrobials where they remain necessary, and parallel efforts to reduce the incidence of bacterial disease that necessitates antimicrobial treatment. Preventing infections in the first place is the most effective strategy for minimising the need for antimicrobials.

Because antimicrobial resistance, like disease, knows no border, managing the risks associated with antimicrobial resistance must therefore be a global priority. To this end, several initiatives have coordinated global efforts to reduce the need for antimicrobials and improve responsible use. For example, the Global Leaders Group (GLG) on Antimicrobial Resistance has an action plan for six priority areas, including advocating for increased innovation to develop new products and tools that reduce the need for antimicrobials. Meanwhile, FAO's RENOFARM initiative seeks to secure participation from at least 100 countries and training of 50 per cent of animal/plant health service providers and other relevant experts in areas relevant to reducing the need for antimicrobials.

The agrifood industry in many parts of the world is also cooperating around the threat of antimicrobial resistance through associations such as the UK's Responsible Use of Medicines in Animal Agriculture (RUMA), the European Platform for the Responsible Use of Medicines in Animals (EPRUMA), and Brazil's Aliança para o Uso Responsável de Antimicrobianos.

In recent years, national and regional efforts in both developed and emerging markets have made progress on reducing the need for antimicrobials in animal agriculture.

Furthermore, industry sales data shows that antimicrobials are the smallest product category within the animal health space and their share has steadily declined over the past decade. In 2013, antimicrobials were 20.9% of global animal health product sales, while in 2023 this fell to 12.3%. This is a 41% decline in antimicrobial's share of animal health product sales over the past decade.[16] Sales data also shows that as antimicrobial sales fall, vaccine sales rise. A recent industry analysis found that a 33% increase in global vaccine sales was mirrored by a 30% decrease in antimicrobial sales.[17] This indicates that replacing treatment with prevention is an effective way to reduce the need for antimicrobials.

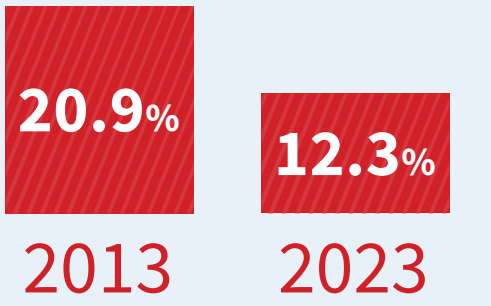
Animal antimicrobial use has decreased across a diverse set of markets:[18]

- In China, antimicrobial use declined 55 per cent between 2014 and 2019.[19]
- In the EU, antimicrobial use fell 53 per cent between 2011 and 2023.[20]
- The US saw a fall of 36 per cent in antimicrobial use from 2015 to 2022.[21]
- The UK's use of antimicrobials in farmed animals decreased in 2022 to the lowest level recorded, with a 59 per cent reduction since 2014.[22]
- In Thailand, consumption of antimicrobials for food-producing animals fell by 49 per cent from 2017 to 2019.[23]
- In South Africa, antibiotics used in animals fell 52% from 2014 to 2020.[24]

Notably, the greatest reductions in antimicrobial use in animals in recent years have also been made in those deemed "critically important" by the WHO. For instance, polypeptide use, which includes Colistin, a drug of last resort, declined 62 per cent between 2016 and 2018.[25]

In markets that monitor and report antimicrobial resistance, including the UK through its Veterinary Antimicrobial Resistance and Sales Surveillance (VARSS) and the European Union via its European Antimicrobial Susceptibility Surveillance in Animals (EASSA) study, levels of drug-resistant disease among livestock remains low for most critically important antimicrobials.[26,27]

Antimicrobials as a percentage of global animal health product sales



41%

decline in antimicrobial's share of animal health product sales over 10 years[16]

However, significant potential remains for further reductions in animal disease levels, particularly in low-income countries, both to prevent the need for antimicrobials and to reduce the impact of livestock losses. A growing volume of evidence indicates that preventative tools, such as vaccination, biosecurity, and improved nutrition can bring down the need for antimicrobials. For example:

- Improved animal health measures – such as biosecurity, vaccination and anthelmintic therapy – led to a reduction in antimicrobial use of 52 per cent in pigs from birth until slaughter, and 32 per cent for breeding animals, according to a study in Belgium.[28]
- Farm biosecurity and management was positively associated with a reduction in antimicrobial use across 70 per cent of results in a review of 27 studies.[29]
- Strong external biosecurity, including purchasing policy, location and environment, was linked to lower antimicrobial use in a study of German pig farms.[30]
- Vaccines are among the top five alternative approaches to using antimicrobial agents, according to a study of pig production.[31]

Proven animal health tools can prevent diseases that would otherwise require antimicrobial treatment. Not only does this reduce the risk of antimicrobial resistance but it also reduces the cost, burden and losses associated with animal illness and treatment. This is particularly important for low-income countries, where livestock diseases have a disproportionate impact on communities and economies. Countries should encourage producers to adopt more disease prevention tools and practices as a proven pathway to reduce the need for on-farm antimicrobials and help meet the goals of the RENOFARM project.

Interventions that reduce disease and need for antibiotics

On the Farm

Digital monitoring

Biosecurity protocols

Veterinarian visits

Animal Health

Vaccination

Precision feed

Genetics

Diagnostics

Part 2: Disease prevention tools to reduce need

This section provides an overview of various tools available to increase disease prevention and reduce the need for antimicrobials, as well as select case studies of their use. These include:

- Vaccination
- Nutrition and internal health
- Biosecurity
- Genetics
- Digital technologies
- Alternatives to Medically Important Antimicrobials

Accompanying each are case studies demonstrating instances where these tools have helped reduce the need for antimicrobials on-farm. These are derived from publicly available studies and private analyses conducted by animal health companies and/or institutions. While the specific mix of tools and technologies to reduce the need for antimicrobials will differ depending upon the specific animal, farm and region, these case studies provide examples for consideration when devising a national prevention strategy.

Vaccination

Headlines

- Vaccines reduce the need for antimicrobials by preventing bacterial disease and/or avoiding secondary bacterial infections.
- Vaccination can reduce the need for antimicrobials, while also increasing farm productivity and income through lower loss rates.
- Side-by-side trials of vaccinated versus unvaccinated herds show lower need for antimicrobials in vaccinated animals.

Vaccines have helped to protect animals, and by extension, human health and livelihoods, from a range of previously deadly and costly diseases. For example, in the UK, salmonella outbreaks, which caused significant damage to the economy and livelihoods throughout the 1980s, were largely eradicated as a result of a widespread poultry vaccination program. The use of vaccinations reduced salmonella outbreaks in the country by 87 per cent from their peak in 1992.[32]

Vaccines are the most effective tool for preventing animal diseases, which subsequently reduces the need for antimicrobial treatments. In addition to saving lives and livelihoods from the burden of widespread animal diseases, vaccination has also been linked to reduced antimicrobial use, reducing the threat of antimicrobial resistance in animals and humans. By reducing the occurrence of bacterial infections, or by preventing secondary bacterial infections which arise due to viral or parasitic infections, vaccinations have a key role to play in reducing antimicrobial use on farms.

A number of successful case studies of vaccination use on farms illustrate the positive connection between vaccines and reduced antimicrobial use.

Case study: How Norway replaced antibiotics with vaccination in salmon farming

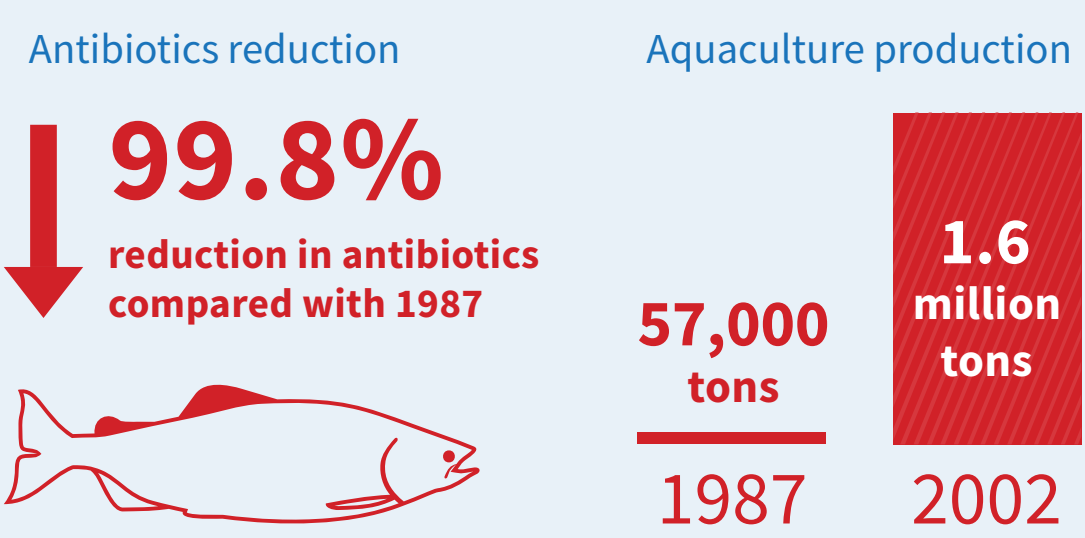
Headlines

- Furunculosis vaccination reduced antibiotic use in Norway's aquaculture sector by 99.8 per cent compared to 1987 levels.
- Today, roughly 99 per cent of salmon produced in the country have never been treated with antibiotics.
- Scotland's trout aquaculture sector has also reduced antibiotic use by roughly 69 per cent between 2017 and 2021, all but eliminating the use of antibiotics critical for human medical purposes.

Due to outbreaks of the bacterial infection furunculosis, which can kill fish and significantly disrupt aquaculture production, antimicrobial use reached a peak in the Norwegian fish farming industry in the late 1980s.[33] In response, a campaign coordinated by the industry and government sought to boost the uptake of furunculosis vaccines among fish farmers, thereby reducing the level of antimicrobial use and the risk of antimicrobial resistance.

This campaign enabled a 99.8 per cent reduction in antibiotics compared to their level of use in 1987, with roughly 99 per cent of salmon produced in the country now never being treated with antibiotics.[34] At the same time, Norwegian aquaculture production has continued to grow, from 57,000 tons produced in 1987, to 1.6 million tons in 2022.

Reducing the need for antibiotics in Norwegian aquaculture



Elsewhere, vaccination has also allowed the Scottish aquaculture industry, including both salmon and trout production, to significantly cut antibiotic use. According to data from the Responsible Use of Medicines in Agriculture Alliance (RUMA), the trout aquaculture sector in Scotland has reduced the level of antibiotic use by roughly 69 per cent between 2017 and 2021. Likewise, all farmed salmon in Scotland in 2021 was reported as vaccinated, with no Highest Priority Critically Important Antibiotics for human medical purposes – or HP-CIAs – used throughout the sector.[35]

Case study: How *E. coli* vaccination offers poultry producers a three-fold return on investment

Headlines

- *E. coli* vaccination reduced antibiotic need and lowered medication costs by 80 per cent for two-kilogram broiler birds.
- Birds vaccinated for *E. coli* also experienced 30 per cent lower rates of rejection and removal for consumption as food.
- Producers achieved a 3:1 return on investment due to *E. coli* vaccination, driven by reduced antibiotic need, medication costs, and mortality.

E. coli is a bacterium which can cause inflammation and diseases in livestock, which can also be transmitted to humans through contaminated foodstuffs. Live *E. coli* vaccination in poultry – which generates an immune response similar to natural infections – has been shown to reduce the level of antibiotic need, as shown by trials conducted in the United States.

Conducted by a large poultry producer in 2014/15, vaccination trials used two different sizes of birds (two-kilogram and three-kilogram birds). Data illustrates that, when provided with a live *E. coli* vaccination, two-kilogram birds experienced 80 per cent lower medication costs and almost 30 per cent lower field condemnations – or rejection for consumption as food.[36]

Three-kilogram birds benefitted from vaccination to a similar degree, with no vaccinated flocks suffering from excessive mortality – compared to almost 20 per cent of non-vaccinated flocks. The return on investment for producers as a result of *E. coli* vaccination was illustrated to stand at over 3:1, due to reduced antibiotic need, medication costs, and mortality.

Case study: Q-Fever vaccination trials show connection to reduced antibiotic use

Headlines

- Trials of a vaccine for Q-Fever, a bacterial disease impacting cattle, demonstrated a connection between vaccination and reduced antibiotic need.
- In the third year of trials, the mean frequency of antibiotic treatments per cow was statistically significant when comparing vaccinated and unvaccinated cows.
- Antibiotic use in vaccinated herds trended downwards over time, compared to increased need for unvaccinated herds.

Q-Fever is a widespread bacterial disease, caused by the bacteria *Coxiella burnetii,* which can infect livestock and cause significant damage, as well as abortions and still births in cattle, sheep, and goats. However, a three-year trial for a Q-Fever vaccination in Germany involving 49 farms and measuring the use of 12 antibiotic classes suggests a correlation between Q-Fever vaccination and reduced antibiotic need. In the third year after vaccination, the difference in the mean frequency of antibiotic treatments per cow was statistically significant when comparing vaccinated and unvaccinated cows: antibiotic use in vaccinated herds trended downwards over time, whereas it increased for unvaccinated herds.[37]

Nutrition and internal health

Headlines

- Better nutrition and internal health can boost an animal's natural defences against bacterial illnesses, reducing the need for antimicrobials.
- Phytogenic feed additives often derived from plants have been shown to improve feed efficiency and immune responses for farm animals, as well as improving the effectiveness of animal vaccines.
- Feed additives based on β-mannanase enzymes also improved growth and performance among broiler chickens, and significantly reduced bird mortality.

As in humans, nutritional and internal – or "gut" – health can boost an animal's natural defence against bacterial illnesses. Carefully managing an animal's diet can improve their overall health, productivity, welfare, and in turn, improve their body's ability to resist and fight off bacterial infection.

Nutritional and internal health can therefore play a key role in reducing antimicrobial use on farms. Supplements and feed additives are an emerging product area that can improve gut health and boost the natural immunity of animals, therefore reducing or altogether avoiding the need for antimicrobial treatments in the event of bacterial infection.

A number of innovative approaches are already reaching the market or are on the horizon. These include probiotics added to animal feed, which can prevent disease and target specific health challenges, plant-based feed additives, which can be combined with animal feed to alter the gut microbiome and improve immunity, and the rapidly expanding field of novel feeds – for instance, those derived from insect-based proteins and seaweeds, which offer new opportunities for precision nutrition, and benefits for welfare and sustainability.

Several successful case studies of improved animal nutrition and internal health on farms illustrate a positive connection with reduced antimicrobial use.

Case study: Feed additives support better gut health for poultry

Headlines

- Livestock farmers are incorporating feed additives known as "phytogenics", which are often all-natural and derived from renewable sources like plants.
- Phytogenic feed additives support improved intestinal health, reducing antibiotic need, while also improving feed conversion, body weight gain, and reduced mortality.
- Trials of plant-based feed additives also illustrate a strong connection with heightened immune response, feed efficiency, and responsiveness to vaccination.
- These additives improve the natural immunity of an animal, strengthening its ability to fend off bacterial disease and avoid antibiotic treatment.

A rising demand for poultry products has increased the pressure on farmers to choose the most sustainable products that also support optimum animal health. The use of feed additives known as "phytogenics" – which are often all-natural and derived from renewable sources like plants – are increasingly being adopted to improve immune and intestinal health of farm animals. Improved intestinal health could also play a key role in reducing the need for antibiotics, while also improving feed conversion, body weight gain, and total mortality rate in animals.

Key photogenic feed additives include products that contain saponins and polyphenols, which are extracted specifically from the plants *Quillaja saponaria* – also known as soapbark and native to Chile – and *Yucca schidigera* – native to the deserts of southwest North America.

Studies of phytogenic feed additives derived from these plants show consistent increases in the length of villi, or cells found in animals' intestines, in poultry – a good indicator of gut

health. Trials also indicated that plant-based feed additives led to heightened feed efficiency and immune response, as well as improving animals' responses to vaccines against coccidiosis, a parasitic disease which targets animals' intestines, and reduced salmonella "shedding" – or spread of the disease.

The feed additives were able to strengthen the natural immune system of an animal through better gut health, which helps the animal to fend off a bacterial infection. This can prevent the animal from falling sick and avoiding the need for treatment.

Case study: Direct-fed microbials overcome barriers of antibiotic transition

Headlines

- Shifts away from antibiotic use can often cause challenges for producers related to food safety, performance, and animal health.
- A direct-fed microbial (DFM) in the animal's feed improved bird health and supported the transition away from antibiotic use, according to one broiler operation.
- In total, improved nutrition boosted feed efficiency by 1.1%, bird weight by roughly 5%, and led to a nearly 25% reduction in overall processing plant carcass condemnations.

A broiler company in the US was seeking to adopt nutritional tools to support a shift towards antibiotic-free operations. The program was also experiencing several issues, including performance and health challenges, which are typical of the difficulties involved when shifting away from the long-standing use of antibiotics without any alternative.

In response, the company implemented a direct-fed microbial (DFM) in the animal's feed in an effort to improve the gut microbiome of the animals, supporting better bird health, performance, and reduced antibiotic need.

Data from the trial showed that the use of the DFM reduced problematic pathogens and supported a shift towards healthier gut microbiomes for the company's birds. For instance, thanks to the in-feed additive, feed efficiency improved by 1.1 per cent, bird weight increased by roughly five per cent, and there was also a nearly 25 per cent reduction in overall processing plant carcass condemnations.[38] Improved nutrition therefore played a key role in boosting overall health for the broiler operation, while increasing efficiency and productivity.

Case study: Feed additives contribute to significant reduction in poultry mortality

Headlines

- β-Mannans fibres are found in many vegetable feed ingredients, and can be mistakenly identified as a pathogen by broilers' immune systems, triggering an unnecessary immune response.

- A feed additive based on β-mannanase enzymes not only prevented this wasteful immune response, but improved broiler growth and reduced the burden of disease.
- Data shows that mortality was reduced from 42.71% in the control to 20.87% in the enzyme group under severe challenge and reduced from 9.78% to 3.75% under moderate challenge.

The intestinal tracts of modern broiler chickens face a range of health challenges that can compromise intestinal integrity, gut function, and the overall health of the animal. These include diseases such as coccidiosis and *Clostridium perfringens,* which can be influenced by dietary factors, nutrient balance, and non-infectious factors.

While vegetable-based feeds provide important nutrients for livestock, many also contain β-Mannans, an anti-nutritional fibre.[39] These fibres have a molecular pattern similar to a pathogen, which creates a 'Feed-Induced Immune Response' (FIRR) in poultry. This mistakenly triggers the immune system, which consumes energy, wastes nutrients, causes intestinal inflammation, and ultimately reduces animal performance.

However, studies of feed additive based on β-mannanase enzymes showed improved growth alongside reductions in health challenges and antibiotic treatments. One study found that the occurrence of post-weaning diarrhoea and the number of antibiotic treatments during post-weaning were "significantly reduced" in diets supplemented with these enzymes.[40] Another analysis found the additive was shown to reduce the impact of Necrotic Enteritis. Specifically, data shows that mortality was reduced from 42.71 per cent in the control to 20.87 per cent in the enzyme group under severe challenge and reduced from 9.78 per cent to 3.75 per cent under moderate challenge.[41] This means that β-mannans feed additives can be effective in supporting the management of disease challenges in production systems where antibiotic use is reduced.

Biosecurity

Headlines

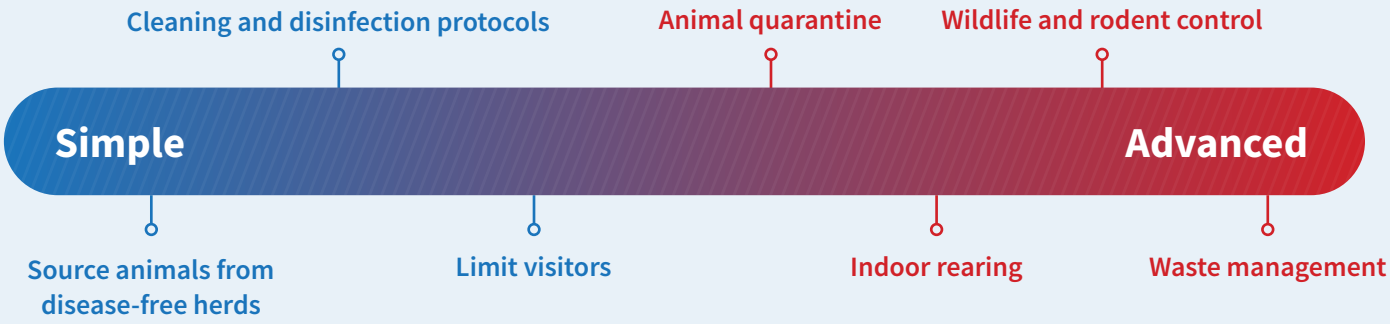
- Biosecurity measures represent a physical barrier against the spread of diseases on farms and reduce the risk of their spread to humans.
- Biosecurity measures range from simple procedures such as boot washing for farmers and isolation for infected animals, to high-tech air filtration systems for indoor animals.
- By preventing the spread of disease on, between, and out of farms, biosecurity represents a vital tool in reducing the use of antimicrobials in agriculture.

Biosecurity measures are vital in reducing the spread of diseases among livestock, as well as reducing the risk of their spread to humans. Biosecurity, broadly, covers the physical measures that are used to prevent the spread of disease on and between farms – including zoonotic diseases which can be transmitted between animals and humans. Simple measures, such as boot washing stations for farmers, well-defined cleaning and disinfection protocols, and animal quarantine and isolation, all fall under the umbrella of effective biosecurity measures to reduce the spread of disease. Likewise, biosecurity also includes more high-tech air filtration systems, which filter in crucial fresh air for livestock housed indoors, reducing the risk of bacterial disease or viruses.

Biosecurity measures, when combined with other tools, are a vital component in reducing the uptake of antimicrobials on farms, representing a physical barrier against the spread of disease. For instance, a study of EU swine herds found that an increased uptake of combined animal health measures, including biosecurity and vaccination, led to a reduction in antimicrobial use by 52% for fattening pigs, and 32% for breeding animals.[42] Likewise, a review of some 27 studies across 16 countries found that 70% of results showed a positive association between farm biosecurity and management with a reduction in antimicrobial use.[43]

Spectrum of biosecurity measures

Simple measures are those that require less equipment or training for implementation, while advanced measures may require more skills or financial investment.



Case study: Reducing infections and AMR through sanitation and hygiene

Headlines

- Environmental factors related to water and waste management can impact both the spread of disease and the rise of antimicrobial resistance.
- Analysis of 104 studies showed reductions in antibiotic use by up to 52% when farmers, veterinarians and other actors were involved in biosecurity measures to improve antibiotic stewardship.
- Biosecurity measures in aquaculture are particularly important to reduce the risk of resistance spreading through water resources.

Water, sanitation and hygiene (WASH) measures play an important role in preventing the spread of disease and protecting the health of people and animals alike, thereby reducing the need for antimicrobial treatment. A review of 104 studies from 39 countries found positive effects of WASH interventions in animal rearing for reducing infection burdens, antibiotic use and antimicrobial resistance.[44]

Given the close interactions between aquaculture and water resources and ecosystems, WASH best practices are particularly relevant. Efforts to uphold water quality in aquaculture, waste management strategies that help prevent resistant genes from contaminating water

bodies, and personal protective equipment for farmers and veterinarians all reduce the spread of both pathogens and antimicrobial resistance.

Importantly, the review highlighted the value of engaging farmers and veterinarians in the development and implementation of biosecurity strategies. Interventions that included discussion among livestock professionals with knowledge of antibiotic stewardship were able to reduce antibiotic use by 19-52%. This compares to reductions of 9-20% when cleaning and disinfection protocols were introduced without prior consultation.[45]

Case study: Protecting pigs from disease with external and internal biosecurity measures

Headlines:

- Higher levels of external biosecurity were associated with lower antimicrobial use among pig farms in Germany.
- Actively improving biosecurity measures to limit exposure to disease can be an alternative strategy to simply reducing antimicrobial use.

Among farrow-to-finish pig herds, antimicrobial treatment is most needed in weaned and suckling pigs, which most frequently suffer lameness and gastro-intestinal diseases that can impact growth and development. Biosecurity measures to prevent such diseases are divided between external measures, including purchasing policies, feed and water supplies, and environmental factors, and internal measures, such as suckling and nursery periods, and the isolation of infected animals.

A study of 60 swine farms in Germany's major pig producing regions found higher scores for external biosecurity compared to internal biosecurity. Higher biosecurity scores were also associated with lower levels of antibiotic treatment.[46] Farms with high levels of antibiotic use were typically those with less strict hygiene measures and cleaning regimes.

Such evidence indicates that strengthening the biosecurity status of farms is a key strategy for reducing antimicrobial use as stronger protections and practices to prevent disease spread lowers the need for treatment.

Genetics

Headlines

- Improving animal genetics through breeding can boost livestock health, productivity, and resilience to disease, heat stress, and other health threats.
- By identifying traits that increase an animal's disease resistance, scientists are able to guide farmers' breeding decisions towards those breeds less susceptible to bacterial infections.
- Scientists are also researching gene editing techniques to develop resistant varieties of common livestock breeds, reducing the need for antimicrobials while boosting productivity and animal health.

Improvements in genetics offer the potential for more productive and healthier livestock, bringing "One Health" benefits to people, planet and animal agriculture. Modern gene-editing techniques, for instance, can select traits that either improve an animal's resistance to a variety of health risks – such as heat stress or disease – or improve their efficiency, for instance, by boosting an animal's productivity or by reducing the methane emissions it produces. Researchers at the Centre for Tropical Livestock Genetics and Health (CTLGH), for example, have developed a technique to reproduce a naturally occurring gene mutation that can improve the thermotolerance of cattle living in hot countries.[47]

By selecting for traits that increase an animal's disease resistance, scientists can leverage modern genetic technologies to reduce antimicrobial use in farming systems. For instance, scientists have used CRISPR gene-editing technology to produce a calf with resistance to bovine viral diarrhoea virus (BVDV), one of the most important viruses affecting the health and well-being of bovine species, which also increases the risk of bacterial infection by damaging cattle's immune systems. Initial studies show the gene-edited calf had a dramatically reduced susceptibility to infection, demonstrating the potential for further research and development into gene-editing technologies to help reduce antibiotic use in agriculture.[48]

Case study: Genetic testing to boost cattle resilience and profitability

Headlines

- Diseases cause significant damage to livestock productivity and profitability for farmers as a result of mortality, the burden of disease, and reduced outputs.
- One 10-year study of 13,000 dairy cows across the US assessed and ranked the genetic makeup of cows to inform farmers' breeding decisions.
- The top 25% of cows displayed 44% less antibiotic use, also requiring 27% less labour, producing 35% more milk, and generating $869 more profit per cow.

Diseases can cause significant damage to the productivity of livestock around the world. For instance, recent studies have found that the impact of animal diseases on egg production in 2018 were modelled at roughly $5.6 billion in losses.[49]

In one 10-year study of 13,000 dairy cows across 11 US-based operations, however, a global animal health company sought to make use of genetic testing to increase the resilience and profitability of cattle. The study used a genetic test assesses cattle and "rank" them according to their genetic makeup and predict which animals will perform better and are less likely to fall sick in their lifetime.

Results of the study found that the cattle in the top 25 percent of the genetic rankings (when compared to the bottom 25 per cent) required 44 per cent less antibiotic use, as well as producing 10 per cent fewer methane emissions. Those cows ranked in the higher percentiles also displayed 22 per cent less lameness and required five per cent less feed and 27 percent less labour, producing 35 per cent more milk and $869 more profit per cow.[50]

The study shows how, with the support of genetic testing, farmers can make more informed breeding decisions that increase productivity while reducing the need for on-farm antibiotics by selecting for cows that display greater resilience.

Digital Technologies

Headlines

- Digital technologies, made up of modern monitoring tools, can provide more efficient and precise readings of livestock health.
- By equipping farmers and health professionals with more accurate and timely data, digital technologies can support reduced antimicrobial need on farms.
- A range of digital technologies are applied on farms today, from ear tag sensors to AI-driven video and sound monitoring.

The use of digital technologies offers the potential for more efficient and precise livestock health interventions. Digital technologies in livestock health broadly encompass modern monitoring tools that can provide rapid and highly accurate readings of animal health. These include simpler approaches such as ear tag sensors, which can monitor the activity, feeding, temperature, and behaviour of entire cattle herds. These sit alongside more sophisticated tools, such as AI-driven video and sound monitoring, which can pick up signs of ill-health – for instance, filtering out sick animal sounds among the wider sounds of the herd – for earlier diagnosis and treatment by veterinarians.

By providing more efficient and precise readings of livestock health, digital technologies play a vital role in reducing the need for antimicrobial use on farms. By picking up signs of disease and ill-health among livestock earlier and more accurately, digital tools can also support more rapid veterinary interventions, which can reduce the level of antimicrobials subsequently applied by health professionals.

Case study: AI-powered sound monitoring guides early disease responses in swine

Headlines

- Disease outbreaks cause significant economic losses for modern pig production worldwide, yet individual monitoring, diagnoses, and treatment is constrained by large herd sizes and labour shortages.
- An AI-powered sound monitoring tool allows farmers to monitor the health of their herds, picking up signs of disease early, guiding more precise and effective health interventions.
- Data shows that the sound monitoring tool has contributed to reduced antimicrobial use in Thailand and the EU, with better health and welfare outcomes for livestock, and greater productivity for farmers.

The global swine industry continues to experience substantial economic losses due to respiratory disease outbreaks in modern pig production worldwide. These disease outbreaks not only negatively impact productivity for farmers but contribute to heightened antimicrobial use and reduced animal welfare. Yet, large herd sizes and labour shortages have made timely, individual assessment of livestock animals challenging – contributing to imprecise actions, including treatment with antimicrobials.

One sound monitoring system offered by a global animal health company and available in 20 countries in developed and developing regions illustrates the potential for digital technologies to address these challenges. The tool, which provides continuous, sound-based monitoring for swine herds, helps to monitor the respiratory health status of growing pigs, and detect any signs of disease.

The system listens for early indicators of respiratory issues and provides alarms and notifications for producers through smartphones or other devices. The data provided by the monitoring tool allows farmers to finely tune and standardise health interventions, while providing simple, low labour-intensive visualizations of collected data.

Data from Thailand and the EU shows that the monitoring system has led to a decrease in individual antibiotic treatment and overall use, due to the early and more precise intervention guided by the system.[51] One study of swine production in Northern Denmark found a 38% reduction in antibiotic use except for cases involving influenza.[52] Likewise, studies of the tool show that pigs have benefitted through improved healthier, well-being, with farmers benefiting from higher productivity and a lower cost of disease for their herds.

Alternatives to Medically Important Antimicrobials

Headlines

- Priority antibiotics include those deemed 'critically important' for human health, meaning responsible use to avoid AMR development is particularly important.
- Use of non-medically important antimicrobials for disease treatment can reduce the risk of bacteria developing resistance to antimicrobials important to human health.

Alternatives to medically important antimicrobials are a growing field that supports improved health and resilience for livestock. Medically important antimicrobials (MIAs) are any antimicrobials that can be used in people and within that group are 'Critically Important' antimicrobials and 'Highest Priority Critically Important' antimicrobials (CIAs and HP-CIAs). Avoiding the use of these medicines where possible can help limit the potential for resistance developing within people.

Antimicrobials that are *only* used in animals are not considered medically important to people and have a low risk of developing resistance that would affect humans. Typically, these antimicrobials are not used in human medicine because of issues like toxicity, whereas in animals they are safe and effective. The World Health Organisation has identified eight classes of antimicrobials that are considered 'not medically important', including classes such as orthosomycins and quinoxalines that are currently used in livestock production. While many bacterial disease require MIAs for treatment, shifting to animal-only antimicrobials when possible can reduce the need for MIAs in livestock production and help prevent the development of resistant bacterial infections that could harm people.

Case study: Non-medically important antibiotics for treating poultry diseases

Headlines

- Necrotic enteritis and dysentery in poultry and swine are two diseases that cause significant animal distress and economic loss to farmers, with both typically treated by medically important antibiotics.
- Animal health companies have invested in repurposing non-medically important antibiotics, such as avilamycin, for use in animal health.
- The use of non-medically important classes enables farmers to treat disease while reducing the overall risk of antimicrobial resistance.

Necrotic enteritis and dysentery in poultry and swine cause significant animal distress and economic loss to farmers, with both typically treated, controlled, and prevented by using medically important antibiotics. Unnecessary or overuse of these antibiotics could contribute to antimicrobial resistance, endangering both human and animal health. Reducing the threat of antimicrobial resistance in poultry and swine is particularly pressing, given their role as food producing livestock for humans.

Some non-medically important antibiotics can be used to treat certain livestock diseases. Avilamycin, for instance, is a non-medically important antibiotic that has been repurposed to treat and control necrotic enteritis in poultry and dysentery in swine.

Following observations from veterinarians about the positive health outcomes of animals receiving the drug, researchers were able to repurpose avilamycin to treat and control diseases in swine and poultry. The repurposing of the medicine has allowed farmers continued access to antibiotic treatments for their livestock while reducing the risk of antimicrobial resistance developing that could affect humans.

Part 3: Implementing prevention to reduce the need for antimicrobials on farms

A full and growing suite of preventative animal health tools that reduce the prevalence of bacterial infection, and therefore, the need for on-farm antimicrobials, provides practical opportunities to manage the threat of AMR. However, the availability and accessibility of these tools continues to vary greatly around the world, making global progress on AMR uneven and inconsistent.

Overcoming hurdles to prevention at the farm level, such as a lack of adequately trained veterinarians, vaccine infrastructure and investment, particularly in low-income countries, will be key to scaling up prevention strategies. This will require greater levels of cooperation across public and private sectors, and additional financing.

Four projects across developed and developing regions show how the implementation of disease prevention strategies through effective partnerships can avoid outbreaks, reducing the need for antimicrobial treatment.

A.L.P.H.A. Project

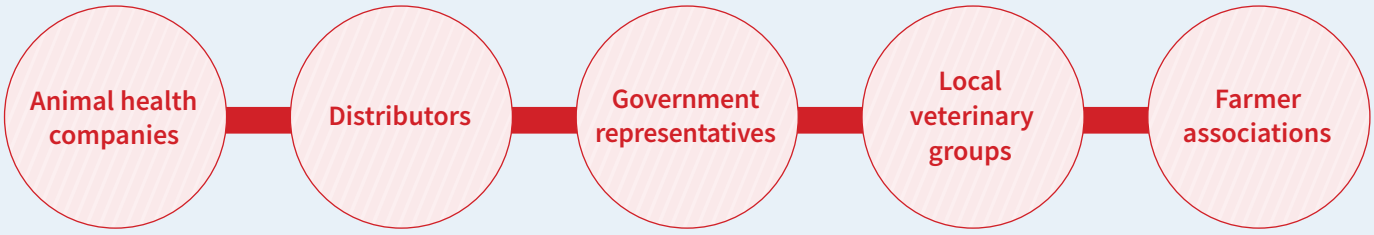
The African Livestock Productivity and Health Advancement (A.L.P.H.A.) initiative is a collaboration between a major animal medicines company and the Bill & Melinda Gates Foundation to increase access to veterinary medicines and services in four African countries. The objective of the project is to advance livestock health and productivity, improve disease diagnostic infrastructure and develop laboratory networks in Sub-Saharan Africa.

Five years after launching in 2017, the project has increased the number of preventative animal health products available in the region from just four to more than 90, including vaccines, parasitic treatments and medicines. The initiative has since provided veterinary care to 128 million animals, established 16 diagnostics laboratories, and trained 26,000 farmers, veterinarians and para-vets on veterinary care.

A.L.P.H.A. relies upon close collaboration between public and private sectors, including a global animal health company, governmental authorities, local veterinary associations, national and international NGOs, farmers associations, and private sector distribution companies. A holistic approach that brings together relevant, local players in animal agriculture and veterinary health helps ensure the right voices are heard when strategies are developed.

This effort has significantly expanded capacity to prevent disease outbreaks and the need for antibiotics in Uganda, Nigeria, Ethiopia and Tanzania. A second grant was provided in March 2023 to expand the A.L.P.H.A. project (now A.L.P.H.A. plus) to include aquaculture in an additional seven countries. A.L.P.H.A. Plus will focus on dairy and beef production, poultry and aquaculture in Ethiopia, Nigeria, Tanzania, Uganda, as well as Kenya, Ivory Coast and five additional markets from East, West and Central Sub-Saharan Africa.

Actors necessary for successful public-private partnership



Reducing the need for antibiotics is more successful when all work together towards the same goal.

PREVENT Project

The PREVENT project (Promoting and Enabling Vaccination Efficiently, Now and Tomorrow) is a partnership between one of the world's largest veterinary health companies and animal medicine non-profit GALVmed, with the support of the Bill & Melinda Gates Foundation.

The project, which started in April 2021, equips medium-sized hatcheries across Africa with the resources to vaccinate day-old chicks against common poultry diseases. Administering vaccines at the hatchery rather on the farm offers several benefits: vaccines can be stored and handled under optimal conditions, including maintaining the cold chain, and administered by trained technicians to ensure every chick is effectively vaccinated.

By providing small-scale producers with healthier chicks, together with improved flock health and husbandry advice, the project aims to cut waste and make poultry production across target countries more sustainable by reducing the likelihood that chicks will need antimicrobials.

In the first two years of the PREVENT project, 24 hatcheries that previously did not vaccinate chicks were recruited in eight countries in West, East and Southern Africa. To date, 100 technicians have been trained from four countries and made 1,800 farm visits, organising 100 farmer meetings to increase awareness of the benefits of hatchery-vaccinated chicks and good biosecurity.

As a result, 37 million day-old chicks were vaccinated, each with an average of three doses of vaccine, making them less likely to contract diseases and require antimicrobial treatment. Eventually, the initiative expects to produce 50 million vaccinated chicks annually for 150,000 farmers.

Responsible Use Coalitions

In recent years, a number of coalitions have formed to promote and facilitate the responsible use of antimicrobials and disease prevention strategies to reduce their need across the agri-food supply chain. These often include a broad spectrum of members, including producers, veterinarians, processors and retailers.

Examples of these "farm to fork" coalitions are the UK's Responsible Use of Medicines in Animal Agriculture (RUMA), the European Platform for the Responsible Use of Medicines in Animals (*EPRUMA),* and Brazil's *Aliança para o Uso Responsável de Antimicrobianos.*

These coalitions have provided trainings, coordinated actions, and supported policies that have delivered measurable reductions in antimicrobial use and improvements in disease prevention, including vaccination. For example, in 2023, RUMA organised a series of "One Health" webinars to promote the responsible use of medicines, and EPRUMA has produced a series of best practice factsheets and resources.

Spanish Swine Production

A major animal health company worked directly with Spanish pig farmers to enhance their disease prevention measures after preventative group antibiotic treatments were no longer permitted in the EU beginning in 2022.

The approach was based on four pillars of animal health: good animal husbandry, effective biosecurity, relevant vaccination and the responsible use of antibiotics, inspired by the animal health industry's mantra of "as little as possible but as much as necessary".

The company provided a "One Health" package of support, including biosecurity surveys, phased "all-in, all-out" rearing systems to limit the spread of disease, and vaccines to prevent bacterial infections such as *E.coli* and Salmonella.

Various diagnostic and monitoring tools also ensured that relevant and useful data was fed back to the farmers and their veterinary teams in accessible and easy-to-understand formats to enable vaccine regimes, biosecurity protocols and other management practices to be fine-tuned and optimized. This helped to deliver maximum benefits in terms of improved pig health and welfare, enhanced public health through reduced use of antibiotics and better control of zoonotic diseases.

The efforts also involved collaboration with other businesses, such as animal feed companies, to ensure that all aspects of the health and welfare of pigs, especially newly weaned piglets, was addressed.

A total of 15 leading Spanish pig producers adopted the model with positive results, safeguarding the progress that saw veterinary antibiotic use decrease in the country by more than 64 per cent between 2014 and 2020.

Conclusion

With no direct alternatives, antimicrobial treatments are among the most valuable tools in both human and veterinary medicine. Without them, it is impossible to treat bacterial infections that can otherwise be responsible for significant losses and mortality across livestock herds. Antimicrobial resistance therefore poses a direct threat to the sustainability of veterinary care, and animal health and welfare. The unique application of antimicrobial agents makes their ongoing use unavoidable, and yet maintaining their efficacy requires responsible and prudent use.

While levels of antimicrobial resistance in animals are in some cases low today, it is essential to remain vigilant in the years ahead. Loss of antimicrobial effectiveness due to AMR risks creating sustainability, animal welfare and food security challenges. Doubling down on responsible use efforts and relying upon proven practices that reduce the need for antimicrobials in animal agriculture can avoid this outcome.

The most effective proven approach for reducing the need for antimicrobial treatment is to prevent the diseases that require them. Evidence from livestock operations around the world indicates that when animals are protected from disease through vaccination, biosecurity and good husbandry practices, they require less antimicrobial treatment. This has multiplier benefits for livestock producers through increased productivity and reduced costs, while also minimising the antimicrobials entering the environment and improving animal welfare.

The FAO's RENOFARM initiative builds on this evidence to equip countries to increase disease prevention and reduce the need for antimicrobials. The 10-year global campaign recognises that it is neither ethical nor sustainable to simply reduce the use of antimicrobials without also reinforcing disease control and prevention. To do this, the initiative will engage the entire production chain, from international bodies and institutions to the public and private sectors.

Preventing animal diseases to preserve antimicrobials also supports broader development goals. Initiatives like RENOFARM, which support healthier animals and lower antimicrobial usage, also contribute to better production, better nutrition, a better environment and better lives, helping to achieve the UN's 2030 Agenda for Sustainable Development and the related Sustainable Development Goals (SDGs).

Collaboration to scale up the use of existing preventative tools can help reduce the need for antimicrobials and minimise the risk of resistance. Progress is under way, but more global cooperation is needed to ensure that no one is left behind and our shared "One Health" goals are realised.

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