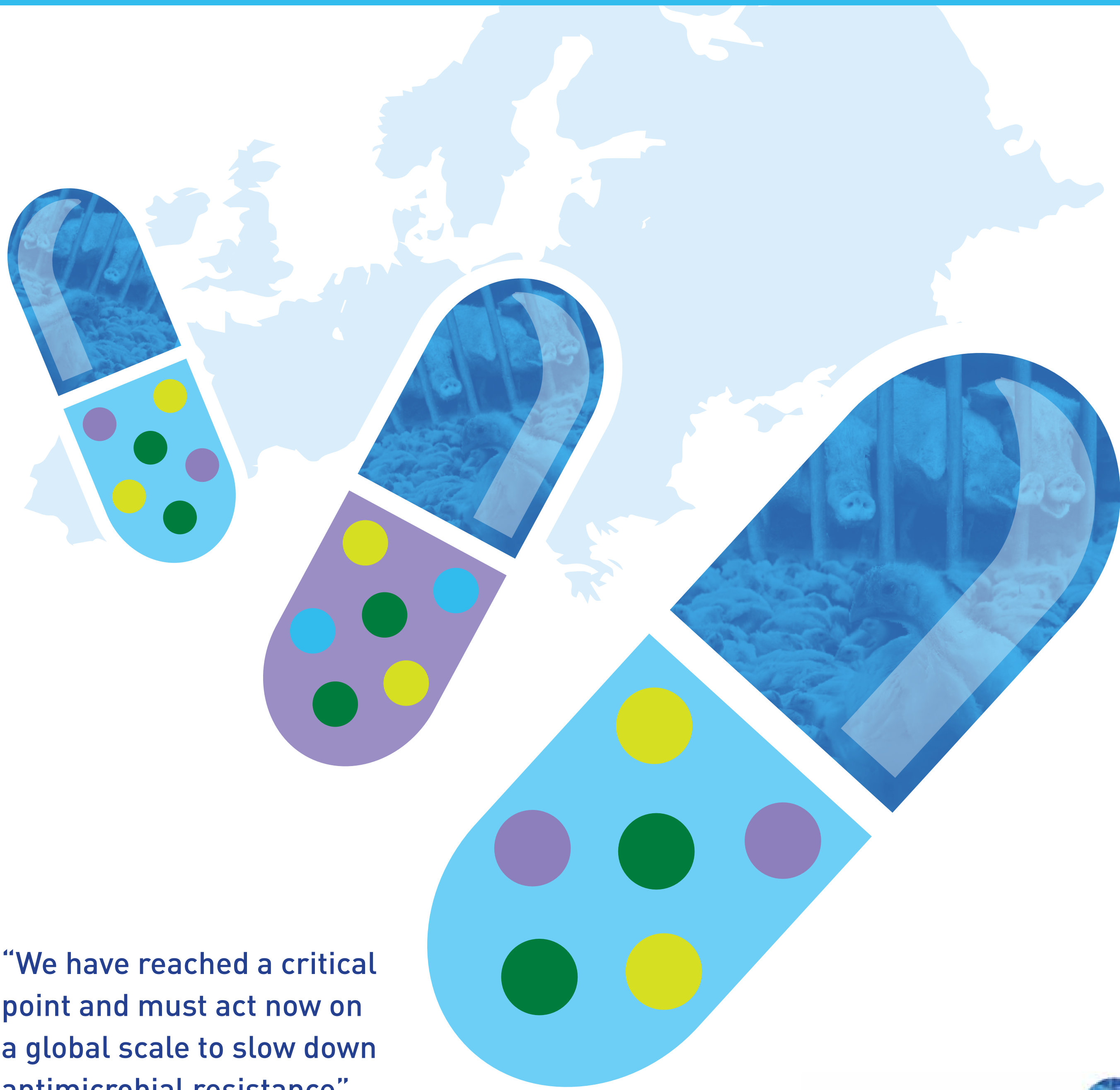
Real farming solutions to antibiotic misuse

What farmers and supermarkets must do



"We have reached a critical point and must act now on a global scale to slow down antimicrobial resistance"

Professor Dame Sally Davies,
UK Chief Medical Officer

ALLIANCE TO SAVE OUR ANTIBIOTICS

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Introduction

Antibiotic resistance is now recognised as a major international issue across the world. Last year, after a high-level meeting at the United Nations, the Heads of State for the first time committed to taking a coordinated approach to address the root causes of antibiotic resistance across multiple sectors, especially human health, animal health and agriculture.

Action against the overuse of antibiotics in farming is starting to occur globally. The World Organisation for Animal Health (OIE) reported last year that worldwide, out of 130 countries surveyed, 96 had ended the use of antibiotics as growth promoters. In Europe, action is more advanced, and there is even discussion about the need to ban preventative antibiotic group treatments.

The UK farming industry has also responded to public pressure by making some long-overdue, but nevertheless, very significant cuts to farm antibiotic use. While these reductions are very welcome, much more remains to be done, and the evidence put forward in this report shows that much more can be done.

Despite these many positive developments, the overuse of antibiotics in farming remains far too widespread. An EU report published earlier this year showed that in Europe about twice as many antibiotics are used in farm animals than are used in humans. In other parts of the world, use is even higher. Furthermore, it is predicted that unless there is an intervention we are on course to see the demand for meat to almost double by 2050, when it is estimated that deaths caused by antimicrobial resistance will be at 10 million annually and may outnumber cancer.

This report sets out what we believe to be one of the key solutions to achieving the drastic and long-lasting reductions to farm antibiotic use that we need: improvements to livestock farming systems.

We present the latest evidence, and scientific data showing that disease incidence, and antibiotic use varies by farming system and by husbandry methods. Reforming farming systems and husbandry will help preserve antibiotics for human use, improve animal welfare, and help provide more sustainable livelihoods and good-quality food for an increasing population.

We also look at the UK retail sector and the work that supermarkets are doing to achieve change in their supply chains. We report on some clear progress, with several supermarkets announcing new policies on antibiotic use. Some supermarkets, however, still have much to do.

And finally in this report, we have also thought it timely to reiterate the necessity of legislation as a positive tool for change. It is remarkable that in 2017 it is still entirely legal in the UK and in most of Europe to feed antibiotics to groups of animals when no disease has been diagnosed in any of the animals. The solution to this problem is clear – a ban on preventative group treatments – and is already being implemented successfully in some European countries.

Executive summary

For many years, antibiotics have been routinely overused in livestock farming, particularly in pig and poultry farming. However, in recent years, due to the rise of antibiotic resistance and the lack of new antibiotics being discovered, the British farming industry has responded to public and scientific pressure and has begun to make significant efforts to reduce its use of these medicines.

The poultrymeat industry has reduced its antibiotic use by about 70% since 2012 and more recently, the pig industry has also taken action. While these initiatives are welcome, overall use levels remain much higher than those achieved by best practice, and so much more remains to be done.

Furthermore, these reductions have been achieved partly by increasing the use of alternative medication, rather than by reforming the farming system itself in order to reduce disease incidence. The pig industry relies heavily on the routine use of zinc oxide, a polluting feed additive, which selects for antibiotic resistance and will be banned in the UK and throughout the EU in 2022. The poultry industry, similarly, has increased its already extremely high use of non-medically important coccidiostat antibiotics. Some human-health concerns exist about the overuse of these products too.

An alternative approach exists, which involves altering farming systems to improve animal health. As antibiotic-use data collection improves, there is increasing evidence that less intensive farming systems require far smaller quantities of antibiotics.

There is now evidence that increasing the weaning age for piglets, rearing pigs outdoors or in "enriched" indoor systems with lower stocking densities (the number of pigs per square metre) can improve pigs' gut health and reduce the need for antibiotics. Breeding for more robust sows which produce a more manageable number of piglets would also lead to greater piglet and sow health.

For poultry, the latest data shows that slower-growing breeds of chickens have far less need for antibiotic treatment than fast-growing breeds which currently reach slaughter weight in just 32-40 days. Lower stocking densities are linked to lower disease incidence, as air quality is better, wet litter is less of a problem and disease spread is reduced. Free-range and organic farming both have lower stocking densities than conventional production and use slower-growing breeds. Access to the outdoors is also expected to reduce disease incidence in these systems.

In the UK, antibiotic use in dairy cattle is significantly higher than in beef cattle, and the main health problems requiring treatment are mastitis, foot problems and uterine problems. According to an European Food Safety Authority (EFSA) review, these health problems are greater in "zero-grazing" dairy systems where the cows are kept indoors all year round. Genetic selection for high milk yield is also positively correlated with the incidence of lameness, mastitis, reproductive disorders and metabolic disorders.

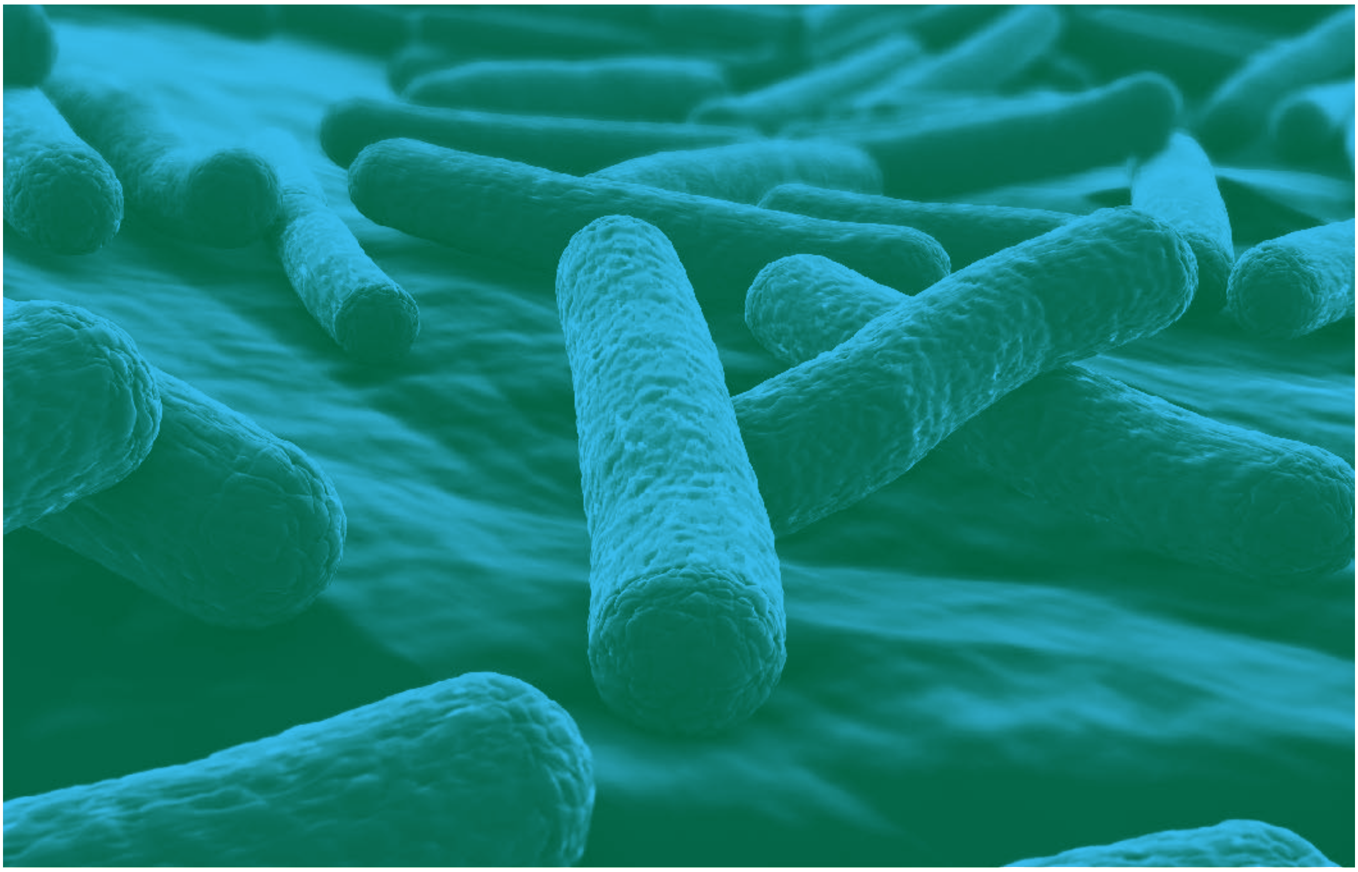
Beef cattle in the UK are often farmed less intensively that in some other European countries with significant veal-calf industries. The latest data shows that this results in much lower antibiotic use in the UK. This is as expected since, according to EFSA, in intensive beef systems, disease incidence is linked to overstocking, inadequate ventilation and excess feeding of concentrates, whereas cattle raised on pasture generally have good welfare.

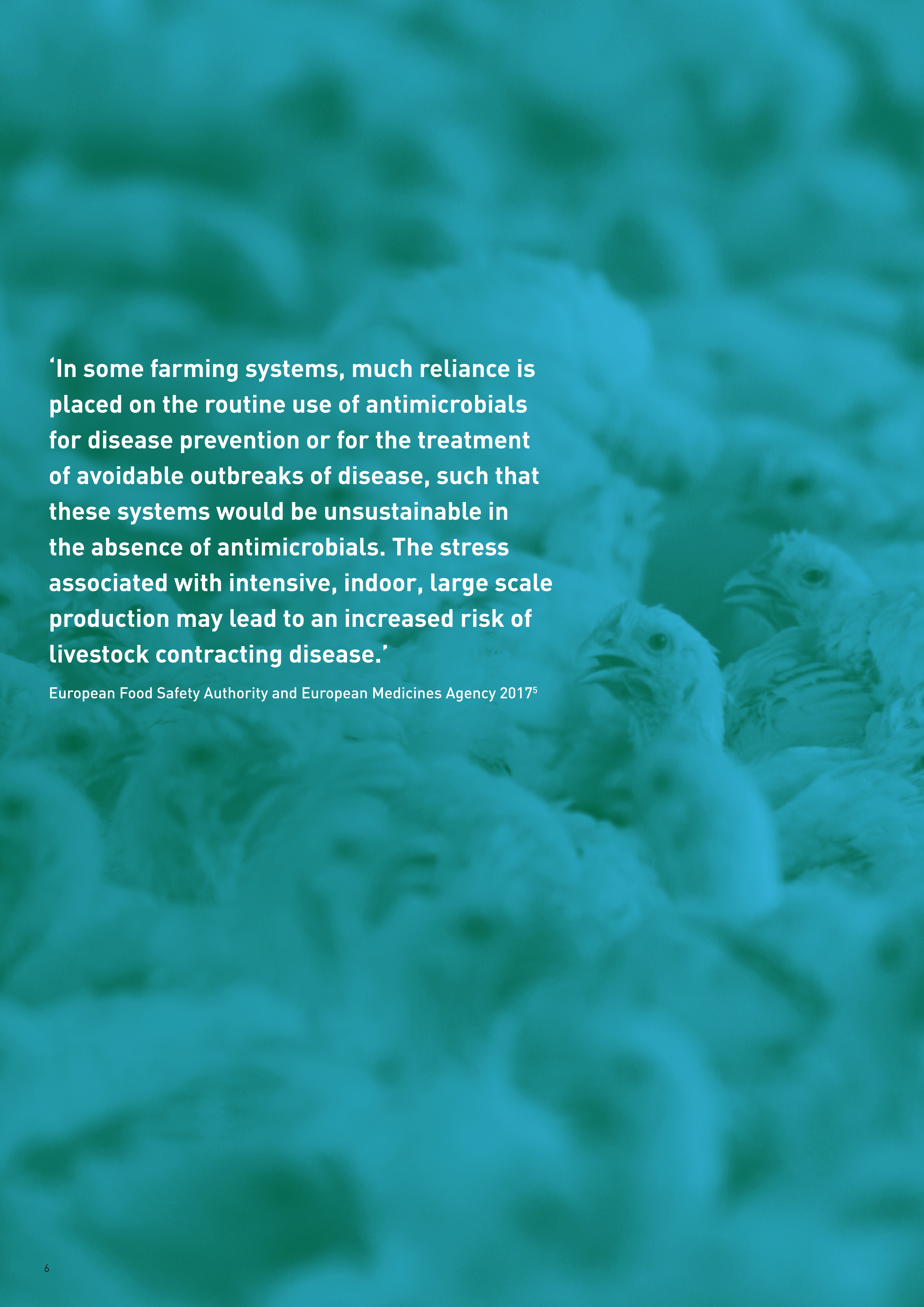
Overall, there is now clear evidence that by selecting more robust breeds of farm animals, and keeping them in improved conditions, that the incidence of many diseases can be greatly reduced. In practice, systems which apply these principles, such as free-range, organic or higher-welfare indoor farming, are achieving much lower levels of antibiotic use. In order to achieve the reductions in antibiotic use that are now needed to help preserve antibiotic effectiveness into the future, a major re-think of farming systems is needed.

We have put the publicly available antibiotic policies of nine of the UK's largest supermarkets under scrutiny, to see who has committed to banning routine preventative antibiotic use and is making commitments to reducing antibiotics in their supply chains, and who isn't. Our findings show that five supermarkets have clear bans on their suppliers using antibiotics for routine prevention (Co-op, M&S, Sainsbury's, Tesco and Waitrose), one has a ban in some species but not in others (Morrisons), one has some restrictions but no ban (Aldi) and two have no restrictions other than legal restrictions (Asda, Lidl). Overall, Waitrose has the most comprehensive antibiotics policies, followed by M&S, Sainsbury's and Tesco, whereas Lidl is the only supermarket to have no publicly available policies. We will be repeating this evaluation annually to track progress.

Regulatory action has been shown to be very effective in helping drive reductions in farm antibiotic use. New regulations on the use of farm antibiotics are urgently needed in the UK and in the EU. These should include:

- a ban on the use of preventative use of antibiotics in groups of animals where no disease has been diagnosed in any of the animals.
- the use of the modern cephalosporins and the fluoroquinolones, which are antibiotics classified as 'critically important in human medicine', to be limited to the treatment of individual sick animals where sensitivity testing, or the results of recent sensitivity testing, shows that no other antibiotics are likely to work.
- a ban on all use of the antibiotic colistin, which in recent years has been used as a life-saving treatment of last resort in human medicine.
- measures aimed at improving animal health and welfare in all antibiotic-reduction strategies. Such measures should look to reduce stocking densities, improve piglet health at weaning, and avoid the use of breeds of animals which require particularly high antibiotic use.





‘In some farming systems, much reliance is placed on the routine use of antimicrobials for disease prevention or for the treatment of avoidable outbreaks of disease, such that these systems would be unsustainable in the absence of antimicrobials. The stress associated with intensive, indoor, large scale production may lead to an increased risk of livestock contracting disease.’

European Food Safety Authority and European Medicines Agency 2017[5]

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Farming systems and antibiotic use

A controversial topic

The link between farming systems and levels of antibiotic use has long been controversial. Despite evidence to the contrary, the British government and industry advocates maintain that there is no link between farming systems and antibiotic use, and that instead it is the individual farmer that is most responsible for the level of disease and thus the need for antibiotics.

In 2015, the Parliamentary Under Secretary of State for farming, food and the marine environment, George Eustice MP, wrote that "All farming systems use antibiotics. Intensive livestock systems do not necessarily use large amounts of antibiotics [...] Intensive and extensive systems have their strengths and weaknesses, and offer some compromise on welfare. The single most significant influence on the welfare of livestock is the quality of the stockmanship, not the specific system in which the livestock are reared"[1]. Similarly, the lobby group RUMA (Responsible Use of Medicines in Agriculture) which represents the pharmaceutical and farming industries says that "there is no scientific evidence that intensive farming systems contribute more to the overall risk of antibiotic resistance than extensive farming systems"[2].

In reality, as stated by the government-commissioned Review on Antimicrobial Resistance, antibiotic use is "particularly prevalent in intensive agriculture, where animals are kept in confined conditions"[3]. In fact, the European Food Safety Authority and the European Medicines Agency (EMA) have even stated that certain intensive systems "would be unsustainable in the absence of antimicrobials"[4].

The reason why industry and government representatives have been able to deny the link between farming systems and antibiotic use is because for many years there has been a lack of data on the levels of antibiotic use in different farming systems. In most countries, including the UK, the only data available has been on the sales of antibiotics, which is difficult to separate by species and provides no information on use by farming system.

Fortunately, some countries are now collecting antibiotic-use data directly from farms and in some cases this enables use by farming system to be established. A small number of studies have also compared antibiotic use by system. These sources are consistently showing large differences in antibiotic use by farming system in all major species, and highlight the need to radically change our approach to farming if we are to reduce antibiotic use to more sustainable levels.

'Large numbers of animals living in close proximity, or in non-hygienic conditions can act as a reservoir of resistance and accelerate its spread. There are often many opportunities in intensive farming environments for drug-resistant bacteria to be transferred between, for example, thousands of chickens being reared in the same indoor enclosure'

EFSA and EMA 2017[5]

Antibiotic use in pigs

In the UK, and in many other countries, antibiotic use is by far the highest in pigs. The British pig industry has, however, begun to significantly reduce its antibiotic use in the last couple of years in response to public and regulatory pressure. In 2016, use was cut by 34% from 278 mg of active ingredient per kg of Population Correction Unit (PCU – the European unit measuring the size of livestock population) to 183 mg/kg[5]. This, however, remains over three times higher than the government's target of 50 mg/kg for farm antibiotic use[6].

This UK level of use also still compares poorly to the small number of other countries which have data on antibiotic use by species, particularly when compared with Sweden, where pig farming is significantly less intensive, see Table 1. However, other EU countries, like Spain and Italy, that don't have species-specific data are likely to have much higher use in their pigs, since their use across all species is over 350 mg/kg of PCU.

Table 1

Antibiotic use in pigs in 2016 (mg of active ingredient per kg of Population Correction Unit)

United Kingdom	>183 mg/kg
France[7]	104 mg/kg
Netherlands[8]	47 mg/kg
Denmark[9]	44 mg/kg
Sweden[10]	15 mg/kg

RUMA and the National Pig Association have recently set a target of reducing antibiotic use in pigs to 99 mg/kg by 2020, which would mean that use in 2020 would remain twice as high as in Denmark and the Netherlands and over 6 times as high as in Sweden.

Some of the reductions in use so far appear to have been achieved by relying on alternative treatments to antibiotics. A key alternative that is being used in piglets is zinc oxide, which is added to piglet feed at medicinal doses to control post-weaning diarrhoea[12]. Post-weaning diarrhoea is a major cause of antibiotic use in the pig industry (see below). According the NPA, zinc oxide, which also has a growth-promoting effect, is now being used in 70-90% of piglets in the UK, which is contributing to reductions being made to antibiotic use[13].

However, based on advice from the European Medicines Agency, the European Commission has decided to give Member States five years to withdraw all zinc oxide oral veterinary medicines due to concerns that it is toxic to plants and aquatic organisms and, because it is not biodegradable, it will accumulate in the environment. The European Medicine Agency also pointed to evidence that the use of zinc oxide may select for antibiotic-resistant organisms, although it wasn't able to quantify this risk. Nevertheless, several studies have found that the use of zinc in feed can increase the incidence of antibiotic-resistant *E. coli* and of MRSA in piglets[14, 15, 16].

With zinc oxide due to banned, and as the Veterinary Medicines Directorate plans to implement the ban by giving the full five years for the transition[17], the National Pig Association (NPA) is concerned that this may lead to antibiotic use increasing again[18,19].

Another possible treatment that is sometimes used to prevent post-weaning diarrhoea in piglets is the inclusion of porcine blood plasma in the feed, as the antibodies in the blood help prevent bacterial infection[20]. Porcine blood plasma is permitted in many countries around the world, including in the EU[21] and the UK[22], but UK Red Tractor Standards for pigs do not allow it[23] and the NPA says that more than 92% of pigs in the UK are not fed blood products[24].

With the upcoming ban on zinc oxide, there may be pressure on Red Tractor to lift the ban on porcine blood plasma. However, the use of porcine blood plasma has already been linked with the spread of the highly-virulent Porcine Epidemic Diarrhoea (PED) virus from the United States to Canada in 2014[25]. PED is now present in Europe, although the strain is perhaps slightly less virulent[26].

The possibility of spreading of the PED virus, and perhaps other viruses, and maybe also *Clostridium difficile* spores, via blood plasma should be a warning to not reintroduce the practice of feeding porcine blood to pigs.

So if neither zinc oxide or blood plasma are part of the long-term solution, then as increasing antibiotic use will not be acceptable, the industry may need to consider examining weaning practices which are at the root of so many of the disease problems.

Later weaning helps lower antibiotic use in organic and other less intensive systems

Pigs in intensive, indoor systems can receive antibiotic treatment at each stage of their lives until slaughter, usually at under 6 months old. But it is at weaning, when piglets are often mixed with other piglets, and develop post-weaning diarrhoea due to stress and dietary change, when antibiotic treatment is at its highest. In some cases, even antibiotics that are classified as critically important in human medicine are used to control post-weaning diarrhoea[27].

However, several pieces of evidence which have been published in recent years show that the extent of antibiotic use at weaning can vary hugely, depending on the farming system and husbandry used.

In Denmark, antibiotic-use data is collected from all pig farms. The Danish data shows that antibiotic use in organic systems is ten times lower, and at weaning time it is 20 times lower, see Table 2. It is worth noting that, for the organic pigs, unlike the non-organic pigs, there is no sudden increase in antibiotic use at weaning time. This is probably because organic piglets cannot be weaned before 40 days of age, whereas in non-organic farming, they can be weaned from 21 days, which means that organic piglets have more developed gut flora at weaning.

Table 2

Antibiotic use in organic and non-organic pigs in Denmark[28]

	Organic pigs	Non-organic pigs	Number of times non-organic use greater than organic use
	Number of doses per 1,000 animal days		
Sows and piglets	4.1	23.5	5.7
Weaning piglets	4.6	94.4	20
Slaughter pigs	5.1	18	3.5
All pigs	4.8	51	10.5

Later weaning can also be of benefit in indoor, non-organic systems. A study comparing antibiotic use on 227 pig farms in four EU countries found that use in Sweden was nearly seven times lower than in France, and use in Belgium and Germany was even higher than in France[29]. Most of the difference in use occurred in weaners: as with organic pigs in Denmark, there was no sudden increase in antibiotic use in Swedish pigs at weaning time, and in fact use decreased. By contrast, in the three other countries, antibiotic use increased sharply at weaning, so that piglets received 20 to 30 times more antibiotics than they did in Sweden, see Table 3.

The most likely explanation for the difference was the later weaning of piglets in Sweden where the median age of weaning was 35 days, whereas in France, Belgium and Germany it was between 22 and 25 days.

Table 3

Antibiotic use in pigs in four European countries

	Belgium	France	Germany	Sweden
	Mean number of doses per 1,000 animal days			
Suckling piglets	175.6	59.1	245	76
Weaned piglets	407.1	374.3	633.4	21.4
Fattening pigs	33	7.3	52.9	6.1
Entire growing period	142.9	108	242.8	22.7
Mean weaning age	23.5	24	24.4	35

According to industry data, the average weaning age in the UK and the EU is around 26 or 27 days[30]. In order to minimise problems with post-weaning diarrhoea, moves to a later weaning age urgently need to be considered by the industry.

Lack of data on antibiotic use by farming system

There is still a significant lack of usage data which compares antibiotic use in different systems such as conventional intensive, free-range and organic production.

As mentioned above, the BPC now collects annual usage data from all of its members. However, none of this is published by farming system. Similarly, as discussed elsewhere in this report, several supermarkets have begun collecting usage data from their poultry farms, but none so far have committed to publishing it by system, even though the way the data is collected would almost certainly enable such comparisons to be made.

A small comparative study, carried out by Defra on UK pig and poultry farms, found much lower levels of use on organic poultry farms, see Figure 1.

Organic production differs from conventional production in many respects, several of which are very likely to have an impact on antibiotic use[4]. These include stocking densities, access to the outdoors and the bird genetics, including in particular their growth rate.

Free-range production stands in between organic and intensive with respect to stocking densities and growth rate, and it is therefore very likely that antibiotic use in free-range production is somewhere between use in organic and use in intensive production.

Straw and "enriched housing"

According to a recent report by EFSA and the EMA, barren environments may result in behavioural abnormalities, such as tail biting and aggression[31]. Pigs housed in straw-based systems generally have fewer injuries and feet problems than those kept on slatted floors[31] and straw bedding has also been reported to reduce gastric ulcers and lung damage[4, 32, 33]. EFSA and the EMA point out that Swiss "animal-friendly" farms (multiple areas, straw bedding, access to outdoor facilities) used less group-based antimicrobial treatments than control farms with slatted floors[34].

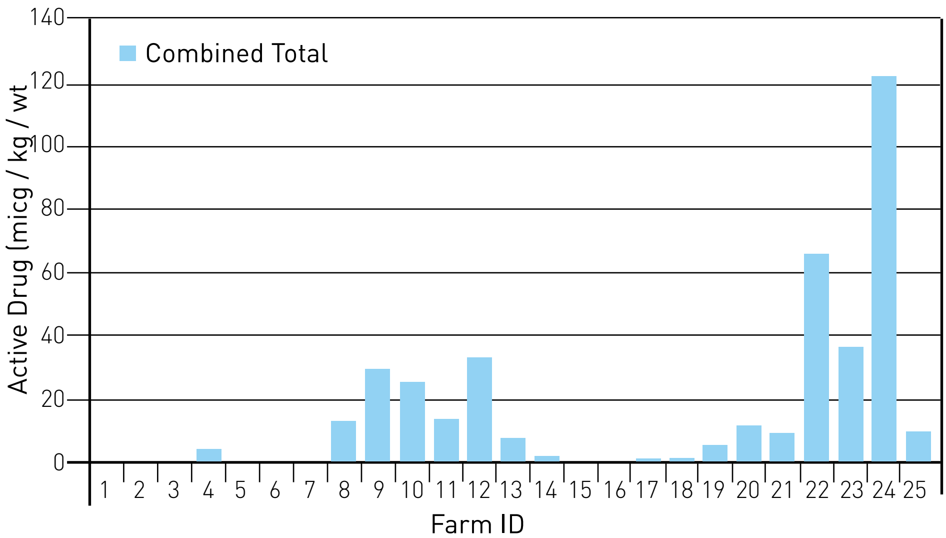
The Porcine Reproductive and Respiratory Virus (PRRSV) has been a major cause of increased antibiotic use, and of economic loss, in the pig industry as it increases pigs' susceptibility to many bacterial infections[35]. A recent Dutch study found that pigs in larger, enriched pens (straw, peat, wood shavings) were less susceptible to co-infection by PRRSV and *Actinobacillus pleuropneumoniae* (a cause of respiratory disease in pigs). The scientists said that "enriched-housed pigs showed a remarkably reduced impact of infection and were less prone to develop clinical signs of disease". They suggested that diminishing chronic stress in pigs could help reduce antibiotic use[33].

Outdoor rearing

Although there is limited data, farming systems which require that pigs have outdoor access, such as organic farming or Swiss "animal friendly" farming, appear to have significantly reduced antibiotic use. It is known that organically farmed pigs have much lower antibiotic use, as Danish data and research by Defra scientists in the UK has shown, see Table 2 and Figure 1.

Figure 1 Lower use of antibiotics in organically farmed pigs and poultry compared with non-organically farmed animals in the UK[36]

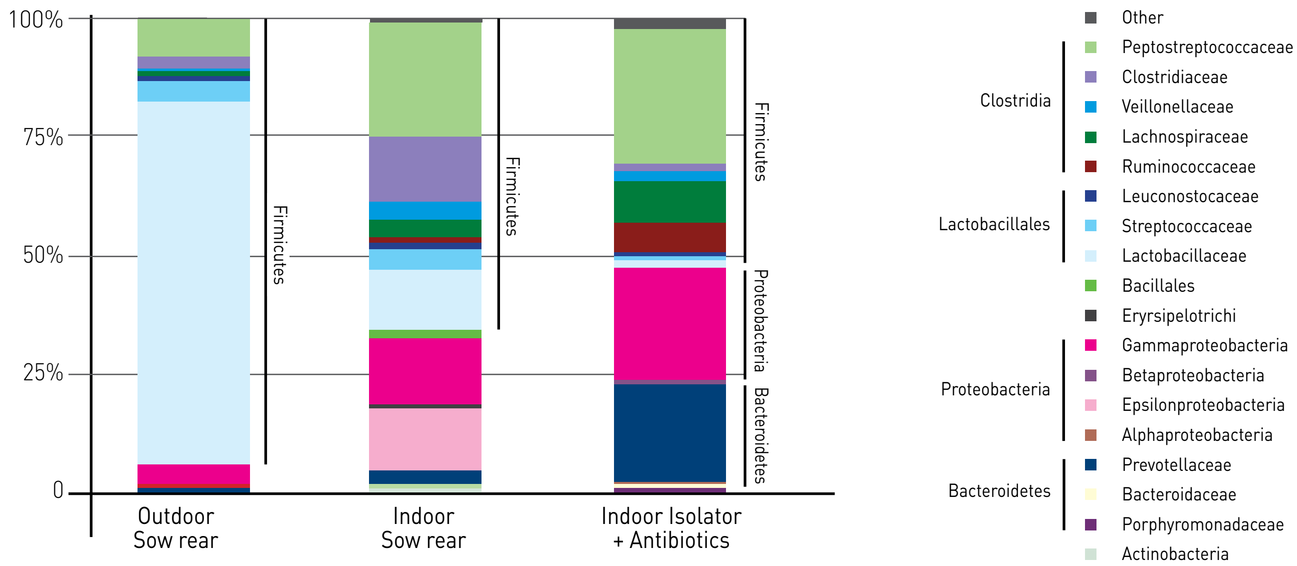
Use of antibiotics per kg of meat produced on organic poultry (1-7) and pig (14-18) farms compared with non-orgainc poultry (8-13) and pig (19-25) farms



However, organic production also differs from conventional production in terms of feed used, weaning age, stocking densities and other husbandry practices. Nevertheless, the EFSA and the EMA state in their report that access to outdoors is one of the practices used in alternative farming systems that "may also be used in other systems to reduce the need for antimicrobial use"[4].

Apart from reducing the likelihood of disease transmission between animals ("internal biosecurity"), a reason why outdoor rearing may reduce the need for antibiotics is that it appears to alter the gut microflora compared with indoor housed pigs. A British study compared the gut bacteria from genetically-related piglets raised outdoors and indoors. It found that the piglets reared from sows kept outdoors had much higher levels of the beneficial *Lactobacilli* bacteria. In contrast, piglets from sows housed indoors, whether receiving antibiotics or not, had higher numbers of *clostridia* and other potentially pathogenic bacteria[37, 38, 39]. See Figure 2.

Figure 2 Differences in the gut flora of outdoor and indoor-reared piglets[38]



The scientists said "Rural, outdoor environments support the establishment of a natural microbiota dominated by *lactobacilli* and containing low numbers of potentially pathogenic bacteria and this may be an important factor in maintaining mucosal immune homeostasis and limiting excessive inflammatory responses in the gut". A healthy gut is also likely to help reduce the need for antibiotics.

Breeds

A key indicator of performance used in the pig industry is the number of piglets reared per sow per year. The average in the UK is now over 26 piglets, with the top 10% producing over 30 per sow[40]. Selective breeding has led to ever greater litter sizes. Some super-prolific sows are now producing in excess of 17 piglets born alive per litter[41, 42], meaning that the number of piglets born can even exceed the number of teats the sow has[43, 44].

A scientific review by scientists from Scotland, Denmark and Norway found that large litter size is associated with increased piglet mortality, low birth weight, teat competition and increased likelihood that piglets will not get access to adequate milk. The scientists said that long-term effects on the piglets could include impaired gut function and immune function. There were also likely consequences for the health of the sow, such as udder damage[45]. A Swedish study found that large litter size has also been found to shorten the sow's productive life, reducing her ability to produce more than 4 litters, as these highly productive sows have more udder and lameness problems[46].

Very large litter size may also mean that early weaning is necessary, in order to avoid the sow losing too much condition.

Breeding for more robust sows that have a more manageable number of piglets should be encouraged to reduce reliance on antibiotics. Outdoor systems, for example, breed for maternal traits in sows to reduce the need for intervention at farrowing, and have lower piglet numbers per litter[47,48].

Antibiotic use in poultry

The use of medically-important antibiotics has been cut very significantly in UK poultry in recent years. Since 2012, the British Poultry Council – which represents 90% of poultry meat produced in the UK, but does not include egg production – has been collecting data on its antibiotic use and its latest report shows that use of medically important antibiotics has been reduced by 71% between 2012 and 2016[49]. The BPC's welcome initiatives on antibiotic use include:

- an end to all routine preventative antibiotic use
- an end to all use of the last-resort antibiotic colistin
- an end to all use of the critically important fluoroquinolone antibiotics in chickens.

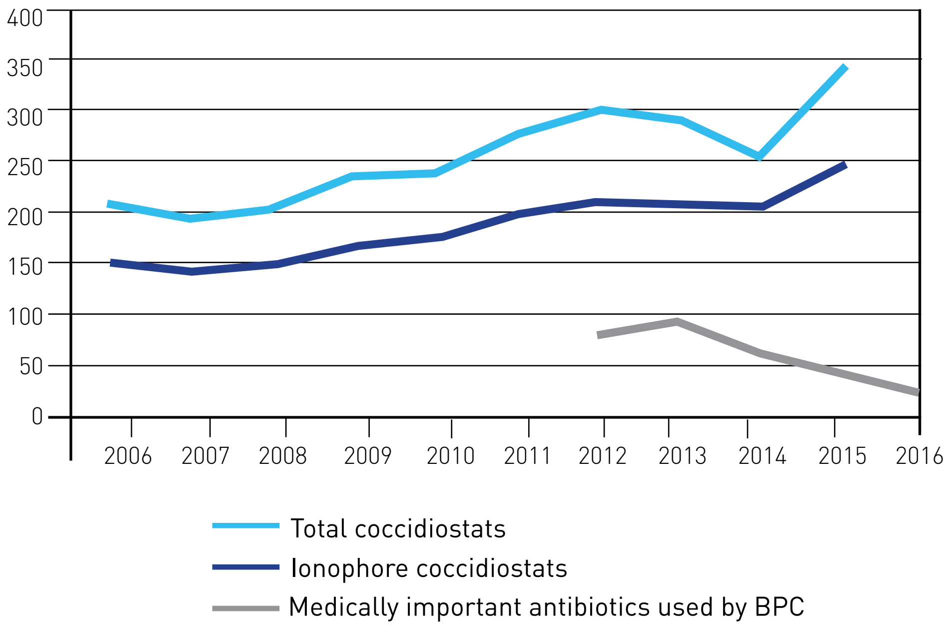
It is clear that part of the BPC's reduction in use are down to targeting treatments more accurately when they are needed, rather than relying on relatively routine use of antibiotics. The BPC also says that it has been achieving its reductions through focusing on good husbandry, hygiene and stockmanship.

However, the BPC also says that it has replaced antibiotics "with alternatives where available"[49]. Alternative treatments may refer in some cases to vaccination. However, another alternative, widely used in poultry are "coccidiostats". These are antimicrobials, which are not used in human medicine due to toxicity concerns, that can be added to feed without the need for a veterinary prescription to control the disease coccidiosis which occurs in intensively farmed poultry. The most widely used coccidiostats are the ionophore antibiotics.

Data we have obtained from the Veterinary Medicines Directorate via a Freedom of Information request shows that use of ionophores and other coccidiostats has increased very significantly in recent years and reached record levels in 2015, see Figure 3.

Figure 3 Use/sales of medically important antibiotics and coccidiostats in poultry (data from the Veterinary Medicines Directorate and the British Poultry Council), in tonnes of active ingredient.

Use of antibiotics per kg of meat produced on organic poultry (1-7) and pig (14-18) farms compared with non-orgainc poultry (8-13) and pig (19-25) farms



The increasing quantities of coccidiostats being used may be partly due to the ban on the growth promoters which was implemented in the EU in 2006, as well as recent reductions in preventative use of medically-important antibiotics. In addition to their growth-promoting effect, growth promoters helped control necrotic enteritis, an intestinal disease which is widespread in intensively farmed poultry[4]. Ionophores are also known to control necrotic enteritis[50]. Furthermore, like zinc oxide in pigs, several ionophores have a known growth-promoting effect and some used to be licensed as growth promoters in pigs and cattle in the EU. Several ionophores, used as coccidiostats in the UK, are used as growth promoters in non-EU countries[51].

The routine and widespread use of ionophores in poultry does not raise the same level of concern regarding antibiotic resistance as the overuse of medically important antibiotics does, due to the fact that these antibiotics are not used in human medicine. There are nevertheless some human-health concerns associated with their overuse. High levels of use can lead in some cases to Maximum Residue Levels being exceeded in food, which can be a concern due to the ionophores toxicity[52]. There is also some evidence that the use of certain ionophores can 'co-select' for resistance to medically important antibiotics in certain bacteria[50].

So whilst the use of medically important antibiotics in poultry can clearly be cut without altering farming systems significantly, the heavy reliance on alternatives like coccidiostats does raise some concerns.

Antibiotic use is much lower in slower-growing chickens

Under standard intensive production, broilers are now slaughtered at between 32 and 40 days of age[53, 54]. In free-range production, however, broilers cannot be slaughtered before 56 days of age, and in organic production this increases to 70 or 81 days[54, 55].

As the European Food Safety Authority (EFSA) Panel on Animal Health and Welfare explains, "Over the second half of the 20th century, the growth rate of commercially-produced broiler chickens has been increased greatly, with standard broiler chickens now reaching 1.5 kg body weight in 30 days whereas 120 days were needed in the 1950s. Simultaneously, the feed conversion ratio (the amount of feed eaten per kg of chicken growth) has been reduced from 4.4 to 1.47"[56]. As EFSA's Panel on Animal Health and Welfare says, "It has been shown that this is largely the result of genetic selection and it is generally accepted that most of the welfare problems [in broilers] are caused by genetic factors".

Rapid growth of broilers has been linked in various studies with welfare problems, including metabolic problems and leg problems, immobility and also with higher mortality[56]. There is also now clear evidence, from the Netherlands, that slower-growing breeds have a much lesser need for antibiotics.

In the Netherlands, a public campaign led since 2012 by an animal-welfare group, Wakker Dier, has highlighted the plight of fast-growing chickens, which they refer to as "plofkip" (exploding chicken)[57]. By raising public awareness of the issue, the NGO managed to put pressure on supermarkets to move away from the fastest-growing breeds, and towards animals that have a "better life" with a minimum slaughter age of 56 days.

The public pressure has led many supermarkets to commit to selling more expensive, slower-growing birds, although the standard the supermarkets have mainly adopted has a minimum slaughter age of 45 to 49 days. By the end of 2016, 90% of retail poultry meat in the Netherlands was from these "slower-growing" birds, representing 27% of total production (most Dutch production is exported)[58].

Despite Dutch supermarket broilers often still being relatively fast growing, industry data shows they receive three to six times fewer antibiotics, with the exact number depending on the measurement used[59, 60].

The Plofkip campaign provides a remarkable example of supermarkets and industry accepting consumer pressure to improve animal health and welfare by partly reversing a key aspect of modern intensive poultry production. The use of even more slow-growing broilers, as used in UK free-range or organic production, would likely lead to even greater reductions in antibiotic use.

Stocking densities

Stocking density is a measure of the average amount of livestock per area of farm space. More cramped conditions can increase animal stress and the spread of disease, hence increase the need for veterinary interventions. The baseline maximum permitted EU stocking density for standard broilers is 33 kg of chicken per square metre, although under certain conditions, widely met by the poultry industry, derogations allow this to rise to a maximum of 42 kg/m^2.

The UK only allows a maximum stocking density of 39 kg/m^2 for farms that meet the conditions of the EU derogation, and the Red Tractor Standards place a limit of 38 kg/m^2. So the standard maximum stocking density used by most intensive chicken farms in the UK is 38 kg/m^2, which equates to 19 birds weighing 2 kg per square metre, or less than an A4 sheet of paper per bird.

Free-range and organic production not only have requirements for access to the outdoors, but the permitted stocking densities for fixed housing are also lower: for free-range it is 27.5 kg/m^2 and for organic it is 21 kg/m^2.

According to the EMA and EFSA, higher stocking densities have been associated with increased preventative use of antibiotics due to the expectation of increased disease risk[4]. An earlier EFSA study found that the top-ranking "environmental" hazard for broiler welfare is stocking density [56].

Higher stocking densities promote stress, particularly thermal stress in the birds and are associated with wet litter, increased ammonia concentrations in the air, increased footpad dermatitis and lower welfare[4, 53, 56]. Heat stress damages the immune system and is associated with intestinal injury[53, 61]. Higher stocking densities also mean that there is a need to thin the flock (some birds are removed for early slaughter), which is a stressful event for the birds.

Ammonia concentrations in poultry houses can be very high. Ammonia is produced in the litter, particularly wet litter, by microbial decomposition. High levels of ammonia damage the immune system. Concentrations above 10 parts per million (ppm) can also damage the lung surface and increase the birds' susceptibility to bacterial respiratory disease, especially E. coli infection. These high concentrations have been linked with air sacculitis, pneumonia and septicaemia caused by *E. coli*[53, 62]. These infections are a major cause of antibiotic use in the poultry industry[4].

The maximum ammonia concentrations permitted under Red Tractor standards is 20 ppm[63], which is twice the concentration associated with increased susceptibility to respiratory infections.

Lowering stocking densities would be likely to reduce wet litter problems, lower ammonia concentrations and reduce respiratory and intestinal diseases which require antibiotic treatment.

The cost of reducing stocking densities would not be very significant. A report by an advisory committee to the European Commission calculated that reducing stocking densities from 38 kg/m^2 to 30 kg/m^2 would increase production costs by 5% and the cost to the consumer by just 2.5%. Similarly, reducing the stocking density to 20 kg/m^ would only increase production costs by 15% and the cost to the consumer by 7.5%[64].

Access to outdoors

According to EFSA and the EMA "The stress associated with intensive, indoor, large scale production may lead to an increased risk of livestock contracting disease"[4].

Although there is very little publicly available data on antibiotic use in animals kept indoors and those with access to the outdoors, providing outdoor access is listed by EFSA and the EMA as one practice of free-range and organic farming systems that could be used in other farming systems to reduce antibiotic use[4]. A Defra study of seven organic poultry farms found that during the two years of the study, only one farm used any antibiotics at all, see Figure 1.

Advocates of intensive farming methods often point to worse "external biosecurity" when animals have access to the outdoors. This means that it is more difficult for animals kept outdoors to avoid exposure to wildlife and pests and to pathogens in the air, soil or insects. However, "internal biosecurity", which is the risk of disease transmission between animals in a herd of flock can be much better because of decreased contact between animals and better air quality.

Poultry housed outdoors are also likely to be less susceptible to disease as more resilient breeds are chosen.

The range stocking density of free-range poultry cannot exceed one bird per square metre, and in organic farming it cannot exceed one bird per ten square metres.

Antibiotic use in dairy and beef farming

In the UK, antibiotic use in cattle has generally been at a much lower level than in pigs and poultry. Mass medication with antibiotics is not used frequently in UK dairy or beef production, although it is widely used in some European countries with significant intensive veal-farming industries.

Antibiotic use in British cattle tends to be higher in dairy production than in beef production, with mastitis, lameness/foot problems and uterine problems being the principal causes of antibiotic treatment[4].

Routine preventative antibiotic use does occur on dairy farms to prevent mastitis during the cow's 'dry' period. A 2010/11 Defra survey found that 85% of non-organic farms used routine, non-selective antibiotic dry-cow therapy[65]. The survey also found that each year approximately 30% of cows in a dairy herd develop mastitis, and 93% of farmers used antibiotics to treat mastitis.

Precise figures on antibiotic use in cattle are not available in most countries which, like the UK, predominately collect antibiotic sales data. Because many antibiotic products are sold for use in more than one species, it is not generally possible to say which species they are used in.

Sales data for the UK shows that, in 2015, 14 tonnes were sold for use in cattle only (compared with 300 tonnes sold in 2015 for use in pigs or poultry only), with a further 65 tonnes sold for use in more than one species. This means that total use in cattle was somewhere between 14 tonnes and 79 tonnes.

A more accurate estimate of use in cattle is provided by a survey of prescription data by 60 veterinary practices carried by Farmvet Systems Ltd using the VetIMPRESS software they created to help farmers and vets find evidence for improvements in animal health and welfare. Since there are approximately 300 veterinary practices dealing with cattle in the UK, this is a relatively representative sample.

The data collected by Farmvet Systems shows that antibiotic use in dairy farming is about 26 mg/kg. No fully reliable figures are available for beef cattle due to the fact that many farms with beef cattle also have sheep, and it isn't possible to determine from the information held by veterinarians which animals the antibiotics have been used in. Nevertheless, it is well known that in the UK antibiotic use in beef cattle is much lower than in dairy cattle, so it is very likely that use in beef cattle is well below 26 mg/kg.

This level of use is actually low in comparison to other EU countries with species usage data. It is particularly low in comparison to the usage levels in the Netherlands. See Table 4.

Table 4

Antibiotic use in cattle in several EU countries (mg/kg of PCU)

UK dairy cattle	26
UK all cattle	<26
Denmark all cattle	32
France all cattle	39
Netherlands veal calves	288
Netherlands all beef/veal	270
Netherlands dairy cattle	17
Netherlands all cattle	83

The remarkable difference between the British and Dutch usage levels is due to the exceptionally high usage of antibiotics in Dutch veal/beef production, which is much more intensive than beef production in the UK. It provides very clear evidence that different ways of farming cattle result in large differences in antibiotic use.

The Netherlands has already implemented many initiatives aimed at reducing farm antibiotic use, such as banning routine preventative use (including banning blanket dry-cow therapy), setting reduction targets, collecting antibiotic-use data from each farm and benchmarking of farms and veterinary practices. These initiatives have led to a reduction of antibiotic use in veal calves of nearly 50% since 2007[66], but despite these achievements use remains 20 to 40 times higher than in British beef cattle.

EFSA and the EMA recently stated that "In some farming systems, much reliance is placed on the routine use of antimicrobials for disease prevention or for the treatment of avoidable outbreaks of disease, such that these systems would be unsustainable in the absence of antimicrobials. The stress associated with intensive, indoor, large scale production may lead to an increased risk of livestock contracting disease"[4]. EFSA and the EMA said that intensive white veal rearing, as practised in the

Netherlands, was an example of such a system, and the data in Table 4 seem to confirm this.

Similarly, EFSA has stated that "The farming system by itself is a major factor determining the health problems of dairy cattle"[67].

Access to grazing

Systems in dairy farming vary considerably, from those which allow the cows access to pasture all year round, to those where they are housed for part of the year and to 'zero-grazing' systems where the cows are kept permanently indoors. In the UK, most dairy cows have access to pasture during the summer months, but increasingly cows are being kept indoors and large, zero-grazing herds are becoming more common in the UK and worldwide.

Unfortunately, the likelihood of health problems in such intensive systems is higher. According to a review carried out by the EFSA, "If dairy cows are not kept on pasture for parts of the year, i.e. they are permanently on a zero-grazing system, there is an increased risk of lameness, hoof problems, teat tramp, mastitis, metritis, dystocia, ketosis, retained placenta and some bacterial infections" [67]. Many of these infections are major causes of antibiotic treatments in dairy farming[4].

High productivity dairy cows and disease

For many years, dairy cows in Europe and the UK were bred mainly for yield. This is a major reason why the average annual yield for a dairy cow in the UK has increased from 4,100 litres in 1975 to 7,900 litres in 2014 [68]. Some of the most productive herds are now producing in excess of 10,000 litres a year[69].

According to EFSA, genetic selection for high yield is a "major factor causing poor welfare, in particular health problems, in dairy cows". EFSA says that "The genetic component underlying milk yield has also been found to be positively correlated with the incidence of lameness, mastitis, reproductive disorders and metabolic disorders"[67], which are conditions often requiring antibiotic treatment.

Lameness, in particular, is correlated with higher milk yield. The greatly distended udder can cause an uneven load on the inner and outer claws of the hind feet, predisposing the cow to feet problems[71]. The incidence of lameness has greatly increased over the past decades as milk yields have increased. According to a 2010 review of lameness in UK dairy cows, studies have found lameness prevalence rates varying from 0%

up to 79% of cows in a herd, with average rates being between 25% and 37%[71]. This compares with a lameness average of just 4% found in a 1957/8 survey of British dairy cows[72].

In more recent years, breeding programmes have changed and now include health and welfare goals[73], however it is clear that much more change will be needed to improve the genetic make-up of dairy cows as ADHB Dairy indicates that there have been few significant improvements in lameness problems in the past 25 years[74].

Intensive beef and veal farming

An EFSA review of intensive cattle and calves farming found that many of the practices of these systems were associated with health and welfare problems[75].

Whereas EFSA said that "the husbandry of suckler cows at pasture generally results in good welfare", it found that for more intensively farmed cattle the major health and welfare problems "were respiratory diseases linked to overstocking, inadequate ventilation, mixing of animals and failure of early diagnosis and treatment, digestive disorders linked to intensive concentrate feeding, lack of physically effective fibre in the diet, and behavioural disorders linked to inadequate floor space, and co-mingling in the feedlot".

For intensively-farmed "white" veal calves, EFSA said that a major threat to their health were enteric diseases and anaemia linked to their largely liquid diet and lack of fibre[76]. A Belgian study also found that antibiotic use in intensively-farmed veal calves was approximately 25 times higher than in cattle raised on pasture, and the scientists blamed the high level of antibiotic use on stocking density and transporting and mixing of calves from different locations[76].

Since respiratory problems and enteric problems are major reasons for antibiotic use in intensively-farmed cattle and calves[4], it is unsurprising that the antibiotic use data confirms so clearly that cattle raised on pasture have much lower needs for antibiotics.

2

Supermarket antibiotic policies

The UK grocery market is highly dominated by large supermarkets: in 2017, eight of the largest supermarkets hold a 93% share of this market.

These businesses therefore have a unique role to play in the reduction of antibiotic use in food supply chains due to the influence they have with farmers supplying them.

For many years, many supermarkets failed to take the issue seriously. However, in the past couple of years, in particular since the publication of the government-commissioned Antimicrobial Resistance Review (the "O'Neill Review"), there has been a considerable amount of work happening behind the scenes in the head offices of the UK's largest supermarkets. Agricultural teams, Corporate Social Responsibility teams and antimicrobial-resistance experts have been working together in a variety of ways to devise new policies to reduce antibiotic use in their supply chains.

Where the supply chains are more integrated, as is the case with the poultry industry, it has been easier to get rapid shifts in practices, but for cattle and sheep, supermarkets need to deal with a much wider range of suppliers. Nevertheless, with some supermarkets we are starting to see new policies being introduced across all species.

For the first time, the Alliance has put together an assessment of the difference supermarket antibiotic policies to see which businesses have taken the most comprehensive action, and which ones are still failing to act.

How we assessed different supermarket policies

For this assessment, we have sought information from antibiotic policies which are publicly available, as we believe that the public has a right to know how its food is being produced. Also, when policies are publicly available, consumers are better able to make educated decisions about what they buy. We have put links to the various policies up on our website so that they can all be easily accessed from one place.

At the start of this project, we wrote to the supermarkets to let them know that we were undertaking this assessment, and we were pleased to find the majority of supermarkets were willing to speak to us about the work they have been doing. We sent a copy of the parameters we used in the assessment to the supermarkets, the questions we asked were:

- Do you have a publicly available policy on farm antibiotic use? In particular, does your policy ban suppliers from using purely preventative antibiotic treatment as group treatments when no disease has been diagnosed in any of the animals in the group?
- Does the policy ban suppliers from using antibiotics for routine prevention?
- Does the policy restrict the use of the "critically important antibiotics" (modern cephalosporins and fluoroquinolones) so that these antibiotics can only be used where sensitivity shows that other treatments would not be effective, and so that they are never used for prevention or for group treatments?
- Does the policy ban the use of the last-resort antibiotic colistin?
- Do you gather data on antibiotic use by your suppliers? Is this data collected by farming system ie, conventional/ intensive, free-range, organic?
- Is this data publicly available or are there plans to make it publicly available?
- Do you have an antibiotic reduction strategy?

What we found

Table 5

Supermarket antibiotic-use policies

	Policy publicly available	Bans routine use of antibiotics	CIAs restricted	Bans colistin	Monitors antibiotic use	Reduction strategy in place	Publishes antibiotic use data
Aldi	✔[i]	✘[ii]	✔	✘	✔	✘	✘
Asda	✔	✘	✔	✘	✘	✘	✘
Co-op	✔	✔	✘[iii]	✘	✘	✘	✘
Lidl	✘	✘	✘	✘	✘	✘	✘
M&S	✔	✔	✔	✔	✔	✔	✘
Morrisons	✔	✘/✔[iv]	✘/✔[v]	✘	✔	✔	✘
Sainsbury's	✔	✔	✔	✘	✔	✔	✘
Tesco	✔	✔	✔	✘	✔	✔	✘
Waitrose	✔	✔	✔	✔	✔	✔	✔

[i] Aldi: public position on antibiotic use is available, but not the policy.
[ii] Aldi: not banned, however "prophylaxis only permitted under the direct instruction of a veterinary surgeon. Producers must retain a record as to why prophylaxis was necessary, and have a management strategy on how to prevent future prophylaxis."
[iii] Co-op: Not mentioned in the policy, but reference to "working to avoid the use of antibiotics that are important to human medicine" can be seen in a document published on the Co-op website.
[iv] Morrisons: routine use banned in chicken, egg & milk production, but not beef, pork and lamb. By 2020 all Morrisons branded fresh pork will be from pigs where routine use has been eliminated.
[v] Morrisons: Restricting the use of CIAs applies to milk, chicken and egg production, and from 2018 will include pork. Beef and lamb not covered.

Waitrose has taken action on nearly all of the areas outlined in our questions. They have banned routine preventative use, restricted the use of the critically important antibiotics, and have publicly stated that they've banned the use of the last-resort antibiotic colistin. They are the only supermarket that has committed to publishing antibiotic-use data for its suppliers, although it is not yet clear whether this will be by farming system.

Publishing use data by farming system (including conventional, free-range and organic) would be an important step to take as it would provide key information enabling different farming systems to learn from the lowest users.

M&S have similarly published a very detailed policy which addresses all of the parameters set out in our questions, bar the publication of data gathered on antibiotic use in their supply chains. M&S joins Waitrose in being the only two supermarkets to publicly state that they have banned the use of colistin.

Tesco and Sainsbury's have also implemented a good range of policies, including banning routine preventative use and restricting the critically important antibiotics, but unlike Waitrose and M&S, they have not yet banned colistin. They also do not publish antibiotic-use data, although they do collect some data.

The Co-op has banned the routine preventative use of antibiotics, though it isn't explicit in their policy whether CIAs are restricted.

Aldi has a public positon on antibiotics published on its website, rather than a full policy. Within this it mentions measures to limit routine preventative use of antibiotics, but it is not explicitly banned. It is monitoring use, and has restricted the use of CIAs.

Morrisons has banned routine preventative use in chicken, dairy and egg production, but has yet to ban such use in other species. They have also only partly restricted the use of critically important antibiotics, and do not appear to collect antibiotic-use data. Their policy mentions a "pro-active approach" to monitoring and reducing use.

Asda has a publicly available policy, but it only includes restrictions on the critically important antibiotics, and has no ban on routine preventative use.

Lidl is the only supermarket that has no publicly available policy and has made no public commitment to reducing antibiotic use.

Monitoring of antibiotic use varies across the supermarket policies with an almost equal split between those that do and those that don't. For supermarkets that are trying to monitor use, this is likely to be focused at first on the pig and poultry industries, as the UK pig and poultry sectors have already put in place systems for monitoring use. Antibiotic-use monitoring, however, is still being set up by the cattle and sheep sectors.

Supermarkets that monitor antibiotic use are also much more likely to have an antibiotic-reduction strategy in place. This is probably because they feel that in order to reduce use you must first know where you are starting from.

What next?

All supermarkets must commit to ending all routine preventative use of antibiotics in their supply chains. There is already significant political and farming-industry support for such a move, and there is plenty of practical farmer and vet-focused best practice guidance which can help to make this a reality.

While many supermarkets have programmes to reduce and/or phase out the use of critically important antibiotics, their next step should be to publish information about how much of these types of medicines are still being used, and in which species.

Monitoring usage must be high on the agenda for supermarkets so that reduction strategies can be devised. Publishing antibiotic-use data by farming system is also essential. Some supermarkets already have such data for some species, and publishing it is essential.

We will recreate this assessment in 2018 to monitor progress and will again publicly release the findings.

3

Need for regulatory change

Since 1st January 2006, no antibiotics can be used in farm animals for growth promotion in the European Union. Antibiotics can now only be used in livestock if a veterinary prescription is obtained. Since the EU ban, many other countries around the world have also decided to phase out growth promoters, and last year the OIE reported that 96 out 130 countries surveyed no longer permitted growth promoters[1]. The United States also finally stopped using growth promoters in 2017.

Unfortunately, these actions against growth promoters have proven to be ineffective in preventing antibiotic overuse. This is because it is still legal in most of these countries, including the UK, for a veterinary prescription to be written for mass medication with antibiotics even if no disease is diagnosed in any of the animals. As a result, routine preventative mass medication can still occur: a survey of the Belgian pig industry found that 93% of cases of mass medication were purely preventative, with no disease diagnosed in any of the animals[2].

In recent years, the UK livestock industry has begun significantly reducing its use of preventative mass medication, and the British Poultry Council says it has ended all such treatments. Nevertheless, there remains a strong case for a UK and international ban on all such treatments as it would accelerate moves towards responsible use and render illegal the most egregious practices.

In March 2016, the European Parliament voted by 95% for new veterinary medicines legislation which would ban all preventative group treatments, and restrict other group treatments to exceptional cases where it was needed[3]. Unfortunately, the legislation has not yet been approved by the Council of Ministers who have yet to produce their position on the legislation.

The British government said in 2015 that in the EU negotiations on new veterinary medicines regulations it would support an end to preventative group treatments[4], but it subsequently said it would not implement any UK ban until agreement had been reached at an EU level[5].

The government's argument is that to introduce regulation in the UK before an EU agreement would put British farmers at a competitive disadvantage. However, six European countries, Denmark, Finland, Iceland, Norway Sweden and the Netherlands, have already ended preventative group treatments. These countries generally have much lower antibiotic use than countries that continue permit such group treatments[6], and there is no evidence the better regulation has made their farming industries less competitive.

The Alliance is now calling for:

- a ban on the preventative use of antibiotics in groups of animals where no disease has been diagnosed in any of the animals.
- limit the use of the modern cephalosporins and the fluoroquinolones, which are antibiotics classified as "critically important in human medicine", to the treatment of individual sick animals where sensitivity testing, or the results of recent sensitivity testing, show that no other antibiotics are likely to work. These antibiotics should not be permitted for group treatments or for prophylactic use.
- a ban on all use of the antibiotic colistin, which in recent years has been used as a life-saving treatment of last resort in human medicine.
- measures aimed at improving animal health and welfare in all antibiotic-reduction strategies. Such measures should look to reduce stocking densities, improve piglet health at weaning, and avoid the use of breeds of animals which require particularly high antibiotic use.

Internationally, the EU should also rapidly adopt the European Parliament's position on antibiotic regulation, or the huge overuse of antibiotics which is occurring in some Member States like Spain, Italy and Cyprus may continue for many more years[6].

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“Consumption of antimicrobials by animals to produce meat products, in the BRICS countries (the major emerging economies of Brazil, Russia, India, China and South Africa) alone...is set to double between 2010 and 2030.”

Antimicrobials in agriculture and the environment: reducing unnecessary use and waste.The review on antimicrobial resistance, chaired by Jim O'Neill 2015

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The Alliance to Save Our Antibiotics is an alliance of health, medical, environmental and animal welfare groups working to stop the over-use of antibiotics in animal farming. It was founded by the Soil Association, Compassion in World Farming, and Sustain in 2009 and is supported by the Jeremy Coller Foundation. Its vision is a world in which human and animal health and well-being are protected by food and farming systems that do not rely routinely on antibiotics and related drugs.