

How Political Cultures Produce Different Antibiotic Policies in Agriculture: A Historical Comparative Case Study between the United Kingdom and Sweden

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Abstract

The purpose of this article is to provide an understanding of how different countries formulate and regulate antibiotic use in animals raised for human consumption. A comparative case study was undertaken, analysing historical documents from the 1950s to the 1990s from the UK, the first country to produce a scientific report on the public health risks of agricultural antibiotic use; and Sweden, the first country to produce legislation on the growth promoter use of antibiotics in food animals. Sheila Jasanoff's concepts of 'co-production' and 'political cultures' have been used to explore how both countries used different styles of scientific reasoning and justification of the risks of agricultural antibiotic use. It will be argued that national dynamics between policy, science and public knowledges co-produced different risk classifications and patterns of agricultural antibiotic use between both countries. UK's political culture used 'expert committees' to remove the issue from public debate and to inform agricultural antibiotic policies. In contrast, the Swedish 'consensus-oriented' political culture made concerns related to agricultural antibiotic use into a cooperative debate that included multiple discourses. Understanding how national policies, science and public knowledges interact with the risks related to agricultural antibiotic use can provide valuable insights in understanding and addressing countries agricultural use of antibiotics.

Introduction

Although antimicrobial resistance (AMR) is a universal public health concern, gaps remain in our current understanding of the magnitude of the problem in

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Sociologia Ruralis, Vol 58, Number 4, October 2018

DOI: 10.1111/soru.12206

humans and animals and the impact on the environment. A major health concern is the 'inappropriate' agricultural use of antibiotics in animals raised for human consumption (O'Neill 2015). Whether or not there is a link between antibiotic use in animals and the development of AMR in humans through food and the environment is controversial (Schwarz *et al.* 2001; Kahn 2016). To address the uncertainty and scientific complexity of AMR, global efforts have been directed at reducing antibiotic use in both human and animal populations. Historical and recent data show large differences in antibiotic usage and its regulation between countries (EMA 2016). These differences have been explored in several studies focused on the political, economic, technical, legal and behavioural causes that affect agricultural antibiotic use. However, all these studies adopt the stance of 'what is wrong and what needs to be fixed' (Dar *et al.* 2015; Meek *et al.* 2015; O'Neill 2015). By taking this stance, they reduce farm antibiotic use to a singular cause and solution, thereby failing to identify the relational component of these differences (Buller *et al.* 2015, Wallinga *et al.* 2015). Chandler *et al.* (2016) have used the concept of 'antimicrobial infrastructures' to describe the importance of historical trajectories of antimicrobials to consider how they have been used and regulated, as a way of understanding current practices. Kahn (2016) also examined the politics of AMR and agricultural antibiotic use in the UK, Sweden, Denmark, Europe and the US using an historical lens. Although Kahn (2016) describes at length the different scientific discourses and regulatory approaches, she does not examine how the earliest international scientific evidence, the 'UK Swann report' – the first report on the hazards of antibiotic use in food animals – resulted in different policy approaches to agricultural antibiotics between countries.

This article explores the politics of antibiotic use in food animals and its possible link with AMR in humans. It uses an historical comparative analysis between the UK, the first country that produced international advice to restrict economic antibiotic growth promoters (AGPs) in animals produced for human consumption; and Sweden, the first country that officially banned the use of AGPs in animals produced for human consumption. It will also explore *how* these two countries produced different risk classifications and policies on agricultural antibiotic use. In direct contradiction to traditional risk policy studies which adopt the perspective that science is value free (Stirling 2010), it is argued that the UK and Sweden use scientific reasoning in different ways to assess the risks of agricultural antibiotic use. Theoretical reasoning from Science and Technology Studies (STS) will be used to demonstrate that science and its technologies are culturally influenced and a product of the context they are embedded in (Bijker *et al.* 1987; Jasanoff 2004; Sismondo 2011). STS is useful in this context because of the way it examines how science is produced, legitimated and integrated in the policies and products of societies (Metzler and Webster 2011; Ulucanlar *et al.* 2013). Resisting the rational production of scientific knowledge, Jasanoff (2004, p. 3) uses the concept of 'co-production', to show how science and its technologies both produce and are produced by 'social practices, norms, conventions, discourse, instruments and institutions'. Consequently, the risks of biotechnologies are also co-produced and are framed by the contexts in which they are developed and used. To emphasise the entanglement of science, national politics and public knowledges, Jasanoff (2005, p. 21) has introduced 'political cultures', which she uses

to explore how countries have specific ways of using science in political decision making about biotechnological risks. This, at the same time, steers knowledge and innovation of the biotechnology under discussion. In her comparative study between the UK, Germany and the U.S. on issues such as embryo research, genetically modified food, stem cell debate and other products of biotechnology, Jasanoff shows how different risk constructions and innovation policies emerged over time between the three countries, due to 'different ideologies, priorities and ways of national reasoning' between policy, science, and public knowledges (2005, p. 275). Moreover, scientific claims and their use do not possess the power of 'truth' in themselves; they are part of historically established ways of national risk framing, institutional arrangements, public input and culturally specific ways of legitimating science in society (Jasanoff 2005). At the same time, Jasanoff argues that 'the public' is not a passive, homogeneous recipient of knowledge but instead, engages actively in the production and application of science and technologies (Jasanoff 2005, p. 255). She refers instead to an assemblage of 'publics', emphasising the plurality of publics or public knowledges (2005, p. 255). Jasanoff is also interested in how publics have culturally specific 'tacit knowledge-ways' through which they assess scientific claims (2005, p. 255). As other STS scholars have argued, publics are capable of acting within political systems and reinventing them, as well as being created and co-produced by them (Callon *et al.* 2001; Marres 2007; Asdal 2008). This is in contrast to models focusing on the 'public understanding of science', which see science as universal and attribute differences in social uptake of science as a consequence of public misunderstanding or ignorance and these differences can be overcome by better informing the public (Jasanoff 2005, p. 249). Instead, Jasanoff (2005) advocates we should explore how political cultures have specific ways of making science accountable to citizens and how these citizens in turn have culturally embedded ways through which they collectively acquire and apply knowledge about science and its technologies. Importantly, 'social contracts' can be in play between science and politics to 'steer' scientific findings into political goals and to set boundaries on biotechnological risks (Jasanoff 2005, p. 226). This has also been argued by Stirling (2010), who suggests that we should explore presented risks beyond the 'single definitions presented by science that are most amenable to political manipulation' (p. 4). The way political cultures use science during the rationalisation of emerging biotechnological risks is formulated by Jasanoff (2004) as the *stabilisation* of biotechnologies. This concept of stabilisation will be used to study how farm antibiotics became legitimised/stabilised and problematised/destabilised over time through political cultures. Political cultures as such 'co-produce' the knowledge and innovations of biotechnologies.

Following Jasanoff (2005), the period in the UK between the 1950s–1990s can be characterised as a political culture governed by 'expert committees' (p. 102). The government maintained (and still does) a strong relation with science and scientific 'expert committees' in the governance of risks. These expert committees are presented as providing independent and impartial advice to the government on the basis of evidence and means that they enjoy a widely respected status of 'character, experience and expertise' through which they gained public credibility (Jasanoff 1997, p. 228). The UK government uses these expert committees to settle scientific controversies and to act on behalf of the public under the imperative of public safety.

Sweden on the other hand is not only characterised by State interventionism, but also by a 'consensus-oriented' political culture, bridging State and private actors (Boström and Klintman 2006, p. 165). Scientific controversies are managed outside the traditional science-policy arena. Instead of identifiable scientific experts being used as the (only) powerful actors to formulate and steer risk policies, as in the UK's expert committees, the Swedish agricultural decision-making process involved wider public participation (Saifi 2004). This produces a more open approach towards the governance of the risks related to agricultural antibiotic use.

The political cultures of both countries will be used as a framework to study how, between the 1950s–1990s, they co-produced the stabilisation, destabilisation and re-stabilisation of agricultural antibiotic use. The article starts by exploring the agricultural contexts of both countries and how antibiotics as both therapeutics and economic tools emerged in relation to the modernisation of agriculture. With the goal of maximising food production, agriculture and its modern techniques were used as a means to improve both countries' economic position in return for cheap and abundant food. As such, agricultural antibiotics in both countries became legitimised in a 'productivist' framework. When scientific controversies about the public health risks of economic agricultural antibiotics unsettled their use in the 1960s, the UK Swann expert committee was established in 1969. However, they presented inconclusive results on the public health risks of antibiotics used in food animals. This allowed the UK's political culture to downplay the public health risks thus enabling their continued use until the end of the 1990s. By contrast, Sweden's consensus-oriented political culture led several scientific and non-scientific discourses to enter the debate, which led to a different risk management of agricultural antibiotics. The discussion explores what can be learned from understanding the impact of a country's political culture on risk policies and the implications of this for future policy on agricultural antibiotic use.

The methodology comprises of a comparative case study using a desk-based discourse analysis of primary and secondary sources between 1950–1990 based on the following search terms: 'The Swann Report', 'farm antibiotics', 'antibiotic resistance', 'intensive farming', 'factory farms', 'animal welfare' and 'environmentalism'. Primary sources included European, UK and Swedish policy documents, UK newspaper articles of 'The Daily Mail' and 'The Times' and the UK veterinary journal 'Veterinary Record'. Secondary sources included scientific journals and books that discussed one or more of the former search terms. Following the methodology of a discourse analysis, attention was paid to what was said by whom in order to capture the co-producing effects of discourses and identities. This allowed an examination of how farm antibiotics in both countries became institutionalised through the interplay between scientific knowledges, expert committees, politics and public knowledges.

Setting the scene: post-war productivist agriculture and the *stabilisation* of agricultural antibiotics

At the beginning of the twentieth century around 10 per cent of the British population were employed in the agricultural sector, agriculture in the UK was of little

economic and public interest (Self and Storing 1963). By contrast, Swedish society was characterised as 'agrarian', with two thirds of the Swedish population working in small family farms responsible for supplying the needs of local communities (Morell 2011). Agricultural values were largely absent in the UK, while in Sweden there was a strong identification with nature (Self and Storing 1963; Morell 2011). This differences in terms of the value of agriculture, influenced the way in which agricultural antibiotic use became problematised. After the Second World War, Europe experienced the benefits of industrialisation which enabled agricultural economies to flourish. After years of food shortage, political targets were set to maximise agricultural output for economic purposes and to guarantee an era of food security (Grant 2005). The UK saw agriculture as a mechanism by which the national economy could be restored and its international trade position strengthened (Self and Storing 1963; Murdoch and Ward 1997; Grant 2005). The Swedish government wanted to make its agricultural sector more 'rational' and 'efficient', to transform its mostly rural society into a modern society (Flygare and Isacson 2011; Martiin 2015). The responsible agricultural government departments, the Ministry of Agriculture, Fisheries and Food (MAFF) in the UK and the Ministry of Agriculture in Sweden, became heavily involved with regulating agriculture during the 1950s–1970s (Murdoch and Ward 1997; Saifi and Drake 2008). To guarantee the stability of agricultural markets and agricultural prices, both countries set up agricultural price setting schemes that involved annual negotiations between State representatives and farmers to fix prices of agricultural products (Cox *et al.* 1986; Martiin 2015). In the UK, Post-war agricultural policies were developed between the government and agricultural stakeholders (Wales *et al.* 2006). Consumers in the UK were excluded from political decision-making by the government who believed that if they could guarantee the consumer food safety, 'the consumer would unproblematically consume' (Wales *et al.* 2006, p. 190). In Sweden, however, consumers were involved in the price setting schemes of agricultural products, and this was an important part of Sweden's post-war agricultural politics (Martiin 2015), which were built on transparency and negotiation with its consumers (Vail *et al.* 1994). Nevertheless, in both countries, productivist attitudes towards modern agriculture prevailed between the 1950s–1970s. Farms, farmers and their representatives all became part of the economic construction of the agricultural sector, as the agricultural community became convinced that efficient and maximum food production could only be ensured when farming was industrialised (Murdoch and Ward 1997; Saifi and Drake 2008).

The modernisation of agriculture not only produced new relations between the government, the agricultural industry and consumers, but increased market opportunities for various scientific technologies that improved animal husbandry systems, including agricultural antibiotics. Agricultural antibiotics were introduced therapeutically in both countries by the end of the 1940s to treat sick food animals (Randall 1969). By the beginning of the 1950s, it was discovered in the United States that when antibiotics were fed in low doses to food animals, these animals showed improved growth, food conversion ratio, and reproductive performance; so-called Antibiotic Growth Promoters (AGPs) (Soulsby 2007). The Post-war modern agricultural landscape, and its close relation with science as a means to industrialise agricultural husbandry, allowed agricultural antibiotics to be used as both a therapeutic

(including preventative use) and an economic tool in the use of animals in food production. In the decade that followed, antibiotic use in food animals took on new purposes, quickly establishing them as standard, not only for the treatment of disease, but to prevent disease and as Antibiotic Growth Promoters (AGPs) (Randall 1969). The use of antibiotics as growth promoters acquired special attention as they could be used as 'economic tools'. In addition, as AGPs they did not require a veterinary prescription (Barton 2000). Importantly, there was no European legislation at that time and each member State approved its own regulations about AGP use (Castanon 2007).

Strong relations developed between agricultural ministries and farmer unions with a strong interest in managing the agricultural market-place together. However, while the UK excluded public debates from political discussions, Sweden made agricultural issues part of wider societal debates. Importantly, in Sweden, the high value placed on nature, combined with concerns about the impact of agricultural techniques on the environment raised environmental concerns in Swedish political debates (Vail *et al.* 1994). Moreover, the public participation model in Sweden allowed these concerns to infiltrate scientific risk debates on modern agriculture practices (Vail *et al.* 1994). The differences in governmental models and the co-production of consumers regarding the governance of agricultural policies therefore greatly influenced how both countries received the first scientific report on agricultural antibiotic use, and how the issue was problematised.

Controversies in the 1960s: political cultures and the *destabilisation* of agricultural antibiotics

UK: antibiotic scientific controversies and the role of 'expert committees'

In the 1960s, after agricultural antibiotics were constructed as economic and therapeutic tools, the first scientific evidence on resistant bacteria in food animals was reported (Randall 1969). At the same time, animal welfare concerns from consumers started to raise questions about modern agriculture (Stuart 1964). The UK's political culture of establishing expert committees to settle discussions played an important role in how agricultural antibiotic use was to become framed and regulated. In the UK, the problematisation of intensive farming practices and 'animal welfare' at the beginning of the 1960s can be seen as one of the first 'expert' discourses in which antibiotic use was considered and 'co-produced' by science and the UK government. A key event in the UK at this time was the publication of animal welfare activist Ruth Harrison's book 'Animal Machines' in 1964, in which she described the moral and ethical dimensions of intensive poultry and livestock farming. Intensive livestock farms became framed as 'factory farms', referring to the automated practices and detrimental livestock conditions. The book initiated extensive public debate and led to mass demonstrations in London that condemned the 'cruel' modern farming methods (Winter 1964). However, the agricultural industry and farmer communities responded stating that Harrison presented an unfair picture of farming to the public (Stuart 1964). The National Farmer Union condemned the book as a 'false picture of British

agriculture', and the Poultry and Egg Producers' Association described its comments on intensive egg and poultry production as a 'slur on production' (Winter 1964). In the media, the response to Harrison's condemnation of intensive farming practices was dismissed as 'emotional reasoning' (Food for the table – food for thought 1964). However, in 1965, in response to the public outcry on Harrison's book, the government had to intervene to settle the controversies and to restore public trust in agricultural practices. They appointed an expert committee chaired by Professor Roger Brambell, who produced the 'Report of the Technical Committee to Enquire into the Welfare of Animals Kept Under Intensive Livestock Husbandry Systems', which became known as 'The Brambell Report' (Brambell Report 1965). Importantly, the UK's political culture had a tendency to use scientific expert committees to explore matters 'technically'. These expert committees enjoyed a widely respected status of 'character, experience and expertise' through which they gained public credibility (Jasanoff 1997, p. 228). The Brambell report concluded, surprisingly, that in the absence of scientific evidence to measure animal welfare, the ethical dimensions of animal's feelings should be taken into account when making decisions on agricultural intensive systems (Woods 2012). However, the Brambell report (1965) also encouraged the 'progressive state' of intensive agricultural systems and claimed that in relation to housing standards and the continuation of antibiotic use in livestock: 'the effects are more likely to be beneficial than adverse' (p. 14). Although tensions between scientific and ethical perspectives on animal welfare still remain unresolved (Woods 2012), the Brambell report supported the continuation of intensive livestock practices and within this the use of antibiotics. At the same time, international scientists were reporting bacteria with drug resistance in both humans and animals and in the UK, questions were raised as to whether this could be related to the practice of antibiotic feeding in farm animals. The matter was examined by a joint expert committee under the chairmanship of Lord Netherthorpe in 1960 (Randall 1969) and their report concluded in 1962 that the situation should be further explored, but reasserted there was no human health risk. The economic benefits of AGPs were re-emphasised and the committee advised continued feeding of AGPs to food animals (Randall 1969). As such, the 'expert' committees, used by the UK government to settle public controversies, were in fact co-producing the continued legitimisation of agricultural antibiotic use.

In the years that followed, new scientific counterclaims on the relationship between drug resistance, food safety and AGP use were made by veterinarians (Anderson and Path 1968; Smith 1968). Moreover, veterinary scientists Anderson and Path (1968) believed that intensive animal husbandry systems and practices provided opportunities for resistant bacteria to develop and spread, and they questioned the economic purpose of farm antibiotics. Public anxiety was also starting to rise about the effects of chemicals on health, such as DDT, insecticides and on 'things that may find their way into our food' (The Times Agricultural Respondent 1969). As a result, the economic purpose of farm antibiotics continued to be questioned or 'destabilised' by competing scientific, political and public discourses. In response to these growing concerns another expert committee was established to address these scientific and public concerns – the Swann committee – who published their recommendations in the Swann Report in 1969. The remit of the committee was to discuss the control of AGPs (antibiotics distributed without veterinary prescription to serve

economic purposes) and the control of therapeutic antibiotics (antibiotics needing veterinary prescription and which served medicinal purposes) (Randall 1969). An area of particular interest for the Swann Committee was to identify AGPs which would be of economic benefit to the U.K., but would not impact on the efficacy of therapeutic drugs for humans by developing AMR (Swann Report 1969). The Swann report (1969) concluded that agricultural antibiotic use in general could pose a hazard to human and animal health as it could stimulate the development of resistant bacterial strains. However, it also recognised the economic importance of AGPs use. It advised antibiotic used in animals should not to be used as growth promoters and suggested further exploration and monitoring of the issue by setting up yet another independent scientific committee (which would not happen until the late 1990s). Swann (1969) recommended that agricultural antibiotics should be divided into two risk categories: 'feed' antibiotics (AGPs) that would be available without prescription and 'therapeutic' antibiotics that would only be available by veterinary prescription. The preventative use of antibiotics was considered less important. The shift in framing AGPs as 'feed' antibiotics can be seen as a tactical move; it downgraded the risk of AGPs into a 'harmless' food additive. The risk classification was supported by the veterinary community in UK who believed it was the higher dosages of therapeutics that led to AMR and not the sub therapeutic dosages of AGPs (Kahn 2016). In effect, the Swann report approved continuation of economic agricultural antibiotic use and 'co-produced' the use of farm antibiotics. The UK consumer was used to matters that concerned public safety being handed over to scientific expert committees who would inform the UK government (Jasanoff 1997; Wales *et al.* 2006). Although several UK consumer organisations existed at that time, they were not unified and did not therefore act as a co-operative pressure-group in support of consumer interests (Tivey 1968). The absence of a strong consumer movement limited the opportunity for consumers to participate in food policies (Tivey 1968). This is despite, the Chairman of the public group the 'Farm and Food Society' stating that: 'there is now a mounting pile of evidence to show that "factory farming methods", which over the last decade have made rapid advance with the full support of successive Governments and of the N.F.U., hold health hazards for the consumer'.¹

The UK government represented the interests of the consumers through the advice of expert committees, which kept issues related to food risks as a private dispute between policy actors and scientists (Lowe *et al.* 2003; Jasanoff 2005; Wales *et al.* 2006). Against this political culture of science-centred approaches towards food risks and lack of public engagement, the risk classification of agricultural antibiotics into feed and therapeutic antibiotics became established and the risks were diverted from the public radar.

Sweden: democratic formulation of the risks of agricultural antibiotic use

Sweden's strong environmental values and its political culture of consensus-oriented regulation of environmental and public health risks co-produced a different 'space' for the debate about agricultural antibiotics. During the 1960s–1970s, Sweden's agricultural landscape underwent massive change (Saifi 2004). As with the UK, the

Swedish agricultural model was characterised by State interventionism to modernise agriculture (Flygare and Isacson 2011). Although the Swedish public held the Swedish State ultimately responsible for a clean environment and a healthy society, environmental and agricultural policies were developed through democratic debate between science, State and consumers (Vail *et al.* 1994; Boström and Klintman 2006). When Rachel Carlson's book *Silent Spring* was published in 1962 in Sweden, it led to public discussions about the environmental effects of modern agricultural practices (Flygare and Isacson 2011). Public concerns were raised about chemical use and toxic substances entering the environment that could lead to adverse effects (Vail *et al.* 1994). Swedish animal production had a long tradition of controlling infectious diseases in livestock (Wierup 2001), but veterinarians were concerned that antibiotics were increasingly being used to cover up poor animal husbandry practices (Kahn 2016). This prompted veterinarians to question the dependency of Swedish agriculture on industrial techniques. After the publication of the Swann report, Swedish veterinarians were one of the first groups to raise concerns about AGPs. Swedish farmers, who were dependent on the internal market, worried about the loss of trust by consumers in their products and also started to question the use of AGPs (Kahn 2016). When scientific evidence was published raising questions about the growth-promoting effects of AGPs on calves in the early 1970s, it led the calf and beef production industry to voluntarily end the use of AGP (Wierup 2001). In a public letter, the Swedish Farmer Association (LRF) promised the restrictive and careful use of antibiotics (Edqvist and Pedersen 2002). Moreover, the LRF itself requested that the Swedish government ban the use of AGPs in food animals. The Swedish Board of Agriculture reassessed the case but drew similar conclusions to the recommendations in the Swann report and advised the continued use of AGPs (Edqvist and Pedersen 2002). No consensus was reached between science, State, farmers and consumers on how to regulate AGPs and the controversies in Sweden on AGP use in food animals continued (Edqvist and Pedersen 2002). To maintain the trust of consumers and to limit the development of resistant bacteria, farmers themselves proposed that antibiotics should only be used under veterinary control (Edqvist and Pedersen 2002). In 1981, a series of newspaper articles in *Dagens Nyheter* (Daily News) reported that more than 30 tons of antibiotics were used in feed animals for growth promotion each year (Cogliani *et al.* 2011). Swedish consumers were outraged and a consumer report in Sweden in 1984 showed that consumer faith in meat had dropped significantly, which prompted farmers to produce food without the use of drugs (Cogliani *et al.* 2011). As scientific uncertainty continued, both consumer organisations and the LRF asked for mandatory policy measures to control the use of antibiotics (SOU 1997). The Swedish consensus-oriented political culture took both scientific and public knowledges seriously resulting in the 1986 *Feeding Stuff Act*, which banned the use of AGPs in agriculture (SOU 1997). Despite this, concerns about the regulation of preventative and therapeutic use of agricultural antibiotics in Sweden continued to grow and this further impacted on the risk classification and use of agricultural antibiotics (Grave *et al.* 2006).

The Swann report in Sweden raised more concerns than it answered. While it resulted in further research, this reached similar conclusions to the Swann committee. As science in the political culture of Sweden fulfilled a democratic role instead of

a determining role, the debate remained open and as such, the risks of economic and therapeutic use of agricultural antibiotics were constructed as a 'visible' societal issue. This was in contrast to the UK's exclusive reliance on expert committees to inform and frame the risks about agricultural antibiotic use. The Swedish 1986 *Feeding Stuff Act*, which banned AGP use in agriculture, made Sweden the first country to build an economically viable agricultural system without using antibiotics to compensate for poor management and low housing standards (Wierup 2001).

1970's–1990's: political cultures and the *re-stabilisation* of agricultural antibiotics

United Kingdom: the classification of agricultural antibiotics as economic and therapeutic tools

Following the publication of the Swann report in the UK, an article in the Financial Times responded with the message that 'the case against antibiotic feeding has not been fully proved by any means. It could be said to be as much instinctive as factual' (Cherrington 1969). The scientific uncertainties of the report became a focus of protests from farmers and the pharmaceutical industry in 1970 who feared the consequences of limited antibiotic use in food animals (Fishlock 1970; Reeves 1970). Farmers feared additional costs would be accrued were the recommendations to be implemented and protested that small providers would be forced out of business (Williams-Smith 1970). Although many politicians supported the report, a House of Commons (1969) meeting discussed the danger of economic losses due to feed additive stocks, effects upon husbandry systems and the extra costs of food production. This only became more intensified by the growing influence of Europe. When the UK joined the EEC and the Common Agricultural Policy (CAP) in 1975, it had to engage with Europe's agricultural focus on maximum food production and food security, which further incentivised the intensification of animal husbandry systems (Grant 2005). Europe followed Swann's recommendations of dividing farm antibiotics into two categories: feed antibiotics and therapeutic antibiotics (Castanon 2007). British policy makers did not set up an independent committee to explore the AGP issue further and when Margaret Thatcher came into power 1979, her deregulatory agricultural ambitions and disinterest in farming led to a dilution of the Swann Report's recommendations (Edqvist and Pedersen 2002). In the decades that followed, several scientists (Levy *et al.* 1976; Linton 1977; Threlfall *et al.* 1978; Dutta and Devries 1984) reported evidence of the transfer of multidrug resistant bacteria between human and animals. However, in the absence of sufficient scientific evidence that the agricultural AGPs in use could pose a danger to animals, humans or the environment, they were allowed to be used (Castanon 2007). The potential risks of therapeutic antibiotics used in food animals, raised in the Swann report, became largely ignored up until the 1990s (Barton 2000). What becomes clear is that the political cultures of Europe and the UK treated the absence of conclusive evidence produced by expert committees on the link between the agricultural use of AGPs and AMR in humans as the absence of immediate risk. The media and consumers lost interest which kept further scientific scrutiny at a distance and enabled

parts of the Swann's report to become aligned with governmental economic interest and the productivist mentality of the agricultural lobby. The perceived absence of human health risks associated with AGPs resulted in a re-stabilisation of antibiotics in Europe and the UK turning them into economic and therapeutic tools. The debate was effectively silenced until the mid-1990s (Edqvist and Pedersen 2002).

During the 1980s–1990s, environmental and agricultural sustainability discourses began to emerge that created more public awareness of food safety and food quality in Europe (Grant 2012). The Bovine spongiform encephalopathy (BSE) crisis in the UK during the 1980s–1990s proved to be a critical event as the UK consumer lost trust in experts and blamed UK authorities for withholding information on the risks (Jasanoff 2005). A public debate developed which demanded that agricultural decision-making should become more accessible 'beyond the farming unions and agricultural officials' (Lowe *et al.* 2003, p. 24). The UK political culture started to experience a shift in the 1990s towards a style of governance that included consumer discussions and political transparency about the risks posed by science and its technologies (Jasanoff 2005; Irwin 2006; Wales *et al.* 2006). New scientific evidence of resistant bacteria in food during the late 1990s forced UK politicians into a review of agricultural antibiotics favouring public knowledges over the agricultural lobby (Department of Health 1998). The economic properties of AGPs that had made them so popular became a weapon used against them. AGPs were misused and over-used *because* of their economic properties. Scientific committees, both in Europe and the UK, were set up by the end of the 1990s to evaluate antibiotic use and AMR both in humans and animals (Barton 2000). As a result, Europe and the UK started to phase out AGP use, leading to a complete ban of AGPs 8 years later in 2006, and implemented further destabilisation of agricultural antibiotic use in the decade that followed (Soulsby 2007).

Sweden: the re-classification of agricultural antibiotics: therapeutic use only

Pushed by a strong environmental lobby, Swedish policymakers developed new goals during the 1980s to limit the environmental impact of mainstream agriculture, to stimulate local food production and to support organic farming (Flygare and Isacson 2011). Concerns were not restricted to politicians, farmers and consumers anymore, but were echoed as well by public discourses on animal welfare during the 1980s (Vail *et al.* 1994). Moreover, the Swedish writer Ann Lindgren, well known for the creation of 'Pippi Longstocking', published a series of satirical stories on farm animals in leading newspapers, fuelling the animal welfare debate in Sweden (Lohr 1988). A new *Animal Welfare Act* was passed in 1988 which was aimed at preventing animal diseases through high production standards on farms: Sweden was the first country in the world in which farm animals received rights (Ministry of Agriculture, Food and Fisheries Sweden 1998). As earlier discussed, the UK government framed the animal welfare debate as a technical debate, which led to some technical modifications to improve housing systems but animal husbandry systems continued to be intensified (Woods 2012). The animal welfare debate in Sweden however was not silenced or dominated by science; it became a topic that involved a wide range of

both technical and ethical discussions that questioned animal husbandry systems and their production techniques (SOU 1997). In contrast to the UK, animal welfare established itself as an important pillar in agricultural debates and pushed farmers and veterinarians to adjust their practices in favour of animal welfare (Federation of Swedish Farmers LRF 2015).

After the ban of AGPs in 1986, agricultural antibiotics became classified as therapeutic veterinary medicines only and had to be dispensed through pharmacies, supplied by drug wholesalers or manufacturers (Wierup 2001). Veterinarians were not permitted to own a pharmacy or sell medicines for profit (Wierup 2001). The ban of AGP use, concerns about AMR, therapeutic agricultural antibiotic use prescribed by veterinarians only, the new focus by the public on agricultural sustainability and the flaws of animal husbandry systems resulted in Swedish farmers searching for alternatives. For farmers to produce both economically and ecologically responsible products without the use of antibiotics, investments in animal environment and management became essential (Ministry of Agriculture, Food and Fisheries 1998). In the years that followed, actions were not only taken to limit the public health risks from feed antibiotics, but also to abolish prophylactic use and limit therapeutic uses of farm antibiotics. In addition, the Swedish National Veterinary Institute (NVI) started to collect scientific facts and statistics on antimicrobial use in farm animals during the 1980's and undertook 'problem-orientated' research to limit further antibiotic use (Ministry of Agriculture, Food and Fisheries Sweden 1998; Cogliani *et al.* 2011). The Swedish approach to controlling infectious diseases in livestock led to the incorporation of preventive methods such as improved biosecurity, improved housing, more use of vaccines and vector control, better diagnostics including testing for sensitivity to antimicrobials (Wierup 2001). These measures, together with more effective use of antibiotics, lowered agricultural antibiotic use significantly in the years that followed. Swedish consensus-oriented policy culture framed the risks of agricultural antibiotics differently within a wider debate on the future intensive animal husbandry systems. As Sweden's political culture was characterised by consensus through a clear separation of interests, it did not solely rely on scientists to inform their decision-making process (Asdal and Gradmann 2014). The scientific uncertainty on the risks of AGPs and antibiotic use in general forced Sweden to explore the topic further and eventually ban AGPs and restrict antibiotic use to avoid potential public health risks. Societal pressure on different fronts, such as consumer pressure, farmer concerns, animal welfare, sustainability discourses, contributed to the scientific governance of agricultural antibiotic use (Edqvist and Pedersen 2002).

Discussion

Reflecting upon UK's 'expert' oriented political culture, science has played an ambiguous role in the trajectory of farm antibiotics. Although scientists initially questioned the legitimacy of using farm antibiotics as AGPs, the immediate risks of both AGPs and therapeutic antibiotics were downplayed by expert scientific committees (Brambell, Netherthorpe and Swann) and the UK government, resulting in the continuation of their use. Within this political system in which consumers accepted the

privileging of science over beliefs, advice from expert committees on farm antibiotics became constructed as 'matters of fact' instead of sites of controversy (Latour 1987). Hence, the UK government, experts and consumers did not act in isolation; they co-produced the 'silent' UK consumer. This enabled continuation of both economic and therapeutic use of agricultural antibiotics up until the late 1990s, when national food crises constructed a new type of consumer and institutional reform. In contrast, Sweden's consensus-oriented political culture engaged with consumer concerns, and reshaped the debate (SOU 1997; Ministry of Agriculture, Food and Fisheries Sweden 1998). Scientific evidence was negotiated before risk policies were established. Absence of conclusive scientific evidence was seen in Sweden as a possibility of risk and the use of agricultural antibiotics for economic purposes in food animals became a serious issue. This pushed the Swedish Ministry to reclassify their use and resulted in the frame of therapeutic use only (SOU 1997).

Inevitably, the different historical risk framing and regulation of agricultural antibiotics has co-produced different agricultural antibiotic trajectories in recent years. In the last decade in the UK, renewed national and international attention to resistant bacteria in food animals, green discourses and consumer debates have destabilised agricultural antibiotic use. In the wake of several food scares during the 1990s, the UK government was forced by public opinion to reform its institutional structure; core values of 'transparency and openness' became entrenched in UK food policies (Irwin 2006, p. 301). To validate the neutrality of science, public engagement became a standard part of UK policy making (Wales *et al.* 2006). As such, the UK government institutionalised consumers as a legitimate actor to participate in food policies. Although consumers are now represented in a consumer committee within the new Food Safety Authority, their formal powers remain limited (Wales *et al.* 2006). Moreover, UK's 'expert' policy culture still appears to dominate as publics are only able to enter into already formulated frames of governance (Irwin 2006). In contrast, Sweden had active consumers negotiating about the future of agricultural antibiotic use (SOU 1997). The UK government, responded to renewed national and international pressure on both human and agricultural antibiotic use by setting up a new scientific 'expert committee'. Framed by the moral overtones of antimicrobial 'overuse and misuse', 'The Review on Antimicrobial Resistance' under Chairmanship of economist Lord Jim O'Neill was set up in July 2014 by past UK Prime Minister David Cameron, to restore public trust in UK's governance of human and agricultural antibiotic use (Morris *et al.* 2016). In line with the overuse and misuse frame, this expert committee has formulated targets for the UK agricultural industry to reduce overall use in the agricultural sector from 62 mg/kg in 2016 to 50mg/kg by 2018 (Department of Health 2016). Through this target setting, the UK government will be able to provide 'evidence' that usage has been lowered over time which legitimates its policies to the public. However, the problems and structural needs of the agricultural industry, such as farmer productivist mentalities, problems of agricultural housing and infrastructures and the financial problems arising from the small margins under the UKs agricultural industry (RUMA 2016) remain largely unchallenged. In the past, price-setting schemes secured farmers income and empowered their position, but they are now struggling to survive as part of the UK's neoliberal food market (Farndale 2016). This market is dominated by British supermarkets who keep the

food prices artificially low by fighting over market share (Farndale 2016). As such, by maintaining the narrow frame of 'antibiotic overuse and misuse', the UK government indirectly showed its disinterest in the agricultural sector by not engaging with concerns from other publics to explore how the UK agricultural industry could be pushed toward to a healthy sustainable industry. Jasanoff (2005, p. 245) calls the former the 'stickiness of frames', in that the frame through which governments approach issues/risks can lead to political inaction and inability to deal with the issue at stake. The Swedish example has shown that the will to reduce antibiotic use depends on a variety of factors (Ministry of Agriculture, Food and Fisheries 1998). The Swedish political culture proved to be reflective and pragmatic in its risk management of agricultural antibiotic use. A consensus-oriented debate between scientific knowledges and non-scientific knowledges on agricultural antibiotic use and intensive farming enabled a broader scope of what was at stake and what needed to be done (SOU 1997; Cogliani *et al.* 2011; Magnusson 2016). At the same time, State interventionism was accepted as the boundaries of agricultural antibiotic legislation were collectively decided upon. This pushed the agricultural industry to restrict their therapeutic antibiotic use and to adopt new innovative techniques (Wierup 2001). Today, in line with the Swedish political culture, antibiotic strategies, antimicrobial guidelines, biosecurity, disease-control programmes, and optimised management and husbandry are continuously negotiated between the different parties (EMA 2016). The Swedish government set up mandatory evaluation of farm building plans, and developed mandatory and voluntary disease control programmes which have economic incentives for the farmer. The latest European Medicine Agency Report (2016) on antibiotic sales for food-producing animals in 2013 showed that the population-corrected (PCU) sales in tonnes of active ingredient was 422 tonnes in the United Kingdom compared to 10 tonnes in Sweden. Differences in epidemiological profiles between countries of bacteria and AMR in humans and animals have been identified as well the in latest public health reports of both the UK and Sweden (ESPAUR 2015; SWEDRES-SVARM 2015). According to a Swedish antibiotic expert: 'Sweden is 30 years ahead of many other countries when it comes to reducing its antibiotics' (Grecko in LRF 2015, p. 2).

Although the concept of political cultures provides valuable insights into how political cultures produce different risk and regulatory frames on agricultural antibiotics, there are some limitations as well. When Jasanoff (2005) used the concept of political cultures to understand why biotechnological developments were received differently in three countries, the UK and Europe had just recovered from food scares, which both challenged and produced new relations between politics, science and consumers. Today however, the interplay between markets and consumers is becoming more important when exploring how political cultures construct collective knowledge on food issues and how this interplay acts upon existing science-policy frameworks. The dynamics between science, markets and consumers has been theorised by Buller and Roe (2014) by using Caliskan and Callons' concept of 'economization' and 'marketization'. They showed how the animal welfare expectations of consumers have become assembled through 'technics, practices and materialities' into the body of the animals (Buller and Roe 2014, p. 142). In the governance of agricultural antibiotics, food supply chains increasingly dominate the science, techniques and

standards that define 'responsible' antibiotic use in the bodies of animals and therefore products from our food animals (Davies 2017). Hence, the impact of markets should not be underestimated when exploring how political cultures produce collective knowledge on science and its technologies. However, the concepts political cultures and co-production provide only a limited understanding of how the science-policy frames at a macro level filter into micro practices and local knowledges. Gray and Gibson (2013) have argued that farmer identities and practices are mainly shaped by the micro industrial agricultural networks they are part of, and advocate for more understanding of how these local networks influence local farmer decision-making. In a similar vein, Enticott (2012) has explored how veterinary expertise is enacted through 'localized negotiations' and 'pre-existing material relations' of the social worlds they are part of (Enticott 2012; p. 79). Tironi *et al.* (2013) have used Jasanoff's concept of 'civic epistemologies' or public knowledges to explore how Chilean farmers make sense of Genetically Modified (GM) technologies. They critically discuss how the concept limits itself to 'collective ways of knowing' about scientific technologies and it fails as such to grasp why Chilean farmers on a subnational level deploy multiple, often contesting frames upon the 'nature, function and effects of GM technologies' (2013, p. 102). To avoid the use of 'fixed' epistemic frames of civic epistemologies, the authors introduce the concept of 'hybrid epistemologies' to embrace the fluidity of knowledge production as such (Tironi *et al.* 2013, p. 102). Hence, although the concept of public knowledges has proven to be useful to understand cross-national differences in the uptake of new technologies, limitations occur when differences are observed between public knowledges of science *within* the same country. Hence, if we want agricultural actors to adopt new antibiotic frames, a full assessment of their antibiotic rationalities is essential. Although the combined use of political cultures and co-production offer predictive theoretical power to explore how countries use science to govern agricultural antibiotic use, complementary research is needed to understand how networks of antibiotics are actually 'performed' in the settings in which they are used.

Conclusion

This article has explored *how* the dynamics between policy, science and publics produced different styles of scientific reasoning and justifications of agricultural antibiotic use. It has argued that political cultures *matter* when trying to understand how farm antibiotics are regulated in different countries. Moreover, agricultural antibiotics and their infrastructures are heavily entwined with a country's political culture. Although it is not denied that economic incentives influence agricultural antibiotic use, it is argued one should explore how economic incentives push political cultures in their agricultural decision-making regarding farm antibiotics. The entanglement of scientific knowledge, expertise, political models and public knowledges have been (and still are) co-producing the framing of agricultural antibiotic use, their actual use and the effects of their use. Binding antibiotic use solely into the moral public health framework of 'overuse and misuse' limits what might be possible, leaving the 'responsible' use of antibiotics only partially achievable. Leaving a country's

agricultural political context and its science-policy nexus unexplored, risks missing the national drivers that influence the construction of farm antibiotics resulting in policy initiatives that fail (or succeed) to deliver on their goals. Exploring the controversies which surround antibiotic use on a national and international level offers the possibility of identifying new ways to change behaviour and allow for multiple viewpoints to be included in decision-making processes.

Notes

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¹ Better Farming or Self-Betterment? Factory “Farming” Under Attack, published in *The Veterinary Record*, Volume 86, page 110, author unknown.

Acknowledgements

The research was funded by the National Institute for Health Research Health Protection Research Unit (NIHR HPRU) in Emerging and Zoonotic Infections at University of Liverpool in partnership with Public Health England (PHE), in collaboration with Liverpool School of Tropical Medicine. Stephanie Begemann is based at The Institute of Infection and Global Health. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR, the Department of Health or Public Health.

References

- Anderson, E.S. and F.C. Path (1968) Papers and originals drug resistance in *Salmonella typhimurium* and its implications. *British Medical Journal* 3 (5614) pp. 333–339
- Asdal, K. (2008) On politics and the little tools of democracy: a down-to-earth approach. *Journal of Social Theory* 9 (1) pp. 11–26
- Asdal, K. and C. Gradmann (2014) Introduction: science, technology, medicine – and the state: the science-state nexus in Scandinavia, 1850–1980. *Science in Context* 27 (2) pp. 177–186
- Barton, M.D. (2000) Antibiotic use in animal feed and its impact on human health. *Nutrition Research Reviews* 13 (2) pp. 279–299
- Bijker, W.E., T.P. Hughes and T. Pinch (1987) *The social construction of technological systems: new directions in the sociology and history of science and technology studies* (Cambridge, MA: The MIT Press)
- Boström, M. and M. Klintman (2006) State-centered versus non state-driven organic food standardization: a comparison of the US and Sweden. *Agriculture and Human Values* 23 (2) pp. 163–180
- Brambell Report (1965) *Report of the technical committee to enquiry into the welfare of animals kept under intensive livestock husbandry systems* (London: HMSO)
- Buller, H. and E. Roe (2014) Modifying and commodifying animal welfare: the economisation of layer chickens. *Journal of Rural Studies* 33 (1) pp. 1873–1392
- Buller, H., S. Hinchliffe, J. Hockenhull et al (2015) Systematic review and social research to further understanding of current practice in the context of using antimicrobials in livestock farming and to inform appropriate interventions to reduce antimicrobial resistance within the livestock sector. A research prepared for DEFRA Available online at <https://www.gov.uk/government/publications> Accessed 16 December 2016

- Callon, M., P. Lascoumes and Y. Barthes (2001) *Acting in an uncertain world: an essay on technical democracy* (Cambridge, MA: The MIT Press)
- Castanon, J.I.R. (2007) History of the use of antibiotic as growth promoters in European poultry feeds. *Poultry Science* 86 (11) pp. 2466–2471
- Chandler, C.I.R., C. Hutchison and E. Hutchison (2016) Addressing antimicrobial resistance through social theory: an anthropologically oriented report (report) (London: London School of Hygiene & Tropical Medicine) Available online at [http://www.lshtm.ac.uk/php/ghd/research/app/anthropologyofantimicrobial resistance.html](http://www.lshtm.ac.uk/php/ghd/research/app/anthropologyofantimicrobial%20resistance.html) Accessed 16 December 2016
- Cherrington, J. (1969, November 11) Why antibiotics face their Swann song. *The Financial Times* p. 4
- Cogliani, C., H. Goossens and C. Greko (2011) Restricting antimicrobial use in food animals: lessons from Europe. *Microbe* 6 (6) pp. 274–279
- Cox, G., P. Lowe, and M. Winter. (1986) From State Direction to Self Regulation: the historical development of corporatism in British agriculture. *Policy & Politics* 14 (4) pp. 475–490
- Dar, O.A., R. Hasan, J. Schlundt *et al.* (2015) Exploring the evidence base for national and regional policy interventions to combat resistance. *The Lancet* 387 pp. 285–295
- Davies, I. (2017) Tesco milk suppliers to cut use of critical antibiotics. *Farmers weekly* Available online at <http://www.fwi.co.uk/livestock/tesco-milk-suppliers-to-cut-use-of-critical-antibiotics.htm> Accessed 1 October 2017
- Department of Health. (1998) Government response to the House of Lords Select Committee on Science and Technology report resistance to antibiotics and other antimicrobial agents. Available online at <https://www.gov.uk/dh> Accessed 8 January 2018
- Department of Health. (2016) Government response to the review on antimicrobial resistance. Available online at www.gov.uk/dh Accessed 7 May 2017
- Dutta, G.N. and L.A. Devries (1984) Gram positive intestinal bacteria of farm animals to growth promoting antimicrobial agents. *Journal of Applied Bacteriology* 56 (1) pp. 117–123
- Edqvist, L.E. and K.B. Pedersen. (2002) Antibiotics as growth promoters: resistance to common sense. Pp. 100–110 in P. Harremoës, D. Gee, M. MacGarvin *et al* eds., *The precautionary principle in the 20th century: late lessons from early warnings* (London and New York, NY: Earthscan Publication Ltd)
- Enticott, G. (2012) The local universality of veterinary expertise and the geography of animal disease. *Transactions of the Institute of British Geographers* 37 (1) pp. 75–88
- ESPAUR. (2015) *English surveillance programme for antimicrobial utilisation and resistance (ESPAUR) 2010–2014* (London: Public Health England) Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/477962/ESPAUR_Report_2015.pdf Accessed 7 May 2017
- European Medicine Agency. (2016) Sales of veterinary antimicrobial agents in 29 European countries in 2004. Trends from 2011 to 2014 Sixth ESVAC report (Report No. EMA/61769/2016) Available online at http://www.ema.europa.eu/docs/en_GB/document_library/Report/2016/10/WC500214217.pdf Accessed 7 May 2017
- Farndale. (2016) How Brexit would affect British farmers. *The Spectator* Available online at <https://www.spectator.co.uk/2016/02/how-brexit-would-affect-british-farmers/> Accessed 7 May 2017
- Federation of Swedish Farmers LRF. (2015) Swedish pig production - a few facts on pig production in Sweden. Pamphlet, Stockholm Available online at [file:///C:/Users/Stephanie/Downloads/swedish_pig_production_2015%20\(5\).pdf](file:///C:/Users/Stephanie/Downloads/swedish_pig_production_2015%20(5).pdf) Accessed 7 May 2017
- Fishlock, D. (1970, January 22) Critics of farm antibiotic curbs are “alarmist.” *The Financial Times* p. 4
- Flygare, I.A. and M. Isacson (2011) The tension between modernity and reality, 1945–2010. Pp. 214–255 in J. Myrdal and M. Morell eds., *The agrarian history of Sweden: From 4000 BC to AD 2000* (Lund, Sweden: Nordic Academic Press)

- Grant, W. (2005) Agricultural policy pp. 7–23 in P. Dorey ed., *Developments in British public policy* (London: SAGE Publications Ltd)
- Grant, W. (2012) Agricultural policy, food policy and communicable disease. *Journal of Health Politics, Policy and Law* 37 (6) pp. 1031–1048
- Gray, B.J. and J.W. Gibson (2013) Actor-networks, farmer decisions, and identity. *Culture, Agriculture, Food and Environment* 35 (2) pp. 82–101
- Grave, K., V.F. Jensen, K. Odensvik et al. (2006) Usage of veterinary therapeutic antimicrobials in Denmark, Norway and Sweden following termination of antimicrobial growth promoter use. *Preventive Veterinary Medicine* 75 (1–2) pp. 123–132
- Harrison, R. (1964) *Animal machines: the new factory farming industry* (London: V. Stuart)
- House of Commons. (1969) *Hansard* Deb 20 November 1969 vol 791 cc1525-31
- Irwin, A. (2006) The politics of talk: coming to terms with the “new” scientific governance. *Social Studies of Science* 36 (2) pp. 299–320
- Jasanoff, S. (1997) Civilization and madness: the great BSE scare of 1996. *Public Understanding of Science* 6 (3) pp. 221–232
- Jasanoff, S. (2004) *States of knowledge: the co-production of science and the social order* (London and New York: Routledge)
- Jasanoff, S. (2005) *Designs on nature* (Princeton, NJ and Oxford: Princeton University Press)
- Kahn, L.H. (2016) *One health and the politics of antimicrobial resistance* (Baltimore, MD: John Hopkins University Press)
- Latour, B. (1987) *Science in action* (Cambridge, MA: Harvard University Press)
- Levy, S.B., G.B. FitzGerald and A.B. Macone (1976) Spread of antibiotic-resistant plasmids from chicken to chicken and from chicken to man. *Nature* 260 (5546) pp. 40–42
- Linton, A.H. (1977) Animal to man transmission of Enterobacteriaceae. *Royal Society of Health Journal* 97 (3) pp. 115–118
- Lloyd-Evans, L.P. (1983) The swann report in the 1980s. *Veterinary Research Communications* 7 (1) pp. 101–105
- Lohr, S. (1988) Swedish farm animals get bill of rights. *The New York Times* Available online at <http://www.nytimes.com/1988/10/25/world/swedish-farm-animals-get-a-bill-of-rights.html> Accessed 16 December 2017
- Lowe, P., C. Ratschow, J. Allinson et al. (2003) *Government decisionmaking under crisis: a comparison of the German and British responses to BSE and FMD Centre for Rural Economy Research Report* (Newcastle: University of Newcastle upon Tyne) Available online at <http://www.ncl.ac.uk/cre/publish/pdfs/rro3.01a.pdf> Accessed 7 May 2017
- LRF. (2015) The Swedish Pig production: a few facts on pig production in Sweden Available online at www.lrf.se Accessed 7 May 2017
- Magnusson, U. (2016) *Sustainable global livestock development for food security and nutrition including roles for Sweden*. Discussion Paper No. N2016.38 Available online at <https://www.slu.se/globalassets/ew/org/andra-enh/uadm/global/pdf/fao-report-livestock.pdf> Accessed 16 December 2017
- Martiin, C. (2015) Modernized farming but stagnated production: Swedish farming in the 1950s emerging welfare state. *Agricultural History* 89 (4) pp. 559–583
- Marres, M. (2007) The issues deserve more credit: pragmatist contributions to the study of public involvement in controversy. *Social Studies of Science* 37 (5) pp. 759–780
- Meek, R.W., H. Vyas and L.J.V. Piddock (2015) Nonmedical uses of antibiotics: time to restrict their use? *PLOS Biology* 13 (10) pp. 1–11
- Metzler, I., and A. Webster (2011) Bio-objects and their boundaries: governing matters at the intersection of society, politics, and science. *Croatian Medical Journal* 52 (5) pp. 648–650
- Ministry of Agriculture, Food and Fisheries. (1998) *The Swedish model of animal production* (Stockholm, Sweden: Ministry of Agriculture, Food and Fisheries) Available online at http://www.iatp.org/files/Swedish_Model_of_Animal_Production_The.pdf Accessed 7 May 2017

- Morell, M. (2011) Agriculture in industrial society, 1870–1945. Pp. 165–213 in J. Myrdal and M. Mats eds., *The agrarian history of Sweden: from 4000 BC to AD 2000* (Lund, Sweden: Nordic Academic Press)
- Morris, C., R. Helliwell and S. Raman (2016) Framing the agricultural use of antibiotics and antimicrobial resistance in UK national newspapers and the farming press. *Journal of Rural Studies* 45 pp. 43–53
- Murdoch, J. and N. Ward (1997) Governmentality and territoriality. *Political Geography* 16 (4) pp. 307–324
- Myrdal, J. and M. Morell (2011) Agriculture in industrial society, 1870–1945. Pp. 7–17 in J. Myrdal and M. Morell eds., *The agrarian history of Sweden: from 4000 BC to AD 2000* (Lund, Sweden: Nordic Academic Press)
- O'Neill, J. (2015) Review on Antimicrobial Resistance (Chaired by Jim O'Neill). Antimicrobials in agriculture and the environment- Reducing unnecessary use and waste. (London) Available online at <https://amr-review.org/sites/default/files/Antimicrobials%20in%20agriculture%20and%20the%20environment%20-%20Reducing%20unnecessary%20use%20and%20waste.pdf> Accessed 7 May 2017
- Randall, C. (1969) The swann committee. *Veterinary Record* 85 (22) pp. 616–621
- Reeves, R. (1970, January 6) Farm drugs curb under attack. *The Financial Times* p. 4
- RUMA. (2016) Government response to O'Neill findings welcomed amid calls for joined-up leadership and capital investment Available online at <http://www.ruma.org.uk/government-response-oneill-findings-welcomed-amid-calls-joined-leadership-capital-investment/> Accessed 7 May 2017
- Saifi, B. (2004) The sustainability of Swedish agriculture in a coevolutionary perspective. Doctoral dissertation (Uppsala, Sweden: Swedish University of Agricultural Sciences) Available online at http://pub.epsilon.slu.se/643/1/Agraria_469_Tryckfil.pdf
- Saifi, B. and L. Drake (2008) Swedish agriculture during the twentieth century in relation to sustainability. *Ecological Economics* 68 (1–2) pp. 370–380
- Schwarz, S., C. Kehrenberg and T.R. Walsh (2001) Use of antimicrobial agents in veterinary medicine and food animal production. *International Journal of Antimicrobial Agents* 17 (6) pp. 431–437
- Self, P. and H.J. Storing (1963) *The state and the farmer* (Berkeley and Los Angeles: University of California Press)
- Sismondo, S. (2011) *An introduction to science and technology studies* 2nd edn (West Sussex, United Kingdom: Wiley-Blackwell)
- Smith, H. (1968) Anti-microbial drugs in animal feeds. *Veterinary Record* 83 (6) pp. 143–147
- SOU (1997) Antimicrobial feed additives. Report from the commission on antimicrobial feed additives. Report no. 132 Available online at <http://www.government.se/contentassets/f09ed76c354441b6b5e4d51f1f637101/chapter-1-4-antimicrobial-feed-additives> Accessed 16 December 2017
- Soulsby, L. (2007) Antimicrobials and animal health: a fascinating nexus. *Journal of Antimicrobial Chemotherapy* 60 pp. 77–78
- Stirling, A. (2010) Keep it complex. *Nature* 468 (7327) pp. 1029–1031
- Stuart, V. (1964, March 19) Food for the table - and food for thought. *The Times Literary Supplement* p. 241
- Swann Report (1969) *The joint committee on the use of antibiotics in animal husbandry and veterinary medicine* (London: HMSO)
- SWEDRES-SVARM. (2015) *Consumption of antibiotics and occurrence of antibiotic resistance in Sweden* (Solna and Uppsala: SWEDRES-SVARM) Available online at http://www.sva.se/globalassets/redesign2011/pdf/om_sva/publikationer/swedres_svarm2015.pdf Accessed 22 December 2016
- The Times Agricultural Correspondent. (1969, November 10) Rapid action on farm antibiotics. *The Times* p. 9

- Threlfall, E.J., L.R. Ward and B. Rowe (1978) Epidemic spread of a chloramphenicol resistant strain of typhimurium phage type 204 in bovine animals in Britain. *The Veterinary Record* 103 (20) pp. 438–440
- Tironi, M., M. Salazar and D. Valenzuela (2013) Resisting and accepting: farmers' hybrid epistemologies in the GMO controversy in Chile. *Technology in Society* 35 (2) pp. 93–104
- Tivey, L. (1968) The politics of the consumer. *The Political Quarterly* 39 (2) pp. 181–194
- Uluçanlar, S., A. Faulkner, S. Peirce et al. (2013) Technology identity: the role of sociotechnical representations in the adoption of medical devices. *Social Science and Medicine* 98 pp. 95–105
- Vail, D.J., K.P. Hasund and L. Drake (1994) *The greening of agricultural policy in industrial societies: Swedish reforms in comparative perspective* (Ithaca, NY: Cornell University Press)
- Wales, C., M. Harvey and A. Warde (2006) Recuperating from BSE: the shifting UK institutional basis for trust in food. *Appetite* 47 (2) pp. 187–195
- Wallinga, D., G. Rayner and T. Lang (2015) Antimicrobial resistance and biological governance: explanations for policy failure. *Public Health* 129 (10) pp. 1314–1325
- Wierup, M. (2001) The Swedish experience of the 1986 year ban of antimicrobial growth promoters, with special reference to animal health, disease prevention, productivity, and usage of antimicrobials. *Microbial Drug Resistance* 7 (2) pp. 183–190
- Williams-Smith, H. (1970) The "cost" of Swann. *Veterinary Record* 86 (5) pp. 133–135
- Winter, J. (1964, March 12) Farm mail. *Daily Mail* p. 17
- Woods, A. (2012) From cruelty to welfare: the emergence of farm animal welfare in Britain, 1964–71. *Endeavour* 36 (1) pp. 14–22

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