

# ROADMAP

## Rethinking of antimicrobial decision-systems in the management of animal production

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## Report on the results of qualitative and quantitative research on veterinary practices

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## About the ROADMAP research project

The overall aim of ROADMAP is to **foster transitions towards prudent use of antimicrobials (AMs) in animal production in different contexts to manage antimicrobial resistance (AMR). Prudent antimicrobial use (AMU) will be achieved by enhancing antimicrobial decision-systems along the food and drug supply chains.** ROADMAP will focus on supporting animal health and welfare through prevention and health promotion actions.

AMR is recognized as a significant threat to global public health and food security. Overuse and improper use of AMs in many parts of the world contribute to the emergence and spread of AMR. Although human and animal health require AMs, it has been estimated that two thirds of the future AMU growth worldwide will be in animal production. Improving the management of AMU in farm animals is therefore a critical component of dealing with AMR and optimizing production in the livestock sector. Nevertheless, the variety of contexts of AMU in the livestock sector is a major challenge to managing AMR. **There is no “one-size-fits-all” solution to improve AMU and strategies must be contextually developed** (for instance, strategies used in the Danish pig industry are difficult to adapt and adopt in the French free-range poultry farming). Successful solutions must be combined and tailored to the production systems and the social and economic context in which they operate.

ROADMAP will meet three general objectives, in line with the EU AMR Action plan: i) **Rethink AM decision-systems and animal health management;** ii) **Develop options for encouraging prudent AMU in animal production;** iii) **Engage all actors in the food and drug supply chains in fostering a more prudent use of AMs.**

## Project consortium

Part. N°	Participant organisation name (acronym)	Country
1	Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE) **	France
2	Association de coordination technique agricole (ACTA) ***	France
3	Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) **	France
4	University of Liverpool (ULIV) *	United Kingdom
5	Cardiff University (CU) *	United Kingdom
6	James Hutton Institute (HUT) **	United Kingdom
7	Alma Mater Studiorum - Università di Bologna (UNIBO) *	Italy
8	Aarhus Universitet (AU) *	Denmark
9	Eigen Vermogen van het Instituut voor Landbouw en Visserijonderzoek (EV-ILVO) **	Belgium
10	Research Institute of Organic Agriculture (FiBL) **	Switzerland
11	Stichting Wageningen Research (WR) *	Netherlands
12	Swedish University of Agricultural Sciences (SLU) *	Sweden
13	Southern Agriculture and Horticulture Organization (ZLTO) ***	Netherlands
14	European Forum of Farm Animal Breeders (EFFAB) ****	Netherlands
15	Fundacion Empresa Universidad Gallega (FEUGA) ****	Spain
16	Dierengezondheidszorg Vlaanderen (DGZ) ***	Belgium
17	INRAE Transfert (IT) ****	France

\* Universities/veterinary schools

\*\* Research institutes specialized in both fundamental and applied agricultural and veterinary sciences

\*\*\* Public and private advisory services Organisations

\*\*\*\* Knowledge transfer and Innovation organisations

## Table of contents

<b>1 Summary</b> .....	<b>6</b>
<b>2 The development of preventive approaches to animal health. A threatened or reconfigured veterinary professionalism?</b> .....	<b>6</b>
2.1 Rise of preventive approaches and protocolisation of veterinary expertise .....	8
2.1.1 Is the vet a health advisor? Dynamics of protocolization.....	8
2.1.1.1 <i>Preventive approaches supported by public and private initiatives</i> .....	8
2.1.1.2 <i>Preventive approaches as a diversification of veterinary expertise</i> .....	10
2.1.1.3 <i>Preventive approaches supported by a variety of protocols</i> .....	11
2.1.1.4 <i>Preventive practitioners as “health detectives”</i> .....	12
2.1.2 Prudent AMU as driver of protocolization.....	13
2.1.2.1 <i>The new role of antibiotics in preventive approaches</i> .....	13
2.1.2.2 <i>Rise of AMU monitoring as a market-oriented demand: when protocolisation is related to contractualisation</i> .....	15
2.2 The ambiguity of protocolisation.....	16
2.2.1 The discomfort of protocols: how does it feel to be a veterinarian nowadays? .....	17
2.2.1.1 <i>The burden of bureaucratic tasks</i> .....	17
2.2.1.2 <i>The challenge of accessing data</i> .....	18
2.2.1.3 <i>The discomfort of policing farmers</i> .....	19
2.2.2 Tensions in the various forms of knowledge promoted by protocols .....	19
2.2.3 How care protocolization redefines the relationships between health professionals .....	21
2.2.3.1 <i>New forms of collaboration</i> .....	21
2.2.3.2 <i>The role of guidelines in sharing knowledge</i> .....	23
2.2.3.3 <i>Remaining forms of competition</i> .....	24
2.2.4 Remaining issues faced by the veterinary profession to keep supporting the development of preventive approaches through care protocolisation .....	25
2.2.4.1 <i>Adapting veterinary business models to the new reality</i> .....	25
2.2.4.2 <i>The worrying issue of veterinary demographics</i> .....	26
2.3 Conclusion .....	26
<b>3 Veterinarians’ attitudes regarding AMR and AMU: a quantitative perspective</b> .....	<b>27</b>
3.1 Materials and method .....	27
3.1.1 Method.....	27

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3.1.1 Who are the respondents? .....	29
<b>3.2 Results.....</b>	<b>32</b>
3.2.1 Cross-tabulations and MCA .....	32
3.2.1 Hierarchical Clustering on the first factorial design.....	35
3.2.1.1 <i>First cluster (black)</i> .....	35
3.2.1.1 <i>Second cluster (red)</i> .....	37
3.2.1.1 <i>Third cluster (green)</i> .....	39
<b>3.3 Discussion .....</b>	<b>42</b>
3.3.1 Is the reduction of AMU a consensual topic? Lessons from the MCA.....	42
3.3.2 Better understanding veterinary positions thanks to a MCA-HAC analysis.....	43
3.3.2.1 <i>First cluster: Business-oriented vets, timidly mobilised for AMU reduction</i> .....	43
3.3.2.2 <i>Second cluster: Public health-oriented vets, committed for prudent AMU</i> .....	44
3.3.2.3 <i>Third cluster: Disenchanted vets, considering they have done enough and not much mobilised anymore</i> .....	45
3.3.3 Limits .....	46
3.4 Conclusion: Who cares?.....	47
<b>4 Conclusion: How to promote preventive approaches to animal health? Perspectives on the challenges facing the veterinary profession.....</b>	<b>49</b>
<b>5 Acknowledgements .....</b>	<b>50</b>
<b>6 References .....</b>	<b>51</b>
<b>7 Appendix.....</b>	<b>52</b>

## List of acronyms and abbreviations

AMU: Antimicrobial use

AMR: Antimicrobial resistance

EBM: Evidence-based medicine

PVM: preventive veterinary medicine

## 1 Summary

The reduction of antibiotic use in veterinary medicine is nowadays largely associated with the development of preventive approaches in animal health. The tasks of WP2 aimed at understanding the transformation of practices, knowledge and working conditions of veterinarians in relation to the promotion of prudent AMU have therefore focused on the individual, organisational and structural factors that currently favour the development of preventive approaches. These appear to be a central issue for the veterinary profession, which is facing major challenges in inventing and implementing ways of managing animal health that meet the major health, environmental and economic challenges of this new century.

Two major surveys were conducted as part of the Roadmap WP2 project. Firstly, a qualitative survey aimed at gathering the views and experiences of veterinarians in different national contexts: this survey highlights the difficulties encountered by veterinarians in implementing preventive approaches and promoting prudent AMU, and shows the profound transformations that the veterinary profession is currently undergoing. Secondly, a quantitative survey to understand the variability of veterinarians' attitudes towards AMR and AMU: this identifies several clusters within the profession, which are differentially distributed according to countries, sectors and working conditions, and within which each veterinarian develops different ways of thinking and acting in relation to the AMR problem. In conclusion, we emphasise the major structural factors that we believe need to be supported in order to maintain the ongoing transition towards prudent AMU and preventive approaches in animal health, and we suggest different ways of mobilising the profession according to the different contexts identified.

## 2 The development of preventive approaches to animal health. A threatened or reconfigured veterinary professionalism?

The current reduction of AMU in livestock is correlated with a change in veterinary medicine, shifting towards more preventative approaches to animal health. This trend echoes transformations that occurred in human medicine, through the development of evidence-based medicine (EBM) (Timmermans, 2004, 2005). Literature on human medicine has analysed the development of EBM as a three-fold movement of “rationalization, marketisation and bureaucratization of medical prescription” (Freidson, 2001). In other words, there is a dynamic of protocolization of care and of medical practice

that allows an extension of the medical expertise beyond clinics: biological and genetical markers, hygiene and nutrition practices, physical activities, etc. (sometimes even cognitive development and school performances) have become objects and metrics of the medical expertise (some authors call it “medicalization of the society” – Conrad, 2017).

However the side effect of this protocolization could be in certain cases a process of “de-professionalisation” (Freidson, 1985; Haug, 1988): it means that the medicalization of the society doesn’t necessarily require medical professionals and expertise anymore. Since a large and growing part of medical activity consists in monitoring indicators and following standardized decision-trees, the work doesn’t require specific medical knowledge and could be done by other professionals, such as nurses or other technicians. According to Pascal Roquet and Richard Wittorski (2013), “deprofessionalisation” refers to “a fundamental dynamic that threatens the status of established professions and their social recognition, but above all refers to a loss of autonomy, or even of professional authority, in the exercise of individual and/or collective professional activities”. Situations of deprofessionalisation cannot be thought of in isolation from the socio-economic contexts and trends that are favouring them. Generally speaking, the dynamics of deprofessionalisation have been observed in relation to the “precariousness of jobs, fragmentation and dissemination of tasks, challenges to the social protections linked to employment, reduction in professional autonomy, etc.”. In the case of veterinarians, these dynamics are linked to the concentration of agricultural and veterinary businesses and to structural changes in the value chains that are empowering downstream economic stakeholders over upstream actors.

Questioning the nature of the links between the protocolisation of animal medicine and veterinary deprofessionalisation leads us to another interrogation: that of the capacity of veterinarians to engage in a reconfiguration of their professional activity that is not necessary synonym to a loss of autonomy or authority, but to the establishment of new ways of working through which they would redefine and maintain their legitimacy. However, the protocolisation and standardisation dynamics that are underlying the development of preventive approaches to animal health are supported by and benefit specific segments of the veterinary profession. Therefore, even if the reconfiguration of the profession cannot necessary be described as a deprofessionalisation, this dynamic reshapes the role and power of veterinarians over animal health.

These questions will lead us to characterise the protocolisation process of veterinary medicine and the degree of which professional autonomy is lost or maintained: how preventive approaches are being developed in professional knowledge and practices, how strategies of reducing AMU tends to standardise and rationalise prescribing practices, how the jurisdiction of animal health is reshaped and shared with other professional groups, in which ways care protocolisation provides economic levers for a given segment of the profession and finally does protocolisation leads to deprofessionalisation of veterinary medicine?

#### **Brief historical overview**

Vet medicine has become a “profession” from the late 19th in most of the European countries, based on a jurisdiction over animal health slowly conquered over the farmers and agricultural organizations (Berdah, 2012; Woods, 2014). Professional expertise has been established through clinical and biological knowledge over animal diseases.

Preventive approaches have several roots depending on countries, but they are now at the heart of veterinary activity in many contexts, yet with local variations. In France, first holistic approaches tend to emerge in the 1970s and 1980s but they were very context-specific and based on local histories; they were not even called “preventive approaches” at that time (Fortané, 2017). Their generalization starts in the 2000s for industrial pig and poultry production, and only from 2010 onwards in dairy production – and is strongly driven by AMR

public policies and private initiatives aiming at reducing antibiotics (Fortané, 2021). In UK, a rise of PVM has been observed in the 1960s but it started to fall in the 1980s (Woods, 2013). However, like in Western and Northern European countries, preventive approaches tend to develop nowadays, although facing various professional issues (Ruston et al. 2016).

### Materials and method

This study is based on qualitative interviews with veterinarians from different countries. The interviews have been done between 2020 and 2022, depending on the availability of veterinarians which varied quite a lot according to the Covid situation in the different countries. The interviews aimed at understanding the daily practices of veterinarians and focused on different themes: working conditions, relationships with other professionals, tools and knowledge used during farm visits, strategies to decrease AMU and promote preventive approaches to animal health.

France: about 10 pig vets, 20 poultry vets, 15 dairy vets

Sweden: about 20 dairy vets, 5 poultry vets

Denmark: about 20 dairy vets

UK: about 20 dairy vets

Italy: about 10 pig and poultry vets

## 2.1 Rise of preventive approaches and protocolisation of veterinary expertise

This first part of the report deals with protocolisation, understood as the dual process of standardisation of care practices and rationalisation of tools for measuring and controlling the health status of animals. It is based on the enactment of monitoring devices, guidelines, control systems, technical sheets, etc. This protocolisation is inspired by Evidence-Based-Medicine approaches to enable veterinarians to make optimal decisions regarding the diagnosis of an animal. As in human medicine, EBM finds its legitimacy in the desire to improve care quality and in the concern of more holistic and preventive approach to animal health. Nowadays the standardisation of health practices in veterinary medicine is coupled with the strong obligation to control the use of antibiotics and to reduce animal health management costs.

### 2.1.1 Is the vet a health advisor? Dynamics of protocolization

#### *2.1.1.1 Preventive approaches supported by public and private initiatives*

This shift towards PVM has especially been politically driven. The political agenda of the AMR problem and governmental plans over the last ten years have encouraged the implementation of strategies to reduce AMU in livestock. Providing a better framework for the use and prescription of antibiotics in animals was also called upon by agri-food industry specifications (through private standards) or from the veterinary profession (through good practice guidelines). Consequently, there has been an increase in the number of norms promoting a more holistic/diversified approach to animal health and welfare, moving from cure to care and preventing systematic AMU (which was rather part of past veterinary practices).



In Sweden, like in Denmark, many changes in legislation on veterinary herd health consultancy over the years, pushed preventive approaches. Since 2010 in Denmark, the introduction of the mandatory Veterinary Advisory Service Contracts (VASC) established a new framework for the collaboration between the veterinarian and the farmer with the aim of preventing disease on farms and rationalising AMU. Then, the framework of the collaboration in terms of frequency and content of visits has been revised several times. Therefore, legislation describes in detail the frequency and content of veterinary visits on dairy farms. This predefined content of veterinary herd health visits must be related to the liberalization concerning farmers' use of medicines. Certainly, first, the liberalization of medicine use for dairy farmers in Denmark in 2006 might have introduced a period of trivialisation, through which antimicrobials have almost become part of the infrastructure in some conventional farmers' landscape. However, with the application of contracts, conventional farmers were allowed to have medicines available at the farm to treat certain diagnosed diseases (prescribed by the veterinarian for certain animal groups) if they choose one of two specific veterinary agreements; the more liberal the access of medicines, the more frequent the visits. Consequently, the majority of dairy herds are affiliated with some herd health program and these are generally supervised by a veterinarian. Veterinarians also perform more occasional advisory visits on farmer demand. In Sweden, The Swedish Veterinary Union has a general AMR policy and the majority of dairy herds are affiliated with some herd health program, and these are generally supervised by a veterinarian. This dairy veterinarian's work with planned visits and herd health management is associated with some restrictive policies: preventive AMU is not acceptable, broad-spectrum antibiotics should be avoided as far as possible and treatment should be based on bacterial culture result and sales of antimicrobials for animals have been monitored since 1980. These two national contexts show close links between government initiatives to reduce AMU and professional veterinary organisations. The Swedish case sheds light on relatively advanced modes of collaboration. In 1998, the Swedish Veterinary Association adopted a general antibiotic policy (SVF 2020), stating that antimicrobials should only be used when absolutely necessary, and that infection preventive measures should be applied as far as possible.

To a lesser extent, in France, this is the political agenda of the AMR problem which encouraged the implementation of strategies to reduce AMU in livestock. Although it is governmental plans, this political initiatives also involved veterinary and agricultural sectors, and therefore private initiatives. Preventive approaches have been historically promoted in industrial veterinary medicine and implemented by veterinarian's big practices themselves. Animal health and economic performance of the farm were conceived within a sort of an epidemiological framework. Therefore, health management were less oriented by legislation than by professional veterinary organisation. Paradoxically, this is the business model based on the sale of medicines which contributed to the development of preventive veterinary medicine. As they were mostly paid by the sale of drugs, veterinarians no longer charged for their services (travel, diagnosis, advice or autopsy), and so they increased client's loyalty through a sort of "captive market". Cooperatives benefited the most from the creation of a captive market (Bonnaud and Fortané, 2018). In the UK context, regulation are more recent and are supported by veterinary organisations. However, the monitoring of AMU and changes to AMU are mainly driven by the market. In 2019, the British Veterinary Association took a policy statement included 15 recommendations for vets to follow (BVA 2019). It includes the recommendation that each practice should have a written protocol or policy detailing the circumstances under which metaphylactic use is considered appropriate. Nevertheless, it was the Red Tractor quality assurance scheme, that is to say industry led quality assurance and food safety certification, which was a key mechanism for fostering more prudent antimicrobial use in the UK livestock sector. Italy is a quite similar case study. The national strategy to combat AMR was as so far few structured. Two kind of vets are active in implementing policies. First, *the public veterinarians*, in the last 15 years, made efforts to raise awareness among farmers on the AMR issue. But, it is the *private company veterinarians*, who are the most influent because they closely work with many companies which have already implemented alternative strategies to AMU before new regulations came into force. Such an approach was based on economic evaluations: "*Medicines represent a cost for the farm; so, if we find a cheaper solution that allows us to avoid drugs, we are willing to try it. We often use herbal and acidulant products to replace antimicrobials*" (Vet working for an integrated poultry farm). Since 2011, association of Italian poultry producers, started a monitoring programme of AMU and subsequently a plan to reduce AMU at the farm: "*Since 2017, the company has implemented an antibiotic-free standard in a free*

*range chicken production. Subsequently, this standard has covered other productions, up to involving 1 million animals for a week".*

### 2.1.1.2 Preventive approaches as a diversification of veterinary expertise

Despite the diverse articulation of political, professional and economic factors contributing to the implementation of AMU reduction programmes, all the cases show that veterinary expertise nowadays deals with many aspects of animal health and farm management. In a way that is quite similarly observable in many countries and production sectors, reducing AMU requires new ways of working and the development of specialized advice in various fields: biosecurity, nutrition, housing conditions, water quality, herd health plans, reproduction, etc. The first approach of the disease remains certainly "at the bedside" of the animal, by observing the symptoms that makes it possible for the diagnosis to be made and the treatment to be delivered, but, for many years now, other approaches have been developed and linked to the 'classic' clinic in such a way that veterinary expertise in animal health is now plural: biological analyses, epidemiological data, zootechnical knowledge and even 'alternative' conceptions of health (such as ecological approaches to pathogenicity).

In countries with health management government programmes, the "preventive" approach is "institutionalised", so to speak. The farm "management" perspective implies that veterinarians provide variety of services and advice to their clients (technical advice on nutrition, housing (ventilation, feed and watering distribution), biosecurity and so on...). In Denmark, in the veterinary herd health consultancy (VHHC) program, the veterinarian and the farmer focus on optimising herd health and production, partly through legislatively determined tasks such as a regular evaluation of AMU, animal welfare and biosecurity. For instance, in poultry sector especially, veterinarians' diagnostic practices generally start with an analysis of deviations in a flock – e.g. increased mortality, deviating intake of feed or water, or deviations in growth. Similarly, in the cattle sector, veterinarians no longer only carry out emergency visits (and planned visits in relation to castration and dehorning of calves), but work with preventive health and biosecurity. Thus, some of bovine veterinarians work with systematic herd health management, preventive health and biosecurity.

In specifically industrial productions, animal health is conceived at the scale of the herd (and not the individual animal), and is articulated to non-medical matters such as feeding, housing and genetics, and integrate the economic issues of performance and profitability within the advisory support vets provide to their clients. In Italy, where many poultry vets work for private companies, they deal with both health and zootechnical aspects: *"I mainly deal with healthy animals and I take care of their zootechnical management"; "I go to strictly control the zootechnical aspects, so from the detection of the weights to trying to manage during the fattening cycle, especially the feeding or various selection operations, etc., in such a way as to get to the bottom and have the best relationship of food conversion. So I follow this part and in addition, I also follow the pure health aspect "*. An Italian veterinarian sums up this dual role of technical and health assistance perfectly: *"I am a technical veterinarian with both types of skills (medical and zoo-technical)... Today the veterinarian's job is no longer just health care, but it is more that of farm management"*. In intensive farming, most diseases are influenced by environmental factors (e.g. air quality and respiratory syndromes). Farm veterinarians manage to improve environmental conditions and prevent animal diseases: *"The veterinarian is no longer the one who treats, but the one who deals with hygiene and prophylaxis"*. In France, there are significant changes in the supply of veterinary services and the professional and economic models on which they are based. While the sale of antibiotics was for a long time the main source of income for veterinarians, they now have diversified their remuneration and learned to value the diversity of their expertise. Preventive medicine, as approaching animal disease from a perspective that is less clinical and more technical (looking at hygiene, nutrition, housing, etc.), has largely compensated for the loss of income because it markets it possible for veterinarians to bill new services. The development of this preventive expertise relies on a strong specialisation which is necessary to differentiate from competitors. For example, one veterinary practice in pig production has a strong reputation in the field of ventilation system audits. It sells technical back-office to livestock buildings companies but also to suppliers of aeration and ventilation equipment. In the poultry sector, some

veterinarians work on the quality of chicks in upstream hatcheries, to maintain good egg quality. To do so, they check incubators and heated system.

However, some sectors still struggle to implement such changes. Our data coming from French and UK dairy veterinarians show that this production sector is less inclined to accept a diversification of veterinary expertise, in particular paying for veterinary advice. It doesn't mean that preventive approaches don't exist in dairy medicine but they are still very much centred on pharmaceuticals (preventive or zootechnical medicines, including vaccines, hormones or antiparasitics), and are less based on optimising zootechnical parameters and adjusting breeding techniques.

### 2.1.1.3 Preventive approaches supported by a variety of protocols

The way those preventive approaches are being implemented relies on the development of tools and instruments embedded in various types of protocols guiding veterinary activity. We have identified three different kinds of protocols: public regulations, private standards and professional guidelines.

In Sweden and Denmark, public regulations and professional guidelines are closely linked. In Sweden, the Strama application [application on phone with information on AMU guidelines] is used by vets as well as professional branches guidelines. One can even speak of "culture in the branch" focusing on preventive disease. The branch organisation, Svensk Fågel [Swedish Poultry], has an antibiotic policy promoting minimal AMU which is described as an important source of information. Veterinarians also describe that they are in regular contact with each other and discuss AMU in order to reach coherence in the branch. Similarly, in Denmark, legislation describes in detail the frequency and content of veterinary visits on dairy farms, including required approaches to preventive veterinary medicine (examples of this are diagnostic requirements before initiating mastitis treatment or treatment with certain types of antimicrobials (broad-spectrum), the formulation of preventive plans as part of herd diagnosis on specific diseases (allowing farmers to initiate treatment on farm without veterinary interference on the specific day), or any time parasitic drugs are prescribed.). In parallel, veterinarian interviewed described how they created their own [practical] treatment guidelines on this basis : *"The official treatment guidelines from the Danish Veterinary and Food Administration are followed as good as possible, and we have created our own [practice] treatment guidelines based on it. Furthermore, we take the guidelines on how many days to treat from the producer of the specific product (the medicine company) into account."*

In the French and UK cases, guidelines have been encouraged by both legislation and private standards more than professional guidelines. In France, the "prescription-delivery" decree (2007) requires a "farm health check" (BSE) being carried out and a "care protocol" being established and monitored during regular visits, in order to be able to prescribe medicines without a clinical examination of the animals. The objective is to define farm health status by identifying the main diseases observed during the previous year, some of which being considered as priorities. At the end of this visit, the veterinarian elaborates with the farmer a care protocol. It consists in a list of preventive and curative measures (antiparasitic, vaccines, anti-inflammatory drugs, etc.) to be administered for the recurrent pathologies met in the farm. At the same time, some antibiotic-free standards, initiated by producers' organisations or downstream actors (such retailers or food industries), require veterinarians to follow precise specifications in terms of AMU (molecules, dosage, therapeutic indications, etc.). In UK, if government has published a policy statement on AMU in food producing animals, most of formal protocols detailing the circumstances under which antibiotic can be used have mainly been issued through industrial guidelines. In 2018 the Red Tractor label changed its guidance to stipulate that dairy and beef farmers have to carry out an annual review of AMU with their vet; highest priority critically important antibiotics must only be used as a last resort under veterinary direction, including a sensitivity or diagnostic test; and it is recommended that one member of staff carry out training on antibiotic handling and administration (Red Tractor Assurance, 2018). A number of vets stated that the change in market-based protocols helped them do their job or brought change on the farm, especially for clients who are on high welfare contracts. Vets need to adhere to the protocols and policies stipulated by the supply chain actors that the farmer is linked to. This

could be the Red Tractor label or Northern Irish and Scottish equivalent, or the milk processor or retailer the farmer supplies.

#### 2.1.1.4 Preventive practitioners as “health detectives”

This preventive and diversified approach is being expressed in a “detective” approach where vets have to be creative and inventive to sort farmers problem out (in case of outbreaks, but also with the challenge of reducing AMU). This “health manager” position makes it possible for veterinarians to link their prescriptions to a varied number of services (analysis of results, team training, technical parameter monitoring plan, farm audit, health check-up, etc.).

In a lot of interviews, the veterinarians were ironic about clinical situations whose resolution implies not only relying on one's automatisms and habits as a practitioner, but also forms of deduction based on farm observation, knowledge of farmer practices and finally, good sense. One French poultry vet explains: *“I see a very simple clinical case, I was in a laying hen, I didn't understand at all why it was dropping in laying, the hens were doing well. I take a lot of samples and finally [Vet] went back, he looked and quite simply there were a lot of eggs going under the carpet, it was at the collection, I had never been confronted with that. When you're a young vet you think about pathology, and finally you look under the carpet and you see that you have 800 eggs that go under the carpet”.*

This veterinary “treasure hunt” implies working at a holistic level, by carrying out a detailed evaluation of the health, technical and economic data of each farm. This also requires the articulation of a wide range of clinical and technical knowledge and the use of a multitude of tools to assess the health status of animals. In the Danish context, VASCs have become central to advice services in farms. For example, veterinary visits typically include: evaluation of treated and dead animals since the last visit, evaluation of herd health and production, antimicrobial use, animal welfare (two visits per year with a special focus on this) and biosecurity (special focus once yearly). In addition, veterinarians are required to write farm-specific reports at regular intervals. In Sweden, veterinarians frequently talk about “parameters”, mirroring how statistical data on flock (e.g. mortality, feed intake, growth) is key for diagnosis. A veterinarian describes: *“Because you know exactly how they should manage every day in relation to mortality, intake of feed, feed ratio, intake of water [...] these parameters, they know exactly how they should develop”.* Also information about the birds’ milieu, for example regarding the temperature and ventilation in the stable, are described as vital. Moreover, the diagnostic practice might draw on information beyond the actual flock with a health problem: E.g. if there are other flocks with health problems that somehow are connected to the flock at hand: *And then I go there and go through the parameters in the stable, and check where the animals come from, what kind of feed they get, several of different things and parameters in the stable, and then I combine it with other things I already knows: for example concerning the flock of the parents, if the flock of the parent has chicks that has had similar symptoms then that's where I continue to search. Or if a feed company had had the same deviations also in other places. [...] I collect information and then the detective work begins, and I search for the cause. Is there something wrong in other flocks? What are the common factors between them?* In France, similar logic is at work in the largest veterinary practices, which offer health monitoring and follow-up services focused on specific breeding problems ('milk quality', 'reproduction', and 'parasitism'). This logic modifies the very understanding of veterinary activity, as pointed out by a young practitioner who presents his work as *“something more around a computer or paper and pencil [laughs] rather than really with a stethoscope and the thermometer!”* In UK, as dairy farming tends to be very demanding, vets working with dairy farmers are most likely to be on farm regularly to provide services like pregnancy diagnosis or hoof care as well as emergency care, so may be more in tune with other aspects of the farm e.g. calf and dry cow welfare. They may be able to offer more in the way of preventative options, e.g. herd health plans, suggestions around improving biosecurity and/or are able spend longer with clients advising and facilitating general on-farm improvements.

Finding optimised solutions also changes the scale of the veterinarian's intervention, which goes far beyond the farm itself. In France for instance, by establishing themselves in the role of health coordinator, vets enlarge their potential clientele to upstream actors such as hatcheries, breed farms or feed companies, or

downstream actors like slaughterhouses. In the pig sector for example, some veterinarians work with the R&D teams of feed companies to develop balanced feed ration. In Sweden, veterinarians in poultry sector work a lot with monitoring health statistics at the slaughterhouse in order to inspect animals health and collect data on the farms they follow on a regular basis.

## 2.1.2 Prudent AMU as driver of protocolization

### 2.1.2.1 The new role of antibiotics in preventive approaches

The AMR issue is supporting the global trend of diversification and protocolization of veterinary expertise. This global approach that goes beyond clinical knowledge and includes many technical components of farm management is often describe as holistic or preventive, and is often perceived as a necessary transition in veterinary expertise in order to become less dependent on AMU.

These changes in the perception of the role and the toolkits of veterinarians are expressed by practitioners in all countries. A UK vet describes how changes coming from AMU led them to take a more preventive approach: *“over the last couple of years Arla in particular have pushed for higher and higher welfare standards and they’ve also pushed for not using prophylactic antibiotics, particularly when it comes to calves so that’s been a big change as well in the industry. It means more that we have to work towards preventative healthcare so our role has changed a lot probably in the practice in the last 5 years.”*

One poultry French vet interviewed insists on the benefits of incentives to reduce AMU in terms of increased complexity of veterinary work and therefore intellectual emulation: *“Yes, if there hadn’t been this pressure to limit the use of antibiotics, we wouldn’t be here. It was almost a professional fault not to use antibiotics. Afterwards, as it was expensive, not everyone used it systematically. For us, the improvement in antibiotic resistance and the use of antibiotics, at first we saw it as a big threat because antibiotics were still significant in terms of the margin they could provide. Then we realised that if we wanted to use less antibiotics, we needed more technique. Before, antibiotics were a bit of a safety net. Now, there are no longer any antibiotics, so farmers have an interest in working on what we call the basics. After that, you have to invest in the building and in the feed too. Sometimes we tended to optimise the feed to give them just what they needed. Sometimes it was a bit too optimised to the detriment of the animal’s health. It’s really a global approach. It’s vaccination, the quality of the chicks, renovated buildings, no air leaks, proper heating, quality feed. There is an awareness: antibiotics are not automatic”.*

In a similar vein, in several interviews conducted in Sweden, being careful with antibiotics was framed in terms of professional pride and as opposed to taking (unprofessional) short-cuts. Veterinarians described that use of narrow spectrum antibiotics, and finding other treatment alternatives than antibiotics, often require precise diagnostics and veterinary expertise: *Yes, for me it is also a matter of prestige, to treat what you actually know with...rather, how you could frame it, precision. To close your eyes and aim widely/broadly, then, anyone can do that. Another vet says: “I think that...when I am working, now I mean the horses again, but when I am working with some horse who has received what I see as questionable prescription of antimicrobials, or deworming. When it is like this “we have not taken any sample, but we always deworm” or “but I always have some intramammary tubes or Socratyl to apply in wounds” then I perceive that veterinarian as an inferior veterinarian”.*

Within this “new” approach, perception and use of AMs don’t have the same place anymore: AMU is rarely systemic (sometimes metaphylaxy), rather for emergencies.

A Danish vet said: *“The essence of prudent antimicrobial use is to avoid unnecessary use of antimicrobials. For that reason, it is important to choose the right antimicrobial from the start. Preferably, that should be a small*

*spectrum antimicrobial, if antimicrobials are needed at all [...] It is an individual assessment of the single cow, and primarily relevant in clinical cases. You perform the needed diagnostics, consider the expected treatment effect of the specific disease and the treatment effect seen in the specific herd. Based on these aspects, you make your decision to use antimicrobials or not, and if antimicrobials are indicated, you decide on the specific type of antimicrobial.”*

A French poultry veterinarian also testifies to this general trend: "No, you really give antibiotics when you need them. Even for bacterial diseases, for example, colibacillosis, that was our philosophy anyway. For me the biggest alternative to antibiotics is zootechnics anyway. That's what I tell farmers and I try to train technicians, it's not the alternative to antibiotics that's needed because we're in metaphylaxis, but it's prophylaxis that should be done. For me, what I am launching and what is important is the concept of preventive medicine. Because it is with preventive medicine that you will intelligently reduce the use of antibiotics”

In Italy also, the prescription of the drug is not immediate anymore, vets should wait a few hours to evaluate the clinical evolution of the problem: "It is a fairly recent approach, born from the awareness of veterinarians and farmers towards the prudent use of the drug". Anamnesis collection, clinical visit and laboratory tests are compulsory to confirm the diagnosis. Antibiotic is prescribed as a last resort for the treatment of infectious disease, but the health management of the farm must be based primarily on prevention (in particular by taking care of biosecurity and ensuring optimal environmental conditions) "You cannot continuously pre-cribe antibiotics or fill management shortcomings with the antibiotic”.

Even, industrial programs as the Red Tractor health review in UK acts as a moment to take stock of and question any prophylactic use on the farm: "It just raises the official question doesn't it, because you have to confirm that in the Red Tractor report any prophylactic that's used and if it used put in the report and if not we'll say why not. So no it's just a good moment of focusing attention isn't it?". One cattle English vet clearly describes prophylactic use changing to metaphylaxis. "The antibiotic in milk which was really commonplace about probably 5-6 years ago now that's now not allowed, it used to be added into feed and you can't do that now. But there will be times where they might have calved a lot of cows and the hygiene hasn't been great and we might diagnose a salmonella problem and say right for the next...we need to for the next maybe 3-4 weeks we will use prophylactic antibiotics whilst we're putting in other steps and then we'll take them off. So it's like it's used intermittently from a welfare point of view.”

The prescription and use of antimicrobials is now mostly embedded in protocols, and the decision to use AMs is equipped with knowledge and information that are related to protocols. Therefore, with protocols, vets reaffirm their medical competence on 'complex cases' that they are able to manage.

Many examples illustrate the complexity in the decisions made in cattle practice by the veterinarian on whether to use antibiotics or not. One Danish vet interviewed described the decision to use or not use AMs as follows: "Last week we [in our practice] had a cow with mastitis caused by Klebsiella. In our practice, we completely agree that antimicrobials will not have any effect on those cases, so we treated her with painkillers. She continued to have fever, which is logical since she is battling an infection, however, it lasted for one and a half week. The farmer started to question the treatment choice and requested some broad-spectrum antibiotics – he thought that would solve the issue. My basic understanding and attitude is that antibiotics will not help in this case, but I cannot know for sure whether the cow also suffers from sepsis and potentially would benefit from antibiotic treatment. So this is a tricky situation and an outweighing of pros and cons. I ended up telling the farmer that we will not know if the treatment will have any effect – it might as well not. And in this specific case, I actually ended up euthanizing the animal because I thought the welfare of the animal was too compromised; having 41.6 degree Celsius in almost 14 days... that is not okay!" Another Danish vet said the following: "The essence of prudent antimicrobial use is to avoid unnecessary use of antimicrobials. For that reason, it is important to choose the right antimicrobial from the start. Preferably, that should be a small spectrum antimicrobial, if antimicrobials are needed at all [...] It is an individual assessment of the single cow,

*and primarily relevant in clinical cases. You perform the needed diagnostics, consider the expected treatment effect of the specific disease and the treatment effect seen in the specific herd. Based on these aspects, you make your decision to use antimicrobials or not, and if antimicrobials are indicated, you decide on the specific type of antimicrobial.”* In Italy, vets working for industrial groups can often rely on epidemiological data on the farm’s medical history to guide their therapeutic choices. The results of laboratory tests (e.g. antibiograms and MIC plates) are routinely recorded: *“The introduction of new regulations further boosted such approach, which however was already in place since several years”*. In Sweden, before prescribing antimicrobials it is also routine to take a milk sample and culture for bacteria. In most cases veterinarians culture the samples themselves on the veterinary practice.

### 2.1.2.2 Rise of AMU monitoring as a market-oriented demand: when protocolisation is related to contractualisation

The development of protocols, in particular those aiming or contributing to AMU reduction, is pushed by vet’s clients (producers organisations, slaughterhouses, retailers) and tend to strengthen vertical integration. The main integrators and supply contractors invest in new technologies (for example, health monitoring) and encourage contractualisation for audit process. The establishment of systems of recommendations and rationalisation of tools for measuring and controlling the health status of animals implies forms of 'collaboration' (the ability of a profession to encourage cooperation with competitors) - and forms of 'liaison' (involvement of clients in the definition of objectives and the development of specialist knowledge).

Contractualisation pushed by big cooperatives and agri-food industries is a trend that can be observed in the Italian, French and English cases. This formalisation of contracts includes a certain number of audits, checks-health and follow-up activities. In France, contractualisation is a way for vets to benefit from the 'right' pay for high added-value-services that are not solely based on prescription and sale of medicines. Within the “veterinary corporate group”, a meticulous work of adjusting commercial tools to the clients characteristics is carried out: industrial operators demand, for example, to anticipate the cost of services for their entire stock of farms, following the example of biosecurity or animal welfare audits. A significant effort is devoted to perfecting commercial offers and adapting contracts, as one veterinarian points out: indeed, the clarification and harmonisation of their commercial offer is a condition for maintaining the client relationship. The development of "antibiotic-free" quality approaches forces veterinarians to use alternative treatments as a first line of defence. During a control visit to a chicken farm, a French veterinarian explains the prescription he made for a digestive infection. He explained the economic implications of downgrading the batch in the event of non-compliance with the "no antibiotics" specifications, and then justified his decision to opt for an alternative solution by relying on the results of the first laboratory analyses, which showed a *"flora drift of 3 out of 6, insufficiently serious to resort to Tylosin [an antibiotic]"*. He also recommended reseeded the commensal flora in order to avoid future relapses. As this interaction indicates, the development of quality approaches requires the veterinarian not only to find more complex solutions and adjustments from a zootechnical and clinical point of view, but also to respond to economic imperatives, in particular the evaluation of *"the opportunity to continue with PSA [Pig without antibiotics] or to let it go with conventional production [which is not subject to a quality approach and therefore less remunerative per kilo]"*, as one pig veterinarian mentions.

In Italy, since 2017, farms joining UNAITALIA, the association of Italian poultry producers, started a monitoring programme of AMU and subsequently a plan to reduce the use of antibiotics at the farm: *“Since 2017, the company has implemented an antibiotic-free standard in a free range chicken production. Subsequently, this standard has covered other productions, up to involving 1 million animals for a week”*. The construction of antibiotic-free labels is part of a general strategy to reduce private company costs. Many companies have already implemented alternative strategies to antimicrobials before new regulations came into force. Such an approach was based on economic evaluations: *“Medicines represent a cost for the farm; so, if we find a cheaper solution that allows us to avoid drugs, we are willing to try it. We often use herbal and acidulant products to replace antimicrobials”* (Vet working for an integrated poultry farm). More generally, the work of

veterinarians working for private companies is codified by the respect of care protocols which tend to harmonise the management of animal health and husbandry practices. The farms are visited at least once a week even in the absence of problems. Meetings between veterinarians and technicians of the group are regularly scheduled: *"On Thursday, we always have a meeting in the company with the technical group to share problems"*. Moreover, scheduling of routine farm visits is influenced by biosecurity. The reproduction sector (long-living animals and young animals) is mostly visited at the beginning of the week to prevent the spread of pathogens from other farms seen previously: *"On Mondays, I dedicate myself to the reproduction sector"*; *"The management of biosecurity in breeding stock greatly influences my work, in the sense that before visiting breeding farms I spend a few days when I don't visit any other farm"*; *"At the beginning of the day I try to visit young animals"*; *"Then we go to the older animals or those with more parasites, which have more problems or potential problems towards the end of the week"*. In addition to fieldwork, veterinarians also carry out office activities (compilation of health records, traceability of the companies visited, and the findings made). The vertical integration system facilitate introduction of new technologies for data monitoring and audit process: *"Every 20 days to see the bacterial and Enterobacteriaceae loads of the chicks, every month we do environmental swabs to see what we have in the incubator, because low bacterial loads in the hatchery means having a healthier chick both in the incubator and in hatching. On the breeder it's the same thing: producing cleaner eggs with a healthier breeder means having a lower bacterial load. Disinfection of egg storage cells to break down bacterial loads means having a healthier egg, which if incubated produces a lower bacterial load"*.

In UK, vets need to adhere to the protocols and policies stipulated by the supply chain actors that the farmer is linked to. Retailers and beef and milk processing companies have a significant influence on antimicrobial governance in the beef and dairy sectors. Dairy farmers who are on 'supermarket aligned' contracts may be subject to different rules about AMU, which is a condition of their contract. Vets stated that the types of tools and protocols used on-farm differed depending on the type of supply chain the farmer was in. Retailer aligned contracts required higher standards and a more rigorous preventive, herd planning approach.

Diversification of veterinary services and protocolization of care impact daily veterinary work and veterinary activities. The standardization of health management tends to de-specify professional expertise in a way that it relies more and more on technical skills that are shared with other professionals. Following protocols, in particular when they favour prudent AMU, then becomes an important dimension of what it is to be a "good vet". However, this protocolization of veterinary activity shows how regulatory and market-related constraints now tend to limit professional autonomy. In these circumstances, in which way professional legitimacy can be renewed and reaffirmed? And which forms of professionalism (both in terms of labour organisation and business models) would be able to allow this?

## 2.2 The ambiguity of protocolisation

This second part focuses on the tensions between protocolisation and deprofessionalisation. The scientific and social legitimisation of veterinarians enabling them to gain autonomy and power in the animal health jurisdiction seems to be threatened. In a competitive service market, vets share non-clinical skills with others actors. Standardized and routinised care protocols take them away from the field and can be easily replicated. Technical and sometimes clinical skills can be taken in charge by farmers and farm technicians, while biological, epidemiological, pharmacological knowledge and activities (which are an increasing source of professional legitimacy of vets) can be delegated to data scientist or laboratory technicians (i.e. necroscopic examinations; controls of immunity, parasitology and serology; bacteriological analyses, quality control of cleaning/disinfection procedures).

However, vets like to adapt to the singular conditions of each farm when they provide their expertise and they don't always follow what the protocols recommend. Adaptation, creativity and inventiveness



have become very important skills for vets to deliver personalized (and optimal) services to their clients. Reducing AMU, within farming systems that have been historically designed to rely on massive use of antibiotics, is actually a task that heavily rely on these creative and adaptative skills which can be described as a capacity of articulating and coordinating many domains of skills and knowledge. A new professional hierarchy is therefore emerging, dividing those who can establish themselves in the position of care coordinators (or health managers), able to master different types of protocols, from those who remain more or less stuck on limited skills and can only operate specific tasks under the control of coordinators/managers.

However, such a change in the veterinary profession doesn't only concern medical practice and knowledge (i.e. the dynamics of protocolization described above). It also relies on organizational and economic changes at the scale of veterinary businesses and animal health market, that can support those new services through making them legitimate and profitable. At the moment, this important evolution of the profession seems to be led by very specific types of veterinary practices, in particular large independent corporate groups or big practices integrated with the livestock industry.

### 2.2.1 The discomfort of protocols: how does it feel to be a veterinarian nowadays?

Following those protocols impact veterinary work on a very practical way. As described in the first part, the daily tasks that vets have to perform encompass much more than “classical” acts such as autopsy or clinical diagnosis and directly deal with filling forms, monitoring data and indicators, writing inspection report, etc. There is also a more virtual work now (i.e. not face to face), that is using pictures, What's App chat, etc. Veterinarians have divided feelings about these new forms of routine.

#### 2.2.1.1 The burden of bureaucratic tasks

It can be seen that regulatory requirements have increased the amount of bureaucratic and administrative work for veterinarians. For instance, in Italy, in the zootechnical field, there are a series of steps imposed by law: waiting for the suspension times, filling in the electronic veterinary prescription and the electronic register of treatments, identification of the animals treated in an antibiotic free regime to be downgraded. In Sweden, the interviews indicate that regular task of vets is to write medical record. In Denmark, some pig vets spend time on or have systems set up for calculating how much antibiotics they can prescribe within the yellow card limit each month. Many veterinarians feel uncomfortable with these new tasks. These bureaucratic constraints generate routine and boredom at work, particularly because they take veterinarians away from the field work with farmers that initially motivated the choice of this profession. Above all, they are becoming an increasingly important part of the veterinarians' agenda, as is the case in Denmark. In practices, the afternoon is mostly filled with office work where the veterinarians usually sit in a common office at the clinic and may exchange scientific knowledge, have discussions while writing the required farm reports, prescribing medicines, writing bills or registering the daily tasks.

This multiplication of administrative tasks can also lead to a loss of meaning at work. Some of the regulatory procedures are proving to be irrelevant in practice. They contribute to the density of office work and are ultimately not very operational in practice. In Denmark, in the pig sector, many vets describe this requirement as an example of a “bureaucratic monster” as they do not find samples once a year professionally relevant. They described the “misuse” of diagnostics, e.g. milk samples that were required by law, which caused many milk samples to be taken and analysed without the results being used for anything meaningful. A similar situation is seen in pig practice where regulation require diagnostic samples for diarrhoeic pathogens at least once a year, if batch treatment with antibiotics is used. This is a feeling also shared by Italian veterinarians, who highlight the risk of diverting veterinarians from their primary function of clinical and health surveillance of herds. One of the interviewees points to the risk of counter-productive measures, which ultimately deviate

from their initial objective (to systematise knowledge of diseases and treatments), by distancing veterinarians from field work: *“I see this as a risk of further aggravation of our normal functions, so other colleagues will have to be hired, because if the bureaucratic part becomes an increasingly large part of the veterinarian's job then we will probably not be able to maintain the same level of attention and professionalism on animal health. It is not a problem to be controlled”*. Having to be focused on making these checklists is diverting their attention from animal health to the mere compilation of these checklists.

Finally, as expressed by the interviewed Danish veterinarians, the feeling of self-determination in veterinary work has decreased, and thereby also the responsibility and motivation for addressing suboptimal AMU within herds, creating a feeling of hesitancy or apathy on a personal level. Some pig vets express a great deal of frustration due to legislation which threatens their autonomy and authority. Some argue that the strict regulation prevent them from applying professional and correct treatment of animals in need of long time medication.

#### 2.2.1.2 The challenge of accessing data

Access to data has become a central issue in veterinary practice. Since data monitoring and analysis is an important part of preventive approaches to animal health, data access is essential in veterinary activity. However, it is not always easy to get the required data. It seems there is a large variability of data access depending on the contexts (i.e. when vets work closely with cooperative in integrated sectors it is easier than when vets working with independent farmers who are left apart the integrated system).

Contexts where health management is a regulatory monopoly attributed to veterinarians and very closely supervised, or cases of highly integrated production systems, favour the systematic production of data as well as their optimal use. In Denmark, data production is organized and different data sources are articulated for the analysis. Dairy vets use of data from the Danish Cattle Database which includes the milk yield recording programme (slaughterhouses and breeding companies are added to the database). Furthermore, veterinarians describe the use of data from milking robots, economic simulation models such as SIMHERD, as well as diagnostics (milk samples, blood samples, cow side tests for mastitis and diarrhoea detection etc.). Using those data for diagnostics are considered as essential and, in their opinion, should be used more frequently by some vets. However, they consider that this requires time and effort to create value on the farm as using data is not only about taking samples, it is also about analysing the results and put them into a farm-specific perspective. In Italy, vets working for industrial groups can often rely on epidemiological data of the farm's medical history to guide their therapeutic choices. The results of laboratory tests (e.g. antibiograms and MIC plates) are routinely recorded: *“The introduction of new Regulations further boosted such approach, which however was already in place since several years”*. The prescription is made based on historical epidemiological data and antibiograms are performed only if the etiology is not clear based on clinical and pathological data. In France, veterinarians can rely on digitised data collected by other operators to build their expertise. For example, a veterinarian uses the indicators provided by slaughterhouses to advise farmers on their farming practices: *“If, for example, there is an outbreak of arthritis in slaughterhouse seizures, during the veterinary visits that we are able to make, we will discuss this point with the farmer to see at what stage we can act to reduce this incidence. If it's respiratory seizures, we need see whether the vaccinations have been done properly, or whether, by chance, a new pathogen has emerged [the farm].”*

The case of milk production in France and Great Britain is an exception. In these two cases, veterinary activity is even more "hand-made" in the sense that advice on farming is less based on results analysis than on purely clinical work. The lack of infrastructures dedicated to laboratory analysis explains the random nature of the use of data in the British case, whereas the absence of a structure for the sector under the banner of monopolistic industrial groups, and therefore the greater fragmentation of the breeding stock in terms of veterinary and health monitoring, explains the dispersion of data in France. An English vet explains that the use of routine analytical or diagnostic testing is uncommon in the farming sector in the UK. Tests are expensive and farmers

feel they are already financially compromised. In addition vets are concerned that animal health can be jeopardised in the time taken to obtain results. In cases where there has been a particular problem that has not been resolved or repeatedly arises then testing is more likely: *“It’s difficult, the lab coverage isn’t as good here ...so by the time you get the results its often too late. They’re very good for post-mortems, so at least that will be done locally and things but most other work the samples have to be sent away so it takes several days for results. So, we don’t do a lot of...I guess in outbreak situations or proper farm investigations we’ll do it but for some of the animals we never do it”*. In the dairy sector in France, which is less integrated, data are produced by technical and economic support organisations, particularly milk recording, insemination cooperatives, feed suppliers and milking equipment suppliers (Hellec, 2009). Veterinarians have to ask farmers to transmit to them data.

### 2.2.1.3 The discomfort of policing farmers

Vet activity is constrained by these tasks of policing and inspecting farmers, either for public regulation or for private standards. Veterinarians fear a gradual shift in their activity from advice to control of farmers.

Danish vets feel they have to police farmers (with regards to regulation) while in the mean time they also need to satisfy their clients. The difficulty in balancing the dual role of being an enforcer of legislation and at the same time the farmer’s collaborator in terms of veterinary consultancy was described by many of the interviewed veterinarians. A vet exemplified this: *“I know that many of my farmers don’t comply with the rules for what they are allowed to treat. They don’t tell me, but I can sense it. [...] But what can I do? I am not there when it happens. [...] I can check if the cows have actually recovered, but I can’t really act more as a police officer than that. You cannot demand more from practicing veterinarians – we also need to be able to go there once a week. We can’t do that if we start berating the farmer.”* Moreover, those policing tasks are not well paid and are perceived like a bureaucratisation of their work (through which vets are also being policed), in the sense that have to fill forms and database (routine work) which is quite reductive compared to what they do on farms. In Italy, vets had been involved in the implementation of an electronic management of the treatment, since April 2019. This new computerized system, called Classyfarm, is a source of concern because it changes role of vets who become more and more farm controllers. Vets had to reassure farmers who were first reluctant to this obligatory tool electronic register, which brought about absolute transparency of the traceability of the drug and therefore greater controls also by the public authorities with ease of tracing.

In UK and France where antibiotic-free standards are quickly developing, vets are facing a complex dilemma: reinforcing the control of sanitary practices of farmers and reducing AMU while, in the meantime, preserving animal welfare. In UK, some interviewees did also state that they felt somewhat uncomfortable with their role of policing the farm’s adherence to AMU policies embedded in market-based certification schemes. They were paid by the farmer, but they had this larger public health, supply chain regulatory role, and those interests might not always align. Same feeling in France where pig vets explain that they are comfortable with policing farmers when it comes to check whether or not they follow the specifications of their contract (antibiotic-free label). In France, economic valuations by bonuses push farmers, by fear of economical downgrading of treated batches, to neglect the health of the animals. In other words, the antibiotic free approach comes up against welfare. All the veterinarians we met agree on this observation: *“And this is the debate we have with certain integrators, we go back to the suppression of necessary antibiotic treatment, i.e. we don’t do it, the batch deteriorates, there are lots of deaths. This means that there is suffering in the animals and we are not well off. At some point, this logic of removing certain products will be limited by the welfare aspects”*.

### 2.2.2 Tensions in the various forms of knowledge promoted by protocols

One particular aspect of the new veterinary services that has developed through care protocolisation aiming at reducing AMU is the increase of tailor-based approaches that veterinarians try to deliver to

their clients. This “precision prescription” is based on customised diagnoses and personalised advice. Some vets have indeed a singular relationship with their farmers and can provide quasi-personalised expertise. A new praxeology of veterinary reasoning is therefore developing, based on the technicalisation of veterinary knowledge. Veterinarians can think in terms of health plan strategy related to the specific economic goals of their client.

Although the prescription and sale of medicines remain essential to the financial survival of veterinary practices, their legitimacy has been renewed. From now on, evidence-based medicine makes biological and epidemiological knowledge the basis of professional authority in the context of precision medication. Vets use personalized advice and cutting-edge prescription. Veterinary tools are being improved, in particular laboratory analysis instruments, which are becoming more and more precise and efficient.

In the Danish case, vets may use cow-side blood tests such as Glutavac test (for signs of acute inflammation) and Fassisi Bodia (for detection of calf diarrhea caused by E.coli K99, Rotavirus, Coronavirus or Cryptosporidia), do blood tests for calcium levels after calving, use ultrasound for detection of pneumonia in calves or pregnancy/corpus luteum check. Use of own veterinary clinic laboratory for bacteriological culturing and resistance testing of milk samples/intraperitoneal fluid/vaginal discharge is common. Furthermore, analysis of fecal samples for detection of parasitic infections are usually done at the veterinary clinic. Farm-site autopsies are regularly used as well. Other diagnostic tests are usually performed by external laboratories. More advanced economical analysis are available to veterinarians through subscription to SIM-HERD (a dynamic herd-specific prospective analysis of economic results from changing certain herd parameters). Multivariable statistical analysis based on data from the Danish Cattle Database can be retrieved by veterinarians who are part of a certain veterinary association (Dyrlæger & Ko), which contains 27 of the Danish veterinary practices with a specific focus on cattle (a large share).

This sophistication of prescription call for new skills and areas of veterinary specialisation. In the poultry sector in France, a lot of analysis can be conducted: necroscopic examinations ; controls of immunity, parasitology and serology ; bacteriological analyses, quality control of cleaning/disinfection procedures. This development of increasingly precise and efficient analysis tools creates dependency on the diagnosis that only specialised veterinary analysis laboratories developed by large corporate veterinary group can undertake. It increases their economic weight in the veterinarian world. We are therefore witnessing the establishment of diagnoses that are not only aimed at curing sick animals, but also at guaranteeing the optimisation of treatments, as emphasised by a laboratory technician employed by a veterinary analysis laboratory: *'When they carry out vaccinations, to make sure that the immunity takes hold, for example, they take animals beforehand to check that there are no parasites'*. The challenge for veterinarians is to target prescriptions by designing tailor-made products. This is the case with auto-vaccines, whose manufacturing process is based on personalised expertise, as described by a veterinarian specialising in the monitoring of clinical trials: *"Today, we have many auto-vaccines that contain between two and seven strains of streptococci. This makes for more complex products [...] You have to send the strain to the laboratory, the laboratory has to cultivate it, prepare it, neutralise it, and prepare its vaccine"*. As can be seen here, the scientific legitimisation of the prescription is not only appreciated as a therapeutic gesture but is also seen as a way of creating a personalised relationship with the farmer. The explanation of the manufacturing process, the results of the first tests, the attempts and failures, all contribute to the creation of a "singular dialogue" between the doctor and his patient, but it is no longer that of the clinic, nor of the technique as such, but on some sort of an evidence-base veterinary medicine whose legitimacy and authority relies on personalised scientific services.

However, “empirical” expertise does not fully disappear. Knowledge of the farm and of the farmer, close observation of clinical signs and ability to adapt to emergencies continue to be important in veterinary medicine. This introduces tensions for veterinarians who sometimes have to juggle between different repositories of expertise.

Empirical expertise is still important, but this seems to be coupled to the availability of farm-relevant scientific evidence. In Sweden, in cattle sector, interviewed veterinarians gave examples on how their clinical experience was in opposition with guidelines and research: “I would say that I have initiated treatment, it is not Baytril [quinolone] if there is a coli mastitis, then I have probably initiated treatment with Hippotrim [sulfadiazine and trimethoprim] actually, so if they have been...and I do actually think, I am not sure if it is...if they would have recovered anyway, or if they would have died anyway.... It does happen that the ones who get treatment dies nevertheless, but they might also get well. And then if it is because of that [the treatment] or not... You know I am a bit ambivalent, yes”. In some interviews veterinarians described that they needed to deviate from guidelines in some specific farms where for example penicillin do not have effect. In Danish context, personal experiences and emotions, rather than scientific evidence, guided some veterinarians when making AMU choices. Furthermore, less-experienced veterinarians felt pressure to prescribe according to colleagues' and farmers' preferences for certain antimicrobials. Changes in Danish legislation seemed to have introduced hesitancy and a lack of motivation within the veterinary profession, and that AMR was perceived as an abstract threat not applicable to the veterinarians' daily professional decision making. So, the lack of field-generated research of local relevance nourished a culture in which AMU choices are built on personal experience rather than scientific evidence, which also diminished newly educated veterinarians' self-confidence in relation to their AMU choices. Other examples illustrate how clinical experiences from specific farms also are an important source of knowledge for the veterinarians. In poultry sector in France, learning by trial and error remains central. One vet said: *“One case where it's quite frequent is for standard production, so I had done the experiment, amoxicillin doesn't work at all on the problems of colibacillus on this production. Even though we have an antibiogram that is sensitive to this molecule, we can see that through experience, but these are questions of experience, my colleagues told me that, behind this, we always have relapses of the problem”*. An other states: *“The prescription instructions are to orientate towards products that are really effective, i.e. in concrete terms, if I have the choice to treat a respiratory colibacillosis in poultry between oxytetracycline, even if I have a sensitivity on paper, and a product based on trimethoprim sulphonamide, I will always choose the product based on trimethoprim sulphonamide because it is really effective, whereas the other one is effective on paper, but is not necessarily effective in the field”*.

### 2.2.3 How care protocolization redefines the relationships between health professionals

#### 2.2.3.1 New forms of collaboration

New collaborations between vets and others animal health advisors contribute to redefine the role of vets. They are aware that advice need to be valuable and useful to the farmer, and that their specialised knowledge needs to be combined and put into practice in a collaborative effort between the relevant actors. In this configuration, vets tend to place themselves as health managers or health coordinators, that is to say the professionals who have a global view of a given issue and can coordinate the strategies to respond to it.

In countries where vets are considered as consultant in animal and herd health, they have responsibility of gathering the relevant actors to enhance and develop a collaboratively supported health plan. In general, there has been a request from veterinarians to collaborate more with the different advisory services engaged at a specific farm, bringing in and bridging the speciality knowledge of the different advisors rather than competing with each other in the same areas.

In a Danish setting, with VASC's supported by legislation being central to advice services in farms, the problem might be the other way round. Thus, in many cases, the farm's health status is entangled with everything else on the farm, e.g. reproduction management, feed management, housing, milking etc. Vets therefore should have general knowledge on many different aspects of the farm in order to be good advisors. Some of the interviewed vets potentially try to cover all these aspects on their own, whereas others seem to “outsource” the specific area to the specialised consultant. However, they all take the responsibility of gathering the relevant actors to enhance and develop a collaboratively supported farm plan. An interviewed vet described:

*“The fact that we [the different farm consultants and the farmer] are sitting together at common meetings gives a much better knowledge sharing and understanding of the farm situation. At the specific meeting, we agreed on how to secure better heifers in the future, i.e. a specific hoof trimming and insemination strategy. Furthermore, the responsible persons are pointed out and a follow-up meeting is automatically arranged at the next quarterly meeting. In the meantime, we can monitor the effect of the initiatives. These collaborative efforts really have a great effect on the development of this herd.”* Another example from an interviewed vet: *“I have some farms where the feed consultant and I are there at the same time at every second farm visit I need to pay. At these meetings, we have a different focus. We still go through the cows that have just calved, but afterwards, we have a whole hour to focus on the farm goals and the status of these goals. In that way, you experience a greater progression on the farm. Furthermore, you feel much more obliged as a vet to be well prepared at those meetings”*. To some of vets, it was natural to think about the collaboration with other advisors of the farm. This was practiced through for example common meetings where the farmer’s overall goal and ways to obtain these were being discussed and settled between relevant actors, i.e. the farmer, the vet, the feed consultant, the bank advisor, the inseminarian, the hoof trimmer etc.

In Sweden, there are a very limited number of poultry veterinarians (two are employed by Slaughterhouses, one is an independent veterinarian, one veterinarian is employed by a food-company). So it is easier for them to collaborate. In cattle sector, vets work with feed advisers and with veterinarians at the organization VÅXA which works with preventive health only. They conceive all these partners as a team: *“I say “you know, now there were many of those, you have had a lot pf problems with stomachs and calf paralysis, we have to check the feed state together”, thus with the feed advice then, and then find, you usually find the problem and sort it out. (...) It is a team, it is not only me, it is together with the farmer and feed adviser that you sort it out”*

In France and Italy, it appears that the porosity of the boundaries between medical and technical fields allows vets to impose themselves as the "health managers" of preventive medication, in other words as the coordinator of a global management of the farm. In France, in poultry and pig sectors, for the majority of farms, the technician and the veterinarian work as a team. They both work for the producer organization to which the farmer belongs. The first takes a look at the technique and the management of breeding, while the second takes a clinical look. Technician and veterinarian inform each other of the advice given to the farmer and the protocols that to be followed: *“Depending on the seriousness of the situation, we call either the technician or the vet to carry out an autopsy when a sow dies. If the technician comes, the vet is informed of the protocol that has been put in place and vice versa, it is a team effort between the technician, the veterinarian and the farmer”*. In Italy, in integrated supply chains, the role of 'coordinator' is established and thought by and for an optimised labour organisation. The group of veterinarians often refers to another veterinarian who has the role of coordinator. Relationships between professionals belonging to the same zootechnical area are frequent (interactions are routine tasks within integrated supply chains). Veterinarians manage the "ecosystem" of the farm and for this purpose, they work with zootechnicians and nutritionists. Relationships between professionals belonging to the same zoo technical area are frequent (interactions are routine tasks within integrated supply chains). The coordinator sets operational guidelines to be shared, but each veterinarian has his autonomy.

Delegating care protocols to others is a way for veterinarians to put themselves away from “routine” clinical acts and to reaffirm their medical competency on 'complex cases' (Hughes 1996) that they are the only ones to be able to manage. A labour division of sanitary work occurs and places vets on the top of medical legitimacy. Technicians from cooperatives, are perceived as veterinary assistants that promote the application of protocols, and who have a duty to support the farmer in implementing the recommendations that vets made, as explained by a French vet: *“They [the technicians] are on the front line and we supervise everything a little bit. So we have technical relays in the form of food, geneticists or others. And then we are increasingly consulted about problems that have nothing to do directly with pathology but where our word carries weight: “My litter box is damaged, etc., it could lead to a pathology, you need to come and see”*. The integrated supply chains system facilitates collaboration because it is a way to optimize different scales of services and perfect vertical integration. In Italy, a sectorial strategy, led by Unaitalia, was put in place since 2013 and stakeholders perceived that AMU should be reduced in the whole supply chain, and this could be more efficiently done

collectively without creating commercial conflicts. A much higher exchange of information between vets from different companies, farmers, public and private vets and other professionals about the sanitary aspects is currently practiced in the Italian poultry sector. Stakeholders realize that it is the interest of everybody to keep these problems under control, since one problem in one farm can cause a much larger problem to the whole supply chain.

### 2.2.3.2 The role of guidelines in sharing knowledge

Some vet practices have optimised prescription by establishing internal professional guidelines, in particular by sharing data and experiences. This can be seen as a form of professional self-regulation, i.e. a way to reappropriate what public regulation or private standards are asking them in terms of reducing AMU. Those professional guidance can take different forms: either official guidelines issue by professional organisations, or more informal rules shared at a more local level among veterinarians from the same practice or area.

Corporate groups and professional association are particularly active to promote guidelines and 'indigenous' recommendations. On the one hand, it is the company organisation and search of efficiency which drive professional self-regulation while, on the other hand, veterinarian organization are identified as spaces for training and circulating state-of-the-art health data. In France, corporate veterinary groups have internal professional guidelines known as "case portfolios" shared through internal databases, which are based on local veterinary caseload: "*From our experiences, we make small documents internally that we exchange and that also help us in our alternative or non-alternative approach*". These portfolios include a "treatment guide" with treatment advice based on antibiotic sensitivities collected through surveillance networks, as well as a basic "article bank", which are often given to new veterinary recruits. Such portfolios can be maintained and updated annually by veterinarians collectively with various supplementary tests. However, veterinarians may feel restricted to such "case portfolios" and may avoid them in order to be able to reason independently: "*We produce annual statistics on antibiotic sensitivity per species for each bacterium, this gives us an idea, and we can do this at national level as well as at regional or departmental level (...). We create a little booklet called [name], which includes all these statistics (...), it is published every year and sent to all group practices and to all veterinarians*" In Sweden, the Veterinarian Union (Veterinärförbundet) own paper (Svensk VeterinärTidning) was in several interviews mentioned as a source of information on AMU research and guidelines. The veterinarians who were employed in the District Veterinary Organization described that guidelines and research results were routinely distributed to them within the organization. Some veterinarians also described further educations and conferences as a source of knowledge. However, the time for such activities was described as limited due to the workload.

Most of veterinarians mentioned social media or internal digital application as sources of information on AMU and as a broadcast channel. An illustrative example is given by an English vet who describes the use of What's App groups between vets: "*We already have What's App groups in place for different things so I run like a Young Stock Group and we have chats on What's App about various little things. We're happy for them to send pictures and videos and things and that part of prescribing and advice has changed massively, some practices will charge for that*". In France, corporate group use common digital social networks. They can feel supported by their peers, although it does not necessarily mean that they get an immediate response, generating greater confidence in their decisions: "*Two years ago I had cases of guinea fowl chloacitis, in bibliography you don't have much [information], and it was by calling friends who told me what was already being said in other networks, and who gave me therapeutic clues that work super well.*" Swedish vets at the same veterinary station have in many interviews described application as a crucial source of information on AMU: "*You know there is always hard to keep, what is the most recent information, but you try to be in contact with colleagues, you check the Strama application [application on phone with information on AMU guidelines] you have some*

*colleague who is chief veterinarian on small animals who you might ask, so, yes. You try to keep up-to-date both with colleagues and internally”.*

### 2.2.3.3 Remaining forms of competition

The non-clinical skills are shared by other actors, and the protocolisation of care and animal health management makes it easier for non-vets to perform tasks that did historically belong to vets. Preventive approaches have thus renewed the interprofessional competition between vets and other actors providing services to farmers (feed mills, breeders, etc.), or actors setting production targets to the farmers (contract buyers, etc.), as well as the intraprofessional competition that occurs among veterinarians.

Vets face difficulties to compete with other actors who are providing health-related services to farmers. Their expertise is challenged by advisers from other professions. In Denmark, veterinarians benefit from legislation that requires their presence at the farm in comparison to other consultants/advisors who need to sell in their expertise. However, it is the farmer who decides which advisors and advice he/she wants to listen to. There is some level of competition between veterinary practices and other advisory services such as feed consultants. Farmers feel less obliged and less attached towards their veterinarian and are more inclined to change to another veterinary practice if their needs change. In France, competition with actors who can take up preventive approaches to animal health (technicians, etc.) increases: *“In breeding, it was different again, in Gallus breeding, we had teams of technicians who have known each other for years, we have protocols, and they know the treatments very well. I would say that they were not the ones prescribing, but almost. The animals are brought to us for analysis, but they already know what will come out”.* In UK, a vet describes how other professions, who are often cheaper, deliver health advices too: *“There are plenty of other people going up farm drives, nutritional advisors, farm consultants, feed guys, feed sales guys who’ve got a solution to everything. I sat around the table with a feed sales guy telling a farmer how to cure his cell count problem and he was talking the biggest load of nonsense I’ve ever heard in my life. But the farmer was listening because it sounded quite easy for him to do. So it was like oh well we might have it here, we’ve never done that and it was never going to work but he doesn’t charge £150 an hour like the vet does so...it was very appealing and that’s like going on the internet to sort a problem instead of phoning up the right person to advise you. It will work for a lot of things but it won’t work for the complicated things.”* UK farmers tend to use qualified representatives from independent feed companies to provide advice on nutrition although vets are qualified to offer general advice if so required.

New protocols can also lead to increased competition within the veterinary profession. A French vet states that it is difficult to deny critically important antimicrobials to farmers in a region that has other veterinary practices which might be willing to prescribe them to get a competitive advantage. An English vet explains: *“So even though we’re prescribing them [critically important antimicrobials] when we could just say no you’re not having them, in a competitive area like around here we’ve got another 4 big practices around here and they’ll just say “I’ll go up the road to Nantwich and get them”, or “well if you’re not going to let me have them.” Sure enough there’ll be somebody at Nantwich who says “ok look we’ve got a new client here, they’ve got a thousand cows and they’re asking for this antibiotic and LLM won’t give it to them.” They’ll give it to them so...we’re a business as well and we have to be mindful of that”.*



## 2.2.4 Remaining issues faced by the veterinary profession to keep supporting the development of preventive approaches through care protocolisation

### 2.2.4.1 Adapting veterinary business models to the new reality

The diversification of veterinary services and protocolization of care implies a change (or at least an adjustment) of the business model of veterinary practices, in particular in countries where vets were dependent on antibiotic sales. There may be some cases where economic change doesn't seem too important as vets can still make their living on other drug sales. But in other countries where vaccines, or hygiene, nutrition and biosecurity products and advices, could be provided by other professionals, the economic viability of veterinary businesses is more challenged. Situations can also vary according to production sectors and systems: it looks like in integrated sectors where vets are employed by the integrators, they are less directly concerned by this issue of profitability, while in sectors where vets are more independent and self-employed these issues are essential.

The establishment of care protocols meets economic inventiveness and adaptation for stabilising new business models in a competitive environment. Vets are looking for a new form of economic valuation of veterinary services.

In countries where vaccines, or hygiene, nutrition and biosecurity products and advices, could be provided by other professionals, the economic viability of veterinary businesses tends to be challenged. In Denmark, transition toward preventive standardize medicine is difficult because they struggle to make a living out of it: *"Farmers don't want to pay for an advice they don't know whether it's gonna work or not... while antibiotics effects are much easier to foresee. Vets who want to go this way are not supported/encouraged"*. Veterinarians are thus looking for charging services and earn money from writing farm report. More generally, it requires veterinarians to focus on creating value in their advisory work. Indeed, the framework of advisory veterinary work given by legislation is likely to weaken vet added-value. In consideration of many changes in legislation on veterinary herd health consultancy over the years, they feel that new changes could come around any time – and that the veterinarians' monopoly as the farmers' closest collaborator is in risk of being outperformed and removed from legislation in the future (e.g. if the required number of obligatory farm visits stated in legislation were to be reduced or completely removed). These thoughts lead them to describe their attempts to create value in their advisory work, so that they could continuously secure their own value and usefulness at the farm.

In France and UK, veterinarians face important challenges to establish business models that were less dependent on medicine sales. They have sometimes difficulties to value their services because their business model is not stabilized yet. The marketing and economic development of veterinary services and products is of central importance in a context of strong inter- and intra-professional competition. An English vet summed up: *"I mean we've had a lot of discussions about this at the practice because there is a diminishing margin on medicine sales and there's been cross subsidy for as long as you can remember in term of professional fees and making money out of medicines, for mixed practices and certainly for large animal practices with that getting squeezed and that's the future you know, there will be less margin in it. Where do you make your money? And can you keep those professional services going and we've always rolled those out and innovated and tried to come up with new ones and what have you but can you keep them all going without that kind of cross subsidy and that's a challenge you know and that will be the challenge of the future and as you say there, its...finding ways of getting on farm, you can't...if you're just churning reports out from the office and don't set foot on the farm, farmers will...they'll think they can do everything themselves."*

In France, the diversification of veterinary services and protocolization of care implies a change (or at least an adjustment) of the business model of veterinary practices. The health manager position makes it possible for veterinarians to link their prescriptions to a varied number of services (analysis of results, team training, technical parameter monitoring plan, farm audit, health check-up, etc.). Moreover, the mastery of precision tools allows veterinarians to position themselves on the market for products that are not subjected to

"marketing authorisation" (nutritional, hygiene, phytotherapeutic, etc.), where they are often asked to participate in the formulation and composition of products. They are therefore seeking to use their expertise to the formulation and manufacture of these products with high added value, as indicated by a veterinarian working for corporate group: *"All our work is to develop original, technical products. We worked on a formulation of a plant-based painkiller to relieve poultry and turkeys that have difficulty walking at the end of a batch. As these products are on the fringes of the market, we manage to market them"*.

#### 2.2.4.2 The worrying issue of veterinary demographics

Finally, changes supporting a shift toward preventive health animal approach are affected by demographical change of the profession. There are more and more difficulties for recruiting young vets in farm animal medicine and some areas are already facing veterinary shortages.

In Denmark, it is increasingly difficult to get enough veterinary students engaged in cattle practice. Furthermore, it is difficult to keep veterinarians engaged in cattle practice once they are employed. The reason is related to the nature of the veterinary work within cattle practice (too little clinical work, working hours / shifts, too difficult to make a difference in terms of farm health, conflicting opinions on animal welfare and how the future of dairy farming looks like (with respect to climate changes especially). Pig sector is also lacking of candidates. The specialized line for pig practice in vet school is very unpopular these days. Young vets leave practice soon because they are discouraged by the bureaucracy and some of them are affected in their daily lives by fear that they will get a penalty from the authorities for doing something wrong (perhaps without knowing it).

In Sweden, during the last decade, both the supply and demand of veterinary services has changed. There is a general shortage of veterinarians. In additions to this, the general interest for farm animal health care among new veterinarians and students is in decline, in favour of pets. At the same time the number of farms has decreased drastically during the last decades. Between 2010 and 2020 the number of dairy farms in Sweden was reduced by 45 %. Several over the interviewed veterinarians recognize a large decrease in the number of farms they work at. Moreover, the district veterinarian organisation is finding it harder to recruit registered personnel, and private veterinary businesses are often unwilling or unable to offer their services during on-call time.

Similar observations can be made in UK and France. The size of the farmed livestock population in the UK have considerably decreased and have led to farmers cutting costs - including the amount spent on veterinary treatment - wherever possible to improve profitability. Many veterinary practices no longer offer large animal services as a result. Also, remaining large animal practices have found it increasingly difficult to recruit young vets, and has resulted in more practices withdrawing treatment for farm animals. In France, veterinary shortages in rural areas have been an issue for years now. However, the development of preventive approaches to animal health are sometimes seen as a lever to attract young veterinarians who are looking for a working routine that is more easy to anticipate than professional activities structured around emergency tasks.

## 2.3 Conclusion

The veterinary expertise is more diversified and protocolised nowadays thanks to the development of preventive approaches, that are often perceived as way to become less dependent on AMU: therefore vets have the legitimacy to intervene on more aspects of health and farm management but in the meantime animal health has become a less protected jurisdiction and a more competitive market. Vets should therefore be aware of a risk of de-professionalization, in the sense that non-veterinary actors can more easily provide services that can compete with those of vets.

However, it doesn't look like we can make the same conclusions than in human medicine. Although situations vary according to countries, sectors and types of businesses, it seems that diversifying skills is a new skill as such : vets are the only professionals who can provide those holistic approaches (even when they struggle to valorise it economically) and can therefore act as supervisors or managers of animal health and AMU reduction strategies. In many countries, vet professional associations have directly contributed to the design of public policies and national action plans aiming at reducing AMU.

All in all, vets manage to maintain their professional autonomy within the protocolization process of their activity... although we must pay attention to what type of veterinary practitioners and veterinary business benefit the most from this trend, since they may become the new "gold standard" of the veterinary profession, while other ways of working and exerting veterinary activity may disappear. Even though the risk a de-professionalisation of veterinary medicine seems to be avoided, a risk of a two-tier medicine remains preoccupying.

### 3 Veterinarians' attitudes regarding AMR and AMU: a quantitative perspective

In parallel with the qualitative survey, we have explored the practices and representations (which we will refer to here as 'attitudes') of European veterinarians with regard to AMU and AMR on the basis of a quantitative survey. The first objective is to understand how veterinary attitudes are distributed according to major structural variables such as age, gender, country, speciality and working conditions (type and size of practice in particular). A second objective is to place attitudes related to AMR and AMU in the context of broader animal health management practices: relations with farmers or technicians, knowledge mobilised during diagnosis, or the tools used during interventions, provide an overall understanding of how veterinarians carry out their activity. It is through this framework that they perceive AMR and AMU. Our surveys, both quantitative and qualitative, meet this dual objective in order to gain a sociological understanding of the attitudes of European veterinarians.

#### 3.1 Materials and method

##### 3.1.1 Method

The first phase of the survey, consisting of the construction of the questionnaire, started in spring 2020. A first skeleton of the questionnaire was elaborated by the lead partner of this task (INRAE) and then discussed with the case-study leaders of the involved countries (France, UK, Sweden, Denmark, Italy, Switzerland - except for Spain which the decision to also pass the questionnaire was taken later). The objective was then to refine each part of the questionnaire so that it made sense and considered the specificities of each country. Several questions were thus reworded, removed or added. The questionnaire was initially planned for autumn 2020 but was finally postponed due to the Covid: we felt that the situation could bias the responses, in the sense that the veterinarians would have spoken about their practices and their positions with regard to AMU and AMR in a way that did not correspond to a "normal" situation. As the situation persisted, we finally decided in the summer 2021 to amend the questionnaire slightly so that respondents would understand that they were expected to provide answers that were not necessarily correlated with the Covid situation, and to create a small additional

section to assess the impact of the pandemic on their practices. In the end, the results of this section could not be used because few participants responded, and the national situations were too disparate for the questions to make sense. The questionnaire was finally disseminated in the winter of 2021-2022 on the LimeSurvey software.

The survey is based on a questionnaire organised around three sets of questions. The first set includes socio-demographic questions (age, gender, experience, country of training and country/region of practice) as well as those that allow the practice context to be specified: type of practice (mixed practice or rural practice), respondent's speciality (dairy or beef cattle, pigs, poultry, etc.), number of clients, type of structure (private practice, corporate groups, practice attached to an integrator, etc.). The second set of questions asks about respondents' views on the impact of a reduction in AMU on both their practice and the society as a whole, and also includes questions on how veterinarians inform themselves, the tools they use to diagnose, and therefore how they prescribe. Finally, the last block of questions (not used here) asks veterinarians about how the coronavirus crisis has changed their practices. Most of the questions are presented in the form of a Likert scale ranging from 1 to 5. In the following report, for the sake of readability, we have grouped together answers 4 and 5 ("Totally agree"), as well as answers 1 and 2 ("Do not (at all) agree"), the individuals who chose answer 3 are then considered as those who are indifferent or who do not feel concerned by the statement proposed to them. This modality was therefore treated as a category in its own.

The questionnaire was translated and distributed by each of the following partners in the project (UK, Denmark, Spain, France, Italy, the Netherlands, Switzerland) to veterinarians in their country via the Internet (the questionnaire takes about 20 minutes to complete and can only be completed online), either through lists or professional press titles (through which local partners such as veterinary unions agreed to distribute the invitation) or through private contacts (colleagues of veterinarians involved in the project). The questionnaire was also promoted on the project's social networks (e.g. Twitter, Facebook and website). After deleting the very incomplete questionnaires and data cleaning, we obtained a final base of 481 respondents spread over six countries (only the Dutch questionnaire was discarded as it had too few responses to be used).

All of this work was carried out using R software, with the FactoMineR package. After a series of descriptive statistics, we carried out a Multiple Correspondence Analysis (MCA) on the opinion variables directly related to AMU and the consequences of antibiotic reduction, which were used as active variables. Indeed, the MCA is a graphical method that allows us to find the best "image" of an n-dimensional space (the set of our questions and therefore of our variables) in a two-dimensional space. In other words, the space of interest (here, that of practices and representations concerning AMU and AMR) forms an n-dimensional "cloud" whose synthetic representation must be easily apprehended and which therefore consists of the projection of this cloud onto a factorial design containing only two dimensions. It is therefore a method that makes it possible to describe a social world by analysing the way in which the variables are interrelated, i.e. how some of their modalities are linked or, on the contrary, in opposition (Duval, 2013; Lebaron & Le Roux, 2015). The variables used as supplementary variables, i.e. those that do not contribute to the construction of the MCA but which are then projected onto the factorial design, then make it possible to illustrate and refine the interpretation. Therefore we chose to use the social and professional characteristics of the respondents as an addition. This method thus makes it possible to represent the social space, or to use a more Bourdieusian vocabulary, the field of attitudes regarding AMU, AMR and the consequences of antibiotic reduction. In this way, we can see how some of these ways of thinking and doing are very strongly linked or, on the contrary, how they are opposed to each other.

By completing this method with a Hierarchical Ascending Classification (HAC), we can fully exploit the advantages offered by the MCA, since we can reason from the variables and their modality (for which we describe the positions on the factorial design of the MCA) but also in terms of individuals, since the HAC offers us the possibility of identifying groups of respondents whose characteristics we can then describe. Indeed, the AHC works on the principle of successive aggregation of individuals by bringing together those who are most similar, until the homogeneity within each group is the strongest (thus the intra-cluster variance is minimal) but each group is very different from the others (thus the inter-cluster variance is maximal).

For the MCA and HAC, we removed individuals who were missing answers to at least one third of the questions representing our variables of interest (n=13). This threshold of one third was set by the very configuration of the survey: a significant drop-out threshold was observed when switching from one page to another of the questionnaire, and this page jump corresponds to one third of the questions in the survey. For the more sporadic non-response, we considered that the respondent declared himself "indifferent" to the proposed statement, which corresponds to ticking 3 on the Lickert scale, except in a few specific cases which are explained below.

### 3.1.1 Who are the respondents?

The 481 respondents are spread over 7 countries. With 116 respondents, France and the United Kingdom were the countries in which the questionnaire was most circulated, together accounting for almost half of the responses (48%).

FIG 1 - DISTRIBUTION OF QUESTIONNAIRE RESPONDENTS BY COUNTRY (IN VALUE AND %)

Country	Nbr of respondants	% of respondants
France	116	24%
UK	116	24%
Italy	80	17%
Denmark	76	16%
Sweden	42	9%
Switzerland	33	7%
Spain	28	6%
Nederlands	3	0%

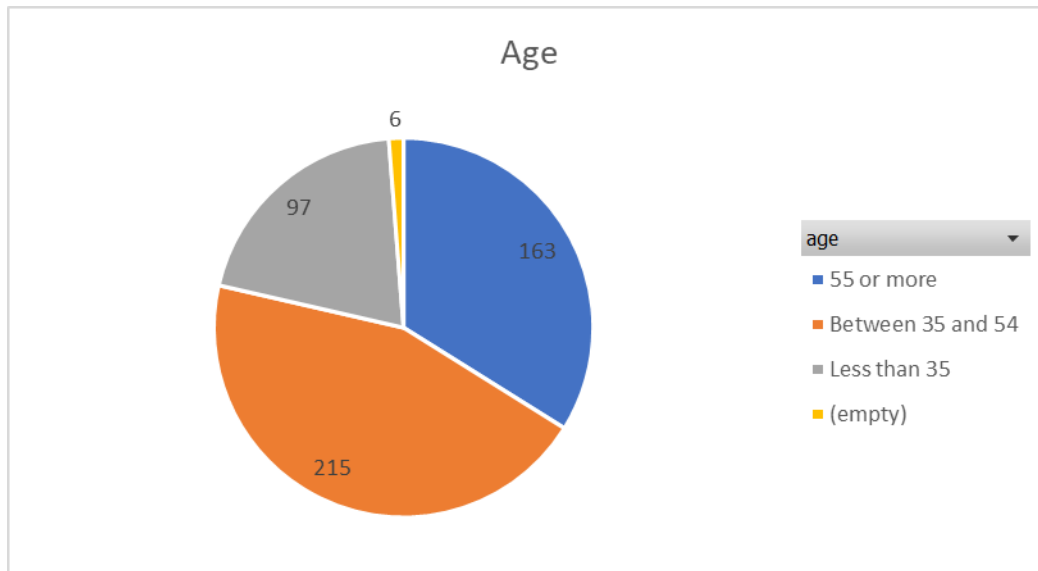
**Reading:** 116 respondents are veterinarians in France, they represent 24% of the respondents in the sample

**Field:** 481 individuals

**Base:** Roadmap Vet Survey

The sample is slightly more male (266 males versus 205 females, with 10 respondents who preferred not to disclose their gender).

FIG2 – DISTRIBUTION OF THE SAMPLE BY AGE OF RESPONDENTS



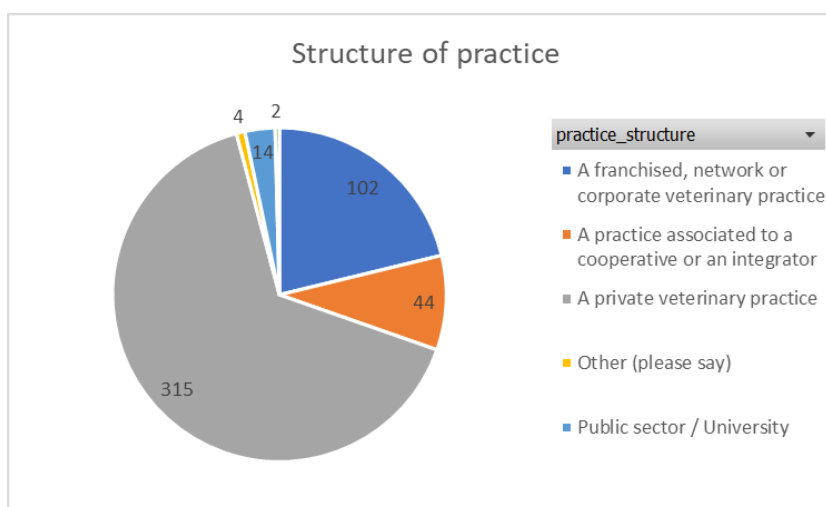
**Reading:** 97 survey respondents are under 35 years old

**Field:** 481 individuals

**Base:** Roadmap Vet Survey

The age variable was broken down into three categories: vets under 35, vets between 35 and 54 and vets over 55. The most represented category was mid-career vets with 215 respondents (44.7%), while respondents under 35 years of age were the least represented, with 97 respondents or just over 1 in 5 (20% of respondents).

FIG 3- DISTRIBUTION OF THE SAMPLE ACCORDING TO THE TYPE OF PRACTICE



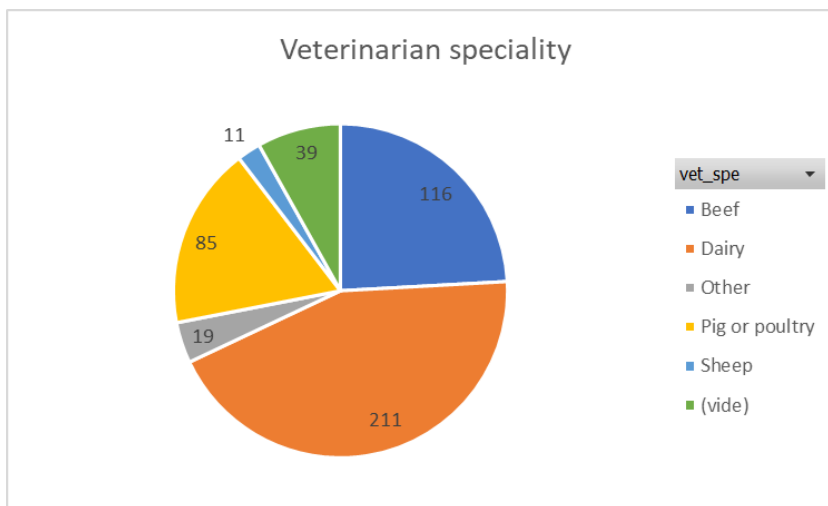
**Reading:** 315 survey respondents work in private practice

**Field:** 481 individuals

**Base:** Roadmap Vet Survey

A large majority of respondents worked in private practice (315 respondents or 66% of the sample), while only 14 respondents reported working in the public sector. The latter category includes all respondents who did not identify themselves in any of the three categories and therefore chose to indicate another practice structure. When the latter has a link with the public sector (teacher in a veterinary school, member of a health authority carrying out a control or training mission for other veterinarians, etc.), we indicated that the veterinarian was working in the public sector. This is the case, for example, for veterinary inspectors in France or for veterinarians who are members of the national health service ("ASL") in Italy.

FIG 4- DISTRIBUTION OF THE SAMPLE ACCORDING TO THE RESPONDENT'S SPECIALITY



**Reading:** 85 survey respondents specialize in pig or poultry production

**Field:** 481 individuals

**Base:** Roadmap Vet Survey

Finally, if we look at the specialty of the veterinarians interviewed, we can see that there is a predominance of veterinarians working with cattle, whether in dairy or beef (327 respondents in total, including 211 specializing in dairy cows). Veterinarians working with monogastric animals (pigs and poultry) represent less than 1 in 5 respondents (85 respondents or 18% of the sample), while the number of non-responses is relatively high (39 respondents or 8% of the total respondents).

Although the structure of the sample is not so far from that of the total number of veterinarians surveyed by the Federation of Veterinarians of Europe (FVE) in 2018, our database nevertheless shows an over-representation of male respondents, whereas according to the European survey, 58% of European veterinarians are women. This can be explained by the age and specialty of our respondents. Indeed, older veterinarians are over-represented in our sample as the over 55s represent 33.89% of our sample compared to the European average of 18%. This is mainly because the majority of veterinarians surveyed reside in seven countries, several of which have an older than average veterinary population (France, Sweden, Denmark and Italy, together accounting for 65% of our respondents).

Therefore, even if there is an over-representation of older veterinarians at the expense of younger veterinarians, this is less significant than the comparison with the European average would suggest. Furthermore, the survey focused on the practice of veterinary medicine with farm animals, which is more often practiced by men, so it is logical that men are particularly numerous in our sample.

### 3.2 Results

#### 3.2.1 Cross-tabulations and MCA

Although we do not present all of the descriptive statistics performed, some of the cross-tabulations deserve some elaboration. For example, we asked about the relationship between country of practice and the importance of reducing AMU for veterinarians.

FIG 5 - OPINION ON ANTIBIOTIC REDUCTION BY COUNTRY OF PRACTICE (NUMBER AND % ONLINE)

It's important to reduce AMU (row%)	(Totally) agree	(Totally) disagree or indifferent	Total
Denmark	68,4	31,6	100
England	96,4	3,6	100
France	69,0	31,0	100
Italy	87,5	12,5	100
Northern Ireland	72,7	27,3	100
Scotland	78,1	21,9	100
Spain	60,7	39,3	100
Sweden	100	0	100
Switzerland	78,8	21,2	100
Wales	87,5	12,5	100
All	79,0	21,0	100

**Reading:** Of the Danish veterinarians who responded to the survey, 68.4% agreed or strongly agreed that AMU should be reduced.

**Note:** For the variable measuring the importance of reducing AMU according to veterinarians, we re-coded the "not very or not important" and "indifferent" modalities, based on the fact that a majority of respondents had answered "Important or very important" (79% of respondents) and therefore that the "indifferent" modality was close to the "not very or not important" one.

**Field:** 481 individuals

**Base:** Roadmap Vet Survey

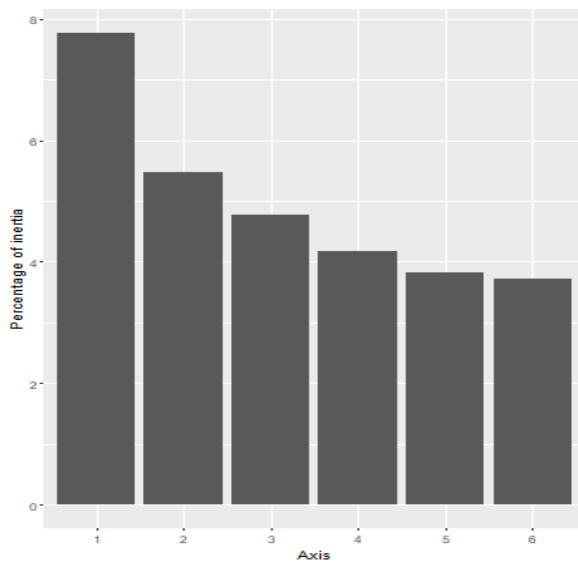
79% of respondents from all countries consider it important or very important to reduce AMU. Although this proportion varies from one country to another, ranging from unanimity (e.g. Sweden) to a



relative consensus as in Spain (60% of responses "Important or very important"), but also in Denmark and France (68.4% and 69% respectively). This cross-sorting invites us to go further, since countries in which policies to reduce AMU have existed for a long time are not always those for which the problem of reducing AMU appears to be important (the example of Denmark is remarkable here). On the other hand, in some countries such as Italy, which are not among the countries where the reduction of AMU has been particularly marked, the respondents are very largely concerned by this problem.

To do this we carried out a MCA on the main variables relating to practices and representations on AMR and AMU and projected the variables relating to age, gender, country of practice and those relating to type of practice, specialty, etc., into the additional variables.

FIG 6 - EIGENVALUE HISTOGRAM

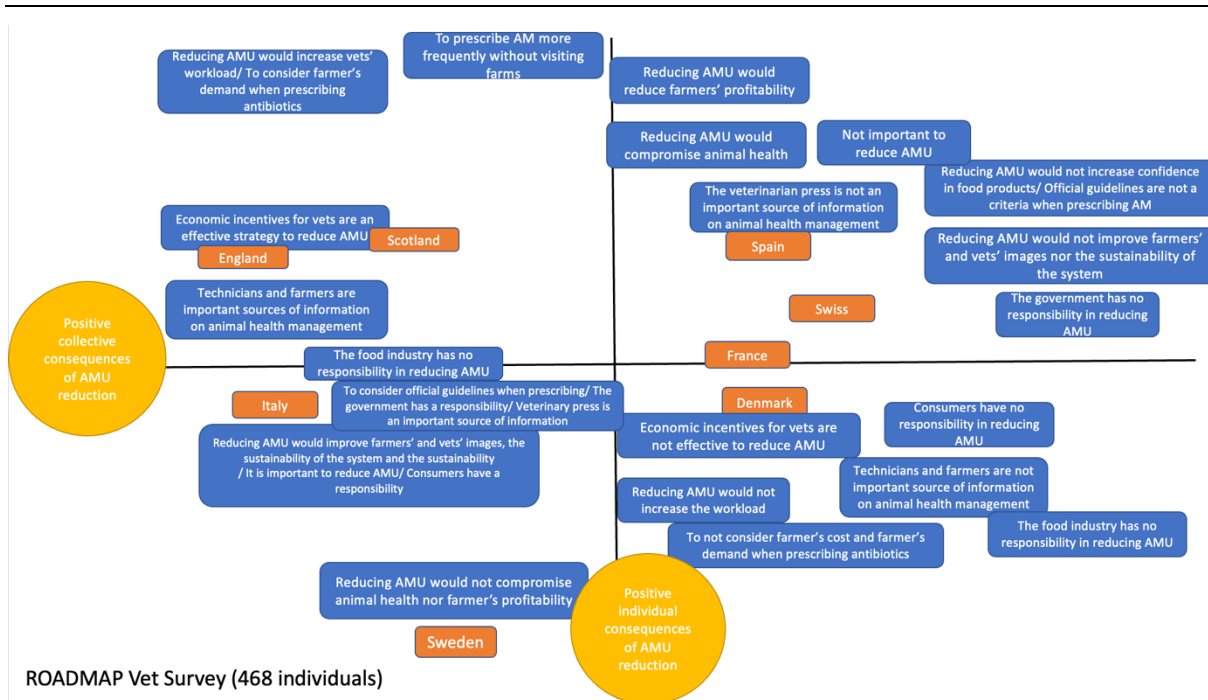


**Interpretation:** The first axis represents 7.8% of the total inertia.

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

We will focus our analysis on the factorial design made up of the first two axes since the first axis explains 7.8% of the total inertia and the second 5.5%, for a total of 13.3% between them.



To the right of the horizontal axis are the respondents who believe that reducing AMU will not improve the sustainability of the agri-food system, the image of veterinarians and farmers, or even increase public confidence in food products. They do not attribute responsibility to the food industry, consumers or government for reducing AMU. Finally, they do not rely on farmers or technicians for advice on animal health management, and they do not take into account official recommendations for prescribing antibiotics. Conversely, moving to the left, veterinarians are the most likely to think that a reduction in AMU will have a positive impact on the society as a whole. For example, they believe that it will enhance the sustainability of the system, improve the image of veterinarians and farmers, and increase public confidence in food products. In addition to this, they rely more on the different actors, both farmers and technicians, with whom they work.

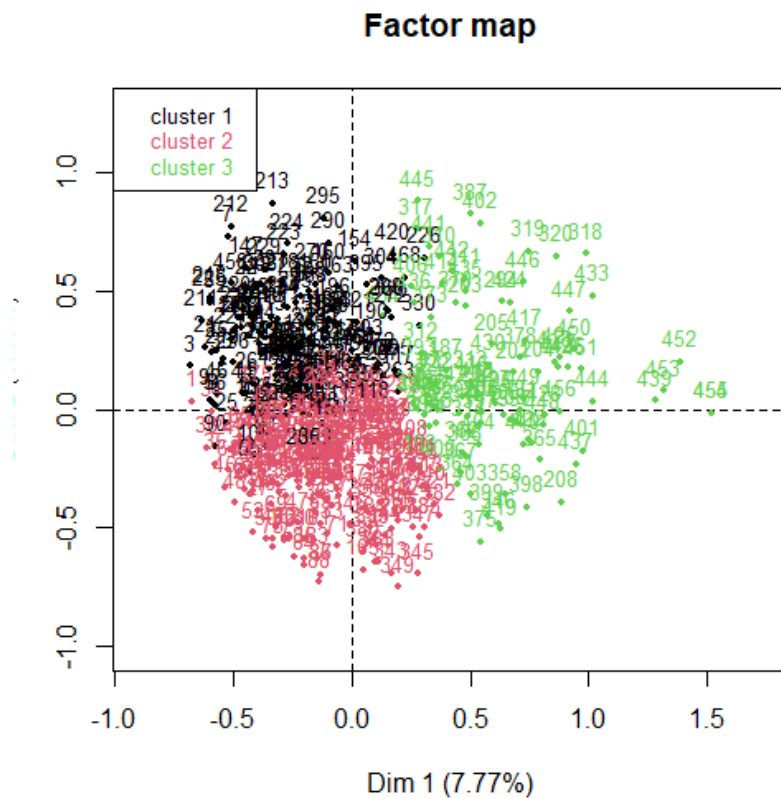
As regards the second axis (vertical one), it is the variables that summarize the respondents' attitudes regarding the consequences that a reduction in AMU could have on the profitability of farms that contributes most to the construction of the axis, and the modalities of this variable are perfectly opposed on either side of the design. Thus, at the top of the axis, we find veterinarians who fear that a reduction in AMU will lead to a reduction in farmers' profits, but also that it will have a negative impact on the health of the animals and that it will cause more work for the veterinarians. These same veterinarians say they consider the demand of farmers and the cost to them when prescribing antibiotics. They acknowledge that they have been prescribing antibiotics more often without going to the farm in recent years, and do not think it is important to reduce AMU. At the bottom of the axis, on the other hand, are the veterinarians who do not fear any negative impact on their work or that of the farmers. They do not believe that a reduction in AMU will reduce farm profitability or endanger animal health, and they are optimistic that it will not lead to an increased workload.

In summary, the first axis of the MCA thus appears to summarize respondents' attitudes towards the social and collective consequences that reducing AMU might have, while the second axis represents veterinarians' attitudes towards the economic, or rather, individual consequences that such a reduction might have.

### 3.2.1 Hierarchical Clustering on the first factorial design

We then performed a hierarchical ascending classification (HAC) on the MCA. The best partition is the one that allows us to identify three clusters that we describe with the help of a series of cross-tabulations, part of which is visible in the appendix. Figure 8 shows the cloud of individuals obtained and their distribution in the different clusters.

FIG 8 - CLOUD OF INDIVIDUALS DISTRIBUTED IN THE THREE CLUSTERS OBTAINED BY HAC



**Field:** 468 individuals

**Base:** Roadmap Vet Survey

We can identify three relatively distinct clusters, in particular the border between cluster 2 (red) and cluster 3 (green) which forms almost a straight line that only a handful of individuals cross.

#### 3.2.1.1 First cluster (black)

The first cluster occupies almost the entire northwest quadrant, the area of the factorial design where one finds individuals who are most concerned about the negative individual consequences of MVA,

but who are much more optimistic about the collective consequences it could have. This cluster comprises 171 individuals, i.e. 37% of the individuals in the database. The individuals in this cluster are relatively concerned about the demand of farmers for antibiotics and the cost that this may represent for them when they have to prescribe them. For example, nearly 30% of the individuals in this cluster consider that the fact that the farmer asks for antibiotics is an important or very important factor in their decision to prescribe them, whereas only 15% of all respondents hold the same opinion (fig 9).

FIG 9 - PLACE GIVEN TO THE FARMER'S REQUEST CONCERNING THE DECISION TO PRESCRIBE AN ANTI-BIOTIC ACCORDING TO THE CLUSTER - PERCENTAGE ONLINE

Farmer demand	(Very) important	Indifferent	Not (very) important	Total
Cluster 1	29.2	45.0	25.7	100.0
Cluster 2	6.1	21.8	72.1	100.0
Cluster 3	9.0	28.0	63.0	100.0
All	15.2	31.6	53.2	100.0

**Reading:** Of the respondents in cluster 1, 29.2% think that it is important or very important to take the farmer's request into account when prescribing antibiotics.

**Significance:** Chi2 = 91 p<0.001; Cramer's V = 0.31

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

Individuals in this cluster also stand out for the trust they place in farmers, and to a lesser extent, in the technicians with whom they work. Finally, relatively more of them, compared to the other two clusters, think that economic incentives given to veterinarians could be effective in helping them to reduce AMU, even though this solution is not very popular with all respondents: 23% of veterinarians in this cluster completely agree or agree that this could be a good solution, whereas only 16% of all respondents share this opinion (fig 10).

FIG 10 - IMPORTANCE GIVEN TO ECONOMIC INCENTIVES FOR VETERINARIANS BY CLUSTER - PERCENTAGES ONLINE

Vet incentives are appropriate	(Very) important	Indifferent	Not (very) important	Total
1	22.8	29.8	47.4	100.0

2	13.2	14.7	72.1	100.0
3	10.0	14.0	76.0	100.0
All	16.0	20.1	63.9	100.0

**Reading:** Of the respondents in cluster 1, 22.8% agree or strongly agree that giving economic incentives to veterinarians is an effective tool to reduce their antibiotic prescribing

**Significance:** Chi2 = 30 p<0.001; Cramer's V = 0.19

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

In this cluster, the youngest veterinarians (under 35 years old) are over-represented as well as those who practice in the UK (see appendix). Also over-represented are beef and sheep practitioners and those who work in practices with more than 10 vets. Finally, the respondents in this cluster are more likely to work in practice belonging to corporate groups.

### 3.2.1.1 Second cluster (red)

Cluster 2 (in red) occupies the entire South-West quadrant, as well as half of the South-East quadrant, which it shares with the third cluster. It is made up of 197 individuals or 42% of the respondents. Respondents from this cluster are the most likely to consider the reduction of AMU as an important or very important issue, with 94% sharing this opinion compared to 78% of all respondents (fig 11).

FIG11 – IMPORTANCE OF REDUCING ANTIBIOTIC USE IN LIVESTOCK BY CLUSTER – PERCENTAGES ONLINE

Importance of reducing AMU	(Very) important	Indifferent or not (very) important	Total
1	82.5	17.5	100.0
2	93.9	6.1	100.0
3	43.0	57.0	100.0
All	78.8	21.2	100.0

**Reading:** Of the respondents in cluster 1, 82.5% agree or strongly agree that it is important to reduce MVA

**Significance:** Chi2 = 105 p<0.001; Cramer's V = 0.47

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

In the same vein, more of them agree that this decrease will have positive consequences on the sustainability of the agricultural system, on the image of veterinarians and farmers in the society and on public confidence in food production (fig 12).

FIG 12 - OPINION ON THE POTENTIAL IMPACT OF THE DECREASE IN AMU ON CONSUMER CONFIDENCE IN AGRICULTURAL PRODUCTION - PERCENTAGES ONLINE

Believe in consumer confidence	(Very) important	Indifferent	Not (very) important	Total
Cluster 1	76.6	19.9	3.5	100.0
Cluster 2	87.8	9.1	3.0	100.0
Cluster 3	22.0	39.0	39.0	100.0
All	69.7	19.4	10.9	100.0

**Reading:** Of the respondents in Cluster 1, 76.6% agree or strongly agree that lower AMU will improve consumer confidence in food production.

**Significance:** Chi2 = 166, p<0.001; Cramer's V = 0.42

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

Furthermore, they are under-represented among respondents who consider the negative consequences that the reduction of AMU could have individually, in terms of workload for example, since 86% think that the reduction of antibiotics will not increase their workload, while this opinion is shared by 68% of respondents (fig 13).

FIG 13 - OPINION ON THE WORKLOAD THAT COULD RESULT FROM THE REDUCTION IN AMU - PERCENTAGES ONLINE

Increase of workload	(Very) important	Indifferent	Not (very) important	Total
Cluster 1	20.5	35.7	43.9	100.0
Cluster 2	4.6	9.1	86.3	100.0
Cluster 3	8.0	18.0	74.0	100.0
All	11.1	20.7	68.2	100.0

**Reading:** Of the respondents in cluster 1, 20.5% agree or strongly agree that the decrease in MVA will increase their workload.

**Significance:** Chi2 = 78, p<0.001; Cramer's V = 0.29

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

Finally, veterinarians in this second cluster were also the most likely to believe that the responsibility for managing the problem of AMR lies with government and consumers.

When prescribing antibiotics, respondents in this cluster were more likely to rely on the veterinary press (Fig 14) and recommendations, while they were relatively sensitive to the demands of farmers (Fig 9) or the cost to them.

FIG 14 - TRUST IN THE VETERINARY PRESS TO GUIDE ANTIBIOTIC PRESCRIBING - PERCENTAGES ONLINE

Trust veterinary press	(Very) important	Indifferent	Not (very) important	Total
1	56.7	28.7	14.6	100.0
2	73.1	21.8	5.1	100.0
3	64.0	19.0	17.0	100.0
All	65.2	23.7	11.1	100.0

**Reading:** Of the respondents in cluster 1, 56.7% found the veterinary press to be an important or very important source of information

**Significance:** Chi2 = 18, p<0.01; Cramer's V = 0.14

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

In this second cluster, Swedish and to a lesser extent Italian veterinarians are over-represented, as are women and sole practitioners. Veterinarians in this cluster are more often specialized in dairy cattle and to a lesser extent in poultry and pigs (see appendix).

### 3.2.1.1 Third cluster (green)

The third cluster (in green) occupies the eastern part of the graph, i.e. half of the south-east quadrant and the majority of the north-east quadrant, that is to say the part of the factorial design where the majority of individuals who are pessimistic about the collective consequences of an AMU reduction. Since attitudes towards individual consequences are distributed along axis 2, an important heterogeneity is appears within this cluster. It includes 100 respondents, or 21% of the veterinarians interviewed.

In this cluster, we find the veterinarians who are the least likely to think it is important to reduce AMU compared to respondents from all clusters. Relatively more veterinarians than in the other clusters agreed that reducing AMU could have negative consequences for animal health, with 55% of respondents in this cluster agreeing with this view compared to 35% of all respondents (fig 15).

FIG 15 - OPINION THAT LIMITING AMU COULD LEAD TO A DEGRADATION OF ANIMAL HEALTH AND WELFARE - PERCENTAGES ONLINE

Negative consequences on animal health	(Very) important	Indifferent	Not (very) important	Total
1	45.0	35.1	19.9	100.0
2	16.2	26.9	56.9	100.0
3	55.0	24.0	21.0	100.0
All	35.0	29.3	35.7	100.0

**Reading:** Of the respondents in cluster 1, 45% agree or strongly agree that the decrease in AMU could worsen animal health and welfare.

**Significance:** Chi2 = 82, p<0.001; Cramer's V = 0.30

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

Similarly, respondents in this third group are more likely to disagree that lower AMU could have a positive impact on the sustainability of the system (fig 16) or on consumer confidence (fig 12).

FIG 16 - OPINION THAT LIMITING AMU COULD IMPROVE THE SUSTAINABILITY OF THE SYSTEM - PERCENTAGES ONLINE

Consequences on the sustainability of the food system	(Very) important	Indifferent	Not (very) important	Total
Cluster 1	60.2	31.0	8.8	100.0
Cluster 2	63.5	25.4	11.2	100.0
Cluster 3	10.0	20.0	70.0	100.0
All	50.9	26.3	22.9	100.0

**Reading:** Of the respondents in cluster 1, 45% agree or strongly agree that lowering AMU could make the agri-food system more sustainable.

**Significance:** Chi2 = 169, p<0.001; Cramer's V = 0.42

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

When asked about who is responsible for the AMR problem, respondents in this cluster most often disagreed with the idea that industry, consumers or government are responsible for the problem (fig 17).



FIG 17 - OPINION ON THE RESPONSIBILITY OF THE AGRI-FOOD INDUSTRY FOR THE AMR PROBLEM - ONLINE PERCENTAGES

Responsibility of the food industry	(Very) important	Indifferent	Not (very) important	Total
1	72.5	24	3.5	100.0
2	64.5	23,3	12.2	100.0
3	35.0	18.0	47.0	100.0
All	61.1	22.4	16.5	100.0

**Reading:** Of the respondents in cluster 1, 72.5% agree or strongly agree that the agri-food industry is responsible for managing the AMR problem.

**Significance:** Chi2 = 93, p<0.001; Cramer's V = 0.31

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

Furthermore, relatively fewer veterinarians in this cluster relied on the technicians they worked with, farmers (Fig 9) or the veterinary press (Fig 14) when prescribing. They are also less likely than other respondents to say they rely on recommendations when prescribing antibiotics.

FIG 18 - IMPORTANCE GIVEN TO RECOMMENDATIONS WHEN PRESCRIBING AN ANTIBIOTIC - PERCENTAGES ONLINE

Following guidelines when prescribing	(Very) important	Indifferent	Not (very) important	Total
1	79.5	17.5	2.9	100.0
2	83.8	13.2	3.0	100.0
3	55.0	27.0	18.0	100.0
All	76.1	17.7	6.2	100.0

**Reading:** Of the respondents in cluster 1, 79.5% consider the recommendations to be important or very important criteria that they consider when prescribing antibiotics

**Significance:** Chi2 = 43, p<0.001; Cramer's V = 0.22

**Field:** 468 individuals

**Base:** Roadmap Vet Survey

Danish, French, Spanish and Swiss veterinarians are over-represented in this cluster, as are respondents who work in large practices (more than 6 veterinarians) and those who work in private practice (see Appendix). This cluster also has a slightly higher proportion of men and middle-aged respondents (between 35 and 55 years). Finally, respondents in this group are also more likely to be multi-skilled

veterinarians, reporting several specialties or, to a lesser extent, indicating a specialization in pigs and poultry.

### 3.3 Discussion

#### 3.3.1 Is the reduction of AMU a consensual topic? Lessons from the MCA

Although the issue of reducing AMU seems to be the subject of a general consensus among respondents, differences are still marked between countries. In some countries, such as Sweden and England, the issue seems to be little debated, as the vast majority of respondents think it is important to reduce AMU (100% and 96.4% of respondents respectively). In other countries, on the contrary, the question is the subject of more mixed opinions, which can be explained either by the fact that there is simply not (yet) unanimity on this issue in the country, or by the fact that AMU has already been strongly reduced and that it does not seem possible to reduce it further.

Consequently, it seems interesting to understand the what structures this consensus and therefore to understand what difficulties or obstacles respondents anticipate when it comes to limiting AMU in livestock. The marked differences between countries reflect differences in local contexts, particularly in terms of public policy, since in some countries measures to reduce AMU have been in place for several years, and it is reasonable to believe that this has contributed to making the issue of (over)prescribing antibiotics a central concern for vets. However, this also leads us to understand what this variable of the respondent's country of practice actually conceals and therefore to examine how the social organisation of the veterinary profession (type of practice, specialisation, size of the structure and legal status, etc.) effectively accounts for the way in which practices and representations regarding AMR and AMU are structured.

The MCA carried out thus describes the social space of attitudes towards AMU and how the various practices and representations of veterinarians oppose each other. We can then identify two main systems of opposition, summarised by each of the axes.

The horizontal axis summarises the attitude towards the collective consequences that a decrease in AMU could have. Indeed, the further to the left one moves, the more respondents adhere to the idea that limiting AMU could have positive consequences on consumer confidence in agricultural products, on the image of veterinarians and farmers in society or on the sustainability of the agri-food system. And as one moves to the right, respondents become increasingly sceptical about all these dimensions, with 'indifferent' respondents located around the centre of the factorial design.

The vertical axis appears to reflect attitudes about the individual consequences of reducing AMU on farm profitability, animal health and veterinary work. At the bottom are the respondents who disagree that less AMU could increase their workload, worsen animal health, or even weaken farm profitability. Conversely, the further up the axis one goes, the more the veterinarians interviewed see the decrease in AMU as a threat to farms and the work of veterinarians.

Rather than summarising all of this information in a quadrant analysis, we performed a Hierarchical Ascending Classification (HAC) on the MCA, which we believe is more relevant for describing how the individual respondents are distributed on the factorial design. Indeed, the HAC allows us to get away from the Manicheism that an analysis structured by the axes of the plan could lead to, along which the "pros" and "cons" AMU reduction would be distributed.

The HAC reveals three clusters that we have described using practices and representations variables regarding AMU and AMR (active variables in the MCA) and also the social and professional characteristics of respondents (illustrative variables in the MCA).

### 3.3.2 Better understanding veterinary positions thanks to a MCA-HAC analysis

#### 3.3.2.1 *First cluster: Business-oriented vets, timidly mobilised for AMU reduction*

The first cluster brings together veterinarians who are generally in favour of reducing AMU, but who differ from respondents in the other two clusters mainly in the attention they pay to farmers when prescribing antibiotics: they are concerned about the cost of antibiotics, take farmers' requests into account when prescribing, which explains why vets place particular trust in them, much more so than other respondents. As a result, the vets in this first cluster are concerned about the negative consequences that AMU reduction could have on farms, particularly in terms of workload and profitability, although they indicated that they agreed that at a more collective level, such a reduction could have positive consequences on the food system or consumer confidence. Although they are in favour of reducing AMU, they are very economically dependent on their clients, which may explain why relatively more of them think that economic incentives can be effective tools to encourage AMU reduction.

The social and professional characteristics of the respondents in this cluster allow for a better understanding of veterinary attitudes and in particular the attention they give to farmers and farm profitability. Firstly, the over-representation of the youngest veterinarians (under 35 years old) in this cluster is quite logical since, at the beginning of their career, veterinarians are more dependent on farmers to build and maintain their network. It would therefore be difficult for them to go against the farmer's interests when prescribing antibiotics. Secondly, the over-representation of veterinarians who work in very large practices, more often belonging to corporate (called "networks" in some countries like France), seems to induce a form labour division which makes this dependence on the client important and which means that the economic variable also weighs heavily on the decision to reduce AMU. Indeed, the qualitative survey showed us that while these practices favour the development of preventive approaches and diversified services (with, as a corollary, a sensitivity to the prudent use of antibiotics), they are based on economic models that are perfectly adapted to the interests of their clients, both farmers and producers' organisations.

Moreover, this economic pressure can also take another form, this time at the level of the livestock sector rather than the practice. The fact that vets specialising in beef cattle are over-represented in this cluster can also be explained by the fact that this sector is highly integrated and therefore very dependent on upstream and downstream industries. This is reflected in the attention paid to the cost of treatments for the farmer, but also in the particular responsibility that the respondents of this cluster attribute to the agri-food industry in the AMR problem (compared to that which they attribute to other actors in particular, cf fig 17). Finally, the importance given to the economic factor by the respondents of this cluster can also be interpreted at a more global level, related to market issues: the over-representation of British veterinarians, as well as that of veterinarians who have specialised in sheep, can be explained by a contextual effect linked, for example, to Brexit and the greater exposure of certain markets to global competition. Therefore, it appears clearly that the attitude of some veterinarians towards AMU, especially when there are such clear national specificities, cannot be detached from the study of local economic contexts.

### 3.3.2.2 *Second cluster: Public health-oriented vets, committed for prudent AMU*

Respondents in the second cluster were much more supportive of reducing AMU than those in the other two groups. Like those in the previous cluster, they agree that this could have positive consequences both for the farming system and for consumer confidence or the image of veterinarians in society, but a higher proportion of them do so, and more importantly, a higher proportion of them have a strong opinion on the subject, whereas respondents in the previous cluster show a higher proportion of indifference on these issues. As for the negative individual consequences that the reduction of antibiotics could have on animal health, on the profitability of farms and on the workload, the respondents of this cluster declare that they do not agree with them. Whether from a collective or individual, social or economic point of view, the reduction of AMU is considered positively.

They are also opposed to the respondents of the first cluster in their way of diagnosing and prescribing: the farmer's request and the information delivered by the latter or by the technicians they work with are not elements they strongly consider. A greater proportion of the respondents in this cluster replied that they tend to use information from the veterinary press, that they often refer to official guidelines and recommendations and that they carry out diagnostic tests to guide their prescriptions. Mobilised around the positive impact that AMU reduction could have on society, they practise a veterinary medicine based on scientific data and recommendations, rather than on the information they get from the farmers. They are predominantly public health-oriented veterinarians, and this may also explain why they blame the government and the food industry, and to a lesser extent consumers, for the AMR problem, as if it were a global issue and therefore everyone's business.

It is therefore not surprising to find in this cluster an over-representation of veterinarians working for the public sector, as representatives of an animal health administration (for advisory or control missions) but also teachers in a veterinary schools. Furthermore, in this cluster, veterinarians working in a practice related to a cooperative or integrator are more numerous than in the other clusters, as well as those working alone, which can be explained by the fact that it is in this cluster that we find a slight over-representation of veterinarians in dairy cattle, but also to a lesser extent in pigs and poultry. Although this category of practice is actually quite different depending on the national contexts, the common point seems to be that they are salaried veterinarians and as such are rather independent of the economic interests of their clients (which does not prevent them from being close to their clients on a social or technical level). Finally, women are slightly over-represented, as are veterinarians working in mixed practice (meaning that they cure both companion and farm animals) - these two elements being linked since women are over-represented in pet medicine. Furthermore, this result should not be interpreted by of a hypothetical link between a more care-oriented female 'nature' but rather by the fact that the labour conditions in agricultural and veterinary settings favour the delegation of 'dirty work' to the most dominated agents: care and its sometimes thankless tasks (repeated visits and travel, strenuous work, etc.) are more often entrusted to women (as well as young and less protected workers) within the framework of a veterinary labour organisation which increasingly values managerial and entrepreneurial tasks.

The greater inner variability of this cluster reflects its size, since it includes 42% of respondents, all of whom agree on the positive consequences that an AMU reduction could have. This leads us to consider that, behind a relative homogeneity in terms of the way in which the reduction of antibiotics in veterinary medicine is conceived, this opinion may in fact be shared by individuals who are very different in terms of attitudes and positions in the social space. Indeed, it should be remembered that the HAC was only constructed on the basis of attitudes variables (and not of socio-professional background, which are here the illustrative variables). As such, it is not necessarily incompatible to observe, in the

same cluster, an over-representation of veterinarians who work alone and/or who work in mixed practices, and others who are, on the contrary, veterinarians for a cooperative or an integrator. Thus, the same way of thinking and doing can in reality be structured by very heterogeneous conditions of practice and have a disparate background. For example, in the case of dairy veterinarians, one might think that their lower, or at least less direct, dependence on downstream industries allow them to serenely consider AMU reduction (i.e. without being overly concerned about the economic consequences that this might have). They may thus share very similar ideas to public sector veterinarians even if they are not from the same segment of the profession.

Finally, Swedish veterinarians, and to a lesser extent Italian veterinarians, are over-represented in this cluster; Danish veterinarians, although not directly part of this cluster, are not far behind either. While Sweden's position is not surprising given the country's long-standing and significant commitment to antibiotic reduction, the over-representation of Italian practitioners is questionable. This result reflects the clear over-representation of respondents declaring a link with the public sector among Italian respondents: here, the "country" variable therefore hides a recruitment bias<sup>1</sup>. This result is clearly visible on the MCA: Italy and Sweden are in very different positions on the factorial design since Italy's position flirts with the horizontal axis and is therefore much further North on the vertical axis, which reflects a greater scepticism about the positive individual consequences of AMU reduction. In contrast, the Swedish respondents are at the very bottom, rather to the right, and as such are almost emblematic of a full acceptance of the idea that limiting AMU can be positive in all respects. The Danish veterinarians are closer for historical reasons (the fight against AMR is also a long-standing political objective that is well anchored in the professional culture), even if the economic model of their clients and practices places them in the latter cluster.

### 3.3.2.3 *Third cluster: Disenchanted vets, considering they have done enough and not much mobilised anymore*

The final, smaller cluster is distinguished from the other two by a more than sceptical attitude towards AMU reduction: less than one in two respondents thought it was important or very important to limit their use. Individuals in this cluster were less likely to use the veterinary press or diagnostic tests to take medical decisions, and less likely to trust the information provided by farmers and moreover technicians. More broadly, they are pessimistic about the positive collective consequences that AMU reduction could have on the system and consumer confidence and, although they do not particularly identify a risk to their workload, they also believe that this reduction could have significant negative consequences for farm profitability and, above all, for animal health. It is particularly on this last point that the veterinarians in this cluster clearly differ from the other two groups: for them, reducing AMU represents a real danger for animal health and welfare in the sense that antimicrobials are perceived as necessary tools for maintaining good health conditions. Respondents in this cluster are therefore in sharp contrast to respondents in cluster 2 who, on the contrary, see the reduction of AMU as an opportunity to improve the sustainability of the system, and who therefore disagree with the idea that limiting antibiotic prescription would degrade animal welfare.

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<sup>1</sup> Furthermore, if the dendrogram is partitioned at the next iteration of the AHC, the first cluster is divided into two: one composed of British veterinarians who are very sensitive to the demands of farmers and who are more mixed about the positive consequences that the reduction of AMU could have collectively, and the other, in which Italian veterinarians are over-represented. In this 'new' cluster, respondents shared the view of the previous cluster on the negative economic consequences that AMU reduction could have, while at the same time being very positive about the changes it could bring about at the societal level.

The veterinarians in this group are more likely to be middle-aged men (between 35 and 55 years old) who say that their activity is exclusively focused on livestock, without any particular speciality, or on pigs and poultry. They were more likely to work in large private practices (6-10 vets). Finally, respondents from Denmark, France, Spain and Switzerland are over-represented in this cluster. How can we account for their positioning? This may be due to an age effect, interpreting the fact that these practitioners were generally trained at a time when the issue of AMR was not as prominent in the public debate. According to an argument similar to the one used for the previous cluster, behind this important reluctance to AMU reduction, there may be different reasons expressed by the respondents depending on their position in the social space. Respondents may just as well consider that the AMR problem does not concern them (or no longer does), either because they have no choice but to use antibiotics to guarantee animal health (which may be reflected in their low recourse to diagnostic tests or recommendations) and that AMR policies have not yet contributed to changing practices, or because they have the impression that they have already done a great deal in this area, as is undoubtedly the case for respondents in the pig and poultry sectors, or countries like Denmark and France in a lesser extent.

The analysis of the 'country' variable is quite interesting here, as it reflects the temporality of these changes. Indeed, as this cluster is the most spread on the factorial design, it is interesting to interpret the position of the respondents in relation to the position of the country variable on the MCA. Thus, French, Spanish, Swiss and Danish veterinarians are distributed differently within the cluster. For example, Danish respondents are rather on the borderline with the second cluster, which may reflect the long history of their AMR policies: Danish respondents are aware that AMU reduction does not have negative consequences on their work (which brings them closer to the previous cluster) but they may no longer consider this measure as a priority in their country, or at least they do not think that it could have more positive consequences than it already had, hence their positioning within the third cluster and on the factorial design. Therefore, they do not feel that going further would change much unless they would completely transform their agricultural system, which is not the path they are on. Then, the further up the vertical axis you go, the more numerous the French and Swiss respondents become, followed by the Spanish. These are the countries where antibiotic reduction policies are the most recent and their mistrust of the individual consequences that they could generate is more acute, certainly because they do not have enough hindsight to assess the consequences and thus potentially dispel their fears.

### 3.3.3 Limits

First of all, our sample size is relatively modest, so it is difficult to conclude that it is representative of the European veterinary population. That said, given the absence of a large European sociological survey on the issue of antibiotic prescription, our analyses, even if incomplete, are intended to provide an initial basis for research in this area and can only invite future research to confirm or infirm the results. The observation of a fragmentation of attitudes towards the AMU reduction, which we have tried to explain by the social and professional characteristics of the respondents, would also benefit from being enriched by more qualitative research that would question individuals on their prescription practices, on the way in which they actually deliver antibiotics on farms, and on the way in which AMU policies really have a concrete impact on their work on farms.

Secondly, the survey raises the same difficulties as those inherent in any European survey. First of all, it is not possible to rule out translation bias, since the questionnaire was available in English but also

in the national language(s) of each country, and it was in this second mode that the respondents preferred to complete it. In addition, each project partner was responsible for disseminating the survey. It is therefore impossible to ensure that the survey was distributed through identical channels in each country (professional lists, word-of-mouth, etc.) in order to control recruitment bias. The over-representation of public sector veterinarians in the Italian questionnaire or the fact that one of the clusters is characterised by a clear over-representation of British veterinarians may be partly due to this recruitment bias. Finally, it is likely that the harmonisation of data at European level has led to approximations or errors because it smoothens national situations. In this respect, national specificities such as the categories of GDS in France or Distriktsveterinärerna in Sweden, which are used by the respondents, are not reflected in the harmonised questionnaire and are therefore difficult to interpret. Thus, while respondents could easily indicate that they did not recognise themselves in any of the proposed practice structures (private practice, corporate groups or networks, and practice attached to a cooperative or an integrator) and indicate in plain language an answer to enable us to understand their practice type, recoding was sometimes complicated to carry out because it required entering into the national specificities of each country and capturing the subtleties. In addition, the questionnaire makes it difficult to enter the regional specificities of each country. The question of the region of practice was asked, but it was not always usable, either because the region considered is too disparate, or because of the small number of respondents for each geographical entity considered, which sometimes makes the risk of de-anonymisation too high. However, it would have been interesting to be able to study the way in which the agricultural structure of the practice area (region where farms are highly integrated or very extensive, agricultural density, specialisation, etc.) affects the attitudes of veterinarians. In particular, this would have made it possible to go beyond the 'national' variable by comparing responses from geographical areas in different countries that are, in terms of farming practices, comparable.

### 3.4 Conclusion: Who cares?

While on average all respondents seemed to agree with the need to limit AMU, the consensus became fragmented when we went into the details of opinions on the anticipated consequences on society and on the work of veterinarians. We then identified two main systems of opposition which essentially relate to the scales at which AMU reduction could have concrete impact: a collective level which incorporates considerations about society as a whole (in particular the agri-food system and the trust that consumers place in it) and the social image of veterinarians and farmers; and an individual level which is more concerned with the working conditions of farmers and veterinarians, in particular the challenges they face in terms of animal health, profitability, and workload. Thus, one may be in favour of a reduction in AMU for the collective benefits it generates while being more reluctant about the individual costs, as well as thinking that such a reduction would be beneficial on all (or, conversely, none) of these levels. Geometric data analysis allows us to understand the associations or, on the contrary, the oppositions between these practices and representations regarding AMR and AMU. Coupled with hierarchical ascending classification, it allows us to identify groups of practitioners whose position in the social space reflects their differences. By analysing the social and professional characteristics of the veterinarians who make up these groups, we have thus understood how the conditions under which they work can affect their approach to reducing AMU, and also how certain veterinarians who work in conditions that are sometimes quite different finally agree on their way of thinking and doing about this issue.

Such research is all the more important because, by deconstructing the idea of a consensus behind the need to limit AMU and by going into the details of the reluctance that some people may have with

regard to this objective, we place our analysis beyond a Manichean vision that would oppose the "bad students" who do not (yet) understand the need to reduce AMU to the "good students" who fully support this idea and see no obstacle to its achievement. This is especially true when it comes to the question of who is most concerned about animal health, which is at the heart of the veterinary profession. The survey shows us how difficult it actually is to answer this question. The analysis of the HAC clusters shows how this concern is actually transversal in the social space, precisely because it is pro-*tean*: all veterinarians are concerned in their own way with the health of humans and animals, even if they do not necessarily place the same actions and values behind these notions.

For example, the vets in the first cluster are those who are closest to the farmers and their concerns. The fact that they are most in touch with what is happening on the farm could make them the guardians of animal health, and thus oppose the practitioners in cluster 2, for whom the demand and information provided by farmers are less important. And yet, it is in this second cluster that we find the respondents who are most in favour of reducing AMU from a public health perspective. In this respect, the fact that they strongly disagree with the idea that AMU reduction could degrade animal health and welfare seems to reflect a political position towards what they consider to be, at best, a *cliché*, at worst, a fallacious justification invoked by all those who do not want to change anything. And yet, in contrast, respondents from the third cluster are the ones who most clearly display their fear of seeing animal health and welfare deteriorate if antibiotic use is restricted, whereas respondents from other clusters are less clear-cut. Their scepticism regarding the restriction of AMU is focused primarily on this issue, as if concern for animal health and welfare was in fact the main argument justifying their hostility to restrictions on these pharmaceuticals that they perceive as indispensable to their mission as veterinarians. This also shows the extent to which veterinarians' attitudes are affected by public debates and, more broadly, by the political timeframes in which practice changes and transitions take place. For example, veterinarians in countries such as Italy, where AMU is still fairly high compared with others, may express strong support for reduction objectives when they are aware of and involved in action plans to reduce AMU, whereas veterinarians in countries with a long history of AMU reduction but whose current focus is on other issues, such as Switzerland or Denmark, appear less concerned. In each of these cases, the major and current controversies around animal health and welfare (i.e. does reducing antibiotics not ultimately compromise the health of animals?), which are often fuelled by political and economic stakeholders to influence public decisions, constitute important fault lines around which the different clusters are formed and distinguished. However, all of them claim to be concerned by care... but by putting this value in differentiated narratives of what it is to be a 'good vet'.

The results of the survey thus show the extent to which this issue of care is transversal to all the clusters, even if it is embodied in very heterogeneous ways of doing and thinking about veterinary medicine and antibiotic prescription in particular. In terms of AMR policies, this implies developing communication tools that take into account these different ways of perceiving care among veterinarians, and therefore adapting the arguments according to the group to which they are addressed so that they resonate with the way veterinarians think about it, and are thus more likely to mobilise in the long term in favour of the prudent use of antibiotics.



## 4 Conclusion: How to promote preventive approaches to animal health? Perspectives on the challenges facing the veterinary profession

Preventive approaches are considered essential levers for reducing AMU in animal husbandry. They allow for a holistic approach to herd health and integrate health management with zootechnical considerations on nutrition, biosecurity, buildings, etc. Cost-benefit studies show that "prevention is better than cure" also on an economic level. For example, the implementation of effective vaccination strategies allows health management at lower cost than antibiotics.

The development of preventive approaches obviously requires awareness and a change of attitude on the part of veterinarians, and this is underway overall, even though the dynamic is part of different timeframes and sometimes different issues depending on the contexts. However, this transition is above all based on large structural phenomena, without which the behaviour of the actors cannot change. We have identified four major processes that promote and characterise the development of preventive approaches, including the prudent use of antibiotics:

- Diversification of veterinary knowledge and services: animal health professionals must move away from strictly clinical and individual approaches, and learn to use technical tools that are broader than diagnosis and drug prescription.
- Renewed working relationships with other livestock professionals: this diversification of veterinarians' professional expertise implies rethinking the labour division of health and zootechnical work between veterinarians, farmers and technicians. Depending on the sector and production system, these relationships may take different forms, but overall we are witnessing a transformation of the role of the veterinarian into a health manager, capable of overcoming jurisdictional conflicts between the different professional groups involved in animal health management.
- Protocolisation (and sometimes bureaucratisation) of health management: this role of health manager is only possible through the implementation of protocols that allow for preventive and holistic management, such as monitoring and analysis of sanitary and technical-economic data, as well as procedures that favour the delegation of tasks to farmers and technicians and their supervision by the veterinarian.
- Emergence of new business models for veterinary practices: these new ways of working can only operate if they are part of economic models that ensure the financial viability of veterinary businesses (historically dependent on the sale of medicines in many countries). New contractual ties are therefore being established between veterinarians and their clients to encourage preventive monitoring of herds (rather than emergency health care), while businesses are expanding their activities to diversify their sources of income (training, technical advice and livestock audits, sale of alternative products such as hygiene, food supplements, alternative medicines, etc.).

These four phenomena are in progress in all the cases surveyed, but there are variations, as well as specific obstacles and levers, depending on several factors. A quantitative study enabled us to identify several of these factors. It appears that European veterinarians fall into three main groups according to their attitude to changes aimed at reducing AMU and developing preventive approaches.

- Business-oriented veterinarians who are rather timid about embracing these changes because they remain concerned about the negative consequences they may have on farmers and their farms (profitability, workload, etc.).
- Veterinarians concerned about public health issues who directly support the reduction of antibiotics and consider that the benefits are both collective (image of veterinarians and farmers, sustainability of production systems, etc.) and individual (animal health and welfare, working conditions of farmers and veterinarians, etc.)
- Veterinarians who are rather disenchanted and think they have already done a lot to reduce AMU and do not express a strong desire to go much further, as they do not see any further benefits, either individual or collective, that this could bring. In particular, they consider that further limiting the use of antibiotics would be detrimental to animal health and welfare.

These three categories of veterinarians are distinguished according to structural factors, in particular countries, livestock sectors (and therefore production systems and relations with farmers) and types of businesses (and therefore their economic models). It thus seems quite clear that it is on these different factors that policies to combat AMR must work in depth, and differentially depending on the context, to further encourage the development of preventive approaches and the prudent use of antibiotics. Of course, more traditional measures such as training and awareness-raising remain important, but they would undoubtedly be insufficient to push further the trend towards reducing AMU, which is already fairly well underway in Europe as a whole.

In our view, the major risk of not taking these structural factors into account could be the establishment of a two-tier veterinary medicine, where practices that have already made most of the structural, economic and organisational transitions towards preventive approaches would capture the most lucrative clients in the animal health market, while others would remain stuck in less efficient and less profitable ways of managing herd health and thus leave farms unable to embrace the necessary changes on the side. Ultimately, there are no “good” and “bad” veterinarians, but professionals who do not experience quite the same realities and who cannot be mobilised in the same way in favour of a continuous reduction in AMU. It is also important for veterinarians to better understand the different experiences and narratives of farmers in order to better support them in the necessary transitions, and to jointly implement changes towards health management methods that are appropriate for all partners. AMR policies must take into account these different situations in order to address veterinarians in a way that is favourable to their long-term mobilisation and, above all, that promotes the major structural levers on which the in-depth transition that all stakeholders are calling for is based.

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## 6 References

- Berdah, Delphine. 2012. « Entre scientification et travail de frontières : les transformations des savoirs vétérinaires en France, XVIIIe-XIXe siècles ». *Revue d'histoire moderne contemporaine*, n°4 : 51-96.
- Bonnaud, Laure et Nicolas Fortané. 2018. « L'État sanitaire de la profession vétérinaire. Action publique et régulation de l'activité professionnelle ». *Sociologie*, vol. 9, n°3 : 253-268.
- Conrad, Peter. 2007. *The medicalization of society: on the transformation of human conditions into treatable disorders*, Baltimore, Johns Hopkins University Press.
- Duval Julien, 2013, L'analyse des correspondances et la construction des chams, *Actes de la recherche en Sciences Sociales*, 200/5, p. 110-123.
- Fortané, Nicolas. 2017. « Naissance et déclin de l'écopathologie (années 1970-années 1990). L'essor contrarié d'une médecine vétérinaire alternative ». *Regards sociologiques*, n°50 : 133-159.
- Fortané, Nicolas. 2021. « Antimicrobial resistance: preventive approaches to the rescue? Professional expertise and business model of French "industrial" veterinarians », *Review of Agricultural, Food and Environmental Studies*, vol. 2, n°102 : 213-238.
- Freidson, Eliot. 1985. « The Reorganization of the Medical Profession ». *Medical Care Review* 42, n° 1: 11-35.
- Freidson, Eliot. 2001. *Professionalism, the third logic: On the practice of knowledge*. University of Chicago press.
- Haug, Marie R. 1988. « A Re-Examination of the Hypothesis of Physician Deprofessionalization ». *The Milbank Quarterly* 66 : 48-56.
- Hellec, Florence, 2009. « Des formes méconnues de conseil aux agriculteurs. L'exemple de l'inséminateur de bovins ». In Claude Compagnone, Caroline Auricoste et Bruno Lémery (dir.). *Conseil et développement en agriculture. Quelles nouvelles pratiques ?* Educagri/QUAE, Paris-Dijon : 201-217.
- Lebaron Frédéric and Le Roux Brigitte (eds.), 2015, *La méthodologie de Pierre Bourdieu en action. Espace culturel, espace social et analyse des données*, Paris, Dunod.
- Roquet Pascal and Richard Wittorski, 2013, « La déprofessionnalisation : une idée neuve ? », *Recherche et formation*, 72, 9-14.
- Ruston A, Shortall O, Green M, Brennan M, Wapenaar W, Kaler J, 2016, Challenges facing the farm animal veterinary profession in England: a qualitative study of veterinarians' perceptions and responses. *Prev Vet Med* 127:84–93
- Timmermans, Stefan. 2005. « From Autonomy to Accountability: the role of clinical practice guidelines in professional power ». *Perspectives in Biology and Medicine* 48, n° 4 : 490-501.
- Timmermans, Stefan, et Emily S. Kolker. 2004. « Evidence-Based Medicine and the Reconfiguration of Medical Knowledge ». *Journal of Health and Social Behavior* 45 : 177-93.
- Woods, Abigail. 2013. « Is prevention better than cure? The rise and fall of veterinary preventive medicine, c. 1950–1980 », *Social history of medicine*, vol. 26, n°1 : 113-131.
- Woods, Abigail. 2014. « Science, disease and dairy production in Britain, c. 1927 to 1980 », *Agricultural History Review*, vol. 62, n°2 : 294-314.

## 7 Appendix

	Denmark	England	France	Italy	Northern Ireland	Scotland	Spain	Sweden
1	10.5	19.3	15.8	17.0	5.3	12.9	4.7	4.7
2	17.3	6.1	24.9	21.8	0.5	3.6	4.1	15.7
3	23.0	4.0	38.0	7.0	0.0	1.0	12.0	3.0
Ensemble	16.0	10.5	24.4	16.9	2.1	6.4	6.0	9.0

	55 ans ou plus	age.NA	Entre 35 et 54 ans	Moins de 35 ans	Total
1	36.3	0.6	37.4	25.7	100.0
2	35.0	2.0	45.7	17.3	100.0
3	29.0	1.0	56.0	14.0	100.0
All	34.2	1.3	44.9	19.7	100.0

	vétérinaires travaillant seuls	2 à 5 vétérinaires	De 6 à 10 vétérinaires	plus de 10 vétérinaires	nb_vets_R.NA	Total
1	17.5	26.3	24.6	24.6	7.0	100.0
2	24.9	29.4	27.4	13.2	5.1	100.0
3	9.0	29.0	31.0	21.0	10.0	100.0
All	18.8	28.2	27.1	19.0	6.8	100.0

	A franchised, network or corporate veterinary practice	A practice associated to a cooperative or an integrator	A private veterinary practice	Public sector / University	Total
1	25.1	6.4	65.5	2.9	100.0
2	20.3	11.2	63.5	5.1	100.0
3	17.0	11.0	71.0	1.0	100.0
All	21.4	9.4	65.8	3.4	100.0

	All	Beef	Dairy	Horse	Other	Pig or poultry	Sheep	Total
1	4.7	26.3	44.4	0.6	5.8	13.5	4.7	100.0
2	8.6	21.3	46.2	0.0	2.5	19.8	1.5	100.0
3	14.0	25.0	37.0	0.0	2.0	22.0	0.0	100.0
All	8.3	23.9	43.6	0.2	3.6	17.9	2.4	100.0

	Farm animal	Mixed practice	practice_spe.NA	Total
1	51.5	48.0	0.6	100.0
2	48.7	50.8	0.5	100.0
3	57.0	41.0	2.0	100.0
All	51.5	47.6	0.9	100.0