

ROADMAP

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

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Preliminary report on social science theoretical framework

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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*



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List of acronyms and abbreviations

AMR – Antimicrobial resistance

AMU – Antimicrobial use

ANT – Actor Network Theory

STS – Science and Technology Studies

WP – Work Package



1. Summary

This report presents a brief overview of different theoretical approaches which were reviewed as part of preparing the research to be undertaken as part of work package 2 (WP2) of the ROADMAP project. ROADMAP focuses on antimicrobial resistance and the use of antimicrobials in different animal farming systems. Work package 2 is the work package which focuses on practices and processes at the farm level. The different approaches reviewed in this report thus cover approaches that are directly relevant to the farm level as well as a number of approaches which may help to understand the links between the farm level and other levels (which are investigated in more detail in other parts of the ROADMAP project). The report covers Supply Chain Analysis, the Multi-level Perspective on Transitions, Discourse Analysis, Biosecurity Studies, Risk Society, Science and Technology Studies, Social Practice Theory, Good Farming and approaches focusing on Relationality, the More-Than-Human and Care. Not all of these approaches are theories as such or are necessarily unified fields of enquiry. Some should instead be regarded as focal lenses homing in on particular topics and aspects.

This report is a first, preliminary overview of approaches based on the social sciences, especially agricultural sociology and cultural geography. We do not here attempt to combine these different approaches into one coherent approach or to create yet another, new approach. Instead we seek to highlight how the different approaches can help to bring attention to different aspects of antimicrobial use and resistance. At the end of a project, another report will be produced which outlines the approach taken and the lessons learnt.

2. Introduction

The ROADMAP project is far from the first project which attempts to understand and grapple with issues of antimicrobial use (AMU) and resistance (AMR) in relation to livestock farming. While many such projects have focused on aspects of microbiology and epidemiology as well as individual behaviour, ROADMAP contains a strong social science component. As such, it is based on the premise that AMU and change ought to be understood as social practices influenced not only by biophysical, economic and individual psychological factors, but also multi-level political, material and social systems and processes involving multiple actors.

The project is structured as a number of work packages (WPs) which concentrate on different aspects of AMU. Though guided by a shared framework, each work package team develops a more detailed theoretical framework to guide their specific approach. This report deals with the approach taken in the second work package (WP2) which focuses on the farm level interactions between farmers, farm workers, advisors, veterinarians and other humans, as well as with more-than-human actants such as the animals, microbes and pharmaceuticals. The wider societal, political and economic contexts, and influence of other actors such as retailers and policy makers are still present and taken into account in WP2, but as seen and experienced from the perspective of the farm level. This report describes how the ROADMAP team conceptualises and approaches the tasks in WP2 as well as the links to other work packages.

The approach taken in WP2 is characterised by the use of mixed methods and by drawing on literature from the social sciences including agricultural sociology and cultural geography. Though a relatively recent topic in the social sciences, use of antimicrobials in farming has been described, investigated and conceptualised in a variety of ways from both natural and social science perspectives. Often, the focus has been on the behaviour of the individual farmer (or veterinarian) though other studies have



focused either on political aspects and or taken a closer look at the science of antimicrobial resistance and how scientific facts about antimicrobials are produced (see Chandler et al., 2016a for an overview of social science studies on AMR).

Given the focus of WP2 on the farm level, we here focus on those approaches that seem particularly relevant and promising for understanding practices and changes at this level while leaving aside other approaches that would be more relevant to other aspects of AMU and AMR. That said, it has been important for ROADMAP to move beyond behaviouristic approaches with their focus on the individual and on psychological factors. We therefore undertook a review of the literature and of different approaches that could help us shed new light on AMU and AMR at the farm level. The following sections provide very brief presentations of some of these approaches and how we understand their relevance for the work of WP2 in ROADMAP.

This report is written as part of the ongoing work of the ROADMAP project and should as such be regarded as work in progress that will develop further as data is collected and the project team's understanding deepens. The aim of this report is therefore also not to come up with a unified theoretical approach (whether a completely novel approach or by choosing one theory above others from those presented below) but to select those approaches and theories which enhance understandings of particular aspects of AMU. We believe that different approaches have various strengths and weaknesses which help bring these aspects into focus, while also having specific 'blind spots' of issues and angles that are not addressed. In the following sections we look at these strengths and weaknesses and the implications they have for understandings of AMU. We here follow Sovacool & Hess (2017) in allowing different approaches to sit uneasily alongside each other and explore where they lead. In the last section, we explain how some of these approaches are feeding into the data collection and analysis in the ROADMAP project. At the end of the project a final report on the approach taken will be produced and be made publicly available.

3. Theoretical approaches of relevance to ROADMAP WP2

The following sections provide a brief overview of the different theoretical approaches that were considered, though not all of these were included as part of the final theoretical framework WP2. Some approaches which have been used previously to look at issues of AMU, such as the theory of planned behaviour and ones focusing on individual behaviour and values have been left out from this review as an explicit aim of ROADMAP was to go beyond these and bring new perspectives to the subject. Not all the approaches discussed are theories as such; some should instead be regarded as lenses or focal areas applied to particular topics. They have nevertheless been included here as they can help bring relevant aspects of AMU into focus.

While attempts at characterisation, classification and ordering always contain an element of the arbitrary and can never do justice to the full breadth, diversity and relations within as well as amongst approaches, for the purpose of this report we first present those approaches which can mainly help us understand the wider social, technical, political and economic context in which actors at the farm level operate and how these different levels are linked to each other. These approaches include Supply Chain Analyses, Multi-Level Perspectives on Transitions, Discourse Analysis, Biosecurity Studies and Risk Society. This is followed by four approaches which are more directly applicable at the farm level, namely Science and Technology Studies, Social Practice Theory, Good Farming studies and Relational, More-than-Human approaches to Care.



3.1 Supply Chain Analysis

Supply Chain Analyses look at the world of farming as part of economic systems which shape the opportunities and constraints for different types of farming systems. They do this by analysing production systems, such as food production, in terms of decisions and structures within the whole supply system including inputs, production, processing and marketing and consumption (Therond et al., 2017). Supply Chain Analyses generally start from the premise that in order to understand production systems and how to bring about change, all the different parts of the production system need to be taken into account. This is because they are highly interconnected and changes in one part of the supply chain will impact on another. In the case of antimicrobial use in the livestock sector the food supply chain can be divided into:

- i. inputs (feeding and breeding industries, pharmaceutical companies, veterinary practices and wholesalers);
- ii. production (depending on the sectors: breeders, hatcheries, farrow-to-finish farmers etc.);
- iii. processing (slaughterhouses, processors, food industries);
- iv. marketing & consumption (retail industry, restaurants, consumers).

Many analyses of supply chains identify and characterise different types of supply chains and look at the implications of these differently organised supply chains. In relation to food supply chains, these include for example conventional supply chains and alternative or quality supply chains (Marsden et al., 2000, Therond et al., 2017). Conventional supply chains usually involve the use of conventional inputs and production processes, large and often widely dispersed distribution channels, the involvement of multinational corporations at many levels of the supply chain and the commoditisation of goods sold. Alternative or quality supply chains may involve niche production methods such as organic or permaculture, often shorter and more spatially contained distribution channels, smaller organisations and potentially more equal power relations between actors and the quality or niche aspects of the goods communicated to consumers at purchase (Marsden et al., 2000). Some studies have sought to combine an analysis of food supply chains with additional factors such as biotechnical aspects of farming systems (e.g., Therond et al., 2017).

As in most fields, there is a large diversity within Supply Chain Analysis. While the more mainstream approaches are either descriptive or rest on the assumption that problems can be solved by creating the right kinds of supply chains, other strands take a more critical perspective explicitly focusing on how issues of power and inequality are inbuilt into the logic of supply chains and markets and why efforts at reforms may not result in radical change if these underlying logics and power differentials are not addressed (Busch, 2016). This can for example be seen in issues around certification and the creation of standards. While certifications and standards are often created through the coming together of different players in the supply chain, the voices of larger players such as retailers carry more weight than others (Loconto and Busch, 2010, Ransom et al., 2013). As a consequence, these larger players can use the certification process to shape the supply chain so that it best suits their interests (Ransom et al., 2013). Even amongst players who nominally take up the same position in the supply chain, certification and standards may lead to the exclusion of some (Busch, 2016). This is for example seen amongst farmers, where small-scale farmers often cannot afford the cost associated with the certification process or may not be able to live up to the required standards.

Focusing on the supply chain can help to identify potential points which could impact AMU (e.g., supermarkets imposing particular standards or information regarding AMU), but can also point towards barriers. Different supply chain structures may have different impacts on AMU and present different



challenges as well as opportunities for change though the more critical approaches to supply chains suggest that altering supply chains alone may not change underlying dynamics and power structures. In contrast to some of the other approaches listed here, Supply Chain Analysis focuses on structures and formal organisations. It can therefore be a useful tool for analysing structures that constrain or enable the actions of individuals, e.g. in the form of suppliers of antimicrobials and supermarket chains with particular production requirements. However, as it is less concerned with individuals and their practices, it will inevitably leave out many of the other aspects that shape what happens at the farm level.

3.2 Multi-level Perspectives on Transitions

Similarly to Supply Chain Analysis, Transition theories or studies look at the wider context though here the focus is on innovation and change rather than on analysing the status quo of an existing system. Transition theories encompass a variety of approaches used to study how socio-technical transitions happen, and to some degree how these transitions can be shaped or made to happen. The focus is often on new technologies, and on the factors that enable or hinder their spread. In the context of ROADMAP, we have concentrated on the Multi-Level Perspective (MLP) on transitions (see e.g., Geels and Schot, 2007) as this approach is useful in linking processes at different levels from the micro to the macro. In this approach transitions are understood as the outcome of interactions of events or processes between different levels. These consist of niches, socio-technical regimes and socio-technical landscapes.

Niches constitute the lowest level (the micro-level) in the MLP and consist of small networks and individuals. It is at this level that innovations are understood to happen. In the context of antimicrobials this could, for example, be a pharmaceutical lab/researcher, veterinary practice or small group of farmers who develop new antimicrobial substances or ways of dealing with animal diseases or ensuring animal health. The next higher level is the sociotechnical regime which represents the existing system with its organizational networks, material aspects, institutional actors, rules and values. This could, for example, be existing pharmaceutical companies, retailers, agricultural advisory systems, legislation and policy. While some of these elements are thus the same or similar to those which would be included in a Supply Chain Analysis the sociotechnical regime is conceived as broader and includes additional elements and organisations and the focus is on how this level interacts with both the higher and lower levels. The sociotechnical regime is seen as relatively stable. Changes are therefore most likely if the sociotechnical regime is somehow disrupted. Such disruptions can, for example, come from the socio-technical landscape, which constitutes the highest level in the MLP. The socio-technical landscape thus constitutes the macro-level and is seen to be largely outside the influence of niches and regimes. The sociotechnical landscape comprises natural, political and social elements. Events at the landscape level could, for example, be changes in markets or disease outbreaks which can disrupt sociotechnical regimes and thereby open up opportunities for niches and their innovations. The recent Covid-19 pandemic has powerfully demonstrated this as it has forced many businesses including farmers and veterinarians to adapt processes and products to deal with disruptions in supplies, work and transport routines.

While the success or failure of innovations is seen to depend in part on their inherent qualities (i.e. their superiority or inferiority to other technologies), it is also seen to depend on events at the levels of sociotechnical regime and landscape. Success or failure thus mainly becomes a question of alignment between developments at the level of the niche and events at the other levels. Creating supportive niches may thus not be enough to ensure the success of innovations. These may, instead depend



on events at the regime and landscape level to provide opportunities for innovations to spread and become established and ultimately integrated into the sociotechnical regime (e.g. as new product on the market or a new organisational structure). Despite its emphasis on increasing stability and resistance to change going from the niche to the regime and landscape level, the MLP does not posit a one-way interaction or pathway. Instead, it is recognised that there can be different transition pathways which can lead to the successful establishment of innovations under different circumstances (Geels and Schot, 2007, Sovacool and Hess, 2017).

In the context of ROADMAP, the MLP can help to understand what conditions might enable or hinder not just the development of novel approaches to AMR but for these to become established and integrated into higher levels e.g. in the form of supply chains and policy. It can thereby help us get away from a simplistic focus on changing farmers' (or veterinarians) behaviours in the face of existing legislation, market structures and norms.

Criticism of the multi-level perspective includes its focus on single regimes and on innovations which makes it less helpful in understanding changes in everyday practices which often cut across different domains (Hargreaves et al., 2011).

3.3 Discourse Analysis

Where both Supply Chain Analysis and MLP are focusing very much on organisations and structures, Discourse Analysis looks at the ways in which phenomena are established, defined and dealt with through forms of representation and associated practices (Chandler, 2019). Similar to Science and Technology Studies (see section 3.6), Discourse Analysis pays close attention to the relationships which give rise to and shape particular discourses. However, where Science and Technology Studies focus on the way in which diverse elements come together in scientific practices to create scientific facts as well as technologies, Discourse Analysis focuses more specifically on forms of representation. Discourse Analysis can help bring to light not only the kinds of understandings and relationships on which, for example, current AMR policies rest, but can also point to the things that are left out, and to the consequences of framing problems of AMR in particular ways rather than others (Chandler et al., 2016b). Discourses shape how we understand the world and what we understand as the best way to act. Particular discourses will thus locate responsibility in particular places and groups (e.g., the farmer, the vet, the hospital the state or the pharmaceutical company as responsible for AMR), promote particular moralities and will point to particular solutions and points of intervention (e.g., regulation or incentives aimed at farmers, information provided to consumers, development of new AMs or vaccines by pharmaceutical companies) (Chandler, 2019, Chandler et al., 2016b).

Often, discourses will cover and link different fields so that the logic applied in one field gets imported and applied to another field. Brown and Nettleton (2018) for example show how economic terminology and logic is applied to the biology of antimicrobial resistance and vice versa. Similar to the work within Science and Technology Studies, Discourse Analysis can thus help us to unpack how particular logics come about and how discourses shape responses and may contribute to making some potential responses disappear from view while others come to be seen as natural.



3.4 Biosecurity Studies

'Biosecurity' refers both to policies and practices relating to the governance of biological risks, as well as their critical study. Broadly speaking, it describes political techniques and strategies aiming to manage and control 'unruly biological matter', whether microbes and viruses or invasive plants and animals (Barker et al., 2013). Of particular interest to ROADMAP are the interventions and monitoring practices which aim to regulate 'pathological lives' in the context of food production systems (Hinchliffe et al., 2016). Within the natural sciences, these have often been considered through a biological and epidemiological lens which focuses on disease transmission and its prevention. Practices informed by such a focus may be framed as a universal good, with associated research aiming to find out how to inform farmers and motivate them to carry out better biosecurity (Donaldson, 2013). In contrast, social science research has sought to foreground the political and social aspects of biosecurity practices, its different governance regimes and ontological politics. This work has increasingly highlighted how contemporary forms of biosecurity are complex and transient assemblages of knowledges, techniques, institutions and practices (Braun, 2013; Hinchliffe et al., 2016; Law, 2006). Moreover, they also emphasise how policy and regulatory protocols are contingent and contested by different actors and their practices (Enticott, 2008; Enticott et al., 2014; Law, 2006). Critical literature on biosecurity, therefore, can help improve understandings of the tensions between the macro- and micro-systems, interactions and decisions involved in AMU policy and animal health care practices at a farm-level.

There are several key aspects commonly highlighted by critical biosecurity literature. Firstly, that its enactment and understanding has historically centred on various spatial and moral boundary-making and bordering practices. These might include the territorialisation of agricultural spaces and sites, or else the bodies of animals, viruses and bacteria (Enticott, 2008; Hinchliffe et al., 2013; Hinchliffe et al., 2016). '[T]o separate diseased from healthy life' (Hinchliffe et al., 2013), disease spread through farm animals and their spaces has often been regulated through a variety of interventions. For example, practices improving sanitation and hygiene; segregating healthy and un-healthy animals; or through culling ill or undesirable animals (Barker et al., 2013; Hinchliffe et al., 2013; Law, 2008). However, these studies have also shown that governing through such 'border-lines' is problematic, in part, because the world (and human economies) requires the circulation of multiple forms of life to survive, thus rendering absolute separation neither possible nor desirable (Barker, 2015; Hinchliffe et al., 2013). Understanding the topological spaces of microscopic, viral life- as in the case of AMR- thus challenges the effectiveness of such an approach to managing animal health.

A second element relates to this interconnectedness and the possibility that viruses and bacteria can unexpectedly emerge within different places, animals and assemblages. Therefore, biosecurity interventions have been shown to target both 'present' and 'potentially present' pathological threats (Braun, 2013; Hinchliffe et al., 2016). Policy and practices, therefore, are not merely enacted in response to disease events, but also in anticipation of these through logics of 'pre-emption' and 'preparedness' (Hinchliffe and Bingham, 2008; Braun, 2013). Through preparedness, governing regimes plan for what comes after inevitable events by producing logistical protocols and practices that order lives, things and information to maintain economic and biological systems and networks. However, such interventions require ethical judgements by practitioners and are bound up in complex material and moral politics.

Relatedly, work from the social sciences has highlighted how biosecurity, in practice, is not smoothly enacted, but contingent on a variety of human and nonhuman factors. Firstly, official protocols and frames of disease might be contested and diversely understood by actors, such as farmers, whose own situated, 'proximate' knowledges and experiences contrast with these (Enticott 2008; Maye et al., 2014). In other words, decision-makers can frequently overlook the culturally-rooted belief systems



that co-constitute alternative conceptions of risk, health and disease (Enticott 2008). Furthermore, this also relates to wider tensions of (dis)trust between practitioners and authorities (Enticott et al., 2014). Under such conditions, valid questions have been asked about which and whose knowledges are deemed most important, the ways in which these are included or excluded from decision-making, and whom particular outcomes are mostly likely to benefit (Enticott and Wilkinson, 2013). Critically, research has also shown that the success of biosecurity regimes is often dependent on the inclusion of tacit and experiential knowledges to help generate more resilient and comprehensive ecologies, as in the case of avian flu (Hinchliffe and Lavau, 2013). Indeed, it is through such knowledge ecologies that practices and systems are better able to adapt to the unexpected, place-specific interactions, ‘interferences’ and realities that challenge the objectives of regulation (Hinchliffe and Bingham, 2008).

Looking at AMU and AMR through the lens of biosecurity can help direct attention to the ways in which animal health, its management and associated risks are understood and framed by different actors, whether farmers, farm workers, farm animals, vets, consumers, society, etc. Biosecurity literature’s focus on differing knowledges and the spatialities, temporalities and materialities of illness, disease and intervention, can further understandings of the ways in which AMR, AMU and its reduction are conceived at the farm-level, and in relation to wider systems.

3.5 Risk Society

While Biosecurity Studies look at the way in which risks associated with animal diseases are perceived and dealt with at the farm as well as other levels, Beck’s seminal work ‘The Risk Society’ (Beck, 1992) is a sociological account of the wider social world through the lens of risk. The theory contends that society has reached a stage of socio-technical development, defined as second modernity, or late industrial society, in which anthropocentric risk is one of its primary characteristics: the risks that characterise the modern world are of our own making. Technological development has brought, alongside clear benefits, a host of risks including new nuclear horizons, genetic possibilities and uncertainties, and an existential crisis fixed upon manmade environmental degradation. The Risk Society reveals socio-technical ambiguities and paradoxes. Whereas scientific and technological domains were commonly framed as providing solutions and progressive improvements to problems centring on human needs and condition, now, in second modernity, promising advances are inextricably fused with uncertainties threatening the greatest calamities (Beck, 2009). In lockstep with such paradoxes, science is argued to have lost its authority amidst raging social conflicts about the very definition of risks. The Risk Society identifies major changing societal patterns underlying the proliferation of risk, including a ‘de-traditionalisation’ of practices; a corresponding ‘individualisation’ of human action with actors increasingly cut off from former ties of class, kin, community and shared practice; and a globalisation of technology, science and society which magnifies risk.

Risk Society analyses generally focus on risk at the macro level, typically investigating the social and institutional arrangements in which they are contested and negotiated (Giddens, 1998). A political dimension is explored whereby new forums and configurations of power are critically evaluated in regards to their capacity to enable change (Beck, 2016). However, the theory does consider both practice and change and, therefore, can be usefully applied at the farm level to support other approaches.

It is straightforward to conceptualise the issue of AMU and AMR as amongst the paradoxes that the risk society illuminates: scientific advances that on the one hand offer medicinal benefits across a myriad of health conditions, including life threatening illnesses that are treated at an economically affordable and global scale, on the other hand, have created dependencies and resistance that represent an



alarming risk. “Even if new medicines are developed”, the World Health Organization fears these “will remain a major threat”. This has resulted in a clear sense of the problem appearing beyond the scope of science and technology solution unless political action results in behavioural change (Sadati et al., 2020).

3.6 Science and Technology studies

While the Risk Society focuses on socio-technical ambiguities and paradoxes and how new technologies have brought with them new risks, Science and Technology Studies (STS) focus on the ways in which scientific facts and technologies are produced. Importantly, STS emphasise the socially constructed nature of scientific facts and technologies (e.g., Hutchison, 2016, Sismondo, 2007). They thereby question the ‘naturalised’ portrayal of scientific findings as neutral facts, a view which often dominates in the natural sciences. Instead, STS point to the many ways in which the production and employment of scientific facts are always embedded in the fabrics of the societies in which they arise and are employed and promoted. This fabric consists of cultural, social, political and economic processes and structures as well as the material forms which express and shape these, for example, in the form of laboratory equipment, university buildings, scientists’ bodies and the phenomena that are being studied (e.g. microbial organisms and the drugs developed to combat these). Where Discourse Analysis focuses on the ways in which phenomena are constructed through particular representations, STS in contrast take a broader look at what makes scientific facts and technologies and emphasises the material nature of the things that together produce a fact or technology. Representations are thus just one aspect and even these exist mainly in material forms such as papers, ink, and the many different elements and components that go into producing computer laptops and servers as well as laboratory equipment.

STS do not represent a unified field of study with a shared theoretical starting point. Instead, there is a diversity of approaches with different emphases (Sismondo, 2007). One of these is Actor Network Theory (ANT), which emphasises the connections amongst humans, other species, technologies and material objects (Law, 1992, Ritzer, 2004, Sismondo, 2004). Whereas longstanding social theory has seen agency as limited to humans, consciousness and intentional actions (or as very limited in general), ANT views agency as something that also characterises other living as well as non-living entities and which arises in these interconnected networks. It thus de-centres humans as the only agential actors and instead speaks of multiple and diverse actants that together make up and shape networks (Sovacool and Hess, 2017). Likewise, significance is seen to arise out of the relationships between these multiple and diverse actants rather than as residing in the actants themselves (Law, 1992, Ritzer, 2004). In the case of AMU and AMR, actants might include microorganisms, genes, pharmaceutical drugs, farm animals, feeding troughs, refrigerators, supermarkets, markets, and laws, as well as farmers, farmers’ family members, veterinarians, consumers, laboratory technicians and politicians (to mention but a few). All of them ‘do’ things to the other members in the network, though this doing does not need to be intentional. Importantly, even where conscious intentions exist these are not given precedence or assumed to automatically lead to desired outcomes. Outcomes are thus always properties of the network rather than of individual actants. It is the relationships between all these different actants together which create AMR and invest it with significance.

Some STS approaches focus mainly on describing the processes through which scientific facts are produced and become widely circulated and accepted. While these approaches are usually critical in their stance, some STS take a more overtly activist approach. These latter aim to hold techno-scientific knowledges accountable and ensure they promote the interests of the public rather than a minority of



private individuals or to the detriment of the common good (for example, as in the case of the development of weapons of mass destruction on the basis of nuclear physics or microbiology) (Sismondo, 2007). Descriptive and more activist approaches are not necessarily at odds with each other and many studies may contain components of both (Sismondo, 2007). This is particularly relevant for a project such as ROADMAP which has an applied focus on an issue relevant to public interests.

Science and technology studies can help us focus on what scientific findings do as well as what things they may preclude, as explained by Hutchison: '[...] the formulation of AMR as a scientific object can be reviewed in the light of the linguistic and relational accounts within science, policy and society. Such work allows us to reconsider the ways we imagine AMR, and allow for the emergence of alternative ways to construct AMR as problem, offering other possible avenues for future intervention.' (2016, p. 27).

3.7 Social Practice Theory

While Science and Technology Studies focus on the production and practice of science and technologies, Social Practice Theory focuses on everyday practices and how these arise, are sustained, changed and become extinct. Practices are here understood as largely routinised forms of behaviour that consist of different elements such as embodied doing, know-how and skills, ideas and meanings, objects and materials. Pantzar and Shove (2010) discern between three broad groups of elements of practice, namely, skills (including forms of knowing), images (including meanings and symbols) and materials (including objects and technologies). Practices consist of particular ways in which these elements come together to form more or less coherent and recognisable entities. Importantly, practices need to be enacted in order to persist over time. Each time a practice such as an animal health check is enacted its different constitutive elements are activated (e.g., the bodily skill of handling animals, knowledge of animal behaviour and diseases, the animal, diagnostic instruments, animal handling facilities and meanings and images associated with caring for animals). Practices change when the links between its elements change or new ones become part of the practice (e.g., new diagnostic or treatment methods as well as new farming routines or perceptions of animal welfare and behaviour). Different elements of practice do not usually all change at the same time, but, changes in one element can lead to changes in others.

Different practices together form systems of practice, such as animal care or farming practices. At the same time, individual practices usually cut across different domains and influence. For example, animal health checks are parts of farming practices as well as veterinary practices and slaughterhouse practices. At the same time, practices are influenced by other systems and their elements. Again, in the case of animal health checks this can, for example, be influenced not only by the availability of elements directly related to health checks (such as diagnostics and animal handling facilities) but also by communication and transport systems (e.g., computers, phones, internet connections, cars, tractors, roads, farm tracks, etc.) which may influence access to (different types of) information, animal health care products and services.

Importantly, many practices are carried out in a largely routinised fashion where they are not actively chosen or questioned, but just enacted as 'the way things are done'. The focus of Social Practice Theory is, therefore, as much on the continued existence and reproduction of practices as it is on their changes. While other approaches, such as Multi-level Perspectives on Transitions (see section 3.2), focus on the successful spread of innovation and end the story where these have become established



(or not), Social Practice Theory is equally interested in what makes practices persist over time as well as how they change.

In relation to antimicrobials in livestock farming, Social Practice Theory can help understand how pharmaceutical substances come together with other elements. For example, how animal housing relates to ideas and norms about meanings of animal health and good husbandry, legislation and retailers' standards, availability of veterinary services, the characteristics of the animals and microbes, and other practices such as those related to crop cultivation or family life. In some respects, this may seem very similar to approaches such as ANT (see section 3.6). However, the main differences include the focus on the everyday in practice theory and the discernment of different elements of practices, including meanings, which are given less emphasis in approaches such as ANT.

A criticism of Social Practice Theory is that it cannot easily be used to direct and govern changes and transitions in practices and that the influence of wider structures and context may sometimes disappear from view (Sovacool and Hess, 2017). Furthermore, with the focus being on practices as enacted by individuals, practice theory is less useful in understanding changes at higher levels (e.g. legislation and supply chains).

3.8 Good farming¹

While the ROADMAP project is seeking to go beyond the focus on individual norms, values and behaviours, it is still relevant to look at the way in which notions such as what it means to be a good farmer can be relevant in relation to AMU. The 'good farmer' concept explores the norms farmers hold themselves and their peers up to and how this influences their practices. This is similar to elements of meanings associated with particular practices as seen through the lens of Social Practice Theory. Assessments of 'good farming' commonly draw on Bourdieu's concepts of capital (Burton et al., 2008; Butler & Holloway, 2015; Haggerty et al., 2009; Sutherland, 2013; Sutherland & Darnhofer, 2012). Bourdieu's work explores power dynamics within society and how power and social order are reproduced and transformed (Bourdieu, 1984). According to Bourdieu (1986) capital is accumulated through labour and comes in the form of economic capital – material and financial property; social capital – networks of connection with other people; and cultural capital – signs of prestige and status. Cultural capital can exist in different forms: in institutionalised form such as educational qualifications, in objectified form of high status goods, and in embodied form in skills and mental dispositions acquired over time which are visible to others (Bourdieu, 1986). Critically, these types of capital are exchangeable to various degrees – economic capital can be exchanged for cultural or social capital (e.g. utilised to develop skills or gain access to particular social groups). Capital acts as a conservative force in the world; capital has the potential to produce profits and to reproduce itself, meaning that not all outcomes are equally likely in the social world – those with capital are likely to produce more capital, those without must invest more labour to produce capital (Bourdieu, 1986).

Using Bourdieu's theory, farmers will strive to be good farmers through accumulating different kinds of capital within the field of agriculture (Sutherland and Darnhofer, 2012). Much of the early good farming literature argued that farmers are resistant to change – that cultural capital ensures that things stay the same, because farmers get both economic and cultural value out of performing actions which are symbolic of being a good farmer (e.g. Burton, 2004; Burton et al., 2008). More recent literature has

¹ This section is an adapted version of parts of a previously published article: Shortall et al. 2018. True Cowmen and Commercial Farmers: Exploring Vets' and Dairy Farmers' Contrasting Views of 'Good Farming' in Relation to Biosecurity. *Sociologia Ruralis*, 58, 583-603.



argued that good farming standards can and do change, but it takes time. The cultural capital inherent in good farming leads to a degree of inertia, but when farmers are challenged in some way (particularly if practices are no longer profitable), then farmers will change their activities and renegotiate associated good farming standards (Sutherland, 2013; Sutherland and Darnhofer, 2012). In addition, farms within different geographic regions, agricultural sectors and production markets such as organic and conventional have been shown to have different ideals of good farming (Sutherland, 2013). Previous studies have shown how good farming is associated with economic capital in the form of agricultural machinery and equipment (Butler & Holloway, 2015); social capital in the form of social ties and mutual obligations between farmers (Flanigan & Sutherland, 2016; Sutherland & Burton, 2011), cultural capital in the form of prestigious skills, knowledge, experience and symbols of good farming such as a tidy fields and well-kept live-stock (Burton, 2004; Butler & Holloway, 2015; Haggerty et al., 2009; Naylor et al., 2016; Sutherland, 2013) and farmers' agricultural pedigree and connection to a farming family (Burton, 2004).

A small number of studies have used the good farming concept in relation to animal health. These studies have shown that good farming is exemplified through the cultural capital embodied in stock keeping skills: having the skills to assess the health and welfare of an animal by eye (Naylor et al., 2016; Burton, 2008; Butler & Holloway, 2015; Haggerty et al., 2009, Shortall et al., 2018). Good farming is also exemplified in the objectified cultural capital in healthy and profitable animals (Wilkie, 2005; Naylor, 2016), and high standards of animal welfare (Haggerty et al., 2009). The condition of a farmer's livestock can be 'read' by other farmers through visual signs of health and vitality such as a shiny coat, bright eyes and alertness and energy in movement to assess the farmer's level of skill as a stock keeper (Burton et al., 2008). Naylor et al. (2016) carried out a study on good farming in relation to exotic diseases and identify three good farmer ideals: stock keeping skills and care for the animals; being a good neighbour and not causing biosecurity problems for the sector – in terms of buying and selling animals with care and culling animals when they pose a risk to other farmers; and the good public facing farmer who has a reputation for biosecurity.

The changing 'rules of the game' addressed here primarily relate to economic duress and intensification. Wilkie (2005) argues that the role and importance of the stock keeper has changed with the industrialisation and intensification of agriculture; larger herd sizes mean that farmers may not be able to get to know their animals individually. The result is a change from "husbandry to industry" (Wilkie, 2005 p.216). This change has been highlighted in recent literature on mechanisation: Butler & Holloway (2015) showed how adopting automatic milking systems could change the farmer's understanding of good farming, with practices of judging animals by eye being partly or wholly replaced with the use of data to monitor health and wellbeing. Naylor et al. (2016) found understandings of good farming divided along the same lines in different sectors. In poultry and pig systems good farming consists of monitoring certain key performance indicators such as mortality rates and water intake, whereas in the cattle and sheep sectors good farming was identified as tacit skills and knowledge that allowed farmers to assess health and welfare by eye. Hansen (2014) shows how mechanised dairy production systems mean that workers need not have skill or experience working with animals. Haggerty et al. (2009) also found tensions within the notion of good farming in pastoral sheep production in New Zealand, with progressive ideas of intensifying production through increasing stocking density conflicting with some farmers' traditional views of caring for sheep to ensure their health and welfare. Shortall et al. (2018) found two conflicting 'good farmer' identities among vets and farmers interviewed: the large, commercial farmer who has the economic capital to invest in biosecurity and veterinary services; and the self-sufficient stock keeper whose cultural and social capital lead them to manage herd health independently.



3.9 Relationality, More-than-human approaches and Care

Recent decades in the social sciences have seen a growing interest in what has been called relationality and the ‘more-than-human’ (Whatmore, 2006). This interest does not constitute a homogenous field or approach but is reflected in diverse forms and fields (including ANT as outlined in section 3.6). This development has been linked to a renewed interest in materialities, embodiment and the way in which bodies and materials are entangled in diverse relationships which produce meanings, practices and material outcomes. In contrast to more-than-human approaches, early studies of care focused mostly on human-to-human care. However, care studies (and theoretical considerations around care) share a focus on relationality with more-than-human approaches and in recent years these different approaches have been brought together to look at care in the context of more-than-human relations. Here, we first briefly outline some basic ideas from Care Theory before returning to the coming together of care and the more-than-human.

Within Care Theory, humans are seen as fundamentally embedded in social relations on which they depend for the fulfilment of their needs (Puig de la Bellacasa, 2017, Tronto, 1993). Care can be defined as attending to the needs of others (whether human or more-than-human) in a very broad sense. It is defined by Fisher and Tronto as, ‘everything that we do to maintain, continue and repair our ‘world’ so that we can live as well as possible.’ (Tronto, 1993, p. 103). In the view of Care Theory, everybody is dependent on receiving as well as giving care (Puig de la Bellacasa, 2017). Giving and receiving care and being embedded in social relations is part of what provides life with meaning and value. Care is thus understood both as broader and more fundamental than the limited number of activities which traditionally have been associated with women and the domestic sphere (e.g. in the form of caring for children and the elderly). As mentioned above, these relations of care were initially mostly understood as pertaining to other humans though more recent studies have extended this to include the more-than-human. The focus on relations means that the field of enquiry is widened to include emotions, morality, multiple values, and situated and embodied forms of knowledge, all of which are seen as relevant and legitimate (Puig de la Bellacasa, 2017).

Care theory has its roots in feminist theory and as such includes a focus on power differences amongst those making decisions about care, implementing care and receiving care, as well as how these differences structure access to care and to resources available for caring (Puig de la Bellacasa, 2017, Tronto, 1993). Relationships of care are thus always situated within existing power dynamics and can both help to reproduce and uphold existing power relations as well as to challenge these (Puig de la Bellacasa, 2017). It is therefore necessary to take into account these power relations as well as questions about the ends and purposes of care, different ways in which care is enacted, and different preferences for how needs are met (Tronto, 2010).

A growing body of work has developed theory specifically at the intersection between care and more-than-human scholarship (e.g. Mol et al. 2010; Puig de la Bellacasa, 2011; Greenhough, 2011; Joks & Law, 2017; Daniels & Mather, 2017; Davies et al., 2018; Donald, 2019). Whilst disparate in many ways, this work is united in its de-centring of the human subject with roots back to Science and Technology Studies and ANT. Extending Tronto and Fischer’s seminal conception of care, Puig de la Bellacasa (2017) asserts that “care is everything that *is* done (rather than everything that “we” do) to maintain, continue, and repair “the world” so that *all* (rather than “we”) can live in it as well as possible. That world includes ... *all* that we seek to interweave in a complex, life-sustaining web (modified from Tronto 1993, 103)” (p.161).



Rather than being conceived of solely as something a human does to another human or animal, care is considered a more-than-human relational achievement in which important work can be done by creatures, plants, technologies, other objects and infrastructures. Moreover, after Barad (2007), care cannot be seen solely as the product of *intentional* agency but of a mutual, emergent unfolding through practice: “Care is not one way; the cared for co-forms the carer too” (Puig de la Bellacasa, 2017, 219). Even notions of a particular species and their individuals being discrete, singular, binary givers or receivers of care is troubled by revised understandings of them as permeable, symbiotic communities (e.g. Haraway, 2016; Lorimer, 2016). Relational, more-than-human approaches to care are in their emphasis on connections and emergent outcomes closely linked to approaches such as ANT which similarly focus on connections between human as well as more-than-human actants (section 3.6).

Puig de la Bellacasa (2017) underlines three key dimensions of care:

1. Care as labour/work - entailing material, concrete practice;
2. Care as affective relations - affect as embodied, not necessarily positive (could involve pain and tedium as much as affection or joy);
3. Care as ethics - e.g. moral imperatives or obligations to look after another

These dimensions “are not necessarily equally distributed in all relational situations, nor do they sit together without tensions and contradictions, but they are held together and sometimes challenge each other in the idea of care” (Puig de la Bellacasa, 2017 p. 5). More-than-human caring happens through a profoundly embodied, reciprocal affecting and being affected (Despret, 2004). Indeed, work done in multispecies ethnography makes the case that in order to generate more liveable worlds with nonhuman others, we need to learn to, notice, ‘listen’ to, and be more attentive to nonhumans (Kirksey & Helmreich, 2010) and indeed find better ways to let animals themselves ‘speak’ on their own terms (Birke, 2014). Therefore, having affect as a central pillar of care - and the work done by emotions - is particularly helpful when examining more-than-human creatures since they tend to articulate and respond through bodily movements, gestures, comportments, multiple senses, and biochemical signalling in ways that can be obscured when we foreground human ways of being and knowing, especially by Western sensory hierarchies privileging vision over touch (Myers, 2015). There is a need to attend to how such affective ecologies are “contoured by affinities and repulsions” (Hustak & Myers, 2012, p. 79) and how they are produced through particular temporalities (Puig de la Bellacasa, 2015) and spatialities of care and its governance (e.g. Conradson, 2003; Popke, 2006; Philo & Parr, 2019). Attention to the geographies of care - including the mobilisation of proximity and distance - provide a useful link between biosecurity (section 3.4) and care framings, as well as to notions of good farming (section 3.8) and wider moralities of agricultural systems, such as moral legal geographies of ends, means and identities (Brown, 2007), and other legal geographies of more-than-human care (Srinivasan, 2013).

These points underline how care is always situated and multifaceted - “there can be no singular vision of what care is or what it might become.” (Martin et al., 2015: 10) - and thus always contingent and power-laden. As Martin et al. (2015) explain:

“Care is a selective mode of attention: it circumscribes and cherishes some things, lives, or phenomena as its objects. In the process, it excludes others. Practices of care are always shot through with asymmetrical power relations: who has the power to care? Who has the power to define what counts as care and how it should be administered? Care can render a receiver powerless or otherwise limit their power. It can set up conditions of indebtedness or obligation. It can also sediment these asymmetries by putting recipients



in situations where they cannot reciprocate. Care organizes, classifies, and disciplines bodies” (p.3).

Acknowledgements that care is contested, conflicted and non-innocent are imbued with an imperative to attend to care because its politics are always already circulating, including in the logics and gendered, racialised, colonial networks of capitalist accumulation (Murphy, 2015; Haraway, 2016). In the context of livestock farming, these asymmetries are found between humans and the farm animals as well as amongst humans working and living in farm environments (farm owners, farm workers, women, family members, external advisors, veterinarians, etc.). These asymmetries have important implications for decision making, enactment and reception of care. In the ROADMAP project a number of case studies (termed ‘marginal case studies’) have specifically been selected to represent and investigate how the marginal status of some human as well as more-than-human influences matters of care.

This means that care can have darker sides, for example, when caring for particular creatures entails the killing of others. Care can be enlisted in violence and be used to legitimise and render it invisible (van Dooren, 2015). In livestock production, care is always practiced through asymmetrical relations of power since humans and various animals do not typically possess the same capacities to articulate and respond - and therefore be visible - within human-defined frameworks of wellbeing. The tool belt of care practices for animal health and biosecurity can include culling, isolation, differential forms of attention and attentiveness, and other forms of disciplining livestock bodies so as to ensure a range of care outcomes from merely surviving to thriving. It then behooves us as researchers of agricultural care practices to attend to the very conditions in which particular forms of care become possible or precluded (after Martin et al., 2015) and what that means for questions about how best to care; how care is cultivated and at what cost; who cares for whom, what, why; what counts as care; as well as the way particular mobilisations of care implicate particular ways of constituting more-than-human relations. In other words, how care relations become articulated, known and responded to. Practical, affective and ethical relations of care will be used and put to work in a wide variety of ways in AMU, and sometimes in ways that are taken-for-granted and relatively obscured. As Puig de la Bellacasa (2017, p. 5) suggests more broadly, “staying with the unsolved tensions and relations between these [three] dimensions [care as labour, care as affective relations and care as ethics] helps us to keep close to the ambivalent terrains of care”.

Core to this body of work is thus the assertion of care as a form and practice of critique, yet one that seeks to re-assemble rather than just take apart its relations (Puig de la Bellacasa, 2017). We can identify in the work of Haraway (2008; 2016) how some key elements of care are operationalised in such a way. She urges an openness and attentiveness to the multispecies webs in which one is already entrained, where “[c]aring means becoming subject to the unsettling obligation of curiosity, which requires knowing more at the end of the day than at the beginning” (Haraway, 2008, p.36). Caring thus means staying with the task and sometime burden of knowing even when that becomes difficult or seemingly hopeless. It means following traces of contingency in ways that make present key absences and consequences. ‘Staying with the trouble’ in this way is suggested, not as a disembodied, dispassionate form of knowing, but, drawing on Despret (2004), as a willingness and ability to be moved. It is a way of cultivating mutual capacities to be affected, and through such affective exchange thus rendering each other response-able, capable of responding in ways that allow living and dying well. Part of this, for Haraway (2016), means creating the conditions in which we can imagine and re-story possibilities for more-than-human practices of care to be otherwise, which could be through artistic as much as scientific ways of knowing.

A more-than-human care lens can help the study of AMU at the farm level in a number of ways by:



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- enabling us to examine specifically situated mobilisations of care and ask: What does it mean to care in various parts of AMU assemblages and with what effects? I.e. allows us to look at the farm as a site and coalescence of care, and thus to invite a deeper understanding of how particular sets of more-than-human relations are made liveable
 - taking us beyond livestock as passive recipients of care in farm-level practices but rather as co-active in the mutual emergence of care practices along with the wider web of humans, microbes, medicines, feed, barns, fields, fences, bedding, cattle crushes, and so on, being alive to the situatedness of care practices within particular vulnerabilities, spatialities (including proximities and distances) and temporalities.
 - invite us to identify (sometimes taken-for-granted) practical, affective and ethical mobilisations and contingencies of care practices in livestock production, and make connections between them
 - helping us situate AMU in real fleshy human and nonhuman bodies and materialities, whilst encouraging tracing the power-laden relationships that co-constitute them outwards from the farm level
 - providing a framework for dealing with the complexities, ambiguities and conflicted dimensions of more-than-human care
 - acknowledging thinking ‘with care’ constitutes a solid, reflexive foundation for considering our own roles and accountabilities as researchers as we engage and remake AMU worlds in particular ways (Martin et al., 2015);
 - exploring the prospects of doing AMU more care-fully: making space for us to imagine and develop alternative possibilities for thinking about and enacting AMU: “Paying attention to practices of care can be a way of getting involved with glimpses of alternative, liveable relationalities, with other possible worlds in the making” (Puig de la Bellacasa, 2017: 170)
 - linking farm-level practices of care to the practices of care done elsewhere (e.g. by vets, scientists, policymakers, auctioneers, pharmaceutical personnel etc)

4. Classifications of different approaches and potential fit with WP2

In projects such as ROADMAP, theoretical frameworks often consist of the adoption or adaption of an existing theory or approach to structure the research and to guide questions, data collection and analysis. This helps to ensure both consistency and transparency throughout the research (Grant and Osanloo, 2016). However, when dealing with complex issues such as AMU and AMR in large scale projects aiming to understand different aspects at different scales, using a single theoretical framework may not be feasible or the best approach. A different way of using theories is to let theory follow from data or to juxtapose insights resulting from different approaches, thereby ‘triangulating’ research findings and providing different insights (Sovacool and Hess, 2017), whether or not these sit easily alongside each other.

To look at the potential contributions of different approaches it can be helpful to try to order them according to their focus, scale, assumptions and goals. Sovacool and Hess (2017) provide different classifications of some of the theories which have been presented in the preceding sections. Their first classification relates to where theories sit in terms of focusing on agency, structure, meaning, relations



and normativity. While agency, structure and meaning constitute different ‘poles’ in a triangle, relational approaches are seen to sit somewhere in the middle of these approaches. ‘Relational’ is, in this typology, used in a broad sense to include approaches such as ANT, Social Practice Theory, Care Theory and Multi-Level Perspectives on Transitions. ‘Normativity’ as used in this typology can either represent separate approaches, such as political ecology and social justice approaches where the normative element is an inherent focus of the approach, or it can be an aspect that is sometimes incorporated in other approaches. An example of the latter would be Science and Technology Studies that not only describe the socially constructed and contingent nature of particular scientific facts and technologies, but which set out to democratise science and ensure that it promotes the public good (Sismondo, 2007). Given that ROADMAP WP2 wants to go beyond individually focused approaches and to look at how practices at the farm level are influenced by different actors as well as the wider context, the relational category as defined in this typology seems to provide a promising avenue to pursue. While the ROADMAP project as a whole also has a normative aspect in terms of aiming to contribute to prudent AMU, WP2 mainly focuses in the first instance on understanding existing situations as well as past changes. This understanding together with information from other work packages will subsequently be used to identify potential points and forms of change.

The second typology presented by Sovacool and Hess (2017) classifies approaches according to their goals and assumptions discerning functionalist-institutionalist, interpretivist, critical humanist, and conflict theories (Table 1). As pointed out by the authors, these are ideal types in a Weberian sense and individual theories and their applications may therefore span or potentially be placed in several categories (depending on how they are employed)(Sovacool and Hess, 2017).

Table 1. Classification of theories according to their goals and assumptions (adapted from Sovacool and Hess, 2017).

	Functionalist Institutional	Interpretivist	Critical Humanist	Conflict
Goals	To search for regularities and sources of disequilibrium	To describe and understand social complexity and multiple perspectives	To describe and problematize assumptions in order to identify potential for change	To identify and modify patterns of domination
Assumptions	Society as a self-regulating system	Society as socially constructed action	Society as historical change and development	Society as a system of struggle and oppression
Topical focus	Norms, values, and institutions	Discourse, practice, and culture	Historical change and cultural difference	Societal conflict
Approaches	Refinement through causal analysis	Discovery through code analysis	Insight through critical analysis	Liberation through structural analysis
Methods	Probing representative samples of subjects	Identifying specific cases, questioning informants	Comparing specific cases or existing research, questioning assumptions	Evaluating historical evidence and structural conditions
Potential placement of theories	Supply Chain Analysis	Relational approaches	Multi-Level Perspective on Transitions Discourse Analysis	Care theory



	Multi-Level Perspective on Transitions		Biosecurity studies Supply Chain Analysis Risk Society	
	Good Farming			
		Social Practice theory Discourse theory Science and Technology studies Care theory		

As the focus of ROADMAP WP2 is to gain a better understanding of what happens at the farm level in terms of AMU, approaches sitting somewhere in between interpretivist and critical humanist approaches in this classification would seem promising. This would point towards the usefulness of approaches such as Social Practice Theory, Discourse Analysis, Science and Technology Studies, and Relational, More-Than-Human approaches and care.

Finally, theories can also be classified according to the scale at which they focus although some theories may cut across scales or be applied at different scales. Approaches such as Discourse analysis, Risk society, and Food chain analyses typically focus on the level of society or the market while care theory, practice theory, relational approaches and good farming studies typically focus more at the local level. These latter approaches may therefore be more useful for the farm level focus of WP2. Meanwhile, Biosecurity studies, Transition theory and Science and Technology studies focus on interactions between and across different levels and can therefore be useful in linking what happens at the farm level to the wider context, and provide bridging points between WP2 and other work packages of the ROADMAP project.

5. Conclusion

Based on the review of different approaches with their different foci, goals and assumptions, a number of approaches stand out as particularly useful to help gain a better understanding of AMU at the farm level. These include Relational, More-than-Human approaches and care, and Social Practice theory which can be applied at the farm level and focus on the intersection between structures, agency and meanings. Furthermore, these approaches straddle ‘interpretivist’ and ‘critical humanist’ categories with the goal to respectively ‘describe and understand social complexity and multiple perspectives’ and ‘describe and problematize assumptions in order to identify potential for change’ (Sovacool and Hess, 2017, p.735). Some of these, such as More-than-Human approaches and care, are already being brought together to provide a focus on care within entangled human and more-than-human relationships. Bringing on board Social Practice Theory can help to provide a focus on the way in which meanings, materials and skills come together in the enactment of practices and how their transient relationships. Additionally, Biosecurity Studies and Multi-level Perspectives on Transitions can help to provide the links to other parts of the project which focus on larger scales.

While attempts have previously been made to integrate some of these approaches such as, for example, the Multi-level Perspective on Transitions and Social Practice theory, this can risk obscuring important differences and insights that different approaches can provide (Hargreaves et al., 2013, Sovacool and Hess, 2017). Instead, it can be more fruitful to explore where different approaches will lead, what insights they produce and where there are points of intersection between them (Hargreaves



et al., 2013, Sovacool and Hess, 2017). This is not always straightforward and needs to be done mindfully of the different assumptions and methodological approaches entailed by various theoretical approaches. While approaches may sit in uneasy tension alongside each other, it nevertheless seems a strategy suited for a large scale, complex project such as ROADMAP, where partners bring different expertise and viewpoints to the project. This is, therefore, the approach taken in this preliminary report on the WP2 theoretical framework, which allows us the space to adapt and learn as we proceed with the research. While we have highlighted the particular promise of approaches, such as relational ones with a focus on the more-than-human and care or Social Practice Theory, we do not yet attempt to generate an integration of these different approaches, but keep them as lenses through which to explore AMU at the farm level.



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