Reconfiguring animals in food systems: an agenda for research
For: Research Agenda on Food Systems

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Section 1. Introduction

Contemporary food systems have been responsible for significant transformations in the bodies and experiences of farmed nonhuman animals (henceforth farmed animals). As Derrida has written, the transformation of animals 'has occurred by means of farming and regimentalization at a demographic level unknown in the past … the industrialisation of what can be called the production for consumption of animal meat … the reduction of the animal not only to production and over-active reproduction (hormones, genetic crossbreeding, cloning and so on) of meat for consumption but also of all sorts of other end products' (2002: 394). Similarly, 'the practices of maximising control over life and death, of "making live", in Foucault's words, through eugenics, artificial insemination and selective breeding, pharmaceutical enhancement, inoculation, and the like are on display in the modern factory farm as perhaps nowhere else in biopolitical history' (Wolfe 2012: 46). At the most fundamental level, farmed animals have been reconfigured to 'fit' better into agricultural production systems, food processing and retail systems, and changing patterns of food consumption. Three brief examples serve to illustrate this. First, the bodies of farmed animals have been largely reconfigured through changes in breeding and reproduction practices. The deployment of genetic knowledges and technologies has increasingly allowed interventions in the breeding of farmed animal populations which have focused on specific bodily characteristics and capacities including, for example, growth rates, milk yields and corporeal conformation (references). As just one example, Michael Watts describes changes in the growth rates, feed efficiency and body size of broiler chickens, writing that 'Since 1940, the industry's feed conversion rate has declined precipitously from three pounds [1.36kg] of feed per pound [0.45kg] of liveweight to under two pounds [0.9kg]. Over the same period of the average broiler liveweight has increased from 2.89lb [1.31kg] to 4.63lb [2.1g], and the maturation period … has plummeted from over seventy days to less than fifty' (Watts 2000: 297). As such, these bodies are seen as more productive within output-oriented agriculture, as 'efficient' within food systems oriented towards producing cheap food, and as well suited for disassembly and processing into the extensive range of food products demanded by retailers and consumers. Second, farmed animals have become increasingly entangled with continually developing on-farm technologies which are responsible for monitoring and managing their lives and bodies. Here, for example, increasing levels of automation have seen technologies such as automatic milking systems replace human labour-intensive milking practices with implications for how dairy cows are expected to behave and for their relationships with people(Holloway 2007), and monitoring technologies inserted onto or into animal bodies produce increasing amounts of data which can be used to manage farmed animals, individually instead of at herd level, at the micro scale. And

third, changes in farming systems have had significant implications for animal health and welfare. Changes in herd size are part of this story. For example in the UK the Agriculture and Horticulture Development Board suggests that between 1996 and 2018, the mean number of cows in a dairy herd almost doubled, from 75 to 148 cows (with many much larger herds becoming established during that time too, see Holloway and Bear 2011). In the US, the phenomenon of so-called CAFOs (Concentrated Animal Feeding Operations) or feedlots has resulted in the concentration of beef production in a relatively small number of very large operations (Gollehon et al. 2001; Imhoff 2010). The USDA's Economic Research Service (https://www.ers.usda.gov/topics/animal-products/cattle-beef/sector-at-a-glance) thus reports that CAFOs containing more than 1000 animals account for less than 5% of feedlots, but produce 80-85% of US beef cattle. Those feedlots with over 32,000 cattle produce around 40% of all beef cattle.

Herd size is not the whole story, however. The management of farm animals in particular farm systems is also important. Endemic so-called 'production diseases', those diseases (such as lameness or mastitis) associated with or made more likely by the conditions in which farmed animals are kept and by the expectations placed on them to be productive in certain ways, are prevalent despite high levels of veterinary intervention(McEldowney, Grant, and Medley 2013). Trading patterns, and hence the circulation of animals over space and between farms, contribute to the persistence of infectious diseases such as BVD (Bovine Viral Diarrhoea), again despite the existence of testing and vaccination regimes aiming to reduce or eradicate their presence. It might, indeed, be argued that such veterinary interventions, in attempting to react to the problems associated with problematic farming systems, contribute to the persistence of such health and welfare issues by normalising them and attempting to remediate them, marginalising arguments that farming systems themselves, and the wider food systems that drive farming practices, could be altered so as to make production diseases less likely.

Developing the argument from these three examples, this chapter aims to review several aspects of the reconfiguration of farmed animals in contemporary livestock agriculture, and to thus develop an agenda for ongoing research into how such animals are transformed as they are caught up in the complex networks of modern food systems. Focusing mainly on examples of animal agriculture and aquaculture in the Minority World, and in particular Western Europe and North America, the chapter looks at how the changing technologies and knowledge-practices of farming, and the changing nature and demands of food systems (from production to consumption and beyond) have been associated with changes in how farmed animals are bred, reared, understood and related to.

The remainder of this chapter is presented as follows. Section 2 focuses on the reconfiguring of farmed animal bodies and populations in contemporary farming systems. Section 3 explores the concurrent reconfiguration of farmed animal subjectivities and experiences as they are remade to fit into farming systems. Section 4 examines how the meaningfulness of farmed animals is restructured in contemporary food systems and also discusses changes in understandings of

farmed animal agency. In each of these sections, contributions towards a developing research agenda are suggested. Finally, Section 5 aims to draw these suggestions together and outline a research agenda for future research into the ongoing reconfiguration of farmed animals in contemporary food systems.

Section 2. Reconfiguring bodies and populations

This section discusses the reconfiguring of farmed animals as individuals and populations within contemporary farming systems. It briefly outlines the emergence of selective breeding and explores its more recent manifestations which have increasingly made use of 'geneticised' techniques. The section outlines how these processes have focused on, and had implications for farmed animals as both individual embodied creatures and as defined populations of animals at herd, breed, national or international scales. A key argument here is that the animals and the systems are co-constituted. Although farmed animal bodies have been significantly transformed over time through breeding and management practices, their bodies have affordances (things they *can* do) and constraints (things which *limit* their reconfiguration) which affect what farming systems *can* evolve, while the systems which do evolve clearly have important effects on farmed animals. At the same time, then, as farmed animals are transformed over longer timescales to fit farming and food systems, they are affected individually and collectively by those systems in ongoing and immediate ways, both bodily (for example in terms of health or disease) and in terms of their subjective experience of being farmed. Because of the potentially detrimental effects on farmed animals, there are clearly ethical questions concerning what farming systems *should* be practiced, and these are returned to in subsequent sections.

Space precludes a detailed discussion of the emergence of selective breeding practices. In brief, particular emphasis is placed on the development of pedigree breeding in the 18th Century, associated with the emergence of specific, so-called 'improved' breeds of livestock (as opposed to regional 'types'), many of which persist to the present day. Pedigree breeding practices have been associated with a wider transformation of agricultural systems, such as enclosure and the increasing incorporation of agriculture within capitalist modes of production, as well as the involvement of aristocratic landed interests along with 'progressive' farmers and stock breeders looking to enhance the financial, production and status value of their farmed animals. The history and effects of these practices has been explored in detail (see, for example, Ritvo 1987; Derry 2003). Selective, pedigree breeding, often using processes of close inbreeding (e.g. mating an animal with its own offspring), and the creation of breeds as identifiable kinds of farmed animal, were dependent on meticulous record keeping and the production of extensive databases regarding the animals concerned. In particular, parentage records – animals' pedigrees – were (and are) vital in recording the relationships between animals, being a mechanism for proving those relationships and thus establishing the quality of any individual animal on the basis of its parentage.

The construction of farmed animal breeds is significant in terms of the reconfiguration of animals' bodies because, in the absence of alternatives such as

genetic proof of membership of a particular type, it was the *visual* apprehension of an animal which informed prospective buyers, for example, that the animal concerned was indeed a member of a particular breed. As such, strictly policed 'breed standards' were written by the breed societies which were established to promote each breed. Breed standards tend to emphasise the appearance and aesthetic qualities of animals, emphasising colouration for example, often in great detail (Holloway and Morris 2014). Animals which do not meet the standards may be ineligible to be recorded in the herd or flock books of the relevant breed society. Over time, there has thus been a set of tensions, played out differently with regard to different breeds, between a desire to retain the breed standard according to which breeds have been 'fixed' according to type, and a countervailing desire to 'improve' breeds to meet changing farming and market conditions, and/or changing aesthetic sensibilities. 'Improvement', in this sense, might mean continuing to seek reconfigurations of animal bodies by making them larger, more efficient, more productive or with different conformations. In some breeds, such as Belgian Blue or British Blue cattle, such reconfiguration has produced extremes of bodily conformation such as the 'double muscling' seen in these breeds (Stassart and Whatmore 2003). Double muscling results from a genetic abnormality in cattle, which has been selectively bred for in order to increase the animals' productivity, despite in many cases producing welfare issues such as problematic calving.

As mentioned above, in this process of reconfiguring animal bodies, record keeping, the production of data, and certification as a way of instilling trust in the qualities of farmed animals, are crucial. The breeds are constituted in and by the data, and the data help reproduce the breed. This process has intensified over time as processes of performance recording, and more recently genetic assessment of animals' qualities, have grown in importance. Performance recording, for example of feed conversion efficiency, milk yields, growth rates, or 'killing out' percentages (the ratio of useful meat to bone etc. in a slaughtered animal) has increasingly supplemented pedigree records. This data feeds back into the reconfiguration of animals' bodies as breeding strategies aim to produce bodies with specific qualities. Importantly, the creation and use of this data is associated with changed understandings of farmed animals, so that they can represented as populations with particular population-scale characteristics or norms, against which individuals can be compared (Holloway et al. 2009). These populations can be the herds or flocks on individual farms, but might also be breed or type populations, or national or even international populations as breeding (through the circulation of live animals, embryos, eggs or sperm) is globalised. Considerations of farmed animals as populations can then lead to larger-scale interventions in breeding and management practices with implications for the configurations of animals, as what is sought is standardised and thus predictable and designed to conform to the needs of particular food processing and retailing segments and systems. Individual animals, measured against population norms, can be managed in different ways, including (for example) the culling of those which do not meet production standards.

In many breeds, performance data is now represented as aligned with animals' genetic qualities, presented in terms of the likelihood of them passing on certain genetic characteristics to their offspring which will be expressed in their phenotypes. Estimated Breeding Values (EBVs), based on performance recording, and genetic markers, derived from analysis of blood, semen or hair samples from animals are widely used in this context. Breeding animals can thus increasingly be selected according to a set of 'genetic' traits, allowing breeders to choose to emphasise (say) growth rate, calving ease or meat tenderness in making choices about which animals to breed with which. Indeed, for some commentators emphasising 'progressive' strategies, breeding based on the traditions of breeds, with an emphasis on animals' colour and so on, should become outmoded as these genetic techniques can better inform decision-making based on the performance and 'eating' qualities that actually matter (Holloway 2005). Especially in pig and poultry breeding, for example, for most commercial farming there has been a move away from traditional breeds towards 'hybrids' created by large commercial companies based on their genetic qualities (Watts 2000), and sold to farmers as trademarked types which will, assuming they are housed and fed correctly, perform in very predictable ways.

In much cattle and sheep breeding, by contrast, the breed as a concept and bodily manifestation retains a valency. Nevertheless, the establishment of new bodily configurations is happening in these species too, with the creation of new, branded 'composite' breeds (e.g. the Stabiliser cattle breed, or the so-called Easycare sheep, in the mid to late 20th Century) claiming to combine the best qualities of several breeds into a new type of animal. As with poultry and pigs, the creation of such composites has tended to be associated with relatively recently formed breeding companies, taking breeding out of the hands of disparate groups of farmers with varying breeding objectives and skills, and concentrating it into the hands of companies who sell breeding animals on to individual farmers. In some cases, as in the further cases of food system companies who contract with farmers to rear animals to enter into their food processing (Holloway et al. 2015; Morgan, Marsden, and Murdoch 2006), the companies' control extends to being able to influence how the farmers then manage and breed their animals, transforming relations of power in farmed animal breeding and influencing the ongoing reconfigurations of farmed animal bodies. In relation to all species, these processes are countered by organisations aiming to preserve traditional breeds for a variety of reasons (e.g. they have aesthetic and heritage value, and might be seen as retaining important genetic qualities for future farming scenarios). These organisations include the breed societies themselves as well as groups such as the Rare Breeds Survival Trust (in the UK) or the Livestock Conservancy (in the US) with a wider remit of protecting livestock genetic diversity in the face of a tendency for farming to focus on a narrower genetic pool.

To end this section, the above discussion leads to a set of questions as part of an agenda for research concerning farmed animals in changing food systems. First, it remains important to continue to trace the implications of the ongoing physical reconfigurations of animal bodies as farming systems and breeding techniques and

practices change. As well as breeding, these interventions include the use of chemicals and pharmaceuticals such as hormones and antibiotics which both controversially facilitate certain kinds of food system practice, and have implications for the bodies and welfare of farmed animals. In breeding itself, techniques such as gene editing are becoming increasingly seen as offering the potential to rapidly 'improve' livestock populations, yet such techniques remain controversial in part because of their association with sustaining intensive forms of animal agriculture. Second, the changing relationships between understandings of individual farmed animals and animals as populations remains an important area of research, as it influences how animals are conceptualised and treated. A third area of interest concerns breeds and breeding practices, and how the intensified application of genetic knowledge-practices is intertwined with the (re)constitution, or decline, of breeds. Relatedly, a fourth area for continued research is the changing power relations associated with these processes, which exist differentially across different farmed animal species and sectors, and vary geographically, but are connected to the increasing importance of companies and other organisations in breeding and managing farmed animals.

Section 3: Reconfiguring subjectivities

In this next section, the chapter builds on the previous section's discussion of the corporeal remaking of farmed animal bodies, by exploring how farmed animal subjectivities and experiences are also reconfigured as they are remade to fit into farming systems. The section also discusses how intersubjective relationships involving humans and farmed nonhuman animals are affected by ongoing reconfigurations of animal bodies and subjectivities.

The previous section emphasised how the reconfiguration of farmed animals had changed their bodies, through the use of breeding strategies and technologies. At the same time, aspects of animal subjectivity have been changed as they have been expected to adapt to different farming systems. In exploring this dimension of change, subjectivity is not seen as an inherent characteristic of a (human or nonhuman) animal, but as something which is a relational effect of, in this case, specific farming systems and particular kinds of farming knowledges, practices, technologies and spaces (Holloway 2007; Miele 2016). The argument is that what it is to be a dairy cow, for example, can be different, depending on whether she is part of a more or less intensive farming system, what kinds of milking technology are used, what kinds of spaces she inhabits and so on. Two brief examples illustrate this.

First, at the same time as breeding for bodily characteristics such as size, colour or productivity, selective livestock breeding has also aimed at reconfiguring subjectivity. Breed society standards, for example, often refer to qualities of subjectivity which are expected to be apparent in breed members: references to 'breed character' for example suggest that individual animals express a shared breed personality. At the same time, some breeds in particular, especially those associated with more extensive, upland farming environments, are expected to exhibit sets of

characteristics such as independence, self-sufficiency and resilience in the face of challenging environmental conditions. More widely, breeding strategies have attempted to breed more docile and pliable animals. Such animals might, first, present less danger to the people farming them, and second, might be more compliant with more intensified farming systems in which they experience crowding, noise, or close confinement. They might thus exhibit less stress in such systems, meaning that from the farmer's perspective they are likely to be more productive. Combining attempts to manipulate animal bodies with reconfiguring their subjectivity, discussion has even taken place regarding breeding chickens, and potentially other animals, to be blind, as a way of reducing the stress such animals experience in intensive farming conditions (Thompson 2007). Taking this further, philosophical debates have considered the ethical implications of creating 'brainless' animals (Solon 2012), for similar reasons (something which accords with recent developments in the field of in vitro meat production, in which meat is 'grown' industrially, rather than 'harvested' from the bodies of animals (see below)). This effective removal of subjectivity is clearly a highly controversial suggestion, removing the integrity of the animal as an animal, but more widely these approaches to breeding for docility or resilience to the conditions of intensive farming come under sustained criticism for acting to facilitate and reproduce farming systems that many see as ethically problematic

Second, certain technological changes have resulted in changing expectations being placed on farmed animals. What they are expected to do, associated with the constitution of a particular subjectivity, alters in relation to the introduction of new technology. For instance, the advent of automatic or robotic milking technologies on dairy farms means that cows are expected to choose to visit the milking robot to be milked, several times during each twenty four hour period. This contrasts with 'conventional' parlour milking, in which the cows are milked together, as a herd, usually twice per day. Automatic milking represents the cow as an individual subject, able to choose when to be milked, and as having a freedom which conventionally-milked cows lack. In terms of how the cow is subjectified in automated milking, however, this freedom is constrained by expectations that she *will* choose to be milked regularly, that she will be a productive herd member, and that she will not *resist* the system by either not choosing to be milked regularly enough, or by visiting the machine too regularly in the search for food (Bear and Holloway 2019).

Beyond these elements of subjectivity, other aspects of farmed animal experience can be characterised in terms of their welfare. While understandings of animal welfare and the closely related concept of health have changed over time (see, for example, Buller and Roe 2018), it is evident that welfare as the subjective experience of farmed animals is closely related to the specific nature of different farming systems and is part of the reconfiguration of animals bodies and subjectivities. Health and welfare are thus systematically part of farming systems, with specific welfare issues being constituted within those systems (McEldowney, Grant, and Medley 2013). For example, some health and welfare issues, such as lameness or mastitis, are specifically referred to as 'production conditions', and are

associated with both the environments animals are kept in (for example, the use of concrete and slatted flooring for indoor animal production) and the physiological demands put on their bodies (for example, the significant metabolic demands put on dairy cows to produce high milk yields, or the effects on broiler chicken bodies of the very rapid growth rates they are genetically predisposed to achieve).

The reconfigurations of subjectivity briefly outlined here, and which are linked to changes in farming systems and farmed animal bodies, can also be associated with important reconfigurations in the intersubjective relations between humans and animals in farming. In this sense, the subjectivities of farmed animals and humans are co-produced in farming systems. Here, for example, important notions of what it is to be a 'good farmer' (Burton et al. 2021) have co-evolved with the changing bodies, subjectivities and experiences of farmed animals, and with growing demands from consumer groups, activist groups and private and public sector organisations for animal welfare to be considered in agriculture. Notions of what makes a good 'stockperson' (Butler and Holloway 2016) or caregiver (Buller and Roe 2018) have also changed in relation to some of the reconfigurations mentioned above. For example, Butler and Holloway (2016) show how what is expected of farmers and stockpeople in dairy farming has changed with the advent of automated milking systems which create large amount of data about animal bodies and productivity: the people involved have to learn to know their animals in part through that data, and to make interventions in the lives of their animals on the basis of the data. More widely, new kinds of data stimulating different kinds of interventions are increasingly created by the various monitoring devices which are attached to animals (such as tags measuring activity levels), or literally placed within animals' bodies (such as boluses in cows' stomachs measuring rumen activity). Similarly, the increasing availability and use of 'genetic' information in livestock breeding reconfigures the relationships between breeders and their animals, at the same time as the animals' bodies are remade in genetically-inflected breeding strategies. Breeders come to know their animals at least partly in terms of such data, supplanting or supplementing previous visual and haptic ways of knowing (Holloway and Morris 2012). In this way, the increasing amounts of data available about farmed animals' bodies and behaviours become part of how animals' bodies, behaviours and subjectivities are reconfigured in contemporary agricultural systems.

As a further dimension of this, assessments of animal health and welfare have increasingly been driven by standardised auditing processes rather than by informal farmer judgements, often tied to accreditation and certification schemes which aim to reassure consumers that their food is being produced in acceptable ways. For example, dairy farmers are encouraged to conduct regular mobility scoring of their cows as a way of assessing the prevalence and severity of lameness, and to drive remedial measures which might include both changing the cows' environment and treating individuals for specific foot conditions. Auditing schemes create further layers of data, and themselves act to drive change in farming practices and animals' bodies and experiences and through their emphasis on the specific criteria they embody and measure. Such schemes represent a degree of institutionalisation in

how animals are reconfigured, as external agencies (including veterinary organisations, accreditation organisations, and retailers) drive the adoption of sets of standards, and audit adherence to those standards as they are enacted through on-farm practice. Further evidence of such institutionalisation can be seen in industry-led schemes focusing on specific diseases. In England, for example, the BVDFree England programme aims to eradicate this viral cattle infection (which can affect animals' productivity and make them more susceptible to other diseases) through a programme of testing and vaccination. In this scheme, some animals are configured as 'Persistently Infected' (PI) cows which will pass on the infection to other animals and to their own calves. Farmers are expected to cull PIs so that other animals are protected from them. Herds of cattle are in this way reconfigured around the specific characteristics of a viral infection, with the aim of actually reconfiguring a national population of animals to be, overall, more healthy(Shortall and Calo 2021).

Finally here, it is important to note the complexity and ambiguity of human-nonhuman intersubjective relationships in agriculture. The emphasis on productivity highlighted in this section is supplemented by other kinds of relationship which can figure at least some farmed animals in alternative ways, and which can also involve their reconfiguration as such animals are engaged with in different ways, through their breeding and care. Thus, at the same time as such animals are regarded and evaluated in terms of their growth rates or milk yields, etc, they can at the same time be regarded as companion animals (Holloway 2001), and as individuals and groups with which farmers or care givers experience intense but problematic relationships of care (de La Bellacasa 2017). For example, Convery et al. (2005) discuss the profound sense of loss and grief experienced by UK farmers whose animals were subject to compulsory slaughter as part of the measures taken in response to the outbreak of Foot and Mouth Disease in 2001. In cases like these, the attachment to certain sorts of animals points to processes of differentiation which distinguish between different kinds of farmed animals in farming systems, implying that there will be a differentiation of treatment and intersubjective relationship too. For example, breeding animals and pedigree animals kept in relatively small numbers are likely to be the subjects of 'closer' relationships than animals being rapidly reared for meat or being kept in very large numbers.

This section leads to a further set of questions informing a research agenda in this field. First, there is a need to continue exploring the production of nonhuman subjectivities as food systems, technologies and relationships change. As part of this, continuing to examine changing human-nonhuman animal relationships in agriculture remains important as these inform understandings of different human subjectivities, and the emergence and contestation of ethical relationships in farming. Second, there is a need to continuing need to focus on different dimensions of health and welfare issues in relation to farmed animals. How persistent issues have been and are being addressed and are understood by different groups (including the nonfarming public alongside farmers, vets, policymakers and others) is an important area of ongoing research, alongside the study of the implications of emergent health and welfare issues for animal bodies, experience and subjectivities. Finally,

emergent ethical issues surround the ongoing entanglement of animals with techniques and technologies, such as novel breeding processes, which reconfigure their experience and subjectivity as well as their bodies (Twine 2010). These issues warrant research which examines the views of different interest groups, again including the nonfarming public, on the future of food systems and the sometimes problematic human-nonhuman animal relationships involved.

Section 4: Reconfiguring the agency and meaning of animals

This final section of the chapter briefly addresses some of the ways that farmed animal agency, and the meaningfulness of animals in different situations, has been and is being reconfigured alongside the remaking of their bodies and subjectivities described in the previous sections.

First, relationships between animals and different kinds of environmental issue are experiencing ongoing renegotiation. On the one hand, farmed animals in certain circumstances have become figured as environmental agents. That is, in some spaces they have been regarded as beneficial to attempts to conserve and manage certain ecosystems. The practice of 'conservation grazing' (WallisDeVries et al. 1998) for example has made use of often 'traditional' breeds of cattle and sheep, as their selective grazing allows the flourishing of particular vegetation species, and even their hoofprints might contribute to producing microenvironments assisting the conservation of invertebrate or bird species. Similarly, pigs have been used in woodland and scrub management. This might be seen as the configuring of farmed animals as providers of 'ecosystem services', expressed through their capacities as (for example) grazers and browsers. On the other hand, however, farmed animals, and perhaps more properly the farming of animals, have been figured as agents of environmental crisis. There are several dimensions to this (Sage 2011). These include the increasing concern about the contributions to greenhouse gas emissions (GHG) made by cattle especially, emissions of other pollutants in manure, and thinking more systemically, concerns about significant transformations of environments such as rainforest into either grazing land or land used to produce crops grown to feed animals reared elsewhere. In this sense, animal bodies are figured as contributing to the climate crisis through their own bodily metabolisms and in terms of the systems which feed them. Concerns about animals' emissions of GHG or other pollutants influence other reconfiguration processes which directly affect animals bodies and experiences, for example through attempts to reduce their environmental impact through intervening in the interactions between animal bodies and environments (for instance by manipulating cows' physiological processes by altering their diets, or their rumen functioning) or through the genetic manipulation of animals to create, for instance, the Enviropig©, engineered to excrete less phosphorous (Forsberg et al. 2003).

Second, farmed animals have also been figured as associated with health threats not only to themselves, through various concerns about livestock diseases and biosecurity as mentioned in previous sections, but also to people through the transmission of zoonoses (i.e. diseases which can affect human and nonhuman

animals) and the potential of new diseases emerging from more intensive forms of contact between farmed animals and people, and which might affect people. Animals thus become associated with risks to human health, and these concerns have been heightened as people have become more aware that the functioning of particular farming systems, and the specific practices involved, create pathogenic ‘disease situations’ (Hinchliffe et al. 2016) conducive to the spread of disease. For example, maintaining large populations of animals confined in indoor spaces means that disease transmission can be rapid, while the frequent long-distance movement of animals makes the spread of disease over larger geographical areas more likely. Responding to these concerns, a whole biosecurity infrastructure focusing on separating farmed animals from possible disease sources, and on tracking and recording animal movements, has arisen (Bingham, Enticott, and Hinchliffe 2008; Hinchliffe et al. 2013; Hinchliffe et al. 2016). As such, then, the reconfiguring of animal bodies to fit into particular kinds of farming system acts back again on those animals as they experience particular kinds of confinement and bodily intervention (such as the use of prophylactic medication) which itself may produce further anxieties such as those related to antimicrobial resistance (Morris, Helliwell, and Raman 2016). Prophylactic use of antibiotics, for example, has been used in some systems not only to try to protect animals against infection, but actually to promote rapid growth as farmers aim for more ‘efficient’ and speedy rearing. This does raise concern not only about the evolution of the bacteria affecting farmed animals so that they are able to resist antimicrobials, but also that such resistance becomes more possible in those bacteria which might affect people.

Finally in this section, the meaning of farmed animals as food has undergone reconfiguration as food systems and consumption practices have changed: animal bodies’ meaningfulness as meat in different food systems varies. Broadly, in systems associated with the mass consumption of animal bodies, there is a focus on production quantity, on qualities such as the efficiency and standardisation of production and on the relative cheapness of animal products. Contrasting with this, other systems are associated with an elite preoccupation with ‘quality’ products, defined in terms of the taste and texture of animal products and with sets of associated meanings linking those products to particular places, people and production processes (e.g. organic production) (Ilbery et al. 2005). In this latter case, particular kinds of animal become important, with some consumers seeking products from ‘rare’ or ‘heritage’ breeds, or meat associated with breeds embodying qualities of taste and texture such as Wagyu or Aberdeen Angus beef. Here again, the material and symbolic configuration of animals is linked to certification and protection regimes, as animal products are labelled with information guaranteeing the breed of animal or the way it was reared. Yet other groups of consumers are moving away from the consumption of animal products altogether, for a range of ethical, health and environmental reasons. This consumption trend may have implications for the future reconfiguration of farmed animals. For example, reduced consumption of animal products may mean that animals figure more in terms of the preservation of rural heritage, in much reduced numbers, rather than as units of production. At the same time the emergence of ‘alternative’ or substitutive modes of meat production,

such as in vitro meat, radically changes understandings of what meat is as it becomes displaced from actual animal bodies (Sexton, Garnett, and Lorimer 2019).

As in previous sections, the discussion above presents some further areas for inclusion in an emerging agenda for food systems research. These include a continued focus on changing relationships between farmed animals and environmental issues, on evolving biosecurity issues and 'disease situations' as they affect human and nonhuman animals and have recursive effects on farming practices and on the bodies and experiences of farmed animals, and on the implications of changing consumption patterns for food systems and farmed animals. The Covid-19 pandemic raises the profile of a further dimension of this. At the time of writing the causes of the pandemic are still being explored, however it is likely that the encroachment of farming practices onto previously uncultivated land, driven by situations where many small farmers are being excluded from their traditional lands, along with the use of 'wild' animals for food, presents opportunities for more encounters between people and 'new' viruses with the possibility that those viruses become able to infect, and become transmitted between, humans. The complexities and geographical and social variability of food systems and production-consumption relationships are likely to continue to mean that animals (both domesticated and 'wild') are configured very differently as they are caught up in different consumption practices and systems, with significant effects on what they mean in those systems, how they are treated, valued and understood, and what effects they can have on human health.

Section 5: Conclusions

This chapter has explored several dimensions of the ways that farmed animals have been reconfigured in contemporary food systems, focusing on how ongoing processes of reconfiguration lead to the creation of a research agenda emphasising continued scrutiny and interrogation of the entanglement of animals with rapidly changing farming systems and practices and of the wider political-ecologies of meat-oriented food systems (Emel and Neo 2015). First, it discussed the remaking of individual and populations of animals through breeding and management practices. Second, it covered the remaking of farmed animal subjectivities and experiences, aspects of reconfiguration which are concurrent with the remaking of bodies but which also imply a need to pay attention to what farmed animals experience as a result of farming practices which focus on their bodies and their productivity, and what is expected of farmed animals in different farming systems. Third, the chapter explored some aspects of the reconfiguration of farmed animal agency, suggesting that the meaningfulness of animals is changed along with interventions in their bodies, subjectivities and experiences. In relation to each section, dimensions of a continuing research agenda have been suggested. Throughout, the emphasis has been on the relationships between farmed animals and farming and food systems: these are co-produced, so that an understanding of how farmed animals are reconfigured requires analysis of the practices and relationships encapsulated within specific systems.

This implies that a reconfiguration of animals is just one part of systemic changes which need to be examined simultaneously. However, if animals are regarded as actors and as sentient subjects, able to affect and be affected by how farming is done, there is an ethical need to pay them particular attention in analyses of continuing and contested changes in farming and food systems which include ongoing rounds of enclosure (Watts 2000), intensification and (neo)productivism, as well as divergent pathways which might emphasise processes of extensification, more sustainable, regenerative and agroecological modes of livestock farming, improvements in animal health and welfare, and even the reduction or ending of the consumption of animal products. While some challenge absolutely the consumption of animal products and their bodies, as seen through the increasing adoption of vegan and vegetarian diets, for many more consumers there is at least a growing desire to know more about where their food comes from and to be able express their 'care' through their consumption choices. In relation to the themes addressed in this chapter, most outside of farming will have limited knowledge of breeding techniques and how animal bodies are reconfigured, and they may know little about modern farming systems and practices. However, many are anxious about the conditions in which farmed animals are produced and kept, expressing this through a rejection of 'intensive' farming, and seeking welfare labelling and foods of known provenance, or through seeking reconnection with food producers (and thus by proxy with their animals and farms) through 'alternative' food networks of various sorts (Kneafsey et al. 2008; Goodman, DuPuis, and Goodman 2012). And yet there are also many consumers for whom this kind of re-engagement with and expression of care for sources of animal products is a luxury, or is indeed not a concern.

Because of these differences in food system pathways (e.g. intensification or extensification) and in people's perspectives on farmed animals a research agenda in this field needs to pursue multiple lines of enquiry, focusing on different practices and visions for the future of food systems. If it assumes that some kind(s) of animal farming will persist, it needs to avoid simplistic assumptions about which farming practices are better and to engage with actual practices, experiences and human-nonhuman relationships which will be geographically specific and potentially very diverse. At the same time it needs to acknowledge the multiple perspectives on the ethically-problematic practice of farming animals, exploring the commonalities and differences evident in the views of different groups of farmers, different publics and others. This 'staying with the trouble' (Haraway 2016) of livestock farming means addressing rather than avoiding difficult questions about the ongoing reconfigurations of animal bodies, subjectivities and agency.

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References

Bear, C., and L. Holloway. 2019. 'Beyond resistance: Geographies of divergent more-than-human conduct in robotic milking', *Geoforum*, 104: 212-21.

Bingham, N., G. Enticott, and S. Hinchliffe. 2008. 'Biosecurity: spaces, practices, and boundaries', *Environment and Planning A*, 40: 1528-33.

Buller, H., and E. Roe. 2018. *Food and Animal Welfare* (Bloomsbury: London).

Burton, R. J. F., J. Forney, P Stock, and L. A. Sutherland. 2021. *The Good Farmer: Culture and identity in food and agriculture* (Earthscan: London).

Butler, D., and L. Holloway. 2016. 'Technology and Restructuring the Social Field of Dairy Farming: Hybrid Capitals, 'Stockmanship' and Automatic Milking Systems', *Sociologia Ruralis*, 56: 513-30.

Convery, I., C. Bailey, M. Mort, and J. Baxter. 2005. 'Death in the wrong place? Emotional geographies of the UK 2001 foot and mouth disease epidemic', *Journal of Rural Studies*, 21: 99-109.

de La Bellacasa, Maria Puig. 2017. *Matters of care: Speculative ethics in more than human worlds* (U of Minnesota Press).

Derrida, Jacques, and David Wills. 2002. 'The Animal That Therefore I Am (More to Follow)', *Critical Inquiry*, 28: 369-418.

Derry, M. 2003. *Bred for perfection: Shorthorn cattle, Collies and Arabian horses since 1800* (Johns Hopkins University Press: Baltimore, Maryland).

Emel, Jody, and Harvey Neo. 2015. *Political ecologies of meat* (Routledge).

Forsberg, CW, JP Phillips, SP Golovan, MZ Fan, RG Meidinger, Ayodele Ajakaiye, D Hilborn, and RR Hacker. 2003. 'The Enviropig physiology, performance, and contribution to nutrient management advances in a regulated environment: the leading edge of change in the pork industry', *Journal of Animal Science*, 81: E68-E77.

Gollehon, N, M Caswell, M Ribaudo, R Kellogg, C Lander, and Letson D. 2001. *Confined Animal Production and Manure Nutrients* (Department of Agriculture Economic Research Service: Washington DC).

Goodman, David, E Melanie DuPuis, and Michael K Goodman. 2012. 'Alternative food networks: Knowledge, practice, and politics'.

Haraway, Donna J. 2016. *Staying with the trouble: Making kin in the Chthulucene* (Duke University Press).

Hinchliffe, S., J. Allen, S. Lavau, N. Bingham, and S. Carter. 2013. 'Biosecurity and the topologies of infected life: from borderlines to borderlands', *Transactions of the Institute of British Geographers*, 38: 531-43.

Hinchliffe, S., N. Bingham, J. Allen, and S. Carter. 2016. *Pathological Lives: Disease, Space and Biopolitics*.

Holloway, L. 2001. 'Pets and protein: placing domestic livestock on hobby-farms in England and Wales', *Journal of Rural Studies*, 17: 293-307.

———. 2005. 'Aesthetics, genetics, and evaluating animal bodies: locating and displacing cattle on show and in figures', *Environment and Planning D-Society & Space*, 23: 883-902.

———. 2007. 'Subjecting cows to robots: farming technologies and the making of animal subjects', *Environment and Planning D-Society & Space*, 25: 1041-60.

Holloway, L., and C. Bear. 2011. 'DNA typing and super dairies: changing practices and remaking cows', *Environment and Planning A*, 43: 1487-91.

Holloway, L., and C. Morris. 2012. 'Contesting genetic knowledge-practices in livestock breeding: biopower, biosocial collectivities, and heterogeneous resistances', *Environment and Planning D-Society & Space*, 30: 60-77.

———. 2014. 'Viewing animal bodies: truths, practical aesthetics and ethical considerability in UK livestock breeding', *Social & Cultural Geography*, 15: 1-22.

Holloway, L., C. Morris, D. Gibbs, and B. Gilna. 2015. 'Making meat collectivities: entanglements of geneticisation, integration and contestation in livestock breeding.' in M Goodman and C Sage (eds.), *Food Transgressions: Making Sense of Contemporary Food Politics* (Ashgate: London).

Holloway, L., C. Morris, B. Gilna, and D. Gibbs. 2009. 'Biopower, genetics and livestock breeding: (re)constituting animal populations and heterogeneous biosocial collectivities', *Transactions of the Institute of British Geographers*, 34: 394-407.

Ilbery, Brian, Carol Morris, Henry Buller, Damian Maye, and Moya Kneafsey. 2005. 'Product, process and place: an examination of food marketing and labelling schemes in Europe and North America', *European Urban and Regional Studies*, 12: 116-32.

Imhoff, Dan. 2010. *CAFO reader* (Watershed Media).

Kneafsey, Moya, Rosie Cox, Lewis Holloway, Elizabeth Dowler, Laura Venn, and Helena Tuomainen. 2008. *Reconnecting consumers, producers and food: exploring alternatives* (Bloomsbury Publishing).

McEldowney, J, W Grant, and G Medley. 2013. *The regulation of animal health and welfare: science, law and policy* (Routledge: London).

Miele, M. 2016. 'The making of the brave sheep ... or the laboratory as the unlikely space of attunement to animal emotions', *Geohumanities*, 2: 58-75.

Morgan, K, T. K. Marsden, and J. Murdoch. 2006. *Worlds of Food: Place, Power and Provenance in the Food Chain* (Oxford University Press: Oxford).

Morris, Carol, Richard Helliwell, and Sujatha Raman. 2016. 'Framing the agricultural use of antibiotics and antimicrobial resistance in UK national newspapers and the farming press', *Journal of Rural Studies*, 45: 43-53.

Ritvo, H. 1987. *The Animal Estate: The English and other Creatures in the Victorian Age* (Harvard University Press: Cambridge MA).

Sage, Colin. 2011. *Environment and food* (Routledge).

Sexton, Alexandra E, Tara Garnett, and Jamie Lorimer. 2019. 'Framing the future of food: The contested promises of alternative proteins', *Environment and Planning E: Nature and Space*, 2: 47-72.

Shortall, Orla, and Adam Calo. 2021. 'Novel industry-government governance mechanisms for the eradication of bovine viral diarrhoea in the UK and Ireland', *Journal of Rural Studies*, 81: 324-35.

Solon, Olivia. 2012. "Food projects proposes matrix-style vertical chicken farms. Wired." In.

Stassart, Pierre, and Sarah J Whatmore. 2003. 'Metabolising Risk: Food Scares and the Un/Re-Making of Belgian Beef', *Environment and Planning A: Economy and Space*, 35: 449-62.

Thompson, Paul B. 2007. "Welfare as an ethical issue: Are blind chickens the answer." In *Bioethics Symposium: Proactive approaches to controversial welfare and ethical concerns in poultry science. http://www. csrees. usda. gov/nea/animals/pdfs/bioethics_symposium_report. pdf Accessed Nov*, 3-5.

Twine, Richard. 2010. *Animals as biotechnology: ethics, sustainability and critical animal studies* (Earthscan).

WallisDeVries, Michiel F, Michiel F WallisDe Vries, Jan Pouwel Bakker, Jan Pieter Bakker, SE van Wieren, and Sipke E Van Wieren. 1998. *Grazing and conservation management* (Springer Science & Business Media).

Watts, M. 2000. 'Afterword: Enclosure.' in Philo C and Wilbert C (ed.), *Animal Spaces, Beastly Places* (Routledge: London).

Wolfe, C. 2012. *Before the Law: Humans and Other Animals in a Biopolitical Frame* (University of Chicago Press: Chicago).