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ANIMALS AS BIOTECHNOLOGY

ETHICS, SUSTAINABILITY AND CRITICAL ANIMAL STUDIES

RICHARD TWINE

Animals as Biotechnology

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Introduction

From the Sciences of Meat to Critical Animal Studies

I take it as a not overly ambitious claim that with regards to 'meat' we are living in interesting times. The global discourse of climate change continues to place a question mark around the human production and consumption of other animals. Since 'meat' and the consumption of other animal products is better understood as a particular relationship between humans and other animals, we can also frame its politicization as an amplification of critical scrutiny around a significant facet of human–animal relations.[1] Where climate change discourse operates to disclose further the human–*environmental* relations bound up in 'meat', its success as a 'commodity' – something which is understood as disguising such relations – is, at least in relative terms, under threat.

The key impetus for this book has been my witnessing of the simultaneous emergence of two rather oppositional trends in academic knowledge production that both pertain to human–animal relations and more specifically to what we can term the scientific, economic and cultural production of meat. The first of these refers to the array of specialized biological sciences that during the 20th century developed around the business of breeding farmed animals. I am pointedly interested in the shift within such sciences, especially during the first decade of this century, to the molecular, to the potential of producing animals as biotechnology. If I have already pressed a claim on the urgency of the 'present' by mentioning the issue of climate change, we can furthermore point to the contemporary moment as significant for the initial commercialization of certain molecular techniques of animal breeding. The second emerging trend I refer to is the interdisciplinary development of animal studies over the last nearly 40 years. Not to be confused with 'animal research' and mostly emerging from the humanities and social sciences,[2] animal studies has re-evaluated the role and presence of nonhuman animals[3] in a wide range of disciplines where they have been for the most part ignored. It is also unprecedented for the way in which it has politicized human–animal relations, a development which is even more apparent, as we shall see, in the variant *critical* animal studies.

To gain a sense of the contemporary ambivalence around framings of 'animals', there has perhaps been no better method than spending time with both of these communities. Thus in researching this book I have talked at length with those scientists who work to

improve the profitability of the commodification of animals and I have also attended animal studies conferences with scholars who are exactly opposed to such practices and where the catering has been largely vegan.[4] Yet in both of these communities there are degrees of complexity in ethical understanding and moral outlook that speak to the wider societal questioning of both our relation to other animals and to nature. Although this book may be read as the work of a sociologist engaged in both animal and critical animal studies research around the molecular turn in the sciences of meat, this does not necessarily culminate in any simplistic politics. While I take the perspective that setting animal biotechnology in a broader social context is a prerequisite for a critical focus, it also brings into relief, as we shall see, the complexity of bringing about social, economic and political change.

I use this introductory chapter for various tasks. First, I outline the basis that situates the work in a broader set of relevant debates and intellectual spaces, explaining the particular approach to the subject of animal biotechnology that is chosen here. Animal studies is difficult to define since it is a relatively new academic formation and because it is both contested and interdisciplinary. It is a critical theory in the sense that its emergence in academia is partly bound up in that of social movements advocating for change to particular intransigent human–animal relations. Thus we can witness the development of subdisciplinary foci on nonhuman animals within and between the major humanities and social science disciplines (including history, geography, cultural studies, philosophy, political science, sociology, psychology, criminology, gender studies, anthropology, media studies, literature, art, law, theatre studies and musicology). In general terms these endeavours have involved internal disciplinary critique and redress around the exclusion of the nonhuman and, relatedly, dissatisfaction with an assumed human–animal distinction in academic knowledge production. This critique encapsulates the view of this distinction as falsely polarizing differences between 'human' and 'animal' and of naturalizing a certain epistemological and normative anthropocentrism (human-centredness) across the academy. Implicit here is a further critique of the bifurcation of disciplinarity along the nature–culture boundary. Both in their histories and nomenclature, the *human*ities and social sciences signal a certain species apartheid. It should not then be surprising that the 'natural sciences' of ethology and animal welfare are also usually given an important role in animal studies, especially in terms of the way in which their recent findings have questioned a sharply polarized distinction between 'human' and 'animal', but also, significantly, because generally they share with the rest of animal studies an interest in the notion of animal subjectivities.[5] It is useful to underline at this early stage that animal studies should also be read as an interrogation of the *human*, as a critical openness to rethinking what we understand as 'human' and to reconceptualizing its historical and cultural consolidation as constituted by being 'not animal'. Increasingly there are affinities and overlaps between animal studies and ideas of *post*humanism that I return to a little later in this introduction; these will prove germane for the overall direction of this book. For the time being, the initial point to make is that while I situate this work in the interdisciplinary overlaps of animal studies, I am also influenced by my particular location as a sociologist and through some of the ways in which debates in my 'home' discipline are relevant to both understanding animal studies and to approaching biotechnology. So I am interested in this introduction to also convey the various overlapping academic identities from which this work emanates.

The second task for this introduction is to outline the areas of biotechnology of interest and to explain the particular molecular techniques and terminology in more detail. Since a significant proportion of animal biotechnology refers to a molecular turn in specific breeding practice, it is not surprising that it is an area with a potential bearing on a wide range of human–animal relations. The main focus of this book is the application of genomics and biotechnology to animal agriculture. This is for two main related reasons. On the one hand biotechnology in this area is of specific interest owing to the way in which it is bound up in vital contemporary debates around sustainability, and on the other agriculture is numerically the area of human–animal relations where most animals are used and potentially where a lot of change could be made.[6] Nevertheless, in choosing this focus the book does periodically discuss animal biotech in other areas such as medical research and 'companion animal' relations. Indeed, as will become apparent (most obviously in Chapter 3), I argue that ultimately the domains of agriculture and medicine, often presumed separate, are in fact rather interlinked. Finally toward the end of this introduction I outline the structure in more detail, indicating the various arguments and themes of the book.

Sociology and Animal Studies

Although the discipline of sociology in its origins was largely premised on a particular disavowal of the 'animal' and related demarcation of the 'human', sociological research of the last 30 years has exhibited a more promising reflexivity to its own disciplinary boundaries. This questioning of the discipline may be seen as an attempt to unravel its dualistic heritage, an undertaking which of course has not been confined to sociology. It is not too much of an exaggeration to say this is emblematic or at least a central conceptual scheme in contemporary research in most disciplines and is especially salient to transdisciplinary movements such as animal studies and gender studies. I take dualism to be a Western, historically entrenched, if not uncontested, method of constructing difference and stabilizing identity. More specifically, dualism is a way of 'construing difference in terms of the logic of hierarchy' (Plumwood, 1992, p12) and so is more than just treating domains as different or dichotomous. More fundamental than its role in the colouring of disciplinarity and academic structure is the pertinence of dualism to the construction of identity and power in all modes of political struggle. Such a grand statement can only be justified when we begin to appreciate how different dualisms form an 'interlocking structure' (Plumwood, 1993, p43) that reinforces a notion of human exceptionalism from 'nature'. Some of these key dualisms are oppositions between culture and nature, mind and body, human and animal, male and female, social and biological, and reason and emotion.[7] Dualisms are both externally and internally relational in that they narrate reiterations on a theme reinforcing particular shared sets of ontological and normative assumptions between each other, and internally to ascribe sharply demarcated essences. Evidence for their generative power can be seen in reference to the traditional sociological nexus of concern over class, race and gender relations. Reading the left-hand-side terms provides an indication of various cultural hegemonies, perhaps most notably the evocation of a particular and exclusionary idea of the 'human'. Reading the right-hand terms indicates the interrelated means by which discourses of gender, race and class have posited difference hierarchically. It has thus been a consistent conduit

for negatively construing otherness to associate groups (nonhuman animals included) with 'nature', 'bodiedness', 'emotionality', 'biology', 'animality' and so forth, although it is also more complex than this in that dominant groups may harvest 'nature' for conceptual resources with which to construct identity. A good example of this is that although 'women' have historically been associated with 'nature', masculine identity may also commonly draw on ideas of 'nature' or animality as a conduit for thinking itself powerful and denying bodily or emotional vulnerability. Similarly, while I have already stated that the 'human' has been constructed against that which is deemed 'animal', it also borrows from animality seen, for example, in the periodic naturalization of human meat eating by reference to carnivorous nonhuman animals.

At this point in considering dualism, the sociological imagination clicks (with helpful nudges from animal studies and others) and realizes the importance of thinking the 'animal' and 'nature', and *re*thinking its various foundational concepts. It is not just that categories of 'nature' and 'animal' are recognized as important for thinking how gender, race and class have been represented and so crucial for the critical focus of sociology, but that its core concepts such as 'society' and 'sociality' have been, for the most part, thought in anthropocentric ways. This process of sociological reflexivity unravelled during the last third of the 20th century with the emergence of various new subdisciplines of which the 'sociology of animals' was just one. My argument here is that these subdisciplines can be read in retrospect as an attempt, if not particularly coordinated, to try to reconceptualize the discipline in other than dualistic terms. Beyond the emergence of an animal-inflected sociology, we should also include environmental sociology as well as sociologies of the body, emotions, gender, death and scientific knowledge – the latter being a part of interdisciplinary science studies.[8] The cumulative effect of this new knowledge has been to question the unreflected humanism that had been at the heart of sociological enquiry – in the sense of a rational, disembodied, masculine actor. An ontology of the self and sociality purified of nature and its dualistic referents has been called into question.

In the confluence of animal studies and sociology this has had several research trajectories, none more important than reconceptualizing the idea of 'sociality as a marker of the human'. This has some way to travel: the sociology of human–animal relations remains somewhat esoteric to mainstream sociology, just as every animal studies scholar faces a challenge when returning to and communicating with their 'home' discipline. As women's and gender studies scholars have found, challenging ingrained centrisms is not a quick process. Tovey has complained of a general invisibility of other animals in sociology, especially within environmental sociology (2003), which arguably has been more successful in gaining disciplinary respect than the sociology of animals.[9] Tovey's critique is especially directed at the invisibility of domesticated farmed animals in sociological work,[10] which, as she points out, is curious as it is hard to conceive that such domestication could have arisen in the first place without a certain nonhuman sociality and human–nonhuman communication. In quite obvious ways human social lives include a wide range of relations with living (and dead) agential nonhuman animals. Often these relations influence our self and social identities. Beyond such points it is not that other animals become social by virtue of their relations with humans, but that other animals broaden our understanding of sociality in rather diverse ways. To concur with Tovey, taking domestication seriously

is important if sociologists are to better examine the ways in which humanity impacts on the lived, experiential lives of other animals. Indeed arguably domestication ought to be of specific sociological interest. If sociality is a key sociological concept, then it is relevant to note that the genetics of domestication tend to select for docility rather than sociality in farmed animals – building in a degree of management into the very genetics of the animal and perhaps producing animals with less capacity for interaction.[11] Animal sociologists have been assisted by the contribution of other novel sociologies that have been interested in broadening out understandings of the social and of agency as hybrids of human and nonhuman entities. Notable here is the approach of actor-network theory (ANT), a particular anti-dualistic approach within science studies.[12] The ANT concept of generalized symmetry decentres the human as one part of a network with various other nonhuman actors. As Goodman states:

> *Its premise is that agency is always a collective, networked outcome, performed by nondualist sociomaterial associations. In this relational and processual conceptualization, nonhumans are actively present and consequential.* (2001, p193)

In common with much of feminist science studies,[13] ANT wants to account for the 'liveliness' of the nonhuman (including technologies) in understanding sociality. This is also counter to anthropocentrism in the sense that it questions the degree of *control* humans have over both other animals and their technologies.[14] As will become clearer later, it is simplistic to assume, for example, that the relations of domestication are somehow complete and achieved. Biotechnology illustrates how domestication is a processual relationship in which humans are trying to control animal breeding in various economically framed directions, but that such attempts have unforeseen consequences that may thwart notions of ultimate human control. Similarly, it would be difficult to begin to understand climate change without some notion of the nonhuman as agential, of producing unexpected twists to our assumptions of how we might assume relations to unfold.

The way in which I have set out the commonality between these sociological sub-disciplines as interested in conceptual and ontological innovation, and as particularly critical of dualism, is of import to thinking about animal studies as a whole. It contextualizes animal studies as part of a broader context of academic reflexivity, which entails that it should be of interest to those scholars who, whatever their discipline, are focused on substantive areas such as gender, the body and emotionality. In turn this work should be of interest to animal studies. Moreover, if the point of critique of animal studies conceptually is a particular assault on human–animal dualism, and that dualism is similarly pertinent to the operation of, for example, gendered, classed and racialized relations, then we can see animal studies as productive to a broader understanding of intersectionality: a social science concept that posits shared features and interaction between what have traditionally been seen as categories of oppression. Intersectionality is a multifaceted concept that is used in different ways. I shall return to it shortly in order to outline how this book draws on the idea.

If the setting of animal studies within a broader movement that challenges dualism is intended to point out its potential appeal to sociology and across the academy, I am constructing here not only a sense of the ways in which taking nonhuman animals seriously benefits cognizant impulses in academia, but also drawing on sociological

debates for the benefit of animal studies. More specifically this book taps into sociological work in order to add to the analysis of biotechnology within animal studies. For example, the sociology of science (of genetics in particular) is drawn on to think about the wider economic framing of animal biotechnology and I use sociological concepts of the body to think more fully how agricultural science constructs the bodies and 'being' of farmed animals. We can also in this introduction draw on the reflexive tradition of sociology to think through what is an important issue for any book about human–animal relations as well as being a recurrent point of tension within animal studies, namely the question of political engagement.

Political Engagement? Burawoy's Sociology and Critical Animal Studies

If the field of animal studies can be said to be operating (appropriately enough) with a proverbial 'elephant in the room', then that issue is advocacy. In other words, an ongoing question is to what extent animal studies scholars should also be activists for social change that benefits the lives of nonhuman animals? As this issue of normativity is also one common to sociology, I draw on sociological work to explore it further. This question is not wholly separate from the issue of anti-dualistic conceptual renewal already discussed, since challenging interconnecting dualisms and replacing them with an impure notion of the human as *entangled* with the nonhuman constructs a relational ontology that binds the fate and flourishing of 'humans' and 'nature' together. However, this is not quite the same as saying that a posthumanist sociology espouses a particular political programme or ethical position.[15] Yet it does make clear, as Goodman states, that 'the novel socionatural assemblages of contemporary agricultural technoscience, and the risk of irreversible, unintended and shared socionatural harms, remind us how much ontological choice matters' (2001, p195).

Ontological work could be seen as re-politicizing sociology, but in a positive sense keeping open just how that politics might express itself in varying productive sociological critiques of social, economic and environmental policies.

In one analysis, sociology might be seen as a slightly confused discipline in terms of its relationship to political change. While it has a strong critical tradition influenced by social movements, its historical roots are also tied to a positivist notion of sociology as a value-free science. Although it is feasible to retain a notion of sociology as a science that produces critical knowledge about the social, work by sociologists of scientific knowledge would strongly argue that previous attempts to construct sociology as value-free were anyhow based on a flawed model of the natural sciences. Indeed one premise of contemporary sociological enquiry into genetics and biotechnology is to examine how a science with a eugenicist legacy may remain prone to gendered, racializing or ableist assumptions. That agricultural science naturalizes instrumental values towards domesticated animals is unambiguous. In light of such points about the interestedness of science, there is now a degree of consensus that sociology (at least in the British form with which I am most familiar) is an engaged science with a particular orientation to issues around social justice.[16] Aforementioned challenges around the meanings of 'social' here speak to whether or not 'justice' or 'politics' is to be understood in anything other than anthropocentric terms.

To explore this further I turn briefly to the influential work of Michael Burawoy, who in his 2004 address as the then President of the American Sociological Association (ASA) conceptualized sociological labour as comprising four interdependent forms: professional, critical, public and policy. Burawoy (2005) defines these as follows:

1 *Professional* sociology refers to the work conducted in research programmes that define the evolving assumptions, theories and concepts of the discipline.
2 *Critical* sociology examines the explicit and implicit foundations of the research programmes of professional sociology. It attempts to make the latter 'aware of its biases, silences, promoting new research programmes built on alternative foundations' (2005, p268). Critical sociology argues that the discipline must also address extra-academic audiences and engage in debate about the direction of society. (Given the way in which globalization processes have also undermined the sociological concept of society, I assume here that we must understand this questioning of societal ends in transnationalist terms).
3 *Public* sociology refers to this bringing of the discipline into conversation with varied publics. It includes everything from teaching to writing in the media as well as collaborative research with civil society groups. Burawoy argues that sociology ought to expand its public role in this way, for example by deepening the quality of societal debate around various issues of injustice. (In terms of thinking about the sociology of science, this form of sociology certainly has important resonances with the now considerable body of work around public engagement on science and technology).
4 *Policy* sociology refers to a client-led sociology whereby sociologists respond to particular problems presented to them and then make recommendations to policy.

Burawoy refers to both critical and public sociology as producing *reflexive* knowledge since they examine the 'value premises of society as well as our profession' (2005, p269). Moreover he sees all four forms as working to strengthen each other, but that all are prone to exist in their pathological form if they are over-responsive to their particular audiences. The *policy* form may become overly servile, the *professional* overly insular and theoretical, the *critical* dogmatic, and the *public* sociology may over-pander to its publics. Overall this is a useful framework that we can apply to thinking about animal studies and the 'animal' within sociology. Yet Burawoy can be brought to task for failing to break out of traditional sociological anthropocentrism. His approach, to use his own terms, arguably requires a little more critical sociology. His argument is, rightly I think, for the rejuvenation of the reflexive forms of sociological knowledge, namely critical and public. He argues that sociology has a responsibility to defend the social, to proliferate the actors of civil society (including the likes of NGOs, charities and social movements) who are also interested in probing the 'direction of society'. Yet he intertwines this with a view of sociology as 'defending the interests of humanity' (2005, p287). This can be read as jarring with those counter-dualistic sociological subdisciplines mentioned previously that precisely question the uses of the 'human' as a moral clarion call given its exclusionary history. Since these new sociologies have constituted perhaps the most obvious form of *critical* sociology during the last 30 years for the way they have undermined the traditional focus of the discipline, it is important not to reproduce the equation of the defence of the social with that of 'humanity'. In spite of Burawoy's faux

pas, if we take the arguments of animal studies and environmental sociology seriously, then we must also realize that a 'defence of the social' can be understood to also include in some way the more-than-human.

Nevertheless, Burawoy's framework remains useful. Not only can we now set animal studies in sociological context as a critical sociology that questions the assumptions of professional sociology, but we can see the role of sociology in animal studies as providing reflexive knowledge around our substantive interest in human–animal relations and the role they have in relation to the 'direction of society'. An animal-inflected sociology is thus also a public sociology that seeks to enrich the depth of debate around the contextuality of human–animal relations. If these relations are characterized as sites of exploitation, as they are by many civil society groups, it will not be surprising to see public sociology as advocating against such exploitation, as it has similarly done in terms of intra-human constructions of difference and power. While this entails that many sociologists in this area will, for example, be vegetarian or vegan, it should not entail, to use Burawoy's idea of the pathological form, that such a normative perspective is expressed in a dogmatic uncritical dissolution of the boundary between sociology and social movement. Sociology retains a heuristic distance in that it can contest particular modes of advocacy argument. For example, in thinking about animal biotechnology, a sociological perspective may contest an oppositional discourse that labels such technology 'unnatural' and offer alternative framings (I return to this point in Chapter 1) or be critical of animal advocacy organizations generally that, for example, oversimplify the social context of ethics or employ sexist imagery in their campaigning.[17] Moreover, the sociological openness to a diversity of civil society groups and interests ensures that research programmes will benefit from 'taking on the role or perspective of the other' and exploring a wide spectrum of diverse situated perspectives.

This discussion bears relevance to the recent outline of an explicit *critical* animal studies[18] (CAS) in opposition to animal studies (see, for example, Best, 2009). Although CAS notes the success of animal studies across academia, it is critical of the dangers of it becoming overly abstract and dislocated from various publics. This is comparable to the sort of fears indicated by Burawoy of a professional sociology becoming pathologically aloof from extra-academic audiences and detached from social movements. In practice there is not a strict boundary between animal studies and CAS, but the latter wishes to distance itself from what is probably a minority of animal studies scholars whose work is detached from any appreciation of the material experiences of nonhuman animals for which humans are significantly responsible. In contrast CAS scholars stress ethical veganism and may work with those civil society groups or individuals who campaign against animal exploitation. Thus CAS, though also interdisciplinary, can be seen akin to the forms of reflexive sociology – critical and public – in the terms described above. Therefore a reflexive sociology that, for example, queries ontological frames in sociology and bioethics, opens up new research directions, and thinks through the role of human–animal relations in the direction of (an increasingly globalized) 'society' significantly shapes this book. We can already note work by several sociologists who are unequivocal that the confluence of animal studies and sociology translates into advocacy for the lives of other animals (for example Nibert, 2002; Irvine, 2008). Sociologists such as Nibert also conform to a further way in which CAS distances itself from animal studies (Best, 2009, p40), namely by giving more attention to political economy, and more specifically a

critique of capitalism as inseparable from a critique of both animal commodification and environmental destruction. Certainly the cultural frame of dualism predates capitalism, but it is impossible to ignore the relationship between the intensification of capitalism and that of animal exploitation. This stress on political economy perhaps also has the effect of grounding a more level disciplinary input to animal studies, which since its outset has relied too heavily on the dominant moral theories of philosophy. CAS facilitates input from a wide range of disciplines, including sociology, that have analysed capitalism. As long as CAS avoids Burawoy's pathology of public sociology (veering into an isolated and uncritical dogmatism), it can be a very necessary frame for thinking critically about the broad sociopolitical enmeshment of human–animal relations.[19] Sociology is also an appropriate perspective from which to approach thoroughly naturalized practices and categories. The social and economic relationships necessary for the successful commodification of farmed animals into 'meat' which are inclusive of the sciences of meat under discussion in this book are not, I would suggest, widely known about by a broader public. Even though there have been some moves to culturally demystify these relations recently, sociology and related disciplines have a significant role to play in continuing this process even in what for many people is an unsettling and intimate issue. Burawoy's reflexive knowledge of public sociology, which can be read as an update of C. Wright Mills's idea of the 'sociological imagination' (1959), can help people think differently about the broader societal context of their own circumstances and choices. This approach has been important for pointing out the social construction of, for example, gender, race and sexuality, which coalesce in a critique that interconnects the institutionalized 'naturalness' of these categories with their lived consequences. Similarly, sociology works to question the naturalization of the 'human' as, for example, *needing* to consume other animals, and can be used to examine the institutionalized presence of speciesism[20] and its intersection with other relations of power (see Nibert, 2002, p10). These points bring us to two important concepts for (critical) animal studies that I turn to now both to further flesh out the relationship between sociology and animal studies and also to begin to underline their usefulness to this book.

Concepts for Critical Animal Studies: Intersectionality and Posthumanism

Although CAS makes the point of foregrounding a critique of capitalism, an implicit acknowledgement of intersectionality is found throughout animal studies. Since intersectionality is an interdisciplinary and varied concept with a specific sociological origin, here I want to outline in more detail its definition. Its emergence can be traced to feminist work of the late 1980s/early 1990s that was an attempt to theorize the way in which lived experiences of categories of gender and race interacted to shape each other (Crenshaw, 1991). Such research expressed feminist dismay with the potential of gender research to efface various differences under the category 'woman'. Intersectionality was partly a response to thinking through the interplay of *multiple* differences, including race, nation, class, age, sexuality, religion and disability. This is a highly complex task and continues to be an important focus of social science research programmes. The complexity occurs for a number of reasons and can be noted in various debates that have taken place since its initial emergence. First, there has been some shift from an

initial emphasis on marginalized subjects to framing *all* identities as intersectional (West and Fenstermaker, 1995; Nash, 2008). We can note this in how social science research also now examines constructions of 'whiteness', masculinities and heterosexuality, for example, in order to move beyond overly simplistic ideas of domination and oppression, as well as to unpick the assumptions of privileged categories. Second, we can note a concern over analysis that may reinforce the very problematic categories that are being studied. To try to avert this problem there has been a shift to what Valentine calls an emphasis on 'how identities occur in interactions, not on stable or given understandings of social difference' (2007, p13; see also West and Fenstermaker, 1995). This debate has also been concerned with moving from an overly deterministic view of identities as externally imposed to one of agential complicity where various identity categories may be claimed or contested, and experienced as constraining or enabling (or indeed both).

This strand of intersectionality speaks to the humanist emancipatory focus of sociology, but can in *some* senses be broadened to include the more-than-human. What is perhaps lacking from the above tradition of framing intersectionality is a recognition of the way in which dualism operates to shape commonalities between varied categories of difference. As touched on above, this is where animal studies critiques of human–animal dualism have a resonance for the broader work on intersectionality.[21] This is a specific contribution that argues that categories such as gender, class and race are infused with the human–animal distinction. This is predicated on a generalized dominant Western Enlightenment[22] model of the 'human' as defined in a hierarchical opposition to 'animal' and 'nature'. Moreover, in the archaeology of this concept of 'human' there is, via the reiteration of these dualisms within others such as mind–body and reason–emotion, a stage where it begins to incorporate a vision of itself as valorizing self-control. This was essentially the argument made by the Frankfurt School of critical theory in their understanding of a distinction between 'internal' and 'external' nature (Horkheimer, 1947, p93; Leiss, 1972, p153). The idea of 'internal nature' refers to those aspects of the 'human' that are understood as associated with 'nature' or the 'animal', such as the body and emotionality, and the importance of their parallel control alongside that of 'external' nature. This internally torn understanding of the 'human' works as a significant generative dynamic to constructing human difference whereby some humans are figured as failing to conform to an ideal of rational self-control and, in contrast, are represented as more animal, bodily, emotional or sexualized. These have all been part of the representational repertoire of constructing the meanings of gender, race and class.[23] Although not an animal studies scholar, Judith Butler frames this well:

> *The terms by which we are recognized as human are socially articulated and changeable. And sometimes the very terms that confer 'humanness' on some individuals are those that deprive certain other individuals of the possibility of achieving that status, producing a differential between the human and the less-than-human. These norms have far reaching consequences for how we understand the model of the human entitled to rights or included in the sphere of political deliberation.* (2004, p2)

Our ability to pass as 'human' may be compromised by being marked out in various ways as 'more animal'. The human–animal dualism percolates through intra-human categories

of difference, contributing to their sense of fixity. It is pertinent to intersectionality not only through its role in sustaining particular notions of essential difference but also by shaping the *experience* of being negatively marked out by such differences. The animalization of difference contingently encourages feelings of self-disgust that are commonly expressed in feelings of 'being trapped by one's body'. To reiterate, these are general themes and are not supposed to overstate a particular deterministic power. The claim from animal studies is merely to say that human–animal dualism is significant for theorizing intersectionality and ought to be a useful frame for broader research in the social sciences and humanities.

Perhaps the main node of intersection that has been explored in animal studies thus far is that between animals and gender underlining, for example, cultural associations between masculinity and meat, as well as the pertinence of ideas of animality in shaping gender difference (Adams, 1990; Luke, 2007). Other work has pointed to the spatial intersection of sites of exploitation such as the slaughterhouse and processing of dead animals as labour typically carried out by devalued, 'animalized' humans, notably the poor and insecure immigrant workers (see Nibert, 2002, pp109–113; LeDuff, 2003). This is the spatial equivalent of the phenomena of environmental racism whereby there is a prevalence, notably in the US, for sites of toxic waste to be located near poor and ethnic minority communities (Higgins, 1994). In both cases the exploitation of animals and nature maps onto that of exploited human groups. Spatial proximity to the nonhuman only serves to reinforce part of the symbolic basis of their circumstances. When later in this book I turn to the issue of climate change, we can similarly relate such intersectional analysis to the debate about the inequities of those nations responsible for climate change and those likely to suffer its worst effects. Given that global animal production is a significant contributor to climate change, we can see this potentially as a scaled up example of the intersection of animal exploitation with that of less privileged human groups.

At least two points follow from this argument around the importance of considering human–animal dualism within a broader account of intersectionality. These also serve to carry this discussion more explicitly into the second conceptual frame for animal studies I wish to outline, namely that of posthumanism. First, the animal studies approach to intersectionality, which is essentially to target the workings of human–animal dualism as part of a broader dualistic formation, argues against simply seeing various forms of oppression as forms of *dehumanization*. This points to a short-sightedness in simply aspiring for 'human citizenship' and instead advocates pursuing a more systematic questioning of the historically, culturally, economically and politically situatedness of the 'human' (Plumwood, 1992, p9; Adams, 2006, p120). If the partiality of the 'human', if this situatedness, is intersected by particular understandings of gender, sexuality, race and class, then an unreconstructed humanism may well prove something of a false dawn. It is at this point that we can understand animal studies as a questioning of the human as well as of the animal (Wolfe, 2003a, p192). The better approach to dualism is not to affirm the privileged term, but to reconceptualize both terms (Plumwood, 1992). Second, if dualism is such a part of particularly entrenched symbolic stabilizations of identity, it is likely that, for example, hierarchical human–animal relations cannot be reduced to the material benefit that people receive from such relations. Rather relations of power over other animals are constitutive and reiterative of dominant symbolic

understandings of the 'human' and so are better seen as material *and* semiotic. This is an important point because it highlights the way in which intersectionality provides a frame to theorize the *intransigence* (and by implication the mutability) of particular relations. Challenges to dominant human–animal relations may also be resisted owing to their symbolic force in upholding other less obvious relations. On this understanding, for example, our dominant practices of consuming other animals are bound up in a particular constellation of the 'human' that is variously classed, gendered and racialized.[24] The alternative positing of a 'human' that does not eat other animals is thus something of an anathema to various intersecting levels of identity, and one which partly challenges the hierarchical organization of Western dualistic thought. One further understanding of intersectionality that appears in this book is the simpler sense of arguing that dualistic terms are not separate. This uncontroversial contention has been a mainstay of the anti-dualistic reflexive sociology described previously. It can be seen as the first stage in the process of reconceptualizing dualistic terms. This is witnessed not only in arguments against the polarized notion of difference between 'human' and 'animal' but also in environmental sociology work to re-theorize society–nature relations that underline the interplay of human and nonhuman agency.[25] I use this idea of intersectionality later to critique the continued tendency within the sociological focus on biotechnology to ignore interconnections between 'human' and 'animal' biotech. This is similarly the case in bioethics where 'human issues' are referred to as 'red bioethics' and 'nonhuman issues' 'green bioethics'. As we shall see later, it makes little sense for social scientists or philosophers to continue with such dualistic approaches, especially when they have been dispensed with by the very sciences associated with biotechnology.

This discussion of intersectionality has already gestured towards issues of relevance to ideas of posthumanism. Although a somewhat nebulous and variously used concept, posthumanism is similarly concerned with dualistic thought. We can note in the previous discussion that (critical) animal studies is essentially venturing a posthumanist reading of intersectionality, in which the reconceptualization and decentring of the human is inseparable from attempts to resolve both anthropocentric hubris and its exclusionary histories. Posthumanism is partly difficult to define since that which it professes to be 'post' to also has a multifarious history. However, we can see an emerging configuration of academic work in (critical) animal studies, the anti-dualistic sociologies and similar work in related disciplines as constituting a posthumanist perspective that challenges a humanism that reduces value and agency to the human and assumes a dualistic ontology. While perhaps the bulk of posthumanist work has been more focused on the latter of these, animal studies perspectives (for example Wolfe, 2003a,b; Calarco, 2008) have argued the importance of a politicized questioning of human–animal relations within posthumanist theory. Posthumanism is not necessarily antithetical to all tenets of humanism, but wishes to make a break from its self-elevation and simple replacement for a previously banished deity. Posthumanism taps into a historical lineage of ideas that have served to decentre the human which, as Derrida points out, include the Copernican revolution, the Darwinian recapture of the human to the animal kingdom and the Freudian questioning of a human subject in control of itself (2003, pp138–139). Its more recent emergence in academia can be seen as 'a political-analytical perspective' that extends the 'well established critique of the reductive but effective categories of human–animal, nature–culture' (Castree and Nash, 2006, p502).

A major focus of posthumanism centres on ontological critique. Latour's influential claim that 'we have never been modern' (1993) has been repeated in similar form in statements such as 'we have always been posthuman' (Hayles, 1999) or 'we have never been human' (Gane and Haraway, 2006). What all of these curious expressions pertain to is a critique of the dualist ontology of Western thought to emphasize the ways in which we have never really been this 'human' that sees itself as separate from other species. This pretence has been a flight of fancy and one which now faces 'us' head on in the form of related crises of species extinction and climate change.[26] Importantly in line with these claims we must note the sense in which 'nonhuman animals have never been animal'. The effect is to question the humanist moral preoccupation around the 'animalization of various human social groups' and to critically contest, albeit counter-intuitively, the 'animalization of animals' and the 'humanization of humans'. This posthumanist response, important to this book, further develops accounts of the human as enmeshed with the nonhuman and critiques the automatic assumption of a human sovereign power over other species.

Other tenets of posthumanism have recently been shaped in opposition to the position of *trans*humanism (one reason why this field is complicated is because of the propensity of transhumanists to also call themselves posthumanists).[27] Transhumanism has gained more of a foothold in the popular imagination through science fiction and the ubiquitous reporting of science news stories related to the promise of 'enhancing' humans.[28] It is a troubling body of thought for posthumanism since it embraces and extends precisely the aspects of humanism that posthumanism has critiqued. Transhumanism has been termed a type of hyper-humanism (Thacker, 2003a, p75). This fits to an extent: for example, when transhumanism is expressed via bioethical argument, it extends values of liberal individualism, choice and bodily control (Bostrum, 2003; Savulescu, 2001) and recentres a valorization of the human. Although the enhancement dreams of transhumanism are open to the dissolution of boundaries between human–animal and organic–machine, this ontological creativity *remains* within an anthropocentric, rationalist understanding largely ignorant both of the relations of power discussed previously in terms of dualism and intersectionality and of the agency of technology in further shaping social relations (see Thacker, 2003a, p76). While both posthumanism and transhumanism are critical of the closure of the 'human' common to humanism, the former, in its openness to redefining the human, wants to stress – counter to dualism – the embodied and nonhuman entanglements of the human. Hayles captures this well:

> *My dream is a version of the posthuman that embraces the possibilities of information technologies without being seduced by fantasies of unlimited power and disembodied immortality, that recognizes and celebrates finitude as a condition of human being, and that understands human life is embedded in a material world of great complexity, one on which we depend for our continued survival.* (1999, p5)

Transhumanism in contrast appears through its preoccupation with subjects such as extending human lifespan to reproduce the 'internally torn' model of the human alluded to earlier, ill at ease with notions of material limits. Moreover, the transhumanist imaginary,

I argue later, is not unrelated to the capitalist desire to reinvent itself exactly through the biotechnological trumping of ecological and material limits. These tensions between posthumanism and transhumanism can be partly read as offering an interpretive frame for this book. The sciences of meat that constitute the forms of animal biotechnology with which I am primarily interested can be seen as conforming in important ways to transhumanism. In using new breeding techniques to 'enhance' farmed animals in various ways, animal biotechnology consolidates the human mastery of other animals. These sciences – as we shall see – are not precious about the human–animal boundary but resource the 'enhancement' of animals in the service of enhancing humans. Absent to the transhumanist extension of human control is a reflexive knowledge aimed at thinking through the wider consequences and context of such technologically mediated change. The main general aim of this book is to remedy this absence.

Nevertheless, I do want to disclaim a simplistic moral dualism in the way that I deploy this framing.[29] As the Hayles quote implies, posthumanism seeks technologies that may enrich mutual human–nonhuman flourishing and not those that become extensions for pre-existent power relationships. Although molecular techniques for breeding animals emerge primarily as a means to accumulate new economic value for the global 'livestock' industry, the question of whether, ultimately, this negates all applications of animal biotechnology in this area I leave open until returning to it in the Conclusion chapter (page 161).[30]

Animals as Biotechnology

At this juncture it is useful to outline in more detail the molecular techniques of concern. Although this means venturing into some of the specialized terminology of genomics, it is important to grasp what are for many unfamiliar developments in how farmed animals are bred and may be bred in the future. In writing about animal biotechnology, one is faced at first by what is a compelling politics around claims of 'newness', often expressed in different interpretations of the word 'biotechnology'. The Biotechnology Industry Organization (BIO), the umbrella organization that represents the interests of biotechnology companies, wants people to use the terms 'old' and 'new' biotechnology, where the former includes any use of organisms starting 10,000 years ago with domestication (Schrepfer and Scranton, 2004, p6). Although there could be literal reasons for doing this inasmuch as domestication could be seen as the beginning of the human use of other animals as technologies, I resist this because of its transparent intention to normalize so-called 'new' biotechnologies. Instead I define animal biotechnology (when it refers to breeding techniques) as those particular techniques related to molecular knowledge and contemporary biology. Like BIO, I am suspicious of a sharp moral boundary between what they term the 'old' and 'new', yet my apprehension is not because I think the 'new' is benign, but because I do not think it credible to assume that the 'old' is. These points will be returned to periodically.

Although traditional selective breeding of animals was essentially based on appearance, temperament and performance, the specialization of animal science during the 20th century and the refinement of quantitative genetics and statistical analysis enabled a considerable degree of malleability in selection. Such technological change was an important actor too in enabling the significant increase in output of animal products

in Western industrialized countries during the post-war period. Biotechnologies can be seen as broadening out this toolkit of genetic selection in both these qualitative and quantitative senses. The subsequent sequencing of farmed animal genomes holds the promise of letting meat scientists know just what genes they are selecting on and improving knowledge of relations between genotype and phenotype. The molecular techniques here that I define as biotechnology are marker-assisted selection, genomic selection, transgenics or genetic modification (GM), and cloning. Genomics, essentially the study of the whole sequenced genome of a given organism, has become increasingly important to the science of animal breeding. The chicken genome was sequenced in 2004, the bovine in 2009 and that of the pig is imminent. In pursuing economically advantageous selection choices, animal scientists are particularly interested in those regions of a chromosome that are thought causally involved in particular polygenic traits (many qualities of interest are not caused by a single gene). These chromosomal regions are known as quantitative trait loci (QTL). At the more detailed level given by genomic investigation, the interest focuses on single nucleotide polymorphisms or SNPs, which can be defined as:

> *Differences in the genome sequence between chromosome pairs and between individuals at the finest level of the DNA sequence, the four bases that make up the DNA alphabet: adenine (A), cytosine (C), guanine (G) and thymine (T). Once identified, these differences can be routinely assayed (genotyped) in cells collected from an animal.* (Rothschild and Plastow, 2008, p21)

SNPs then are points of genetic variation that may potentially be used to select for different types of animal. Animals are assessed in terms of their transformation into a statistical representation known as an estimated breeding value (EBV) along particular indices of performance such as longevity, or meat or milk yield, defined as 'an estimate of the additive genetic merit for a particular trait that an individual will pass on to its descendents' (Goddard and Hayes, 2009, p381). The statistical method 'best linear unbiased prediction' (BLUP) has traditionally been used to calculate EBVs, which, significantly, are now beginning to be augmented with molecular data. This is important since it may change the criteria around the inclusion and exclusion of particular animals as economically valuable.

The first type of molecular technique is *marker-assisted selection* (MAS). This refers to the identification of different sorts of loci or markers within minute areas of an animal's genome.[31] It is a means of using pre-existing variation in a population to change the types of selection (breeding) possible. Although it is scientifically challenging to locate such markers, some have already been used in genetic 'improvement' programmes. More recently a second technique, known as *genomic selection* (GS), has created a certain amount of excitement among animal scientists and the livestock industry. The technique was first articulated in 2001 (Meuwissen et al, 2001) and has now begun to be used in commercial animal breeding programmes. It has only become viable recently because of the emergence of cheaper, high-throughput, genotyping technology and the creation of SNP chips containing tens of thousands of SNPs. Often described as a scaled-up version of marker-assisted selection, genomic selection uses thousands of markers from throughout the whole genome to produce an even more accurate calculation of EBV

(Goddard and Hayes, 2007). As DNA chips with even higher numbers of SNPs are created, GS is expected to translate into higher returns based on more rapid genetic 'progress' or 'improvements' across various traits of economic interest to the livestock industry. GS is proposed as a technique to select for more complex traits. Given that it has been described as a revolutionary change to animal breeding (Goddard and Hayes, 2009, p382), it is perhaps short-sighted to put all focus on better-known molecular techniques.

This brings us to the remaining two techniques, which, while better known, have yet to be commercialized in agriculture.[32] These are *genetic modification* and *cloning*. Here genetic modification (GM) usually refers to the ability to insert novel genetic material with a functioning outcome into an animal (transgenics), but may also refer to the modification of pre-existing genes that have their function altered or 'switched off'. Genetic modification may be achieved by a number of methods, including transfer using viral vectors, sperm-mediated DNA transfer and somatic cell cloning (Robl et al, 2007). That cloning is itself a method for achieving GM illustrates the relatedness of these two techniques. However, the two techniques can also exist separately. Cloning is achieved through somatic cell nuclear transfer (SCNT) involving the insertion of nuclear DNA (the DNA from the nucleus of a donor cell) into an egg (oocyte) cell that has previously had its nuclear DNA removed (in a process termed enucleation). The newly inserted nuclear DNA is encouraged to fuse with the cytoplasmic elements in the recipient cell by a small electric shock. This also acts to initiate steps towards cell subdivision and the development of a new embryo that is implanted into the uterus of a donor mother.[33] Contrary to popular belief, such a clone is not an *exact* copy of the donor organism, since only *nuclear* DNA is reproduced. There is also a small but significant DNA presence in the mitochondria – organelles that live in the cytoplasm of a cell. These four techniques outlined constitute the biotechnologies of principal interest to this book since they are being applied or developed as a means for new forms of capitalization within the livestock industry.

My methodological approach as a sociologist interested to learn more about animal biotechnology has involved various modes of engagement with animal scientists. In 2006 I carried out semi-structured interviews with 22 UK-based animal scientists around ethical and social aspects of developments in farm animal genetics and genomics. These comprised welfare scientists as well as geneticists and thus offer insights on current salient issues and differing ideas of animal welfare. All these scientists either worked at or were involved in work at two world leading research centres based in Central Scotland: the Scottish Agricultural College (SAC) and the nearby Roslin Institute, famous for being the site where Dolly the sheep was cloned and notably an institute focused on both agricultural and human medical research. Approximately a quarter of those interviewed were welfare scientists, with the remainder mostly animal geneticists (two agricultural economists were also interviewed). Six were female and sixteen were male, with the majority established scientists as opposed to early career. These interviews were a valuable first step in familiarizing myself with the subject and while they are not a major focus of this book as a whole I do draw on them in some of the following chapters. Perhaps their single most useful purpose was in dissuading a homogenized view of animal science. Certainly at the time of the research the SAC provided a space for a wide divergence of views that included a number of vegetarian animal welfare scientists

alongside animal scientists more interested in profitable animal production. Both Roslin and the SAC were ideal sites to probe a number of questions, not least the potential impact of genetics and genomics on understandings of animal welfare, but also some of the conflicts and contradictions of animal welfare. During the last five years I have also attended several UK animal science and genomics conferences, the Biotechnology Industry Organization (BIO) conference in 2006 in Chicago and a 2008 conference on livestock and climate change held in Tunisia though organized by the British Society of Animal Science (BSAS). Finally during this period I also joined professional animal science organizations and familiarized myself with the state of play in current research.

This book is divided into three sections. Part I, 'The Animal and the Ethical', reviews the wide range of work in animal ethics but argues that this diversity fails to achieve representation in fields such as bioethics that have a credible policy influence. I set about restating bioethics as a posthumanist field with a better appreciation both of the inseparability of human, animal and ecological ethical issues and of the social and political contexts of the ethical. Part II, 'Capitalizing on Animals', examines the means by which molecular techniques are beginning to emerge in global livestock breeding. This includes an analysis of nascent regulatory frameworks in the UK and US and how they may contribute to the commercialization of molecular techniques. This section of the book also examines in more detail the intersection between human–animal relations and capitalism. Specifically this centres on the way the animal body in livestock science is conceptualized and an analysis of the manoeuvres of livestock genetics companies in already capitalizing on the molecular turn in animal breeding. Part III, 'Capturing Sustainability in the Genome', traces the various ways that animal science is internalizing critiques of meat into the very materiality of the animal body. This refers to the sustainability issues of climate change, human health and animal ethics emerging as domains that are perceived as being successfully negotiable by molecular techniques. However, in highlighting the contradictions between a forecasted significant global increase in livestock production and claims on sustainability – a forecast itself used to legitimate biotechnology – I explore alternative approaches to these problems that foreground a posthumanist reflexivity around human–animal relations.

Part I

The Animal and the Ethical

I begin with the contention that ethical questions around human–animal relations, especially those that pertain to farmed animals and animal biotechnology, cannot be fenced in to a narrow philosophical discourse. While philosophy is a vital part of thinking through such ethics, the issues with which proposed applications of animal biotechnology in agriculture intersect necessitate both an eruption in the diversity of philosophical approaches and the sort of pluralistic interdisciplinary approach increasingly characteristic of (critical) animal studies. Accordingly, we should strive to be inclusive of different ethical perspectives and alternative points of critique that underline the broader social and political context of the ethical. Such openness is strongly affirmed when we note how the status quo of the mass industrial production of nonhuman animals is playing a significant role in a climate change scenario that threatens to radically change the material conditions for all life on the planet. It would as a result be irresponsible to refrain from casting a critical perspective over the tacit 'ethics' that support such an institutionalized and naturalized part of our global human–animal relations.

In broadening out the ethical in both academic and policy spheres it is necessary, I argue, to acknowledge the partial fiction of an 'animal ethics' which continues to speak to an obscuring human–animal dualism. This subfield cannot be wholly divorced from our ethical relations to human animals, just as fields of applied ethics that at first glance seem only to enrol the 'human' (for example medical ethics) cannot be separated from our ethical relations to nonhuman animals. There is a sense in which it is exactly the signifier '*bio*ethics' that should be preferred to these subfields as a way to think the ethical *across* species, even if, as currently constituted, it is not up to this task. Consequently, I devote

space in this section to thinking through some of the necessary changes to bioethics in order to make it a more inclusive and meaningful project. This book eschews a neat ethical roadmap, but instead acknowledges the complexity of ethical questions in this area. In order to think through the ethical questioning of animals as biotechnology, it is necessary to situate the analysis within its broader social and economic contexts.

In this first section of the book there are several interrelated themes and aims that run throughout its three chapters. They should be read as partly preparatory for setting up the more contextual approach to animal biotechnology pursued throughout this book. I argue that 'animal ethics' is too narrowly conceived and remains too marginalized from discourses of public and policy ethics, most especially in the institutionalized discourse of bioethics. I explore the conditions of the ethical and ways in which these could be addressed to better facilitate a voice for the ethical questioning of human–animal relations. Finally, I illustrate with reference to animal biotechnology the intersection between the 'medical' and the 'agricultural', which is part of an argument for a *critical bioethics* reflexive to its dualistic and humanist heritage.

1

Undomesticating the Ethical

One of the behavioural consequences for domesticated animals is that over many generations there has been an overall trend towards selecting for docility. Such animals are easier to control and so cheaper to rear.[1] Domestication also serves as a useful metaphor for thinking about the narrow framing of 'animal ethics' when it comes to public and much academic discourse about farmed animals and biotechnology. Ethical thinking here appears as if disciplined in order to dissipate its unruly and disruptive potential. This is in contrast to the incredibly varied and fertile academic and advocacy field of 'animal ethics' that has emerged over the last almost 40 years, itself tapping into much older traditions such as 19th-century writings on anti-vivisection and vegetarianism. Since I think it an important goal to open up technoscientific agricultural practices to as wide an ethical deliberation as possible, part of this problematic is to liberate this ethical richness into broader public ethical debate.

In the absence of this I argue that we are left with a rather docile ethics that is little more than a business-as-usual approach to the subject. This is suitably complicit to facilitating agricultural animal biotechnology and securing a particular future that later on in the book I argue fails on several important measures of 'sustainability'. We can note two major conflicting future visions of human–animal relations in this context that speak to wider debates about society–nature relations: such as tensions between humanism/posthumanism and the broad questioning of 'progress'. While the intellectual and advocacy movement of critical animal studies wants to initiate a rolling back and potentially an abolition of animal agriculture, the biotechnological vision is creatively involved in new modes of technoscience that assume an instrumentalist ethics, and crucially are embedded within a scaling-up of the capitalization of the animal. It would be highly misleading to interpret this as a parochial ethical debate. Instead it has, as will become clearer later on, ramifications for pressing interconnected contemporary debates over climate change and food security.

In this first chapter of the section I have three main aims. The first strand is a microcosm of themes expanded upon later in the book, namely to underline how the biotechnological vision of human–animal relations is being secured by the reproduction of a shallow (if it happens at all) consideration of 'animal ethics'. Although animal advocacy movements since the 1970s have attempted to politicize the 'animal', this unsurprisingly comes up against institutional attempts to curtail this potential novel

political status. The second strand is to briefly outline animal ethics and recent reflexive challenges to these from within animal studies. These challenges point to the complicity of initial animal ethics with anthropocentrism and highlight alternative directions for ethics. These alternatives are noteworthy for their affinity with emphasizing the intersectionality between 'animal ethics' and other relations of power. If we are serious about overcoming dualist ontology, there is a need to question not only the anthropocentrism of conventional ethics, but also the idea of an ethics of the nonhuman as ontologically distinct (see Castree, 2003). The final strand is to begin to think through animal ethics in relation to bioethics, which leads in to the concerns of Chapters 2 and 3. Outside any consideration of the nonhuman, there have been significant challenges to traditions within bioethics and these are shown to be further relevant for the task at hand to open up the ethical field.

Whose 'Progress'?

It has become common to describe contemporary Western human–animal relations as characterized by an ambivalence which came to cultural prominence during the 20th century (Thomas, 1983; Franklin, 1999; MacNaghten, 2004). It was during the latter half of the century especially that the intensified resourcing of animals bound up in science and commerce was incongruously joined by novel ethical forms characterized by claims over rights, individualization and ethics of care. During this time even the significant contexts of intensive agriculture and scientific research involving animals were subject to more regulation and a *degree* of delegitimization. However, given both the institutionalized material and symbolic investments that many people continue to have in heterogeneous modes of using animals, it is naïve to think that our ambivalence will simply be resolved by the gradual 're-enchantmant' of animal lives.

This ignores the way in which animals continue to be cast within new paradigms of economic growth and technological progress as objects of consumption in both research and agriculture. It is precisely their elaboration as biotechnologies that has the ability to further embed their commodification within these areas. The use of GM animals in biomedical procedures is increasingly prevalent and molecular techniques in agriculture have begun to be commercialized. This I take to be the first point of ethical interest in relation to animal biotechnologies: new, more efficient ways of breeding animals are likely to become standardized and 'locked in', contributing to the further socioeconomic embedding of animal agriculture.[2] Globally we are currently witnessing increases in the numbers of animals produced and consumed as food. Molecular techniques of animal breeding are not driving this trend, but in general particular framings of food security provide productive hooks in arguments for funding, developing and commercializing biotechnology, which may be seen as the ready-made answer to such concerns.

Biotechnologies generally are couched within a politics of the new, whereby an underlying assumption by both adherents and critics is that 'newness' becomes a proxy for 'danger' and ethical excitement. In debates around both GM crops and GM animals, there then follow attempts to either explicate or deny such 'newness'. Such practices find their way into regulatory discourse, as I outline in Chapter 4. I will argue later in this section that this discourse of newness when applied to animal biotechnology misses the point somewhat, especially in relation to thinking about 'regular' non-molecular animal

breeding. That molecular techniques for breeding farmed animals are in various senses 'new' is obvious and revealed in scientific discourse about their rationale. However, not all molecular techniques necessarily share the same potential to reconfigure human–animal relations in this respect. I would suggest that it is most obviously the potential of transgenic animals that may come to conform to what Michael terms the shift towards the 'technoscientific bespoking of animals – the making to order of mice, rabbits, sheep, pigs and so on' (2001, p206). This I take to be the second major ethical point of import stirred by animal biotechnology. It introduces a novel authorial power over other animals, which while continuous with the controlling ethos of selective breeding, constitutes a significant and qualitative broadening of the animal scientist toolkit. This reinforces an understanding of the 'human' as powerful and controlling over other animal species.[3]

When I interviewed animal scientists around the ethics of molecular breeding, most were very interested to engage on this issue, with only a few expressing discomfort. Unsurprisingly the majority espoused a form of utilitarian 'humane' ethics that underlined the importance of animal welfare, though some welfare scientists expressed stronger disagreement with the work of their geneticist colleagues as well as with the broader issue of the scale of the livestock industry. The ability of the debate over the newness of molecular techniques to potentially act to deflect ethical reflexivity also arose. For example, one geneticist remarked that 'we've so manipulated animals to our own ends anyway that this is just another extension of the same thing'. However, this sort of argument was rejected by an animal welfare scientist, who stated that:

> *Yes, they always say that … I don't think it's fair to say well you know we've been doing it already in the past. You know there are ethicists that deal with that and I know that it's not an ethically sound argument because you are perfectly entitled to put cut-off points and say this far and no further. [Just because] you approved of one thing, you don't have to approve of everything that follows.*

This highlights both particular strategies to limit the scope of the ethical and disagreements between animal scientists that I return to later. It should not be surprising to find particular means of presenting aspects of domestication as naturalized human–animal relations opaque to ethical or political reflexivity. A further example that arose in one of my interviews was of domestication as a *contract* between humans and animals. This raises all sorts of peculiar questions around consent and glosses over the inequitable character of the relationship (for further discussion, see Palmer, 1997).

That the commercialization of molecular techniques may normalize new ways of breeding animals and herald a novel authorial power over other animals serves as a sobering reminder to those who assume that globally we are in the midst of a gradual progression towards more respectful and less exploitative human–animal relations. Within Western science cultures, 'progress' continues to be understood in a starkly anthropocentric sense. If we follow a brief tangent, we can also note this in relation to the animal experimentation issue. Using the UK as an example, recent Home Office statistics for the number of animal procedures performed using GM animals serve to quantify how genetic modification is now markedly reversing the previous downward trend in animal experimentation overall. The figures for 2008 reported just fewer than 3.7 million animal research procedures. Genetically modified animals accounted for 38

per cent (1.4 million) of these procedures (Home Office, 2009). This compares with 2002 figures of just over 2.7 million procedures, of which GM animals accounted for 26 per cent (710,000) of these. As further comparison, in 1995 GM animals were only used in 8 per cent of procedures. There has now been an increase in overall procedures each year since 2002. The longer-term impact of biotechnology on these figures is unclear. For example this may be a post-genomic spike whereby scientists are using large numbers of mice to investigate genetic function in the wake of the sequencing of that animal's genome. However, since transgenics is being used to address one of the criticisms of the use of animals in research – which is that, as models, data acquired is not simply transferable to the human case – it is also inspiring a profusion of animal models that are constructed as more 'human-like'.[4]

These examples point to the naïvety of assuming that humanity is aboard a trajectory in which the circle of moral concern is gradually widening to include the nonhuman. Similarly we can note a more complex picture than simply stating that the scientific cultures around biomedical research and agricultural breeding are out of touch with a broader culture that has come to increasingly value other animals. Human–animal relations provide an apt example of the way in which ethics can be contradictory and contextual. In many countries now we can point to broad support for values of animal welfare. We might say that the current dominant understanding of the human is to be a *humane* being. In the UK, for example, after a protracted legislative process fox hunting was banned,[5] animal welfare laws have been updated,[6] there has been a significant growth in the companion animal sector and scientific interest in animal minds has increased to suggest further recognition of nonhuman subjective experience. Nevertheless, such shifts and understandings of 'humane' are inescapably accompanied by spatial sequestration whereby the geographies of violent human–animal relations are effectively hidden away from the public gaze and critical scrutiny. Welfare ethics are palatable in that they do not fundamentally challenge practices of the human that continually (re-)embody anthropocentric values (Francione, 1996). They buttress the symbolic power of human–animal hierarchy and are protective against more fundamental challenges to human–animal relations and patterns of consumption. These are mundane and unsurprising points. The hierarchical human–animal dualism is deep seated in the West; therefore, the stereotyping of vegetarian or vegan challenges to this (Cole and Morgan, 2009) is more-or-less predictable.[7] Such challenges overall are more important than welfare ethics (this is not to say that welfare ethics are at all unimportant to animals living in agriculture as you are reading this) not only to satisfy a broader notion of animal ethics but also to address the intersection of the livestock industry with human and ecosystem wellbeing.

Although, as indicated earlier, I want to question the notion of an autonomous subfield of knowledge known as 'animal ethics', in the next part of this chapter, I outline some of the ethical arguments for treating animals better that have been proffered, as well as some of the more recent critical reflections in the field which are germane to my aims here. That recent posthumanist writing on animal ethics dovetails with a broader critical discourse that has been levied against bioethics points to a growing dissatisfaction with 'ethics' which I productively draw on. Some writers, of course, have already turned their attention towards the ethics of animal biotechnology, but I wish to supplement this with the argument that we cannot hope to adequately perform this task until we have reconfigured the ethical field in various ways.

Multiple Ethics for 'Animals'

The field of animal ethics remains somewhat academically peripheral. The philosopher Matthew Calarco opines that:

> *Questions concerning animals are typically relegated by Anglo-American philosophers to a sub-specialization within environmental ethics, which is itself considered a minor area of applied ethics. Given that the field of applied ethics is, in turn, often viewed as a minor field in philosophy and (more pejoratively) as a distraction from more serious and substantial philosophical pursuits (namely metaphysics and epistemology), it is no wonder that many philosophers interested in exploring the rich set of issues surrounding animals and 'animality' have chosen to do so within the context of the semi-autonomous region of animal studies.* (2008, p1)

Where progress in distinct disciplines has been effectively constrained, animal studies has provided a space for animal ethics which has aided its dissemination into areas such as sociology, geography, history, cultural studies and anthropology. Since animal studies has generally been interested in examining the intersectionality of 'animality' with constructions of gender, class, race and sexuality, questions of animal ethics have been further distributed throughout the arts, humanities and social sciences. Related posthuman accounts of intersectionality, notably ecofeminism, have also served as conduits for bringing animal ethics questions to the fore in non-traditional academic spaces. Later I argue that the interdisciplinary field of bioethics ought to similarly be a more effective conduit for animal ethics, but first I should backtrack a little to briefly outline those key ethical arguments that were both constitutive of animal ethics and arguably, initially, of animal studies itself.[8]

To begin with developments in animal ethics mapped onto traditions in ethical theorizing from 20th-century analytic philosophy: utilitarianism, rights theory and to a lesser extent virtue ethics. Subsequently the utilitarianism of Peter Singer and the theory of animal rights by Tom Regan, both outlined in the 1970s, have become the best-known arguments in animal ethics. Influenced by the ideas of Jeremy Bentham, Singer's position argues that an animal's capacity to suffer and to experience pain and pleasure necessitates that we take their interests into consideration (1995, pp8–9). Since both humans and other animals have this capacity, there ought to be an equal consideration of preferences. Regan's case for animal *rights* argues through the concept of 'a subject-of-a-life' that animals, like humans, have inherent value. First he makes the distinction between moral agents and moral patients, arguing that most humans fall into the former category, while nonhuman animals and some humans fall into the latter. According to Regan, moral agents are able to act according to particular ideas about morality, to determine right and wrong, whereas moral patients lack the ability to control their own behaviour in ways that would make them morally accountable (2008, p19). In this distinction both young children and people with certain kinds of mental impairments are moral patients. In contrast to utilitarianism, Regan argues that it is not the preference satisfactions that have value but an individual him- or herself. Importantly, he argues that both moral agents and moral patients have inherent value because they are both 'subjects-of-a-life'. Individuals are subjects-of-a-life if they:

> *Have beliefs and desires; perception, memory and a sense of the future, including their own future; an emotional life together with feelings of pleasure and pain; preference and welfare interests; the ability to initiate action in pursuit of their desires and goals; a psychophysical identity over time; and an individual welfare in the sense that their experiential life fares well or ill for them, logically independently of their utility for others and logically independently of their being the object of anyone else's interests.* (2008, p22)

As such subjects-of-a-life, animals, Regan concludes, have a fundamental right to be treated with respect as a matter of justice. Although coming from different ethical approaches, both Singer and Regan's positions are *generally* (see below) intended as arguments against consuming animals as food. Criticisms of these approaches should at first bear in mind that if either of these applied ethics were adopted by one or more societies we would have seen a momentous change in human–animal relations, and more significantly an unprecedented *cultural* change. Instead we see the normalization of a significantly moderate version of Singer's utilitarian ethics across most developed countries. An ethic based on suffering is particularly suited to small welfare changes that can be said to constitute attempts to address the experience of animals, without fundamentally calling into question the systemic nature of commodified human–animal relations. While Regan's approach is abolitionist towards the consumption of animals, Singer has over the years been more ambivalent. He has come under recent criticism from abolitionist legal scholar Gary Francione, who argues for veganism as the only consistent animal ethic and whose work underlines the importance of challenging the property status of nonhuman animals (for example 1995, 1996, 2006, 2009). Francione is perhaps best known for his critique of welfare reforms as essentially acting to perpetuate the very practices they appear to ameliorate, since they can work to make people more comfortable about their utility of animals. This is the sense in which I refer to a particular welfare ethic as a docile ethics, domesticated, under control and with a deeper ethical reflexivity curtailed. Relatedly, such domestication of animal ethics is achieved if a welfare ethic is the *only* or *dominant* type with a policy voice. Francione (2009) has criticized Singer for advocating that people could begin to change their consumption habits by switching to more humanely reared animals. Essentially, contra Francione, Singer does believe in an incrementalist position of gradual change and disagrees that welfare change is futile.[9] Nevertheless, it is noteworthy that since these theories appeared in the 1970s, the scale of 'animal suffering' or respect given to animals as bearers of 'inherent value' has not improved. Indeed in terms of global animal production and consumption, including the spread of industrialized confined animal feeding operations (CAFOs) we are on a significant upward forecasted trajectory. Such codified ethics can only be seen as a start towards attempting change. Unless we subscribe to a frankly odd view of the human as one who simply responds to reasoned argument, ethics or philosophy, even in the pluralistic sense that I will argue for shortly, are not capable of carrying the burden of political change. This is even more the case when such 'reasoned' arguments are counter to deeply institutionalized cultural, economic, sociological and historical sets of practices. It is within these registers that we must seek to understand why such practices persist and how they may be challenged. As part of a goal to transition to human–animal relationalities wherein the ethical is not simply

trumped by these registers (such as 'it's nice that you think these animals have interests, but we have a business to run!'), a conception of the ethical requires a deeper critique of anthropocentrism that also operationalizes a broader relational ontology that further undermines a resilient human–animal dualism.

If the initial ethical moves for nonhuman animals can be said to have started this process and to have constituted the field of animal studies, their offspring have significantly rebelled. For critical approaches since then have laboured to underscore the way in which academic knowledge production itself is not immune from anthropocentrism and that this *included* those initial attempts to construct animal ethics. Cary Wolfe phrases this thus:

> *If philosophical work that takes the moral status of nonhuman animals seriously is, in some obvious sense, posthumanist (in other words challenging the ontological and ethical divide between humans and nonhumans that is a linchpin of philosophical humanism), such work may still be quite humanist on an internal theoretical and methodological level that recontains and even undermines an otherwise admirable philosophical project.* (2008, p8)

Attempts to avoid collapsing back into humanism[10] have generally come from feminist ethics and animal studies scholars who have turned to continental philosophy traditions. I review several of these here as they serve the purpose of illustrating some of the richness of the ethical in animal studies and their overlap with a broader critique of bioethics acts as a useful stepping stone in thinking through the necessary revisions to that field that I wish to propose.

The approach of virtue ethics is somewhat different to those forms of consequentialism such as various types of utilitarianism or to the rights and duties emphasis of deontological ethics. It shifts the ethical focus to a questioning of character and the types of people we should strive to be. Thus acting ethically towards other animals can be understood as developing our moral character (Sapontzis, 1987, p90) and deepening particular senses of virtue that are deemed good in and of themselves. Virtue ethics approaches have been open to the role of emotions in action, underlining their moral education as an important part of the development of virtue. Moreover, virtue ethicists tend to be critical of the view of ethics as simply codifiable in rules or principles. Yet Hursthouse (1999) has argued that that should not be read as an inability of virtue ethics to provide a specification of what a virtuous moral agent should do. Particular instructions are generated from various virtues such as charity or honesty (1999, p17). This enrols particular conceptual labour around the reflection on particular virtues, their potential conflict and so on.

A further approach to animal ethics that could be confused with virtue ethics is that of an ethics of care. In contrast to virtue ethics, Donovan (2009) argues that ethics of care is not especially focused on the development of self-virtue but on the care of others. This approach has emanated from feminist perspectives that posit various accounts of intersectionality between the cultural treatment of women and animals (see, for example, Kheel, 1985, 2007; Adams, 1990, 1995; Donovan, 1990; Adams and Donovan, 1995; Donovan and Adams, 1996, 2007; Plumwood, 1997, 2000).[11] Indeed the initial stages of this perspective can be traced to radical feminist thought of the early to mid 1970s (see

Donovan and Adams, 2007, p9) and thus pre-date the formalized animal ethics theories of Regan and Singer. Subsequently, since the 1980s a significant swathe of this literature has critiqued Regan and Singer, and endeavoured to construct an alternative feminist ethic of care for the treatment of nonhuman animals. This historically contingent intersectionality responds critically to the way in which a constructed animality has been projected onto understandings of the feminine. Essentialisms of the feminine and animality have mutually informed each other. From a feminist perspective this is seen in the stereotyping of 'women' and 'animals' as less rational, more emotional/instinctual, and 'more corporeal' and 'closer to nature'. Given such histories, it is unsurprising that feminist perspectives have found problematic ethical theories such as those of Regan and Singer that, they argue, reproduce a particular rationalistic discourse that disavows the place of emotionality in ethics (see, for example, Kheel, 1985). Furthermore, it is argued that Regan and Singer put too much onus on similarity defined in human terms, that they remain uncritically tied to a liberal humanist notion of the subject defined as an independent autonomous individual that is not true of humans never mind nonhuman animals, and that the formulation of an abstract, formalistic ethics is incapable of responding to the particularistic and contextual aspects of ethical situations (Donovan and Adams, 2007, pp5–6). These points are germane both to other critical reflections on latent humanism in animal ethics and to contemporary critiques of bioethics, so I return to them shortly. The alternative feminist animal ethic draws on the social, historical and economic positioning of 'women as carers' in the private sphere to argue for a re-evaluation of the place of emotion in ethical relationality and considerability. This is not to be confused with a reproduction of essence that would either naturalize 'women' and 'caring' or deny 'men' the capacity to care, but a more fundamental reimagining of gender, human–animal interdependency and ethics. Donovan (2007) taps into a history of moral thought that foregrounds sympathy as integral to our ethical relations. Following the work of Max Scheler, she argues that sympathy (as a part of care) is not only an emotion but also a form of knowledge amenable to training (2007, pp177–179). As she acknowledges, this finds expression in notions of *verstehen* that have been methodologically constituent of interpretive social sciences.[12] The obvious advantage of the feminist approach to animal ethics is that it appears to be a better outline of how people actually do live ethically via emotional relations rather than drawing on a codified, calculating checklist of abstract criteria. Yet it still needs to account for the failure of many people to deploy sympathetic care towards nonhuman animals. It does so by situating animal ethics within broader economic, historical and political contexts (Donovan, 2009, pp188–189) such as the capitalist commodification of animal bodies and the intersection of constructions of some forms of masculinity with hunting and meat consumption (Adams, 1990; Luke, 2007).

There are significant nodes of convergence between the feminist critique and recent continental philosophy approaches to animal ethics (for example Wolfe, 2003a,b, 2008; Calarco and Atterton, 2004; Calarco, 2004, 2008; Derrida, 2008). These writers espouse a degree of scepticism towards the theories of Regan and Singer since they argue that in spite of being politically posthumanist, their theories remain complicit with important ontological facets of humanism. As Calarco makes clear, the tradition of continental philosophy cannot be said to have been historically more accommodating to thinking through human–animal relations than the analytic tradition (2008, p2). Yet animal

studies scholars as a 'species' are particularly adept at conceptual scavenging. Continental approaches developed within animal studies share an affinity with the feminist critique to more profoundly call into question human–animal dualism. In this emerging rich discourse both 'human' and 'animal' are terms to deconstruct; the hierarchical human–animal dualism has acted to keep in place essentialist accounts of species difference, while homogenizing a multitude of species heterogeneity under the word 'animal' (Derrida, 2008, pp31–32). Within posthumanist ethics there is an open ethos to rethink human–nonhuman relationalities.

This perspective also points to the problem of approaches from traditional ethics that rely on anthropocentric criteria as a means to value nonhuman animals (Wolfe, 2003a, p10; Calarco, 2008, pp8–9). For those influenced by continental thought, analytic approaches insufficiently 'recognize the influence of prevailing social circumstances on the form and content of their own arguments and presuppositions' (Smith, 2001, p35). Clearly there are alternatives to an overly narcissistic criterion of ethical value. First it may be argued that both Regan and Singer theorized via an overly cognitive and rather disembodied ontology. Shared embodiment and ecological material context is underplayed. As Whatmore noted some time ago, there is a 'renewed interest in corporeal being for understanding ethical competence and considerability' (1997, p41). Both humans and other animal species are collectively subjected and vulnerable to the risks of capitalist externalization, be they pollution, zoonotic disease or climate change. Acampora (2006) exemplifies this approach to explore, via continental philosophical work on the body, a shared somatic core that may foster more-than-human ethical considerability. A further problem that has been noted with the overly cognitive measure of similarity in Regan and Singer is that it gives rise to an ethic that may only apply to some animals, and excludes many of the concerns of *environmental* ethicists (Smith, 2001, p32; Calarco, 2004, p187; Kheel, 2007, p19). While ethical theories have explored various dimensions of similarity, posthuman and poststructuralist ethics also argue that a respect for difference is an important part of considerability. In an unequal relationship, there is a tendency for the privileged to construct the identity of the other in terms of *their* own needs, desires and lacks; denying the difference of the other (Plumwood, 1993, p52). This places ethical import around openness to such difference. This is an important point of discussion in animal studies. I would suggest that the debate over similarity or difference must be mindful that it could itself operate to assume a stabilized human–animal dualism at the very time that many animal studies scholars contest and complicate the demarcation and each signifier. The animal ethics thinking about difference is very justified, yet it is likely that a pendulum swing to difference simply reinforces the dualism (see Aaltola, 2002), while an overemphasis on similarity may risk an uncritical anthropocentrism. In summary, both are important resources for doing animal ethics but in the context of remaining reflexive to the instability of 'human' and 'animal'.

This brings us to a second commonality with the feminist critique that revolves around a questioning of the liberal humanist subject (see, for example, Calarco, 2008, p9). This is a critique now wholly familiar across the social sciences and humanities that during the Enlightenment emerged a dominant model of the human subject as rational, autonomous and disembodied. Specifically the contention is that those early moral philosophy approaches to animal ethics uncritically incorporated this idea of the 'human'. For continental approaches this inadequately roots these attempts in

humanism. This fictional subject was achieved by positioning difference at the very periphery of subjectivity, a performance of 'human' constituted by the exclusion of otherness. This professed *mastery over* and *autonomy from* ideas of the feminine, animality, emotionality, madness, the racialized other, abject and classed bodies.[13] The 'human' in this instance is better seen as a particular will to power that makes use of 'animality' in an ill-fated attempt to keep its ghosts safely at a distance. The rational human is posited as separate to various constructions of difference that become repetitive proxies for 'nature', constructed as a heady symbol of both reproductive power and mortality. Subsequently it makes a certain amount of sense that the liberal human subject finds its contemporary home in *trans*humanist attempts to 'ape' reproductive power and thwart mortality.

A creative challenge to both the autonomy of the liberal subject and the idea of ethical theory as simply having to outline a 'rational code' for people to adopt comes from work around habit (Lumsden, 2008). If we take historical context seriously, then it must be accepted that the self-control and assumed rational mastery by the subject are in important ways illusionary. We are born into a social context with embedded norms and habitual modes of behaviour that we are more or less successfully socialized into. What Lumsden points out is that the exclusion of habit from moral theory works again to polarize humans and animals. He writes:

> *By presenting habit as an alternative to the highly deliberative and reflective view of norm formation, we can undercut and problematize the rigidity of the division between rational man and irrational nature, and create a common ground between humans and nonhuman animals, since habit is neither purely rational nor natural, but is a comprehensive way of experiencing the world that we share with animals.* (2008, p189)

As well as questioning an ever-present rational basis of human ethical behaviour, these points also require an understanding of the ethical that transcends traditional disciplinary boundaries, since an examination of the habitual would also enrol, for example, sociological, historical and psychological perspectives.

The deconstruction of the liberal humanist subject segues into a third commonality between feminist and continental approaches. Due to the aforementioned operation of human–animal dualism within and between varied constructions of human difference, both are attuned to an intersectional understanding of power which in turn augurs *against* a compartmentalized or abstracted ethics. One of the reasons that animal studies has an increasingly broad intellectual appeal is because human–animal dualism is imbricated in far more than relations between 'humans' and 'animals'. Contextually the 'human' has acted as a normative concept as much relevant to, for example, feminist, queer, disability and anti-racist politics. In speaking of animal rights discourse, Calarco comments:

> *In order to gain a voice in the political and legal spheres, it is constrained to adopt the language and strategies of identity politics, which in turn further constrain the discourse to establish a concept of animality and animal interests that must be somewhat distinct from the focus and concerns of other identity politics. This situation creates divisions among progressive causes and leads to a*

> *kind of isolationist approach to animal rights politics, where animal rights are seen as floating in an empty space distinct from political concerns about, for example, women's rights, environmental justice or worker's rights (all of which are, on my understanding of the question of the animal, intimately related to animal rights, even if only for contingent historical reasons).* (2008, pp7–8)

This isolationism is exactly what both feminist and critical animal studies approaches work to ameliorate.[14] I am influenced here by Noel Castree's questioning of the very possibility of the field of 'environmental ethics' that he criticizes for exhibiting a material essentialism which he defines as 'the idea that entities in the world – be they people, animals, microbes, lakes or what have you – ultimately have a set of immutable properties that are relatively or absolutely autonomous from those of other entities and relatively enduring' (2003, pp3–4). Similarly I argue that a subfield of 'animal ethics' is problematic partly because it implies a space purified of the 'human', but also as it cannot presume to fix an understanding of the 'animal' or animality. To explain this further we should, as Castree does, bring some science studies literature on relational ontology to the discussion.

Perspectives from actor-network theory (ANT) and feminist science studies also inform the animal studies interest in reformulating the subject and theorizing human–animal relationality. For example, Haraway (2008) has written on the idea of co-shaping, a mutual interweaving together of human and animal selves (her main example is between humans and 'companion animals'), where people and animals are changed by their encounters contra the myth of autonomy. ANT perspectives have also theorized the agency of nonhuman animals, for example, that of sheep during the UK foot and mouth disease outbreak (Law and Mol, 2008) and more broadly promoted a new ontological sociality that subverts the human–nonhuman distinction[15] (see Goodman, 2001). The endosymbiotic theory of biologist Lynn Margulis (1981) has also been influential to various writers in science studies (for example Hird, 2006) for its posthumanist intimations. Her theory underlines the way in which symbiotic relationships between different organisms have been an important driving force in evolution to the extent that what has been imagined as the bounded 'human' is better understood as an evolutionary assemblage of different species that remains dependent on microbial life, and of course in an external ecological sense a myriad of other species.

This ontological redefinition calls into question one mode in which opposition to transgenic animal biotechnologies may be framed, especially those that mix 'human genetic material'[16] with other animal species. Anxiety over such mixings may be read as a humanist defence against the symbolics of animality breaching and 'degrading' the human. However, this need not be read as a naturalization of transgenics, the analysis of which ought to be properly economically and politically situated. It is a mistake to reduce ethical objection to this humanist yuck factor. Transgenics cannot simply be equated with the realization that we 'have always been posthuman' as a means of ethical bypass.[17] Nevertheless, transgenic technologies do bring into relief the porosity of previously cherished species boundaries; and genomics more broadly, even if it was initially guided by a desire to establish a fixed and special 'human', has arguably ended up underlining similarity and interrelations between ourselves and other species. Castree takes these arguments for ontological relationality to mean not that:

> *Each and every thing in the world lacks some specific material characteristics that help define what it is [but] that the interconnections that help constitute those 'things' are complex and variable, such that if the* same *'thing' is inserted into* different *relational contexts, aspects of its material nature alter correspondingly.* (2003, p10, original emphasis)

Such contextual understandings of being significantly confuse the ability to fix essential characteristics to bounded organisms that then do or do not qualify for this or that degree of ethical considerability.

What I want to specifically take from such ontological work is that our field of interest, 'animal ethics', must necessarily fracture but in politically interesting and undomesticated ways. Understandings of animality are contextual and partly constructed by historically contingent markers of human difference. These ideas of, for example, aesthetics, gender, kinship and class position nonhuman animals into varied contexts that may be partly resisted but are partly shaping of their being. Moreover, the institutionalized ways that we treat animals, such as the domestication and production of farmed animals, cannot be divorced from an active reiteration of the meanings of *human* being. Thus nonhuman animals are enmeshed within a wide array of human identity projects and practices, including the more obvious examples of geopolitical territorial expansion and economic colonialism,[18] as well as the cross-cultural achievement of particular forms of masculinity.[19] It follows, in agreement with Calarco above, that the sort of feminist and continental philosophy questionings of ethical theory highlighted signpost a transition to a considerably more complex notion of the ethical that necessitates an interdisciplinary and intersectional analysis as well as a coalitional politics.

Such attention to intersectionality and interdisciplinarity are now hallmarks of animal studies. However, we are talking about a still marginal academic field that for all its innovation in thinking other animals ethically does not simply translate into the public spheres of either animal advocacy movements or institutionalized bioethical deliberation. Intersectional thinking is challenging both in the sense of understanding complexity but also politically in that it attempts to undermine multiply entrenched overlapping hierarchy. The intersectional politics that have been most successfully argued by the animal advocacy movement most recently are those between animal, environmental and human health, heightened within the threat of climate change. During the last few years these links have made it much more explicitly into policy discourse and I will turn to them in Part III.

At this point we can note that bioethics has traditionally been exactly the sort of rationalist, humanist field criticized above and so does not immediately present itself as a promising space for a more-than-human ethics. In spite of this, as we shall see, many scholars uninvolved in animal studies have constructed critiques of bioethics that are similar in many ways to those of the feminist and continental thinkers outlined above. Therefore we need not be quite as pessimistic about bioethics, since in recent years it has become a field very much in flux. Bioethics is of further interest since it *has* achieved a public policy voice, even though this may be related at times to the acceptability of the particular form of ethics proffered. *Bio*ethics on the face of it ought to be the appropriate term for thinking across species; it *could* be transformed into something better. With this in mind, I end this chapter with some thoughts about nonhuman animals and bioethics.

This leads into the following two chapters, where in more depth I think through the reconstruction of bioethics away from anthropocentrism, especially in the context of thinking about animals as biotechnologies.

Bioethics and Nonhuman Animals

Overall I wish to argue that bioethics currently fails to adequately provide the space in which to ask questions about animal ethics or to examine changes in human–animal relations. As the field of bioethics increasingly addresses developments in the biosciences such as gene therapy, cloning, genomics and stem cell research – thinking through their ethical aspects – animals are largely absent. In a sense they are ghostlike, in the background. Although animal research has become integral to the development of these new biosciences and potential therapies, when it comes to their discussion and ethical analysis, the presence of animals is often absent from the conversation. MacNaghten (2004) has argued that bioethics, especially the way it becomes operationalized in public policy circles, essentially fetishizes a dichotomous either/or choice between utilitarian or deontological ethics. He argues that in such circles a wide range of relevant social and ethical issues may be overlooked, including:

> *Concerns over the unforeseen side-effects of the technology, possible unease about current institutional and commercial commitments to the technology, uncertainty about the integrity and adequacy of present patterns of government regulation and in particular about 'scientific' reassurances of safety, and ambivalence towards the tacit notions of control, precision and 'improvement' in dominant institutional portrayals of the technology.* (2004, p536)

These are important points as they suggest a bioethics which may be closing off germane areas of both sociological and philosophical reflection.

My claim on the exclusion of animals in bioethics is only partial; there are important exceptions. Part of the problem is a sense of disconnect between bioethics and the varied ways of thinking about animal ethics outlined above. Some of the impetus for exceptions to my claim comes from the work of animal welfare scientists. The concept of the ethical matrix (Mepham, 2000) was developed to examine ethical issues around animals and farming and the same author has written widely on the issue of transgenic animals (see Mepham and Crilly, 1999). More recently we have seen the first text explicitly called *Animal Bioethics* (Marie et al, 2005). This edited compilation is a comprehensive summary of principles and teaching methods aimed at veterinary and science students largely written by people from animal welfare science who have moved into the area of ethics. It is not possible at this stage to say whether or not such exceptions that frame their ethical questioning of human–animals relations *within* the field of bioethics represent a significant move to redefine the field. Although not explicitly always self-referenced as *bioethics*, the European Society for Agricultural and Food Ethics (EurSafe) has provided one important forum for research on animal ethics. Furthermore, the *Journal of Agricultural and Environmental Ethics* has published much work on ethical questions around animals and agriculture. However, it must be underlined generally that these exceptions have a majority focus on animal welfare and so a utilitarian ethical

framework.[20] There still remains, then, a lack of academic or bioethical space for a *broader* consideration of animal ethics.

At present there is little evidence of the presence of animals in self-referenced *bioethics* texts or journals, in spite of Peter Singer, mentioned above, also being a very well-known bioethicist. Generally human bioethical issues are cleaved off from animal questions. Indeed Singer's own well-known co-edited anthology on bioethics (Kuhse and Singer, 2001) contains only one small section related to animal experimentation. It appears as if the sort of ontological reconstruction discussed above that would contextualize human health as interrelated with that of other species is inadequately acknowledged by bioethics at present. A bioethics that remains largely silent on the potential shifts underway in human–animal relations in contemporary technoscientific scenarios risks on the one hand excluding other animals from its definition of the ethical and on the other missing how such changes may be conjointly shifting in some sense meanings of the 'human'. In the following two chapters I challenge this model of bioethics.

2

Towards a Critical Bioethics

It is of keen interest that we find external to the debates around animal ethics discussed in the previous chapter a comparable questioning of the field of bioethics. Recent critiques of bioethics (some from bioethicists themselves) similarly find fault with an unreflective reproduction of the liberal humanist self, abstract ethical codes insensitive to context and an overemphasis on analytic philosophy. In this chapter I experiment with the concept of a 'critical bioethics' that could be seen as trying to answer some of the criticisms of bioethics. In not wanting to be overambitious I am specifically interested in this chapter and the next in challenging what I see as the perpetuation of culture–nature and human–animal dualism in mainstream bioethics. In attempting to dismantle this we can anticipate a bioethics that can better think through the lens of intersectionality mentioned in the previous chapter. Put simply, I want to counter an overly humanist bioethics with a broader non-anthropocentric notion of health. The idea that bioethics can be equated with human medical ethics is challenged, partly by revisiting perhaps the first pronouncement of a 'bioethics', which since became derailed and largely superseded. Following the points raised previously, I argue the case for significant overlap between entities such as 'medical ethics', 'animal ethics' and 'environmental ethics'. This project can be said to have much in common with recent calls for a posthuman bioethics (Shildrick, 2004; Murray, 2007; Zylinska, 2009).

V. R. Potter, who coined the term bioethics in 1970, had clearly intended this closer relationship, which he returned to in his idea of 'global bioethics' (1988). The contemporary narrowing of bioethics to a primary concern with the application of philosophical principles to medical ethics appears as both a confusing and unfortunate act of enclosure. While many of today's leading bioethicists may no longer give due importance to Potter's work, it arguably contains important elements in danger of being forgotten. His vision for a mutually intertwined and informative medical and ecological bioethics is as relevant as ever. I will complement this with some of my own reasons for challenging the boundary between bioethics and environmental ethics under the general rubric of contesting the 'bio' in bioethics, which I substantially develop in Chapter 3. Overall I suggest a definition of a 'critical bioethics' comprising three parts.

First, to be critical, bioethics must be *interdisciplinary*. Reducing bioethics to the narrow preserve of a certain branch of philosophical expertise stakes a particular claim over the ethical, discounting the important contribution of other disciplines or

other philosophical perspectives. The *self-reflexivity* expressed in contesting the 'bio' in bioethics forms the second part. The narrowing of bioethics to bio/medical ethics represents a tacit anthropocentric conception of the 'bio' in bioethics which also tends to downplay sociopolitical, socioeconomic and nonhuman inputs into human health. And third, bioethics must *avoid an uncritical complicity* with unexamined views of scientific rationality and progress. This includes the idea of the ethical actor in terms of the liberal humanist subject already noted. Employing a philosophical perspective that espouses a similar rationalist worldview as the science it claims to ethically watch over runs the danger of complicity and of failing in a broad questioning of potential technoscientific change.

These three features can form mutually reinforcing and overlapping elements of a more critical bioethics. This is not intended to be a comprehensive and final definition, but to enjoin with concurrent questionings of the bioethical field. A redefinition both in terms of interdisciplinarity and a widening of the 'bio' in bioethics, as I will demonstrate, both occur through the questioning of culture–nature dualism, and hold the promise of a bioethics that is better positioned to assess whether a particular technology or decision-making process is either 'ethical' or for the social good.

Bioethics and Interdisciplinarity

The problematic of culture–nature dualism that shadows almost all discussions on interdisciplinarity opens up two main areas of critique of relevance to bioethics. Questions over interdisciplinarity and bioethics relate not only to which disciplines ought to be allowed a bioethical voice, but also involve debates over what constitutes the subject matter of bioethics. Strictly delineating subject matter encloses as much as the view that one discipline, or indeed one paradigm of one discipline, be dominant. These delineations remain implicitly and somewhat surprisingly structured by traditional positivistic notions of disciplinary hierarchy. Thus bioethics has tended to uncritically bask in the scientific prestige of discourses such as universalism and rationalism, perhaps the two normative discourses that have come in for the most criticism from critical social theory in the past 30 years. It is then not surprising that in recent years a significant challenge to possible hegemonic tendencies in bioethics has come from sociology and social science more generally. In parallel to joining this debate here I also wish to raise an issue over subject matter which also dovetails with my argument for self-reflexivity as an element of a critical bioethics. By contesting the 'bio' in bioethics and so leading into the second section of this chapter, I will ask questions of what I see as the anthropocentric bias in bioethics which underlines a split between human issues and environmental/animal issues.

Shifting emphasis in subject matter attests to the temporality of what is understood as appropriate bioethical subject matter. Moreover, there may be differing emphases in different parts of the world. Although a partial (yet increasingly pertinent) bioethical focus, the new genetics and biotechnologies serve an initial heuristic purpose for my argument. They illustrate a divide that I wish to contest. Often the phrase 'new genetics and biotechnologies' is used to refer to medical human aspects on the one hand (new genetics) and applications to nature on the other (biotechnologies). This is also sometimes expressed in the idea of 'red' and 'green' bioethics. Below I shall argue against

the feasibility of this divide and for a position that brings bioethics and environmental/animal ethics much closer together. First I want to concentrate on the former issue of interdisciplinarity and bioethics, and argue that the social sciences are crucial to a critical bioethics.

At first glance, it might be said that deliberations on the relationship between philosophy and the social sciences in bioethics represent a shallow type of interdisciplinarity. The argument here would be that the 'real' goal of interdisciplinarity ought to be to bridge the divide between the natural and social sciences. In a sense, this is correct and bioethics ought to have an important bridging function in this respect. But it ought to be specified just what is intended by 'bridging the divide'. In the context of bioethics, there is a role for educating scientists on the ethics and economic and social context of science and technology. Indeed one of the intimations of an animal bioethics noted at the end of the last chapter (see, for example, Marie et al, 2005) is exactly about bringing ethics 'into' the cultures of science. But the critical questions are which ethics and how is the broader economic and social context of science being framed if at all? The goal of this sort of work (one can also point to the emergence of ethics teaching in veterinary schools) can be to act as a healthy check against continued scientific myths of neutrality and naïve realist views of scientific 'facts' as purified of values. However, given the tendency of some bioethicists to take empirical science as read, I would suggest that this can only really happen effectively when there is a closer relationship between bioethicists and sociologists of science.

The International Association of Bioethics (IAB) defines bioethics as the 'study of the ethical, social, legal, philosophical and other related issues arising in healthcare and in the biological sciences'.[1] Interestingly, this is a definition not held by all bioethicists, yet its breadth does encourage an interdisciplinary approach to bioethics. As we can also see with animal studies, definitions of fields can be problematic and perhaps do not always acknowledge their temporal and contested nature. One area which serves to underline the currently contested definition is precisely the social science engagement with bioethics that began in the mid 1990s (DeVries, 1995)[2] and has since developed into a wider critique of bioethics. The professionalization of bioethics is of specific sociological interest as it inflects its concerns over medicine as both a carrier of social morality and a part of the social control of populations (Lopez, 2004, p877). Subsequently part of the focus is on how bioethics may be shaping biomedical knowledge and social practices. Yet this should not be a case of a social science 'straw man' critique of philosophical bioethics, since it should be recognized that the contemporary challenge to hegemonic definitions also comes from 'within' bioethics (see, for example, Campbell, 1999).

The social science critique may be approximately divided into two related areas, both of which take issue with a perceived decontextualization found in bioethics, and specifically its adherence to 'principlism'. First, it has been argued that the framing of bioethics around the four principles of 'autonomy', 'justice', 'beneficence' and 'non-maleficence' (associated especially with the influential work of Beauchamp and Childress, 1979) falsely abstracts and universalizes bioethical issues and that, furthermore, this context-stripping ought to be addressed by empirical research that addresses the lived, embodied, experiential and complex particularistic nature of ethical decision-making (see, for example, Benatar, 1997; Chadwick and Levitt, 1997; Light and McGee, 1998; DeVries and Conrad, 1998; Gervais, 1998; Schotsmans, 1999; Spallone et al, 2000;

Haimes, 2002; Levitt, 2003; Lopez, 2004). The adherence of some bioethicists to principlism has also been critiqued for putting too much emphasis on 'autonomy' or conceptualizing it non-relationally (Holm, 1995; Donchin, 2001), and for foregrounding consequentialist arguments (Chadwick and Levitt, 1997). Principlism has had slightly less influence in continental Europe, where alternative approaches such as 'personalism' have emerged. In contrast to an overemphasis on autonomy, personalism requires a balancing of the value-orientations of individual uniqueness, social relationality and societal solidarity (Schotsmans, 1999, p18), making it, like feminist bioethics, attentive to the social and societal context of ethical decision-making and faithful to a construction of moral agency as inherently relational.

This critique alerts us to the danger of a distanced bioethics which may make policy recommendations without much awareness of how ethical decisions are made in everyday life, adopting the classical gods-eye view and assuming an out-of-date notion of a disembodied, non-emotional representation of social action and actors. Perhaps the context-stripping theoretical method par excellence found in bioethics, as Levitt points out (2003, p15), is the strategy of constructing a hypothetical case in which actor X and/or Y is faced with such and such a moral decision. While not without some heuristic value, this is essentially a bioethicist's laboratory in that s/he can completely control the actors and events that occur as if to demonstrate an ethical case, yet without making any reference to social realities that might reveal 'messy' relationships and emotions between actors.

This kind of argument against abstraction and the case for empirical methods in bioethics have been argued forcefully by the authors above, and so I want to put more stress here on the second, related social science critique of bioethics, which I assert as being the general inattention to sociopolitical and socioeconomic contexts in bioethical argument. This, I argue, can be remedied by a better interdisciplinarity and can make an important contribution to the avoidance of uncritical complicity in bioethics and to a critical bioethics more generally. It would be a narrow interpretation of social science to assert that the only role it may have could be to supply 'factual' empirical data for the refinement of bioethics. For this interpretation, which Haimes describes as the 'handmaiden role' (2002, p89), discounts the normative critical tradition in the social sciences that coalesces around an integrated examination of power, figured primarily in a nexus of class, 'race' and gender relations. The emergence of environmental sociology and animal studies has begun to address the anthropocentrism of this tradition. At a time when bioethics faces a critique from within, for example from feminist bioethics[3] (Purdy, 1996; Rawlinson, 2001; Tong, 2003; Shildrick, 2004) and from those arguing against neo-colonial Western ethics and the importance of other ethical traditions (Holm, 1995; Gervais, 1998; Widdows et al, 2003), it seems that the critical social science tradition has much to offer bioethics, not least the elaboration of the socioeconomic and sociopolitical contexts in which ethical questions are framed and decisions are made. Tensions certainly can be noted here in the way that, for example, new genomic knowledge sometimes aided by bioethics rides a reckless biological and ahistorical reductionism over decades of sociological research into such areas as sexualities, gender and general explanations of social behaviour. This is classically illustrated in the less than critical 'discovery of a new gene for' sort of announcement. Applying greater sociological context to the case of animal biotechnology takes various forms that I elaborate later. These include, but are not limited to, examining the economic imaginary (a particular strategic narrative of the

future) of adherents of animal biotech and thinking more sociologically about peoples' ethical decision-making in relation to consuming animals.

A learned attentiveness to myriad relations of power provides a vital corrective to the view of a level playing-field to which ethical principles can be applied. The knowledge of the historical role that biological reductionism has played in naturalizing such relations of power furthermore provides the social scientist 'doing bioethics' with a critical stance towards the contemporary reproduction of such discourses, especially in genomics. As DeVries and Conrad (1998, p253) argue, a sociologically informed bioethics looks somewhat different and asks different questions. To give some examples, in the case of sex selection it may be argued from an autonomy viewpoint that parents have a right to select for sex to achieve what is often referred to as a familial 'gender balance'. Yet from a critical social science viewpoint it could be pointed out that this makes many assumptions about gender (what boys and girls are, and what they can or cannot do) and that sex selection could contribute to such gender essentialist points of view. Thus doing bioethics from this perspective would think about the potential impact on the wider societal context. A self-defined individual good may not be the same as a social good. A further example of sociopolitical contexts germane to animal biotechnology is the move by companies such as Advanced Cell Technology (ACT)[4] to clone endangered animals. In 2003 the company successfully produced clones of the Banteng, a wild bovine species related to the domesticated cow. This could appear as an unproblematic philanthropic use of biotechnology in the cause of animal conservation; certainly the technology *could* be used in this way. Yet it could also be seen as a technological approach that is neatly complicit with wider cultural and economic factors which drive habitat loss and overdevelopment, and excuses measures to tackle these underlying problems. If one looks more closely at the ACT case, the research involved collaboration with another company, Trans Ova Genetics, who are involved with agricultural cloning research.[5] That the ACT website speaks of their approach as 'maintaining valuable diversity' points to an instrumental understanding of the idea of 'conservation' and the potential value of non-domesticated species in enhancing the genotypes of the domesticated. In his 1999 IAB presidential address, Alistair Campbell expressed many of the criticisms of bioethics put by social scientists, stating:

> *I think it is notable that, despite some remarkable initiatives in virtue ethics, feminist bioethics and narrative ethics applied to healthcare, the bulk of bioethics literature is still predicated on the methodological assumptions of the rationalistic empiricist schools which have dominated Anglo-American philosophy. Certainly in some European countries there is fascinating work based on the more radical implications of post-structuralism for an understanding of health and healthcare, but little of it seems to find its way into the 'mainstream' English language bioethics journals.* (1999, p186)

This underlines how the field of bioethics, by being open to interdisciplinarity, is gradually being contested both by other philosophical traditions and by social science perspectives, despite being prone to persistent prior rationalist and utilitarian hegemonies.

In spite of the critiques of bioethics from various social science and feminist perspectives, none of these authors have said anything of note on the reduction of

bioethics to medical ethics. Continuing in this reflexive vein, I now move on to expand the notion of a critical bioethics to say something on the subject and take issue with what may be argued is a narrow, anthropocentric conception of the 'bio' in bioethics.

Contesting the 'Bio' in Bioethics

The belief that bioethics can enclose an effective consideration of the ethical impact of the life sciences around human health and decision-making perpetuates the dualistic assumption that humanity somehow exists apart from nature. This puts bioethics on a head-on collision course with a central argument from much of environmental philosophy that it is just this separation that has encouraged the Western human to deny dependency and value to nature. In contrast, the intention here is to bring medical and environmental/animal ethics closer together and in so doing contribute to a critical redefinition of bioethics. Further, in Chapter 3 I broaden this section out to specifically think through human–animal interconnections in the context of biotechnology.

My approach shares some commonality with that of Potter's (1988) formulation of a 'global bioethics', more on which below. The 'bio' in bioethics should be conceptualized to be attentive to the interconnections between the human, ecosystems and nonhuman animals. Moreover, taking a cue from some forms of environmental ethics,[6] the 'bio' in bioethics should be more reflexive to its own anthropocentrism, incorporating the analysis of an ethics of relationality between human and nonhuman. In other words, owing to our ecological embeddedness, human wellbeing is tied in part to that of other species. I now outline an argument for why bioethics ought to be set in ecological contexts and less guided by species boundaries.[7] First, we must call into question underlying definitions of 'health'. What is excluded from our definition if we exclude ecology and other animals? Relatedly, we can point to some interconnections between human health and animal health that undermine an anthropocentric focus. A further part of the argument is a little more complex. Many of the medical issues with which bioethicists concern themselves are practices that act on human and nonhuman bodies. Biomedical science has tended to view bodies dualistically, solely as part of nature rather than as also cultural. In turn this has promoted approaches to the body that are objectifying *across* a human–animal distinction. Although in certain respects this has partly been a beneficial frame, it also raises ethical questions about the limits of continually rationalizing bodies and how such a decontextualizing approach can miss the importance of the sociality of corporeality as a determinant of health. I will now explore these arguments in a little more detail.

The critique of the medical model of health is hardly new. Its main point is that it conceives 'health' as a property of a bounded individual body (see, for example, Freund and McGuire, 1995, p206; Bowring, 2003, pp145–146), as opposed to an alternative relational definition that figures health as also situated within historical, political, social and ecological contexts. The medical model favours medical responses over environmental and/or sociopolitical responses (such as tackling social inequalities in health by introducing anti-poverty measures). This inattention to a person's social positionality (see Tong, 2003, p95) and ecological embeddedness also lends itself to locating responsibility for health and illness with individuals themselves. Moreover, it is not difficult to see how a bioethical emphasis on individual autonomy could reinforce

such definitions of health. This need for reflexivity is all the more surprising given that Potter's original notion of bioethics in the early 1970s incorporated a much broader notion of health than the classic medical model, including, for example, ecological considerations.

In his original text, *Bioethics – Bridge to the Future* (1971), Potter was concerned that 'medical science has thus far not penetrated very deeply into the question of what constitutes an optimum environment for the human species' (p104). In his follow-up, *Global Bioethics*[8] (1988), Potter expands on his integrated view of bioethics. His model of bioethics gave equal weight to what he termed medical and ecological bioethics. While Potter saw a difference between these two in that medical bioethics is understood as more concerned with short-term action to improve and prolong the life of individuals and ecological bioethics as more fundamentally related to long-term attempts to preserve ecosystems for the benefit of human health, he ultimately seeks a harmonization of the two under a general movement for 'global bioethics' (1988, pp74–78). He laments the divergence of medical and ecological issues into their own fields, a narrowly conceived bioethics and environmental ethics. As Engelhardt writes in his foreword, 'Bioethics the term has developed its own history with little regard to Potter's original intentions' (1988, px). Against the grain of these developments, Potter attempts to weave in issues such as hazardous waste, the degradation of water resources, and chemicals in the environment alongside more traditionally conceived medical issues. Zylinska (2009) has also recently highlighted the potential of Potter for a posthumanist bioethics and praised his situating of ethical questions in a wider sociopolitical nexus. It is now the case that a global focus *has* begun to establish itself in bioethics. This, for example, wants to challenge a bioethical preoccupation with high-technology and underlines the importance of thinking health in terms of global disparities and the intersections of war with health (see, for example, Dwyer, 2003). This is bioethics that refuses to impose a clean boundary between the 'ethical' and 'political' and brings us back to Potter's original vision.

In spite of this partial reclamation, Potter is not a panacea for contemporary bioethics.[9] For example, his evocation of environmental issues exhibits a preoccupation with population control, gives undue weight to individual responsibility and is arguably ethically shallow given the mostly anthropocentric reasons for including ecology within his wider definition of health. Despite these criticisms, Potter is worth returning to precisely because of his main argument that bioethics ought to foreground a definition of health that is attentive to the interconnections between the human and the nonhuman. The reduction of bioethics to medical issues echoes traditional dualistic notions of the human as somehow separate from nature.

This is odd since it is now hardly profound to think of the many linkages between the health of the environment or animals and that of humans. Examples include the risk of increased skin cancer due to the degradation of the ozone layer, risks to human health from living near sites of intensive agriculture and the risk of Creutzfeldt–Jakob disease to humans by forcing carnivorous eating habits on cattle, to name only a few. It has also been suggested that strengthening the links between human and animal health is an important part of reforming food policy (Hewson and Lang, 2005, p1268). Here the thinking is that since poor animal welfare is also a threat to *human* health and that dominant health advice has been to shift national diets away from high-fat, energy-dense foods (often meat and dairy), there is scope for joined-up thinking between vets and

doctors.[10] Moreover, it is reasonable to assume that when large-scale research such as human 'biobank' projects reveal the limits to the determining power of genes, scientists are going to want to know much more about the interplay of bodies and environments, construed broadly. This is likely to have a knock-on effect for bioethics. These points also underline the importance that public health and public health ethics should have for bioethics overall. Taking Potter's central argument on board can assist us to do bioethics which ontologically takes the human as both embodied and as embedded in nature. These are central arguments of many environmental ethicists who seek to move us away from dualistic understandings of the human as somehow disembodied and separate from nature (for example Mellor, 1997). It would be unfortunate if contemporary bioethics, by ignoring links to environmental ethics and issues, were to inadvertently support this obsolete abstracted idea of the human.

The exclusion of 'nature' not only threatens to compromise our understandings of health within bioethics, but it also lessens the likelihood of considering animal ethics. Though not a point emphasized by Potter, the shift he laments from bioethics to biomedical ethics is also an anthropocentric move that decentres considerations of animal ethics. This exclusion juxtaposes incongruously alongside a present context where genomics brings animal ethics increasingly to the fore via the possible intensification of the instrumentalized animal. Irrespective of positions taken on the moral value of animals, it is simply a poor bioethics that fails to acknowledge and account for diverse research contexts which implicitly ethically frame animals. Giving due place to animal ethics within bioethics addresses anthropocentric ethical enclosure and broadens our understanding of the 'bio' in bioethics.

My final point in this section will lead into the third and final constituent part of this experiment in 'critical bioethics': namely avoiding complicity with unexamined notions of rationality, humanism and progress. In particular, biomedical attitudes to the body may be another reason for bioethicists to make links with the nonhuman. Earlier, when discussing interdisciplinarity, I outlined some of the sociological engagement with bioethics. At this juncture it is relevant to complement that by stressing the value of *historical* perspectives to bioethics. For example, the omission of such analysis risks losing sight of trends and patterns in biomedicine, which in this case may have a bearing on medical attitudes to the body. Historical research locates biomedicine as a part of culture and enables us to see how it has been bound up in broader structural trends. Freund and McGuire argue that modern medicine has been partly shaped by the broader cultural tendency of rationalization, which they define as 'the application of criteria of functional rationality to many aspects of social and economic life, the promotion of bureaucratic forms of organization, and an emphasis on efficiency, standardization and instrumental criteria for decision-making' (1995, p212). This was bound up and expressed in the phenomena of medicalization, wherein biomedicine gradually assumed authority and control over new areas of social life. Important here was a technical, disenchanted view of the body as dualistically separate from the (rational) person and amenable to scientific improvement. Inserted into a Western historical dualistic narrative, biomedicine represents the cultural domination of human physicality, which is assumed to symbolize nature. However, the traditional biomedical view that the body simply represents nature uncritically reproduces a dualistic view that not only separates mind from body, but also discounts the social, economic and cultural construction of

the body. There exist good historical and contemporary examples of medicalization where biomedical culture views the body in this dualistic way.[11] The classic example remains the medicalization of pregnancy and childbirth, but extends now to the pre-conception control of fertility. Furthermore, Ritzer has argued that we also now see the medicalization of death, ranging from the efforts of biomedicine to enhance lifespan to the increasing use of cremations as a more efficient means of managing the dead (1996, pp170–174). It is interesting to think of the obvious ways in which humanity is embedded in nature, with reproduction and death two such processes that cannot fail to remind us of this fact. Yet these are exactly two of the main processes which have been subjected to attempts at biomedical control. When genomics is understood as a transhumanist discourse to 'enhance' or 'correct' 'defective' or 'deviant' bodies, it is broadly in line with this rationalization trajectory. As I shall outline later, it is exactly an emphasis on efficiency and standardization that appears to underpin the turn to the molecular in animal breeding.

In this light it is possible to see biotechnology as perhaps one of the most ambitious attempts yet to extend the human domination of nature, only this time we, or rather our abject bodies, are the target of our own attempts at mastery or 'enhancement'. This provides one further reason why bioethicists may wish to consider closer ties with environmental ethics, since it could be imperative to think through the ways in which there are connections between the human mastery of the environment, understood as ecosystems and nonhuman animals, and the biomedical control of the human body, conceptualized as 'nature within' (see also Shildrick, 2004, p157). This trajectory is not inevitable, so-called 'mastery' may be benign, or indeed beneficial, and new scientific understanding need not be inherently pernicious. However, there is a responsibility here for bioethicists to be more attentive to the power of science and medicine, and that this attentiveness can be accentuated by closer ties with both historical perspectives and ethical approaches that are counter to anthropocentrism. One reason behind this lack of attentiveness is arguably an uncritical complicity with unexamined notions of rationality and scientific progress, and it is to this final aspect of my discussion that I now turn.

The Question of Complicity

The previous example of body commodification tells us that scientific faith in dualistic kinds of rationality may be ethically dangerous and expose what several authors have referred to as the 'irrationality of rationality' (for example Bauman, 1989; Ritzer, 1996). This serves to underline just how 'question-begging' attempts to define bioethics on the basis of 'rational decision-making' are (see, for example, Harris and Holm, 2002, p357). What is the rationality concept being utilized here? For example, is it seen as a human universal, and is it exclusionary of emotion? Rationality, then, I would argue, ought not to be deployed by bioethicists in an essentialist manner, evoked as a strategy of tying up an argument, with the assumption that it stands for something fixed and eternal, instead of constructed. The partiality of rationality was recognized by Campbell in his 1999 presidential address to the IAB, when under the heading of 'The tyranny of rationalism', he wrote:

> *Our idea of 'free, open and reasoned' has been shaped by a particularly Western mode of reasoning, one which has been remarkably successful in enabling the*

> *emergence of an all-controlling technology, but is by no means the only way, or even the best way, of establishing our ethical signposts. It cannot be accidental that such a way of doing ethics fits neatly into the idea of constant economic progress as an end for humanity.* (1999, p186)

This is similar to what Arthur Frank has termed a 'protectionist bioethics', one which operates within a consumerist frame of reference and foregrounds individual choice. For Frank, one problem with this type of bioethics is that it 'has trouble taking seriously how one's individual choice affects others' (2004, p19). One can refer this back to the previous sex selection example, where individual choices have social consequences. The possibility that bioethicists are intellectually or commercially captured is less surprising if there is a common discourse of rationality and progress at play. This is not to say that bioethics should position itself as antagonistic to science, but rather that it does have a role, where required, to communicate to scientists and policymakers the constructedness of scientific knowledge and the specificity of scientific values, and it simply cannot do that if it uncritically apes entrenched humanist notions of rationality. As Campbell notes, bioethicists may think of rationality in a number of ways, such as acting in a self-interested manner or of departing from any notions that conceive of nature and human bodies as sacred (1999, p187). Yet such ways of deploying the 'rational' are partial and, as argued above, discourses of desacralization may act as precursors to instrumentalized treatment.

Bioethicists also ought to reflect on their own professionalization and 'expert' status, which may incorporate a dualism of rational philosophers versus an uneducated emotional public often typecast, for example, through the dismissive idea of the 'yuck factor' response to new science and technologies. It could be argued that this dualistic representation is yet another deceptive deployment of the idea of facts versus values. Some of the criticism of bioethics relates to how bioethicists act, and how bioethics is represented, in non-academic spheres, especially in relation to commercial interests (see Ashcroft, 2004; McMillan, 2004; Elliot, 2004). Broad self-reflexivity to one's role is a vital component to promoting critical bioethics. McMillan (2004) provides a useful discussion on this with his distinction between moral analysis and moral criticism in bioethics. As he points out, most people 'doing bioethics' perform both of these to different degrees (p170). The crux is that if bioethicists veer too much towards analysis, they risk resembling an archetype of the disinterested 'value-free' theorist which denies or disguises what many see as our essential 'interestedness' (Ashcroft, 2004, p163).

Philosopher Grant Gillett has added to Campbell's 'critique from within', questioning the use of rationality in bioethics. For example, he refers to a mode of arguing in bioethics as 'the Humean reduction and vicious reframing', which is defined as 'the narrowing of focus to features that omit elements of a situation of central relevance in forming a moral judgment' (2003, p256). This brings to mind the problems of abstraction in bioethical argument discussed earlier. Several of Gillett's conclusions also chime with the anti-dualistic arguments above. He argues for a relational conception of ethics, seeing our moral values as grounded in affective social relationships. In doing so an understanding of rationality as not dualistically separate to the emotional is stressed.

I finish this chapter by providing two examples that further highlight the problems of basing ethics on a rationality which is separate from the social or from emotion.

Moreover, these are elements of rationality that mirror classic Enlightenment, dualistic models and provide the bioethicist with a limited critical vantage point towards new developments in science and technology. They also bear on the important question of what constitutes progress.

One of the most fundamental issues thrown up by genomics is the possibility of active genetic selection of newborn humans. Taken to the extreme, this could take the form of 'germline enhancement' of the human. While pre-implantation genetic diagnosis (PGD) is *already* used to screen out embryos with inherited genetic conditions, genomics could allow us to actively compose newborns in terms of non-disease genes or through tools such as sex selection. If this prospect is accompanied by moral indignation, it ought to be recalled that this is now routine in the nonhuman case, such as with farmed animal breeding. Raising the possibility of human selective breeding is just one way in which genomics could be said to unsettle the taken-for-granted human–animal hierarchy.

The bioethicist Julian Savulescu (who may justifiably be seen as a transhumanist bioethicist) argues through his principle of 'procreative beneficence' that 'couples (or single reproducers) should select the child, of the possible children they could have, who is expected to have the best life, or at least as good a life as the others, based on the relevant, available information' (2001, p413). He specifically orientates his discussion to non-disease traits such as intelligence and sex selection and makes hints towards physical features such as height. Clearly aware that his principle is open to the accusation of eugenics, he argues that:

> *A public interest justification for interfering in reproduction is different from procreative beneficence which aims at producing the best child, of the possible children, a couple could have. That is an essentially private enterprise.* (2001, p424)

It can be countered that a weak public–private distinction is being made here, since it is hardly a private enterprise if such action is socially endorsed or encouraged. Perhaps more compromising to his principle is that it is dislocated from the social. In other words, presumptions are made over the content of 'best life' and 'best child', with insufficient attention to how these are socially and historically mediated. For example, normative prescriptions to select for intelligence not only assume it to be a quantifiable attribute but that it can be shown to be meaningfully genetically determined. Moreover, normative prescriptions to select for physicality ignore how the evaluative scaling of different bodies is a social construction bound up in interconnected relations of power such as gender, 'race' and class (see Young, 1990). A venture into 'cosmetic genomics' would, however, represent the logical trajectory of a 'rational' Enlightenment project ill at ease with embodiment generally and 'deviant' bodies specifically. In an approach that fails to adequately situate reproductive choice and 'procreative beneficence' in a broader social and political context (see Parker, 2007), Savulescu implies using genomics to combat social inequalities (see Bowring, 2003, p180), a move that would construct its own normative idea of the 'human'.

The question of whether in the future we should use new technology to extend the human lifespan also raises issues over our uses of reason and our notions of progress. Indeed life extension has become a popular feature of transhumanist discourse. In a

cautionary take on this, Glannon (2002), arguing from an evolutionary biology perspective, has stated that 'altering the genetic mechanisms of aging could lead to a shift in the number of mutations between earlier and later stages of life, because we would be altering the functions for which genes are naturally designed' (p344). Gradually in the more distant future we *could* be subject to more disease in earlier life as such mutations would no longer necessarily be being selected against. His caution is based on a concern for the protection of future generations and highlights a potential complication of human germline or selective breeding. Harris and Holm (2002) argue against his position by attacking the ethical deployment of the precautionary principle more generally. For them the precautionary principle 'requires science to be ultra-conservative and irrationally cautious and societies to reject a wide spectrum of possible benefit from scientific advance and technological change' (p357). Yet caution seems highly prudent in the case of developments around genomics. Owing to their scientific novelty, they are open to potential uncertainty, especially in relation to possible future harm and unforeseen unintended consequences. Harris and Holm's words may rather be seen as illustrative of the arbitrariness of strategic uses of a discourse of what is or is not rational to support a partial view of progress.

Apart from any evolutionary biology argument, sociologically the hypothesis of life extension evokes social attitudes to death, dying and ageing. Any such bioethical discussion ought to occur in recognition of a social context where the elderly and aged bodies are culturally devalued, and death and dying remain taboo issues which remind us of both our connections to nature and vulnerability. Fantasies of life extension can be seen as further attempts at distancing the 'human' from its 'animality'. Research into life extension does not take place within a sociopolitical vacuum but conforms to a hegemonic cultural value that death and ageing are somehow offensive to a rationalized view of the human. There are associated aims here about reducing illness in later life that may be distinguished from that of extending human lifespan, but it is certainly contestable that biomedicine should be given the starring role in improving welfare among the elderly in lieu of improved social policy and material support. In some ways this mirrors debates around the role of technology in animal welfare discussions, which I shall return to in Chapter 8. Precaution then may be prudent here not solely due to the unforeseen consequences of biomedical research, but also because of how that research may be complicit with ultimately damaging assumptions that our notions of rationality may make of ageing and death.

I have presented an interlinked, three-way definition of a critical bioethics that coalesces around the concepts of interdisciplinarity, reflection on understandings of the 'bio' in bioethics and the avoidance of complicity with anthropocentric ontology. This definition I suggest initiates an experimental process that answers some of the major criticisms of bioethics and may better equip it to think in a broadly critical and contextual way about new developments in science and technology. Of course the real danger (or perhaps promise) is that such a bioethics would be distinctly more unpalatable to a nexus of commercialized science interests. I have arrived at this understanding of a critical bioethics partly by taking a critical stance toward dualisms, a strategy more familiar to environmental ethics. This hybridization and exchange of methodology acted as an appropriate catalyst for thinking through some of the criticisms that have been made of bioethics by those both in and outside the field. In the following chapter I

open up the issue of the 'bio' in bioethics in more detail by focusing on human–animal dualism in the context of 'animal biotechnology'. In doing so I not only continue the task of questioning anthropocentric ontology, but call to task the assumption that one may conduct the enterprise of thinking human biotechnology socially and ethically without also responding to the nonhuman.

3

Thinking Across Species in the Ethics of 'Enhancement'

One example of the uncritical habits of bioethics has been to speak and give life to a discourse of 'enhancement' to describe technological work on the body. In line with its anthropocentric focus, this has in most cases been in reference to human bodies. In broader *social science* approaches to biotechnology there has similarly been an exclusion of other animals, with research on 'agricultural biotechnology' often being reduced to GM crops issues and medical ethics or medical sociology often quiet on the role of animals in medicine. To speak of 'enhancement' already espouses a particular value judgement as to the role of science and biotechnology in human wellbeing and uncritically enrols a transhumanist promise of technological inevitability. In contrast, the use of scare quotes at the outset of this chapter retains a notion of futures as contested.

Drawing on the critical bioethics outlined previously, this chapter takes a broad species-level approach to the social and ethical aspects of biotechnology. Critical bioethics aims to foreground interdisciplinarity, sociopolitical dimensions and reflexivity to what becomes bioethical subject matter. The chapter focuses on the last component and uses the example of nonhuman animals as a way to think about both 'enhancement' generally and bioethics. It constructs several arguments for including animals as part of 'enhancement' debates and considers some connections between human and animal 'enhancement'. The chapter concludes in a plea for an enhancement of our critical abilities to examine some of the underlying social, moral and ethical assumptions bound up in varied anticipated 'enhanced' futures. Moreover, this task is taken up in the remainder of the book, when attention turns to another contested term: 'sustainability'. The broadening of the 'bio' in bioethics is key to thinking more contextually around what we construct as the ethical. The focus here is to question separate analyses of human and animal biotechnology (and medicine and agriculture), but a truly species-broad approach must also integrate an understanding of how the commercialization of *plant* biotechnology intersects with animal agriculture and human health. Although not the focus of this book, I return to this question partly in Chapter 7.

Important conceptual attempts at both defining enhancement and thinking through the usefulness or otherwise of the therapy–enhancement distinction have been made (Parens, 1998, Juengst, 1998). Therapy is usually assumed as treatment that returns

the body to something resembling a 'normal' functioning state, with 'enhancement' adding something novel to embodied functioning and experience. Juengst argues that enhancement usually functions as a 'moral boundary concept' (1998, p29) demarcating the proper boundaries of medicine in terms of goals and obligations (see also Parens, 1998, p2). For Juengst, enhancement in some cases might be better understood through the concept of medicalization to indicate in fact the encroachment of medicine into new, non-traditional areas (1998, p43). Enhancement also functions philosophically as a concept to contest or uphold various notions of the 'human', evoking several strategies ranging from 'normal' species functioning to more deconstructionist transhumanist visions. Enhancement may be couched in the relatively benign language of personal self-improvement or discussed in terms of the commodification of self or one's children. Arguments from precedent (Parens, 1998, p14) may be implicitly mobilized in order to suggest a continuity and moral equivalence between past practice and proposed techno-scientific modes of enhancement. An example of this would be the attempt to justify genetic enhancement by recourse to the long tradition of parental attempts to socially 'enhance' their children through 'social' means or even through largely accepted medical means such as innoculations.[1] It may be argued in this case that it is wrong to discount the moral significance of 'means' and the way in which one enhances one's life project or indeed has it enhanced by others can be highly relevant to one's self and social identity (Parens, 1998, p12; Brock, 1998, p58). Polemical lines have even been drawn between so-called anti-enhancement 'bio-conservatives' and the pro-enhancement 'transhumanists' (Bostrum, 2005, pp202–203). Such examples point to the richness of debate around the social and ethical aspects of enhancement.

Here I take a somewhat different direction and focus in the main on the 'enhancement' of animal bodies. I am interested in animal 'enhancement' both for its own sake and for what it might bring to the human enhancement discussion. To expand, there are animal-centric reasons for this focus, but there are also anthropocentric reasons, as well as an argument for a less enclosed bioethics. In the first case, it may be felt that the moral economy that has arisen around enhancement debates is too often guilty of a narrowing instrumentalization of animal lives at best or plain exclusion at worst. In the second case it may be argued that what is happening in animal enhancement research or ethics could have relevance for thinking through the human case, with or without the notion of a slippery 'animal-to-human' slope. Finally, it could be argued that what is performed on animals involves obvious moral values and ethical principles and that for that reason alone animal enhancement should be part of the wider deliberation on enhancement.

This choice of focus stems from an approach to bioethics developed previously under the concept of a 'critical bioethics'. All of the conceptual elements are of relevance when thinking through the complexities of the issue of enhancement. For example, the importance of bioethicists avoiding a position of *uncritical complicity* with culturally damaging attitudes to the body or of gender is important when considering the issue of cosmetic surgery as 'enhancement'. Furthermore an *interdisciplinary* bioethics is important for thinking about enhancement, with social policy awareness and historical knowledge of eugenics just two important elements to inform ethical analysis. In this chapter I focus on the third element of the critical bioethics concept – a reflexivity to bioethical subject matter. The intention is not to construct an explicit ethical argument but to interrogate the socially constructed terrain of the ethical in enhancement debates.

The aim is to perform two interconnected tasks. First I want to underline the bioethical importance of *animal* biotechnology, and second, to continue a project to extend bioethics more fully than has been practised to date, across the culture–nature and species divide, which means expanding on what is commonly understood as the 'bio' in bioethics. I illustrate this point in particular by pointing to the porosity between medicine and agriculture in the area of enhancement.

The narrowing of bioethics to medical ethics, or sometimes 'biomedical' ethics, represents an *unreflexive* anthropocentric conception of the 'bio' in bioethics, which brackets out environmental and animal ethics and tends to downplay sociopolitical, socioeconomic and ecological inputs into human health. Just as animals linger in the unspoken periphery of bioethics generally, animals receive little attention within the increasingly thriving ethical deliberation over emergent human enhancement technologies. A greater degree of reflexivity underlines the social construction of particular issues to be counted as bioethical issues (Hedgecoe, 2004, p126). Such a socially situated process is unsurprisingly inflected with dominant cultural values that do not provide an ethical space for thinking about the value of animals in the context of developing human therapies or enhancements. At a recent major international conference[2] on the 'Ethics and Philosophy of Emerging Medical Technologies', there was an impressive range of issues covered. These included life extension, psychopharmacology, stem cell research, cloning, human reproduction, cosmetic surgery, biometrics, transhumanism and nanotechnology. Although these subjects were undeniably well approached, there was little evidence to suggest an awareness of a wider context of enhancement that includes the use of animals as models to develop these very same proposed human enhancements. Moreover, the conference was couched in the terms of *medical* ethics and so already signalled a parochial retreat into the unhelpful dichotomous portrayal of 'red' and 'green' bioethics. Such a model of bioethics makes it harder to theorize the connections between the medical and the agricultural that I discuss below, and in the case of enhancement suggests that the emerging technologies we see in these two domains are somehow significantly unrelated. More insidiously, there is a suspicion that the distinction also serves to disguise a historical trajectory that has been concerned with the mastery of materialities *across* species (Plumwood, 1993; Twine, 2001; Clarke, 1998, 2007). The overall impression from this conference and from the wider bioethical conversation on enhancement is that animal biotechnology is backgrounded both spatially and ethically.[3]

Opening up Animal (Bio)Ethics – Smart Mice, Schwarzenegger Mice and Fearless Mice

When beginning to think about the technoscientific enhancement of animals, some rather clear differences become apparent due to the different ethical space which animals ordinarily are made to occupy. The therapy–enhancement distinction deemed pertinent to debates of human enhancement conspicuously is assumed to lack moral purchase in the nonhuman case. Although there are certainly veterinary codes of practice, there is not a comparable Hippocratic Oath or expectation about the proper goals of medicine in the animal case precisely because of the diverse moral value attributed to different human–animal relationalities. In spite of or indeed because of this inconsistency, there are interesting cases where 'enhancements' will be permitted on some animals but not

on others. The recent UK decision not to allow the cloning of horses could be seen as one such example.[4]

In debates around human gene therapy, ethical importance is placed on the distinction between somatic and germline therapies. This reflects the permanency and thus responsibility to future generations when the possibility of altering the human germline is raised. Yet germline enhancement is not generally perceived as an ethical issue in animal enhancement, reflecting, for most people involved, the ethical insignificance of modifying animals and the established practices of doing this in both agriculture and medicine. Of course, this does not necessarily entail that no germline animal 'enhancement' will fail to arouse ethical questioning.

In debates around cloning, ethical importance has been placed on a distinction between therapeutic and reproductive cloning. This enables the exploitation of cloning technologies for the potential benefit of using embryonic stem cells but creates a moral boundary prohibiting *reproductive* cloning, that is the taking to term of a cloned human embryo. A cloned human being is assumed to violate human dignity or individual uniqueness.[5] This is presumably not the case with animals, as several different animal species have now been cloned. This research is interesting as it has taken place across a wide range of species – not only species from agriculture and biomedicine that one might not expect to be constructed as especially morally significant in most cultures, but also companion species such as cats and dogs.[6] This research has been permitted in spite of known problems about premature morbidity and mortality in cloned animals.[7] As with the ethical distinction in gene therapy, the ethical distinction in the case of human cloning seems to not matter in the case of applications to animals.

Staying with the rather obvious nature of these claims, in the case of human enhancement there is an assumption that a given enhancement will actually enhance the life of an individual or social group. In the case of technoscientific animal enhancement, there is little sense of an animal's life and experience being enhanced. Rather, animal enhancement is almost always for the perceived benefit it can provide for the human. Given that our ethics ought to include an acknowledgement of relations of power, it is more accurate to talk of animal enhancement as animal *modification*, genetic or otherwise.

There are arguably counter-examples that one could imagine, and that are indeed being researched, that would confer a survival benefit to some animals. As global warming begins to indicate changing climate patterns, it could prove problematic for agricultural animals to adapt in such a short period of time. Given such a future forecast, the UK's Department for Environment, Food and Rural Affairs (DEFRA) has encouraged research into the assisted selection or modification of animals that would be better suited to a warmer climate. One could envisage such an enhancement having a benefit for the life of such animals, albeit within a context of their continued commodification as livestock. Similarly, endangered animals could be enhanced using biometrics to better ensure their traceability or survival in some way. However, while such counter-examples do caution against the wholesale rejection of the use of the word enhancement in the animal case, they do little to dispel the sense in which the majority of animal enhancement and its associated research takes place for the main benefit of humans. This brings us to an initial important point: that a class of animal enhancement research is directly linked to human enhancement research and ought to be acknowledged as a part of

the bioethical analysis. Research into life extension, intelligence, psychopharmacology, stem cell research, cloning and human reproductive technologies all involve substantial animal research that first attempts to enhance an animal prior to seeing if it might work on the human. There have been high-profile examples of this, including 'smart mice' (Tang et al, 1999) with improved memories, the presumably less smart 'Schwarzenegger mice'[8] (Lee et al, 2004), whose bodies bulk up after the injection of a gene linked to muscle growth, and 'fearless mice' who act more 'courageously' when a certain gene is deactivated (Shumyatsky et al, 2005).

Although such examples have received attention in both the media and from ethicists, this is typically only in the sense of what they may mean for possible future human applications and not as a question of animal ethics. Smart mice have been taken to imply future enhanced human intelligence, 'Schwarzenegger mice' have led to debates about the genetic modification of athletes (Miah, 2004), and 'fearless mice' are discussed in terms of possible new treatments for people suffering from phobias or anxiety disorders (Hutson, 2005). Some of these examples highlight an emergent research focus on behavioural genomics that while enrolling both the biomedical and agricultural also implicitly explores the role of genetics in *human* behaviour. Thus in livestock research there is considerable interest in the genetics of domestication and how this pertains to both aggression and docility in farmed animals (Albert et al, 2009). Meanwhile genetic research around aggression and violence in the human has a particular focus on anti-social young people (see Levitt and Pieri, 2009). These are all important intersections to highlight and it is a poorer bioethics that fails to include all contexts in which moral values and ethical principles are deployed within and between species through related 'enhancement' imaginaries.

The Ethical Bypass and the Argument from Precedent

These examples of animal enhancement have referred mainly to the medical context. Below I broaden this out to include agriculture as well as the crossover points between the two. That animal ethics remain assumed or closed off in enhancement discourse is partly down to what may be termed the 'ethical bypass'. Previously established social practices, here specifically human–animal relations, are assumed to provide a bypass that sidesteps the ethical deliberation of new and proposed technoscientific developments. There are different varieties of this argument routinely deployed in animal enhancement discourse by both animal scientists and ethicists.[9] One such example refers to bypassing the ethics of using pigs for xenotransplantation because most people morally sanction the use of pigs for food. Consequently, the ethical debate around xenotransplantation is often reduced to two aspects of *safety* – namely the problem of animal to human virus transfer and the problem of organ rejection. But does the eating of pigs necessarily entail that their use in xenotransplantation would be acceptable? It may be wrongly assumed that just because a practice is deemed normal it escapes ethical scrutiny. It also may be tempting to think that the former does give some sort of carte blanche. However, this ignores the point that there are different sorts of instrumentalization, some of which may be deemed worse than others. For example, it may be argued, however problematically, that meat is more of a necessity and that xenotransplantation is unethical because other ways could be found to address the donor deficit problem. Bringing into being an animal

for the sole reason of extracting organs for their use by humans *may* be seen differently to raising pigs for food. Here I only wish to make the modest point that moral equivalence, and so a bypass, should not be assumed. That such proposed pigs will in all probability be partially humanized, transgenically 'enhanced' to prevent rejection, supports the view that new technologies may raise novel ethical conditions and questions that require deep reflection. But more profoundly the precedent that is assumed to set up the moral benchmark ought to also be opened to ethical scrutiny.

A further example of the ethical bypass takes place when we witness a continuity argument being made in the case of genetically modified animals (or genomics). Here it is argued that genetic modification is essentially little different from selective breeding which 'we have been doing for thousands of years'. This is arguably a little more rhetorical than the first example. Although it would be difficult to totally argue against continuity between selective breeding and genetic modification in that both form part of a broader historical process in which humankind has managed and controlled 'nature' and food production, the latter is different in several ways. Indeed genetic modification is only one of a set of possibilities that have been further facilitated since the sequencing of the genomes of the main agricultural animals. Associated tools such as microarray analysis and new related fields such as bioinformatics also aid the precision and efficiency of selection. Transgenics allows a novel degree of exchange of genetic material between different species and modifications can be made faster vis-à-vis selective breeding. Again the argument also assumes the precedent to be morally benign. In the case of selective breeding, we know this not to be the case given the well-documented negative welfare implications of, for example, selecting only for productivity (Rauw et al, 1998). The rhetoric of such a continuity argument tries to alleviate or dismiss fears over the new, to reassure sceptics of new technologies. There is little if any opposition to *non-GM* genomics techniques such as marker-assisted selection (MAS) or genomic selection (GS) to produce 'enhanced' agricultural animals, even though they may exacerbate the negative welfare and environmental impacts of selective breeding already witnessed. In this sense it is, as many scientists would argue, dubious to surround GM with *particular* moral excitement, but not because it is straightforwardly continuous with selective breeding but because both genomics and selective breeding also provide ample reasons for ethical scrutiny. There is a sense in which a preoccupation with GM may also simultaneously be naturalizing of non-molecular animal breeding. I have heard animal scientists argue that we have been 'genetically modifying animals' for hundreds of years and this is in a sense true – selective breeding has changed genomes and created new breeds – but this practice and history, although now culturally naturalized, cannot be said to escape either a politics or be impermeable to ethical scrutiny.

What I have here called an 'ethical bypass' Parens refers to as 'arguments from precedent' (1998, p14). He points out that such arguments are widespread and problematic in certain ways. In the context of human enhancement he writes:

> *While the argument is never put in such explicit form, its implicit structure is something like this: We've always used means A to achieve end A; means B also aims to achieve end A; therefore means B is morally unproblematic. For example, we've always increased the teacher/child ratio and reduced classroom size (means A) to enhance student performance (end A); Ritalin (means B)*

> *also aims to achieve enhanced student performance (end A); therefore using Ritalin is morally unproblematic. There are at least two sets of problems with this tendency of thought or form of argument. The first has to do with treating different means as morally the same; the second has to do with treating different ends as morally the same.* (1998, p12)

It is not difficult to detect the presence of such arguments in the bioethics literature. Further examples include attempts to equate cloning (human or animal) with natural twinning, or embryo wastage in IVF with 'natural' early miscarriage (see Harris, 2004). This is an important issue for ethical argument, as if performed without reflexivity such moves can appear like rhetorical naturalization discursive strategies. Parens argues that different means are not necessarily the same as they can work on different 'objects', on a child's body versus the classroom environment in his Ritalin example. This is important because it will impact experientially on a child, with some means not necessarily in a child's best interests (Parens, 1998, p12). It is possible to apply this example to the case of animal 'enhancement'. There is currently a great deal of research being carried out into producing animals that are more resistant to various diseases such as mastitis or Marek's disease, which globally have an enormous annual economic cost. There is good reason to believe that a large proportion of agricultural animal disease is caused by intensive modes of agriculture. Creating a possible solution that is directed towards the animal body rather than the environment has an implication for the welfare experienced by a particular animal. As in the child's case, various means are not necessarily morally equivalent. More generally it is worth noting the wider economic context that encourages technological enhancements on bodies – animal and human – rather than environments, as well as the skewed logic that continues to *wholly* separate the two.[10]

The second problem with arguments from precedent for Parens relates to an assumption that ends are similar. He gives the following example:

> *Enhancement germ-line engineering is 'just like' matchmaking in that the end of both 'procedures' is to influence the shape of offspring. But to say that the procedures are morally the same requires ignoring that they achieve results with vastly different degrees of precision. The degrees of precision are so different that they are arguably different in kind.* (1998, p14)

This would be the difference, for example, between the socially constructed tendency for heterosexual couples to mate according to conventional male–female height differences reinforcing that very same difference and the possibility of future couples genetically selecting male offspring who were tall and female offspring who were small. In the case of animal 'enhancement', Parens's argument against the assumption of equivalent ends maps onto what I said above about the difference in degrees of precision between traditional selective breeding and newly developed techniques of molecular selection and modification.

Although arguments from precedent and the ethical bypass may operate to downplay newness, this is highly contextual since in other situations it is exactly newness that must be stressed, for example to create enthusiasm and expectations, to attract funding for research (Brown, 2003, p4) or to apply for patents. This would suggest that conceptions

of newness are frequently negotiated by the science community as they develop an implicit dramaturgical approach to communicate with a wide range of actors with varying concerns, expectations, hopes and fears. Although some scientists will feel it is in their interests to close off ethical engagement on the issue of animal 'enhancement' by recourse to strategies such as those discussed above, a significant proportion of the animal science community is interested in engaging with ethical issues.[11] But this is a trend which it will be difficult to encourage if the issue of enhancement continues to be addressed in a narrow anthropocentric way in bioethics. A bioethics which better acknowledges the moral values and ethical principles at play in animal 'enhancements' can provide a broader space to better accommodate both the perspectives of animal scientists and more animal-centred ethical positions.

I now want to consider more closely the relationship between enhancing animals and enhancing humans. First I want to ask whether there is a classic slippery slope at play. If the answer is even a qualified yes, then there are good *anthropocentric* reasons for taking animal 'enhancement' seriously.

Is There a Slippery Slope Between Animal and Human 'Enhancement'?

As we saw above through the use of animals as model systems, there is at the very least a biomedical agenda that first carries out research on animals with a view to developing future human applications. Traditionally, the logic of using animals as models to glean useful knowledge has been in the service of developing *therapies.* However, the examples above highlight research that if followed through would be in the domain of enhancement. While this establishes a relationship between animal and human enhancement research, this is clearly insufficient to be confident that there is a slippery slope running from animal research to the human case. It is not at least obvious that work on animal bodies will simply extend to the human.

The causal version of the slippery slope argument, perhaps the most relevant in this case, is often seen as dubious or even fallacious. Williams sums up this slippery slope argument as follows: 'If X is allowed, the argument goes, there will be a natural progression to Y; and since the argument is intended as an objection to X, Y is presumably agreed to be objectionable, while X is not' (Williams, 1995, p213). As he also points out, X may indeed be objectionable to those using the slippery slope argument, but they are still burdened with having to provide an explanation for just why there would be a 'natural progression' to Y. What, in other words, accounts for the slipperiness of a progression from X to Y? One might think that because our culture institutionalizes a moral boundary between the animal and the human, it would be naïve to assume that technoscientific animal enhancements (X) would inevitably lead to human enhancements (Y). Often legal and regulatory lines are drawn (1995, p220) that have the effect of stopping the slope. An example would be the UK decision to permit animal cloning in various species (X) and the hastily created Human Reproductive Cloning Act 2001 to ban human reproductive cloning (Y). Proponents of the slippery slope may then counterattack with the case of the mysterious unregulated rogue scientist who will break the law anyway, thus, for them, recreating the slope. In spite of this move and due in part to the continued presence of the human–animal moral dualism in the

UK and other cultures, it is at best simplistic to assume an animal to human slippery slope. Indeed such a claim can resemble the converse of the rhetorical move of the argument from precedent discussed earlier, this time intended to *prevent* a particular technoscientific development.

Yet just because the slippery slope is not wholly convincing here, it does not follow that thinking about animal enhancement will not teach us more about the social, ethical and historical aspects about enhancement generally. Neither does it mean that all animal enhancements are never going to eventually be applied in the human. The wider context of each specific case must be examined in order to make an informed analysis of whether a given slope may or may not be 'slippery'. For example, the highly competitive context of athletics *may* accelerate attempts to use enhancement technology first tried on animals. Another factor that should be taken into account in any contextual analysis is the history of discursive animalizations of various social groups. We know from social and historical analyses of human relations of power that a persistent discursive technique has been to represent certain humans as closer to nature, a representation that has often been bound up in their symbolic animalization. This has worked along lines of gender, class, religion and race most obviously, but has also been deployed, perhaps more implicitly, in relations that hierarchicalize differences of age, disability and sexuality. Such representations are fundamentally about casting doubt on the rationality of certain marked-out identities with the idea of the animal proving adept here with its dualistic association with the instinctual, bodily and of the 'other'. The point I wish to make here is that although, as I have stated, there is a culturally constructed moral boundary between the animal and the human that renders less likely a slippery slope between how we act towards animals then being applied to humans, the history I have just briefly outlined does make it possible. One example illustrating this argument is the continued trend of human experimentation,[12] often targeting social groups that are represented as less rational in the way I have described. Bioethics must be aware of such sociopolitical histories and not assume either a level playing field or that such discourses have been wholly delegitimized when considering potential impacts of technoscience. The counter-argument that might say this is largely irrelevant to the question of enhancement since privileged rather than oppressed groups are likely to be impacted is, I think, guilty of assuming to know just how 'enhancements' may become normalized and adopted in the future. For the reasons I have outlined, a simple slippery slope between animal and human enhancement is likely only in a case of a breakthrough where an urgent human medical benefit is anticipated. However, in spite of the complexity in analysing the slippery slope question, there are at least sufficient connections to warrant an *anthropocentric* bioethical interest in the question of animal enhancement. Moreover, there are arguably further connections beyond the slippery slope, to which I now turn, that emphasize an interconnection between the *trajectories* of animal and human 'enhancements'.

Towards the Convergence of Medicine and Agriculture?

When initially analysing animal 'enhancement', it is difficult to move beyond the tendency to compartmentalize developments in medicine, agriculture and conservation for example. But to separate out neatly these domains speaks of a legacy of culture–nature dualism translated into 'red' and 'green' bioethics. Critical

bioethics endeavours to move beyond this separation by outlining and theorizing the connections that exist.

Although there are obvious ontological connections between human health and environmental health that already destabilize the red–green dichotomy, recent developments suggest a trajectory of convergence between the substantial domains of medicine and agriculture.[13] For example, 'functional foods' are foods or dietary components that may provide a health benefit beyond basic nutrition. Examples include everything from fruits and vegetables to fortified or enhanced foods. Biologically active components in functional foods impart health benefits or desirable physiological effects (Chadwick et al, 2003, p32). Functional attributes of many traditional foods are being 'discovered', while new food products are being developed with beneficial components, for example, meat with higher omega oil content. This trend to enhance food, to tease out its medicinal qualities, is encouraging the enhancement of animals as functional food products. To simplify the assumed pathway: enhanced animals will yield enhanced foods that will produce enhanced humans, pointing to an intimate future relationship between animal and human 'enhancement'. Developments in nutrigenomics and a growing awareness of the epigenetic[14] function of foods are likely to aid the trajectory of the medicalization of food.

A further example that implies convergence is the production of biopharmaceuticals. Here an animal body is used as a vessel to yield medicine either through bodily fluids such as milk or in the eggs of chickens. For example, the first such drug manufactured from the milk of a genetically modified goat was ATryn® (a recombinant form of human antithrombin), to which the European Medicines Agency granted approval in August 2006 (and the US FDA in 2009). Here we may be tempted into an argument from precedent, since this appears to be a similar sort of instrumentalization to using animals for food. Yet we should attend to the specific context here. Why is this being developed as a particular problem-solving technology? Could such medicines be produced alternatively? How might agriculture and medicine change in the future in light of these signs of convergence? How might we come to think of animals such as chickens or pigs transgenically altered for human benefit? Presumably at the very least, the meanings of medicine and agriculture could change quite radically. The area of cloning also illustrates the crossover between human medical research and the potential commercialization of cloned animals for meat and milk. We can note that the major player in attempts to commercialize agricultural cloning, the company Viagen, now owns all the cloning patents originally associated with the research around Dolly the Sheep, even though that original research was concerned with the human medical domain.

Importantly, it is wrong to theorize a radical historical discontinuity here. Although genomics is serving to intensify connections, in several ways notions of agricultural–medical intersections are not new. First, we can illustrate the latter with some examples of 'knowledge transfer' between the 'human' and 'animal'. Current research investigating the likely quantitative trait loci (QTL) that play a role in weight and fat in mice (Jerez-Timaure et al, 2005) takes advantage of advances in mouse genomics. Moreover, it is funded by a pharmaceutical company hoping that the mouse will provide a model for the eventual development of an anti-obesity pill in humans. Yet over and above this use of the research, there is a knowledge transfer from the research team[15] to agricultural applications. Since the mouse is also used as a model for other animals and not just for the

human, it is proposed that this research can inform the production of leaner 'enhanced' agricultural animals. This provides an excellent example of the porosity between different areas of science and in this case knowledge transfer from human medicine to agriculture. However, we can also note germane examples which exploit the human genome for animal 'enhancement'. This means somewhat uncannily bringing the sequenced human genome into the realm of meat production. Using human genome sequenced data comparatively as a railroad into the new frontier of farm animal genomics takes place in a variety of ways. In a clever pun,[16] Meyers et al (2005), in their paper 'Piggy-BACing the human genome II: A high resolution, physically anchored, comparative map of the porcine autosomes', comparatively map this new territory in a more targeted way than had previously been possible in order to glean more about economically relevant areas of the porcine genome. In seeking out new forms of capitalization mammalian relationality forms a basis to the relevance of human genomic data.[17] Grapes et al (2005) have also commented on the usefulness of the human genome to porcine genomics, specifically in relation to a high human–pig correlation in comparing mutation number in genes. Research into other major agricultural species such as bovine (Everts-van der Wind et al, 2004) and ovine (Wu et al, 2008) genomes also draws on human genomic data. Geneticist James E. Womack has described the Human Genome Project as opening the door to farm animal genomics, but that in turn this work informs the human genome (2005, p1699). This latter aspect is expressed in stronger terms by de Koning et al, asserting that farmed species can bridge the research model gap between 'mice' and 'men' because 'their biology is often much closer to that of humans' (2008, p483). This would suggest the capacity of genomics to alter the meanings of different animals, in this case an instrumental 'doubling up' of farm animals as both food *and* medical research model.

In such contemporary research, *comparative* genomics opens up new knowledges of species similarity between animals, including the human. Although such a field is new, a rationale informing an intentional mutual overlap between human and animal 'enhancement' has a historical lineage. For this we must evoke the history of eugenics, specifically the first decade of the 20th century, when ideas of agricultural selective breeding explicitly informed the human eugenics movement. The American Breeders Association (ABA) founded by agriculturists in 1903 rapidly became a conduit for the exchange of ideas between animal breeders, plant breeders and human geneticists (Patterson, 2002). In her history of the ABA, Kimmelman argued that its agricultural context was crucial for the development of both American genetics and the course of the American eugenics movement (1983). Furthermore, Clarke's history of reproductive science in the US contains a wealth of data to show the intersections of agricultural science and human reproductive science as these disciplines emerged in the 19th and 20th centuries (1998, pp40–45). Although the intersection of agriculture and medicine is not then new or inherently eugenic, it appears that emergent technologies are consolidating and extending a convergence (see also Franklin, 2007c). One of the crucial ethical concerns of myriad biotechnologies now turns on whether the intervening moral delegitimization of specifically *eugenic* intersections is being eroded by new discourses of health and enhancement.

In contemporary animal science, the bodies of animals are being interrogated at the molecular level to find new ways to convert them into innovative forms of biocapital, which Rajan defines as 'the fundaments of life as information that could be commodified

and could operate as currency' (2006, p78), producing bodies that are fitter, optimized, resistant and robust. Such enhanced animals, if consumers deem them acceptable, open new pathways to the capitalization of farmed animals. Selective breeding or newer molecular techniques are not typically burdened with all the negative connotations of the word 'eugenics', since this would have little purchase for the majority of people, who may abhor the idea of a science of human breeding but condone it in the animal case.

Genomics and associated fields may make animal bodies more docile and more economically useful. It does not simply follow that human enhancement technologies will follow a similar trajectory. Nevertheless, we need to be sensitive to the continued operation of economic–scientific constructions of the body which tend to instrumentalize bodies *as* 'nature', falsely understood as passive resource. Certain types of agricultural–medical convergence do suggest such an overarching paradigm of the rational mastery of materialities across species. The ethical point here should not be that we ought to be concerned that constructions of the human body emerge that are akin to the way in which the animal body is understood, but that bodies, of whatever species, are being instrumentalized in this way.

The question of enhancement plays the role of exposing the human-centredness of much of the contemporary research focus on biotechnologies. Yet it largely also ignores an anthropocentric basis for considering animal biotechnology. So although a consideration of animal 'enhancement' is useful for considering the wider context of human 'enhancement' debates, the intention here has been to enhance bioethics, to interrogate its critical fitness for providing an ethical space for the quality of animal lives. Enhancement needs to be understood as particular interventions with material impact. At the beginning of this chapter I voiced some suspicion of the discourse of 'enhancement'. It is probably best viewed as uncritically ceding too much ground to a transhumanist perspective towards technology. In Chapter 5 I turn to Foucault's concept of biopower as a more critical frame from which to 'think across species'. It may be that since human biotechnology raises potentially disturbing questions about a possible neo-eugenics, animal biotechnology which is straightforwardly eugenic becomes a threatening area to consider. This may provide one further explanation for the lack of overall interest from many contemporary social scientists and bioethicists in going near the subject.

We will have an idea that we have selected for an enhanced bioethics when it broadens its 'bio' and provides an opportunity to question equally both new and long-established practices as they pertain to our ethical treatment of other animals. The suspicion must remain that the success of bioethics in being established transnationally and institutionalized in policy decision-making has been predicated on a narrower shallow ethics. Without such ethical depth in civic life and policy contexts it is unsurprising that, as we see in the next chapter, regulatory processes often have a problem in accommodating ethical questions at all.

Part II

Capitalizing on Animals

In order for molecular techniques to become embedded, various elements are required. The biotechnological capitalization of animals requires a favourable regulatory environment, a reductive view of the animal as genetic knowledge and an association with a broader persuasive economic vision around the promise of molecular science. In this second section of the book I outline how all these elements are either already present or coming into place. If Part I alluded to the inadequacies of academic framings in accounting for impacts on nonhuman life, including a narrow conception of animal ethics and a bioethical propensity to separate off 'animal issues' from the 'real' business of thinking about human wellbeing, we can note in the first chapter of Part II their presence within early regulatory moves around animal biotechnology. The nascent regulatory process outlined in Chapter 4 is lacking in the more thoroughly contextual approach to animal biotechnology advocated here, which would not only give serious consideration to broad ethical perspectives but would place these in their wider social and environmental contexts.

The aim here is to foreground an attempt to think through some aspects of the political economy of animal biotechnology and to critically consider the discursive claims of biotechnologists. What is the economic attractiveness of animal biotechnology? Which master narratives are proving productive for shaping biotechnological visions? This section also mobilizes one meaning of intersectionality outlined earlier, which posits human–animal relations as bound up with other social relations. Specifically it aims to underline their presence within the wider mechanics of capitalism, in particular a form that casts biotechnology as the means by which to bypass ideas of biological limits. This form, which is commonly known as the knowledge economy (or more specifically the knowledge-based bio-economy), has begun to shape expectations around the potential of animal biotechnology to inspire a new period of growth in the livestock industry.

In Chapter 5 I draw on Foucault's concept of biopower in order to understand the relationship between animal science and the capitalization of animal bodies. This concept is also, I argue, rather suitable for the approach of thinking across human–animal dualism advocated for in Chapter 3. Between Chapters 5 and 6 the concern is to analyse the relationship between particular understandings of animal embodiment in animal science and their resonance with expectations around the biotechnological mastery of biological limits and to outline early examples of molecular capitalization within the global field of livestock genetics companies.

4

Animal Biotechnology and Regulation

Although a sense of complacency had perhaps developed since the initial peak in interest over agricultural animal biotechnologies during the early 1990s, recent developments in the field since the turn of the century arguably expose the lack of regulatory preparedness vis-à-vis animal breeding technologies. Low public enthusiasm for the consumption of animals produced through such methods may still serve to scupper successful commercialization, but the lack of public involvement in the upstream innovation process and the ability of emergent regulatory regimes to narrow the question of oversight down to health and safety issues would seem to suggest that animals produced through GM and cloning may be with us shortly. In this sense regulations could be seen as enabling tools for capitalization, even if they should be an opportunity for meaningful democratic deliberation between science and the rest of society.

Molecular breeding technologies are entering a critical period that will be crucial in determining their future viability as new tools for 'adding value' to the global livestock industry. These technologies are attractive to the industry in that they potentially allow for far greater selection precision and manipulation of animals' genotypes and potentially, in the case of cloning, the consolidation of the animal as a standardized commodity. Of particular industry interest are their uses in disease resistance, functional foods, and manipulating growth rates and other traits deemed economically relevant. A role for such technologies is also being pursued in less purely economic traits such as animal welfare and environmental impact.[1]

From the perspective of animal welfare or rights the possibility is of interest, because it is clear that the more traditional way of breeding farm animals using quantitative genetics has itself resulted in a series of unanticipated consequences which have impacted negatively on animal welfare. Animal welfare scientists have already called for selection goals to incorporate 'post-productivist values' such as incorporating animal health into breeding goals. The situatedness of both animal science and animal agriculture within broader relations of global capitalism have already inspired concern (FAWC, 2004) that it will be difficult for emerging technologies to be utilized for anything other than the traditional goal of more production. Given that molecular techniques advance the threshold of human control over other species, this should be of broad social concern

since these developments occur at precisely the same period as the emergence of the scientific interest in animal sociality and subjectivity, the continued enthusiasm for animal companionship and the emergence of animal advocacy. It would be odd indeed if the productivist values associated with the modernist mastery of nature should be re-embedded and perhaps extended at exactly the same time as postmodernist explorations of, and sensitivities to, animal subjectivities have just begun to emerge. Pointedly, then, at minimum a regulatory regime broadly construed must interrogate the social, economic and ethical justification for the introduction of molecular techniques. The importance for a broad focus is apparent when we note that actors involved in networking around a promotion of such technologies link their need to rising global meat demand and also as a response to sustainability (see FABRE-TP, 2006). This is in stark contrast to calls (for example Compassion in World Farming[2]; *The Lancet*[3]) for a reduction in animal consumption on the grounds of human health, environmental sustainability or animal ethics. From an abolitionist ethical perspective, the genetic control of animal genotypes is a further example of our disregard for nonhuman others, and the unintended consequences of that control – rather than being a spur for 'better welfare' – are better understood as an illustration of animal science's instrumentalist raison d'être and marriage to commodity capitalism.

This chapter critically explores current regulatory moves within both the UK and US around this issue. In the UK case this necessitates also looking to the wider context of EU regulation and legislation.[4] There is a marked difference between the UK/EU and US in terms of the apparent closeness to commercialization of GM and cloned animals, which is partly figured by differing expectations of public acceptance, but also by complex histories around biotechnology regulation. In particular this chapter examines the framing of innovation in this area and its associated legitimizing 'master narratives' (Felt and Wynne, 2007), as well as its treatment of ethical issues. Initiatives such as the Farm Animal Breeding and Reproduction Technology Platform (FABRE-TP) in the EU and the EC-US Task Force on Biotechnology Research provide compelling evidence for international and transatlantic networking around animal biotechnology and so will be similarly explored.

The examination of the emergence of regulatory discourse is one of the most centrally important contexts for performing an analysis of the promissory rhetoric of contested technoscientific futures. Thus we may note divergent hypothetical trajectories and 'performances of confidence' over several animal biotechnologies, with agricultural cloning and xenotransplantation portrayed as a part of US human/animal futures in a way in which they are not generally in Europe. Such promissory inconsistencies illustrate at least that the enrolling of farm animals into an economic imaginary around the idea of the knowledge-based bio-economy may not be a smooth linear or inevitable process.

How exactly do particular discursive deployments of human/animal futures attempt to secure a particular regulatory environment? Previous debates on molecular reproductive technologies, most obviously GM crops, have in important ways centred on questions of 'newness' and 'substantial equivalence' (see Levidov et al, 2007) between 'traditional' and 'new' techniques. Thus I am interested in this chapter in continuing to analyse the salience of concepts such as 'precedent' and 'equivalence', primarily the ways in which they carry discourses of animal biotechnology and attempt to stake out a particular future. However, first I wish to frame this conversation in the broader discursive

terrain of animal studies and also to provide some important historical background to transatlantic biotechnology regulatory processes.

Regulation and Advocacy

How might the question of regulation be approached from within (critical) animal studies? From one perspective of the animal advocacy movement, a focus on regulation signals a retreat from what should be the main goal, that is to say 'abolitionism', with the use of that word an intentional signifier of commonality with human slavery. Thus in his critique of the animal rights movement, many assumed proponents of which he named 'new welfarists', Francione (1996) argued that incremental changes in animal *welfare* would not ultimately secure abolitionist goals. In this line of arguing it is not the technology behind the industrialized production of animal products which is the problem or should be the concern, but the fact that production is taking place. Francione undoubtedly has a point in that it is not self-evident that welfare regulations have a linear relation to the future abolition of the major ways in which we instrumentalize nonhuman animals, even if neither he nor anyone else is unable to have a privileged retrospective view from the future. However, some welfare measures can be seen to fit rather well with the overall goals of animal production and could also be seen as placatory measures to diffuse opposition. Thus Francione terms many so-called animal rights activists 'new welfarists' for veering from the abolitionist line.

But a regulatory focus may also include recommendations for prohibitive regulations which could prevent potential new 'enhancements' that could extend animal instrumentalization in qualitatively new ways. Thus, although one can applaud the abolitionist stance as consistent with an animal rights position, it is not inconsistent, I argue, to also include a focus on the regulatory sphere from an 'animal rights' or abolitionist perspective. Over and above the problem that one could end up promoting a rather mute animal advocacy movement that remained silent on new technologies if one stuck to Francione's position, I wish to argue that the focus on regulation is crucial for several reasons. First, if one is committed to, at least in some sense, the abolition of agricultural animal production, it ought to be in one's interest to stay informed about the modes of production and the disciplinary sciences at play behind them. Second, if these sciences have the ability to promote new ways of producing and consuming animals, for example through GM animals, cloned animals or biopharmaceutical animals, which could then become socially embedded, it is cogent for an animal rights perspective to pay attention to their regulation, because their coming into being would in the long run make abolitionist goals less likely. In a similar vein, molecular research that selects for healthier meat and milk, for example, also potentially can relegitimize animal products on health grounds (where they have been criticized for high saturated fat content and so on). If successfully commercialized, this would represent a highly adaptive industry reflexive to potential legitimation crises.

But in developing the focus on institutional regulatory labour around the molecular turn in animal agriculture, it cannot and should not be separated from analyses of state and transnational regulation around more traditional techniques. For selective breeding itself does not form an uncontested space which can then be used for 'arguments from precedent' (Parens, 1998) seeking to bypass the critical inspection of molecular techniques.

The attempt to argue that these are simply continuous with selective breeding falters on scientific grounds and the assumption that that continuity negates the need for regulatory scrutiny assumes an imaginary non-maleficence in the case of selective breeding.

Historical Context

Due to the overall lack of commercialization of agricultural animal biotechnologies, there is little historical precedence here. This potentially underlines the importance of this subject as economies prepare to follow trajectories of intensified authorial power in relation to nonhuman animal life. In spite of the lack of precedence, however, it remains insightful and relevant to briefly consider recent transatlantic regulatory policy in biotechnology generally. It is already apparent that the US is further down the road of commercializing both GM and cloned animals, and that GM crops are already very established there. Indeed these developments seem to have provoked the UK and EU into considering these technologies, as we shall see below.

An oversimplified analysis of general transatlantic biotechnology policy could posit a permissive regulatory environment in the UK for medical biotech accompanied by a more cautious approach towards agricultural biotech, with the US exhibiting the exact opposite. Examples often ventured include the UK's comparatively relaxed attitude to embryo and stem cell research alongside a current ban on GM food, contrasted with the commercialization of GM crops in the US and White House political caution over stem cell research.[5] But such a characterization risks glossing over contradictory cases as well as downplaying oppositional voices. Moreover, explanations of either a precautionary or permissive slant risk omitting the potentially co-constructive nature of regulatory processes. Thus Jasanoff (2005, p123) is critical of the tendency to 'explain' UK opposition to GM crops in terms of previous food scare events such as BSE. It is not clear that one could simply map the reasons for public outcry towards BSE onto those aired against GM crops.[6] For Jasanoff, the GM crops political moment saw 'extraordinary reinvention of state–society relations in the management of science and technology' (2005, p123). In one sense, oppositional voices made it more likely for the UK government to confront the democratic lacunae exposed by contemporary innovations in the life sciences. Evidence for this could be seen in official governmental discourse finally taking on board social scientific perspectives on the critique of the so-called 'deficit-model', the notion that the 'public' merely need to be instructed in science to ease the path of innovation (Wynne, 1991). We saw the turn to more deliberative politics around GM crops in 2003 (Jasanoff, 2005, p127), but the ability of the social science critique of tacit scientific authority to influence governmental science-society policy can waver with each new administration.

The UK 'New Labour' government in power from 1997 to 2010 adopted an enthusiastic (sometimes, arguably, naïvely so) position towards biotechnology. The unelected Lord Sainsbury was Science Minister between 1998 and 2006 and it is difficult to imagine that his personal interest in GM technology (he donated £200 million to research into the genetics of disease resistance in plants and had business interests in Diatech Ltd, the company which owns worldwide patent rights over a key gene used in the process of GM crops) did not influence either his choice as Minister or subsequent regulatory strategy. Former Prime Minister Tony Blair also reneged on a pre-election

pledge to conduct a Royal Commission into animal experimentation, thus removing potential pressure and scrutiny on a significant swathe of the scientific community. As we saw in Chapter 1, rates of animal experimentation rose gradually under New Labour due to the greater use of GM animals (the vast majority in *biomedical* research).

This partly reflects a rise in funding around the promissory discourse of the human genome project expressed in the formation of six 'genetics knowledge parks' located in England and Wales. Interestingly, these ventures have included funding for enquiries into 'ethical, legal, social and consumer aspects' of new genetic technologies and have linked in with the UK Economic and Social Research Council's multi-million pound investment in a Genomics Network of social science centres.[7] Thus in spite of the government's enthusiasm for biotechnology, there has been a parallel investment in sociological and ethical research (see Jasanoff, 2005, p239), which on the face of it opens up space for critical deliberation. The vast majority of research money (both in biotechnology and in social science/ethics) has gone to medical biotechnology. However, there is a significant but substantially less funded animal agricultural science research community in the UK with an interest in genomics, and to date this research has not been appropriately matched by a social science and ethics focus on animal biotechnologies. In summary, biotechnology and the life sciences have been hailed by New Labour over the last decade as important potential contributors to the economic prosperity of UK plc, but their rise to prominence has been accompanied at least partly by institutional reflexivity over issues of ethics and public engagement. However, the specific lack of UK regulatory preparedness over molecular techniques in animal agriculture is significant. Governmental exchanges with its own advisory body the Farm Animal Welfare Council (FAWC) seem to suggest a lack of appreciation of the potential speed of the commercialization and a surprising degree of nonchalance given the historical political fallout over GM crops. In 2002 the Agriculture and Environment Biotechnology Commission (AEBC) – which had a remit to provide the UK government with independent, strategic advice on developments in biotechnology and their implications for agriculture and the environment – made several recommendations in the area of animals and biotechnology (AEBC, 2002). In a deep consideration of the issues, these included that new methods and funding should be used to engage the public in decisions about animal biotechnology and that a new strategic body should be set up by statute to examine issues raised by the use of genetic biotechnology on farm animals in the context of its use on other animals and current livestock farming practices. Not only have these not been adopted, but the government also disbanded the AEBC itself in 2005. The pressure group Genewatch also made similar recommendations in 2002 for the government to increase public debate on animals and biotechnology (Genewatch, 2002). Government support of biotechnology seems to be taking place with little regard for how it may impact on human–animal relations, which is contradictory given its simultaneous reputed support for a gradual reduction in animal experimentation through, for example, the recent investment in a national centre for research into the reduction of animals used in experimentation.

Some historical points about the EU regulatory context are also significant to the UK case. Both the EU and US have seen struggles over the question of 'process' versus 'product' in the regulatory domain. During the 1980s certain pro-biotech advocates in the EU were keen for European policy to not regulate around biotechnology as a process. As Jasanoff explains the choice:

> *Should biotechnology be represented for European regulatory purposes as a technological process, demanding special concern because of its intrinsic properties (the UK and German position), or as an in-itself harmless tool for the manufacture of products that could be assessed according to already extant regulatory principles (the US position)?* (2005, p79)

As well as speaking to distinctions between deontological and consequentialist ethics, this frame between process and products also is important to the argument of 'newness' in biotechnologies. Regulating around process implies novelty in the nature of a technology that itself warrants oversight. It was the process view that was adopted in the EU in 1990 with the adoption in particular of Council Directive 90/220/EEC on the deliberate release of genetically modified organisms. This was to set Europe apart from the US especially in relation to agricultural biotechnology. There is also evidence to suggest that since this time, ethical considerations have been explicitly seen as a concern in the EU. In 1991 the European Commission established the Group of Advisors on the Ethical Implications of Biotechnology (GAEIB), which in 1997 became the European Group on Ethics in Science and New Technologies (EGE).[8] The EGE comprises 15 distinguished European academics, mostly in either philosophy or law, each serving a four-year term, with a mandate to advise the Commission on ethical questions. Although on the one hand it is possible to be critical here on the construction of ethics as 'expertise', whereby ethical knowledge is implicitly the preserve of powerful actors who can dispense a neat commodified ethical opinion to give institutions an air of reflexivity, at least there is the putting of ethical questions on the agenda here, which is relatively novel, at least in the case of animal biotechnology. I will return to the EGE later when I turn to their recent (January 2008) pronouncement on the ethics of animal cloning.

Sheingate (2006) recounts how during the 1980s in the US there were struggles between different agencies as to whether biotechnology regulation would become process- or product-focused. In December 1984 the White House Office of Science and Technology Policy (OSTP) invited comments on a proposed 'Co-ordinated Framework for the Regulation of Biotechnology', which included 'statements of proposed policy' by the three main agencies that would have jurisdiction over policy: the Environmental Protection Agency (EPA), The United States Department of Agriculture (USDA) and the Food and Drug Administration (FDA). This revealed differences between the three agencies: for example, it was clear that the FDA favoured a product-based approach, while the EPA, in its concerns over GM and environmental risk, favoured a process-based approach. As Sheingate explains, this was resolved the following year when the OSTP created an inter-agency body known as the Biotechnology Science Co-ordinating Committee (BSCC) in order to clarify questions of jurisdiction – 'in practice, this meant removing language that suggested genetic modification carried unique risks and inserting scientific definitions that limited the scope of the EPA's regulatory authority' (2006, p249). Unsurprisingly, the final version of the Co-ordinated Framework adopted a product-based approach to biotechnology regulation. This essentially was a victory for advocates for a 'continuity' approach whereby biotechnology products (food or drugs) would be assessed and regulated in the same way as other chemical and biological substances. A specific Co-ordinated Framework for *Animal* Biotech is presently under deliberation at OSTP level.

In a further point worthy of note for the US historical context, Sheingate (2006) argues that after agricultural biotechnologies became subject to the Co-ordinated Framework, a bifurcation can be noted in US policy around red (medical) and green (agricultural) biotechnology. The downplaying and regulatory exclusion of EPA concerns over the risks of GM crop technology and the permissive product-based approach of the Framework promoted post-1986 an emphasis on the commercial potential of agricultural biotechnology which was unsurprisingly echoed by corporate interests. Meanwhile medical biotechnology lacked a comparable framework and, as Sheingate suggests, innovations here – in gene therapy, cloning and stem cell research – were less amenable to a product-based approach (2006, p265). Moreover, political pressures were to influence the debate around human cloning and stem cell research. Certainly the situation in the US regarding medical biotechnology is complicated and contradictory in light of, for example, differential public–private funding rules for embryo research. However, in general terms, as Sheingate's analysis suggests, historical institutional and regulatory moves and struggles appear to have created a more permissive context for agricultural biotechnology and one that obviously sets it apart from that in the UK and the EU. However, it remains to be seen to what extent this trend extends to *animal* agricultural biotechnologies. Partly the science here has been more complicated, but moves to commercialize GM animals and cloned animals (until recently) have been slow. The questions are whether this is now changing, how American citizens might react, and what impact it may have on animals, animal production and the political economy of global agricultural trade.

My approach contextualizes the regulation of molecular techniques within that of animal agricultures generally but looks for evidence or otherwise of regulatory responses which entertain a degree of 'newness' within the content of their consideration. To reiterate, I conceptualize molecular techniques as genomics (MAS and GS), GM and cloning. Technologies such as xenotransplantation and biopharmaceuticals bring into being new sorts of animals[9] which hybridize the social construction of animals into neat categories of human utility, whereby pigs, cows and goats become *medical* as opposed to agricultural repositories for humans. However, I do not conceptualize these as molecular techniques as such, as they rely on GM and thus are 'products' rather than processes or techniques. Genomics, GM and cloning are specific yet interrelated. Cloning and GM may involve each other, while GM benefits from knowledge accrued from both structural and comparative genomics. Below I argue that one reason for regulatory oversight of genomics is the slippery slope argument, in this case applied between genomics and GM.

Intellectual property (IP) relations are already being mapped out by the livestock genetics industry, and one may note patents related to genomic selection and associated genetic tests, to genetic modification, and to cloning (see Chapter 6). Indeed the patent taken out on Dolly, the first cloned mammal, born in 1996, is now owned by Viagen, a company that wishes to use cloning in animal agriculture and also a supplier of cloning data to the US FDA (CVM) Draft Risk Assessment of Animal Cloning (2006), as well as a lobbyer to the European Group on Ethics (EGE) Roundtable on Animal Cloning in September 2007. IP relations are revealing here, as one must show that a technique or 'product' is novel for a patent to be granted. That the IP relations can emerge simultaneously while molecular techniques are still framed as continuous with prior non-molecular technology is an ambiguity very worthy of note.

Leaving aside the point that many animal advocates would wish to further regulate 'regular' selective breeding, if not abolish it, the very idea that genomics should be subject to regulation would be strongly objected to by most in the animal science community. However, to reiterate, if the precedent of selective breeding itself has important ethical questions surrounding it, it clearly fails to absolve molecular techniques from such scrutiny. Genomics techniques such as marker-assisted selection (MAS), gene-assisted selection (GAS) or genomic selection (GS) involve no adding in or knocking out of genes. Rather they are more nuanced, refined and accurate versions of selective breeding. Importantly, they allow for new selection decisions that otherwise would not have been possible. Sequencing projects and the emergence of genomic selection subtly shift the malleability of the animal breed in question. This is a significant point when we situate the regulatory analysis back into the sociology of human–animal relations. So although it is true to say that centuries of animal breeding speak to a modernist mastery of certain nonhuman animals which underwent broad global intensification during the 20th century, the emergence of genomics begins to add new tools to the human capacity to shape animal being – at least to the extent that genetics are taken as determining. The point here is that genomics is a small but significant shift in human power over other animals. The deployment of GM technology which is already widespread in the medical sphere takes this further and constitutes, more properly, a novel *authorial* power over other animals.

Neither the UK nor the US has made any regulatory changes in response to the commercialization of genomics-assisted selection techniques. Some livestock genetics companies (for example Aviagen) have purposively put investment into genomics as it is seen as a more ethical breeding technology in the face of a perceived public opposition to GM. Yet the ethical questioning of hubris and queries over the social usefulness of molecular techniques are accompanied by scientific doubts also. In a broad-ranging review paper that presented over 100 references on undesirable correlated effects of selection for high production efficiency in agricultural animals, Rauw et al (1998) showed that such an approach seems to put animals at a greater risk of behavioural, physiological and immunological problems. A further point of uncertainty relates to the pre-existing monoculture of some species in animal agriculture. Further specialization using molecular techniques and market concentration by genetics companies may exacerbate the problem of a lack of genetic diversity (see Notter, 1999).

Transatlantic Developments in Genomics, GM and Cloning

In lieu of a regulatory response to farm animal genomics, the de facto situation becomes one of self-regulation through industry codes and working within the framework of pre-existing legislation. The primary legislation relating to animal breeding technologies (DEFRA, 2006) in the UK is as follows:

1 The Animal Welfare Act 2006 (in Scotland the Animal Health and Welfare (Scotland) Act 2006) – makes it an offence to cause unnecessary suffering to any animal;
2 The Veterinary Surgeons Act 1966 – defines acts of veterinary surgery and sets out how they may be performed; and

3 The Animals (Scientific Procedures) Act 1986 – protects the welfare of experimental animals by licensing projects as well as the researchers and establishments that undertake animal experimentation. Animals covered under the Act are all nonhuman vertebrates, including larval or embryonic forms that have reached a certain stage in development. The Act also covers one invertebrate species (*Octopus vulgaris*).

Legislation also exists to govern specific breeding techniques. Exemptions to the ban on mutilations in the Animal Welfare Act 2006 are listed in the Mutilations (Permitted Procedures) (England) Regulations 2007. Embryo transfer in cattle is covered by the Bovine (Collection, Production and Transfer) Regulations 1995, under which an individual must be satisfied that a cow receiving an embryo is suitable to bring it to term and calve naturally before the technique can be used, and the Veterinary Surgery (Epidural Anaesthesia) Order 1992. Artificial insemination is covered by the Artificial Insemination of Cattle (Animal Health) (Amendment) (England) Regulations 2002 and the Veterinary Surgery (Artificial Insemination of Mares) Order 2004. These specify detailed requirements under which artificial insemination can be practised.

The European context is also germane to UK regulation. EU law on animal breeding procedures is contained in EU Directive 98/58/EC, the Annexe of which states:

> *20. Natural or artificial breeding or breeding procedures which cause or are likely to cause suffering or injury to any of the animals concerned must not be practised. This provision shall not preclude the use of certain procedures likely to cause minimal or momentary suffering or injury, or which might necessitate interventions which would not cause lasting injury, where these are allowed by national provisions.*
>
> *21. No animal shall be kept for farming purposes unless it can reasonably be expected, on the basis of its genotype or phenotype, that it can be kept without detrimental effect on its health or welfare.*

This EU law has been transposed into law in England by the Animal Welfare Act 2006 and by similar legislation in Northern Ireland, Scotland and Wales. There are further EU directives developed during the emergence of GM crops that apply to all GM organisms and micro-organisms. These are Directives 2001/18/EC on the deliberate release into the environment of genetically modified organisms and 98/81/EC on the contained use of genetically modified micro-organisms. These are incorporated into UK law under the Genetically Modified Organisms (Contained Use) Regulations 2000 and its related amendments of 2002 and 2005. Jasanoff has argued that Directive 2001/18/EC effectively weakened the 'stark distinction between the product-based US and the process-based European regulatory approaches' (2005, p83) in relaxing regulation on products derived from GMOs, such as tomato puree, but at the same time reinforcing the precautionary principle in EU biotechnology policy.

The transboundary movement of GM animals is also covered at international level by the Cartegena Protocol on Biosafety, which covers 'products' in contained use or released into the environment. DEFRA states that similar controls are in place for cloned animals and their offspring (2006). The UK government argues that the commercialization

of animal 'products' from GM or cloned animals is a long way off. However, the first challenge to the UK and the EU is likely to be states elsewhere wishing to export cloned or GM animal products to the European market. Regulatory approval in other parts of the world such as the US will put pressure on the EU. It is probably a safe assumption that there would be a degree of public opposition to their commercialization in the UK.[10] Research into cloning and genetically modifying animals in the UK is covered by The Animals (Scientific Procedures) Act 1986 mentioned above. There is no specific legislation aimed *solely* at molecular techniques in animal *agriculture*. Moreover, there are no explicit deliberative exercises on molecular techniques aimed at a broad public at present in the UK.[11]

Much of the discourse around a potential regulatory framework in the UK can be found in the recent exchange between the government's advisory body, the Farm Animal Welfare Council (FAWC), and DEFRA. FAWC submitted a report entitled 'The welfare implications of animal breeding and breeding technologies in commercial agriculture' in 2004. DEFRA produced the government response in late 2006. The FAWC report made eight key recommendations as follows:

1 *FAWC recommends that a Standing Committee be established for the evaluation of new and existing breeding technologies as well as for the consideration of welfare and ethical problems arising as a result of livestock breeding programmes.*
2 *FAWC recommends that the Standing Committee provide advice to Government on the effectiveness of existing legislation, and the possible gaps that exist, relating to farm animal breeding procedures, in order to promote animal welfare.*
3 *FAWC recommends that the Standing Committee give due consideration to ethical questions associated with animal breeding even where measurable detrimental effects on animal welfare may not be immediately evident.*
4 *FAWC recommends that any breeding technology, whether developed within the UK or overseas, be thoroughly evaluated by the Standing Committee prior to, and during, its incorporation into commercial agricultural practice in the UK.*
5 *FAWC recommends that targeted surveillance is made of farms where new breed types or new breeding technologies are first introduced into commercial practice, and that the welfare impact of all such developments is reviewed throughout a period of normally not less than five years after introduction into commercial agriculture.*
6 *In order to determine the consequences of current breeding strategies or any new breeding technology and to provide essential feedback on welfare performance for breed companies, FAWC recommends that a robust surveillance system be established. This should accurately monitor the incidence of specified on-farm welfare problems and be capable of providing information on welfare problems associated with breeding strategies or technologies and to determine the respective genetic and environmental contributions. This surveillance system should include extensive data currently collected, for example, by breed societies and breed*

companies, and should be developed in association with, and as part of, the Government's Animal Health and Welfare and Veterinary Surveillance Strategies.

7 *FAWC recommends that the Government consider methods to close potential loopholes that would allow GM or cloned animals, their gametes or embryos, to enter UK commercial agriculture uncontrolled.*

8 *FAWC recommends that industry, possibly with Government support, should sponsor research and training programmes for the development of husbandry systems to support the demands of new genotypes in relation to their production system.*

In the DEFRA response 1, 3, 4, and 7 were not accepted; 2, 5 and 6 were partially accepted and 8 was accepted. This disappointing response was heralded at the outset when DEFRA stated that 'the Government does not wish to discourage innovation by creating additional burdens for industry, without being fully satisfied of the need for regulation' (2006, p2). This discourse that dichotomizes innovation and regulation is developed further in the DEFRA explanation of the rejection of FAWC recommendation 1. The idea to create a specific Standing Committee to evaluate new and existing breeding technologies as well as for the consideration of welfare and ethical problems arising as a result of livestock breeding problems was rejected on four grounds. These were disproportionate cost, no clear role being seen for a committee, stifling innovation and the global nature of animal breeding issues. This last point pertains to the UK's belief that recourse to international regulation such as the EU would be the better route to follow. Instead of a new committee, then, that might make recommendations that could 'stifle innovation', DEFRA recommended a buttressing of the FAWC role to handle the duties of the proposed committee. This, as both parties acknowledge, necessitates the recruitment of some new members with ethical expertise to FAWC, but at best could be described as a piecemeal solution to the need for a thorough ethical assessment of animal production and molecular techniques. The overall negative response to the advice for regulation (by its own advisory body) is indicative of a clash of imaginaries. The FAWC is populated by enough animal welfare scientists to know the negative welfare impacts of animal production who also have further reservations about a possible transition in UK animal agriculture to molecular breeding techniques.

The UK approach in effect keeps the door open to GM and cloning since it currently eschews the possibility of rejecting these molecular techniques on ethical grounds. The rejection of FAWC recommendation 7 was arguably unfortunate for in January 2007 one such loophole was travelled through when it emerged that a British breeder had indeed imported an embryo from a cloned cow in the US that had been implanted and taken to term.[12] Interestingly, later versions of the DEFRA response document had been edited in early 2007 to acknowledge this event and to argue that such an animal could not yet enter the market anyway as it (sic) would have to undergo a risk assessment at the EU level. DEFRA also draws on the broader European context in giving advice to FAWC's concerns. In noting the formation of Code-EFABAR – a voluntary code aimed at European breeders launched in 2006 – DEFRA argues that FAWC could put similar work into developing a code for British breeders and to feed back any recommendations to the European level (2006, p5). Signatories to the code sign up to a list of good

practice which incorporates some guidelines on animal welfare in relation to pre-existing methods as well as new techniques. For example, breeding organizations must 'ensure the health and welfare of the animals under their care, treat the animals under their care with respect, and ensure that selection for production traits is balanced by appropriate attention to reproduction traits and health and welfare related traits' (Code-EFABAR, 2006). It has to be said this is a voluntary code not accompanied by inspections, and although on the face of it it attempts to respond to critiques of an overemphasis on productivist values, it remains unclear what concepts such as 'care' and 'respect' actually mean here. Moreover, this is an example of self-regulation and so remains open to the criticism that it is likely to put economic interests of breeders first and unlikely to extend concepts of welfare much beyond *physical* fitness.[13]

Meanwhile, UK animal scientists have been busy contributing to important strategy documents over the last few years that include the work of the EC-US Task Force on Biotechnology Research Report on 'The future of livestock genomics' (2006) and work around the production of an EU Technology Platform on Farm Animal Breeding and Reproduction (2006). Several 'technology platforms' have been developed which serve the purpose of providing:

> *A framework for stakeholders, led by industry, to define research and development priorities, time frames and action plans on a number of strategically important issues where achieving Europe's future growth, competitiveness and sustainability objectives is dependent on major research and technological advances in the medium to long term.*[14]

Felt and Wynne (2007) speak of the importance of 'master narratives' to regimes of science governance. Such narratives are to be understood as both performative and normative. They are politically and economically embedded attempts to represent the world and to make claims on the future. Drawing on the languages of both economic and scientific rationalities, they naturalize particular constructions of 'where we should be going'. Common assumptions are the conflation of societal progress with technological advance, as well as the desocialization of scientific knowledge (Felt and Wynne, 2007, pp73–77). The discourses of the aforementioned documents represent such 'master narratives' in relation to the proposed role for the molecular turn in global agricultural production. They are a part of what Jessop (2004) refers to as the 'cultural political economy' whereby dominant economic narratives are conjoined to performed culturally diffuse economic imaginaries. For Jessop the discourse of the 'knowledge-based economy' (which in terms of the biosciences is also often referred to as the 'knowledge-based bio-economy') is the latest attempt at capitalist renewal. The main publication to date of the EU Technology Platform on Farm Animal Breeding and Reproduction is *Sustainable Farm Animal Breeding and Reproduction – A Vision for 2025* (FABRE-TP, 2006). This predicates the use of molecular techniques in terms of projected population increase in 'developing' countries and 'thus' projected demands for animal products. This taps into the discourse of the proposed 'livestock revolution' promoted in transnational policy circles and describing substantial projected increases in animal production over the next 40 years.[15] I have much more to say about these issues in Chapter 7, but here we can note how the EU technology platform vision document –

as well as comparable US reports such as the 'Blueprint for USDA efforts in agricultural animal genomics 2008–2017' (USDA, 2007) – taps into and performs this discourse as well. The 'livestock revolution' discourse externalizes animal welfare, human health and environmental costs from its calculations of economic progress[16] and posits the increase in production as 'demand driven'. Moreover the livestock revolution is presented as being passively accepted by developing countries. The EU technology platform speaks the language of the 'nutrition transition', stating 'as these poorer people get richer, one of the first things they want to buy is more nutritious and satisfying food, and this generally means more animal protein' (2006, p12). This is an odd statement and yet a fundamental one to the document's raison d'être or 'master narrative'. Given that state health advice in Western 'developed' countries has consistently warned of the health risks of overconsuming animal products, it seems strange to then advocate for their increased consumption in developing countries. Of course this would be attractive to Western producers, but would it be in the best health interests of the populations of 'developing' countries? Although at the moment this document is only talking about the adoption of genomics, it advocates the importance of basic research in GM and cloning technologies in order to maintain EU competitiveness. Moreover, it states:

> *As breeding is a competitive global market, cloned or transgenic (genetically modified) animals developed outside Europe or products derived therefrom are bound to find their way eventually to the European market. Currently, however, knowledge of technologies such as cloning or transgenesis (gene transfer) in farm animals is rapidly disappearing from Europe. For Europe, the only way to stay in control of its own decisions is to keep pace with international developments. Europe may want to close its borders to technologies it does not appreciate, but for this it will need sufficient knowledge and high-level scientists to support its claims internationally, for example in World Trade Organisation (WTO) negotiations.* (2006, p14)

Here cloning and GM are represented as globally inevitable, while a 'brain drain' threatens European progress either in terms of commercialization or via too strict regulation. The implicit fear that the UK or EU may be losing a competitive position vis-à-vis the US echoes a similar discourse in 1980s EU biotechnology policy discussed earlier.

The EC-US Task Force on Biotechnology Research was established in June 1990 by the European Commission and the White House Office of Science and Technology. It aims to promote information exchange and coordination between biotechnology research programmes funded by the European Commission and the US government. Moreover, it is involved in staking out the future of biotechnology research and thus is actively involved in the formation of the imaginaries discussed above. In 2006 it published a report on 'The future of livestock genomics', which assesses current progress on molecular techniques (mainly genomics) and considers scope for future transatlantic collaboration. It makes a point of separating out genomics from the 'more controversial' GM and cloning technologies, although also wants to differentiate cloning from GM. It argues that 'there is a great difference in the US on the acceptance of cloning when well described as opposed to being generally included in the broad terminology of genetic modification of animals' (2006, p13). There are careful exercises in nomenclature at

play here. If genomics can be constructed and represented as essentially the same as selective breeding, and cloning can be differentiated from GM, then the assumption is that their commercialization in a new knowledge-based bio-economy may perhaps be safeguarded. Yet in research practice, genomics and cloning and GM all overlap at various times and places. The assumption from the quote expresses the belief that the 'public' will accept new technologies when they are 'well described'. But does this mean *strategically* described? Also, does it downplay real moral concerns that people may have over the adoption of new breeding practices in animal agriculture? Both the Task Force report and that of the FABRE-TP acknowledge societal and ethical concerns but imply that these are essentially short-term barriers.

Although the UK and US both consider themselves world leaders in animal science, there is considerably more research underway in the US which also includes work on GM and cloning. Moreover, although, like the UK, the US has no specific legislation related to molecular techniques, regulatory authorities such as the FDA have begun processes of risk assessment for GM and cloning. It is worth noting that the US Animal Welfare Act (AWA) excludes farmed animals from its definition of animal and also birds, mice and rats in laboratories similarly do not count as animals.[17] This legal institutionalization of not only specieism but also the selective literal objectification of animals to suit certain commercial interests is a point of general difference between the status of animal welfare in the US and the UK. These points, taken together with the greater presence of GM and cloning research in the US, entail that we can generally say in theory that molecular techniques are much closer to agricultural commercialization in the US.[18]

The FDA Center for Veterinary Medicine (CVM) regulates, in whole or in part, diverse animal biotechnology products. GM animals for production or therapeutic claims fall under CVM regulation as new animal *drugs*. This curiosity arose because the FDA used the 1938 Federal Food, Drug and Cosmetic Act to argue that GM animals meet the definition of a drug in terms of their ability to affect the structure or function of the body. Again this is a noteworthy clouding of the medical–agricultural boundary and a peculiar use of legislation that predates the actual development of the technology. In a *Nature* editorial headed 'Animals aren't drugs', the FDA's regulatory approach was described as 'troubling', especially since under US law the existence and application of new drugs are protected from public scrutiny (Campbell, 2008, p2). As discussed above, the regulatory focus constructs the GM animal as a product, not a novel process. To date, no transgenic animals have been approved for use as direct human food, which of course is in contrast to the commercialization of GM crops in the US. But as the FDA web-site reports, a very limited number have been approved for rendering into animal feed components. The FDA is reviewing an engineered Atlantic salmon containing foreign genes that stimulate the fish to grow to market size in about half the time it takes normal salmon. Researchers for the company AquaBounty accomplished this by inserting two genes into the fertilized eggs of the fish. GM animals have, however, been licensed on both sides of the Atlantic for biopharmaceutical production. Moreover, 'GloFish', a fluorescent GM zebrafish, has been commercialized for sale as a pet in the majority of US states. In January 2009 the FDA posted guidelines to industry on developing GM animals and on compliance with its regulatory procedures. Developers have to go through the FDA process of submitting a new animal drug application (NADA). In response to the above fears over transparency, it was announced that each GM-related application would have to go before a public

scientific advisory committee prior to a decision. However, the FDA is clearly unable and unwilling to respond to *ethical* questions posed by American citizens. On its own website Q and A section, posted under the question 'What about ethics? Will FDA consider these in its risk management decisions?', it replies:

> *The issue of ethics and biotechnology is complex. Our experience with other animal-based new technologies such as cloning and the introduction of rBST has shown that most people include animal health in their articulation of what constitutes 'ethics'. We note that the new animal drug approval requirements described in the guidance require a finding of safety to animals, and so we believe that we are addressing those particular health and safety-related concerns. As for issues associated with other social concerns that may fall under the heading of 'ethics', we note that these issues are not within the scope of the guidance. We do, however, continue to participate in various venues in which these issues are discussed so that we can ensure that the discussions are based on fact and not on erroneous assumptions regarding the technology or its outcomes.*[19]

In this extract we can note a conversion of ethics into health, but also a retreat to the 'scientific' and 'factual' aspects. As well as failing to allow for far more nuanced ethical debate, this also gives the impression that the 'science-based' FDA process is itself not somehow bound up in making values-laden normative decisions.

In terms of potential innovation trajectories, there has also been considerable regulatory noise around animal cloning over the last two years. This trajectory could be said to have accelerated, perhaps in part due to lobbying by companies. For example, US cloning company Viagen supplied data to the FDA and lobbied the European Group on Ethics (EGE, 2008) in their consideration of the issue. Yet unsurprisingly given the historical legacy alluded to earlier, we see a divergence in both confidence and approach between the US and EU. In December 2006 the FDA released its draft document on 'A risk-based approach to evaluate animal clones and their progeny'. The first half of 2007 was set aside for public and professional responses to this document, with the final version released on 15 January 2008. The conclusion of the FDA report was 'that meat and milk from clones of cattle, swine and goats, and the offspring of clones from any species traditionally consumed as food, are as safe to eat as food from conventionally bred animals'. Moreover, the FDA rejected the call for labelling, saying that:

> *The agency is not requiring labelling or any other additional measures for food from cattle, swine and goat clones, or their offspring, because food derived from these sources is no different from food derived from conventionally bred animals. Should a producer express a desire for voluntary labelling (for example 'this product is clone-free'), it will be considered on a case-by-case basis to ensure compliance with statutory requirements that labelling be truthful and not misleading.*[20]

Thus for the FDA cloned animals and their offspring are continuous with animals from selective breeding. However, even in scientific terms clones are not exact biological copies. Epigenetic factors – thought to be involved in the unpredictable morbidity and

mortality of cloned animals – as well as the focus of cloning on nuclear DNA but not mitochondrial DNA ensure that the cloned animal is not an exact copy. It could indeed be the case that there are no risks to the consumer in eating meat and milk from cloned animals, beyond the usual risks of a diet high in animal products. However, to have a regulatory process detached from ethical questions – especially those that pertain to our treatment of other animals – is democratically challenged. This ethical vacuity in the US regulatory process came in for criticism during the 2007 public consultation process. Writing in *Nature*, Peter Vermij described the FDA as guilty of bypassing ethics (2007, p7). Vermij also reports on an International Food Information Council (IFIC) poll from November 2006 which showed that 60 per cent of US consumers would not touch products from cloned animals even if deemed safe by the FDA. The continuity argument of the FDA, taken together with its opposition to labelling and its ethical void, suggests a regulatory process heavily skewed towards industry. That it drew its findings from data from two leading cloning companies only adds weight to this assertion. The FDA process was able to ignore the wide possible range of ethical questions around animal cloning as well as the fact that the technique has remaining technical questions surrounding it. The FDA has been criticized elsewhere for excluding the normative dimensions of risk assessment and for a lack of participatory democracy (Meghani, 2009). Moreover, there is some evidence to suggest that this model of regulation reduced to particular notions of safety is becoming institutionalized at a global level. For example, the Codex Alimentarius – a collection of internationally recognized standards, codes of practice and guidelines established jointly by the FAO and WHO in 1963, produced in 2008 a 'Guideline for the Conduct of Food Safety Assessment of Foods Derived from Recombinant-DNA Animals'[21] that explicitly excludes ethical and environmental issues. That the Codex is used by the World Trade Organization (WTO) in resolving disputes may be significant for the future framing of possible disagreements over the commercialization of molecular techniques.

On 11 January 2008 the European Food Safety Authority (EFSA) released its draft opinion on animal cloning (EFSA, 2008a). It acknowledges the higher mortality and morbidity rates among cloned offspring but offers a comparable opinion to the FDA and assumes that the technique can be refined over time. In one of the report's key conclusions it states:

> *Food products obtained from healthy cattle and pig clones and their offspring, in other words meat and milk, are within the normal range with respect to the composition and nutritional value of similar products obtained from conventionally bred animals. In view of these findings, and assuming that unhealthy clones are removed from entering the food chain as is the case with conventionally bred animals, it is very unlikely that any difference exists in terms of food safety between food products originating from clones and their progeny compared with those derived from conventionally bred animals.*[22]

The full EFSA scientific opinion published later in 2008 qualified this somewhat, adding in specific recommendations relating to the continued monitoring of potential genetic abnormalities and issues around animal health, welfare and food safety (EFSA, 2008b, p33). However, perhaps the main difference between the US and EU regulatory process

around animal cloning is that the EFSA work has been complemented by a report by the European Group on Ethics in Science and New Technologies (EGE), released a day after the FDA's report, on 16 January 2008. Thus although the EU has split off science (EFSA) from ethics (EGE) in terms of formal technology assessment, it has substantially included ethics in a way in which the US process has not. In the days following the FDA and EFSA announcements, the Biotechnology Industry Organization[23] (BIO) predictably released positive statements of approval and support. However, BIO failed to comment on the decidedly more critical report of the EGE, to which I now turn.

The findings of the EGE report on 'Ethical aspects of animal cloning for food supply' are in stark contrast to the optimism of both the FDA and, to a lesser extent, the EFSA. The report concludes that 'at present, the EGE does not see convincing arguments to justify the production of food from clones and their offspring'[24] (2008, p45). The abstract of the report states that 'considering the current level of suffering and health problems of surrogate dams and animal clones, the EGE has doubts as to whether cloning animals for food supply is ethically justified' (2008, p45). The report foresees a potential future clash between WTO free trade rules; specifically over the import of cloned animals/animal 'products' into the EU and public opposition to this. However, it does point to the precedent of bovine growth hormone being banned in the EU. The report also favours labelling if, in the future, imports are permitted.

Overall the report includes a range of ethical objections which it groups into four areas of concern: around animals, humans, the environment and society. Yet the text of the conclusion settles on the utilitarian language of suffering and it is clear from the rest of the report that it leaves the door open to the commercialization of animal cloning for food in the future. Although it covers more fundamental objections which centre on notions of 'intrinsic value' and opposition to the further industrialization of animal breeding, the conclusion of the report does not espouse such views. In one revealing extract the report states:

> *In the Amsterdam Treaty animals are recognized as 'sentient' beings and, therefore, while meat production is important in the human diet, and the slaughter of animals a necessity, it should always be clear that the way in which we treat animals should be in accordance with the already existing animals welfare and health standards required in EU legislation.* (2008, p40)

This is both a confusing and confused statement. Clearly one can dance around the meanings of 'sentience' and the moral import that that may imply, but the claim that meat production is important in the human diet falsely elides cultural differences. There are millions of European citizens leading healthy lives without the consumption of meat. It is therefore more accurate to state the *economic*, *social* and *symbolic* importance of meat production and consumption to most people, rather than its dietary importance.

In relative terms, and discounting the merited criticisms of the EGE in terms of what its existence says about understandings of ethics and expertise, the report can at least be seen as a welcome inclusion of ethics into the regulatory process. It calls for a wider discussion on the ethics of industrialized animal agriculture and for the EU to fund widespread public engagement exercises into the subject of animal cloning and related technologies.

Back in the US, it is unclear how or whether regulatory agencies will supplement the narrow safety focus of the FDA with meaningful ethical deliberation. There is at least some reflection on narrowing regulatory oversight to issues of human safety. For example, the USDA Advisory Committee on Biotechnology and 21st Century Agriculture (AC21)[25] in their July 2006 report 'Opportunities and challenges in agricultural biotechnology: The decade ahead' (USDA, 2006) acknowledges that:

> *The commercialization of a transgenic plant or animal product is affected by considerations beyond the safety of the product. Technical challenges may arise when turning a beneficial trait into a marketable food. New products must gain acceptance by consumers and trading partners. Sometimes social and ethical concerns may influence decisions about commercialization. For example the development of transgenic animals may generate, for some people, higher levels of concern than those for plant breeding.* (2006, pp5–6)

This is an awareness of ethics as potential barrier to commercialization and not especially as something to be built in from the outset of innovation trajectories. Ethics then are little more than risks potentially threatening to commercialization rather than grounds for a more precautionary approach as in the EU, and by implication the UK. The AC21 envisions that over the next decade transgenic animals for food or for production of pharmaceuticals or industrial products will be ready for the marketplace. The US regulatory framework is itself identified as another possible risk in that it is potentially ill prepared for 'product' development around molecular techniques. For example:

> *New transgenic organisms may result in substantially different types of products than have thus far been reviewed by U.S. regulatory agencies … Some of these organisms may not be regulated under the current regulatory system, while others may require new or modified regulatory assessment methodologies or may pose challenges for the traditional boundaries of agency responsibility.* (2006, p9)

Animal biotechnology has already been seen to confuse traditional boundaries of agency responsibility in the UK around xenotransplantation (see Brown and Michael, 2004) and also in the lack of clarity between the UK Home Office and Human Fertilisation and Embryology Authority (HFEA) around the regulation of human/animal hybrid embryos. That biotechnologies destabilize these regulatory agency boundaries points in one sense to their novelty but also, to be more specific, their hybridization of the traditional dualistic separation between the 'medical' and the 'agricultural' which has tended to be institutionalized at the regulatory level. Certainly allowing the FDA jurisdiction over GM animals (defining them as 'animal drugs') and cloned animals seems a curiosity, but perhaps it does lend itself to the US federal preference to frame the regulation of molecular techniques in terms of safety, and not much else besides.

This chapter has illustrated the main emergent regulatory moves around animal biotechnology in both the US and UK/EU and underlined how the historical context of biotechnology regulation remains pertinent and how it has partly begun to shape new regulations and pronouncements. Much further research is required that focuses

on the US state level, individual EU member states and other parts of the world. We see a more precaution-based approach in the EU context and a more laissez-faire risk-based anthropocentric approach emerging in the US federal context. Neither the US nor the UK has embarked on a national debate or initiated substantial methods of public engagement on the use of agricultural animal biotechnology in order to satisfy minimum criteria for a democratization of science innovation, all the more intimate and pressing in this case of an area of science which involves what many people eat. The US also favours narrowing down consumer choice in its opposition to labelling in the case of 'products' from cloned animals. In restricting the issue to one of safety, the US government denies its citizens the opportunity to express ethical disagreement with animal cloning. The UK government's response to the FAWC recommendations also sides with commercial interests in a manner that is arguably closer to the US framing than that of the EU generally. It remains to be seen what impact, if any, the EGE report may have on UK regulation in this area.

Advocates for the lives of animals in their context as commodities in global livestock production quickly appreciate an important point through a consideration of these regulatory processes: attempts to apply molecular technologies to animal breeding enrol the commodification of farmed animals into several broad and highly important issues. There are questions of democracy here which revolve around the right to civil participation within processes of scientific innovation and the attempts of commercial and governance interests to bypass such participation. There are questions pertaining to the future of our agricultures in the context of pollution, water resources, climate change and global inequalities. There are questions of human health and there are questions of animal ethics. But due to the novelty of animal biotechnologies, there are also arguably more fundamental questions regarding our underlying narratives of 'progress' and the role of hubris within these. In these future visions of instrumentalized human–animal relations, what alternatives are being excluded and dis-imagined? While animal advocates will place a special importance around animal ethics, however conceived, it is clear that attempts to claim a future free of animal biotechnologies are best served by situating critique at the nexus of these interconnecting themes and to proffer alternative problem-solving approaches to the major problems of our time. Before turning to these issues in more detail in Part III, I now extend the examination of the capitalization of the animal from the regulatory to a consideration of both how animal bodies are framed in animal science and the initial commercial development of molecular techniques.

5

Biopower and the Biotechnological Framing of the Animal Body

The following two chapters examine the various ways in which applications of genomics and new breeding techniques are being commercialized. The subsequent chapter focuses on the capitalization of animal biotechnologies. How precisely are molecular approaches already being made profitable? It also begins to sketch out some of the roles and relationships of important actors in this emerging novel exploitation of domesticated animals. However, first in this chapter I explore technoscientific constructions of animal bodies and how these begin to facilitate modes of capitalization.

During the early 1980s, sociologists first started to explicitly take on 'the body' as a serious topic of enquiry. As I indicated during the introduction to this book, this was an important reflexive period for the discipline, wherein taken-for-granted ontologies of society, social actors and the social were called into question. The importance of the body for rethinking social identity, social regulation, social experience and intersecting relations of power has become accepted and overall, while we should see it as an ongoing project, this has become a notable and successful disciplinary shift. Moreover, this exceeds the discipline of sociology: we can also point to 'bodily turns' in the humanities and social sciences more generally, and it also complements and intersects with the deepening of other sociological endeavours in, for example, the emotions, gender, and health and illness. However, at this point I want to argue that this mainstreaming of the body has been overly disconnected from the emergence of the 'question of the animal' in the humanities and social sciences. Although a sociology of human–animal relations has also emerged, it has been less embedded within other parallel questionings of the discipline. Consequently I think we have witnessed the assumption that a sociology of the body is more or less a sociology of the human body.

What I present here modestly is a contribution to thinking about nonhuman animal embodiment in the context of biotechnological change. In effect I want to partially rejoin the discussion from Chapter 3 on enhancement and suggest that biopolitics does not operate a human–animal dualism and so neither should our approach to its analysis. In spite of my critique here, there are recent transdisciplinary trends of scholarly research that theorize the body via a healthy disrespect for species boundaries. These can be found within the overlap of feminist science studies (for example by Ritvo, 1995;

Birke, 1999; Franklin, 2007b; Haraway, 2008), with the emergence of the so-called 'new materialism' in feminist theory (for example Hird, 2004). This is a varied terrain, with notable differences over the politicization of human–nonhuman relations, for example. Moreover, related multidisciplinary work around biotechnology has perhaps not surprisingly seen the emergence of concepts in a similar vein that attempt to theorize the cross-species capitalization of life (e.g. Thacker, 2005; Cooper, 2008; Helmreich, 2008). These are all important resources towards theorizing the body which begin to usher in an ontological reorientation that is also in a sense a critique both of anthropocentrism and of the capitalist capture of molecular science.

When renowned ethologist Marc Bekoff talks of 'minding animals' in his book of the same name (Bekoff, 2002), he means it in two senses.[1] First, he refers to an ethics of care towards other animals and, second, to an appreciation and understanding of nonhuman perspective, agency, mindedness, sociality and emotionality. If we also work in the politicization of human–animal relations, we arrive at a reasonable description of the primary interests of (critical) animal studies. While it is simplistic to argue that biotechnology represents the exact antithesis of this trajectory of human–animal relations, it is not far from such a framing if we think of it as primarily wedded to a neo-productivism of intensified animal agriculture. In this chapter, then, it is necessary to think of another metaphor that more accurately captures the biotechnological positioning of animal bodies in relationships of commodification and reductionism. Specifically in talking of *mining* animals, I want to illustrate the role farm animal genetic science plays in this trend and how this is being intensified.

Farmed Animals and Biopower

In putting together some constituent elements here for a sociology of farmed animal bodies with specific reference to biotechnology, it is not surprising that the main reference points map onto the original primary influences on the early 1980s shift to a sociology of the body. While feminism was an important general catalyst for this disciplinary shift and now provides the academic space for much deliberation on human–animal relations, the work of Michel Foucault was the other major influence. Indeed the major sociological text on the body, Bryan Turner's *The Body and Society*, was itself part written in response to Foucault (Turner, 2008, pviii).[2]

As animal studies and continental philosophy have begun their fruitful relationship, we can already note varied engagements with the work of Foucault (for example Palmer, 2001; Coppin, 2003; Clarke, 2007; Holloway, 2007; Holloway et al, 2009; Wadiwel, 2002, 2008, 2010). Specifically, here I intend in a rather straightforward sense to apply Foucault's theory of biopower to an understanding of livestock genetic science. I argue that in certain ways this is a particularly good example of biopower and that regimes of bodily regulation and rationalization are unsurprisingly found across the human–animal distinction. As we saw in Chapter 3 when this was discussed in terms of the bioethical discourse of 'enhancement', historically the rationalization of bodies – human and animal – have informed each other. Moreover, capitalism is not specifically precious when it comes to species boundaries.[3]

Foucault famously outlined a transformation in the mechanism of state power from a sovereign form to one of biopower (Foucault, 1976, 2003). During the former

there is a sovereign 'right to take life or let live', while Foucault describes a shift in Western Europe beginning during the 17th century to a form of power that exercises the 'right to make live and let die' (Foucault, 2003, p241). Before elaborating on biopower, let us first compare two extracts. In 1976 he wrote, 'The old power of death that symbolized sovereign power was now carefully supplanted by the administration of bodies and the calculated management of life' (Foucault, 1976, pp139–140). In a further discussion of this transition, published posthumously in 2003, he revised, 'I wouldn't say exactly that sovereignty's old right – to take life or let live – was replaced, but it came to be complemented by a new right which does not erase the old right but which does penetrate it, permeate it' (Foucault, 2003, p241). One can note the comparative ambiguity here between 'supplant' and 'complement'. I think it is important to hold onto the latter notion that sovereign power is complemented by biopower and transformed in the process. It is a mistake to read Foucault as arguing that a shift to biopower is somehow an end to violence. Indeed he is specifically interested in considering how the political power to kill is sustained under conditions of biopolitics. His answer is that racist modes of representation intervene to legitimize killing (Foucault, 2003, p254). Foucault may be read here to mean racism in a general sense of a dominant approach to difference, one which is to an extent applicable to the naturalization of gender, class, race and species hierarchy. He writes on his understanding of racism:

> *It is … a way of separating out the groups that exist within a population. … This will allow power to treat that population as a mixture of races, or to be more accurate, to treat the species, to subdivide the species it controls, into the subspecies known, precisely as races. That is the first function of racism: to fragment, to create caesuras within the biological continuum addressed by biopower.* (Foucault, 2003, p255)

Analogues to this idea of caesura find their way into later theorists of biopower, notably Georgio Agamben's (1998, 2004) interest in the 'state of exception' whereby under a condition of emergency sovereign power is re-exerted.[4] Indeed Agamben's (2004) argument that the contested tensions of human–animal difference are significantly constitutive of Western politics (see also Wadiwel, 2010) reinforce the argument that we should think of 'racism' here in a broad sense. That we should conceive of sovereign power and biopower as coexistent is important for partly applying this framework to human–animal relations and meat production, and I will return to this point shortly.

In Foucault's work biopower is conventionally thought of in terms of the human, of the body and of institutions. This shift towards the optimization of life has been discussed in a broad range of domains – childhood and education, sexuality, criminology and penal reform, Taylorism, doctor–patient interaction, and public health and nutrition being just a few examples. The rise of the social sciences themselves – their statistical investigations into the myriad conditions of populations – have been interpreted by Foucault as part of this biopolitical shift. Meanwhile, medical disciplines have focused on the efficiencies and morbidities of the body. This reflects his interconnected bipolar definition of biopower. The first form of biopower he describes as:

> *centred on the body as a machine: its disciplining, the optimization of its capabilities, the extortion of its forces, the parallel increase of its usefulness and its docility, its integration into systems of efficient and economic controls.* (Foucault, 1976, p139)

This he refers to as an *anatomo-politics of the human body*. I want to suggest here that the species specification is unnecessary and limiting to his overall theory. The second form of biopower is:

> *focused on the species body, the body imbued with the mechanics of life and serving as the basis of the biological processes: propagation, births and mortality, the level of health, life expectancy and longevity, with all the conditions that can cause these to vary.* (1976, p139)

This he terms a *biopolitics of the population*. In tandem these poles convey the economic, social and medical administration of life necessary to the formation of capitalism and the modern state. Yet reading Foucault's description of biopower one is struck how it unintentionally also constitutes a conspicuously pertinent outline of the workings of the animal sciences integral to the conversion of farmed animal bodies into the mass production of meat and milk. Animal breeding has been a biopolitics from the beginning, but it was the start of its intensification during the 18th century by UK breeders such as Robert Bakewell (1725–1795) who were instrumental in professionalizing breeding and consolidating a notion of genetic value and property (see Ritvo, 1995). The detailed recording of widespread statistical information that was partly constitutive of new breeds took place during the 19th century (see Holloway et al, 2009). Herd books were important for the documenting of pedigree animals and performance statistics. For example, in cattle the first herd book for the 'Shorthorn' was published in 1822, while the 'South Devon' Herd Book Society was formed in 1895.[5] It has been argued that the earlier date for the Shorthorn ultimately gave that breed a head start and facilitated the success of their dissemination (Derry, 2003, pp6–7). This founding of herd books places the elaboration of 'nonhuman biopower' as coexistent with Foucault's historicization of human biopower. He did not consider nonhuman animal biopolitics, but he did transiently discuss an interrelationship between human biopower and agricultural improvement (see 1976, p142) which I would like to tease out a little more here.[6] Contemporary animal scientists can be seen as the highly specialized biopoliticians of agriculturally framed animal bodies.

Post-World War II animal science especially has been a central actor in bringing biopower to bear on agricultural animals, as it is not merely that the animal body must be primed to be economically productive but that the animal body must work towards its *own* consumption. The 'genetic progress' (the phrase that animal scientists use to refer to annual economically determined selection improvements) made on animal bodies during this period, together with increased availability and the decreased price of animal products, also shows how this biopower was in a sense subservient to the overarching project of constructing (assumed to be) healthy human bodies. Thus I agree with Holloway et al (2009, p398) on the importance of a non-anthropocentric and relational concept of biopower in which 'people work on nonhuman others as

part of their work on themselves'. The 20th century, of course, was the period of the intensification and industrialization of animals into consumable products. One should resist the naturalization here that this was an inevitable catalyst and complement to human population increase. This could have been achieved via other production and dietary means. But the post-war projects of nationalistic rebuilding were partly premised on an increasingly hidden mass slaughter[7] and consumption of farmed animals that was assumed to contribute to human health and vigour[8] (see Foucault, 2003, p255). This conforms to Foucault's understanding of racism as not merely about fragmentation but also about elimination.

Animal science has and continues to put much labour into both anatamopolitics and population biopolitics. Docility has been selected for across all agricultural species in that 'disruptive' or aggressive animals will tend to be selected out. Of course, there is an associated assumption that such behaviour is genetic and not the product of confinement conditions. A whole array of animal science subdisciplines work to ensure that animal bodies are disciplined to be at the optimum for production. These include, but are not limited to, meat science, behavioural science and reproductive science, with a focus on feed efficiency, physiology, development, nutritional quality, immunity and disease, biometrics, health, welfare, environmental impact, and methods of slaughter. It is difficult to adequately convey this without having familiarity with animal science. One simpler way to appreciate it is to consider the specialization of the animal sciences in the form of the impressive suite of specialized academic journals now in print. When particularly significant announcements are made – such as the sequencing of a genome – they tend to make the major science journals such as *Nature*, *Nature Biotechnology* and *Science*. But the day-to-day research of animal science can be found in journals including *Journal of Animal Breeding and Genetics*, *Livestock Science*, *Animal*, *Meat Science*, *Animal Genetics*, *Journal of Dairy Science*, *Theriogenology* and *Journal of Genetics and Genomics*, to name just a few. Much of the genetic and genome-based work (biopower cannot be reduced to genetics even though molecular biology generally may be seen as its new frontier) consists of 'mining' down into the chromosomal structure of major agricultural species while at the same time using the human and mouse genomes as comparative reference points. Notably, Foucault referred to biopower at one point as a 'technology of drilling' (Foucault, 2003, p249). Many papers report research around chromosomal areas of interest for particular potential genes usually referred to as 'economically relevant', relating to the potential for greater productivity or capital saving as in the case of disease resistance. Here optimization projects strike deeper due to the absence of human norms of privacy, autonomy and justice. Biopower can be said to percolate deeper into the nonhuman animal body vis-à-vis that of the human. Biopower has greater licence, because animals are framed as moral exceptions. This is implicitly recognized by a recent editorial in *Nature Biotechnology* (Marshall, 2009). It bemoans what it sees as the rather underwhelming impact of genomics on human health and welfare, but celebrates the progress being made in farmed animal genomics. The key here, as the article points out, is the ability for animal scientists to use genomic information *directly*, whereas 'it is considered immoral to breed out "undesirable" traits in humans' (Marshall, 2009, p487). In an anthropocentric cultural context, one cannot by definition be performing eugenics on animals, for that is to be termed 'selective breeding'.[9] Normatively dystopian fears about an encroaching biopolitical management of society are informed by this

legitimated animal shadow biopower. Thus ethical objections to new technologies on the grounds of human dignity encourage reflection on the meaning of the 'human' but also evoke the human–animal distinction by which it is partly constituted.

In spite of the terminological difference between 'eugenics' and 'selective breeding', they are methodologically the same science. Although at this point the temptation from an animal advocacy perspective is to use this as a straightforward means with which to critique what we might justifiably term animal eugenics, reproductive control is a complex moral subject. Moreover, genomics-related technologies such as pre-implantation genetic diagnosis (PGD) which expand the boundaries of choice for people with an inherited 'genetic condition' may serve to contest a wholesale cultural stigmatization of eugenics.[10] Not too dissimilarly in human–animal relations, humans (even vegan ones) may exercise reproductive control over their companion animal so as to prevent a surplus of 'unwanted' animals. Nevertheless we can deploy Foucault to understand a little better the commonality of animal and human 'eugenics'. Both have stakes in 'controlling the random element inherent in biological processes' (Foucault, 2003, p259), but more than this, animal eugenics vis-à-vis human eugenics (in its most violent form) work through a *combination* of sovereign *and* biopower. Foucault discussed this in relation to Nazism:

> *We have, then, in Nazi society something that is really quite extraordinary: this is a society that has generalized biopower in an absolute sense, but which has also generalized the sovereign right to kill. The two mechanisms – the classic, archaic mechanism that gave the State the right of life and death over its citizens, and the new mechanism organized around discipline and regulation, or in other words, the new mechanism of biopower – coincide exactly. We can therefore say this: the Nazi State makes the field of life it manages, protects, guarantees and cultivates in biological terms absolutely coextensive with the sovereign right to kill anyone.* (Foucault, 2003, p260)

Yet this sovereign right has undergone a transformation. While the scale of violence has increased exponentially, it became secretive and hidden. If biopower, as I have argued, is a useful concept for thinking about the labour of the animal sciences, this extract resonates with the intensification and industrialization of farmed animals overall. Foucault essentially provides the explanation of why culturally we witness a persistent comparison between this and the Nazi holocaust:[11] both are potent, controlling and disturbing because of this overlap between sovereign and biopower.[12] Both are examples of the industrialization and spatial sequestration of planned violence. In a passage that speaks to transgenesis and synthetic biology, Foucault argues that when biopower creates living matter and viruses, when it is possible to 'not only manage life but to make it proliferate' (Foucault, 2003, p254), it exceeds all human sovereignty and control. This is a biopower that gradually changes what it means to be human and illustrates that, in terms of bodily control, more may ultimately be less. This could indeed be the case with the role of industrialized animal production in fostering climate change, a subject I return to in Chapter 7.

The application here of Foucauldian ideas to animal science and production is not completely unproblematic. In Foucault's theory of power and subjectivity, disciplinary

regimes become internalized, and one's behaviour becomes to an extent self-regulated, introducing a degree of complicity with biopolitics. How can we begin to apply this self-surveillance aspect of his theory to nonhuman animals? This problem has been explored by Palmer (2001), Coppin (2003), Holloway (2007) and Holloway and Morris (2007). How, they wonder (Holloway and Morris, 2007, p95), can nonhuman animals be said to do 'work on themselves' in the way that Foucault's theory directed at humans argues? How generally, then, does biopower work on the process of nonhuman animal subjectification? From the outset this is a difficult question to pose of beings that in a naturalized manner have been denied subjectivity. In one sense it is not at all problematic to think of human biopower producing specific kinds of animal subjects – it is hardly unusual now to think of companion animals with behavioural problems due to previous human cruelty or animals who have suffered confinement exhibiting stereotypic behaviour. The interest of animal scientists in behavioural genetics speaks to the aim of building animal subjectivities into the very anatamopolitics of the animal body and mind; farmed animals have always been selected for 'ease of handling' and temperament albeit without the use of molecular knowledge. Foucault speaks of biopower producing docile human bodies – in the case of domesticated animals docility is bred in. Both technologies undoubtedly work on different levels and most probably through different psychological and emotional mechanisms,[13] but both speak to an *efficiency* of power.

Holloway and Morris (2007) approach this problem by resorting creatively to an alternative ontological focus, one that anyhow is faithful to Foucault's relational understanding of power. Influenced by actor-network theory and posthumanism, they argue for a relational conception of biopower which situates self-regulation across species, for example between animals and breeders. Similarly, Coppin has spoken of the way in which both animals and farmers are subject to a capitalist biopower, perhaps most clearly in the corporate scaling-up of farming operations (Coppin, 2003, pp609–610). This opens a space for thinking about the co-production of subjectivity,[14] as power circulating in the relations between human and nonhuman actors, and of new human and nonhuman subjectivities forming in the context of novel technology transfer. As Holloway has argued elsewhere in thinking through the technological interplay of automated milking systems with bovine being, 'bovine subjectivity has a history rather than an essence, and bovine being and bodily capacities are relational in terms of the different technologies, economies and social relations (with humans and with other cows) cows are associated with' (2007, p1055). Importantly, this grants a history to animals that traditionally have been seen as repositories or expressions of inert matter, as well as an agency in the face of a changing social, political, technological and economic milieu. Coppin has also wanted to open the possibility of thinking about the resistance of farmed animals at a biological, non-conscious level (Coppin, 2003, p612). This could certainly be applied to the unpredictability of genetic selection, sometimes leading to unexpected longer-term reductions in productivity. Overall Foucault's work, while not originally conceived in relation to (farmed) animals, illustrates the way in which during the development of capitalism the regulation of human and nonhuman bodies has been entwined. Biopower is in effect another heuristic tool for thinking about power relations across species.

Biotechnology and Animal Bodies: Metaphor No More?

The sort of ontological framing by Holloway and Morris (2007) above is influenced by academic shifts, notably in actor-network theory and feminist science studies, some of which have taken a serious interest in the agency of other animals. The so-called 'new materialists' (see, for example, Hird, 2004) have similarly argued for a stronger engagement between feminist theory and biology. These developments provide a more welcoming academic space for the nonhuman, also performing various other pertinent roles. First, they counter a view of nonhuman materiality as fixed. This chimes with the application of biopower to animals, which helps give a sense of history to animals as well as pointing to the inseparability of human–animal histories (Franklin, 2007a, p53). Second, these perspectives actively engage with scientific knowledge, avoiding a view of such knowledge as monolithic, uncontested or static. In this context the sort of value attributed to animals within biotechnology is not necessarily uniform or representative of all scientific knowledge. And third, although the sociology of animal bodies is partly inevitably going to focus on the discursive and representational, these dimensions of course have tangible effects on animal bodies. There is a specific role here for the sort of reflexive sociology discussed at the beginning of this book. If our (mis)treatment of animals has been sequestered away from the majority of human populations and the sciences of animal production are in a sense part of largely invisible[15] networks of power–knowledge relations little known by a broader public, then the social sciences can play a role in bringing these relations back to social and critical prominence.[16]

I want to move now – in order to develop this exploratory sociology of farmed animal bodies – to a closer focus on some of the representations at play in the biopolitics previously described.[17] How do animal genetics science and molecular approaches apprehend the body of such animals? I want to approach my answer via a consideration of two tropes – the idea of the body as information and as factory.

The aforementioned cattle breed herd books can be said to have realized an important stage in the development of a statistical biopolitics of farmed animal bodies that during the 20th century diversified and specialized via an emergent understanding of biology as information (see Hayles, 1999). This is apparent during the early part of this century as completed[18] genomes of farmed species are now regularly rolled out and stored virtually for dissemination to global research networks.[19] The website of the US National Animal Genome Research Program (www.animalgenome.org/), an offshoot of the US Department of Agriculture (USDA), provides a centralized hub to explore the genomic databases of all major farmed species as well as the horse (presumably due to the economic value of horses). A further important hub is provided by the Roslin Institute's Ark database (www.thearkdb.org). Publicly funded by the UK Biotechnology and Biological Sciences Research Council (BBSRC), the database provides direct links into sequenced genomic information set out by chromosome.

Animal genomics is in important ways an information science. As feminist biologist Lynda Birke recounts, 'information' became an organizing concept in biology after World War II; it was not merely present in genetics but, for example, in cell biology generally and in the analysis of the nervous system (Birke, 1999). But arguably this has become more than a heuristic organizing metaphor, especially in animal genomics research. As Parry has commented, 'Metaphors, which are conventionally understood

as discursive tools used to illustrate a certain process, are, in some instances it seems, now coming to function as literal descriptors of those same processes' (Parry, 2004, p51). This is evidenced by the material practices of animal scientists which involve less and less lab-based work and more time in front of a computer screen doing work on database molecular information representations of animal bodies. Following earlier work by Canguilhem on the coming together of information theory and molecular biology (Canguilhem and Delaporte, 1994, pp316–317), several authors have analysed this as a part of emergent biopolitics fundamental to the capitalization of new technoscience. At this point it's worth quoting an interview extract from a discussion on transgenics. On the question of moving DNA from one species to another, one animal scientist told me:

> *If you think about it, it boils down to the identity of that little piece of sequence. Now my personal view is that it's just a piece of DNA sequence … you could say I know that sequence, I'm going to go to a machine and I'll make that sequence and it's a pig sequence and I'll put it into a mouse. Now are they both pig genes? They're just a piece of DNA; to me it's just a piece of DNA.*

This raises interesting questions for genetic identity, but for the purpose of this discussion it illustrates how DNA can come to be seen as mobile information largely detached from its original context. As Haraway puts it, 'embodied information with a complex time structure is reduced to a linear code in an archive outside time' (Haraway, 1997, p245). It is Thacker who has probably analysed this in most detail, writing on the movement of biological material from the 'wet' lab to become 'dry' information, a new media. He writes:

> *Biological exchange, in conceiving of biology as information that exists – and persists – across media, radically widens the possibility of what can be exchanged within the biological domain. Not only is the biological commensurate with the economic (for example microbes, cells or DNA that is patented or purchased for research), but the biological can be internally exchanged in ways that are not limited by the division between the material and the immaterial.* (Thacker, 2005, p10)

An example of this would be the transfer of DNA onto a chip which can then enter into relations of economic exchange as a valuable research tool.

Another contributory process to the codification of DNA and biological abstraction is the generation of statistical formulae around genetic knowledge. In animal science, this emerged alongside the development of quantitative genetics. Statistics are pressed into service in order to try and calculate the economic advantage of choosing a particular genetic selection, and of combining particular genetic and environmental adjustments. If animals are converted, abstracted and valorized as economically relevant genes, markers and quantitative trait loci within their codification as DNA, then within associated statistical estimates they can be said to become elements within complex mathematical equations. We can think of animal breeding as a highly controlled biopolitical state of its own. One modelling technique in animal science is known as bio-economic modelling. This emerged in the 1980s within agricultural economics and is a convergence of animal

genetics, economics and statistical modelling used across all agricultural species (see, for example, Roughsedge et al, 2003; Conington et al, 2004). Although animal scientists are initially trained in veterinary science or genetics or welfare, their professional labour can be seen as bio-economic. The modelling technique influences which selection decisions are made based on a broader economic context of profitability projections.

The development of such techniques has been catalysed by the corresponding development of information technology. The discipline of bioinformatics emerged during the 1980s, defined as the application of information technology to molecular genetics. Bioinformaticians now work closely alongside animal genomics scientists. Best linear unbiased prediction (BLUP) is a sophisticated statistical software program that geneticists use to predict estimated breeding values (EBVs) of animals. Moreover, it aims to separate out genetic factors from environmental factors and so yield accurate knowledge of the value of selection alone. It is now being combined with molecular data. An understanding of animals as information is also significant in the sense of the entwined sciences of biometrics and biosecurity. Indeed genetic markers have also been commercialized for use in 'product traceability' (see Plastow, 2003). Here farmed animal bodies are traceable statistics as anxieties over zoonosis have come to the fore. This is a good example of the way in which biopolitical control begets more attempts at control[20] in as much as many zoonoses are significantly the product of intensive farming.

A focus on the productive performance of an animal inevitably constructs a partial view of the value of the animal. Holloway (2005) notes this surge in statistical modes of animal evaluation, arguing that they sit in tension with vernacular visual judgements of the animal traditionally favoured by farmers though now deemed to be scientifically unreliable. In an analysis that chimes with that of Thacker above, he states:

> *As data are made and studied, particular forms of knowledge of the animal body are gained, but the totality of the animal is lost. There is an iterative process of abstraction, as 'raw' data from related animals are processed to construct individual's estimated breeding values (EBV) for specific traits, generalized indices for beef or calving values, and an index comparing animals with others of their breed. Ultimately, an abstract, simplified yet comprehensible representation of the complex reality of nature is put onto paper or computer disks, forms which can then themselves be transported and examined in places and times away from the sites of data collection.* (Holloway, 2005, p892)

This implies a need for animal science to enrol farmers into the use of molecular breeding techniques[21] and new data recording methods as part of a technologically mediated and distributed animal materiality better constructed for the requirements of geographically dispersed research networks, mobile capital and genetic redesign. As Thacker notes, the idea that the body can be understood as information, what he terms 'informatic essentialism', is important to transhumanist thought (Thacker, 2003a), the rendering of materiality as both useful and 'editable'. For reasons already outlined, it is with nonhuman materialities that we already see more intensified attempts to recreate and to enhance productivity. Animal genomics produces quite different knowledge of animal bodies. Compare it, for example, to that which you might experience with your companion animal, or to how ethological science may approach animal behaviour.

There are also radically different sensory and affective priorities at play here. The practice of animal genomic science, increasingly removed from the sensual presence of animal bodies, echoes the distance achieved for and by the consumer in the conversion of animals into the category of meat. If animal biopolitics has worked partly through processes of distancing and sequestration in order to sustain the possibility of our more unsettling human–animal relations, it is instructive that the proliferation of biopolitical elaboration under biotechnology draws on an informatic distancing epistemology. While this may prove effective for short-term capitalization projects, it acts against the prospect of both witnessing and taking responsibility for an intensified ability to manipulate nonhuman animal life.

If 'information' is a crucial representation of animal life and embodiment in contemporary molecular science, a further biological metaphor of the body that appears in the animal case to have become actualized is the view of an animal as a factory. In relation to animal production, we are more accustomed to hearing this in the phrase 'factory farms'. During the early 20th century newly professionalizing agricultural engineers were significantly influenced by the managerial science of Frederick Taylor (Fitzgerald, 2003, p88), with factory methods and process gradually becoming adopted firstly in American agriculture. By the end of the 20th century 'factory farm' had become the rhetorical basis of critiques from animal welfare perspectives that while not against the killing of animals for meat per se, campaigned and continue to campaign to temper the industrialization of animal production associated with close confinement, scale, large animal populations, antibiotic use and now biotechnology.[22] Though it is as statistical nodes of information that farmed animals circulate and as elements in a factory that they partly may live, or at least meet their death, it is the view of the farmed animal's *body* as a factory that is of specific interest here.

Birke has spoken of the concept of the body as a black box in experimental biology (Birke, 1999, p92). This approach treats the body as a closed system and methodologically tries to ascertain what is going on inside the 'black box' by monitoring inputs and outputs. Although many scientists – including animal scientists – would now refute the simplicity of this model, it is one that still has a certain currency in animal science. Specifically, adherents of molecular biology persistently talk of their approach as finally 'opening up the black box' by revealing the actual genes involved in selection and breeding, and it has been a useful rhetorical ploy for arguing the limitations of quantitative genetics.[23] The 'black box' analogy, as Birke argues, is related to a representation of inner animal biology as factory, for example the cell as assembly line factory (Martin, 1989, p37; Birke, 1999, pp98–99). I want to suggest that the biopolitical intensification underway in animal genomics and biotechnology is a conduit for the perpetuation of the factory metaphor, but that it has become actualized. Under biopower, the factory metaphor is unsurprising – the emphasis is on the controlled productivity of the body, be that in the form of meat, labour, fitness or new offspring.

If we think about the biopower of animal science broadly (not just genetics), we see an approach to the bodies of pigs, cattle, chicken and sheep that is about the precise and economically efficient control of inputs in order to try and control a particular qualitatively standardized meat, milk or fibre product. The sequencing of the genomes of these animals is an attempt to widen the toolkit and to heighten the degree of control in breeding. Just as important as genetics is research into feed, feed efficiency and animal

health (which have a genetic component). In a reductionist sense, animal bodies are factories for the production of protein for human consumption, for the conversion of plant material into animal commodities.[24] The commercialization of animal bodies for the production of biopharmaceuticals serves to bring this literal 'body as factory' explicitly into relief. Drugs are traditionally made in laboratories, but the production of GM animals that express biopharmaceutical drugs for human use figures the animal body as the laboratory. For example, in the field of dairy technology, Berry advocates that:

> *The suitability of the mammary gland as a 'factory' for pharmaceuticals due to its relatively large capacity for protein production, and ease of harvesting of the product, will remain the most likely use of transgenics in the future.* (Berry, 2008, p34)

Whereas the conversion of the animal body into information takes the organic into an inorganic media, the body as factory and laboratory reverses this, but similarly blurs the boundaries between organic and inorganic, and between body and technology. Animal biopharma, already commercialized in goats as we saw in Chapter 3, is often referred to as the 'animal as factory' or as an 'animal bioreactor'. A bioreactor is essentially a large metallic vat that supports a biologically active environment and/or chemical production process. Using the animal body instead as this vessel is seen as a cheaper and more efficient way of producing large amounts of drugs. In a Foucauldian sense it is classically an exploitation through keeping the animal alive, the calculated management of that life and the exploration of the productivity that life may be made to confer. In the next chapter I more specifically consider the relations between the biopolitical constructions of farmed animal bodies and their capitalization.

6

Capitalizing on the Molecular Animal: Beyond Limits?

I begin here by considering some biopolitical processes within molecular animal breeding that may be seen as especially bound up in hopes for new ways of capitalizing on animal bodies. The expected profitability of the molecular turn, I argue, revolves around two interrelated methods of capitalization: first, research on a nexus of speed, accuracy and efficiency, and, second, research on the possibility of hybridity. Here I also consider some of the general literature on genomics and ideas of 'biocapital',[1] before then going on to situate capitalization within the broader discourse of the knowledge economy. I also consider some of the ways in which genomics is already being made profitable, as well as the relevant emergent relationships between science and the animal breeding corporate sphere.

A New Species of Capitalization?

As I indicated during the previous chapter, the biopolitical capture of farmed animal bodies should not be reduced to genomics or genetics. The development of animal genomics intersects with that of other technologies, most notably that of sequencing machines. Higher throughput machines and declining sequencing costs, for example, have been important to the emergence of the genomic selection technique. Moreover, the biopolitical work of animal science since the mid 20th century has been assisted by various technologies used in reproductive science. Now ubiquitous in contemporary agriculture, these include the interrelated techniques of semen freezing, artificial insemination (AI), multiple ovulation and embryo transfer. The US company Bull's Eye Genetics provides a good example of the sort of technological infrastructure developed around AI in cattle – selling bull semen for 41 cattle breeds but also equipment such as semen tanks, thawing units and AI 'guns'.[2] Such AI reproductive technology is widespread, especially in the cattle and pig industries. They already provide an important technological path – a pre-existing infrastructure for the dissemination of anticipated future prized genotypes. These techniques highlight that through the mobility of frozen valued gametes or embryos, the process of decontextualization of 'genetic information' from the animal body predates the more recent era of genomic 'mapping'. The use of scanning technologies has also

become important. Ultrasound has been used in animal reproduction for several decades, but I refer more specifically to the use of computed tomography (CT) scanning. This has begun to be used as a method of meat quality assessment in agricultural animals. More familiar as a technology used in human diagnostic medicine, CT scanning is biopolitically important across species. It was also used in the Visible Human Project to visually map the interior of the human body (see Waldby, 2000). Used mainly on live sheep so far, individual animals are scanned, for example in the scheme run by the Scottish Agricultural College (SAC), to produce cross-sectional images that allow 'very accurate estimation of body composition and tissue distribution'. As the SAC website continues, 'It has been used most intensively to predict carcass tissue yields in sheep to accelerate improvements in carcass quality.'[3] Mid-infrared (MIR) spectrometry is also used, for example in the dairy industry to measure milk fat, protein and lactose concentration (Berry, 2008, p32). Overall, these are attempts to reduce uncertainty (and to improve profitability) through a combination of accuracy and speed, and like genomic sequencing promise to 'enlighten' the previously 'black-boxed' animal body. The use of imaging technologies in both animal and human reproduction arguably point to some similar processes. In spite of the advantages offered to women by such biopolitical technologies, it has also been argued that they marginalize a women's agency during pregnancy (Petchesky, 1987; Stabile, 1994, pp88–89), wherein various technological indicators are taken as the voice that scientifically matters. Similarly, the nonhuman animal becomes marginal to reproduction – what matters are the end products of meat, milk or eggs and the methods of scientific optimization. The capitalization potential, then, of animal genomics should be set in this wider technological focus and varied ways of 'mining' the interiority of farmed animal bodies.

Marxist political economists have written widely on the importance of the use and control of time to processes of capitalization (see, for example, Harvey, 1989; Jessop, 2006). Brennan has argued that one of the ways in which capitalist agriculture strives to produce surplus value is through speeding up the rate of reproduction (2000, pp118–120). The aforementioned Taylorist influence on US agricultural engineers is also indicative of the importance of such techniques to the industrialization of animal production. Just as non-genetic technologies are a part of a broader biopower relation with farmed animal bodies, they also play a role with the temporal control of feeding and breeding times through specific geographies of confinement and environmental control, including altered lighting and temperature to increase egg laying. For example, major egg producers Hy-Line International, in describing their 'efficient, high performing' 'product' range of egg layers, include a lighting programme as an integral part of their management guides.[4] The genetic influence on growth rate of an animal interacts with economically determined standards of slaughter weight and contractual arrangements between breeders and slaughterhouses. For example, in the pig breeding industry, slaughter weights vary by country and have risen over time. As long as they are not seen to interfere with meat quality or the physical capacity of on-farm housing facilities, then the move to an increased slaughter weight can be a source of profitability. The same applies if that slaughter weight can be achieved faster with a minimization of inputs including human labour time and animal feed. This is the same capitalization logic being pursued by Canadian company Aquabounty, mentioned earlier, who wish to commercialize their faster-growing GM AquAdvantage® salmon.[5] Molecular breeding

may work to attempt to intensify these temporal efficiency drives, to accelerate growth rates in this case. But speed here is inseparable from a notion of breeding accuracy. Genotypic 'information' distilled, it is hoped by the industry, will engender a greater mass of reproductive return – as in more muscular animals or the 'enhancement' of reproductive power itself, for example in larger litter sizes. A genetic test for the latter has already been commercialized and significant research focuses on the chromosomal whereabouts of genes linked to reproductive traits. Sequenced genomic 'information' is enabling animal scientists to conduct more accurate searches for 'economically relevant' QTL. For example, researchers on pig reproduction have localized genes purported to relate to ovulation rate, teat number, litter size and prenatal survival to chromosome 8 (King et al, 2003), while other research seeks to normalize pathological (meaning 'not economic') reproductive capacity such as investigating suspected QTL behind heritable inverted teat defect. In a starkly biologistic statement, the paper makes clear that 'the mothering ability of a sow largely depends on the shape and function of the mammary gland' (Jonas et al, 2008, p127). We might say that in biopolitics generally, across human–animal boundaries, parental ability is under scrutiny. Such 'pathology' is also a source more generally for capitalization, with considerable proportions of animal genomics research being conducted on disease resistance. Enhancing the productivity of animal bodies in this way also has the advantage of being classifiable under the more benign sounding 'health', or even 'welfare', in a way that research on growth rates or litter size cannot be.[6]

The nexus of speed, accuracy and efficiency is also reflected in animal science commentary around the potential of molecular breeding. Matthew Wheeler, a US researcher on, and advocate for, transgenic farmed animals, argues that:

> *Transgenics provides methods to introduce rapidly 'new' or modified genes and DNA fragments into livestock without crossbreeding … The use of these methodologies will have a great effect toward improving the efficiency of animal agriculture.* (2007, p204)

Wheeler is particularly interested in using transgenics for improving production traits such as extending growth rates and increasing meat, milk and egg quantities. Transgenics is envisaged as a way to yield yet more from the animal body, to transfer 'genetic value' around and between species. Max Rothschild and Graham Plastow, both pivotal advocates for the molecular turn, who have primarily been involved in pig genetics, argue that genomics has an important role to play in the 'livestock revolution' in the developing world. This constructs genomics as improving the efficiencies of production as well as indices such as feed efficiency – the ability of the animal body to subsist on less feed – considered increasingly important by the authors in light of resource competition between fodder and biofuel crops (2008, p23).

In relation to genomic selection, Goddard and Hayes argue that this can improve the accuracy of estimated breeding vales (EBVs). They predict that selecting animals based on genetic markers could replace the traditional costly and time-consuming method of progeny testing. Significantly, as the genomic EBV can be available at birth or even before, the technique will probably lead to the use of reproductive technology to decrease the generation interval (in other words the age of animal at first breeding) and so

increase the number of offspring (2007, p328). Such technologies, they envisage, could include juvenile embryo transfer (ET) involving the extraction of eggs (including the administration of follicle stimulating hormones) from 10–12-week-old calves and from 6–8-week-old lambs (see Armstrong et al, 1997). Even without such ET technology, it has been predicted for dairy cattle that genomic selection can reduce generation intervals of sires of bulls, sires of cows and dams of bulls to one year (Schaeffer, 2006). This biopower pertains to getting more from the animal body, altering again reproductive temporality, saving costs and increasing production. Already detailed projections of the capitalization potential available from genomic selection have been calculated (Schaeffer, 2006). The same paper summarizes that:

> *The potential advantages of a genome-wide selection scheme are too great to ignore. Genetic change can be two times greater than the current progeny testing schemes and the savings in logistical costs could be 92 per cent of today's costs. The company that adopts this strategy the earliest will have a major start over other companies.* (2006, p222)

These examples illustrate how the nexus of speed, accuracy and efficiency continues to be a guiding principle to the biopolitics and capitalization frames of animal science. This is not to convey that all animal scientists, or even animal geneticists, are as championing as these examples suggest. Certainly some of the UK scientists I interviewed were more circumspect, especially in relation to pushing the speed of selection and the over-focus on production traits. I will return to this theme in Chapter 8.

The second related strategy for capitalization I want to briefly set out here is the attempt to create and exploit forms of hybridity. In common with the first strategy, this is not novel to the molecular turn, but is arguably being biopolitically elaborated in new ways. Transgenesis potentially heralds a radically new ability to extract and recombine genetic material from different species that otherwise would not have become hybrid forms. This is the case in the direct use of transgenesis for agricultural production, but also in the out(re)sourcing of farmed animals (or parts thereof) to human medical applications, notably biopharmaceuticals and continued attempts to develop viable xenotransplantation. Moreover, it is also important to stem cell research, for example in the case of hybrid embryos using bovine ova or in the growth of human stem cell lines on a substrate of mouse cells. Since materiality, as we have seen, has been abstracted and generalized to the 'informational', we can also characterize comparative genomics databases as hybrid forms made useful. In seeking out new forms of capitalization, mammalian relationality forms a basis to the relevance of human genomic data to the work of *animal* scientists. New modes of genomic knowledge work by questioning the rigidity of species boundaries, exploiting shared genetic ancestry, and give rise to perhaps unlikely developments such as the utilization of the human genome in the scientific project of animal biopolitics for the production of meat.[7]

Some of these cases clearly draw on pre-established understandings of an instrumental value in regard to the lives of other animals, although some also resource the human, if not quite so thoroughly. Transgenesis may be seen as a risky attempt at capitalization precisely due to possible uses of human/animal hybridity. This can be seen as a transhumanist approach to hybridity, one which questions ontological separation

but not hierarchical orderings. If human–animal separateness has been culturally valued, if a prized definition of the 'human' over and above the 'animal' is taken for granted by many, then, as noted in Chapter 1, the proliferation of hybrid forms may be offensive to a certain form of humanism that is offended by the idea of animal 'contamination'. Michael has framed the social riskiness of hybrid forms somewhat differently (2001). In his argument, transgenics threatens to disrupt the historically constructed symbolic role of animals in human identity constitution. Here he taps into one of the key points made by scholars in animal studies: that representations of animals and animality are important to ideas of the 'human' as well as to particular intra-human conceptions of similarity and difference. Michael specifically argues that the symbolic power of other animals depends on their diversity and fluidity. He also argues that what he terms the 'technoscientific bespoking' of animals in transgenics threatens to compromise this symbolic resourcefulness of other animals. Effectively, our overdetermination of animals threatens to displace long-held assumptions of animals and animality that have been exploited in order to think the 'human'. He writes, 'Paradoxically, we find that the greater the apparent knowability of animals, then the greater the *unknowability* of ourselves' (2001, pp216–217, original emphasis). Michael goes on to argue that such compromise can engender anxiety in public response to animal biotechnologies. Hybridity may also be unsettling in the particular case of transgenic animals combining genetic material from more than one nonhuman species where one is more culturally valued than the other.

Whether or not attempts to capitalize on hybrid forms are risky in terms of a threat to cherished humanist categories, or through a threat to our tacit use of animals as symbolic resources for our sense of identity, one should undoubtedly leave open a space for both public indifference and ethical responses that *cannot* be reduced to expressions of bioethical disgust or sociological anxiety. In Michael's case it is anyhow arguably a positive development to reach the possibility of making manifest our complex 'symbolic exploitation' of animals, alongside our more obvious (yet still often spatially hidden) material exploitation.

The significant question to ask is whether the creative development of novel hybrid forms and the nexus of efficiency, speed and accuracy can actually give rise to new means of capitalization? For it may be that these modes of capitalization primarily work to deliver *short-term* profits only. This is the contention of Brennan's political economy, which she relates specifically to agriculture and speed. Although her account of transgenics stresses changes on the rate of reproduction rather than the more qualitative forms of capitalization also potentially possible, she argues that:

> *The price paid for speeding things up is a price paid by overall productivity, and hence overall long-term profit. There should be a decline in long-term profit to the extent that commodities embody less real substance, and this they must do as they become degraded of substance.* (2000, p120)

This is aptly applicable to several of the unintended consequences of selection decisions using quantitative genetics during the latter half of the 20th century, illustrated by production-related diseases or declining rates of dairy cattle fertility. (Brennan's description might also be an appropriate way to conceive of the contemporary energy

dilemma – how to move to a post-carbon economy, to produce energy sustainability without depleting the planet including ourselves). One may counter that in spite of the unintended consequences of genetic selection, the global 'livestock' industry has obviously been incredibly successful in capitalizing animal bodies. However, Brennan would presumably retort that this is only short-term, and that the longer-term ecological impacts of this are evidence enough of her theory. Animal science can be viewed as a struggle against animal bodies to solve this problem of substance and surplus, materiality and margin.[8] Advocates for the molecular turn believe that this is exactly where their techniques can prevail without the unintended consequences of previous genetic selection.

This problematic preoccupies much of the contemporary science studies analysis of the relationship between capitalism and biotechnology (Helmreich, 2008). Biotechnology is figured by its advocates potentially as the creative capitalist answer to previously assumed limits to growth, a new frontier of capitalization. In this approach the molecular turn ushers in a new era of potentiality, while previous means of selection and reproduction are denigrated. The perspective of traditional breeding methods 'being the problem' is captured well in Sarah Franklin's analysis of cloning (2007a,b). She builds on the historical work around animal breeding by Harriet Ritvo (1995). To reiterate from the previous chapter, Ritvo points to the development of sustained record-keeping and bio-statistics as vital for the emergence of human–farmed animal relations as a property relation expressed in the production of what she terms 'genetic capital'. Her analysis indicates that the promissory and biological aspects of capital can hardly be epochal terms for contemporary biotechnology. In describing the practices of the now famous UK breeder Robert Bakewell during the latter half of the 18th century, Ritvo describes the marked increase in rates of return he received for renting out prized rams to other farmers. Bakewell's success was down to his commodification of an animal's procreative ability, represented as 'a template for the continued production of animals of a special type' (Ritvo, 1995, p416). The biopoliticization of domestication being described here is arguably not only about capitalization. There is also perhaps a sense in which breeders were 'saving' animals from their own animality, reinventing them in the form of a human ideal of the controlled, perfectible body. Franklin relates Ritvo's analysis to contemporary biotechnology to consider how the birth of Dolly, the first cloned sheep, may represent a change in our understandings of genetic capital in at least two main ways. First, Franklin points out that the source of genetic capital is not Dolly herself but the nuclear transfer technology abstracted from her body, performed by scientists in order to demonstrate a potentially superior method of breeding, more reliable than Dolly's body (2007a, pp352–353). This parallels the aforementioned abstraction of genomic 'information' from animal bodies. Reproductive power is essentially usurped by science giving rise to new understandings of paternity (Franklin 2007a, p354), in which Dolly was essentially 'fathered' by human males. This conforms to a certain variety of feminist critique vis-à-vis the masculine appropriation of reproductive power which is applicable to both traditional and molecular breeding; and highlighted earlier in relation to imaging technologies. But in contrast to Ritvo's analysis of traditional breeding, the property relation of genetic capital is now more likely to be formalized through patents (more on which later). The second change to genetic capital, and this is more specific to cloning, is represented for Franklin in the novel genealogy of Dolly. Her capitalization

is via a decidedly non-linear relationality where 'her mother is genetically her sister, as are her offspring' (2007a, p353). This implies that the sort of speeding up attempts at capitalization described earlier do not encapsulate the full range of temporal disruption at play in the production of genetic capital. If transgenesis makes novel anthropogenic genomic change possible, the cloning of Dolly 'instantiates a new form of commodifying genealogy, *because she establishes a new form of genealogy altogether*' (Franklin, 2007a, p353, original emphasis). This could be said to capture well the transhumanist subtext of biotechnology. Capitalization speculates for opportunity through the refutation of previously naturalized evolutionary time and linear genealogy.[9]

The Knowledge Economy as Enabling Master Narrative

While the animal-inflected work of Ritvo (1995) and Franklin (2007a,b) helps refine our understanding of a notion of genetic capital and the material processes behind *expected* capitalization, we are perhaps no closer to knowing whether Brennan (2000) is correct to anticipate that the molecular turn can only be a short-term fix for capital, or whether it exactly bypasses such limits. Others have addressed more generally the biotechnological relation to life and capitalization (for example Cooper, 2007, 2008; Helmreich, 2007). Such work notes an enthusiastic expectant economic discourse of biological potentiality in both scientific and policy arenas, for example in US and EU strategic policy documents. In his work on marine biotechnology, Helmreich notes how 'a vision of the ocean as endlessly generative mimes and anchors a conception of biology as always overflowing with (re)productivity' (2007, p289). Relatedly, Thacker has noted the link between this emergent idea of materiality with alchemy and black magic, where 'information' secures the heady conversion of 'life' into 'property' (2003b). In her history of the relationship between capitalism and science under post-Fordism, Cooper has focused on what she terms the 'intense traffic of ideas between recent theoretical biology and neo-liberal rhetorics of economic growth' (2007, p28). She argues that both have been interested in questioning previous understandings of limits, and a notion of life as autopoietic or self-generational has begun to guide the promissory rhetoric of capitalist growth. She terms this rhetoric 'capitalist delirium' where there is an emphasis on refashioning the world rather than interpreting it (Cooper, 2008, p20). This is essentially another description of transhumanism. As Cooper (2008) notes, the intense interest in stem cell science (especially the idea of totipotency) and regenerative medicine appears to speak directly to a capitalist interest in creatively capitalizing on materiality in novel ways. There is an ongoing need for critical perspectives from the social sciences and elsewhere to question, rather than reinforce, this naturalization of the biological as both inherently productive and as a natural ally of capitalization projects (see Helmreich, 2007, p293; Tyfield, 2008). Although much of this debate has not taken place in relation to *animal* genomics, it is obvious that this promissory frame of biological 'super-fecundity' is similarly germane to capitalization hopes in animal agriculture and its medical offshoots. While it may be problematic from a political economy perspective, either in Brennan's (2000) sense above or in the Marxist interpretation that economic value arises from contingent, historically specific social relations rather than the immanent, eternal qualities of things (Jessop, 2007, p119), it is also multiply questionable from ethical viewpoints that I explore in more detail in the next two chapters.

Cooper's work locates such ideas within, for example, policy goals of the Organisation for Economic Co-operation and Development (OECD), who, like the EU, have enthusiastically adopted the idea of the knowledge based bio-economy (KBBE) that I briefly outlined in Chapter 4.[10] Although it is exactly the point of Foucauldian theories of biopower to underline a long-standing relationship between the biological and the emergence of capitalism, the more recent KBBE discourse appears to present this relationship as something novel, and as especially tied to a new promise of capitalization arising from the biosciences. The European Commission is actively promoting this idea on a number of levels. These include the formation of new European Technology Platforms[11] (essentially vision documents on an array of technologies scoping their future over the next 20 years); the inclusion of the bioeconomy in the new Framework 7 Funding Programme; an Environmental Technology Action Plan (ETAP); and a Biofuels Directives and Biomass Action Plan. Birch has shown how in the UK case this discourse has permeated national and regional investment (2006, p6), illustrated, for example, in the 2002 formation of six genetics knowledge parks in England and Wales. Yet this discourse is certainly transcontinental. It is used in the US,[12] China saw the first international conference on the bioeconomy in 2005 and the OECD (2009) has recently produced an economic roadmap for the bioeconomy up to 2030. In the earlier scoping paper, the OECD defined the bioeconomy as:

> *the aggregate set of economic operations in a society that uses the latent value incumbent in biological products and processes to capture new growth and welfare benefits for citizens and nations … made possible by the recent and continuing surge in the scientific knowledge and technical competences that can be directed to harness biological processes for practical applications.* (2006, p1)

In this quote there is something familiarly utopian in its vision of progress. While once we may have cast robots as the 'free labour' of the future, we now see this repeated in the form of the human-enhanced biological process itself. The deployment of the discourse of 'bioeconomy' by the OECD and other significant economic policymakers such as the EU provides an outlet for a particular master narrative that positions biotechnology as a significant solution to both myriad global problems and the perpetuation of economic growth. The OECD 2009 report 'The bioeconomy to 2030 – Designing a policy agenda'[13] is tellingly adorned with the familiar iconography of a double helix. It speaks of the opportunity for biotechnology to usher in a new bioeconomy while at the same time cautioning that barriers remain to its realization. These barriers are conceptualized as in the main regulatory and social. Significantly the report calls for OECD countries to encourage the application of agricultural biotechnology and to address the lack of funding in this sector (2009, p6). In projecting which animal biotechnologies have a 'high probability' of reaching the market by 2030, the report includes animal cloning (although not GM animals for food consumption). Such examples indicate that animal biotechnology is seen as an important part of a proposed knowledge (bio)economy, while at the same time arguably emphasizing the fragility of the trajectory. These developments are on the one hand presented as inevitable, on the other as concurrently under threat, precarious and in need of supportive policies.

I want to return to the notion of the fragility of the knowledge economy at the end of this chapter. Meanwhile I focus on certain ways in which it is already enabling forms of capitalization around animal biotechnology. Although my focus has been agricultural (including agricultural/medical hybridity), it would be remiss at this point not to briefly mention the entrance of GM animals into biomedical economies. Genetically modified rodent populations are now routinely bred and sold via catalogues to research institutes and pharmaceutical companies, and, as we saw in Chapter 1, in the UK case this has been the basis for the recent annual increases in experimentation statistics. For example, the France-based company Genoway sell knock-in and knock-out transgenic mice and rats to 60 biopharmaceutical companies and act as a partner in several EU 7th framework projects. Genoway's revenue increased by 61 per cent between 2006 and 2007, from €4.6 million to €7.4 million. Of this 2007 figure, €4.8 million was directly as a result of the sale of GM animal models and strategic alliances with biopharmaceutical companies.[14] Although in this sector there is as yet a lack of tangible medical breakthroughs lower down the supply chain, significant revenue is being produced.

Returning to the agricultural sector, we can note several forms of capitalization that relate to the activities of livestock genetics companies. This is inclusive of their networking with external scientists and the academic sphere that has been encouraged by, for example, national and EU funding research regimes associated with the nascent knowledge economy. In the process of this section, I rejoin the view I expressed in the previous chapter of a particular role for the social sciences in acting against the sequestration of networks of science and commerce in animal breeding. Here social science can have a civic role to help a broader public adequately scrutinize novel configurations of food production, science, technology and the economy. In this vein I am informed by Cesagen colleagues who have coined the term 'sociomics' – essentially the attempt to develop digital methods for the social and economic analysis of the biosciences.[15] Although at an early stage, it is clear that such an approach can also have a real benefit for social science research on networks involved in animal biotechnology. For example, one can approach the unearthing of these relationships by searching company websites, industry pages and patent search engines. Additionally, a tool such as Google Scholar[16] is invaluable for tracing the latest published animal science research. However, there is a clear lack of social science endeavour in this area, something which ought to be addressed. These sorts of digital methods will prove to be increasingly valuable in mapping collaborative networks across the private–public spheres, in ascertaining current research and in outlining novel means of capitalization catalysed by the molecular turn in the context of the knowledge economy narrative. Thinking through these novel means proves to be useful for mapping some of these aforementioned relationships and emergent corporate actors.

The first capitalization approach I wish to outline is that of DNA or breed verification. This technology has been commercialized by at least two significant companies keen to gain market position in various applications of animal biotechnology, namely Viagen and Metamorphix Inc (including their wholly owned subsidiary MMI Genomics). Verification is essentially the commercialization of various genetic tests that claim to scientifically establish and validate an animal's breed. Viagen we have already encountered as the most well-known animal cloning company during the discussion of regulation in Chapter 4. But Viagen is a diverse company interested in equine, porcine

as well as bovine cloning, and also in the DNA/breed verification business. Through its 2008 merger with Start Licensing, Viagen acquired a broader sweep of intellectual property rights to reproductive technology, including the original Roslin Institute Dolly patents. As a Viagen press release points out, due to the use of nuclear transfer technology in applications including therapeutic protein production, xenotransplantation and biomedical animal modelling, the company has significantly broadened its potential portfolio.[17] Breed verification technology is driven by corporate interest in meat quality and regulatory interest in biosecurity and traceability. In late 2004 Viagen signed an agreement with the large US Angus beef company, Premium Gold Angus Beef (PGAB). In this relationship Viagen applies its AnguSure™ DNA verification process to hair and post-slaughter carcass samples provided by PGAB. As it turns out, when farm animals are genotyped they can vary quite considerably in the degree to which they conform to a breed genetic standard. This is perhaps unsurprising given that a breed is in an important sense an anthropogenic construct. In preliminary tests of other Angus cattle, no animal attained 100 per cent, some failed the test and many were 'only a certain percentage Angus'. To pass the test, meat had to have at least 50 per cent of its genetics in common with top-registered Angus animals.[18] The verification that Viagen offers is especially attractive to PGAB as they market a particular high-premium Angus cattle that is supposed to be renowned for taste and tenderness. The certification is 'understood' to enhance the authenticity of the brand. DNA verification in this economic exchange begins to be normalized as a part of meat standards and quality-assurance programmes. A label proclaiming verification by AnguSure™ now appears on PGAB beef (in stark contrast to the manner in which American advocates of GM or cloned meat have argued *against* labelling). In late 2005 the USDA approved Viagen's AnguSure™ process, thereby bestowing the company with further market potential to deploy the test. By searching patent databases[19] it is possible to locate the IPR behind the AnguSure™ process. Patent (US6770437B1) 'Method for assigning an individual to a population of origin based on multi-locus genotypes' is essentially a statistical test to ascertain the likelihood that a given animal is a descendent of a particular population based on the occurrence of certain alleles. Echoing the suspicion of vernacular modes of classification (Holloway, 2005) characteristic of non-molecular techniques, DNA verification performs the 'proof of the breed' which producers can deploy to add value to their brand. Even though the first Angus herd book came into existence in 1862, the 21st century DNA verification process attempts to intensify the concept of breed as natural and timeless even as it reveals its partiality. The corporate relations here are an attempt to confer and construct enhanced genetic capital out of the novel opportunities of the knowledge economy.

MMI Genomics, wholly owned by Metamorphix Inc, also provides a range of DNA verification services. An interesting commonality between MMI Genomics and Viagen is that they market technologies to both farmed and companion animals. It might be said that capitalization knows no boundary between the marked ambivalence and inconsistency that we usually exercise between these two socially categorized groups of animals. While Viagen will gene-bank biopsy samples from companion animals for $1500, they no longer offer their cloning service. But MMI's interest in the companion animals market is precisely in DNA verification technology. Their Canine Heritage Breed Test retails for $99.95 and is sold in acutely affective (not instrumental) terms of deepening the human–animal bond. As their dedicated website explains:

> *Like you, many of our customers feel a special connection to their pet. Along with providing a safe and nurturing environment, pet parents are interested in finding out as much as they can about their 'best friend'. The Canine Heritage® Breed Test can help them unravel the mystery and help families feel closer to their pets. The test will cross reference your dog's DNA with the over 100 breeds in our database and let you know the breeds that make up your pet.*[20]

This discourse is more akin to the familiar companion animal manner of speaking about human–animal relations. Although the test offers to genetically mine companion animals, the website speaks more to a 'minding animals' (in Bekoff's terms) relationality, which is quite curious given that the main business of Metamorphix Inc is in the capitalization of instrumentalized human–farmed animal relations.[21] MMI itself offers DNA verification to the cattle industry, but Metamorphix Inc as a whole has a varied portfolio in the livestock industry, as we shall see below.

If the technology of DNA verification here proves useful for an initial indication of the multi-species and multi-technological foci of animal biotechnology companies as well as evidence of an initial means of capitalization, a significantly larger picture of the recent activity of livestock breeding companies has been provided by the work of Gura (2007, 2008, 2009). Her research into livestock breeding companies has made a considerable contribution to the task of outlining emergent corporate relationships and points to a significant degree of vertical and horizontal integration in recent years.

If we consider vertical integration first, the process whereby different stages of the production process are brought under common ownership, we can note the involvement of major global food players with breeding. This takes place either directly through acquisition, through licence agreements with breeding companies or through buying a share of the company. Gura provides some examples: Tyson Foods, the world's largest processor of chicken and red meat, was one of the first to appreciate the strategic importance of breeding with its 1994 acquisition of Cobb-Vantress,[22] now the world's third largest supplier of breeding stock for broilers. Smithfield, which is the largest US pig producer and has expanded into Eastern Europe and elsewhere, has since 2006 had a share in the UK-based pig-breeding company ACMC (2008, pp4–5). Metamorphix Inc, due in part to their 2002 acquisition of Craig Venter's Celera genome company and so their proprietary data relating to the human, bovine, porcine and chicken genomes, found themselves in a much sought-after position. Gura refers to them as 'a spider in the livestock genomics web' (2007, p27), since they now have contracts with Monsanto (pigs), Cargill (cattle), Hubbard (poultry) and Willmar (poultry).

Horizontal integration – animal breeding companies acquiring other breeding companies – has also been an important recent feature of this global corporate sector. The concentration of the market has seen the creation of large cross-species livestock breeding companies (Gura, 2008, 2009). Between 2005 and 2008, four such companies were formed through acquisitions (Gura, 2009). In 2005 the UK-based Genus plc acquired the Pig Improvement Company (PIC), thus becoming the world's largest livestock genetics company with specialization and significant market share in both cattle and pig breeding. In 2007 and 2008 Dutch-based Hendrix Genetics, already a market leader in brown layer chickens, diversified into broiler, pig and turkey breeding via acquisitions of Nutreco's breeding operations in these species: Hybro (broiler), Hypor

(pig) and Hybrid (turkey). In 2008 the French Groupe Grimaud, already a multi-species poultry specialist supplying customers in more than 100 countries, founded the Pig Genetics Development Company and bought a share of Newsham Choice Genetics' pig business. Newsham had itself acquired Monsanto's pig genetics company in 2007. Also in 2008 EW Group, the German-based world leader in poultry genetics, acquired leading salmon breeder Aquagen.

These acquisitions have undoubtedly taken place for various reasons. They increase the scope for capitalization through increased market share, they safeguard a company in case of a species-specific food scare and they offer new opportunities in terms of expansion. The majority of livestock genetics companies are significantly transnational. Noteworthy here are the moves of poultry genetics companies into pig genetics, given the global growth of pig production, especially in emergent markets such as China. For example, Hypor, the pig breeding subsidiary of Hendrix Genetics, has been exporting breeding pigs to China since 2003 and entered into joint-venture agreements with two major Chinese agribusiness companies in 2006.[23] As part of this venture, 816 breeding pigs were flown from Canada to Qingdao, Shandong Province, during 2008.[24] Hypor, it seems, is pushing Genus plc/PIC hard in competing over the Chinese market, with the latter also announcing in 2009 an intensification of Chinese operations. Genus plc has contracted to lease production nucleus capacity in Liaoning Province. As a press release states:

> *The new production nucleus farm is expected to commence activities in October 2010 and when completed Genus will have established sufficient production capacity to enable its customers to breed an estimated 17 million pigs per year in China. This represents almost twice the whole UK output for pigs.*[25]

Genus plc/PIC is also notable for the introduction of a royalty model in its business practice. The company is trying to lessen the quantity of direct animal sales it is involved in, especially within its more developed markets, and move to selling genetics on which it then charges a royalty. This particular means of capitalization of genetic knowledge is favoured as it gives the company a certain stability of income. Breeding animals are sold for a lower price but with a royalty attached to any progeny they produce. The model carries a higher margin as the breeder continues to produce from this genotype.[26] Gura has criticized the royalty model as one that could transfer risk from the company down to the farmer (2008, p6).

As well as new market opportunities, it is arguably the case that especially the horizontal integration outlined by Gura is also bound up in anticipated technological opportunities related to the molecular turn. The extent to which the range of companies outlined by Gura are actively involved in developing molecular breeding techniques is a crucial question to probe but a difficult one to accurately answer. The competitiveness of companies trying to secure market dominance ensures that such information is not necessarily simple or straightforward to obtain. However, it is obvious that no major livestock breeding company is either ignorant of or uninvolved in strategizing, researching or actively deploying such techniques. A certain amount of information can be gleaned from aforementioned digital methods. Company websites, annual financial reports, press releases and patent databases are especially useful here. Although we

have already seen that salmon farming is potentially the closest to market in terms of GM animals, there is certainly also experimental research on the genetic modification of other agricultural animals in case the regulatory environment improves for their commercialization in the future. Perhaps the best place to track such research down is via patent databases. However, this is also imperfect, since not all experimental research is necessarily going to culminate in intellectual property applications. Furthermore, if research related to breeding GM animals is located in such databases, it is not necessarily linkable to a specific breeding company. Although submitting a patent may serve a protective role, it also alerts competitors to one's potential marketing strategy. Animal scientists are also ambivalent about the practice of patenting, as I shall turn to shortly.

Livestock Genetics Companies and the Molecular Turn

It is useful at this point to review as adequately as possible the involvement of livestock genetics companies in developing molecular breeding.[27] To recap, within this I include cloning, genetic modification, genomic selection and marker-assisted selection. To begin with cloning and GM, it becomes clear that often research into both these techniques has been undertaken by the same companies or scientists. Moreover, cloning and GM research transcends medical–agricultural boundaries, with companies and scientists working across these and transferring knowledge between the two. As we have seen, Texas-based Viagen has been the obvious and most audacious player in agricultural animal cloning. In 2007 they partnered with Iowa's Trans Ova Genetics to form Bovance, a new US company offering cloning services to the cattle industry. Clearly this initiative is contingent on regulatory approval for the use of cloned animals as breeding stock. It is common for scientists working in animal biotechnology to hold faculty positions as well as to have involvements in the corporate sector. This mirrors the biotechnology industry generally, with the narrowing of the gap between the private and academic spheres, as well as its encouragement by national governments within the transnational knowledge economy. For example, cloning scientist Steven Stice holds a significant patent portfolio that illustrates previous affiliations to the University of Massachusetts and his work for the company Advanced Cell Technology. Stice's achievements include producing the world's first cloned rabbit (in 1989), the first cloned transgenic calf (1998), the first chimeric transgenic calves (1998) and the first chimeric transgenic pig (1998). He now has his own laboratory at the University of Georgia, specializing in human stem cells, animal cloning and genetic engineering. In common with other animal cloning pioneers of the 1990s, such as those working at the Roslin Institute, Stice has in the main become interested in animal cloning as a model for theorizing human medical applications. However, his Georgia lab still retains an interest in agricultural applications, illustrating again the way in which animal scientists do not frame the agricultural and medical as separate. Another pioneering scientist, who worked with Stice, is James Robl. He has also been an important figure in animal cloning and genetic modification and like Stice was originally based at the University of Massachusetts, before cofounding the company Hematech. This company brings animal biotechnology into the arena of bioterrorism. Specifically it is developing genetically modified cattle that can produce polyclonal antibodies to act as drugs for defence against biological warfare. Although at first glance this appears like another medical use of animal biotechnology, Hematech has since

2003 been involved in a joint venture with the aforementioned Trans Ova Genetics, who supply their bespoke cattle. Trans Ova Genetics is thus located to profit from both agricultural and medical applications in the molecular turn of animal breeding.

This constitutes some of the corporate and animal science intersections around cloning and GM, but the majority of current activity among livestock genetics companies is not surprisingly with marker-assisted selection (MAS) and genomic selection. A good example of uptake in marker-assisted selection is to be found from the aforementioned Genus plc/PIC. The Pig Improvement Company has a portfolio of 39 patents,[28] many of which are related to genetic markers. Patent databases reveal a long-standing relationship between the company and the Department of Animal Science at Iowa State University. Genus plc/PIC has been able to call on the work of leading scientists in porcine genomics such as Max Rothschild, Graham Plastow and Christopher Tuggle. Metamorphix Inc/MMI Genomics, through their relationship with Cargill, have also developed a portfolio of MAS patents. Formerly of University of Arizona, Sue DeNise, who specializes in beef and dairy cattle genetics, joined Metamorphix in 2002 and provides a good example of an animal scientist who has moved from academia to industry, now herself involved in research and named as inventor on many of the company's patents. Other companies with patents related to MAS include Dansire (cattle), Lohmann Tierzucht, a subsidiary of E-W Group (poultry) and Newsham Choice Genetics (pigs). This last example of NCG pertains to arguably the most high-profile and controversial patent application in farm animal genomics. Before Monsanto sold their interest in pig breeding to the renamed NCG in 2007, this controversy was known as the 'Monsanto pig patent'. This regarded the 2005 patent application (EP 1651777 B1) entitled 'Use single nucleotide polymorphism in the coding region of the porcine leptin receptor gene to enhance pork production'. This application received opposition from both Greenpeace and European farmers, since it appeared to seek to patent genetics that, according to Greenpeace, already existed in all European pig breeds. Thus there were fears that Monsanto was involved in an interpretation of the novelty of their patent application that could have left many farmers having to pay royalties for subsequent breeding from animals with this particular genotype. The European Patent Office (EPO) granted the patent in July 2008 but reduced the scope of the claim so that it related only to the firm's scientific method, but not the pig itself, the gene sequence or the kit used for selection.[29] Indeed the patent now contains only 12 claims, none of which refer to the progeny of animals. The EPO clarified that in Europe a company can patent an animal only if it is transgenic. Gene sequences can be patented only if they have an industrial application and only if they have not been made public before. In spite of the reduction of this patent's scope, there remains opposition to it, and to the patenting of life generally. The case illustrates the possibility that distinct MAS methods may be patented and royalties obtained from subsequent progeny. The ambiguity stems, at least in the EU case, over how to interpret Article 8 (2) of the 1998 EU Biotechnology Directive 98/44/EC on the legal protection of biotechnological inventions (Tvedt and Finckenhagen, 2008). This directive can be read as a struggle over how to cope with patenting life, since lifeforms are, unlike the bulk of products patented, self-reproducing. Article 8 (2) states that:

> *The protection conferred by a patent on a process that enables a biological material to be produced possessing specific characteristics as a result of the*

> *invention shall extend to biological material directly obtained through that process and to any other biological material derived from the directly obtained biological material through propagation or multiplication in an identical or divergent form and possessing those same characteristics.* (European Union Biotechnology Directive, 1998, p7)

This implies that in the case of process patents such as the Monsanto example, protection will indeed broaden out to include progeny and thus in theory cause a conflict between corporations and farmers over the ownership of animals as property. Here the property status of animals obviously remains naturalized, but there are intimations that corporations may try and capture property and capital from those further down the chain. Yet trying to shape breeding animals into regulations and standards not intended for self-reproducing lifeforms raises various kinds of uncertainty. First, there may be questions over whether patent claims on animal reproduction adequately satisfy general patent criteria to be new, inventive, and useful or industrially applicable. This is the step by which scientists in effect argue that they supplant the animal's agency with their own scientific inventiveness. Moreover, for MAS or genomic selection, this is where a case has to be made that it is new and different to selective breeding, even if in other contexts a scientific argument for the non-newness of these techniques is a part of their naturalization. Tvedt and Finckenhagen (2008) have raised three other forms of uncertainty around such animal breeding patents. These are to ask just how many generations of progeny might patent protection be extended to, what happens to ownership if a patented animal were to breed with a non-patented animal and how might the occurrence of natural genetic mutation in progeny confuse patent rights. At a time when patent applications around animal breeding are on the increase, there is clearly a degree of confusion that will probably only be resolved by individual challenges and legal cases (Tvedt and Finckenhagen, 2008). There is further uncertainty among the global community of animal scientists as to whether patenting in this area ought to be encouraged. Certainly those of an entrepreneurial persuasion with links to livestock genetics companies have argued favourably for patent protection and stated that patents have assisted technology transfer in the livestock industry (Rothschild et al, 2004). However, other animal scientists reflect on their work as being in the service of farmers and are more suspicious of the power that patent protection may grant the corporate sphere. Additionally, there are collegial and scientific norms of knowledge sharing that do not necessarily sit easily with the potential normalization of patenting. Thus in a recent editorial in the *Journal of Animal Breeding and Genetics*, it was argued that 'without intellectual property, we can continue to share ideas, to invest in data collection and to make even faster progress' (VanRaden, 2009, p91).

A further high-profile patent case was the so-called 1999 'Edinburgh patent' (EP 0695351). This concerned the patenting of animal transgenic stem cells. But since in scientific English, the term 'animal' covers not just animals but also human beings, there were concerns that the patent could cover the cloning of human beings. This controversy highlighted public anxiety over human instrumentalization, but illustrated also the naturalization of that of nonhuman animals. It is noteworthy that both this and the Monsanto patent were largely objected to on humanist grounds.

Although genomic selection is a more recent breeding technology than MAS, it is already attracting interest from breeding companies. The first commercial use of genomic selection was announced in late 2006 by Hybro, the broiler subsidiary of Hendrix Genetics.[30] Metamorphix/MMI Genomics are also in the process of exploiting whole genome selection via their relationships with both Cargill[31] (cattle) and Hubbard/Groupe Grimaud[32] (chickens). Metamorphix/MMI has developed their GENIUS-*Whole Genome System*™ to analyse dense SNP marker maps of both species. They will then receive a royalty stream from any new selection lines. All three major egg and broiler subsidiaries of the E-W Group – Aviagen, Lohmann Tierzucht and Hy-Line – are collaborating to implement genomic selection in their respective breeding programmes.[33] Genomic selection is also of interest to the dairy industry, with Australian company Innovative Dairy Products (who also work with New Zealand's Livestock Improvement Corporation) recently being granted a patent (WO2008025093A1)[34] entitled 'Whole genome-based genetic evaluation and selection process', comprising a method and system for the prediction of the merit of at least one individual in a population. Given the efficiency arguments already discussed around genomic selection (Schaeffer, 2006), it is not surprising the speed at which companies have acted in an attempt to gain a leading market position.

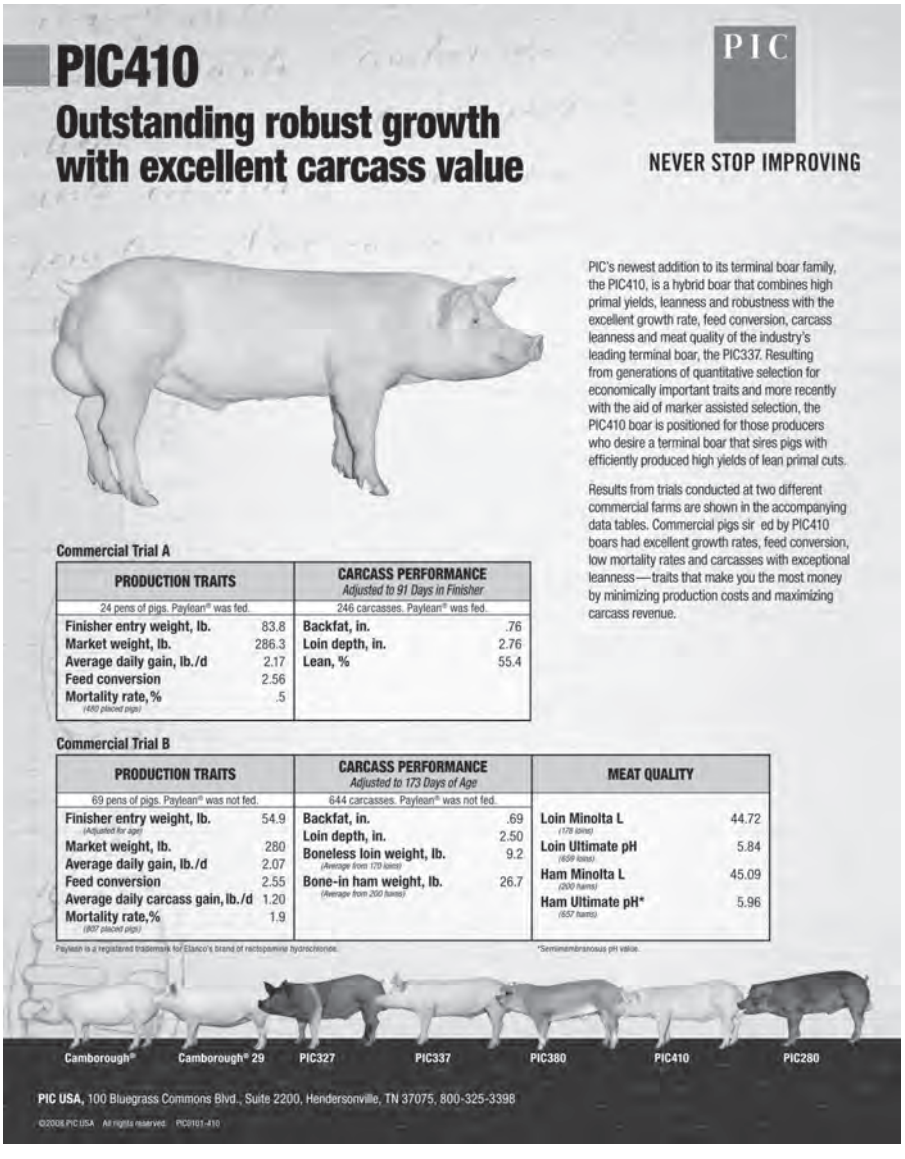
Corporate websites are a useful source from which to glean information about the readiness of livestock genetics companies to implement molecular techniques, but more than this they communicate a sense of the reduction of farmed animals to consumer goods with associated complex lists of technical specifications. In fact there is certainly uniformity between these corporate websites. Many have a link to their 'product' ranges, where customers can check the latest specification of new breeding lines on offer. This is very akin to going online and checking the specification list on the latest digital camera or laptop. Advertising of specific animals lines – these are standardized product ranges, not specific individual animals as such – is assisted by their naming into recognizable brands. These again illustrate the commercialization of MAS such as the 'PIC410', a 'hybrid boar that combines high primal yields, leanness and robustness with the excellent growth rate, feed conversion, carcass leanness and meat quality of the industry's leading terminal boar, the "PIC337"'.[35]

The figure opposite shows the product information for the PIC410, including quite typical information pertaining to performance and quality. It is also worth noting that during one trial pigs were also fed Paylean® – Elanco's brand of ractopamine hydrochloride, a drug used to promote leanness in pigs. Elanco are part of Eli Lilly and Company, a significant global pharmaceutical company (10th largest by sales in 2008), known for marketing Prozac and Cialis. Again we see capitalization transgressing distinctions of human–animal and medical–agricultural, as well as a further example of biopolitics beyond the genetic. Newsham Choice Genetics have also similarly marketed product lines such as the 'EBX® terminal sire'[36] and the 'SuperMom™ maternal line', the latter with the following promotional description:

> *Newsham took maternal genetics to a higher level when they developed SuperMom, designed to enter your breeding herd, yield large litters, support them through weaning, and remain in your breeding herd for the long haul. Healthy and robust, SuperMom provides you with lower involuntary cull and*

death rates. Not only does she produce more pigs, but SuperMom has the milk production that allows her to wean vigorous pigs – giving them the edge they need for healthy average daily gain and feed efficiency.[37]

This is uncanny discourse in a sense, because it combines instrumental language related to profitability, efficiency and death with the subjectification of SuperMom™ as a 'she'.



Source: PIC

Product information for the PIC410

This is repeated in similar fashion on the company website of ACMC when describing their 'Meidam DL GP', part of their Dam Line female 'range'. This is presumably both a pun on 'madam' and 'meisham', the breed of pig from which she is derived. She is described as:

> *The perfect mother. The only one of its kind. The mother of all mothers – as she is prolific and gentle. She is selected to have more teats at Great Grand Parent level and has an abundance of milk to rear her young. Ideally suited to any breeding system whether for in- or outdoor production.*[38]

Elsewhere on the ACMC website, she is described as being more docile and having a calm maternal temperament. These examples illustrate how the commodification of the animal takes place via an intersection with the commodification of a particular construction of the feminine, of generative 'maternal value', which acts as a currency with which to communicate desirable values to customers. Yet the subjectification at play remains uncanny due to the fate of such 'products' in mass industrialized production and slaughter.

In summary, this review provides good evidence from a number of sources that livestock genetics companies have positioned themselves to exploit developments in the molecular turn. This provides a beginning to a sociological project to map and analyse the way in which a notion of the knowledge economy is providing a conduit for varied corporate attempts to capitalize on the molecular turn. However, further research will be required. Here, as in other areas of the knowledge economy, animal biotechnology is successfully promoted via the 'triple helix' of university–industry–government relations (Etzkowitz and Leydesdorff, 1997). One of the key elements noted in the development of the knowledge economy is the narrowing of public–private distinctions, for example in the changing role of the university, increasingly expected to have more economic impact or in the use of public–private funding initiatives. In the UK, for example, there has recently been a significant debate about the further institutionalization of the economic function of the university (see, for example, RCUK, 2007). The differences in perspective among animal scientists on the issue of patenting mentioned previously can be seen in terms of what Jessop refers to as a contradiction between knowledge as an intellectual commons and knowledge as intellectual property. Inasmuch as biotechnology represents a new capitalist accumulation project as part of a broader knowledge economy, the private sphere gradually encloses around previously non-commodified spaces and knowledge such as indigenous or tribal knowledge (Jessop, 2007, p126), but also as I argue here knowledge of nonhuman animal genomes. The corporate exploitation of academic labour and public funding can be seen as further cases of the same process. This is not to suggest that innovation emanating from publicly funded academia could somehow be hermetically sealed off from exploitation, but that the rationale of such work when guided by corporate interests may suffer from a lack of public accountability or not necessarily be in the broader societal or ecological interest. This is one of Gura's points of concern in her research on livestock genetics companies (2007). While Chapter 4 noted some of the corporate involvement in the regulatory sphere, here we can underline the part-public funding of private interests. Gura is critical of the way in which the European Commission has invited industry-led

stakeholder groups to advise on EU funding policy on animal genomics, arguing that they have successfully convinced the EU administration that a threat of US dominance in this sector necessitated redress (Gura, 2007, p22). We can also note national-level partnerships between states and livestock genetics companies. For example, in 2008 Cobb Vantress announced a four-year, US$10 million poultry genome research programme with partners Hendrix Genetics and the USDA. Of this the USDA contribute $2.5 million.[39] Hendrix Genetics also benefited from €700,000 from the Dutch Ministry of Economic Affairs in 2007.[40] All major sequencing projects have also received a significant degree of public funding. The chicken genome was funded by the US National Human Genome Research Institute (NHGRI), one of the National Institutes of Health (NIH). The sequencing and analysis of the bovine genome was funded by the USDA and the NHGRI. The International Swine Genome Sequencing Consortium (SGSC) involves academic, industry and governmental members. It has 13 different funders including the USDA, the EC, the UK Wellcome Trust Sanger Institute, and others from the US, France, The Netherlands, South Korea and Japan. The merging of public and private embodied in these networks and consortia are testament to the ability of corporate interests to co-opt public funds and state support for a particular narrative of progress. Moreover, they speak to globalization debates over the power of individual states vis-à-vis that of large transnational (food) companies such as Tyson and Smithfield.

We have, then, an emergent, we might say, 'utopia' around the capitalization of the molecular turn. However, it can be argued that this capitalization can only be dreamt of by the forgetting of conveniently externalized factors. Just as the reinvention of animals as biotechnology is predominantly blind to the moral re-evaluation of human–animal relations amplified most recently in the period since the 1970s, the knowledge economy operates through exclusion in order to preserve the brazen certainty of its narrative. In a recent creative analysis of the knowledge economy, Kenway et al (2006) argue that it is haunted by alternative economies which if taken seriously would serve to undermine its confidence and represent it as fragile. They list these as the risk, gift, libidinal and survival economies. The risk economy undermines blind faith in economic growth and the conflation of knowledge with control; the gift economy foregrounds the relationship between knowledge and reciprocity; the libidinal economy questions the domestication of imaginative, critical knowledge; and the survival economy introduces crucial questions around cultural and natural diversity and the relationship between economy and ecology (Kenway et al, 2006, pp121–122). Within all these haunting counter-narratives, animals and their virtual molecular selves also roam. Indeed our treatment of other animals is already the perfect spectre to ideas of the 'human' as civilized and rational. Human relations to farmed animals in the molecular vision of the 21st-century knowledge economy are neither post-industrial, immaterial, weightless nor bloodless. The following two chapters aim to recuperate the externalized consequences of capitalization in a molecular turn that is premised on various forecasts of farming more animals than ever before.

Part III

Capturing Sustainability in the Genome

The relatively recent emergence of climate change as a political actor is arguably the biggest threat to the capitalization hopes outlined in Part II. Climate change discourse brings into relief and makes more obvious and culturally amplified the intersection between our relations with other animals and how they are enmeshed with human and ecological flourishing. That the global livestock industry is failing on various measures of sustainability has not gone unnoticed by animal scientists. In this third and final section of the book, I characterize the ways in which animal scientists are drawing on molecular techniques as an attempt to respond to these failings. First, I note some of the ways in which the language of sustainability has become an organizing frame for animal science. Second, I note attempts to produce animals as biotechnology that are healthier for human consumption and more ecologically benign and respond to some of the ethical questioning of animal breeding.

This orientation gives animal science an affinity with ideas of a green capitalism that is not so much about challenging patterns of consumption as a means towards sustainability, but about promoting the notion of a more technologically efficient adherence to what is regarded as sustainable growth. This is demonstrated in the way the idea of the 'livestock revolution', a forecasted significant increase in meat production and consumption between now and 2050, acts as a guiding principle for animal biotechnology. Such a scenario is suggestive of an animal science that conflicts with other areas of science, notably climate change science, public health and animal welfare science. A key question here is whether the claims of animal biotechnology advocates stand up to scrutiny. Furthermore, what alternative solutions might deserve a voice at

the policy table? Is it really viable to challenge climate change without questioning the anthropocentric values that underline its emergence?

In the final chapter, I consider an alternative to the biotechnological imagining of sustainability that dovetails with recent critiques of economic growth and underlines the importance of changing dominant patterns of consumption. Such challenges to deeply embedded practices of production and consumption cannot be divorced from debates around need and more fundamentally around the meanings of the 'human'. I explore the role of human–animal relations in achieving new forms of social practice that make a real contribution to sustainability in a broad more-than-human sense.

7

Mobilizing the Promise of Sustainability

A commonality shared by many of those writing from science studies perspectives – especially sociology, political economy and anthropology – on genomics and the biosciences is an interest in the notion of promise. The conceptions of biocapital discussed in the previous chapter posit the practices of genomics, its rationale and communication, as promissory knowledge claims. As the science of genomics is worked through and presented, it is inseparable from this promissory context. This way of thinking about a 'promising' technology – the word switches from adjective to verb – opens up a critical space to think about the fragility of scientific knowledge claims embedded within social, economic and political contexts. This chapter pursues the notion of promise in relation to farm animal genomics, focusing on the positioning of such sciences through a discourse of sustainability. Farm animal genomics is not alone among contemporary biosciences in this positioning – others include marine biotechnology (Helmreich, 2007), GM crops and synthetic biology.[1] Two initial points can be made. First, it is important to probe any mobilization of 'sustainability', given its nebulous and contested history. And second, it can be argued that such a positioning in the case of farm animal genomics has become precarious given the increasingly publicized link between global livestock production and climate change.

As many animal studies scholars have highlighted when discussing human–animal relations, our primary means of interacting with other animals is through transforming them into food or clothing. Our main relationship is with the consumption of dead animals, re-enacted daily in what seem like mundane actions – eating, dressing and walking. The obviousness of this is worth restating precisely because one thing promissory technoscientific discourse attempts to do is control the future and it is important to be attentive to whether our most significant (numerically at least) means of relating to other animals will be contested or perpetuated by the strategies of biotechnological intervention in animal breeding. What intimations, then, of future human–animal relations may reside in such promises? What assumptions may they make and what of their normative baggage? Following Sarah Franklin's concept of 'ethical biocapital', I argue below that the promissory terrain of farm animal genomics is anticipatory towards incorporating imagined social and ethical critiques into the very 'culture medium for

creating new life forms' (2003, p99) as a response to the critical discourse of animal studies and the much broader cultural questioning of animal production.

Biotechnologies as 'Promising' Practices

Fortun argues that genomics must be examined through the notion of promise because 'promising is an ineradicable feature of genomics' (2008, p10). Similarly, Brown asserts that 'logically we cannot differentiate between our expectations of biotechnologies and what in reality those biotechnologies are, both in the present and the future' (2003, p17). From the outset, genetic scientists and their related public relations have been involved in popularizing a useful and attractive construction of their project – that which has the best chance of enrolling diverse support. Brown's framework for taking into account the temporal and spatial situatedness of expectations is useful here. These temporal aspects include the politics over 'newness' referred to earlier, broader cultural narratives of scientific 'progress' and an analysis of the way in which 'our presents are situated in relation to memories of past futures and future presents' (Brown, 2003, p10). Promissory discourse may be seen as the maintenance, reproduction and performance of particular future-orientated narratives for multiple professional and policy groups. In Brown's scheme, the spatial dimensions refer to the 'whom' and 'where' of such discourse, including the strategic framings of these groups as well as those by groups such as investors and patients. Important here is also to grasp both who the promises are being made to and whether anyone is asking for technoscientific promise. In some cases, expectation and desire for *technological* salvation is assumed in specific patient groups. This is especially the case for biomedical innovation and for those uses of farm animals – notably as biopharmaceuticals and as proposed xenotransplants – which imagine a patient group in need, while assuming the sort of therapeutic trajectory they may wish for. Molecular animal breeding techniques bolster their promissory value here by being more overtly, on the surface, about human health. This can also be seen in animal sequencing projects where, for example, the sequencing of the chicken genome was significantly predicated on its value for comparative understanding with the human genome. Similarly, the animal science community tries to sell farm animal genomics on the basis of using such animals as biomedical models for human disease.

Although Brown's explanatory framework for thinking about the imagining and performativity of biotechnological promising has a broad general utility, I want to argue that in the case of farm animal molecular approaches, there are different factors involved. First, however, we should note a potential simplification by the social science conceptual work on promise. It may work to gloss over difference within and between scientific subfields, presenting a falsely homogenized adherence to a particular future colonizing hegemony. Drawing on the above work around the temporally situated character of biotechnological promise, we can point to the internally cyclical character of new 'revolutions' and false dawns. This emphasizes the way in which in part professionalized scientific disciplines make promises to, and within, *their own* communities. Promise here is cohesive and galvanizing to the scientific subfield itself, providing shared goals and applied relevance to scientific labour. However, it would be wrong either to assume that promissory discourse is internally uncontested or that, given the porosity of sub-disciplinary boundaries, an 'internal scientific community' is a static, easily demarcated

entity. The history of promise in relation to molecular approaches to animal breeding has certainly undergone cycles of expectation. The late 1980s and early 1990s saw initial interest and expectation in GM animals, the late 1990s and early 2000s saw the emergence of hope around marker-assisted selection which continues but during the last few years has been joined by considerable expectation over the technique of genomic selection. These shifting cycles of promise have themselves fed back and shaped expectation among animal scientists, as was illustrated during my interview research. There was a feeling among several scientists interviewed that genomics was yet to live up to expectations and had been subjected to a fair amount of hype, as these extracts illustrate:

> *Quite often results from genomics and genetics are sensationalized and built up and the expectations from genomics and genetics are so high, or have been certainly in the farm animal industry, whereas in reality to date it hasn't actually reaped nearly the benefits that one might expect given the amount of investment that has been put into it.*

> *There have been massive advances in molecular genetics, there have been huge contributions to knowledge, but I would argue that contributions to genetic improvement of animals, and probably to a lesser extent plants, have not lived up to those earlier promises.*

> *Many of my colleagues here we're slightly cynical about the great sort of splurge of interest in genomics and the apparent potential of it. And in fact it's not delivered very much at all. Whereas the whole issue of just how effective marker-assisted selection can actually be as opposed to the more old-fashioned quantitative genetic approach which certainly works, this is just an ideological thing. I guess I side with my quantitative genetic colleagues here, who are probably seen as being in the old camp, but that's because they work with real-life animals breeders, you know, and they actually are out there making a difference. Whereas the other people I think are much more lab-based, kind of more theoretical really.*

> *Competition between the research institutes means that you've got to out-promise your competitor in terms of the value of your technology to win the funding to take it to the next level. And I think genomics has oversold itself while the technology is in an early phase, in its infancy.*

Although a certain loyalty to quantitative genetics is expressed, there was also enthusiasm in molecular techniques and the new knowledge generated among several interviewees. The approaches are not mutually exclusive and are beginning to be used side by side. It also remains to be seen whether the latest interest in genomic selection attains widespread commercialization, although, as we have seen, there are strong moves in that direction. These extracts of course remind us of the critical reflexivity of scientists themselves, suggesting that promising works through contested hegemony, not by homogeneity. Within animal science, promises and expectations may be contested by subdisciplines such as animal welfare science, whose practitioners are likely to be more critical of overly geneticized understandings of farm animal behaviour, a point which I shall return to later. Cycles of expectation are related to epistemological reframings of increasing complexity

that undermine prior, often reductionist, notions of genetic causality (Fortun, 2005, p158; see also Keller, 1995). Although a general point, this is also specifically the case in animal genomics. Many 'traits' are polygenic – both genes and QTLs interact in complex ways and epigenetics provides just one way in which the biological and the social unravel as impure. Cloning and transgenics are also complicated procedures which are challenging to 'make work' in farmed animals. Moreover, commercialization of a given technique cannot be reduced to the efficacy of the science and is determined by a varied context of political and economic factors. It is therefore unsurprising that expectations within animal sciences themselves fluctuate considerably. Promises around sustainability merit particular scrutiny, since both a 'promise' and an idea of 'sustainability' imagine a claim on the future. Most influentially, 'sustainability' was initially operationalized within a discourse of 'sustainable development' as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'[2] (WCED, 1987, p43). In a sense, discourses of sustainability are already promissory – they constitute an attempt to construct a promise to future generations – which implies that they can provide especially productive hooks around which to hang technoscientific expectations.

However, the ability of sustainability to be an effective hook for molecular promise is partly contingent on the breadth of its definition. Thus more recent definitions, such as that operationalized by the UK government in 2005, posit sustainable development (rather than sustainability per se) in terms of five principles. These are achieving a sustainable economy, promoting good governance, using sound science responsibly, living within environmental limits, and ensuring a strong, healthy and just society (see DEFRA, 2005). There are three main points to take from a definition like this. First, it acknowledges a sense of intersectionality between environmental sustainability and human social justice and thus begins to respond to elements of the critique of dualist ontology outlined in Part I of this book. Second, in underlining environmental limits and human health it makes it much more difficult (as we shall see) for a molecular turn in animal breeding to be premised on sustainability (unless such meat scientists are also advocates for decreases in meat/dairy consumption, which for now seems unlikely). And third, we can note with interest that such a definition of sustainability that foregrounds environmental limits can be seen to conflict with wider governmental support for the ideas of a knowledge-based bio-economy that cast biotechnology as the bypass for material limits. Clearly this neglected tension over the meanings of sustainability shapes the promissory capacity of biotechnology.

In terms of this promissory context, farmed animal genomics is arguably distinct from other biosciences. I have briefly mentioned internal critique, but there are other considerations too. For example, there are no 'patient groups' to promise to or enrol in the effort. Farmers may be constructed as surrogate patient groups, but equally as a potentially problematic public who need to be convinced of new science. Promises in the area of increasing and altering farm animal production are potentially precarious in specific and diverse ways. Partly because of this lack of a patient group base, the promissory imaginations around farm animal genomics are less public. Moreover, this is arguably important since promises of substantial increases in intensive animal production may not play well politically. In contrast to other biosciences, farm animal genomics faces a cultural and scientific milieu of partial delegitimization related to both animal production and consumption.

This conspires to render promises harder both to make and to keep. Cultural contestation here shapes the possibility of molecular farm animal breeding whereby it is not merely the problematic of introducing molecular techniques but the broader question of animal breeding and consumption at stake. This questioning occurs along three main points. First, although environmental problems associated with intensive animal production have been known about for a long time, the recent strengthening of the link between climate change and livestock production per se contributes a further critical reflexivity towards eating practices. Second, meat and dairy consumption has consistently been presented as a human health risk. Over and above well-documented food scares such as BSE, dietary recommendations themselves advise less not more meat. The saturated fat associated with meat and dairy have been associated with disease risk (see below). The 20th century's dramatic rise in Western meat production and consumption, now increasingly being seen in 'developing' countries, has contributed to coronary heart disease, certain forms of cancer and obesity. And third, the rise in animal rights and animal welfare discourse since the 1970s can be seen as part of an ethical questioning of animal agriculture. Here animal science discourses themselves – welfare and ethology – have contributed to this questioning, while a wide variety of philosophical arguments have been brought to bear against our exploitation of other animals. This cultural background renders the promissory work of animal genomics unstable. Indeed it makes it even more pressing to ask just what is meant by a framing of molecular breeding techniques in terms of 'sustainability' when it is precisely the impression that, on various measures, animal production is not at all 'sustainable'. If these three points can be said to introduce a partial delegitimization of our primary relationship with other animals, it is perhaps telling, as we shall see below, that animal genomics attempts to address itself to all three as part of its broader self-legitimizing portfolio.[3]

Wedded to this relegitimization effort is the explicit contextualization by some animal scientists of farm animal genomics around a set of 'inevitable' mutually reinforcing future scenarios. Such strategies may be seen as attempts to restabilize the promise. Initially, molecular techniques of animal breeding are written about in such a way that presents their eventual adoption as inevitable. The presentation of science here is often brazen, with human and animals futures technologically overdetermined (for examples see Wheeler, 2007; Rothschild and Plastow, 2008). But the portrayed inevitability of molecular techniques is productively parasitic on other broader, interrelated global economic and demographic 'inevitables'. Chief among these is the idea of the 'livestock revolution', which is a future projection of massive increase in farm animal production and consumption over the next 40 years, but is certainly already underway. This in turn is predicated on the 'inevitability' of global population increase, usually projected to reach 9 billion by 2050. Here molecular techniques, it is assumed, can help feed the growing world population (FABRE-TP, 2006). Of further importance is the assumption of the 'nutrition transition', which posits that when 'developing' countries 'develop', their citizens turn to a diet higher in saturated fat, including a more meat- and dairy-centred diet (Popkin, 1998, 2006). It is not difficult to see the usefulness of such a discourse of inevitability, especially if molecular techniques can be used for efficiency and productivity gains, nutritional qualitative changes, and potential sustainability and welfare contributions.

This underlines the way in which technoscientific discourses promising sustainability are tied to the practices of 'forecasting' – a rationalized attempt to produce

knowledge about the future and to quell uncertainty. Future forecasting, however, be it pertaining to demography, animal consumption trends or indeed climate change modelling (see Shackley and Darier, 1998), is prone to uncertainty and the potential exclusion of myriad human and nonhuman actions. Of further significance to the situatedness of expectations around technologies of meat production is the enrolling of particular normative discourses of nature. Ideas of 'nature' in this sense have a ubiquitous presence in normalizing certain human social relations (Soper, 1995). Although usually associated most obviously with relations of power around gender and sexuality, they are equally salient to human–animal relations. In this sense 'nature', as in a certain claim on '*human* nature', constructing the 'human' as that which by its very nature consumes other animals as meat, is a useful normative resource for carrying a particular hegemonic narrative in controlling future expectations of human–animal relations. Like other normative uses of 'nature', it is prone to obscure cultural and historical variability. In thinking through the politics of expectation and promise, there is a broad repertoire of intersecting temporal resources that may productively figure molecular breeding techniques as the naturalized answer to broader 'inescapable' trends. In the remainder of this chapter I examine these points in more detail.

Reinventing Animal Breeding: The Molecularization of Sustainability

Any contemporary discussion on 'sustainability' must account for the politics around the concept itself. This instability entails that any framing of new technologies around it requires careful analysis. There is confusion and questioning along various lines – of its relationship to economic growth, to Western lifestyles, to its weighting of 'economy' vis-à-vis 'environment', and to its coupling within the concept of 'sustainable development' (see Sneddon, 2000; Luke, 2005). Within the continual recycling of the discourse of sustainability, it is often unclear how exactly in practice it might invoke, or not, particular ethical relations to other species. I will return to the question of potential conflicts between sustainability and animal ethics in the next chapter.

Escober has identified a shift in discourse from within the Brundtland report itself to one that speaks of 'managing' nature (1996, p328). The managerial attitude of sustainable development attempts to reconcile the conflict between economic growth and the exploitation of nature 'to create the impression that only minor corrections to the market system are needed to launch an era of environmentally sound development' (p330). For example, Escober convincingly demonstrates that in the case of Colombia, rhetorics of sustainable development and biodiversity protection have encouraged new material relations of capital extraction under the guise of green development as well as indigenous peoples' rights. In a complementary critique, Luke argues that 'sustainable development' has helped facilitate a broad move towards environmental governmentality wherein society–nature relations come ever more under economic scrutiny, sourcing opportunities for 'rational' accumulation strategies as a basis for a stated 'green' capitalism (2005). Such analyses urge caution towards a significantly rhetorical discourse that is at best ethically ambiguous and at worst a conduit for 'greenwashed' novel capital(ist) accumulation strategies. I want to suggest that its ambiguous use as a catch-all term makes it ideal as a value-generating frame for molecular breeding technologies. The

biopolitical knowledge practices performed around farmed animal bodies have become part of the contemporary technoscientific answer to the 'problem of sustainability'.

I analyse this in two related ways. First, by looking at the ways in which animal scientists talk about sustainability, and second, by examining the particular applications of molecular breeding technologies that are posited as a contribution to sustainability in agriculture. While I have already mentioned three potential threats to the sustainability of animal production, a fourth factor colours the thinking of animal scientists. Here sustainability is understood in terms of the internal practical science-led sustainability of animal breeding. Here narrow productivist breeding goals have internally threatened the sustainability of livestock production. For example, it was a consistent comment from my interviewees that the science of animal breeding had moved, or was in the process of moving, away from a narrowly defined selection goal in terms of production (quantity). The case of over-selection on milk yield in dairy cows and the resultant inadvertent decline in their fertility was consistently put forth as an example of the limits of productivism. Articles by animal scientists now are full of references to the need for broader breeding goals which take into account both 'sustainability' and animal health and welfare. There has been a shift to accompany concerns over productivism with this wider range of qualitative selection criteria. Some more qualitative criteria, such as selection for disease resistance, may also of course have an overall effect on production, and certainly the cost-efficiency of breeding. This shift was recognized by the animal welfare scientists I spoke to who thought that, compared to 25 years ago, welfare science is taken much more seriously.[4] The rise in importance of sustainability also means that the work of agricultural economists is becoming more sought after: 'I'm getting people calling at my door rather than me having to go out and search for work,' as one economist put it. There remained, however, some ambiguity about 'sustainability'. The same interviewee was frank about this, saying:

> *You tend to find yourself couching sustainability in the terms that you know your audience wants to hear, which is probably something we oughtn't to do. But because science is so driven by the market, now we've no choice in that.*

Another economist thought that there was still a lot of interdisciplinary work to do around the concept, saying 'I don't think I've ever had a cross disciplinary chat with anybody in SAC about what it is we mean'.[5] One welfare scientist I spoke to thought that the term had been 'watered down so as to mean profitable'. In contrast, a geneticist opined that sustainability as an 'ethos is about trying to develop systems which are profitable but also environmentally benign or hopefully positive or at least more positive than the alternatives and socially and ethically acceptable'. This latter view is now the most typical conception put forward by animal geneticists in the literature.

Some of these important recent contributions to the framing of animal science and sustainability have come from scientists working at or linked to the Roslin Institute (for example Bishop and Woolliams, 2004; Flint and Woolliams, 2008). In their review of how genetic approaches could contribute to the sustainability of livestock production, Bishop and Woolliams begin by discussing the conflicts and challenges facing livestock production. They argue that in developed countries pressures such as declining prices, increasing costs, global competition, public pressure and legislation that imposes further

costs entail that to remain viable livestock industries must reduce costs, increase output quality and increase public confidence (2004, p911). In the case of developing countries, the authors draw on the notions of the livestock revolution (LR) and the nutrition transition (NT) in speaking of the strong increase in demand for livestock products, while recognizing the infrastructure limitations and diverse environmental pressures in many such countries. In both contexts they state that solutions must be sustainable, which they define as 'socially, biologically, environmentally and economically viable over a foreseeable period of time and thereby contribute to the wellbeing of all stakeholders' (2004, p911). This is a fairly broad definition that reflects the aforementioned shift, yet interestingly the paper makes no mention of climate change. In the more recent paper, Flint and Woolliams (2008) introduce the concept of 'precision animal breeding'. This is a broad review of animal breeding and human–animal relations (they do not confine themselves to livestock), as well as articulating a human ethical responsibility for a duty of care towards the animals that we breed. Precision animal breeding has three goals:

> *To increase the scope and precision of predictions of the outcomes of breeding decisions, to avoid the introduction and advance of characteristics deleterious to animal wellbeing or, more generally, the wellbeing of the species, and to manage genetic resources and diversity between and within populations in accordance with the principles set out in the Convention on Biological Diversity.*[6] (2008, p573)

Once again this is a critical reflection on the unsustainability of narrow productivist breeding goals. The authors are both expectant and optimistic about the role of molecular techniques in delivering precision animal breeding:

> *We are at the threshold of an era where our assumptions of what traits can be addressed by breeding, how merit is assessed and the impact breeding may have will need to be completely revised, primarily due to developments in DNA technology.* (2008, p580)

In certain ways this approach represents an intensification of the scientific method – more knowledge, more precision and more control, implying that the mistakes of the past were about insufficiently precise science rather than, for example, the intersection of animal science with the broader political economy of the livestock industry. The paper's articulation of sustainability is worthy of note. Initially the 'livestock revolution' is highlighted, in which the 'expected worldwide increase in consumption of animal products for the decade is seven per cent annually' (2008, p579). Acknowledging the constraint of available land resources to accommodate this increase, they argue that there is a need to produce more from the same resources. The forecasted increase in consumption, coupled with the need for new efficiencies, is taken to illustrate 'both the need and the opportunity for livestock breeding, and placed alongside the requirement for sustainability, the need for precision animal breeding' (2008, p579). They continue:

> *Sustainability in livestock production implies meeting production targets while ensuring targets are also met for environmentally significant outputs, human*

> *feed efficiency, animal health and welfare and maintenance of biodiversity, in both farmed livestock and wild species affected by animal husbandry.* (2008, pp579–580)

Although a broad definition and inclusive of some idea of welfare, this is an understanding of sustainability in terms of meeting targets and improving efficiency, effectively an understanding imported to speak to the biopolitical frame of managerial scientific animal breeding.

As noted in the previous chapter, most animal scientists working in the UK are networked into relationships with other researchers via professional associations, collaborations and conferences in the EU, the US and further afield. The strong UK cohort in animal science has played an important role in contributing to EU animal science strategy. Relevant professional associations here include the British Society of Animal Science (BSAS) and the European Association for Animal Production (EAAP). At this point we return briefly to the previously mentioned recent establishment of the EU Farm Animal Breeding and Reproduction Technology Platform (FABRE-TP) and its intersection with EU-funded projects and networks, notably SABRE 2006–2010 (Cutting Edge Genomics for Sustainable Animal Breeding), EADGENE 2004–present (European Animal Disease Genomics Network of Excellence for Animal Health and Food Safety), and the earlier SEFABAR (Sustainable European Farm Animal Breeding and Reproduction) project that took place in 2000–2003.

FABRE was officially recognized as a European Technology Platform in October 2008; one of 36 future forecasting EU platforms intended to:

> *Provide a framework for stakeholders, led by industry, to define research and development priorities, timeframes and action plans on a number of strategically important issues where achieving Europe's future growth, competitiveness and sustainability objectives is dependent on major research and technological advances in the medium to long term.*[7]

As well as bringing academia and industry together, platforms are intended to guide research funding towards industrial relevance and technological innovation towards sustainable development. In early 2006 FABRE published its vision for 2025 document, providing a roadmap for animal breeding in the EU. The idea of the 'bioeconomy' discussed in the previous chapter, with its language of sustainability, is prominent. It is defined here in terms of:

> *The three pillars – people, planet and profit … sustainable breeding and reproduction means balancing food safety and public health, product quality, biodiversity, efficiency, environment, animal health, and animal welfare in an economically viable way.* (2006, p9)

Overall sustainability is given an economic slant and there is no mention of the several ways in which large-scale animal breeding is environmentally unsustainable or detrimental to public health. The introduction sets the scene, drawing on the aforementioned three

inevitables of population growth, livestock revolution and nutrition transition. On the last it states:

> *This so-called livestock revolution is a* demand-driven *evolution. The supply of cereals for human consumption should soon be sufficient to satisfy the demand in developing countries, but the supply of animal-derived foods is far from the mark. The 23 per cent of people living in developed countries presently consume 3–4 times more meat and fish and 5–6 times more milk per capita than people in developing countries.* As these poorer people get richer, one of the first things they want to buy is more nutritious and satisfying food, and this generally means more animal protein. *Animal product consumption is thus increasing massively in developing countries, and will continue to do so over the next 15–20 years.* (2006, p12; first emphasis original, second added)

It is worth noting briefly the way in which the document frames the LR as demand-driven, as well as its casual assumption equating animal protein as more nutritious and satisfying. I will return to these points later, but this extract is a useful illustration of the power of attaching expectations to the aforementioned forecasted inevitables. The assertion is that there is a considerable future market opportunity for EU animal breeding to grow, in particular to respond to these projected rises in animal consumption, and for the intensification of knowledge transfer (including in the form of breeding stock) to occur outwards from the EU. As it argues, 'Many opportunities are open to the animal breeding and reproduction sector for improving the biological and economic efficiency of food production and increasing food supply' (2006, p16). The meaning of 'sustainability' coalesces here through the intersection of the biological and economic discussed in Chapter 5, as well, once more, as through the idea of efficiency. Sustainability is adapted into a concept of 'sustainable breeding and reproduction', defined as a balancing of:

1 safe and healthy food;
2 robust, adapted, healthy animals;
3 biodiversity;
4 social responsibility; and
5 a competitive and distinctive Europe (2006, p16).

Although on the surface this once again is a relatively inclusive definition of sustainability, all five of these elements are seen through the lens of genetic selection, and productivist language remains to the fore. Thus under (4), social responsibility, in a section on 'environment', the document makes its only mention of climate change, and pointedly in the sense of an opportunity for breeding animals adapted to new climate conditions.

Coordinated by the Genesis Faraday partnership,[8] SABRE is a substantial EU-funded project to apply genomics towards a concept of sustainable animal breeding. It has 33 partners, with the majority EU-based academic animal science partners, but also three partners in China, one in Brazil, and industry partners including Genus plc and Lohmann Tierzucht. Working across a wide variety of agricultural species, the project has included sequencing work towards producing a high-density SNP chip for pigs to be used in genomic selection and the genetics of egg shell quality, epigenetics, gut

health, mastitis and fertility. SABRE operates an almost identical understanding of sustainability to the FABRE-TP and similarly is concerned with its genomic elaboration. SABRE is related to the EADGENE network (with shared members and meetings), which is more narrowly focused on the genomics behind animal health and food safety. As an EU-funded 'Network of Excellence', EADGENE, which comprises 12 academic animal science centres in 10 countries, is concerned with capacity-building, knowledge-transfer, training and scientist exchanges. The work here hopes to improve the efficiency of animal breeding through, for example, the genomics of disease resistance and work related to viruses and vaccination.

Preceding these networks was the SEFABAR project, which specifically carried out work to think through the meaning of sustainability in relation to animal breeding. This led to the project to develop a code of practice – Code-EFABAR – discussed in Chapter 4. In SEFABAR, a work package on ethics was awarded to the Danish Centre for Bioethics and Risk Assessment, which gave the opportunity for conceptual and qualitative analysis around the use of 'sustainability' among animal breeders. In this work it became clear that the sort of elements that might comprise sustainability listed above often may come into conflict with each other (Gamborg and Sandøe, 2005, p225). The novelty of SEFABAR was that it provided a space for dialogue between quite differently positioned stakeholders, with breeders being compelled to think more about the ethical and societal context of their industry. The limitation of such exercises is that abstracted deliberation on conflicts between narrow economistic values and animal welfare and/or ecological values cannot easily be resolved when transferred to the economic context of animal breeding, which has historically externalized such values. As SEFABAR researchers acknowledged, 'the breeders' room for manoeuvre in response to ethical demands may be small, since they are just one link in a competitive food production chain' (Olsson et al, 2006, p45). This of course implies the importance of duplicating such projects with more powerful actors in the chain, such as supermarkets, as well as asking more profound questions about the ability of a market orientated to short-term profit to deliver even on the sorts of conceptions of sustainability framed by these projects.

I now move to a more specific questioning of the promise of sustainability of animal breeding – one not at all addressed by the scientific/industrial communities of animal science initiatives mentioned above, but one, I argue, of three main contemporary threats to the legitimacy of the global livestock industry. By beginning to address in more detail the areas of human health, climate change and animal ethics, I want to convey the ways in which molecular breeding techniques are being used in attempts to relegitimize the livestock industry, the production and consumption of animal products. This analysis adds to the empirical content of the concept of 'ethical biocapital' (Franklin, 2003) whereby ethics are increasingly 'built into new lifeforms' (Franklin, 2003, p98), and so some scientists are trying to anticipate and avoid controversy within the very materiality of their innovation.

Global Animal Consumption and Human Health

By turning now to human health dimensions, the precariousness of the promissory terrain of molecular techniques within ideas of sustainability and various interlinked inevitable

forecasts can be further brought into relief. This also emphasizes globalizing consumption trends, global power relations, and the need to think through the relationship between diet and development. A starting point is to refer to the FAO report *Livestock's Long Shadow* and its observation that globally 0.864 billion people experience under- or malnutrition, while 1 billion are deemed to be overweight and 0.3 billion to be obese (Steinfeld et al, 2006, p271).[9] A year earlier the World Health Organization (WHO) put the overweight statistics higher – overall 1.6 billion overweight and 0.4 billion obese, with a prediction for 2015 of 2.3 billion overweight and 0.7 billion obese,[10] meaning that if realized more than a third of the world's population will be at least overweight. The FAO report constructs animal products to be a potential remedy to malnutrition but also a major cause of obesity. This is a risky prognosis, since there is the potential for the FAO to place itself in a position of advocating for developing countries simply to copy Western modes of development and food consumption. There are several reasons why this might not be in the best interests of developing countries, but there is evidence to show it is already happening.

The Western (over)consumption of meat and dairy products makes a significant contribution to the overweight trend. Obesity specifically confers greater risk for a broad range of conditions, including type II diabetes, coronary heart disease, stroke, hypertension and cancer; as well as a greater risk of socioeconomic exclusion (see WCRF, 2007, p326). Obesity is a complex subject and certainly a 'social problem' that is not reducible to overconsumption. In a sociological sense, the boundary between health arguments and the emergence of 'obesity' as an object of biopolitical scrutiny with gendered, classed and moral dimensions is not always possible to demarcate (see Throsby, 2009). Bodies may be judged differently in different cultures. Thus oppositional discourses against overconsumption would be wise to not narrowly reduce obesity to an issue of scientific fact but to appreciate this extra sociological complexity. Nevertheless, the overconsumption of animal products is an issue that merits confrontation from the multiple perspectives of anthropocentric health concerns, power relations between 'developed' and 'developing' nations, ecology, and animal ethics. Research has argued for more specific links between animal product consumption and human disease. These include links between high intakes of red and processed meats with colorectal cancer (Cross et al, 2007), breast cancer (Taylor et al, 2007) and pancreatic cancer (Thiébaut et al, 2009). A longitudinal study working on a sample size of over 500,000 US citizens concluded that 'red and processed meat intakes were associated with modest increases in total mortality, cancer mortality and cardiovascular mortality' (Sinha et al, 2009). The recent World Cancer Research Fund second report included recommendation number 5: 'Limit intake of red meat and avoid processed meat' (WCRF, 2007, pxix), where red meat is defined as beef, pork, lamb and goat from domesticated animals, including that contained in processed foods, and processed meat as that preserved by smoking, curing or salting, or addition of chemical preservatives, including that contained in processed foods. Animal scientists are increasingly reflecting on such research, as evidenced by one recent review that referred to the WCRF report as a challenge for the meat processing industry (Demeyer et al, 2008). They identify the addition of nitrates/nitrites, used as antimicrobials, antioxidants, flavouring and colouring, as one possible explanation for the carcinogenicity of processed meat. Yet arguably, by focusing on *processed* meat, the review subtly shifts critique away from meat per se. Nevertheless animal advocates

wishing to argue for the intrinsic unhealthiness of meat might be advised to appreciate the socio-technical nexus within which meat production takes place. That is to say, as we shall see below, reflexive attempts by animal scientists to address the unhealthiness of meat and dairy produce problematize the fixity of health pronouncements.

While the livestock revolution (LR) and nutrition transition (NT) cause alarm when thinking about future greenhouse gas (GHG) emissions, they similarly evoke fears over the ability of globalizing patterns of trade, production and consumption to exacerbate the intersection between low income and poor health. It is simplistic and convenient to present these trends as demand-driven, giving the impression that nothing can be done to intervene in forecasted 2050 levels of livestock production. Rivera-Ferre (2009) has also questioned this demand-driven thesis, convincingly arguing for the role of producers in creating the livestock revolution as well as the 'blue revolution' (referring to expansion in aquaculture). As her analysis illustrates:

> *Price has been a major driving force for increasing meat consumption in developing countries, and this was possible thanks to the development of industrial ultra-intensive production systems, accompanied by a process of vertical and horizontal integration, geographical concentration, increasing scales of production, as well as the introduction of contract farming.* (Rivera-Ferre, 2009, p96)

This highlights the way in which the externalization of environmental, animal welfare and human economic costs has been intrinsic to the global growth in the livestock sector, resulting in what is effectively a sustainability time-bomb. Several developing countries have already exhibited large increases in both meat production and consumption. For example, according to Liu and Deblitz (2007, p2), China's output of red meat rose more than sevenfold between 1978 and 2005, from 8.6 million tonnes to 61.6 million tonnes, and poultry output nearly tenfold between 1984 and 2006, from 1.5 million tonnes to 14.6 million tonnes. During this time China also became the world's biggest meat producer. According to FAO figures, China is the leading country in respect of the LR, with a diversity of increases in other parts of the developing world. Indeed although the LR is used to refer to 'developing' countries in quite a sweeping way, it is only a slight exaggeration to in fact equate it with China's pattern of meat production and consumption. Switching to statistics on consumption, by 2003 China was consuming 71.8 million tonnes of meat,[11] compared to 16.9 million tonnes in 1983, more than a fourfold increase in 20 years (FAOSTAT).[12] Most other areas classified as 'developing' exhibit doubling or tripling in this time period but are beginning from much lower starting positions. Outside China the most significant increase in meat consumption in terms of overall quantity is in Latin America. There, total meat consumption rose from 15.2 million tonnes in 1983 to 31.8 million tonnes in 2003. These quoted 2003 figures for China and Latin America probably mean that research published by the International Food Policy Research Institute (IFPRI) projecting 2020 levels of meat consumption for China as 85 million tonnes and for Latin America as 39 million tonnes already constitute an underestimate (Delgado et al, 1999). It is worth contrasting China's levels with those of India for an approximate population comparison and as a way to undermine the assumptions of the LR and the NT. In 2009 India is estimated to

have a population of 1.16 billion people or 17.2 per cent of the global population, while China is estimated to have a population of 1.34 billion people or 19.9 per cent of the global population. Yet meat consumption is vastly lower in India. In 1983 it stood at 2.9 million tonnes, rising to 5.6 million tonnes in 2003 (the Delgado et al 2020 estimate for India is 8 million tonnes). Thus meat consumption in India in 2003 stood at less than 8 per cent of the Chinese level despite the latter's population levels not being that much higher. Although national statistics may be unsatisfactory for the way they conceal diversity within large populations, such a statistic complicates assumptions of the LR and NT. Obviously in the case of India there are cultural and religious traditions against consuming certain animals, with some areas having significant vegetarianism.

In the case of China, it is economically myopic to posit the LR simplistically in terms of consumer demand. This is not to say that there may well not be a process by which upward social mobility is accompanied by increasing consumption of animal products, and that such consumption may not articulate a given culture's positive association of meat with ideas of progress, prestige and power. However, this cannot be said to be tapping into some latent truth within the previously impoverished consumer. Rather, meanings of meat are socially and historically produced as well as being worked on by those who have an interest in raising consumption levels. National factors are further important. MacDonald and Iyer argue that meat consumption increases in China can be partly contextualized by the policy-driven national famine of 1959–1961 which claimed 30 million lives, a bitter experience which they imply has ensured that the emergent Chinese middle classes are keen to identify with a new found era of relative abundance (2008, p5). Since the late 1970s the Chinese state has pursued various policy measures to accelerate the development of livestock production (Li, 2009). These have included measures of privatization, policies to encourage industrialized production and policies encouraging an increase in the scale of farms. Li argues that China has been keen to adopt a 'Western' model of intensive livestock agriculture, including the import of foreign breeding stock, with the added incentive – depending on perspective – of lax environmental and labour protection (2009, p234). Although a move to intensive farming is underway, Li outlines that while in 2003 individual peasant household operations accounted for 93.8 per cent of the farm total, the 6.2 per cent of intensive farms produced 55.9 per cent of farm animal products (p226). This provocative statistic underlines the potential capacity left in terms of Chinese productivism and the associated environmental, health and animal welfare impact. Such impact is of course globally interconnected, and we can note in parallel a greater than 12-fold increase in China's soybean imports between 1994 and 2006 (FAOSTAT). At this point we can briefly return to a point made in Chapter 3 that it is important to highlight in the analysis of global animal production and its molecular turn that it is woven together with parallel developments in crop agriculture. Corporations such as Cargill with interests in both are making each economically symbiotic on the other across diverse geographical locations. The majority of Chinese soy imports are for use as animal feed for both its major agricultural animal, the pig, and for its increasing aquaculture industry. Many of these imports come from the US, but also significantly from South American countries such as Argentina, Paraguay and Brazil. Globally, 97 per cent of soybean production is for animal feed: in Argentina half of all cultivated land is given over to soya, of which 98 per cent is GM, compared to 90 per cent GM in Paraguay (Friends of the Earth, 2008).

These countries are being used as experimental land grabs by complex corporate–state relations for the cultivation of GM crops in a broader context of the livestock revolution. The environmental and social impacts of the sudden growth of the soybean industry in South America are well documented (see, for example, Nepstad et al, 2006; Friends of the Earth, 2008; Jowit and Balch, 2008; Wasley, 2009). These have translated into negative health outcomes seen, for example, in Paraguay through rural unemployment, displacement and pesticide poisoning (Jowit and Balch, 2008). It is important to bear in mind these less obvious, more complex ways in which meat production is proving bad for human health and more specifically how this constitutes an example of intersectionality between human–animal relations and national and international social class relations. Lest we over-focus on China as a driver of such trends, the EU presently constitutes a significantly larger importer of Brazilian soybean, partly as a result of post-BSE prohibitions on feeding cattle animal protein. Subsequently the NGO Friends of the Earth has begun to pressure the UK government on the issue of animal feed, though noticeably only on environmental rather than animal ethics grounds.

Thus intersecting with national policy encouraging livestock production (such as in China) there is a broader political economy of export and import relations that have also played an important role in the LR and the NT, giving rise to a gradual convergence of the diets of 'developing' countries with those of the West. Kasa (2008) presents a useful framework to summarize attempts to explain this convergence. What Kasa terms the market view:

> *claims unsustainable consumption patterns may be an outcome of income increases, widening consumer choice, falling retail prices, and taste preferences in an expanding global marketplace. Implicit here is the belief that markets for all kinds of items are naturally developing mechanisms for managing consumption and production … producer interests are implicitly seen as adapting themselves to market preferences.* (p152)

This may be seen as a disingenuous elevation of the power of the consumer and a masking of producer interests including strategies for demand and supply management. While prices and tastes of course play important roles in consumption trends, this market view is at best simplistic and at worst naturalizing of power relations involving states, agri-food corporations and inter-governmental agencies. Yet it chimes well with the assumptions discussed earlier in relation to the LR and the NT, and the reproduction of these discourses by animal scientists, including the productivist framing of molecular breeding techniques. A second approach outlined by Kasa is exactly to counter the market view and to introduce an analysis of networked coalitions of producer interests. This political-economy approach argues that 'changes in consumer behaviour are as likely to be the consequence as the source of producer expansion into new markets. Such a perspective focuses on how the emergence of new markets benefits powerful nations and well-organized producer groups despite the protests of less powerful actors' (p152). For example, we might partly trace the globalization of the livestock revolution to that which first occurred in the US after World War II. The contemporary 'meatification' of global diets was first preceded by a shift in American culture during the later half of the 20th century to a diet much higher in meat and dairy products. Weis argues that

the problem of the overproduction of grains was given a capitalist solution in the form of a cheap and readily available input for the expansion of livestock production (2007, pp63–64). Foreign export markets were also pursued as a way to profit from the domestic overproduction of grain, and then meat and dairy products. Moreover, since the 1980s, when some Western markets for meat consumption, especially beef, started to decrease due to health concerns, US-based transnational corporations specifically sought to open up new markets in developing countries. For example, Smithfield, Tyson and Cargill all have significant operations in China, and livestock industries (including animal feed) in developing countries have been funded by the International Finance Corporation, the private sector arm of the World Bank (MacDonald and Iyer, 2008; Rivera-Ferre, 2009, p99). For Weis (2007), the 'grain–livestock complex' has been an important part of the development of the global food system, and one that initially secured US market dominance. McMichael has also highlighted the way in which a model of development organized around industrialization and population growth has promoted diminishing indigenous cropland in East Asian countries such as Japan, South Korea, Taiwan and China, encouraging in parallel growing grain import dependence, shifting trade relations and ultimately shaping geopolitical power (2000, p421). In this example it is instructive to note that China has begun to look overseas for new agricultural land, with production for home consumption in Congo, Cambodia, Laos and Indonesia, as well as plans for production in Zimbabwe and Mozambique (MacDonald and Iyer, 2008). In summary, the rapid meatification of diets as one element in a broader specific model of 'development' may not be in these countries' own interests not only in the sense of the negative health impacts of the NT but also as contributing to economic dependency (see also Francis, 2000, p534).

Weis points to the corporate influence on 1950s dietary advice in naturalizing a diet higher in animal products as healthy and nutritional. This cultural aspect of political economy remains important to the legitimization of such diets in countries not used to high levels of meat and dairy consumption. The symbolic value of the American cultural icon of the burger is no doubt productive to the significant spread of American fast-food chains in countries such as China (Lang, 1999, p338; Weis 2007, p105; MacDonald and Iyer, 2008, p2), corporate growth acting in turn to popularize novel eating habits and practices. These examples highlight the ways in which economic actors are concerned to secure particular patterns of consumption and profit, underlining the inadequacy of the market view.

However, as Kasa points out, a third approach to explain dietary convergence aims to highlight how local institutions and actors may reshape global consumption pressures (2008, p152). This is a complex narrative since analytically it is prudent to avoid the potentially deterministic view of some deployments of the global political economy perspective above, which may at their worst reinstate a passive non-Western other. Nevertheless, as the Chinese national policy above shows, local interventions can sometimes dovetail with global capitalist expansion plans. National policy objectives are also shaped within a context of inequitable economic power relations with other countries. In spite of this, it would be wrong to suggest a lack of resistance to developments such as the LR. The aforementioned low levels of meat consumption in India and Kasa's own case study, which highlights how Korean and Japanese consumers prefer domestic varieties of beef, and overall other sources of animal protein (2008), point to local agency in the face

of a globally expanding livestock industry. Furthermore, Taiwan has witnessed protests against US beef imports framed around health concerns over BSE and environmental concerns over climate change,[13] suggesting perhaps that such locally deployed resistance may yet seek to contest the inevitability of the livestock revolution. Taken together, local context and political economy add necessary complexity to the narrow market discourse of the livestock revolution and nutrition transition.

With the considerable rise in the production and consumption of animal products in several parts of the 'developing' world outlined above, it is not surprising now to see a parallel rise in disease prevalence associated with such consumption in the West. But to avoid an oversimplification, rises in chronic disease in developing countries are not solely reducible to rises in animal product consumption but intersect with other changes in lifestyle linked to urbanization, notably decreased physical activity. This combination of dietary and activity change, as researchers interested in the nutrition transition have highlighted, has promoted an increase in both obesity and diet-related diseases in developing countries. The nutrition transition is a broad theory related to a particular model of development with related assumptions of dietary change, urbanization, economic growth, leisure and technological change. Although it could be said that there is nothing inherently predictable about its model of transitionary change, it certainly has some purchase in outlining how countries change within the context of capitalist development. In brief it outlines five patterns: collecting food, famine, receding famine, nutrition-related non-communicable disease and behavioural change. As Popkin comments,[14] the term nutrition transition has become associated with the shift from pattern three to four, and especially how to ameliorate stage four and proceed to stage five, whereby knowledgeable consumers adjust their behaviour to more healthy lifestyles. Clearly there is a broad array of complexity behind such patterns, not to mention the sort of political economy already mentioned. Nevertheless, this framework is being used to analyse development, especially, for example, in China, which although for such a diverse and large society cannot be said to be 'developing' uniformly, is argued to be now experiencing pattern four, associated with the diseases of overconsumption. This characterization holds more accurately for the Chinese urban population, although obesity rates are also increasing in rural China, where simultaneously malnutrition remains a problem. By 1999 the death rate among the urban Chinese had increased to a higher rate than in the early 1970s, primarily from cardiovascular diseases, diabetes and cancers (Du et al, 2002, p172). Although the Chinese government realized the impending public health situation during the 1990s, changes introduced have yet to deliver significant results (Zhai et al, 2002). Popkin (2008) has speculated on the impact of these changes on the Chinese healthcare system and ultimately economic growth, joining a call for a wide range of policy changes.

In this section I have outlined the first of what I frame as the three major critiques of animal consumption – human health impacts, climate change and animal ethics. As we shall see later, in recent years we have begun to see the emergence of scholarly calls for a reduction in both Western and global meat consumption. In terms of human health impacts, it is a strange situation to witness the concurrent Western health advice against the overconsumption of animal products with significant increases in animal product consumption in developing countries under the auspices of the livestock revolution. Given Western involvement in promoting the LR, one can rightly question whose best

interests are being served. Beyond the health impacts of direct consumption, two other areas merit brief inclusion here. First, the now routinized use of antibiotics in intensive livestock production threatens to erode the effectiveness of their use in humans, and second, intensive animal production is a conduit for the production and transmission of novel zoonotic diseases (see Nierenberg and Mastny, 2005, pp32–33; Hari, 2009), the latter most recently seen in the 2009 'swine flu' pandemic. These are two illustrative examples of unanticipated boomerang effects of biopolitical efficiency technologies. Woven into the evidence above on negative health outcomes related to direct animal product consumption, we begin to see on human health impacts alone a strong argument for the rolling back of the LR and a significant critique of intensive animal production, although not here *in itself* a complete argument for the total removal of animal products from human diets.

While genetic science is high profile, the human health impacts of meat and dairy consumption bring it into conflict with other areas of (biological) science, most obviously epidemiology and nutrition. Yet there is good evidence to show that animal genomics is being shaped by these concerns. This contributes to my contention that animal genomics is partly an attempt to fashion animal bodies as ethical biocapital (Franklin, 2003), to both anticipate and respond reflexively to broader cultural critique in the very design of new material forms. The biopolitical work on the bodies of agricultural animals involves in this instance strategies for reducing harmful fat content or increasing the presence of beneficial dietary fats. The relevant terminology used by animal scientists for the former approach centres around investigating the genetic basis of 'carcass composition'. Since the health risks of animal fat have been documented now for quite some time, research in this area predates animal genome sequencing and molecular techniques, though it has been expanded by their development. For example, Harmegnies et al (2006, p550), in their investigation of the relationship between porcine QTL and growth and carcass composition, conclude by recommending future research to employ genomic selection. It is a complicated area for animal scientists not just in terms of genetic complexity but also because fat content is important to taste and so changes are a part of a wider index of 'meat quality'. Furthermore, in common with animal welfare and environmental impacts, scientists operate within a context of industry standards and consumer preference that is liable to change. For example, in the UK the British Meat Processors Association Quality Assured Standard scheme has in place various rules for the salt, fat and preservative content of processed meat products such as sausages.

There is a specific specialization of meat science devoted to measuring fat and producing an 'end product' with specific fat quantities and qualities. For instance, backfat in pigs has become a part of industry-standardized measurements in many countries. Not surprisingly, there is significant animal science research going back to the 1970s around this issue, which technically has become concerned with ascertaining QTL relationships with backfat and is framed around a broader context of human dietary health (Wood et al, 1989; Óvilo et al, 2000; Vykoukalová et al, 2006; Gilbert et al, 2007). Direct selection on genes IGF2 and MC4R for leanness have already been commercialized (see Rothschild, 2004b). Given the health concerns over red meat, there is a similar research effort on fat content in cattle (see, for example, Alexander et al, 2007; Gutiérrez-Gil et al, 2009). Moreover, animal scientists are investigating the possibility of producing animal products as 'functional foods' with added nutritional

value. Use of molecular breeding techniques to achieve this are at the moment rare, but it is one touted use of transgenic farm animals. At the moment 'functional meat', produced for example by increasing the content of beneficial omega 3 fatty acids, can be achieved via non-genetic means such as varying the diet of cattle (see Scollan et al, 2006; Garcia et al, 2008). However, raising omega 3 levels has also been demonstrated to be possible using a combination of cloning and transgenics in pigs (Lai et al, 2006). In this research, part of the rationale for using pigs was the high level of pollutants found in fish meat. Somewhat different technoscientific approaches to obesity include the development of drugs and a technique based on GM mice engineered with a fat-burning pathway that allowed them to consume high levels of food without become overweight (Dean et al, 2009). Although such a technique is some way from being tried in humans, it is not difficult to see the attraction of such an approach to food producers. This may be a different approach to the above work on fat content in animal products, but it is similarly geared toward a non-intervention in patterns of consumption. These approaches protect particular relations of production and consumption and in the case of functional food research may create niche markets for novel animal products. They make less likely alternative paths to sustainability such as reductions in meat consumption. Animal science research here is a critical reflection on the human health concerns of meat consumption and by intervening into the materiality of meat or milk attempts to reinvent it as a more 'ethical' biocapital (Franklin, 2003). Such work raises expectations that sustainability can be achieved without radical changes to pre-existing dominant forms of production/consumption and if successful would attempt to bypass an important critique of the consumption of animal products.

I now move on to the second of my critiques, namely ecological arguments against meat production. But specifically within this I focus on climate change and the potential enactment of molecular breeding techniques within the debate. It is important to also acknowledge that climate change, if realized, will itself have massive repercussions for human health (Chan, 2009).

Global Animal Consumption and Climate Change

Since 2006 it has certainly been a lot more difficult to ignore the issue of climate change in relation to any claim over the sustainability of livestock production. The catalyst was the publication of the FAO report *Livestock's Long Shadow* (Steinfeld et al, 2006). A link between anthropogenic greenhouse gas emissions and livestock production was well known before, but a report from the Food and Agriculture Organization of the United Nations carried significant authority. Taking climate change as a whole, the report calculated that 'the livestock sector is a major player, responsible for 18 per cent of greenhouse gas emissions measured in CO_2e (carbon dioxide equivalent). This is a higher share than transport' (2006, pxxi). Indeed this is second only to energy generation. This is important not least because it immediately calls into question the ability of forecasted substantial rises in livestock production to meet the criteria of moral responsibility towards future generations, a constituent part of all definitions of sustainability. We can gauge the impact of this announcement in that several major animal advocacy organizations have run poster campaigns since the FAO publication arguing for vegetarianism or veganism on the grounds of the climate change link.[15]

Although these organizations would have been well aware of these links beforehand, the FAO report provided the necessary authoritative pretext to mount a more credible campaign. In this way the cultural amplification seen through the media coverage of this report and subsequent campaigning has bolstered the environmental argument for reducing or eliminating meat consumption.

We already live in a time when the ability of climate change to cast a shadow over the future as presently imagined is considerably powerful. It is not an exaggeration to speak of weekly pronouncements of both claims of contemporary evidence for climate change and new projections of social, ecological and economic impact. Indeed tangibly the seriousness of the issue has a sense of having quickened. This has taken the form of revised forecasts from the Intergovernmental Panel on Climate Change (IPCC) as well as scientific predictions of when the Arctic ice mass will have completely melted during summer (presently as early as 2030 – see Pearce, 2009), recent sudden increases in levels of atmospheric methane (Pearce, 2009), a new crack in an Antarctic ice shelf[16] and new predictions stating that sea levels may rise twice as fast as previously forecast.[17] Prominent analysts of climate change have revised their prognoses within a matter of a few years (see, for example, Stern, 2009). Given that the anthropogenic causality of climate change is now accepted, it can probably be safely characterized as the most ecologically broad and systemic boomerang effect of technologically developed global capitalism.[18] It is not surprising that climate change forecasts are being revised. This points both to the limits of the predictive power of models and to the uncertain effect of positive feedback mechanisms. There are several consequences of warming that produce further warming and possible dangerous tipping points. These include permafrost melt leading to methane release, loss of ice cover entailing a decrease in solar radiation reflection, a decline in plankton lessening the ability of oceans to act as carbon sinks and an increase in water vapour, which is itself a greenhouse gas, in the atmosphere. Deforestation acts in a similar way, leading to the loss of an important carbon sink. Changing land-use patterns associated with deforestation provides one of the important ways in which livestock production is linked to climate change and includes the rapid intensification of soya production for animal feed in South America mentioned previously. Deforestation also contributes to species extinction through habitat loss. In global terms, grazing land takes up 26 per cent of ice-free terrestrial land surface, and animal feed crops occupy 471 million hectares or 33 per cent of total arable land (Steinfeld et al, 2006, pxxi). Within the overall figure of 18 per cent of GHG contribution from livestock agriculture, the report breaks this down into 9 per cent of all CO_2 emissions, 37 per cent of methane (CH_4), mostly from the enteric fermentation of ruminant animals, especially cattle, and 65 per cent of nitrous oxide (N_2O), mostly from manure. Both CH_4 and N_2O are more potent GHGs than CO_2. Other contributions of livestock production to climate change stem from its intersection with fossil fuel use. This includes energy for machinery and transport, fertilizer use, and processing and storage, including refrigeration. Beyond direct climate change impact, the report also highlights other environmentally threatening consequences of livestock production. These are ammonia (NH_3) release, high water demands – 8 per cent of global human water use (Steinfeld et al, 2006, pxxii) – and the destruction of biodiversity. These remain salient to climate change itself, because in the case of the high water demands of livestock production – mostly through the irrigation of feed crops – future water shortages associated with climate change have

been predicted. Moreover, the impact of land-use changes associated with livestock production on biodiversity calls into question the very narrow instrumental use of the term in those understandings of sustainability by animal scientists discussed earlier.

Although this report may have jolted the animal science community,[19] some of its crucial framing of the issue is actually rather similar to that of animal scientists and its recommendations of ameliorating actions enrolling of animal science. This commonality takes two main forms. First, the FAO report very much draws on the interconnected assumptions of livestock revolution, nutrition transition and population growth. This is unsurprising since its main author, Henning Steinfeld, has previously published work for the FAO on the livestock revolution, partly championing it as a means of poverty alleviation in developing countries (Delgado et al, 1999). For example, drawing on forecasted statistics, *Livestock's Long Shadow* states:

> *Global production of meat is projected to more than double from 229 million tonnes in 1990–2001 to 465 million tonnes in 2050, and that of milk to grow from 580 to 1043 million tonnes. The environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level.* (Steinfeld et al, 2006, pxx)

The demand for more animal products, it says, is driven by 'increasing populations and increasing incomes' (Steinfeld et al, 2006, p275). Leaving aside the environmental arguments for challenging the inevitability of the LR for a moment, there are other reasons why it may not happen on the scale predicted. Climate change is expected to negatively affect agricultural productivity itself, and it is possible that some of this effect may have begun prior to 2050, thus impacting on the cultivation of feed crops. Similarly, the phenomena of diminishing oil supplies known as peak oil – apart from any environmental imperative to curb fossil fuel use – may also act against the productivity of livestock agriculture.[20] And second, in addition to the LR frame, the FAO report advocates a managerial–technical response to the livestock impact on climate change, which dovetails well with the methodology of animal science. The report devotes no serious space to 'demand management' approaches that could critically evaluate consumption levels. Instead the focus is on producing meat and milk more efficiently. As it states, 'Resource-use efficiency is the key to shrinking livestock's long shadow. A host of tested and successful technical options are available to mitigate environmental impacts.' (Steinfeld et al, 2006, p276). Although the report purports to be against a 'business-as-usual' approach, this reformative method enrols animal science as key salvational actor. However, given that reductionist economically embedded animal science has failed to anticipate ecological impacts in the past, this is potentially a risky strategy.

Nevertheless, it is precisely such a 'molecularization of sustainability' that is being pursued by animal scientists in an attempt to make the animal breeding part of the broader production process more environmental. Mitigative genetic approaches are complemented by approaches that focus on in-depth analysis of food supplements and dietary impact on, for example, methane emissions (see, for example, Lovett et al, 2005; Guan et al, 2006). Research around adaptation also seeks to consider how differently bred animals may respond to future climate change-induced heat stress. One argument being made by animal scientists is that ongoing work to improve the efficiency of genetic

selection of farm animals is already contributing to a reduction in GHG emissions. This is underlined in a review of the different ways in which breeding could help mitigate climate change where Wall et al (in Rowlinson et al, 2008) list three: through improved productivity and efficiency, by reducing wastage at the herd or flock level, and as a direct response to selection on emissions. General efficiency-drives aimed at improving the capital efficiency of livestock production are argued to inadvertently mitigate against GHG emissions in two ways: first through a decline in maintenance costs for each animal, for example when more feed-efficient animals can maintain growth rates on less feed, and second due to increases in productivity the same amount of meat and/or milk can be achieved using fewer animals. The second method listed by Wall et al (2008) is essentially another efficiency spin-off. They argue that selection for fitness traits such as lifespan, health and fertility help to reduce emissions by reducing wastage of animals and keeping them at optimum levels of productivity. A third method – direct selection on methane emissions – is, they argue, complicated by the difficulty of measuring emissions from individual animals (in Rowlinson et al, 2008, p45). Additionally, the ability to directly select for animals that produce less methane, if amenable to genetic control at all, is likely to be complex and distributed across various chromosomal loci. The complexity involved here, however, did not prevent the lead scientist on the bovine genome project from contributing to the expectation when in April 2009, during the media coverage of the announced completion of the bovine genome, he remarked that the project could contribute to the reduction of greenhouse gases.[21]

The scope for animal genomics to contribute to reducing nitrogen and methane emissions was also the subject of a recent project[22] (2007–2008) by Genesis Faraday in the UK, funded by DEFRA. The end-of-project report similarly placed an important emphasis on the contribution of general selection efficiency moves to help mitigate GHG emissions. Moreover, the report points to a problem of incentivization between reducing GHG emissions directly through selection or by means of general production efficiency:

> *By selecting for improvement in most of the other measures of efficiency, such as feed efficiency, breeders and producers will receive a noticeable economic benefit through a reduction in production costs, and the correlated reductions in emissions is an added benefit which is being achieved at little if any extra cost. Given current market conditions, the economic benefits of selecting directly to reduce emissions are less obvious. Under these conditions it may be necessary to provide other financial incentives to encourage commercial breeders to devote their resources and effort into directly selecting for reduced emissions.* (2008, pp7–8)

Markets have typically externalized ecological risks, but operating within this market logic there is indeed justification for a subsidization of mitigation practice. In contrast, the FAO report advises that some sort of system of tax or polluter-pays principle may have to be invoked in livestock agriculture. Although it might be economically attractive to cast ongoing business-as-usual efficiency approaches to animal breeding as an answer to GHG mitigation, it is unlikely that they can lead to significant enough reductions (see Garnett, 2009). The Genesis Faraday project is also notable for its discussion of molecular genetics in this area. For many these will remain somewhat speculative solutions to the

unsustainability of livestock production. Nevertheless, the project advocated further research on genomic selection as a possible use in breeding genotypes that produce fewer emissions. Furthermore, in highlighting the (not yet commercialized) example of Enviropig, the Canadian-produced GM pig which has less phosphorus in its waste, the Genesis Faraday project argues that the 'use of transgenesis could also potentially have a large impact on reducing emissions' (2008, p13). In a similar but more forceful vein, a report entitled 'Genetically engineered animals and public health – Compelling benefits for health care, nutrition, the environment and animal welfare' commissioned by the US-based Biotechnology Industry Organization (BIO) argues that transgenic animals have an important role to play in tackling livestock-related environmental problems, although it omits any discussion of climate change (Gottlieb and Wheeler, 2008).

In a more recent contribution, Tara Garnett of the UK-based Food Climate Research Network has asked one of the most important questions in this debate, namely 'whether it is possible to substantially reduce livestock emissions through technological measures alone, or whether reductions in livestock consumption will additionally be required' (2009, p492). In recognizing the seriousness and collision course of the LR projected production increases with the GHG impact, Garnett takes an appropriately broad focus on this subject, vitally also recuperating a consideration of 'needs' back into sustainability discourse. In particular, Garnett wishes to point out methodological problems with the potential standardization of a particular approach to calculating GHG impacts. Life-cycle analysis (LCA) has become increasingly adopted by UK government-funded research to analyse a given product's environmental impact during production, use and disposal. Garnett, however, contends that it is limited for grasping a broader sense of GHG impact and argues in this case for the inclusion of three further perspectives. These are accounting for the indirect second-order effects of livestock production on land-use change and associated CO_2 emissions, comparing the opportunity cost of using land and resources to rear animals with their use for other food or non-food purposes, and finally the issues of needs – how far humans need livestock products at all (Garnett 2009, p492). Within Garnett's extension of LCA, we see the difference between a reformative and a more radically questioning approach to GHG mitigation. I have underlined the way in which the techno-managerial mitigative approach of the FAO report dovetails with that of animal scientists. Yet Garnett's approach offers a critique of the FAO over-reliance on technical, productive efficiency measures. As she points out, although the report accounts for changing land-use patterns, it fails to pursue the way in which its efficiency recommendation to feed cattle cereals and oilseeds and so potentially decrease CH_4 emissions per animal could also incentivize the clearing of more land to grow such feeds (p4). While a focus on efficiency is bound to act as a stimulus for growth in new science markets, and in this example very probably act as an important driver for the continued development of molecular techniques, it skews the focus on sustainability to production rather than consumption. As Shove writes (in relation to energy use and domestic technology):

> *In concentrating on* efficiency *rather than consumption, policymakers stick close to a politically safe position, providing information and advice but not going so far as to tell consumers and decision makers how to live their lives.* (2006, p293, original emphasis)

Interestingly, there are also other non-molecular approaches to the problem of meat and climate change, which in similarity with molecular approaches implicitly bypass the question of calls for a reduction in animal consumption. These include suggestions of turning to more efficient and less pollutive animals such as the kangaroo[23] as sources of food, or the transformation of environmental externalities such as manure or methane into potential energy sources. Here I would also add the emergence of geo-engineering discourses that include potential strategies of ocean fertilization, cloud formation and mirrors in space to counter climate change (Keith, 2000; Connor, 2009a). It seems counter-intuitive to respond to the unintended consequences of nature mastery with potentially further risk-generative strategies of control. All these sorts of approaches ignore causes and seek to avoid the more complex strategy of challenging path dependencies or markets, the cultural challenges of eating novel animals notwithstanding. The transformation of 'ecological bads' into potential capital opportunities is not a new approach and seeks to deflect the wholesale critique of a particular unsustainable sector or practice. These approaches beg questions around pursuing more ecologically benign consumption practices or, more fundamentally, *less* consumption.

Leading climate change economist Nicholas Stern similarly puts faith in efficiency measures, technological innovation and market strategies such as carbon trading (2009). While it would be odd to argue *against* the enrolment of science in, for example, improving energy-efficiency, one ought to be aware of the possible occlusion of other less obviously technological strategies. There is a question mark here over casting science in a salvational role, when historically the commercialization of innovation has often failed to promote more-than-human flourishing. It is certainly worse than naïve to assume that innovation is wedded to either public or ecological health. Instead of a climate change scientism, further sociological and ethical vocabularies and strategies are a prerequisite if current GHG forecasts are even close to accurate. GHG concentrations have grown from a mid 19th-century level of 285ppm (parts per million) to a current level of 430ppm CO_2e, with most increases taking place in the second half of the 20th century (Stern, 2009, p23).[24] Drawing on climate change modelling and an understanding of what sort of CO_2e level would translate into catastrophic eco-social impact, Stern had previously set a global upper limit of 550ppm CO_2e (2007), which within only two years he had revised down to 500ppm CO_2e, describing the former level as 'much too risky' (2009, p39). This is contingent on an eventual stabilization of at the most 450ppm CO_2e to restrict global temperature rises to two degrees (presumably in the longer term it should fall lower than this). This concentration is expected to be reached by 2015 and so is deemed an impossible short-term target. (It is noteworthy that developing countries have been pushing for a target that could restrict the temperature rise to 1.5 degrees). Stern's analysis is certainly sobering and gives a clear sense of urgency. The revised ceiling of 500ppm CO_2e translates into an 80 per cent cut in emissions by 2050 (assuming world economic growth of 2 per cent per annum until then). Stern is correct to point out that such changes cannot take place without important shifts in ethics, but he initially failed to include any critique of anthropocentrism or appreciation of the importance of critical reflexivity towards human–animal relations as being an important part of climate change debate. It is worth noting that in spite of the previously quoted FAO figure of an 18 per cent GHG contribution from the global livestock sector, Stern only devoted half a page to

the issue (2009, p126) and makes a point of including it in a section on the actions that *individuals* can do to make a difference. Absent is the sort of institutional policy measures he discusses in relation to other possible areas of mitigation such as energy and transport. Stern's omission was dramatically addressed in October 2009 when he made world headlines advocating for vegetarianism as one response to climate change mitigation. In an interview in *The Times* (UK), Stern predicted that attitudes would change about the acceptability of eating meat due to its carbon footprint (Pagnamenta, 2009). Given his reputation in climate change discourse, Stern's remarks have made a significant contribution to the questioning of meat, which unsurprisingly have not been happily received by representatives of the livestock industry. Elsewhere Stern has been criticized for a general lack of awareness of power issues and his faith in economic growth (Helm, 2008). For example, his advocacy of carbon markets has been questioned, given its omission of geopolitical analysis (Giddens, 2009, p201).

Although Stern's comments on meat came after the publication of his *A Blueprint for a Safer Planet* (Stern, 2009), they dovetail with the emergence of scholarly calls for a reduction in meat consumption, specifically tied to ecological and climate change concerns (McMichael et al, 2007; Fiala, 2008a; Garnett, 2008, 2009; Koneswaran and Nierenberg, 2008; Popkin, 2009). In some cases there is not a neat boundary between the climate change basis for such an argument and those from human health and animal ethics. For example, Popkin, who we heard from earlier in relation to his long-standing work on the nutrition transition, has recently outlined multifaceted benefits of reducing meat consumption. He writes, 'There is a global tsunami brewing, namely, we are seeing the confluence of growing constraints on water, energy and food supplies combined with rapid shift towards greater consumption of all animal source foods.' (2009, p544). Popkin embeds this concern within his familiar domain of nutrition, but also produces a more joined-up argument, including climate change and the argument that rising levels of animal consumption are partly to blame for rising global food prices. Notably, Popkin is not arguing for vegetarianism (2009, p543) but for a reduction in consumption; animal ethics is the only major argument absent from his analysis. Garnett's groundbreaking work on food and climate change ventures into the most detail of how a policy for reduction could happen (2008, 2009). For example, writing from within the UK context, she underlines the ways in which government needs to consider how a transition to diets lower in animal products might impact on farmers, as well as including a series of recommendations for the food industry to pay far closer attention to the links between food and carbon footprint (2008, p25). In contrast to Stern, Garnett offers a decidedly non-individualist framing of the issue of climate change and animal consumption. McMichael et al (2007), writing as part of a special issue of *The Lancet* on energy and health, were among the first to argue for reductions in meat consumption on the grounds of both human health and climate change. They proposed an international target of 90g per day per person in all countries. This places most burden on developed countries, which on average consume much higher levels (for example China has only just reached this level), to take action to reduce their consumption. Like Popkin and Garnett, this is a broadly humanist argument for meat reduction that omits a consideration of animal ethics. However, the important point to make here is that these positions question Western patterns of animal consumption and their increasing adoption by developing countries and rebalance the debate between

production and consumption. Crucially, they offer an alternative strategy of change to the arguably over-optimistic self-enrolling strategies of animal science. Moreover, just as we saw earlier conflicts between animal genetics science and other areas of science in relation to the question of animal consumption and human health, we can note at this juncture additional conflicts between the genetic approach and sciences of ecology and climate change at the very least. It is worth noting that arguments for meat reduction are also being joined by criticisms of the Western economic policy of subsidizing meat production, which on the one hand has assisted the cultural development of meat hegemony and on the other disguised the real cost of animal production (see Popkin, 2009; Fiala, 2008b). The Nutrition Ecology International Center, an interdisciplinary scientific committee established to consider varied impacts of food consumption, actively campaigns against the EU subsidy regime.[25] Calls for reductions in meat consumption have become commonplace in the media, not only from Nicholas Stern. Animal welfare charity Compassion in World Farming (CIWF) has for the last few years hosted a campaign to eat less meat. In 2008 Nobel Peace Prizewinner and Chair of the Intergovernmental Panel on Climate Change (IPCC) Rajendra Pachauri advocated vegetarianism to combat climate change[26] and made the front page headline of UK Sunday newspaper *The Observer*. In May 2009 the Belgian city Ghent made the news over local government plans to turn the city vegetarian one day a week,[27] and in June 2009 Sir Paul McCartney and other celebrities launched a campaign for 'meat-free Mondays', again on the pretext of combating climate change.[28] In December 2009 McCartney took this message of 'Less Meat=Less Heat' alongside Rajendra Pachauri to the EU Parliament on the eve of the COP15 meeting in Copenhagen.

Realising calls for reductions in meat consumption, however, is far from simple. For example, it might be countered that a strategy which on the face of it seems less technological would not be any easier to achieve. I return to this point in the Conclusion (pages 161–175). I have illustrated attempts by animal science under a legitimacy threat from both human health and ecological concerns to materially reconstruct animal products as ethical biocapital. The creativity here revolves around an approach which attempts to deflect both the critical purchase of these concerns, but significantly also uses these 'meat crises' as conduits themselves for the attempted consolidation of new molecular breeding techniques. Yet their experimental nature and their framing within unsustainable forecasted trends such as the livestock revolution undermine their ability to act as genuinely effective sustainable promises. The essentially humanist calls for a global reduction in animal consumption from these concerns largely avoid overt framings of animal ethics in their discourse. However, certainly pro-animal figures and groups have eagerly joined the debate, and campaigned on the grounds of climate change as a proxy for vegetarianism or veganism. Yet like health concerns, climate change is not in and of itself an argument for such an ethical position, given that a much-reduced infrastructure of livestock production could be envisaged that would have minimal impact on GHGs, or that reductions in other sectors such as energy or transport (albeit interconnected with livestock production impacts) could ameliorate overall GHG outcomes. However, the intertwining of public health and environmental concerns opens up a space for critical reflection over the way in which intensive instrumentalized human–animal relations are ultimately not in the interests of human flourishing or progress. These concerns do provide important elements for a broader argument against human violence

towards nonhuman animals, but one that has to be conjoined to non-anthropocentric sociological critiques of intersecting power relations as well as arguments from the wider discourse of animal ethics.

I shall return to the issue of climate change and meat in the Conclusion, as it raises important questions around need, consumption, sustainability and associated particular claims on the human that require further examination. But first in the following chapter I turn to the third critique of animal production and consumption, that emanating from critiques over our ethical treatment of other animals. Moreover, this is also a further area in which molecular breeding techniques are being proffered as having a role to play – at least in the sense of making improvements to animal welfare. To what extent is this promising?

8

Searching for the 'Win–Win'? Animal Genomics and 'Welfare'

In the previous chapter I discussed the ways in which the human health and climate change impacts of animal agriculture may compromise its sustainability. I would suggest that the relationship between animal ethics and sustainability is more complex. In one understanding it may be argued that 'sustainability' is an anthropocentric concept and thus has no clear relationship to animal ethics. If it envisions care to ecosystems, it does not go as far as considering animals. Moreover, it could be argued that climate change imperatives entail that animal ethics are somehow of less importance. This could be exacerbated by new systems of production that try to control GHG emissions by using more intensive methods of animal rearing. Similarly, the control of zoonotic diseases could threaten organic production methods, even if many would side with the counter-argument that it is precisely intensive conditions that facilitate such risks. Indeed this chimes with the opposite argument that animal ethics are in fact highly integral to sustainability precisely because of the multiple unsustainable impacts of animal agriculture. In this understanding sustainability is a relational term that accounts for the ethical import of the more-than-human. If we switched to a system of vegan agriculture, a whole array of benefits to this notion of sustainability could be realized (Visak, 2007).

However, it is a position between these two (if slightly closer to the first) that has begun to be institutionalized, at least in the context of UK and EU agricultural policy during the last decade (Buller and Morris, 2008). Buller and Morris chart the gradual consolidation of a specific frame of animal ethics – animal *welfare* – into policy discussions of sustainability. More broadly, while noting the anthropocentric affinity between animal welfare and sustainability, they argue for the emergence of novel subjectifications of animals in this overlap, and as distinct to contemporary constructions of farmed animals as either *threats to* or *vehicles for* sustainability. It should be noted that there is significant diversity within these latter two figurations of the relationship between farmed animals and sustainability. Thus to perceive animals as threats to sustainability may be based solely on concerns of human welfare or, as above, in the broader critique of animal production. In this latter argument, animals themselves are not subject to blame, but their exploitation by humans is. Similarly, arguments that proffer animals as vehicles for sustainability through the maintenance of environmental quality or for the maintenance

of rural economies (Buller and Morris, 2008, p138), while instrumental, can include a wide range of human–animal relations.

It seems accurate according to the analysis of Buller and Morris that we begin to see the more direct targeting of animals in sustainability discourse. They point to references to animal welfare in documents including the EU's 1999 Rural Development Regulation and, in the UK, DEFRA's Animal Health and Welfare Strategy. The ethics of this shift should not be overstated, however, as it does not constitute a dramatic change in the status of animals in agriculture. It could be argued to conform to a particular model of the relationship between animal ethics and sustainability whereby improved animal *welfare* enhances the social acceptability[1] and so the *economic* sustainability of the animal production sector (see, for example, Marie, 2006, p206). If so, this would confirm the doubts of animal advocates suspicious of the deployments of animal welfare (see below). However, one consequence, arguably, of this coupling of animal welfare and sustainability has been to provide a context for welfare science research as part of a broader sustainability frame. Just as in the previous chapter my interest was tuned to the use of (molecular) genetics in research around human health and climate change, here I am interested in focusing on similar research around animal welfare. Increasingly, as I outline here, genetics and genomics are being framed as tools for animal welfare.

The term 'win–win' is employed by animal geneticists when they believe they can achieve a given type of selection that is perceived to have a 'good' outcome both in terms of productivity and welfare, capturing well the ambivalence and indistinct uses of 'production' and 'welfare' as frames for specific breeding decisions. It speaks to the reality that animal welfare scientists operate within an economic context, which means that more often than not they must translate animal welfare improvements into a language of economic return and utility. If changes are perceived as having a cost to industry, they are unlikely to succeed unless they can find their way into higher 'welfare' premium ranges.

This chapter analyses the potential impact of genetics and genomics on animal welfare science, arguing that the ambivalence of welfare and production becomes especially salient around the idea of animal 'health', which can be taken to signify both welfare and production. A further issue is whether animal welfare science is being subject to geneticization. Drawing on interviews with animal scientists, I explore the tensions of this in practice and the economic shaping of animal genomics and welfare. Although social and ethical considerations are increasingly on the agenda, it is suggested that they can only gain a limited foothold due to both the commercial outlook of *agricultural science* and the economic constraints of contemporary global agriculture. I argue that the translation of animal ethics into animal welfare provides the third example of the process by which attempts are being made to turn animal bodies into ethical biocapital. Higher welfare 'products' are intended to enhance the economic and social sustainability of livestock production. Specifically, this can be read as a process that endeavours to perpetuate pre-existing and growing patterns of meat and dairy consumption worldwide.

For those who centre an analysis around issues of power and non-utilitarian ethics, it is problematic to focus solely or at all on welfare. Welfare and the killing of animals seem like an inescapable contradiction.[2] A welfarist approach is a specific kind of ethics

that operates within the confines of anthropocentric thought and accepts the utility of animals. In a self-identified compassionate[3] and scientific approach towards albeit more *humane* human–animal relations, it continues to proffer a 'human' that exists over and above other animals. Welfare in this understanding may be understood as a placation of our dissonance in our treatment towards other animals. Welfare in agricultural animal welfare science is in essence about husbandry modifications (Hall, 2008), implicitly committed to the importance of the livestock industry and/or a model of exploitation based erroneously on the assumption that humans physiologically *need* to consume other animals.[4] An ethic of animal welfare in this understanding, and in common with arguments from climate change and human health, is not a position against the killing of animals for food per se, but one that argues against the *scale* and, more specifically, various qualitative aspects of animal production/consumption. This is significant as it enables it to become an ethic open to commodification, to have in and of itself a certain usefulness.[5] Animal advocates (Francione, 1996) have also been critical of the 'new welfarist' position, which although in critique of the utilitarian ethics of animal welfare, supports an approach of incremental welfare change towards a longer-term 'progress' in our treatment of other animals. In this chapter, while making the important point that a discussion of animal welfare speaks to a particular *frame* of animal ethics, I argue that it is the very contradictions of 'animal welfare' that pique the sociological interest. Moreover, critiques of animal welfare need to attempt to attend to the complexity of issues and meanings at play.

For instance, diverse conceptions of animal welfare point to competing discourses of the animal and underlying values which posit the 'good' life for animals differently. While those whose values fit better within non-utilitarian ethical frameworks (for example virtue ethics or intrinsic value positions) argue that a 'good' life for an animal consists of their actual escape from a system of agricultural commodification, we must note that even within welfarist viewpoints there are a diversity of positions. How these are expressed within science discourse is of interest as it may tell us something about the social context of animal science generally and, more specifically, about conflicting discourses and changes of emphasis. Fraser (2003, p435) introduces a useful description of three different conceptions of animal welfare at play within the broader field of animal welfare science, but also animal science generally. First, we see an emphasis on biological functioning and health as the main determinant of welfare. Second, we see a framework which emphasizes the 'affective states' of animals and so is more focused on concerns of pain, suffering and the measurement of other internal states. And third, Fraser outlines a framework which conceptualizes welfare as allowing the animal to live as closely as possible to 'natural' circumstances. These are rather paradigmatic, since they span a spectrum from neo-Cartesian views of animals to others which attempt to respect the sociality, subjectivity and environmental embeddedness of animals. Such frameworks, as Fraser acknowledges, are themselves culturally embedded and so one must bear in mind how they might translate or not in the geopolitics of global agricultural production. In turn, trends in welfare practice and animal science discourse speak to broader debates in agriculture around productivist and more-than-productivist values. This chapter adjoins this interest with a focus on genetic selection and the emergence of new molecular technologies in animal breeding. It explores some of the impacts that selection and the uptake of genomics may have on understandings of welfare.

I draw on some of my own interview data from animal scientists and refer again to the work of the UK Farm Animal Welfare Council (FAWC), particularly their report on the 'Welfare implications of animal breeding technologies in commercial agriculture' (2004). Before turning to molecular technologies, I want to begin by assessing the relationship between non-molecular genetic selection (selective breeding) and welfare. This is important, since if we over-focus on the molecular, it is too easy to give the impression that non-molecular breeding could be free from ethical questioning. Moreover, the selection philosophy of the molecular turn is often informed by what has taken place using prior non-molecular techniques.

Genetic Selection, Unintended Consequences and Welfare

On the one hand from a perspective trained on the goals of agricultural output, genetic selection has been incredibly successful in optimizing animal bodies to produce more meat and milk. Indeed it has been too successful in that the economies of the West are witness to a situation where output exceeds requirements (see Bishop and Woolliams, 2004, p913) and it is very probable that the low-cost availability of animal products is a contributory factor to those diseases discussed in the previous chapter. However, it is a different unintended consequence that I wish to focus on here.

It has become clear that the productivity drive of selecting for particular genotypes has had the unintended consequence of producing negative welfare impacts on agricultural animals. So much so that 'welfare' issues arising out of production also themselves become issues of 'profit compromising' production. I shall return to the issue of conceptual confusion over 'welfare' and 'production' later on in the chapter. The productivity drive goes hand in hand with other goals of reducing costs in related areas of agriculture. That selection for high production efficiency has resulted in deleterious welfare impacts was reinforced in my interviews with both animal geneticists and animal welfare scientists. These two quotes came from animal geneticists:

> *They've gone hell for leather for high yielding dairy cows, but in actual fact it's made them more susceptible to mastitis and because the management, you know, it can only go so far.*

> *It's clear that many of our current systems and practices have question marks over social acceptability, ethical issues, and that includes the focus on a rather narrow set of production-related characteristics in our breeding programmes which is now known to have caused some unfavourable side-effects. So focus on the milk yield in dairy cattle, for instance, is known to have caused a reduction in fertility, probably an increase in mastitis, probably an increase in lameness.*

In the example here of dairy cattle, the emphasis on production has been to such an extent that the unintended consequence has come to be an issue for the perpetuation of productivity itself. In a broad-ranging review paper that presented over 100 references on undesirable correlated effects of selection for high production efficiency, Rauw et al showed that such an approach seems to put animals at a greater risk of behavioural, physiological and immunological problems (1998). They suggest that animal breeding scientists, in their

focus on the technical aspects of selection, may have lost sight of some of the underlying biology of genetic selection. Thus they put forward the theory that if 'genetic changes are too radical or sought too rapidly, the population may lack the time required to adapt to the changes imposed on it by selection and the homeostatic balance of the animal is at risk' and that molecular techniques could exacerbate this problem (1998, pp27–29). This theory appears to hold true in the case of battery hens. As we saw in Chapter 6, the productivity of egg-laying hens is increased through the genetic manipulation of body weight and the environmental manipulation of day length. Yet the egg-laying pressures are such that a hen's body starts drawing upon reserves of calcium from its bones in order to make eggshell. Unsurprisingly, this weakens the bird's skeletal structure, contributing to welfare problems (Duncan, 2001, pp210–211). This is a further good example of the tension between capitalization and material limits discussed in Chapter 6.

The Farm Animal Welfare Council (FAWC) has for a considerable time drawn attention to the negative welfare impacts of conventional selective breeding techniques (1997, 2004), arguing that health traits should take precedence over production traits in breeding programmes. It is difficult for a welfare argument to have leverage if proposed changes would impact on already established breeding programmes that are commercially successful (see FAWC, 2004, p17). Nevertheless, as I discuss further below there *has* been a tangible shift away from purely productivist values in the research pursued by animal genetics scientists.

The hope from animal geneticists is in fact that more genomic information will allow the possibility to avoid the negative side-effects of selection, although it may be overly optimistic to think that molecular techniques will offer an escape from unintended consequences. This provides a good example of what Beck refers to as the 'boomerang effect' wherein 'sooner or later the risks also catch up with those who produce or profit from them' (1992, p37). Thus the over-rationalization of animal bodies comes unstuck and human attempts to push home the mastery of other species come up against a biological limit which potentially opens a space for critical reflection. But since solutions to the unintended consequences of genetic selection are generally posited in terms of more, yet different, genetic selection, it is clear that the critical reflexivity does not extend *systematically* to a questioning of selection per se. This is evident in Duncan's paper on animal welfare issues in the poultry industry where he repeatedly argues that the solution will be found in genetics (2001). It might appear odd that the very same technical/rational genetics approach that has been implicated in the problem should be turned to as a solution. On the one hand it may not seem reliable and, more sociologically, it may perpetuate a particularly genetic and arguably reductive view of the animal. Yet in the frame of animal breeding, it is difficult to conceive of an alternative that could actually address the physiological problems which animals face. This issue arose in the interviews with animal scientists. Thus in a discussion of lameness with an animal welfare scientist the following exchange took place:

> RT: *What causes that in most cases?'*
> AW Scientist: *It's a production disease; it's an intrinsic part of modern dairy production.*
> RT: *And so even though that's a production disease, there are moves to try and address that through genetic selection?*

AW Scientist: *Yes there are, you can select bulls whose daughters should have a better locomotion score. Several issues there, one is we believe on our side of the fence, the welfare side, they don't really measure this very well. And even if they did what we wanted them to do, there's an enormous amount of difficulty at this end just in measuring our farms. Consequently the heritability is poor. So they can't make much progress with it anyway because the heritability is slow.*
RT: *But it's using the same method that's produced it to try and address it, isn't it?*
AW Scientist: *You mean breeding?*
RT: *Yes.*
AW Scientist: *Yes, which is curious.*
RT: *Because if you tried to solve it through an environmental way, it wouldn't be cost-efficient?*
AW Scientist: *Well, people – very good question – I mean, yes, it's not just that they've been bred to produce lots of milk, they're also kept indoors, and the longer they're indoors, the bigger the risk they get lame. So they could be kept out more often, they could be fed at a lower rate and probably milked less often, that would probably reduce the risk. They could be in better quality cubicles. But that's investment. They could have their feet trimmed more often.*
RT: *It's labour cost?*
AW Scientist: *But it costs, this is the thing, it costs a lot. You know lame cows don't produce milk; they often have to be replaced. And that's one of the things that we've been trying to get across, as you know if you actually add up the hidden cost…*

So even though it's a production disease, it is multi-factorial and not wholly genetic, although there is a correlation between selection for productivity and lameness. In *some* cases, then, the economic context of agriculture may play a role in shaping which problem-solving strategy may be adopted. Yet the question of whether selection is returned to in order to solve a welfare problem also came up when I pondered on its curiosity to a geneticist:

Well it's interesting actually, because I could argue exactly the opposite. I could say if selection caused the problem, then selection stands the biggest chance of being able to correct it. Yes? But that would be my argument. I can understand that people would say well selection caused the problem so therefore we're going to do something else to resolve the problem. But if the problem exists through selection, unless you select against that problem, it will remain there. Unless we genetically improve cows for mastitis, they will remain at their current level of mastitis. So selection obviously has got to occur in order to be able to reduce the mastitis level. The way I see it that the problem has actually been not through selection itself but through inadequate selection.

This last sentence is particularly important as it reflects a view that is rather widespread in animal science that it is not a particular approach or technology that is 'good' or 'bad'

but how you apply it. This is a rather crucial point of contention vis-à-vis social views of science, where techniques themselves are seen as socially, historically and politically embedded. But to accept this might be to allow an overly critical stance that could undermine the rationale of conventional breeding itself. Therefore it is unsurprising that a position of technological neutrality is asserted. Nevertheless, due to the historical trajectory of genetic selection and its associated material construction of the animal towards productivity, there must in fact be some truth in the above quote arguing for a genetic response. Thus it would be incorrect to portray welfare scientists as against selection per se. On this point one welfare scientist said to me:

> *So it's like, you know I disapprove of the fact that we got there in the first place, but given that we are there and if these things are developed, I think that's the least we can do.*

In effect, a particularly productivist trajectory of farm animal domestication has produced both a technical and moral complexity. Similarly, welfare scientists were broadly strongly in favour of selecting animals that could cope with better welfare environments – a situation necessitated by the fact that due to a past history of selection for productivity, some animals are in fact ill suited in terms of strength, mobility and health for better welfare environments. Although a non-utilitarian ethical framework may want to take the position that it is selection itself that is the problem, animal welfare scientists operate within a context where pragmatism is to the fore and their wishes are constrained by the broader economic goals of commercial agriculture. But if animal welfare science is partly tasked with responding to public concerns about the experience of animals in agriculture, then it seems that, given the legacy of unintended consequences, there needs to be further critical reflection on selection itself. One important shift in selection goals that may be seen as a response to such societal concerns has been a new focus on health alongside productivity, and it is this to which I now turn.

'Welfare as Health' and the Idea of the Win–Win

Clearly it is in the interests of animal production to stem the effects of these unintended consequences not self-evidently for ethical reasons but because they also impact profitability. During my interviews, a recurrent idea was that of the win–win selection. This encapsulates a broader selection decision that is said to balance commercial pressures with concerns of animal welfare. In a way it might be seen as the perfect response to animal ambivalence, an attempt to satisfy both trends of instrumentalization and a partial subjectification in Western human–animal relations simultaneously. The concept was mentioned by both geneticists and animal welfare scientists. Here follow some extracts, each from a different scientist:

> *So in a way what we're doing is a win–win situation. If we breed animals that are more resistant to disease, the farmers spend less time and less money on preventative treatments but also the welfare of the animals is improved as well in that they are inherently more healthy than, you know, had we picked the wrong sire.*

I think many farmers would believe that pushing for very high standards of welfare that perhaps people who are detached from animals aspire to is going to cost a lot of money. But in fact a lot of our research on larger species at least shows that there can be win–wins here. In dairy cattle, for instance, we've shown that by expanding selection away from just milk production alone, to include resistance to mastitis and lameness and to include fertility, it is expected to increase economic returns as well as reduce welfare problems.

Obviously some diseases are of major economic importance, and if one could make animals that are basically fitter, healthier and more able to resist disease, then you're benefiting the animal, you're reducing the need to treat them with drugs and antibiotics, so there's a potential downstream benefit for the human food chain. And so there's a sort of a potential for a win–win situation if you can do that effectively.

There are quite a few examples where welfare and production values go hand in hand, but they obviously don't totally mix, or at least not in the eyes of society, otherwise there wouldn't be people saying ban these cruel factory farms. I don't see production and welfare as being equivalent, but I don't see there being a problem with working on a project in which both production and welfare are improved. And it's certainly more likely to be taken up by industry if you can show that you have invented something that's going to improve both welfare and production and everybody wins.

The emergence of sustainability as an important discourse for animal production has arguably provided a context for so-called win–win research projects with animal welfare scientists and geneticists working together. One example is a focus on the concept of 'robustness'. Thus a recent DEFRA-funded project explores the idea of the robust dairy cow. Here a robust cow is defined as one that adapts well to a wide range of environmental conditions or in genetic terms expresses a reduced genotype–environment interaction when tested across different environments.[6] This overlaps with the previous example of the need to select for animals that can cope with improved welfare environments, but 'robustness' is also about producing animals that are overall less sensitive to environmental variability.

It is important to scrutinize the implicit understanding of animal welfare that may be at play within the win–win and related concepts such as 'robustness'. Although reflexivity to the short-termism of pursuing narrow production breeding goals may have opened up the opportunity for broader, welfare-inflected selection criteria, it may be constraining the sort of welfare strategies adopted. While one might counter that it is not surprising that the boundary between production and welfare should become blurred, as they are both utilitarian approaches, the indistinction of the terms within the idea of the win–win raises philosophical questions over the very ethos of animal welfare. If we highlight the words of the welfare scientist above – 'I don't see production and welfare as being equivalent, but I don't see there being a problem with working on a project in which both production and welfare are improved' – the main ethos of welfare is perhaps one of pragmatism, doing what one can to improve welfare within the constraining context of commercial precedence. Furthermore, the approach of adapting

animals to particular environments may well open up novel ethical concerns. This was captured well in an extract with an animal welfare scientist:

> *Adapting animals to environments is not necessarily a bad thing, it just depends on how you do it and what the reasons are for why you do it. In the wrong hands it could be used, for example, to breed animals which are capable of coping with or indeed maybe thriving in what would currently be regarded as suboptimal conditions.*

In terms of narrow motives of commercial gain, it is not difficult to see the possible attraction of a more docile and perhaps less sentient animal that could be kept in cheaper conditions. Farmed animals have been bred for docility or tameness at least indirectly since the beginning of their domestication, but the molecular turn may open the opportunity to accelerate such behavioural selection. Breeding for behavioural change has been argued to have possible commercial benefits, such as improving production and product quality, reducing labour costs, and improving handler safety (see D'Eath et al, 2010). The FAWC report argues that 'while breeding for temperament has been carried out for hundreds of years, the protection of behavioural flexibility and sentience in animal breeding is becoming an issue where regulation may be necessary' (2004, p26). The report also offers the example of research on genetically blind hens that were said to be both more productive and had reduced stress levels.[7] Could, then, such animals be considered to be the products of a win–win selection? Molecular techniques may offer more opportunities for these sort of applications that ethically, as the FAWC report argues, go beyond issues of pain, stress and suffering (see 2004, p25), instead asking questions of the human, of 'how far should we go'. D'Eath et al (2010) refer to such possible animals as unreactive 'zombie' animals. In one sense this would fulfil a reductionist view of the farmed animal as 'walking protein' and could find appeal within a utilitarian emphasis on suffering. A contrasting view may see this as extreme domestication that overextends what 'we' ought to do. Recent research on the genetic basis of domestication (for example Albert et al, 2009; see also Nicholls, 2009) could ultimately expand the range of animals that could be domesticated. These are pertinent examples of how the molecular turn can throw up novel ethical questions. Arguably, however, they also bring domestication as a whole into critical relief, suggesting the obvious if difficult-to-achieve solution to such dilemmas as 'zombie' animals being found in not farming animals at all.

One might further ask how the legal status of farmed animals in the Treaty of Rome as 'sentient beings' as opposed to 'agricultural products' might inform this debate. Perhaps the Protocol on Animal Welfare as part of the Treaty, which made history by referring to animals as 'sentient beings', could be used to legally argue against such selection decisions. However, given the gradual selection for docility that has taken place using non-molecular selective breeding, one could anticipate that proponents would use 'arguments from precedent' (see Chapter 3) to try and justify such selection even if such changes could soon be more precise, biologically systematic and rapid. In addition, as Camm and Bowles point out, the reference to animals as 'sentient beings' does not in fact 'exclude the treatment of animals as goods or agricultural products in other contexts' (2000, p201). While sentience is one concept that may be introduced to perform a

protectionist role, a further one is that of telos.[8] Rollin has defined this as the 'set of needs and interests which are genetically based, and environmentally expressed, and which collectively constitute or define the "form of life" or way of living exhibited by that animal, and whose fulfilment or thwarting matter to the animals' (2003, pp344–345). It is, of course, potentially difficult to talk of a telos in animals that have been gradually but significantly selectively bred over a long period of time, which raises the question of whether the concept can do the work it is intended to perform. The complexity here revolves around the extent to which we can think of particular farmed animal species as representing relatively stable or essential 'forms of life'. Implicit here is the belief that domestication does not wholly disrupt such 'forms of life' and that animals still have needs and desires for particular (social) behaviour. Certainly in one reading Rollin's concept is not merely an argument against the molecular turn but counter to many types of breeding and animal farming operations.

Conventional selection and the use of molecular techniques can be used to impact on both the health and behaviour of animals. With increased knowledge of gene function and interaction, more complicated traits that have been harder to measure may come into the field of manipulation. Some of the initial literature on animal biotechnology addressed welfare impacts of GM and cloning (see FAWC, 1998; Holland and Johnson, 1998; Van Reenen et al, 2001), and while these partly revolved around their practical inefficiency, expressed in large numbers of deaths, potential behavioural change caused by GS or GM could be said to conform, in line with Rollin, to a demonstrative and radically compromised 'form of life'. The concerns for welfare science are that welfare may come to be seen more and more in terms of measurable health, function and performance, and that aspects of welfare that pertain more to the subjective and social life of animals – aspects which may have more of a cost in terms of their provision – will be de-emphasized.[9] The concern here may be that the partial geneticization of welfare is also an instrumentalization of welfare where aspects such as health and robustness may be seen as bound up in productivism as much as they are in welfare. Additionally they could be seen as invested in an overly biologistic account of farm animals, as was the concern of an animal welfare scientist:

> *On the other hand, there's also a trend, a parallel trend where it's almost like we're going backwards in time and welfare is becoming more and more an issue just of health, you know, physical health. And that is partly what we're talking about, you know, it's like metabolic stress, because they're in the first place conceptualizing animals as complex production systems and then they're talking about the health of that system. I see it as my own task and other colleagues' to counterbalance and to develop concepts that are close to the subjectivity of the animal. And to also, I mean, how could you possibly talk about boredom and depression, you know, in a complex metabolic system? It's not going to happen, is it?*

There is, of course, a historical legacy of seeing animals as more biological vis-à-vis the human (see, for example, Birke, 1994). It is just this legacy that many animal welfare scientists are trying to erode by stressing the subjective and social life of farm animals. But for some animal scientists, the use in the above extract of terms such as boredom

and depression represents an error of anthropomorphism. In the tensions that take place between welfare science and animal genetics, the charge of anthropomorphism is certainly deployed as a means to both reinforce human–animal dualism and to portray animal welfare as somehow less than scientific. It is more accurate to present the two fields (each diverse as they are) as in opposition over underlying assumptions of the animal and human–animal relations. Without wanting to dismiss the problems of anthropomorphism, the concept does operate to perform 'boundary work' (Gieryn, 1983) between different claims over 'real' science within the broader animal science field. Animal welfare scientists have long fought to establish their field in the face of such boundary work, a battle that has taken place within disputes over animal consciousness (Dawkins, 1993) and debates around the possibility of measuring animal subjectivity (Wemelsfelder, 1997). Classically, then, with its accoutrements of control, 'objective' measurement, statistics and dispassion, but most decisively in its service to applied commercial goals, genetics has been hegemonic. Attending animal science conferences as part of my research, it became apparent that welfare remains in a marginal position, and welfare scientists reported that they were more likely to attend 'their own' conferences. The debate over whether we can use terms such as boredom and depression is less important than recognizing a subjective and social life for animals and allowing also for the psychological as well as physical impact of close confinement and so on. The point here is that there may be a significant difference in the sort of welfare and accompanied notions of what constitutes a 'good' life for animals in agriculture allowed for in the language of the win–win and selection generally compared to that found in research that takes animal subjectivity and sociality seriously. Since molecular approaches such as genomics are not typically about seeing the whole animal but about probing causal relations between genotype and function within a commercially orientated rationale, it is likely that the sort of welfare framework employed (if at all) will be more akin to that expressed in the quotation above. This corresponds to the first framework discussed by Fraser (2003) at the outset of this chapter as welfare in terms of biological functioning. If this is correct, then molecular approaches could represent a consolidation of neo-Cartesian understandings of farm animals; and discursive jousting with some areas of animal welfare science as the site of their contestation.[10] In the final section of this chapter, I examine more closely the possible relationship that could emerge between genomics and welfare.

Genomics and Animal Welfare

If we were to attempt a position of neutrality in assessing the impact of genomics upon animal welfare, this would be an exercise in determining how social and economic contexts were likely to drive the application of emergent molecular technologies in farm animal breeding. However, a sociological approach in arguing for the sociality of scientific practice stresses that both science and technologies are redolent in meaning, values and goals. The naturalization of a broadly utilitarian outlook towards nonhuman animals is a case in point in animal sciences. Genomics, as we have seen, attempts to offer more precision and control in genetic selection. This is especially relevant for traits that may impact on welfare, as these are generally thought to be polygenic and difficult to measure using non-molecular means (DeNise, 2004, p4; Bishop and Woolliams, 2004, p913). Moreover, phenotype measurement of some traits is expensive and so marker

technology is seen as a possible solution (Dekkers, 2004; Plastow, 2006). Genomics is also seen as providing an important contribution to sustainable livestock production systems (Bishop and Woolliams, 2004).

As highlighted in the previous chapter, the emergence of sustainability as a key principle in agriculture and animal science funding has meant that genomics has become partly orientated to this agenda. This reflects a *partial* erosion of productivism in that breeding goals now may include 'socially and environmentally important traits' alongside the traditional focus on selection for economic output (see, for example, Kanis et al, 2005). There has been something of a shift from within animal science that indicates the awareness of a relationship between economic short-termism, unwanted side-effects and therefore economic unsustainability (see Olesen et al, 2000, p570). If one scrutinizes lists of currently identified genetic markers and commercialized DNA tests for these markers, one sees a diversity of foci (see, for example, Dekkers, 2004, p317; Rothschild, 2004a, p12; Hocquette et al, 2007, p164). Although we observe markers for growth, yield and reproduction which suggest a continued interest in output, we also observe markers related to more qualitative concerns such as meat quality (such as tenderness and fat content), congenital defects, and disease resistance or susceptibility. In spite of the diversity, they all relate to either decreasing costs or enhancing performance. The actual impact of a discourse on sustainability (and the question of which discourse) on the developing trajectories of genomics remains to be seen.

While some of the qualitative emphases to be found within markers and tests made possible by genomics research can be said to pertain to welfare and are discussed in such terms (Plastow, 2006), they speak to the indistinction between production and welfare discussed earlier. When the cost of disease to animal agriculture is put at £1.7 billion in the UK alone,[11] it is not surprising that this is identified as one important area where efficiency gains could be made. That genomics is seen as offering an advantage over conventional breeding in this area is significant to both its funding and general support. Other markers aim to be economically useful either through a further optimization of productivity or by adding value qualitatively to be attractive to niche markets that express consumer preference for a particular taste or for more healthy animal products. However, in terms of animal welfare, genomics would seem to conform to a narrow emphasis on welfare as health and performance that can be spoken about in terms of a win–win but may exclude other definitions of welfare. When welfare is narrowed to signal physical health, it is akin to what Marx (1867) referred to as the maintenance of the worker (albeit in humans). Thus the costs that pertain to the maintenance of the physical existence of the animal ensure continued existence as a productive body. In this case it is misleading to categorize certain measures taken, or modes of genetic selection, as welfare, even if they have the effect of maintaining animal health, because in an ethical sense the primary intention is 'product' quality. Moreover, the related Marxist concept of surplus value is also of relevance here, as welfare is also now a significant way to add value to appeal to certain sets of consumers.

Although it is commonly argued that Europe has high welfare standards (clearly a relative claim), they vary greatly around the world. The sort of research into 'robust' animals discussed earlier is also seen as attractive in terms of global standardization due to the aim of producing animals able to cope in a wide range of diverse environments. Indeed one might envisage a selected 'robustness' being an animal's main source of

welfare, with the concern being that animals will be selected to cope better with the poor welfare conditions touched upon earlier. In a discussion around 'robustness' research, one welfare scientist expressed that:

> *There is a lot of interest in immuno-tolerance in animals. If people could crack the immune system of pigs, for example so that they didn't get sick when you crowd them into buildings …*

A similar point was made in the FAWC report (2004) in relation to the development of genomics, specifically around markers for disease resistance. The report expressed the view that, once commercialized, production traits could take precedence:

> *FAWC recognizes that the application of gene-mapping to selective breeding programmes may be used to rectify recognized welfare problems, for example by selecting for specific health traits such as improved leg health in broilers. We are concerned, however, that with the considerable commercial competition between breed companies, the primary focus of attention will be for production-related traits.* (2004, p18)

It is naïve, then, to assume that commercialization will necessarily foreground either sustainability or a notion of sustainability that includes welfare. On the disease-resistance variety of genomics research, the FAWC report said:

> *While this will have obvious welfare benefits, it is important that the development of such strains is not used to disguise welfare-threatening conditions which would otherwise produce disease and does not discourage the development of higher standards of stockmanship and provision of a good quality environment.* (2004, p19)

The possibility of selecting animals which behaviourally disguise or mask underlying welfare problems has been referred to as the creation of 'stoic' animals (D'Eath et al, 2010). D'Eath et al give the example of animals who display stereotypic behaviour being selected against representing an approach that is only directed towards outward visible symptoms. This expresses a concern over welfare geneticization and the tension between a technical, health model of welfare and one that foregrounds attention to conditions and animal experience.

If here we can see potential risks over the commercialization of animal genomics, as with conventional selection, we can also point to some potential risks around the biology.[12] One example of genomics commercialization in the EU is the National Scrapie Eradication Plan, which uses gene-assisted selection to select for a haplotype that has been associated with scrapie resistance. Villanueva and Roughsedge point out three potential risks with the eradication plan (2006). First, a new transmissible spongiform encephalopathy (TSE) could arise which the currently favoured haplotype may not confer resistance to; second, the eradication programme may lead to lost attributes (in other words 'bad' genes can be 'good' genes and vice versa); and third, selecting exclusively on one line creates the potential for lost genetic diversity. Villanueva and

Roughsedge conclude that the plan 'did not initially consider the wider quantitative genetic implication of its aim. That is the association of non-disease traits with the various targeted genotypes and the effect that the plan would have on the management of genetic variation within the sheep populations' (2006, p12). A process of sperm banking of rejected strains is advocated as an insurance against loss of genetic diversity. It could seem that genomics is as subject to the unintended consequences that have been characteristic of the history of conventional breeding using non-molecular genetics.

This example – although the risks could turn out to be partly addressable through sperm banking – points to the possible dangers of adopting a narrow approach. If in this example we can note a concern of reductionism *within* genetic approaches, it is also this point which structures concerns of animal welfare scientists over genomics. The interviews illustrated that for some animal welfare scientists there were philosophical disagreements with the shift to molecular genetics:

> *Primarily my stance is that that whole paradigm is heavily reductionist. It is based on the purity reductionist approach to animals, and my problem with that is, you know, it's not wrong but it's a huge imbalance. And a claim of the objective science paradigm that that's the only objective paradigm… An animal isn't just a complex system, it's a being, a living being, a subject. And so where is the understanding of that animal? And, you know, another ethical term is integrity, intrinsic value, which I think is very important. And so where is the knowledge to balance reductionist[?] … it's nowhere to be seen.*

Indeed this extract goes beyond the utilitarian ethics of welfare and begins to explore a richer ethical agenda inclusive of deontological ethics. If we accept that molecular approaches may be fostering a far more abstract and desocialized view of the animal (Holloway, 2005), we can note here a real difference in animal epistemologies at play. This is emphasized further if we look at the research methods employed by one of the animal welfare scientists interviewed. This foregrounds the interpretations of people working directly with animals in the form of asking for their descriptors of the animals' welfare:

> *I ask people to develop their own qualitative descriptors. So I don't put it in their mouth, it's really they have to observe the animals and come up with their whole animal descriptors. So terms like 'aimless', 'purposeless', 'bored', 'depressed' – those descriptors came up in the intensive systems and the other systems, the enriched systems – it was like 'playful', 'content', 'lively', 'purposeful', 'busy', you know.*

For this scientist, the research was not only about constructing an alternative animal epistemology, but also about valuing the knowledge of human–animal relations that farm *workers* possess:

> *You can see that typically with knowledge transfer from scientists it is always from high up down and treating the people who work with the animals as if they don't have knowledge.*

This contrasts significantly with the molecular shift which eschews the ocular phenotypic knowledge of breeders as inferior to the interior gaze of molecular scientists (see Holloway, 2005). The molecular turn puts its faith in the technological gaze and farm workers are conceived less as potential sources of knowledge and more as potential obstacles to the application of genomics.

Although we should stress the diversity of positions within animal welfare science, we can see, at least for some, rather stark epistemological, philosophical and political differences over the 'animal' vis-à-vis those implicit within genetics and genomics. These contestations of the animal are on the one hand a tension point in the ongoing dynamic of society–nature relations and conceptualizations, and on the other a prerequisite for thinking about the possibilities, limitations and contradictions of 'welfare' in agricultural production. The concerns of this book have been that these possibilities are potentially being narrowed and the limitations being exposed by an intensification of the 'animal' as abstract genetic code within a global neo-productivism. Yet the strong relationship between animal welfare science and a pragmatic, utilitarian approach is arbitrary and largely shaped by economic context and scientific tradition. Moreover, it is limited and false to view animal welfare scientists as more values-guided while animal production scientists are merely to be seen as following 'hard' value-free science. No animal scientist can escape the fact that through their work they express particular epistemologies and ethics towards nonhuman animals. Just as we saw in the previous chapter conflicts between a productivist animal genetics and biological sciences concerned with human nutrition, morbidity, ecology and climate change, here we can also note significant divergences. Animal welfare scientists would be justified to argue that animal production scientists are unscientific to discount the social and emotional lives of farmed animals. They are in a difficult subservient role due to the economic context of animal production. It is not surprising that through a degree of pragmatism many now work with animal geneticists. However, in doing so they may observe subtle changes to the meanings of 'welfare' and ought to be reflexive to the possibility of capture. In this chapter I have argued that the application of genetics and genomics to animal welfare can be read as consolidating animal production by giving it the veneer of being more ethical. To some this will seem like an overly negative assessment. It is important not to suggest that there has been no shift in values. Yet as Hodges argues (significantly in a special issue of *Livestock Science* devoted to ethics in animal agriculture), 'The present generation of agricultural scientists working in the food chain has been tutored to value efficiency above all other values both in research and in practice' (2006, p268). Additionally, he wants animal scientists to better understand the moral expectations of diverse global actors in relation to food production. Animal scientists have already shown themselves to be adept at forms of interdisciplinarity. This needs to be broadened significantly in terms of ethics and political economy. Such a broadening is rendered less probable by the corporate enmeshments of animal science discussed in Chapter 6. The discourse of genomics suggests a positive effect on animal welfare in the form of ideas such as the win–win. But if, as this chapter argues, we can note both the narrowing of animal ethics to welfare and the subsequent narrowing of welfare to health within the politics of animal science, then there are reasons to doubt that such restructuring will be amenable to an ethics or a 'welfare' that can explore new animal epistemologies or human–animal relations that are more respectful to nonhuman life.

Conclusion

From the 'Livestock' 'Revolution' to a Revolution in Human–Animal Relations

The reality is that our lifestyles are unsustainable[1] – Rajendra Pachauri, Chair of the Intergovernmental Panel on Climate Change (IPCC), November 2009.

Fundamentally we are all facing a choice about values[2] – Margaret Chan, Director-General, the World Health Organization (WHO), November 2009.

Simplistic assumptions that capitalism's propensity for efficiency will allow us to stabilize the climate or protect against resource scarcity are nothing short of delusional – Tim Jackson, *Prosperity without Growth: Economics for a Finite Planet* (2009, p86).

Beyond the Livestock Revolution

It is notable that the use of the word 'revolution' with livestock (but also in the terms 'blue' and 'green' revolution) is essentially a capturing of the term from a previously political meaning to one of economic growth, productivism and quantity. In this concluding chapter, I recuperate the word, bringing it back to its political and ethical dimensions while at the same time acknowledging the complexity of this process as it pertains to human–animal relations. If climate change can be understood as the failure of our technological and economic systems to comprehend the intersections of human activity with undervalued nonhuman actors, should it be any surprise that policies of redress ought to begin with a thorough questioning of both the assumptions of dualistic separation and our values toward the nonhuman? Reconsidering both dominant interpretations and casual acceptances of human–animal relations should be at the heart of climate change policy and sustainability, broadly conceived.

This has been the mode of reflecting on animal biotechnology in this book. The approach to the molecular turn in the sciences of meat was not restricted to a narrow

technology assessment but situated within the broader questioning of human–animal relations and their multiple intersections. In Parts I and II of this book, the sociological and bioethical toolkit was revitalized in order to create a more accountable approach for understanding the cross-species entanglements found within developments in biotechnology. The extra-academic relevance of Part I was to argue for policy responses that need to, first, entertain a more comprehensive appreciation of the ways in which the ethical can be thought of in relation to other animals, and second, via the counter-dualistic understanding of the human as materially embedded, to conceive human and animal flourishing as variously interdependent. The nascent regulatory moves discussed in Chapter 4 were indicative of what happens in the absence of such institutional learning, illustrating how far away we are from a global system that can act against moves to further intensify global animal production. Chapters 5 and 6 outlined the biopolitical reduction of farmed animals in capitalism and illustrated early corporate interest in both the molecular turn and in exploiting the markets of developing countries. Advocates for animal biotechnology were seen to enthusiastically contextualize the molecular turn within both discourses of livestock revolution and the knowledge-based bio-economy. The latter enrols molecular biology and other biosciences as vehicles for the reinvention of capitalism based on their perceived ability to coax and transform biological life into perpetually self-generating capital. In the case of molecular animal breeding, this is understood variously as a more sustainable, economically efficient and productive farmed animal body that, for example, can subsist on less feed or have less environmental impact. This points to a proliferation, at least in the short term, in the modes of capitalization of animals that includes transgenic forms that breach divisions between human and animal and medicine and agriculture.

More positively, 2009 may in retrospect be seen as a watershed year in that the climate change questioning of meat and dairy reached significant new breadth and intensity. This has included the part liberation of the 'livestock revolution' into public discourse and critical scrutiny. One of the tasks for Part III of this book was to denaturalize the view of the LR as demand-driven and as somehow rooted in 'human nature'. Like predicted increases in air travel and attempts to excavate hard-to-reach sources of hydrocarbons,[3] it is on a collision course with climate change mitigation goals. While the attempts of animal scientists to capture sustainability in the genome could be seen as well intentioned, it would require an extraordinary leap of faith to think that the molecular turn can shore up the various deleterious externalizations of the livestock industry played out on ecologies, human and animal bodies. Advocates for animal biotechnology are left with two possibilities. They can optimistically argue that the molecular turn will rise, via the research programmes outlined in the previous two chapters, to the challenges of sustainability. Alternatively, they can scale back their ambitions and argue against the equating of the molecular turn with a productivist livestock revolution. Given that the animal ethics vision of the molecular turn is at most a weak, arguably economistic, rendering of welfare, neither of these positions will constitute an adequate response to the ethical questioning of human–animal relations favoured by critical animal studies. On the contrary, for CAS what is required is a radical posthumanist value shift that reconceptualizes the human through the proliferation of truly sustainable eating practices. Before returning to a more detailed analysis of these points, I begin by summarizing the problems with the molecular turn casting itself as

part of the livestock revolution. This also bears on recent debates around sustainability, economic growth and climate change (Jackson, 2009).

Much of the mitigation discourse in climate change is concerned with underlining the dangers of continuing a 'business-as-usual' model of growth in carbon-intensive sectors, most obviously energy, agriculture and transport. It is worth reiterating that the LR is not a 'business-as-usual' model of economic growth. It significantly *exceeds* this. Indeed it is a projected doubling of meat and dairy consumption by 2050, when population is 'only' forecast to increase by a third in this period. Inasmuch as it could be seen as a good short-term idea for generating capital for livestock production corporations, it can certainly also be seen as a stunningly bad idea for both food security and climate change. It is difficult to conceive that these latter considerations could not take precedence. Moreover, in Chapter 7, I questioned whether the LR is actually feasible. To recall, conflicting demands for limited oil and land could threaten its attainment. If climate change begins to impact on crop cultivation, the ability and desirability to give over so much land to animal feed may be compromised. This issue of land conflict raises a curious point about the livestock industry. The biopolitical proliferation of the sheer global scale of exploited farmed animal life – of which the sciences of meat are an important part – is simultaneously anthropocentric and misanthropic. The latter assertion is expressed in at least two forms of intersection between human–animal relations and human–human relations. Both are examples of animal exploitation that also engender unsettling forms of injustice, most obviously along lines of class and race.

First, we can note the biopolitical bringing into existence of substantial populations of farmed animals that are essentially given subsistence preference over that of many humans. A recent report by the United Nations Environment Programme (UNEP) on the global food crisis highlighted the problems associated with meat and animal feed production. It highlighted the now well-versed argument of the energy inefficiency of meat, producing various impressive calculations of how many humans could be fed if cereals were not used as animal feed (Nellemann et al, 2009, pp26–27).[4] There are complexities here to bear in mind, such as the (in)ability of different land/soil types to support crop production and, as the report points out, the present role of extensive livestock production in contributing to food security in some regions of the developing world. However, these do not ultimately detract from food security arguments for reductions in meat/dairy production. Second, as highlighted in Chapter 7, changing land-use patterns partly instigated by Western food corporations to increase the proportion of land given over to animal feed (for example in Paraguay and Argentina) have significant harmful effects on vulnerable human populations. These examples also call into question the ability of the LR to take on the role of feeding developing world populations, since the broader context of meat/dairy expansion may be harmful to the ecological and social fabric of such countries as well as to the health of those populations. The LR is a paradigmatic form of response to food crises in terms of trade and increased productivity, a method that has continually excluded the political economy of food and failed millions of people in developing countries. While effective strategies for addressing food insecurity will arguably involve a reconception of food as a public good rather than a market commodity (Jarosz, 2009, p2079), they must also address the way in which the carbon-intensive livestock–grain complex has been a conduit for constructing food

dependency rather than food sovereignty (Weiss, 2007; Jarosz, 2009). Climate change will only exacerbate food security issues, and it is now recognized that the two issues must be addressed in a joined-up strategy, and increasingly that involves calls for a reduction in meat production and consumption.

One of the most significant recent contributions to debates on sustainability and climate change has been Tim Jackson's *Prosperity without Growth – Economies for a Finite Planet* (2009). Although the product of the UK government's Sustainable Development Commission, it breached something of a political taboo by questioning economic growth, engendering a lukewarm response from government. However, this is unfortunate, since a refusal to acknowledge that important elements of capitalism are antithetical to sustainability assumes a business-as-usual economic model and, predictably, an overemphasis on market responses to climate change such as carbon trading and technological efficiency. One of these fundamental elements, as Jackson argues, is an understanding of economic stability in terms of continued growth in consumption. From here it is not difficult to note a further source of the political anxiety over positions that question economic growth, since they also place a question mark over the sustainability of Western lifestyles and the way in which the 'developed' world's levels and varieties of consumption have been based on something of a dualistic fantasy – one which ontologically separates human behaviour from ecology. Yet while politicians are wary of being seen to 'tell people how to live their lives', a transition to sustainable consumption, as I shall underline shortly, is accompanied by various beneficial dividends. In some ways, Jackson's analysis is a classic critique of economic growth as failing to respect material and ecological limits. Although human–animal relations are not on his radar, we can relate some of his analysis back to the concerns of this book.

Such an analysis based around ecological limits is in opposition to the bio-economy discourse discussed earlier. To recall, in a perspective that shares certain affinities with transhumanism, the bio-economy champions biotechnology for its ability to reinvent definitions of biological limits, to improve the efficiency of production and to exploit what it frames as new sources of biological capital. In Chapter 6, I presented critiques of this view that either posited increased efficiency and speed as acting against long-term capitalization (Brennan, 2000) or were critical of the bio-economy assumption that value was inherent in biological organisms rather than produced in the context of contingent economic and social relations (Jessop, 2007). Large-scale animal production turns out to be a useful illustration of this disagreement as well as providing further evidence for Jackson's position. Bracketing out direct animal ethics questions for the moment, it is true that the sciences of meat have been very successful in contributing to increased output of animal products. The biopolitics of animal bodies reads like an impressive achievement in efficiency. However, we should not confuse the ability of scientific biopower to increase output with the actual surpassing of finite limits. The dramatic scaling up of the harnessing of the reproductive power of other animals is ontologically blind to its dependency on finite resources of land, oil, water and feed, as well as to the impacts of its deleterious ecological outputs. In common with Jackson's broader critique of Western unsustainability, this has been a short-term capitalization working on borrowed time and appropriated resources that is now rightly being opened up to critical scrutiny. In Chapter 7, I reviewed the ways in which animal scientists

are trying to make animal production more efficient and ecologically benign, as well as how bodies such as the FAO favour this managerial/technical response to climate change mitigation. These conform to what Jackson refers to as modes of decoupling. He writes:

> *The conventional response to the dilemma of growth is to appeal to the concept of 'decoupling'. Production processes are reconfigured. Goods and services are redesigned. Economic output becomes progressively less dependent on material throughput. In this way, it is hoped, the economy can continue to grow without breaching ecological limits – or running out of resources.* (2009, p67)

Jackson further distinguishes between 'relative' and 'absolute' decoupling. The former refers to a decline in the ecological intensity per unit of economic output. As he points out, global 'energy intensity' is now 33 per cent lower than it was in 1970 (2009, p69). Absolute decoupling, on the other hand, refers to a decline in resource impacts in absolute terms. Thus we can have relative decoupling without absolute decoupling. In spite of declining energy and carbon intensities, CO_2 emissions from fossil fuels have increased by 80 per cent since 1970 (Jackson, 2009, p71). Efficiency gains are superseded by overall growth in economic output. This sort of approach can also be seen in the aviation sector. New planes such as the Boeing 787 Dreamliner will be more fuel-efficient as they are made from lighter materials. However, this will make little or even no absolute difference given forecasted increases in global aviation. We can now frame the knowledge-based bio-economy utopian visions of biotechnologically driven green capitalism as a confusion of these two forms of decoupling. It overestimates the ecological and sustainability potential of relative decoupling while omitting the importance of absolute decoupling. Jackson outlines the failure of absolute decoupling to occur not only in GHG emissions but across different examples of material consumption. Moreover, he makes the important point that resource use and carbon footprints of OECD countries such as the UK are difficult to calculate in a globalized economy where the manufacturing sector has to an extent been outsourced to developing countries (we can refer back to the example of animal feed crop cultivation), entailing that they have almost certainly been underestimated (2009, p73; see also Helm et al, 2007).[5] Jackson is not against attempts to increase resource-use efficiency, but convincingly argues that blind adherence to what he terms the 'myth of decoupling' will simply not deliver long-term sustainability. The outcome of this discussion is that there is little choice but to confront consumption and to critically reflect on 'development' and 'growth'. Jackson's thesis is that we urgently need to develop new macroeconomic structures that are sustainable and incentivize sustainable forms of consumption. This points to a radical reinvention of the idea of Western progress and an imperative for 'developing' countries (though we should rightly see all nations as 'developing' now) not to follow the carbon-intensive pathways and power relationship mistakes of the West.[6]

Reducing Meat and Dairy Consumption

In endorsing Jackson's analysis, I posit human–animal relations as highly significant and meat/dairy consumption as a sectorial example of his broader argument. The 'livestock

revolution' should be rolled back – this entails policy interventions that simultaneously counter the increase in meat/dairy consumption in developing countries and levels of Western consumption. One might be tempted to read in this a transition during the narrative of this book, beginning with a biopolitics of animal bodies and now culminating in a biopolitical population management of human consumption practices. However, this would be to miss the posthumanist ontological approach that has been favoured here. Chapter 3 made clear the intersections between the biopolitics of human and animal bodies. Moreover, the continuing LR global increases in meat/dairy consumption also enrol a biopolitics of the management of *human* consumption practices and an imposition of 'truths' about the human body and notions of societal progress. Transitioning to calls for a reduction or elimination of such consumption similarly cannot escape multi-species biopolitical questions and puts forward its own truth claims about the human (body), health and ethics. In addition to the chorus of similar calls outlined in Chapter 7, a reduction discourse dovetails with the recommendations of three recent reports in the UK around the interconnections of food, sustainability and climate change.

The first of these, 'Livestock consumption and climate change – A framework for dialogue', produced by the Food Ethics Council (FEC) (MacMillan and Durrant, 2009), is a measured report that investigates various methods for decreasing the GHG intensity of livestock production. The report concurs with the above discussion, arguing that technical abatement (techno-scientific attempts to improve the eco-efficiency of livestock production) cannot reduce our carbon footprint as much as is needed (MacMillan and Durrant, 2009, p10).[7] The report then turns its attention to consumption and outlines perhaps the first detailed examination of how a government can act to influence the consumption of meat and dairy downwards. Under four strategies – changing preferences, knowledge, availability and price – the report considers various approaches and interventions. These include such approaches as informing and education, improving the labelling of the GHG intensity of food, reducing the availability of GHG-intensive foods, taxing GHG-intensive food, and subsidizing lower-impact practices. It also touches on recuperating externalizations of environmental impact and animal welfare back into the product cost. The report is not intended to be evaluative but to put various interventions on the table for policymakers to assess. It attempts to consider each intervention in terms of its possible risks to the environment, animals, producers and consumers. This sort of approach is important, as it is imperative that livestock producers are given assistance in changing their operations. It is unsurprising that we have begun to see bodies such as the National Farmers Union (NFU) arguing against reduction policies. The report shies away from an intervention that would proactively promote vegetarianism or veganism – I will return to this point in a while.

The second recent report of relevance here is from the aforementioned Sustainable Development Commission (SDC). Entitled 'Setting the table – Advice to government on priority elements of sustainable diets' (SDC, 2009), the report was tasked with clarifying what a sustainable diet means, especially in relation to climate change, and in aiding the UK government to construct policy on sustainable and secure food intended ultimately to guide both consumers and changes to the supply chain. The report, in consultation with a range of stakeholders, constructs 13 guidelines that include consume less, store and cook food in more energy-efficient ways, consume more organic food, reduce food waste, accept variability of supply, and reduce consumption of meat and

dairy products. Furthermore, a hierarchy of interventions is proposed whereby changes likely to have the most significant and immediate impact on making our diets more sustainable, in which health, environmental, economic and social impacts are more likely to complement each other, are prioritized. The three recommendations which the report gives most priority to are reducing consumption of meat and dairy products, reducing consumption of food and drink of low nutritional value (fatty and sugary foods), and reducing food waste (2009, p38). Its findings also highlight less obvious national and global social equality benefits of reducing meat/dairy consumption (p23). Nationally, these are decreased dietary cost, given that vegetarian diets are less expensive than meat diets, and health benefits of eating less red and processed meat, which could be experienced more by low-income groups who presently consume more of these foods. Globally, overall consumption decreases would reduce food prices, since cereal crops currently grown as animal feed could be used to feed humans. The report argues that this is particularly true in South America, where dependence on soy has produced increases in the price of other cereals. Finally, reductions could boost employment in areas such as South America where methods of livestock and animal feed production are not labour-intensive. These are all important points and they are demonstrative of intersectional analysis. They add to the case that the especially commodifying human–animal relations represented by meat and dairy exacerbate human–human inequalities. The report rightly acknowledges potential cultural restraints to reducing meat and dairy consumption, but its findings and those of the FEC are indicative of the way in which this issue has snowballed into prominence.

The third 'report', timed to coincide with the December 2009 United Nations Climate Change Conference (COP15) in Copenhagen, was a special issue on 'health and climate change' published in *The Lancet*. This can be seen as complementary to their 2007 issue on 'energy and health' outlined in Chapter 7. It starts from the prognosis that climate change is the biggest global health threat of the 21st century (Horton, 2009, p1869). However, the framing of the issue is significant for its positive focus: acting against climate change is an opportunity that can reveal a significant health dividend (Chan, 2009). Covering mitigation strategies in the four sectors of food, transport, household and energy, and the health impacts of short-lived GHGs such as black carbon, the papers in the issue argue overall for net benefits and sometimes substantial benefits to health from measures to combat climate change. They argue that such findings constitute an 'additional and immediate rationale for reductions in GHG emissions beyond that of climate change alone' (Haines et al, 2009, p2104). The paper on food, which is essentially concerned with meat consumption, assessed two strategies that would attain a 50 per cent reduction in GHG emissions by 2030 (Friel et al, 2009).[8] Strategy 1 looked at the ability of agricultural technological abatement to meet this target, and Strategy 2 assessed decreased livestock production in addition to abatement. In common with the FEC report, they concluded that abatement alone would be insufficient and that it would need to be accompanied by a 30 per cent reduction in livestock production to meet the 50 per cent target. The study admits its limitations, however. While it argues that such reductions entail lowered saturated fat intake and cholesterol and so a health dividend from, for example, reduced heart disease, it does not consider obesity and diet-related cancers. Moreover, it is a simplification to assume in the context of global trade that national reductions in production equate to similar reductions in consumption.

The paper also appears confused over the issue of 'need' and nutrition. Within the same paragraph the authors write 'an important challenge in public health is to balance the need for adequate population intake of animal-source protein and essential nutrients with reduced consumption of saturated fat' and shortly thereafter 'adequate protein, energy, iron and zinc can be obtained from a plant-based diet' (Friel et al, 2009, p2022). Presumably given the latter statement, a climate–health dividend with a larger impact (reflected in a larger reduction in production) could be achieved than the authors suggest. In common with the two previous reports, the paper ends with a brief consideration of policy levers to achieve its suggested 30 per cent production reduction. These are comparatively similar to those already noted above – food pricing, marketing, labelling – but without any comprehensive formulation of the national and international policies it says are required.

All of these reports are correct to highlight the positive opportunities and dividends of reductions. This begins the necessary task of moving climate change discourse away from notions of sacrifice, austerity and discipline to a more embraceable narrative of social and environmental flourishing. Jackson has also written of the idea of dividend from reduced consumption, but in a more social psychological sense (2005, 2009). This taps into well-established critiques of materialism arguing that in some senses 'less is more', that if we consumed less, people would be happier. We are also gradually being brought back to an important theme with which I began this book, namely deliberations over 'what is human'. In distinguishing between material and non-material needs, Jackson argues that in rich Western countries (we can now understand this bounty in terms of a carbon time-bomb alongside more traditional understandings in terms of global inequality), we have become adept at trying to satisfy non-material needs materially (2005, p25). What this means for Jackson is that our non-material needs – he includes needs for affection, participation, understanding, identity and idleness – are increasingly satisfied through material consumption practices. Immediately a theory such as this is open to the critique of trying to fix 'the human' in various ways; it is, as Jackson points out, a humanistic needs-based critique of modern development (2005, p25).[9] But while it may be humanist in the sense of its assumptions of human need, it is also counter to the universalistic idea within capitalism that promotes this role for consumption practices in neglect of its impact on the more-than-human. The implication of such theories is that the qualities of our relationships have become insufficient to satisfy these non-material needs,[10] that we now mistake material objects as needs in themselves and that we should reclaim non-commodified social relationships to address non-material needs. Thereafter we might recognize a certain dividend in our sense of self and social integration. This could be co-opted as another reason for embracing climate change mitigation through less material sustainable practices, but I am more concerned to tease out its relevance for meat/dairy reduction strategies.

Both the FEC and SDC reports correctly highlight that many of their suggested interventions necessitated by the transition to sustainable food and specifically reductions in meat/dairy consumption will face obstacles. Both reports advocate further research and can be read as enrolling social science approaches to consumption practices in this task. These are in fact complementary to the goals of UK sustainability policy revealed in the publication 'Securing the future – UK government sustainable development strategy', which constructs policy at the community level designed to help

people make more sustainable choices (DEFRA, 2005; see especially Chapters 2 and 6). In this vein, there is an emerging urgent policy requirement to further understand the sociology and psychology of eating practices, in particular those barriers that may hinder reductions in meat/dairy consumption. From Jackson's point above, we can note that meat/dairy consumption can also be read in part as an example of an attempt to satisfy non-material needs through material consumption, even though traditionally it has been conceptualized simply and uncritically as the naturalized satisfaction of human material need. The need for food is equated with a need for meat/dairy consumption. As Jackson (2005) highlights, more recent sociological theories of consumption have criticized this needs-based critique in order to underline its exclusion or devaluation of consumption as a set of practices that give people meaning through the symbolic value of material goods. This has some resonance with the ontologically posthumanist rethinking of sociality underlined at the outset of this book. Social life can not only be rethought as interactions between humans and other animals (and other living agents), but also in terms of the way we practically interact with material goods. When animals are commodified in various ways, notably as food, these two ways of 'rethinking the social' overlap. Therefore the human resourcing of other animals extends beyond the material – they are made 'useful' in a whole myriad of ways. Speaking of consumption generally, Jackson writes:

> *We consume in order to identify ourselves with a social group, to position ourselves within that group, to distinguish ourselves with respect to other social groups, to communicate allegiances to certain ideals and to differentiate ourselves from certain other ideals. We consume in order to communicate. Through consumption we communicate not only with each other but also with our pasts, with our ideals, with our fears and with our aspirations. We consume in pursuit of meaning.* (2005, p31)

These are undoubtedly important points, but also hint at problems of generalization and naturalization. That is to say, not everyone uses consumption in this way to the same extent; not everyone is essentially tied to particular modes of consumption by virtue of their self and social identity. Moreover, the extent of these practices is very probably historically and spatially contingent, bound up in the development of capitalism. This is not to say that people do not shape themselves materially in non-capitalist contexts, but that this sociological turn to the meanings within these relations ought to be careful to not simply naturalize capitalism as a perfect complement to underlying inviolable 'needs' of the 'human'. Instead of settling for a lazy humanism, we can call on the relative fluidity of posthumanist thinking here in keeping open the possibilities of living sustainably. A recognition of the sociality of objects, as Jackson seems to concur, 'opens up the tantalizing possibility of devising some other, more successful and less ecologically damaging strategy for pursuing personal and cultural meaning' (2005, p32). However, as he later acknowledges, this possibility is often thwarted by the lack of incentives for sustainable consumption and, worse, structures of subsidy that favour and 'lock in' unsustainable practices, for example private over public transport (Jackson, 2009, p151). The same, of course, applies in the structural subsidies given to meat/dairy production. It is clear that incentives for sustainable food practices have to be a central part of policy.

In this light, with the goal of reducing meat/dairy production, governments should not be afraid to promote, incentivize and facilitate vegan food practices – those that have the lowest carbon footprint. The case of the relative societal normalization of vegetarianism can be a guide. For example, governments can work with the food retail sector and national vegan societies to improve choice, provision and labelling[11] and work to dispel the common assumption that these are food practices based on sacrifice and a loss of pleasure.[12] The UK government has been rather wary of advocating vegetarianism (let alone veganism), most probably due to pressure from the meat/dairy industry, and though much more research is required in thinking through how to successfully downsize this sector,[13] the promotion of healthier, less carbon-intensive food practices should be understood in terms of opportunity.[14] If action on climate change is urgent – and in spite of degrees of scientific uncertainty inherent to modelling, it seems wise to believe that it is – then all workable strategies for sustainable living need to be explored. While no one strategy is a panacea, those pertaining to dietary change are advantaged by not having to rely on speculative technological innovation. The failure of politicians at COP15 in December 2009 to agree on a legally binding agreement (including no undertaking to sign one in 2010) or national emissions targets could be read as adding to the urgency of pursuing such strategies. If international agreement is figured as a starting pistol for change, then the significant shorter-term target for the peaking of carbon emissions will very likely be missed.

These points on theories of consumption and policy suggest several important avenues of research. First, we must attend to the symbolic power of meat/dairy. Second, and relatedly, using a framework of intersectionality we can construct a better understanding of how such consumption has been a resource for particular categories of identity and human sociality. And third, those groups of citizens, for example vegetarians and especially vegans, whose practices and flourishing undermine an account of meat/dairy consumption as a material need, should be seen as resources for understanding successful transitions to a more sustainable diet. There is already considerable work on the symbolism of meat and to a lesser extent milk (see, for example, Barthes, 1973; Adams, 1990; Fiddes, 1992; Birke, 1993; DuPuis, 2002). Thus meat has been associated with class, strength, masculinity, colonial power, regional and national identities, as well as notions of human dominance and being at the top of a food chain. The human consumption of cow's milk has been associated with ideas of purity and, as DuPuis points out, became bound up in American social reform ideas of the perfecting of human society. Milk as a beverage did not become widespread and normalized in the US until the end of the 19th century (DuPuis, 2002, p6). The high per person levels of meat/dairy consumption in the West are recent historical developments and such symbolism has been a significant element in their popularization. Animal advocates have contested such meat/dairy symbolism, striving to amplify cultural reconnection to its material reality of pain, death and exploitation. Partly as a backlash to these challenges, we can, as Parry argues, note a more recent Western valorization of animal slaughter in gastronomic discourse that can be read as nostalgia for reconnecting with the 'natural world' (2009, p248), but perhaps more fundamentally as nostalgia for the symbolic framework of human–animal hierarchy. A similar point could be made of the hypothetical possibility of mass-produced in-vitro meat. This may be seen as the ultimate attempt to produce 'ethical biocapital', while leaving intact the symbolism of meat consumption.

As noted in the introduction, using a framework of intersectionality is one method with which to begin to grasp the intransigence but also the potential mutability of human–animal relations defined in terms of meat/dairy consumption. This line of research probes the complex ways in which particular mastering human–animal relations are bound up in understandings of group identity. To recall, degrees of resistance to reducing such consumption may be because for many people they underpin part of what it means to be human. Reducing or eliminating meat/dairy from one's diet may conflict with its intersection in human notions of difference. For example, there is a cross-cultural association between forms of masculinity, distance and domination of 'nature' and the consumption of meat.[15] Although behaviour cannot simply be read off from intersecting social categories, for some men giving up such practices may also conflict with their own sense of masculinity. Not eating meat may be associated with social groups that some may not ordinarily choose to identify with, or quite literally a 'loss of manhood'. Drawing on a framework of intersectionality underscores how sustainability transitions are bound up with the need to reconceptualize human social relations. For example, if sustainability practices are gendered, then strategies that also question understandings of gender are also required, because gender and other identity categories act to lock in various unsustainable practices.[16] Although this framework adds complexity to the problematic of engendering sustainable practices, it offers further potential dividends in the sense of fostering sustainability while simultaneously addressing varied forms of justice.

This was the point made in activist discourses leading up to COP15 in December 2009 using the phrase 'climate justice'. Such possibilities are located within debates about the meanings and breadth of 'sustainability'. A narrow economistic use of sustainability that foregrounds the efficiency of production and the reproduction of capital over the political relations of production and consumption is prone to exclude knowledge of how social groups may be differently impacted by particular modes of engaging and exploiting 'nature'. However, the approach in this book, by highlighting posthumanist reflexivity around both the ontological and ethical dimensions of human–animal relations, has been to complement positions that underline sustainability as both gendered and classed with one that posits human–animal relations themselves as central to its definition. Chapter 8 noted attempts to conceive animal welfare as part of sustainability, but in line with other critical animal studies scholars, I argue that this is insufficient and too amenable to capture in terms of perpetuating the business-as-usual commodification of nonhuman animals. As Chan's quote at the outset of this Conclusion chapter points out, we are faced with questions about values. Sustainability defined as a technical challenge to improve efficiency excuses us from considering such questions.

The third avenue of social science research highlighted above is to turn to pre-existing communities already practising various modes of sustainable living. Examples of communities that have specifically politicized food as an 'arena of struggle and a realm of connectivity' (Goodman and DuPuis, 2002, p17) include the Slow Food movement, organic food, raw foodists, permaculture, as well as vegetarians and vegans. All these are orientated towards sustainable eating practices, even if there is variation between and within in how sustainability is defined. Moreover, they are also interested in reconnecting the knowledge and spatial gap between production and consumption common to the commodification of food. These movements are on the margins of society, but because they are characterized by particularly and appropriately reflexive

actors, they ought to be seen as a 'resource' for understanding sustainability transitions and achieving sustainability goals. Their possibility of being mainstreamed is partly compromised by their over-representation by the 'white middle classes', but this is somewhat related to the problems of economic disincentivization noted earlier. There is a need to better understand how sustainable food transitions may clash or be facilitated by the pre-existing and diverse socialities present in society. Specifically returning to the issue of meat/dairy reduction, it is worth bearing in mind that the majority of vegans formerly consumed meat/dairy (and vegetarians meat). Thus we can examine the social and emotional process of such transitions and learn lessons for others.

To what extent do such transitions (that constitute a reconceptualization of human–animal relations) clash with other relations and identities? Which knowledge resources, for example cooking skills or nutritional information, are important for such transitions? How is sociality renegotiated after transition and when re-entering meat/dairy-consuming communities? What are the pleasures and pitfalls of such transitions? How can they be better facilitated? These are just a small sample of questions that are worth probing. DuPuis has argued, in relation to sustainable practices and veganism specifically, that a 'community of practice' is important to help give practices feelings of satisfaction and self-esteem, and to protect against potentially disincentivizing social censure and denigration (2002, p216). Policies that bolster such abilities of communities could represent an untapped important strategy for aiding transition.

Furthermore, as I noted in Chapter 1, it may be productive to couch unsustainable practices in terms of habit, highlighting the non-rational basis of social norms and choice. As the sociologist Alan Warde puts it, 'The dispositions of agents to act within a practice are deeply entrenched *and* embodied; there are emotional and corporeal as well as cognitive bases of behaviour' (2005, p140, original emphasis). This approach, which focuses on social practices, alludes to the limits of policy that seeks to encourage sustainable behaviour merely through the communication of knowledge and guidance that people are expected to rationally follow. Moreover, it reinforces the view that philosophical perspectives on animal ethics alone cannot carry the burden of rationally convincing people to change their behaviours. While I have argued for the importance of a pluralistic and broadly conceived animal ethics, the register of ethics may not ultimately be the *most* effective space in which to foster urgent sustainable eating practices. If, as sociologists such as Warde argue, practices are habitual, entrenched and routinized (rather than merely emanating from 'mistaken' ethics), then sustainability transitions are likely to be fostered by actually building multi-level social infrastructures that can facilitate the formation of novel sustainable eating practices. In the positing of habit as important, there is a tension here around the degree to which we might argue rather generally that humans are inherently habitual. However, even if embraced, this view does not have to equate with a nihilistic retreat into the intransigence of 'human nature'. Lumsden argues that:

> *Even if one is persuaded and forced to recognize that a particular practice – for example meat-eating – is in fact a norm, not a given fact of reality, but something that needs to be justified, the demand to give reasons for it causes discomfort, largely because it is an* unrecognized *norm or value in which we are invested and that is intimately tied to our sense of self.* (2009, p204, original emphasis)

This would seem to enrol the importance of policy that is sensitive to this discomfort and appreciative of how more sustainable practices may be productive of new senses of self that eschew traditional assumptions of, in this case, human–animal hierarchy. Once again, sustainable communities are resources for exploring alternative norms, routines, practices and values. While initially these may be disruptive to habitual modes of practice, they seem to *not* ultimately culminate in a fury of fraught self-anxiety, but rather act to further catalyse and consolidate sustainable practices as *constitutive* of the self.

Beyond Efficiency

At this stage we can bring into relief an obvious omission within this discourse on meat/dairy reduction. As was noted towards the end of Chapter 7 and now reinforced by the three reports discussed above, this narrative operates on the understanding that meat/dairy equate to a particular unsustainable commodity rather than also a dominant part of human–animal relations.[17] Absent is a questioning of these relations for how they impact materially on the experiences of farmed animals. It is noticeable that the above arguments around dividends – alluding to the human health and environmental benefits of GHG mitigation or the humanistic flourishing of 'less is more' sustainable consumption – are unambiguously anthropocentric arguments. This is of interest, since if we understand climate change as being in a significant way the result of (Western) humanity's failure to both understand our material interdependency with the more-than-human and to value this beyond a property relation, then it is curious that we would choose to reproduce a human-centred frame instead of actually *questioning* those values. Environmentalists and animal advocates could with some justification argue that had their questioning of these values been given more political weight earlier, then we would not face such a small time-window for change. The anthropogenic land-use changes that are driving climate change have already taken a toll on species habitat, and climate change itself appears to threaten further extinctions. Under the auspices of the livestock 'revolution', the scale of intensive farming is increasing and the molecular turn is being turned to and eyed with increasing interest by major corporate players in animal breeding. In the animal science biopolitical reductionism of farmed animal bodies outlined in Chapter 5 and the constraints and limitations of animal welfare science discussed in Chapter 8, there is plenty to dwell on around the ethics of how we treat other animals and how these practices iterate definitions of the human. They provide ample justification for taking the work of (critical) animal studies seriously and liberating a domesticated animal ethics to wider import for (re)thinking the 'direction of society'. As outlined in Chapter 2, a bioethics with a reconstructed posthumanist understanding of its 'bio' could make an important contribution to such reflexivity, even as we refuse a simple rationalist notion of the human as autonomously mutable in the face of new ethical or critical knowledge.

Early on, I argued for the partial fiction of a narrowed philosophical field of 'animal ethics' in the sense of the questions it raises being inseparable from, for example, environmental and human health concerns. More fundamentally, the practices by which we embody particular values towards other species inescapably define us. The discourse on meat/dairy reduction at the moment can be seen to be trying to keep these

questions separate. This is not to suggest, contra the hopes of many animal advocacy organizations, that the combined sustainability arguments of climate change and human health necessarily signal the beginning of the end for the commodification of animals as milk/dairy products. As I indicated in Chapter 7, they do not appear to constitute in and of themselves arguments for vegetarianism or veganism, because undoubtedly a much reduced global infrastructure *considerably* down from the annual slaughter of over 56 billion land animals (FAOSTAT)[18] could lessen the aforementioned threats to this understanding of sustainability.[19] Thus animal advocacy groups would be advised, instead of allowing 'climate change' to become the new dominant register for arguing for vegetarianism or veganism, to ensure that first, climate discourse retains a questioning of our values towards nonhuman animals and second, that the likely impacts of climate change on the more-than-human are underlined. Reflexivity to this works against the reproduction of anthropocentrism in the climate change debate.

What does the efficiency discourse of meat/dairy reduction mean for the prospects of farmed animals as biotechnology? What does it mean if we recall the ethical and fundamentally question anthropocentric values? Meat scientists in the molecular turn in animal breeding represent the biotechnological as ameliorating concern over the human health, animal welfare, environmental and climate change questioning of meat/dairy. Even if the uncertainties around using molecular techniques in this way are surmounted, such promises remain invested in an economic context based on growth and the enhancement of scale. The biopolitics of animal bodies that work on the temporality of the body and in calculating and enhancing its economic value are congruent with the goals of livestock corporations. If, in the climate change domain, animal geneticists are correct in thinking that efficiency and mitigation can successfully be bred into animals, then their work could be seen to contribute to the process of relative decoupling but *without* any guarantee of absolute decoupling. Indeed the molecular turn may work only on the *pretence* of contributing to the latter. If, as I argue, we can note an emerging consensus around mitigation policy for a decrease in meat and dairy production, then we must conclude a corresponding delegitimization of animal biotechnology in a productivist, output-enhancing role. A molecular livestock 'revolution' would not only jar with the knowledge base from public health, climate change, ecology and animal welfare science but could be seen as the last vestiges of a discredited view of the exploitation of the more-than-human as wholly inconsequential.

It is unlikely, if the reduction discourse proceeds through an anthropocentric discourse, that the relative decoupling potential of the molecular turn will be opposed, but in lieu of absolute decoupling it will not mitigate GHG emissions. Given the arguments about the overall efficacy of relative decoupling, there is reason to be cautious about its prioritization. In recognizing the commercial context of the global livestock industry, it would be decidedly naïve to assume that relative decoupling will simply be accompanied by absolute reductions in trade and consumption.

Without regulation, there is the danger that efficiency improvements will act as a stimulus to further growth, threatening climate change targets and thus ecological limits. It would not be surprising to see the fuller emergence and marketing of novel 'ecologically efficient genotypes' to developing countries under the auspices of mitigation and philanthropic technology transfer. However, sustainability cannot be captured in the genome but must unfold in the reflexive knowledge accrued around the corporeal and

ecological contexts of human–nonhuman interaction and the normative questioning of hubris. This signals the immensely challenging but unavoidable conclusion that argues for the recuperation of the importance of rethinking human–animal relations – here specifically in the context of agriculture. This does not inherently entail, as some authors argue, a renewed effort to separate out human–animal interaction,[20] or even a simple disavowal of the molecular turn,[21] but it sees the potential move to breed animals as biotechnology as the opportunity, the moment, in which to contest particular discourses of the human as bad faith alibis for intransigence and exploitation.

Notes

Introduction

1 The concept of 'meat' clearly also involves a variety of human–human relations that pertain not only to the human labour necessary to its production and consumption but also to the ways in which these relations may be understood in terms of, for example, class, gender and race. The idea of 'meat' as a particular human–animal relation is informed by the work of Carol J. Adams.

2 Ethology and animal welfare science have also had significant impacts on animal studies.

3 I agree with those in animal studies who argue that the term 'nonhuman animals' is far from ideal. While on the one hand it is useful for situating the 'human' as also 'animal', it does little to undermine the homogenization inherent to the term 'animal'. I use it in the absence at the moment of a better alternative (I occasionally also refer to 'humans and other animals'). Animal studies (like gender studies) is bound to be caught in a struggle over language due to the institutionalized nature of the norms it wishes to challenge. Since 'animal studies' is partly critical of concepts of 'human' and 'animal', it is perhaps better seen as a work in progress that is likely to mutate into something else in the future. In this work I hope to avoid the charge of generally referring to 'animals' by focusing on specific examples of farmed animal species that speak to their experiences of commodification.

4 There is a whole politics around catering at animal studies conferences, or even animal science conferences. In my experience, animal science conferences may sometimes include vegetarian animal welfare scientists dining among the majority 'meat scientists'. In something of the reverse, animal studies conferences are usually all vegetarian or vegan catering, which again can be a source of unease for some. I became vegan in 2004/2005, though I had been vegetarian since 1992. I partly attribute my transition to veganism to the knowledge accrued researching this book, in particular the biopolitical reduction of the animal in the sciences of meat explored in Chapter 5.

5 If we point to the emergence of some ethical reflexivity among meat and/or molecular animal scientists, as I do later, then perhaps some readers would indeed favour a very broad definition of 'animal studies' that would include *any* academic research related to nonhuman animals. Furthermore, sciences such as genomics also undermine assumptions of a polarized human–animal distinction. However, this would be to gloss over disciplinary epistemological and normative differences over respective understandings of the 'animal'. Nevertheless, I generally favour a dialogical approach across such seemingly insurmountable differences. Ethology reports regular new findings around the cognitive abilities of nonhuman animals. For example, in 2009 it was announced that North American mockingbirds are able to distinguish between different humans out of many thousands based on whether they have a history of getting too near to their nests (see Connor, 2009b).

6 I make no assumption about the ease of change in any domain of human–animal relations.

7 This is not intended to be a comprehensive list – other salient dualisms are private–public and reason–erotic. For a more detailed discussion of dualism, see Plumwood (1993).
8 Pre-established sociological concerns around health and illness and food were invigorated by the emergence of these new subdisciplines.
9 It is, however, worth noting that both the British and American Sociological Associations now have chapters or study groups devoted to the sociology of human–animal relations.
10 There are exceptions, such as Wilkie (2005).
11 Two comments to make on this. First, we should not overstate the ability to breed-in docility. Farmed animals still often act in 'unruly' and 'undisciplined' ways, injuring and even killing farmers on occasion. In spite of this, as we shall see later, molecular techniques are rather interested in the behavioural genetics of farmed animals, and the ability to more precisely select for docility may well increase in the not too distant future (I discuss this further in Chapter 8). And second, once sociology properly admits other animals to its understanding of sociality, it would make sense for interdisciplinary work on human–animal relations to take place between sociologists and animal welfare scientists or ethologists.
12 The origins of ANT are associated with the work of Bruno Latour, Michel Callon and John Law.
13 I am most obviously referring to the work of Donna Haraway here and its subsequent influence on feminist science studies.
14 Moreover, both feminist science studies and ANT are material-semiotic approaches, meaning that they posit social relations as those occurring between both material entities and ideas or concepts. This counter-dualistic move is further important for sociology since, even in the newer anti-dualistic sociologies I have mentioned, there may be a tendency to over-focus on the conceptual, semiotic or representational aspects of, for example, animals, the environment and so on.
15 I return to this issue of relationality and ethics in Chapter 1.
16 This is not the same as saying that overtly political sociologists will necessarily be accepted. There is still the suspicion in academia that political interestedness is in some sense counter to scholarly ability.
17 Here I refer to the well known case of People for the Ethical Treatment of Animals (PETA) consistently using naked women in protest and soft-core pornography as a means to communicate their message. See Deckha (2008) and McGuire and McGuire (1994).
18 See the Institute for Critical Animal Studies (ICAS) website at www.criticalanimalstudies.org/.
19 For CAS, 'critical' needs to also mean an openness to self-critique and to be exposed and in dialogue with those of differing viewpoints.
20 Speciesism is the term coined by Richard Ryder and later used by Peter Singer. Ryder simply defined the term as 'the widespread discrimination that is practised by man (sic) against other species' (1975, p16).
21 The same can also be said, perhaps even more so, of the ecofeminist literature on dualism, the most obvious example being Plumwood (1993).
22 I accept to a degree that it is misleading to generalize about 'Enlightenment thought', given the degree to which dualistic thought was also contested in that period (see Meyer, 1999).
23 To be literally *dehumanized* is to be represented, via a dominant construction of the meanings of animality, as more sexual, more instinctual, more bodily. There are many examples of such discourses being deployed across social difference. To note just a few here, homophobia is bound up in the animalization and sexualization of gay and lesbian people and the devaluation of the working classes can take place via fears over their sexuality and 'rule by instinctual behaviour' (see Hawkes, 1996). The animalization and sexualization of 'women' (Adams, 1990) and those who are racially marked out (Jordan, 1968) to represent both categories as less than rational has also been outlined.

24 This is not to make what would be the bizarre claim that only white, male, privileged people eat meat, but rather to affirm historically the association of meat eating with understandings of masculinity, colonialism and class privilege.
25 Such theories are necessary to try and understand a whole array of phenomena that do not conform to the idea of a static and separate 'society' and 'nature'. A good contemporary example is the way in which anthropogenic climate change can lead to increased military conflict in developing countries. See http://news.bbc.co.uk/1/hi/sci/tech/8375949.stm.
26 As should be clear, I do not mean to suggest that the politics of posthumanism are limited to these sorts of issues. While they are indeed the focus of this book, posthuman politics are resonant to several other related areas, such as feminism and queer theory.
27 This has caused some writers to disavow the term posthumanism, or to construct a separate space termed *critical* posthumanism (for example Badmington, 2003).
28 For a more detailed discussion of the complexities and nuances between posthumanism and transhumanism, see Twine (2010).
29 I also do not want to oversimplify debates about new medical therapies which may be seen as types of 'enhancement' to the human. Transhumanism may be seen as neo-eugenic in some ways, but a simple moralistic denouncement of certain technologies is too easy a strategy. Their ethics are typically made more complex through their use of animal experimentation.
30 This is the first use of the word 'livestock' in this book. I use scare quotes initially since for CAS scholars this is one of those especially euphemistic words in the English language that conveys the very normalization of the commodification of farmed animals that is being questioned. Euphemisms in this area, like the word 'meat' itself, are difficult to avoid. My use of them should not be interpreted as uncritical.
31 There are in fact three types of markers that give rise to three types of marker-assisted selection. First, there are direct markers: loci that code for functional mutation, including single gene traits, which is sometimes referred to as gene-assisted selection. Second, there are linkage disequilibrium (LD) markers, and third, linkage equilibrium (LE) markers. LD and LE refer to non-random and random relationships between genes and loci in a given population (see Dekkers, 2004).
32 As a good illustration of the convergence of agriculture and medicine, this statement must be qualified by the observation that GM 'agricultural' animals, specifically the goat, have been commercialized for the production of medicinal biopharmaceuticals.
33 A note about the coverage of animal biotechnology in this book. Such are the wide varieties of domains in which animal biotechnology is being researched and implemented, at an early stage it was decided to focus on the agricultural. However, as this book unfolds I do argue for the relative inseparability of agriculture and medicine – something that is being reinforced by biotechnology itself. Therefore, I do make some reference to the medical. It is also noteworthy that the creation of biopharmaceuticals for human application involves the production of GM animals, as does the more speculative technology of xenotransplantation. Similarly, cloning is important for the creation of stem cell lines and, relatedly, human–animal hybrid embryos. One can only conclude that there is ample space for more books on animal biotechnology broadly construed.

Chapter 1

1 Nevertheless, we shouldn't overstate human agency here. Farmed animals are still very capable of aggressive behaviour towards each other, be that encouraged by close confinement, or indeed violence towards humans due to protection of offspring or poor handling.
2 I explore this point in much further detail in Chapters 7 and 8, using the concept of 'ethical biocapital' (Franklin, 2003) as a lens.

3 Synthetic biology is also a part of this trajectory.
4 While not the focus of this work, the issue of animal experimentation is obviously very complex and raises important ethical questions. More funding for research into alternatives is a prerequisite if this very paradigmatic way of doing science and testing product toxicity is to be ameliorated.
5 There are contentions over whether the ban is being properly enforced.
6 The UK Animal Welfare Act came into effect in April 2007.
7 The best point of comparison is with challenges to gender binaries. Being vegan is commonly misrepresented as extreme, pious and ascetic, and certainly not as pleasurable or hedonistic.
8 I think to be more accurate we also should add ethology to philosophy as the disciplines that were important to the origins of animal studies.
9 See www.abolitionistapproach.com/media/links/p532/fanatical.pdf. Both Regan's and Singer's theories are obviously more nuanced than I can present here. Francione (2006) has argued that:

> *Singer's position is no different from that of institutionalized animal exploiters, who, like Singer, maintain that we can use animals as long as we take care to make sure that they do not suffer 'too much'. Singer's view reduces the issue of animal rights to a debate about what constitutes 'too much' suffering, which misses the point that we cannot justify the use – however 'humane' – of nonhumans. There is nothing wrong with being a 'purist' about matters of fundamental rights. Would anyone maintain that it is 'purist' to reject 'humane' rape or 'humane' child abuse? Of course not.*

See www.abolitionistapproach.com/peter-singer-supports-vivisection-why-are-you-surprised/.

10 It is worth reiterating the point from the Introduction that posthumanism is not a total break from humanism.
11 There are certainly differences between feminist approaches to nonhuman animals. These differences are theoretical, ethical and political. For example, Plumwood's work, which advocates 'contextual vegetarianism', is not as such a part of the 'ethic of care' approach identified with Donovan, Adams, Kheel and others, who for the most part advocate veganism.
12 The term is perhaps best translated as a form of sympathetic understanding. Arguably Donovan here is getting closer to the virtue ethics tradition.
13 Clearly the relevant intersectionality here also includes other important constructions of difference around, for example, sexuality and disability. These intersections of the humanist subject are also one important reason why critical animal studies should be seen as of importance across the academy in that discourses of animality speak to many ideas of human difference.
14 It is important to state that I am not suggesting that either Singer or Regan did not relate animal ethics to broader struggles, but that the way in which they did differs to both a frame of intersectionality and to a more thorough posthumanism.
15 I say 'nonhuman' here, since there is also a strong interest from actor-network theory and feminist science studies in the agency or liveliness of technology.
16 I would agree that this work on relationality may make it difficult to justify such a phrase.
17 I have more to say on 'ethical bypass' arguments in Chapter 3.
18 Here I refer to the use of animals in war, and the trade in animals and animal products as a way of constructing dependent international economic relations. Also see the historical work of Ritvo (1987) for examples that illustrate intersections with social class.
19 Just *how* cross-cultural the links are between gender and the consumption of meat remains an empirical question.
20 I return to some of this work in Chapter 8.

Chapter 2

1 See www.bioethics-international.org/.
2 Social science engagement with bioethical issues of course predates the advent of bioethics itself, with the tradition of medical sociology, for example. Although DeVries's review essay is one of the first explicit works on a sociology of bioethics, he alerts the reader to much older calls for sociologists to explore bioethics (for example Fox, 1976).
3 Feminist bioethics has been overly detached from wider literatures of feminist theory. For example, there are at present, I would argue, insufficient connections made between feminist bioethics and feminist science studies.
4 See www.advancedcell.com/press-release/collaborative-effort-yields-endangered-species-clone.
5 For more on Trans Ova Genetics, see Chapter 6.
6 For example, ecofeminism is critical of anthropocentric ways of valuing the nonhuman.
7 Not surprisingly, there is also a corresponding need for environmental ethics to consider health, although I do not think this enclosing has happened to the same degree from this direction. Consider, for example, the extensive literature on environmental racism and its health implications.
8 For a more recent, well-articulated outline of a global bioethics, see Widdows et al (2003). There is lively debate within bioethics around the idea of a global bioethics and dangers of moral neo-colonialism and universalism (see Widdows, 2007).
9 For more on the residual humanism of Potter, see Zylinska (2009).
10 I have much more to say on links between the consumption of animal products and human health in Chapter 7.
11 I recognize that critiques of reductionism in science and medicine have been around now for some time and that moves have been made for more holistic medical treatments and non-dualistic conceptualizations.

Chapter 3

1 There is a mistake in this type of dichotomous comparison in that it assumes that medical or genetic enhancements would be somehow asocial, and so neglects the social construction of such technologies at present or in the future.
2 This was the XXII EACME (European Association of Centres of Medical Ethics) Conference and (jointly) the XIX European Conference on Philosophy of Medicine and Health Care, Barcelona, Spain, 24–27 August 2005. An earlier version of this chapter was presented at this conference.
3 Philosopher Val Plumwood employs the concept of 'backgrounding' to refer to the denial of the material contribution of devalued identities and is applicable historically and contemporaneously in terms of the backgrounding of nature, women, animals, the colonized and so on. See Plumwood (1993, pp48–49). In this vein, I would argue that plant/crop enhancement should also be part of the broader debate.
4 It should be pointed out that this decision was also related to concerns over the potential impact on the horse racing industry and not merely because of the relatively high moral value attributed to horses in British cultural life.
5 Harris (2004) is a good location for some interesting arguments *for* human reproductive cloning.
6 Genetics, Savings and Clone was the best known company producing cloned companion animals. A clone of your cat was available for $32,000 before the company folded in 2007.
7 Viagen, the livestock cloning company, recently denied that there were any issues over morbidity and premature mortality in animal cloning (at the Biotechnology Industry

Organization conference in 2006, Chicago, IL). It is worth noting the promissory pressures biotech companies are under when it comes to securing investment and articulating their vision.

8 There is a repeated trend in both scientific, corporate and media representations of animal modifications to use humourous language. I have not found any research on these phenomena as yet, but would assume the psychological theory of cognitive dissonance to be cited as part of any future explanation.

9 The examples I give I have heard put forward at conferences and workshops.

10 That one might neatly direct an enhancement towards a body rather than environment seems stuck within an atomistic view that disembeds bodies from their socio-natural environments. Knowledge of phenomena such as epigenetics only renders this assumption less credible.

11 I base this on my own interview research with UK animal scientists about the ethical and social aspects of their work. The most important point in this respect is to not homogenize and stereotype animal scientists.

12 See, for example, the controversy in the US regarding pesticide testing on vulnerable groups: www.organicconsumers.org/school/loophole091605.cfm.

13 Convergence is something of a buzzword at the moment in the especially transhumanist imaginary where so-called NBIC convergence – that between nanotechnology, biotechnology, information technology and cognitive science – is assumed to lead to the enhancement of the human (see Canton, 2004, pp186–198).

14 See 'Genes can be changed by food', http://news.bbc.co.uk/1/hi/health/4441564.stm.

15 Professor Daniel Pomp of the University of North Carolina, part of the research team, spoke in 2005 at the British Society for Animal Science Conference (April, York) and the Ark Genomics European Farm Animal Functional Genomics Conference (September, Edinburgh) to agricultural animal science audiences about the agricultural applications of their work.

16 BAC stands for bacterial artificial chromosome, an artificially constructed segment of nucleic acid often used in genome sequencing projects.

17 Mice, rapidly sequenced owing to their use as a model in medical research, represent a further 'non-agricultural animal' used as a model genome in comparative animal science.

Chapter 4

1 In Part III, I argue that even these are being 'domesticated' to an economic use.

2 To see the CIWF 'Eat Less Meat' campaign, see www.ciwf.org.uk/eatlessmeat/.

3 See McMichael et al (2007).

4 It is worth noting that only Denmark has specific legislation regarding cloning and GM in animals. It bans neither of these.

5 However, the Obama administration is now being more amenable in areas such as stem cell research.

6 Although it is worth noting that both episodes do share a concern over the industrialization of food production as well as contestations over the 'natural'.

7 The research centre where I work, Cesagen, is one of the centres which comprises this network.

8 The EGE website is at http://ec.europa.eu/european_group_ethics/index_en.htm.

9 I say this very tentatively, as xenotransplantation, even for many animal scientists, is a technology with little hope of near commercialization.

10 I base this assertion on the opposition to GM crops and the *comparatively* high animal welfare standards supported in the UK.

11 Clearly for reasons of democratic principle, this should be remedied. Presumably potential producers would also want to know what level of interest there is in the consumption of animal products from molecular techniques. Public engagement initiatives around animal production are more complex, I would suggest, owing to a preference among many people to not want to reflect on the conditions and process of animal production and animal slaughter.
12 For more on the cow named 'Dundee Paradise' see http://news.bbc.co.uk/2/hi/science/nature/6249613.stm.
13 I have more to say on concepts of animal welfare in Chapter 8.
14 See http://cordis.europa.eu/technology-platforms/home_en.html.
15 For example, see www.fao.org/WAIRDOCS/LEAD/X6115E/x6115e03.htm.
16 This externalization is becoming much harder to sustain, especially with an increasing awareness of the substantial contribution to greenhouse gases made by livestock production. Ironically (given their concurrent espousal of the 'livestock revolution' discourse), this was brought home by the FAO itself in a December 2006 report entitled *Livestock's Long Shadow – Environmental Issues and Options* (Steinfeld et al, 2006). For more detailed discussion on this and climate change, see Chapter 7.
17 See this link for some history of the debate to have the AWA changed to recognize birds, mice and rats as animals: www.aavs.org/campaign01.html.
18 Although not a molecular technique according to my definition, we should note that the US meat industry has been using GM bovine growth hormone since 1994 in approximately one-third of the US dairy herd. The milk is not labelled at the point of sale. However, many US consumers have recently turned against such milk in spite of FDA reassurances. It has remained banned in the EU and Canada.
19 Available at www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm113605.htm.
20 Source for both quotes: www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/2008/ucm116836.htm.
21 Available at www.codexalimentarius.net/web/more_info.jsp?id_sta=11023.
22 See www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178676923092.htm. Interestingly, reducing regulation to an assessment of safety may not be as risk-free for commercial interests as first assumed. One of the major areas of uncertainty in GM is the use of GM feed for farmed animals. Usually animals can be commercially advertised as non-GM even if they are fed with GM feed. Yet a recent ruling in New Zealand has gone against this assumption, penalizing poultry producer Inghams Enterprises over its claims that its chickens contain no genetically modified ingredients (see http://tvnz.co.nz/business-news/inghams-gets-ticking-off-over-no-gm-claims-3155754). This ruling was based on research that found GM feed to cause physiological, immunological and metabolic changes to animals. Jack Heinemann, Professor of Genetics and Molecular Biology at the University of Canterbury in New Zealand, concluded that 'the cumulative strength of the positive detections reviewed leave me no reasonable uncertainty that GM plant material can transfer to animals exposed to GM feed in their diets or environment, and that there can be a residual difference in animals or animal products as a result of exposure to GM feed' (Heinemann, 2009, p19). This was not a ruling on the safety of food derived from GM-fed animals, but a contribution to the research literature suggesting various impacts of GM feed and consequently the import of such findings for food labelling laws.
23 BIO describes itself as the world's largest biotechnology organization, providing advocacy, business development and communications services for more than 1150 members worldwide. As someone who has attended their annual convention (Chicago in 2006), this sounds like an accurate description.

24 This opinion was dissented by 1 out of the 15 members of the group: Krzysztof Marczewski.
25 The AC21 consists of 20 members representing the biotechnology industry; the seed industry; international plant genetics researchers; farmers; food manufacturers: commodity processors, handlers and exporters; environmental and consumer organizations; and academics. Under its Charter, 'The Committee is charged with examining the long-term impacts of biotechnology on the US food and agriculture system and USDA, and providing guidance to the USDA on pressing individual issues, identified by the Office of the Secretary, related to the application of biotechnology in agriculture.' See www.ocio.usda.gov/directives/doc/DR1043-049.htm.

Chapter 5

1 'Minding Animals' was also taken as the name of the first international conference on animal studies held in Newcastle, Australia, during July 2009.
2 This citation refers to the third edition; it was first published in 1984.
3 Possibly the best example of this is the intersection of class, race, gender and species in the space of the slaughterhouse. Animal bodies are disembowelled, but it is also a physically and psychologically dangerous place for humans (Cudworth, 2008).
4 I refer the reader back to the discussion in Chapter 1. Agamben here is in turn influenced not only by Foucault but by the work of Carl Schmitt. For a critique of Agamben's elaboration of biopower, see Rabinow and Rose (2006).
5 The South Devon was one of 14 cattle breeds whose herd books date back to the latter half of the 19th century; see www.sdhbs.org.uk/thebreed.html. The major cattle breeding website www.thecattlesite.com/breeds/societies.php now lists exactly 100 cattle breeds and links to their respective breed societies and associations.
6 It is also worth mentioning that Foucault discusses shepherd–flock relations in his work on pastoral power (2001, pp298–325).
7 For a most perceptive argument related to biopower and the contention that humans have in a sense been, and continue to be, at war with other animals, see Wadiwel (2010).
8 It was not until later in the 20th century that health concerns began to be raised about the consumptions of animal products. I have considerably more to say on this in Chapter 7.
9 Compare with the 'killing' of animals and the 'murdering' of humans.
10 Moreover, it is naïve to define eugenics narrowly. Social norms intersecting age, class, gender and race which partly determine human reproductive decisions are also in a sense eugenic. Of course one can also take the position that genomics is enabling backdoor human eugenics in the guise of individual choice, and that the complexity of controlling the reproduction of a companion animal exists only because of the prior asymmetrical development of nonhuman animal domestication.
11 I think it important to be open to the complexities of this analogy. There is a knee-jerk humanist response that recoils from it. It can certainly be used lazily and insensitively in advocacy discourse. There is also an argument about such an analogy glossing over specificity (see, for example, Kalechofsky, 2003). Yet I think Foucault provides a way to understand it and a reason not to ignore it. For further reading, see Patterson, 2002; Davis, 2005; Calarco, 2008, pp111–115).
12 The biopolitics of human difference gathered apace during the late 19th century, when the pseudo-sciences of physiognomy, craniometry and others took on a particularly racist expression (see Twine, 2002).
13 In the conceptual work of critical animal studies, there is no need to collapse human difference to other animals; the point is to question the application of hierarchy to difference.
14 Co-production need not imply symmetry of power, but rather allows for nonhuman agency.

15 I do not necessarily mean to imply here that these networks are secretive, certainly not since much is now available through online research. Instead I mean, for example, that even if meat and food politics are increasingly in the public spotlight through various media, the actual, often publicly funded, animal science networks are not.
16 I develop this more fully in the following chapter with some methodological pointers for grasping such networks.
17 In self-critique, I would say that a more fully developed sociology of nonhuman animal bodies should not only be about the discursive and representational. I concur with Lynda Birke's argument for more material methodologies in such a project (2009) that could include, for example, collaboratory work between sociologists and ethologists.
18 As with the human genome project, it is not always clear when a species has been definitively sequenced. In farmed animal species, partial maps have been in circulation for some time. Issues of whether a given sequenced animal can be said to adequately represent an entire breed or species also arise.
19 A useful online resource for checking which organisms have been sequenced to date can be found at www.genomenewsnetwork.org/resources/sequenced_genomes/genome_guide_p1.shtml.
20 An equally good example is found in ameliorative attempts against the environmental impacts of animal agriculture; see Chapter 7.
21 Lewis Holloway is part of a research team (with Carol Morris, Ben Gilna and David Gibbs) conducting ESRC-funded research on precisely this question in the UK.
22 In fact very few animal advocacy organizations have explicitly campaigned against biotechnology. Examples include Uncaged and Compassion in World Farming (CIWF).
23 This sort of Enlightenment rhetoric has been used at earlier moments of hope over the realization of genetic techniques in animal breeding (see Derry, 2003, p12).
24 I am purposively ignoring the more sociological symbolic consumptive aspects germane here, but I will return to this aspect in the conclusion.

Chapter 6

1 I am sceptical of the use of terms such as 'biocapital' and 'bioeconomy' by several writers in science studies, since they imply that the biological within capitalist economies is somehow new. In contrast to this view, see Franklin (2007b, Chapter 2) for the historical linkages between the terms 'livestock' and 'capital'.
2 For their patriotic website, and supply list, see www.bullseyegenetics.com/supplylist.htm.
3 See www.sac.ac.uk/research/groups/sls/teams/services/ctscanning/.
4 For example, see the management guide for the Hy-Line W-36 at www.hyline.com/userdocs/Hy-Line_W-36_Commercial_Guide_2009.pdf. The lighting program is on p14. Hy-Line have recently been criticized for animal welfare violations, but have defended their use of 'instantaneous euthanasia by maceration' of male chicks (they are ground up alive) 'surplus' to the layer industry; see www.hyline.com/aspx/news/newshome.aspx?nid=87. Hy-Line are a part of the E-W group, the world market leader in poultry genetics.
5 See www.aquabounty.com/products/aquadvantage-295.aspx.
6 I have more to say on this theme in Chapter 8.
7 This speaks to a debate over in what sense genomics may be considered posthumanist. For a detailed discussion on this, see Twine (2010).
8 Compare this 'struggle against the animal body' with Wadiwel's (2010) contention that we are in various senses at war with other animals.
9 I do not think Franklin does this, but it would be strange if feminist science studies were to celebrate the biotechnological reconstruction of genealogy as a way to reinforce a belief

in counter-heteronormative human genealogy. Such a move would gloss over the violence against and suffering of experimental animals and mistakenly assume that social change required some sort of biotechnological legitimating parallel.

10 I thank colleague Larry Reynolds for originally bringing the use of the KBBE discourse within the EU to my attention back in 2005.

11 The most germane technology platform for the subject of animal genomics is the Farm Animal Breeding and Reproduction Technology Platform (FABRE-TP) touched on in Chapter 4 and discussed further in the next chapter.

12 For example, the Iowa-based developmental association 'Biowa' has published a newsletter on Iowa's bioeconomy, *Bioeconomy Update*, since 2003.

13 For this and associated documents, see www.oecd.org/document/38/0,3343,en_2649_36831301_42570790_1_1_1_1,00.html. The 2009 report is the offspring of the earlier OECD report 'The knowledge-based economy' (1996).

14 The source of these figures is at www.genoway.com/PR_genOway_20080407.pdf.

15 Cesagen colleagues at Lancaster University, UK, including Ruth McNally, Paul Oldham and Stephen Hall, have created a 'Sociomics Core Facility', essentially a suite of methodological resources available to researchers in the ESRC Genomics Network. These include the use of Issuecrawler software, patent databases and, more recently, the creation of a research desktop, an open browser-based framework to support information aggregation, analysis and visualization on a given subject. See http://sociomics.lancs.ac.uk/.

16 See http://scholar.google.co.uk/.

17 For the press release, see www.viagen.com/news/viagen-merges-with-start-licensing/.

18 It would certainly be interesting to also apply this test to these 'top registered animals'.

19 The patent database I have used the most is the Thomson Aureka database.

20 Citation available at www.canineheritage.com/general_info.html.

21 While I clearly appreciate that the ambivalence common to many human–animal relations argues against a dichotomy between purely affective and instrumental relations, the ease with which a biotech company can work on both registers remains worthy of note.

22 As some indication of the speed of change in this sector, there have been changes already since Gura's analysis. In 2008 Cobb-Vantress, the subsidiary of Tyson, acquired Hybro, itself a subsidiary of Hendrix Genetics. This was clearly a move to challenge the market dominance of the EW Group in terms of broiler breeding. Also in 2008 Cobb announced a four-year, US$10 million genome research programme with partners Hendrix Genetics and the USDA.

23 See www.hypor.com/dynamic.php?first=3f8620fb589db&second=414773359522c&third=445617e1e7716.

24 See www.albertapork.com/news.aspx?NavigationID=2740.

25 Quoted from www.thepigsite.com/swinenews/20457/genus-increases-porcine-capacity-in-china. I have more to say on China in the following chapter.

26 See the 2009 results of Genus plc at www.buchanan.uk.com/upload/Prelims%20FINAL%2010092009.pdf.

27 I cannot claim here to be wholly comprehensive, owing to the aforementioned methodological problems. Relatedly, it is also possible that this review is overly Western-centric, in spite of the increasingly global links made between these companies.

28 Correct as of 2009 using the Thomson Aureka database.

29 See http://news.bbc.co.uk/1/hi/8002503.stm. This article also reports that since 1977 the EPO has received almost 200 patent applications for marker-assisted breeding of animals. It has granted about 30 of them, but many are still pending. About half are American applications and half European. Monsanto issued a statement in 2009 to say that:

> *There's been some rather wild speculation that these patent applications would prohibit pig farmers from breeding lines of pigs to which they had always freely bred. This isn't true. Any claims issued from these patent applications would apply to only animals and their offspring which had been bred using marker technology covered by patent claims. In any case, the sale to Newsham Genetics included any and all swine-related patents, patent applications, and all other intellectual property. We're out of the pig business.*

See www.monsanto.com/monsanto_today/for_the_record/pig_patent.asp.

30 See www.thepigsite.com/swinenews/12912/first-use-of-commercial-genomic-selection.
31 See www.mmigenomics.com/060704cargillbeefstudy.pdf.
32 See www.hubbardbreeders.com/news/index.php?id=51.
33 See www.aviagen.com/output.aspx?sec=338&con=3872.
34 The novelty of this claim has been contested; see www.psas-web.net/documents/specific/whole_genome_patent_info.pdf.
35 See www.pic.com/cms/USA/762.html.
36 See www.newsham.com/Newsham/product.aspx?Newsham=WebPointID=0&NewsStoryID=0&__TimeStamp__=12/31/9999+11:59:59+PM&catID=15&prodID=4.
37 See www.newsham.com/UserFiles/File/Product%20Sell%20Sheets/SuperMom603&604.pdf
38 See www.acmc.co.uk/meidam_female.asp.
39 See www.hendrix-genetics.com/template.php?sectionId=1013&newsId=56&archive=1.
40 See www.hendrix-genetics.com/template.php?sectionId=1013&newsId=2&archive=1.

Chapter 7

1 See http://news.bbc.co.uk/1/hi/sci/tech/6733797.stm.
2 This definition has been critiqued as vague. For example, Luke argues, 'Whose needs in the present, and whether or not they are needs or desires, and how development is understood to prevail where and for whom, of course, are questions that are left hanging, if not entirely begged.' (2005, pp228–229)
3 This is my theory, but it is interesting to note an explicit version of it from animal scientists themselves. See, for example, Harlizius et al (2004, p33).
4 I will have much more to say on animal welfare science in the following chapter.
5 All the quotes in this section are taken from either economists, geneticists or welfare scientists working at the SAC.
6 It might be argued that it is peculiar to use the language of biodiversity in relation to livestock species, since these are human-directed creations for an economic purpose, as opposed to the relatively much less human direction on non-livestock animal species. 'Biodiversity' here is arguably more about the biopolitical 'health of the population' rather than a non-instrumental valuing of diverse animal species.
7 See http://cordis.europa.eu/technology-platforms/home_en.html.
8 Genesis Faraday, established in 2003 at Roslin, is an organization created to promote and coordinate research in animal genomics. Its sponsors include UK government bodies such as DEFRA and the BBSRC, while its owners include the Roslin Institute and pig breeding company Sygen (which was acquired by the world's largest animal genetics company, Genus plc, in 2005). For further information, see www.genesis-faraday.org/about-us.asp.
9 I acknowledge the problems with measuring and defining these concepts. For the WHO, a BMI over 25kg/m^2 is defined as overweight and a BMI of over 30kg/m^2 as obese.
10 See www.who.int/mediacentre/factsheets/fs311/en/.

11 Meat here on the FAOSTAT database is defined to include only beef, pork, mutton, goat and poultry. As of 2009, 2003 was the most recent year for which FAO data on China was available.
12 The FAOSTAT database is available at http://faostat.fao.org/.
13 See www.taipeitimes.com/News/taiwan/archives/2008/12/03/2003430153.
14 See www.cpc.unc.edu/projects/nutrans/whatis.
15 These include three US-based groups – PETA (People for the Ethical Treatment of Animals), Friends of Animals and HSUS (The Humane Society of the United States), as well as the UK group VIVA (Vegetarians International Voice for Animals). Due to the impact of dairy farming on methane emissions, veganism rather than vegetarianism is a better mitigative action against GHG emissions. Veganism also addresses the non-food uses of animal products.
16 See http://news.bbc.co.uk/1/hi/sci/tech/7984054.stm.
17 See www.independent.co.uk/environment/climate-change/sea-levels-rising-twice-as-fast-as-predicted-1642087.html.
18 Its only rival to this dubious honour is nuclear weapons.
19 It is interesting to note that since 2006 climate change has grown in significance to the (UK) animal science community. Climate change has been the subject of DEFRA research calls, an international conference on livestock and climate change was organized by BSAS in Tunisia in May 2008, and the annual BSAS conference (for example in April 2009) itself now has markedly more content on climate change.
20 Bizarrely, the projected melting of Arctic ice is being couched in terms of exposing new sources of oil and gas extraction by neighbouring nations. See www.independent.co.uk/environment/nature/riches-in-the-arctic-the-new-oil-race-876816.html. This logic is not unrelated to the hydrocarbon industry's attempt to capitalize on harder-to-access sources of oil and gas, such as the exploitation of tar sands in Alberta, Canada. Both speak to a dangerous intransigence.
21 See http://news.bbc.co.uk/1/hi/sci/tech/8014598.stm. Also for recent research targeting burping sheep in Australia, see http://news.bbc.co.uk/1/hi/world/asia-pacific/8385068.stm
22 DEFRA Project Code AC0204.
23 See http://news.bbc.co.uk/1/hi/world/asia-pacific/7645969.stm.
24 As Stern explains, 'CO_2e' refers to 'CO_2 equivalent', which includes important non-CO_2 greenhouse gases (2009, p210). This can cause confusion, because a certain amount of climate change discourse still talks of ppm CO_2. For example, the campaign group 350 is named after a target of 350ppm CO_2 (see www.350.org). On this measure we are already at 390ppm. It is much better to talk of CO_2e, because mitigation should not be confined to CO_2. According to the IPCC 2007 Fourth Assessment Report, reduction targets of 350–400 ppm CO_2 correspond to a CO_2e target of 445–490ppm. The lower part of both these ranges is calculated to be required for a two-degree global temperature rise (IPCC, 2007, p15). An even simpler way to represent this is in terms of total carbon emissions. Thus since the Industrial Revolution, humanity has emitted over 500,000 megatonnes of carbon. In order to have a 75 per cent chance of keeping global temperature rises to two degrees, only a further 250,000 megatonnes can be emitted. At current emissions growth rates, this will happen by 2029 (Brahic and Pearce, 2009).
25 See www.nutritionecology.org/overview/about.html.
26 See www.guardian.co.uk/environment/2008/sep/07/food.foodanddrink.
27 See http://news.bbc.co.uk/1/hi/world/europe/8046970.stm.
28 See www.independent.co.uk/life-style/food-and-drink/news/mccartney-urges-meatfree-days-to-tackle-climate-change-1705289.html.

Chapter 8

1 This also seems to be the interpretation of the recent EU FP7 project 'Welfare Quality'; see www.welfarequality.net/downloadattachment/26536/18763/leaflet%20febr%202008.pdf.
2 A critical interpretation of animal welfare science would be to frame it as just as enmeshed and interdependent with norms of animal domestication and commodification as the (apparently) more productivist animal sciences.
3 The welfarist advocacy group Compassion in World Farming (CIWF) are a good case in point of this approach. They are careful not to advocate for vegetarianism.
4 This is not to say that all animal welfare scientists are the same in this respect. Some are certainly vegetarian.
5 I mean that it is useful because it does not seek to challenge the authority of animal production. It can be converted into a new value. I do not mean to imply that alternative vegan ethics are somehow not open to commodification, just that they are contra the commodification of animals.
6 See http://randd.defra.gov.uk/Default/aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=12095
7 It is interesting to note that in a 2006 interview, utilitarian philosopher and author of *Animal Liberation* Peter Singer advocated using biotechnology to produce 'brainless' or wingless birds. See Broudy (2006) at www.salon.com/books/int/2006/05/08/singer.
8 Although it should be underlined that Rollin argues against the position that telos should prohibit genetic engineering. One could certainly take issue with Rollin's argument, his definition of telos and the essentialist problems of the concept generally.
9 For a critique of the position which argues that animal welfare research must focus on the functioning of animals because subjective experiences fall outside the realm of scientific enquiry, or that studying the functioning of animals is sufficient because subjective experiences and functioning are closely correlated, see Fraser et al (1997).
10 Relatedly, there is now increasing pressure on scientists to produce an objective measure that provides stakeholders (for example consumers) with an overall score for welfare. This may serve to privilege those very 'objective' quantifiable measures that do not typically perform well in understanding the subjective, qualitative aspects of animal welfare.
11 This figure is from Bishop and Woolliams (2004, p914).
12 I do not mean to imply biological risks as somehow isolated from either the sociality of science or the social and ecological embeddedness of animal bodies.

Conclusion

1 Source of quote is www.guardian.co.uk/environment/2009/nov/29/rajendra-pachauri-climate-warning-copenhagen.
2 Source of quote is Chan, 2009, p1871.
3 These include obtaining oil from tar sands and shale oil; see www.newscientist.com/article/mg20427375.900-extreme-oil-scraping-the-bottom-of-earths-barrel.html.
4 The report subscribes to the green capitalist view of using alternative animal feeds to improve the efficiency of agriculture. It is one of the few recent reports in this area not to advocate for a reduction in animal production, in spite of its own emphasis on that sector's environmental impact.
5 See also http://news.bbc.co.uk/1/hi/sci/tech/8283909.stm.
6 I mean this in a broad intersectional and more-than-human sense.
7 The report refers to research by the EU's Joint Research Centre which calculated that technological abatement could only cut the carbon footprint by 20 per cent.

8 These figures refer to the UK. The study also used the Brazilian city of São Paulo as a case study.

9 We can see this theory as far back as 1964 in Herbert Marcuse's often quoted 'The People recognize themselves in their commodities; they find their soul in their automobile, hi-fi set, split level home, kitchen equipment. The very mechanism which ties the individual to society has changed, and the social control is anchored in the new needs which it has produced. (1964, p9)

10 Interestingly, Franklin (1999) has argued that rises in 'pet keeping' can be read as a substitution for social relationships between humans.

11 It should be noted that many major UK supermarkets already label foods vegan. Although advocating for labelling can fall into rather individualistic strategies for changing consumer behaviour, the provision and identification of low-carbon foods remains important as part of a much broader strategy.

12 I am very mindful that vegan practices may appear unfamiliar to many people given the ubiquity and habitual normalization of animal products in Western diets. Policies for sustainable food consumption are probably not going to be very successful if they neglect the aesthetic dimensions of consumption. Yet, at least anecdotally, vegans are incredibly enthusiastic about the pleasures of eating and, in recuperating the ethical to food practices, question a positive aesthetics of meat and more fundamentally the separation of aesthetics from ethics.

13 The UK government responded to *The Lancet* issue on health and climate change by entertaining the idea of killing 30 per cent of the UK's cattle and sheep herd (see http://news.bbc.co.uk/1/hi/8379759.stm). Of course, reducing herd size could be done without any slaughter, and in such a way that took the economic sustainability of rural communities into account.

14 If, as it currently seems, policymakers are obsessed with a discourse of efficiency, then it is probable that, all other lifestyle factors being equal, promoting meat- and meat/dairy-free diets in tandem with less ambitious advice for reduced consumption will yield the best results.

15 The degree of cultural spread on this requires further research.

16 This argument is not new – there are several overlapping relevant literatures here, on gender and sustainable practices (for example Casimir and Dutilh, 2003), masculinities and sustainable agriculture (Peter et al, 2000), as well as a long history of considering gender and sustainable development (see Braidotti, 1994). Although there is recognition in climate change discourse that sustainability is linked to poverty, gender and other categories are less prevalent.

17 Only the FEC report attempts to include the impacts on animals themselves of reducing their consumption.

18 This 2007 figure is an underestimate, because the numbers obtained from the FAOSTAT database omit fish and those animals that die prior to slaughter (in transit, for example).

19 There is a possible exception to this. Veganism could arguably be carried by the climate change argument because a mitigation of methane by cutting out meat/dairy consumption could significantly slow GHG emissions due to the potency of methane and its shorter lifespan in the atmosphere vis-à-vis CO_2.

20 Haraway comes close to this view when she argues that veganism 'would consign most domestic animals to the status of curated heritage collections or to just plain extermination as kinds and as individuals' (2008, p80). First, we might say that an animal may express a preference to live in a 'curated heritage collection' over a factory farm. I would agree that in vegan ethics there is insufficient thought and nuance in thinking around what the liberation of domesticated animals might mean. However, Haraway merely repeats a lack of imagination.

Our relations with domesticated animals change over time – we can see this in the changing role of the horse from an agricultural, transport and military use to either a 'companion' animal or, less joyously, sport commodification. Vegan ethics do not entail the extermination of animals, but the cessation of their breeding for human consumption. I do not think any vegan seriously supports the complete annihilation of, for example, sheep, cattle, pigs and chickens. The case of conservation grazing – the use of semi-feral or domesticated grazing animals to maintain and increase biodiversity – is just one example of a potential future for a reduced domestic animal population. I have intentionally omitted the question of reducing *human* population from this book, because at this point in time I think it obfuscates the main reasons behind climate change and food insecurity. I reserve the right to change my mind on this by 2050.

21 The genetics of domestication highlighted in Chapter 8 open the possibility of viewing domestication in even more malleable terms. De-domestication or 're-wilding' projects are already in progress and raise interesting questions around notions of nostalgia and, as Gamborg et al (2010) point out, novel intersections between animal and environmental ethics. De-domestication *could* be seen as a biotechnological deconstruction of animal breeding that would unsettle fixed notions of domesticated animals and redefine understandings of animal 'liberation'. However, this remains an uncertain technology. In the meantime, it is difficult not to conclude that we have a responsibility to the animals 'we' have bred. Where this breeding has entailed serious health impacts to animals – and the examples from both agriculture and 'pet breeding' are numerous – biotechnology may have a useful ameliorative role in addressing this. Moreover, current attempts to preserve the genetic diversity of farmed animals in biobanks, presently to ensure their successful future commodification, still retains a value beyond this. Other non-agricultural uses of animal biotechnology have been beyond the scope of this book, but applications such as DNA testing to detect illegal trading in whale meat are important (see http://news.bbc.co.uk/1/hi/sci/tech/821619.stm).

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List of Abbreviations

ABA	American Breeders Association
ACT	Advanced Cell Technology (company)
AEBC	Agriculture and Environment Biotechnology Commission (UK)
AI	artificial insemination
ANT	actor-network theory
ASA	American Sociological Association
AWA	Animal Welfare Act (US)
BBSRC	Biotechnology and Biological Sciences Research Council (UK)
BIO	Biotechnology Industry Organization
BLUP	best linear unbiased prediction
BSAS	British Society of Animal Science
BSE	bovine spongiform encephalopathy
CAFO	confined animal feeding operation
CAS	critical animal studies
Cesagen	Centre for Economic and Social Aspects of Genomics
CIWF	Compassion in World Farming
CO_2e	carbon dioxide equivalent
COP15	United Nations Climate Change Conference 2009 (15th Conference of the Parties to the UN Framework Convention on Climate Change)
CT	computed tomography
CVM	Center for Veterinary Medicine (US)
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DNA	deoxyribonucleic acid
EAAP	European Association for Animal Production
EACME	European Association of Centres of Medical Ethics
EADGENE	European Animal Disease Genomics Network of Excellence for Animal Health and Food Safety
EBV	estimated breeding value
EFSA	European Food Safety Authority
EGE	European Group on Ethics in Science and New Technologies
EPA	Environmental Protection Agency (US)
EPO	European Patent Office
ESRC	Economic and Social Research Council (UK)
ET	embryo transfer
ETAP	Environmental Technology Action Plan (EU)
EurSafe	European Society for Agricultural and Food Ethics
FABRE-TP	Farm Animal Breeding and Reproduction Technology Platform (EU)
FAO	Food and Agriculture Organization of the United Nations

FAWC	Farm Animal Welfare Council (UK)
FDA	Food and Drug Administration (US)
FEC	Food Ethics Council (UK)
GHG	greenhouse gas
GM	genetic modification
GMO	genetically modified organism
GS	genomic selection
HFEA	Human Fertilisation and Embryology Authority (UK)
IAB	International Association of Bioethics
ICAS	Institute for Critical Animal Studies
IFIC	International Food Information Council
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IPR	intellectual property rights
KBBE	knowledge-based bio-economy
LCA	life-cycle analysis
LR	livestock revolution
MAS	marker-assisted selection
MIR	mid-infrared
NADA	new animal drug application (US)
NCG	Newsham Choice Genetics (company)
NFU	National Farmers Union (UK)
NGO	non-governmental organization
NHGRI	National Human Genome Research Institute (US)
NIH	National Institutes of Health (US)
NT	nutrition transition
OECD	Organisation for Economic Co-operation and Development
OSTP	Office of Science and Technology Policy (US)
PETA	People for the Ethical Treatment of Animals
PGAB	Premium Gold Angus Beef
PGD	pre-implantation genetic diagnosis
PIC	Pig Improvement Company
QTL	quantitative trait loci
SABRE	Cutting Edge Genomics for Sustainable Animal Breeding
SAC	Scottish Agricultural College
SCNT	somatic cell nuclear transfer
SDC	Sustainable Development Commission (UK)
SEFABAR	Sustainable European Farm Animal Breeding and Reproduction
SGSC	Swine Genome Sequencing Consortium
SNP	single nucleotide polymorphism
TSE	transmissible spongiform encephalopathy
USDA	United States Department of Agriculture
WCRF	World Cancer Research Fund
WHO	World Health Organization of the United Nations
WTO	World Trade Organization

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