Affective enactments of the Enviropig. On farm animals, biotechnology, and how to act in an uncertain world.

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Summary

The global Livestock farming is highly intensive, concentrated, and integrated. Due to resources used to undertake this activity (water, energy and land), coupled with gaseous and mineral emissions (carbon, methane and phosphorus), and also deteriorating animal health and welfare; it is one of the most unsustainable sectors. The demand for animal protein, however, continues to grow in both developed and developing countries. With that in mind, the livestock industry is ripe for innovation. Genetic and genome engineering is a biological and technological innovation (hence biotechnology) promising to meet the demand and offset environmental, animal health and welfare issues.

Despite a growing uptake of biotechnology in livestock breeding, relatively little is known about farm animal biotechnologies in comparison to GM crops, and transgenic animals used in medical research. Although the scientific community has made some efforts to keep the public informed about the innovations regarding GM livestock, the latter are not consulted and fully engaged in the process of designing of such innovations. This leads to further contestations and growing distrust, thus fracturing the opportunity to foster an affective "science-public" dialogue for envisioning sustainable animal farming. The feelings of fear, disgust and uncertainty thus proliferate.

The literature is social sciences so far approached the biotech developments critically. Scholars writing in the field of Critical Animal Studies, Animal Geography and STS have recently suggested that biotechnology is an empty promise that portrays animals as machines removed from their environment. This is one of the reasons why the biotech solution is contested by the public who is said to fear GM animals and feel uncertain how to relate to "new" farm animals.

To gain a deeper understanding of the latest innovations in animal farming, I focused on the first genetically modified animal destined for human consumption and environmental protection – the Enviropig. I spoke to some of the key people involved in the creation of this animal, visited the place in which they have been made and analysed media content published about this animal in the last 20 years. I sought to explore the now-vanished life of this animal because, without the past, we might know very little about the future. But given that the topics of animal research and science, in general, are rich in emotive responses, I wanted to understand what role emotions play in the story of the Enviropig. Building on the growing uptake of emotions, feelings and the so-called affective states and caring approaches in the sociological literature, I approached the Enviropig from the perspective of an affective enactment. This meant that instead of approaching the Enviropig as an example of commodification, I explored the abundant animal, science as practice and moving history of the Enviropig.

This research shows that genetically modified farm animals are helpful rather than scary "monsters". In other words, when genetically modified (GM) farm animals are attended to with care, they open spaces of sciences and reveal fragility and vulnerability of "things", animals and people. These findings have important consequences for the broader domain of science-public dialogue about the future of animal farming and living in an uncertain world.

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And finally, my family: two crazy siblings – Marysia and Marek - and my partner Dan. Thank you for showing me how to love a monster.

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

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I lost my head and I gained a world.

On having no head, Douglas Harding

Chapter 1. Introduction

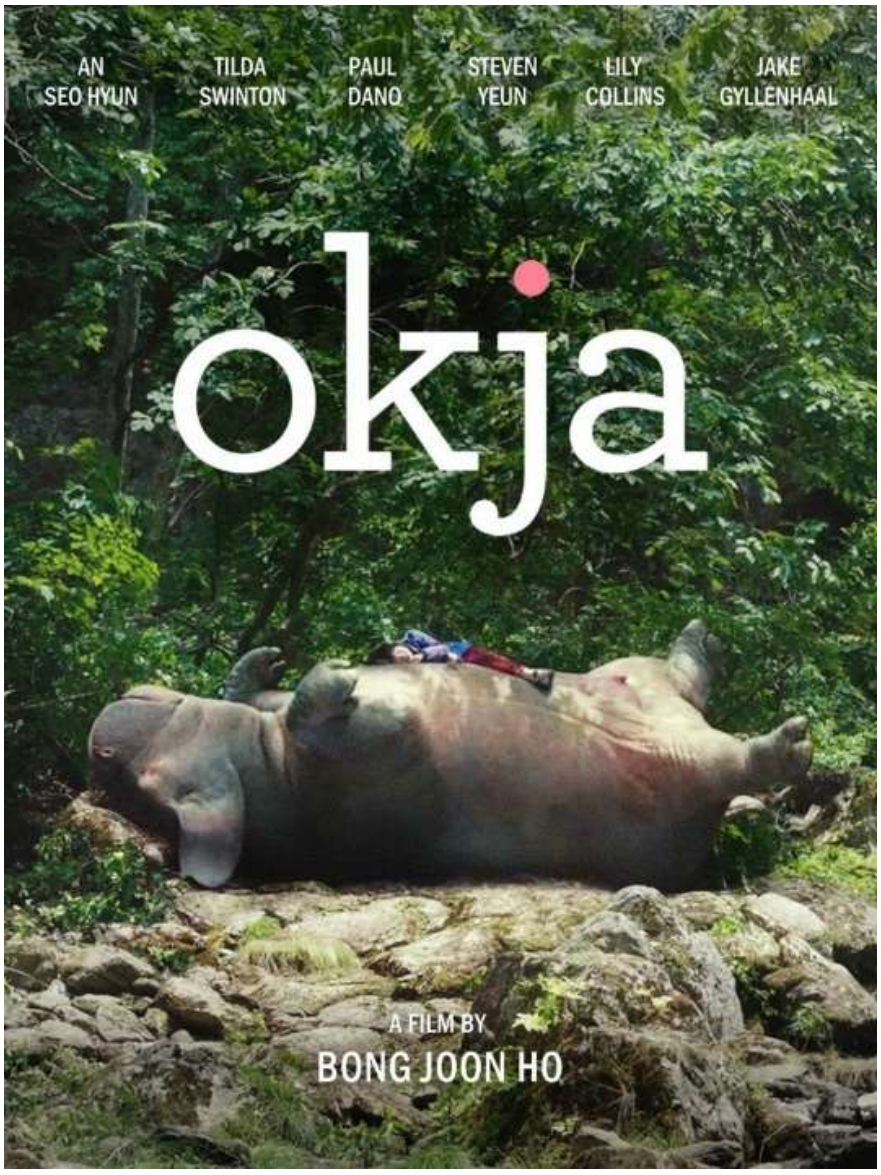
1.1 Living with the new

In 2017, an online streaming service Netflix released a film titled *Okja*[1]. The film was about was about a giant, transgenic pig of the eponymous name.

The story of Okja and her siblings starts when the new owner of a large meat producer (played by Tilda Swinton) decides to create giant pigs to harvest as much meat as possible. To hide this plan, the new boss announces a competition to raise these giant pigs. Okja was one of them. She was chosen by a little girl named Mija, who unlike others, allowed the pig to exhibit all of her behaviours in a remote village in South Korea. Mija and Okja became best friends caring for one another. Figure 1 depicts one of the iconic scenes in which Mija rests on Okja's giant body, both enjoying the sunshine and serenity of the forest.

1 The film was nominated for the Palme d'Or (best picture award) at the Cannes Film Festival https://web.archive.org/save/https://www.rottentomatoes.com/m/okja

Figure 1. The poster for Okja. Source: Medium



But their friendship was cut short by the boss of the meat processing corporation claiming rights to Okja, an animal who was not meant to be loved but to be eaten. Okja was meant to be slaughtered and processed for meat like all the other giant, transgenic pigs. Neither the public, duped by the animal welfare marketing campaign issued by the company, nor did the girl knew about it.

The film ended well despite a rollercoaster of emotions that emerged as a result of Okja being chased, stolen and almost killed. Sadly, for me, only Okja was saved. The millions of other giant pigs were not. An ocean of giant pigs going up a ramp like waves crushing into slaughterhouses was also like a wave of emotions going through me. The scene reminded me of billions of chickens, pigs and cattle going through the conveyor belts of slaughterhouses around the world.

But we do not need to speak of fictional animals to realise that animals like Okja already exist in many forms, which is why I devote this research to exploring a life of another transgenic pig. I am only hoping that like Okja, the story of the Enviropig as retold here, will move us to feel and think differently about transgenic farm animals.

Stranger than fiction

Writing in 1998, Emel and Wolch, noted:

> Transgenic chickens and pigs are expected to inundate the market by 2015, earning billions of dollars in the US market alone. (…). These new forms of life, created by transplanting genetic material, are and will be "owned" by their engineers and corporate founders, a development that has already caused a furore among people in a number of countries. (p.514-515).

As of 2020, transgenic chickens and pigs have not revolutionised the market yet, but efforts have been taken to create transgenic livestock and indeed, commercialise and appropriate them. Pigs and chickens are still of interest to funding bodies because these animals are reared on an industrial scale across the world and so it is of commercial value to enhance these animals. The focus of the current scientific research is on enhancing low immunity against diseases such as avian and swine flu (see Tan et al., 2016).

Table 1 adapted from Forabosco et al. (2013), provides an overview of transgenic animals used in food production. It shows that each species can have designated target traits i.e. growth, milk or health, which are modified by transgenic genes of multiple origins. The table thus shows what is valued in pigs, cows and chickens, but also how these values are created and by whom.

Table 1 GM farm animals. Adapted from Forabosco et al., 2013.

Species	Target trait	Transgenic gene	Origin of gene	Reference
	Growth	GH		Nottle et al. (1999)
		cSKI		Pursel et al. (1992)
	Milk	α- Lactalbumin		Bleck et al. (1998); Wheeler et al. (2001)
	Bacteria resistance			Lo et al. (1991)
	Health	Lysozyme		Tong et al. (2011)
		Unsat. fatty acid		Saeki et al. (2004)
		Omega-3		Lai et al. (2006)
	Feed eff.	Phytase		Forsberg et al. (2006); Phillips et al. (2006)
	Growth	IGF-1		Damak et al. (1996)
	Health	Visna virus resistance		Clements et al. (1994)
		BSE	Deletion	Denning et al. (2001)
		Bacterial resistance		Lo et al. (1991)
	Health	Lysozyme		Scharfen et al. (2007)
	Udder	Monosat. fatty acid		Reh et al. (2004)
	Health	Leukosis resistance		Salter and Crittenden (1989)
		H5N1 resistance		Lyall et al. (2011)
		lacZ		Mozdziak et al. (2003)
	Growth	GH		Chen et al. (1990)
	Health	Lysozyme		Yang et al. (2011)
		BSE	Knockout	Richt et al. (2007)
	Udder/Milk	Omega-3		Wu et al. (2012)
		α and κ-Casein		Brophy et al. (2003)
		Antimicrobial		Wall et al. (2005)
	Growth	GH		Du et al. (1992) now a property of Aquabounty
		Follistatin		Medeiros et al. (2009)
	Health	Cecropin		Dunham et al. (2002)
		Lactoferrin		Mao et al. (2004)
		Lysozyme		Fletcher et al. (2011)
	Envir. tolerance	Antifreeze		Hew et al. (1999)

But, looking across the table, two examples of transgenic animals should draw everyone's attention (see the highlighted cells in the table), because transgenic species of a pig and salmon moved from academic research into the realm of regulatory, commercial and public spheres.

I refer here to a pig with a target trait of feed efficiency with phytase (the transgenic gene) of bacterial origins with a promoter of a mouse created by Forsberg and Philips; and a fish (Atlantic salmon) with a growth hormone (the transgenic gene) of Chinook salmon origins with a promoter of ocean pout[2] created by Du, and now a property of Aquabounty Technologies. Both animals made headlines because in 2010 they were in a race to be approved for human consumption by the Food and Drug Administration (FDA) in the USA. In 2012, the pig, referred to as the Enviropig, withdrew from the race. But, the salmon, referred to as AquAdvantage Salmon, was approved in 2015.

Although the Enviropig has never been commercialised, the story of this animal grabbed my attention. When I first heard about the Enviropig, my initial question was "How did a pig become a candidate for genetic modification?" and subsequently I asked "What does it mean, for a pig, to be friendly to environment?" and "At what point did a pig become unfriendly?"

2 The ocean pout (Zoarces americanus) is an eelpout in the family Zoarcidae. It is found in the Northwest Atlantic Ocean, off the coast of New England and eastern Canada. The fish has antifreeze proteins in its blood, giving it the ability to survive in near-freezing waters. Source: Wikipedia and National Marine Fisheries Service.

These initial questions took me onto a literary journey form Ancient China, through to medieval Europe to not so distant future where chickens are the last livestock animals left (although they will be genetically modified). I became fascinated by historical accounts by White (2011), Malcomson and Mastoris (1998), and Mizelle (2012) which showed that changes in farming practices had profound impacts on knowing pigs, including their character: from fierce foragers to gluttonous and filthy creatures. So, the Enviropig grabbed my attention because it made me question my own assumptions about what a pig is.

But while the historical accounts showed there are as many versions of a pig as there are ways of practicing farming, they did not yet tell me about changes a pig went through as it travelled from farms to labs and headed for our forks. To understand that, I had to take a journey in time, space, text and memory. So, in terms of the evidence, all I had was a "public" story in the media which told me that in the early 1990s, the pigs were created in a research facility in Guelph, Canada using genetic modification; and that animals were presented as a sustainable solution to growing phosphorus pollution in large-scale farming. This is because unlike their non-transgenic cousins, the Enviropigs were able to produce an enzyme aiding digestion of phytase; and therefore, reduce eutrophication[3].

3 It is an excess of nutrients in bodies of water, due to run offs from farms which causes algae growth that leads to oxygen removal and therefore death of marine life.

The Enviropigs were patented in 2002 and in 2010 approved for production in Canada while awaiting another approval, but this time, for food consumption in the United States. But the project and the animals attracted opposition from a public already not accepting of genetic modification of crops. As a result, the project failed to be commercialised and was eventually rejected. As for the animals, they were euthanised due to a mix of public opposition to genetic modification of animals, the emergence of new solutions, and lack of investors. However, in the last days of the project, the public campaigned to release the Enviropigs to a sanctuary for ex-lab animals, indicating affinity to animals, not the project. So, over the span of 30 years, the Enviropig's status changed from scientific success to commercial failure and from Frankenpig to an animal worth saving.

Although seemingly far-fetched, like the story of Okja, the Enviropig story sparked my interest because it speaks to debates about molecular science in relation to farm animals: whether it should be used to meet growing demand for meat, and whether farm animals will become even more commodified behind the scenes. More importantly, the story speaks to concerns over how to live with, relate to and feel about animals who are familiar and unfamiliar at the same time.

So, even though the Enviropigs are gone, debates still arise as to who genetically modified animals are in the eyes of regulations, markets, farmers, consumers, citizen and other animals. The most pressing question for both opponents and proponents is "will biotech animals be

accepted as one of the solutions to agri-food crises (Macnaghten, 2004; Nuffield Council on Bioethics, 2012)?"

When I started this research, it seemed the question was relevant to academics, such as Twine (2010), Morris and Holloway (2009), NGOs such as, Compassion in World Farming, a small group of scientist, a handful of private companies and me.

But, with genome editing gaining more interest, the GM farm animals are not just good to think with. They are of current concern and interest (Latour, 2004a) too. The question, which I posed earlier, is therefore becoming more serious and pressing. A live Zoom webinar[4] titled *Sense, Science and Sustainability*, chaired on the 22nd of July 2020 by Pat Thomas, Director of Beyond GM is illustrating my point. The webinar was centred around the question "Can genome editing, and agroecology co-exist in the sustainable food and farming mix?" (see Figure 2).

The panel consisted of a scientist, organic farmer, an opponent of GM and animal welfare campaigner, who for the first time, somewhat agreed that genome editing can deliver sustainable future if the technology protects animals and farmers and does not lead to greater commodification and monopolisation of life. Philip Lymbery, the director of Compassion in World Farming, who is known for anti-GM sentiments,

4 https://web.archive.org/web/20200731113626/https://abiggerconversation.org/webinar-sense-science-and-sustainability/

during this webinar openly admitted that genome editing has a place in animal farming if it supports farm animal welfare. For instance, genome editing could be used, Lymbery argued, to eliminate routine killing of male chicks who are considered a by-product (because are not suitable for egg laying and meat production) in the egg industry.

Figure 2. The webinar invite. Source: The Big Conversation

CRISPR, TALENS, zinc finger nucleases – these are the new genetic technologies that claim to be the closest to nature yet, and which promise to make farming more sustainable.

Although the questions pertaining to acceptance of GM animals by the public is pressing, it needs unpacking or at least re-directing.

The questions that are much harder and equally pressing relate to concerns over ways of knowing and living with biotech animals. So, for instance, how will be treated in comparison to other lab animals and animals on farms and in field? Would biotechnology create a new subcategory of farm animals? Would it result in the creation of ordinary looking pigs, cows, chickens and goats whose bodies are lab-made? Would they become ordinary enough to be eaten, but too ordinary to save? Will they, like Okja be loved or destined, behind the scenes, for a slaughterhouse without anyone knowing? Or, will they be banned from being loved or eaten on the account of their lab-made bodies? Will they redefine an understanding of what is natural? Would these animals demand new forms of care or would they be deemed too unnatural to care for? Would they in fact prompt us to think what it means to care?

This PhD is an attempt to answer these questions by exploring the case of the Enviropig – a transgenic pig destined for human consumption and environmental protection. In doing so, I aim to contribute to debates about decision-making in uncertain times (Callon et al., 2009).

1.2 Locating this research

Biotechnological innovations can be seen as a cause and/or a response to unsustainable agri-food systems. On the one hand, GM arguably emerged as a response to farming crises, chronic health risks, food safety scares and resource and habitat depletion (Lowe et al., 2008). But at the same, being driven by disciplinary and commercial logics (Lowe et al., 2008:226; Bud, 1994; Jasanoff, 2006). GM is seen as being out of touch with public concerns (Macnaghten, 2004; Greenhough and Roe, 2006) and evokes a much more profound mistrust of science and technology (Callon et al., 2009).

To date, the literature in the field of animal geography and the studies of science and technology has concentrated on the effects of biotechnology on animal bodies, human-animal relations on farms, as well as public acceptance and understanding of animals as well as trust in science. For instance, scholars such as Twine (2010), Morris and Holloway (2009) as well as Lezaun and Porter (2015) approached the use of biotechnology in animal farming from the perspective of biopolitics, thus paying attention to spaces of power, the commodification of bodies and knowledge. Franklin (2007), Sanderson (2015), Macnaghten (2004), and Pierce (2015) on the other hand, explored farm animal biotechnologies by focusing on various actors, places, language, and histories without identifying the “good” or “bad”, “powerful” or “resisting” norms, bodies and practices. To borrow from

Lien and Law (2011), they have focused on enactments of farm animal biotechnologies and thus paid attention to how “new” animals are being done either in text, speech, practices and places, as well as in the relation between “old” animals.

Both strands of literature share a theoretical approach that considers science as, essentially, a set of practices with human and animal history. The purpose of this body of literature is to explore rather than explain “the nature” reality or reveal what is and what is not true. Yet through reading on care as practice (Mol et al., 2015); caring as doing (Puig de la Bellacasa, 2011; 2017) as well as concepts such as monsters (Davies, 2003; Nerlich et al. 2018), in particular on Frankenstein by Latour (2011), and Hammond (2004), affectual encounters (Archambault, 2016), geographies of emotions and affect (Anderson and Smith, 201; Pile, 2010), affective science (Latimer and Miele, 2013; Lorimer, 2008); GM animals in the media (Einsiedel et al., 2002; Väliverronen, 2004), I was prompted to approach farm animal biotechnologies with affect in mind. In other words, I wanted to take the opportunity to explore things that are hard to put in words, define and measure such as feelings and emotions that often come across as sticky bundles of text, places, people, animals and actions. Tu put it differently, I wanted to add an emotional dimension to human and animal histories of science as practice.

In doing so, I aimed to contribute to the literature concerned with decision-making about scientific innovations in uncertain times (Callon et al., 2009). The Enviropig, as a project and an animal, offered an opportunity to explore the emerging socio-technical innovations and shed light on how to move forward to achieve responsible innovation and converse about the things that trouble us.

1.3. Research aims and questions

The aims of this doctoral study are therefore twofold. First, to revisit the story of the Enviropig, and by doing so, address the limited empirical research on farm animal biotechnologies. Second, to engage with the concept of affective enactment to address an imbalance in conceptual approaches to the topic of farm animal biotechnologies. This study contributes a new understanding to geography of science and animal geography by recognising affect as an active ingredient in making sense of farm animal biotechnologies.

The aims of the study were guided by three case study research questions, which were as follows:

- **How has the Enviropig been enacted in relation to contested notions of porcinity?**
- **How has biotechnology been enacted in discourse and practices around the Enviropig?**
- **What is the Enviropig's potential role in navigating through the complexity of emerging innovations?**

From the theoretical point of view, enactment offered an opportunity to engage with the controversial and difficult topic by emphasising multiplicity and complexity rather than a duality of things. By extension, it invites to engage with accessible and less accessible sites of farm animal biotechnologies to come closer to the worlds of farm animal biotechnology and move, with emotions, into the direction of affective dialogue.

Having employed the concept of enactment, this research brings to attention the affects rather than effects of controversial and not so easily encountered animal biotechnologies. Thus, the overall argument is that to move forward and find appropriate solutions to knowing how to live with socio- technical innovations, not just GM animals, difficult conversations and uncertainties need to be attended to with care and affect. The results from this study are of relevance to the literature on public-science dialogue, in particular, how to act in an uncertain world (Callon et al., 2009).

1.4. Thesis structure

In Chapter 2, I expand on the theoretical concepts and approaches mentioned so far. I bring forward views from the literature explaining as to why radical uncertainties and the topic of GM farm animals require an approach infused with care and emotions.

In Chapter 3, I provide an empirical background to this research. I concentrate on the story of the Enviropig in greater detail.

In Chapter 4, I concentrate on the methods used in this study. Given that the Enviropigs are no longer alive, but the topic remains controversial, I concentrate on ethics and positionality before outlining how I decided to address the research questions.

Chapters 5, 6 and 7 address the three research questions which centre around the animal, human and emotional history of science as a set of practices. I tell, in a way, three stories of the Enviropig: as an animal, as a fragile practice, and a moving story. In these three chapters, I try to make sense of the data which pointed to multiplicity, fragility and emotional states associated with being the Enviropig and being with one. These chapters also tell a story of public and intimate science in the making, thus attempting to bring the reader closer to the world of biotechnology and GM animals.

In Chapter 8, I aim to summarise the research and evaluate it by looking back at the main question as to how we can live with uncertainties

Chapter 2. Theoretical and conceptual framework

2.1 Introduction

This chapter draws together the conceptual and theoretical framework for my research. I locate my work within existing bodies of literature surrounding science, animals, care and affect to develop an argument that builds toward a framework of affective enactment.

The overall argument in this thesis is that to be able to move forward and find appropriate solutions to knowing how to live with radical uncertainties, difficult conversations need to be attended to with care (de la Bellacasa, 2011, 2017; Garcés, 2019; Latimer and Miele, 2013). Care here means exploring and situating knowledge by paying attention to affective states one might feel toward animals, scientific innovations, and other humans. In other words, it means working with emotions and feelings rather than hiding away from them.

I start by introducing concepts such as radical uncertainties and controversies as learning opportunities before I move on to talk about caring explorations and the role of affect. Toward the end of the chapter, I consider opportunities for applying affective explorations to the topic of farm animal biotechnologies.

2.2 Living with radical uncertainties

Research shows (Verran, 2002; Wynne, 1991; Latour, 2004; Evans and Miele, 2019) that scientific knowledge sits alongside lay, indigenous and embodied knowledge, forming a gallery of knowledge to draw upon. However, scientific knowledge has become one of the most selected ones. This is because science, as it is commonly argued, is effective at clearing the path toward certainty. But, by defining almost everything from molecules to emotions, science has created divisions between humans and animals, nature and culture, reason and emotion. Research by Callon et al. (2009), Latour (1983), Mol (2002), Lien and Law (2011) argues that because of these divisions, science is now unable to address radical uncertainties. The purpose of this section is to show what I mean by radical uncertainties before I go on to talk about ways of addressing them.

The concept of radical uncertainties is often referred to as the inability to replicate actions to arrive at the same results or predict outcomes of scientific, economic, or policy-making endeavour (Roth, 2009; Zapata and Kaza, 2016; Chenet and van Lerven, 2019). The theorisation of radical uncertainties tends to view them as something hard to address, but with more effort at eliminating obstacles and distractions, radical uncertainties can be solved. The assumption is that scientists are still viewed as the right group of people able to address any of the problems

and provide solutions (Collins, 2017). But what this line of research fails to address is that eliminating obstacles and clearing paths toward a greater understanding of phenomena does not necessarily remove them. On the contrary, it introduces even more uncertainty. Callon et al. (2009) put it this way:

> …contrary to what we thought some decades ago, scientific and technological development did not bring greater certainty. On the contrary, in a way that might seem paradoxical, it has engendered more and more uncertainty. (p.29).

Although some might read this as an anti-science sentiment, I see it as a call to further scrutiny as to why uncertainties persist, what they are, and why they ought to be studied.

Another way of looking at radical uncertainties is linked to the idea of the sheer impossibility of knowing something ex-ante (Roth, 2008). Chenet and van Lerven (2019) using Knight's (1921) concept of radical uncertainties and Esposito (2013) using Callon's theorisation (2007) of the performativity of markets, argue that information about radical uncertainties will not be available in advance to aid decision-making. This would suggest that radical uncertainties can only be brought to light after the fact when it is arguably too late. Although many of us would prefer to know that we do have some control, this line of thinking reveals more about radical uncertainties than it appears. I want to explore it a bit further because from the standpoint of aiming to find ways of how to live with radical uncertainties, this line of thinking offers interesting

insights.

Callon et al. (2009) for instance, argued that radical uncertainties owe their name to the fact that attempts to make sense of them will take years to finalise, and that their deliberation will take place in public rather than in enclosed spaces of science. But the most important point for them is that radical uncertainties emerge out of innovations whose boundaries between nature and culture are blurred. Therefore, the go on to argue, the questions as to how to live with the effects of such innovations go beyond the scientific and technical. Here is how Callon et al. (2009) explained it:

> …inseparably technical and social, and they give rise to unexpected problems by giving prominence to unforeseen effects. All, specialists included, think they have clearly defined the parameters of the proposed solutions, reckon they have established sound knowledge and know-how, and are convinced they have identified the groups concerned and their expectations. And then disconcerting events occur. (Callon et al. 2009:28).

Callon et al. are trying to make a point that despite all efforts to make sure that everyone is on the same page and convinced about solutions offered, unsettling events occur anyway. From the practical standpoint, their arguments indicate that if there is one way to address radical uncertainties then it is important to include all kinds of knowledge. This is echoed in Taleb's (2012) theorisation of uncertainties where he perceives them as learning opportunities to become antifragile rather than robust. To be robust is to aim for perfection and consider all things,

which is not possible. This is because, as scholars adhering to this line of thinking explain, as we do things, we enact them and create the world anew. This means that the goal of addressing radical uncertainties will not be met unless we rethink how we conduct ourselves in the world that is inherently uncertain.

But all those lines of thinking lead to one agreement which is that unforeseen and unprecedented events are on the rise. Events such as the nuclear power plant explosion in Chernobyl in 1986, mad cow disease in the UK, and the most recent pandemic known as COVID-19 (the coronavirus disease that emerged in 2019) to name but a few, illustrate that there is this need to rethink what scientific knowledge is actually capable of and what it is doing as is aims to control uncertainties. A prominent STS scholar, Sheila Jasanoff, reflecting on COVID-19, put it this way, “we have modelled the progression of the disease, but not the social consequences” (2020)[5].

Thus, what I take from this is that when addressing radical events including the topic of this research (animal biotechnologies), those who can turn events around need to make sure the social and material consequences including anxiety, fear and rising inequality among all beings, are fully accounted for and brought to the centre of discussions. I endorse Callon et al.’s (2009) take on radical uncertainties in this

5 https://web.archive.org/save/https://www.thenation.com/article/society/sheila-jasanoff-interview-coronavirus/ last accessed 06 April 2020

thesis as it promotes new and challenging ways of thinking how to address issues surrounding genetic modifications of livestock animals and emerging genome editing. I want to pursue this line of thinking because it challenges the foundational ways knowing the world we inhabit from other beings. Certainly, there are other interesting theoretical discussions that are worth considering when it comes to finding ways of how to address radical uncertainties, for example, finding more data, educating citizens and consumers, addressing risks and so forth. But to me, all of these ideas can be summarised as ways of addressing controversies, and here too we see different approaches which circle back to the ways in which one defines radical uncertainties and where one positions scientific knowledge in relation to other knowledges available in what appears to be a gallery of being in the world.

Now that I have shown the definition of radical uncertainties I am interested in; I also want to unpack the notion of a controversy. This is the focus of the next section.

Controversies as a learning opportunity

Controversy, as Callon et al. (2009) claim, is what gives away a radical uncertainty, which is why it can be used as a learning opportunity about addressing it. But not all controversies are made equal, and, therefore, the approach to studying them differs too. The purpose of this section is to show the link between conceptualising controversies and ways of

addressing them.

The starting point is that there are two types of controversies, namely scientific and science-based (Brante et al., 1993; Martin and Richards, 1995; Edge, 1995; Allgaier, 2010; Pinch, 2015). Scientific controversies are to do with contending knowledge claims within disciplines. Thus, for example, biotechnology as scientific controversy would be debated within a circle of experts working in this area. Social scientists wanting to understand how scientific controversy is settled are then focused on disputes within a group of experts, argued Pinch (2015). This, however, gives rise to an internal, enclosed view of a controversy. Although this type of controversy might give away that a given scientific innovation is uncertain, here uncertainty will be viewed as a risk, as something that needs to be removed from laboratories, for instance.

Science-based controversies, on the other hand, give away a very different type of uncertainty. Science-based controversies are those that involve and affect "other parties and social factors that affect the framing and the outcome of a debate" (Allgaier, 2010:45). Studies of science-based controversies focus on the social, intimate, material, emotional and enrolling effects of science and technology. Thus, for example, biotechnology as a science-based controversy would be debated outside of labs using deliberate methods (Kotchetkova and Evans, 2008; Garner, 2018), such as citizen juries, citizen assemblies, and focus groups that explore the unforeseen, unknown, intimate, day-to-day aspects of consequences of a given innovation. The results of

such deliberations can be fed directly to policymakers to aid the decision-making process and policies. *The GM Nation?* public debate that took place in the 1990s, and the *Climate Assembly UK* that started in 2019, are both examples of an attempt to address controversies surrounding biotechnology and climate change, respectively.

Controversies also help to reveal events that were initially isolated and difficult to see. Processes usually hidden in laboratories or offices are brought into open and public view. Hidden assumptions and interests are revealed, which can then be challenged and scrutinised further (Meyer, 2009:2). Controversies, therefore, can be treated as blessings in disguise to enrich democracy. As Callon et al. (2009) put it, when scientific expertise adopts the form of authoritative discourse, they reveal, through failure to respond to the questions of concerned citizens (p.28), what, who and how it has been secluded.

What follows is that science-based controversies are not just “ideological battles” or “useful means of circulating information” (Callon et al., 2009, p.28). They are actually “powerful apparatuses for exploring and learning about possible worlds” (p.28) and a “way in” to study science in the making (Latour, 1983) rather than “ready-made science” (Meyer, 2009:2.). Controversies, therefore, shine a light on what did not get inside the technical solutions. A controversy also provides an opportunity to go back in time, to reflect and consider the possibilities that were not taken up and constraints that were not identified (Callon et al., 2009). In other words, it allows learning to integrate what was

previously not considered.

To reiterate my point, I see controversies as an opportunity to learn how to address radical uncertainties. But, as I have shown in this section, this also depends on how one views the scientific knowledge. In the next section, I therefore move on to talk about a performative approach to scientific knowledge and use that as a starting point toward learning from controversies to address radical uncertainties.

Learning by exploring performatively

The literature, especially in history, geography, and sociology of science, puts forward countless arguments as to how scientific knowledge has become effective and ineffective at the same time (Edge, 1995). For the purposes of this chapter, I will focus on insights that theorise scientific knowledge as a practice that, at its core, aims to simplify phenomena and in doing so, omits things that are complex, fluid and difficult to grasp. These insights steered me in the direction toward caring for radical uncertainties which provided me with a foundation for incorporating caring and affective attitude toward research about genetic modification of animals. I will come back to this point later. For now, I want to focus on the concept of performativity as it is central to the concept I develop in this thesis.

Scholars such as Latour (1983), Callon (1984), Law (1987) and Mol (2002) emphasised that science is action and so the only way to understand why there are so many interpretations and disputes is to attend to how, for example, a definition of a genetically modified crop or animal is being performed, where and with what or whom. They study science as if it was like any other mundane practice, but nevertheless having world-shaping capabilities (Lien and Law, 2011). In other words, science is understood here as a practice that generates rather than reveals reality and truth (Law, 2007; Callon, 2007). Sometimes called material semiotics, this approach argues that "social structures are being generated at the same time and in the same moment as scientific (or other) forms of classification or knowledge: that the social and the natural classifications are being enacted together in material practices" (Lien and Law, 2011, p.68).

The starting point for the material semiotics approach is that a phenomenon is enacted, varies from place to place and practice to practice, and it is also relative. It is not absolute. In other words, this approach assumes there is no single definition of, for instance, a pig, a fish, or a neutron because definitions are performed in different places and spaces, and therefore, they are multiple. Here is how Lien and Law (2011) explain this using an example from their study of a farmed salmon:

> The main achievement of the [scientific] texts has less to do with an accurate description that

> with their enactment of an Atlantic salmon in a particular way. It is being done as a single, unambiguous class or entity that can be differentiated from alternative life forms. It [the scientific] is a universalising discourse in the sense that it has the effect of enacting universal knowledge.
>
> Performatively, this particular mode of scientific description does itself as generally true across time and space, even though, in practice, it is confined to specific locations such as laboratories, the pages of textbooks, ad popular texts. p.68.

Their take on definitions, primarily the scientific to which they refer as universalising, stands at odds with the previous approaches to studies of science. Their explanation of a material-semiotic approach points to performative rather than social interpretations of a phenomenon. Thus, rather than looking at what experts say, this line of research recommends looking at practices and how things have been defined in action, in places, and in comparison to other phenomena.

The purpose of showing how scientific knowledge is assembled is neither, as critics of this approach argue (Collins and Yearley, 1992), to dismantle things nor undermine the reality or the efforts of scientists. Instead, the purpose of looking at enactments is to enrich and affirm the reality of things by adding further articulations (Latour, 2004; de la Bellacasa, 2011, 2017; Lien and Law, 2011). The other purpose, in a sense, is to offer hope because, as Adal et al. (2017) put it, “if we can track how meanings and materialities are generated, repaired and maintained then we can question their continuity” (p.18) and stability.

Enactments as tools of a material-semiotic approach can show that things can be otherwise because nothing is determined.

Because of their understanding of scientific knowledge through a material-semiotic approach, it is essential for anyone who calls themselves a researcher of science and technology to also be mindful of their own practices. In the midst of things being multiple, fluid and changing, the researchers of science and technology, whom I would like to call “students taught by controversies about radical uncertainties”, should pay attention to how they attempt to address the topics they find valuable, what they pay attention to, and how the multiple things are assembled not just by the scientists, but also by the researchers who study them and their innovations. This what Mol (2002) and Davies (2004), building on Haraway (1998), meant when they said we should be paying attention to the politics of our explorations.

In the next section, I want to start looking at performative yet mindful ways to learn.

2.3 Learning through care

To learn from science-based controversies about radical uncertainties requires an effort to see things objectively, without losing sight of what is essential. For example, when learning from GM controversies, one should pay attention to all those things that have not been included in risk assessments, such as the impact on ecosystems, trust in policy-makers and science, change in relation to plants and animals, from seeing them as natural to lab-made (Bingham, 2006; Driessen and Korthals, 2012). But, as I signalled already, there is another way of learning that involves paying attention to enactments, but also to affective states. But to learn, I argue in this thesis, we should also aim to incorporate all of the neglected things that tend to be shut out from scientific knowledge (Latimer and Miele, 2013; Lorimer, 2008; de la Bellacasa, 2011, 2017) and research about science and its creations.

One of the scholars advocating such an approach is Maria Puig de la Bellacasa, who argued that what should guide researchers in the engagement with science as a practice is the care, not just the concern. Drawing on Latour (2004)'s notion of matter of concern, Puig de la Bellacasa (2011) between concern and care by saying:

> Concern and care can mean similar things – both come from the Latin 'cura'. But they also express different things. So care does not replace concern…One can make oneself concerned, but to 'care' more strongly directs us to a notion of material doing." (p.89).

In other words, concern implies being provoked to think and to think about. Whereas care implies an action: of being moved by

something/someone to do something but also being attached. Care adds a movement and feeling to thinking about things that trouble. Such a caring approach can be summarised in three words: “hand, brain and heart” (Rose, 1983). But there is more to care which is often considered as something that can be found in spaces where it is arguably most needed like hospitals, hospices and care homes, but as Mol et al. (2015) argued, if care is considered a practice it can be found in many places. Care, as Mol et al. (2011, 2015) said, should not be confused with ethics of good care which proliferates in health literature, but should be considered as a way of addressing things that unsettle us.

Read as such, and according to de la Bellacasa, care also re-orientates the researcher toward respect of all involved and away from obsessions with power and imposition of moral and epistemological norms (2011:100). In doing so, the researcher can open himself/herself/themselves to broader and much more diverse interpretations of what it means to care. In doing so, as Mol et al. (2015) argued, the researcher can step away from a narrow view as to what it means to care, about what and where.

Following this line of thinking, caring would include looking at things that have been neglected – those things that have not been mobilised, included and brought to spaces of science, textbooks and public discussions. The neglected things, as Latimer and Miele (2013) put it, are all those elements previously excluded and shut out of knowledge enterprises. Things such as smiles, movements and gestures as well

as moods, atmospheres, and attachments (Parr, 2014:755) as well as other ways of knowing. Puig de la Bellacasa (2011) noted that the neglected things do not need to be necessarily the weak, the vulnerable and the silent, but they can be. Engaging the neglected things, as one of the ways to care, “can situate knowledge about, for example, how to live and do research with and about contested innovations even further and deeper “(Puig de la Bellacasa, 2011:94).

Going back to the concept of radical uncertainties and finding ways to learn how to address rather than fix them, the idea of including the neglected things is rather interesting. Given what has been said about radical uncertainties, it becomes more and more crucial to open ourselves up to all the things that have so far not been included. But, it does not come without a challenge. On one hand, there is this concept of learning about controversies by caring which opens us this whole new way of looking which is so desperately needed (think of the unprecedented events). But on the other hand, there is a danger of getting side-tracked by all the things, by getting blinded by what Franklin called “big science” and lastly falling vulnerable to all the things the researcher sees, experiences and feels too.

Thus, to recall de la Bellacasa again here, “to represent matters of care is an aesthetic and political move “(2011:94). This is very much echoed in the work of Davies (2003) who said that researchers need to be

mindful of the connections between epistemology and ontology in their mappings of hybrid geographies. Davies uses the concept of hybridity (Whatmore, 2002) to highlight the implosion of nature and culture, which can be tricky and challenging for researchers to approach. She used the work of the artist, Eduardo Kac, to warn researchers about the implications of their own mappings. Kac, a professor in Art and Technology at the University of Chicago, commissioned a transgenic rabbit that glows in the dark. He envisaged showcasing Alba the glowing rabbit in art galleries and eventually keeping her and showcasing the possibility of domestication of transgenic species. His project received a backlash over unethical and frivolous use of animals and science.

The story of Kac, which Davies used, speaks to this double problem of caring explorations. The story illustrated how the research labour could be received when investigating new species, whether as one that creates animals, or one that studies their creations. Davies (2003:41) wrote, “our own engagements with and attempts to represent the textures of contemporary technoscience chance the same potentially ambivalent political and moral implication as to the work of artist Eduardo Kac”. In making this comment, Davies urges to be careful as well as caring in the way in which researchers engage the neglected things.

At this point, one could argue that when studying people, concepts such as genetic modification, and animals regardless of the discipline, care

is already practised. For example, clinical researchers i.e. those working with people in a hospital setting, adhere to a duty of care. In animal research, technicians adhere to laws, regulations, and principles as to how to care for animals (Davies et al., 2016; Roe and Greenhough, 2018, 2019; Asdal, 2008; Holmberg and Ideland, 2009). Those working in humanities also follow ethical guidelines as to how to conduct research, verify the information, and address sensitive information (Stephens and Lewis, 2017; Rager, 2005ab; Bryman, 2012; Yin, 2017).

But, according to Mol et al. (2011, 2015) these normative versions of care do not deal well with two things which are relevant to this research. First is the aspect of extending care to research topics, places, people, and animals which tend to be viewed as devoid of care from the perspective of good or ethical care. Second is addressing affective states of doing research.

In the next sections, I concentrate on the literature which took on this challenge of exploring the neglected things while aiming to be mindful of their own explorations. I think it is important to mention them at this point in the chapter for two reasons. First, the studies I am about to mention circle back to the core concept which is performativity. Second, they provide me with an introduction to the next central topics, which are animals and emotions.

The next sections are not exhaustive, but the uniting theme is the idea of re-reading spaces, beings and practices that are uncomfortable, which echo the sensitivities outlined in the concept of caring that I have

just explained. Later, I will bring all these core themes together to discuss their direct relevance to radical controversies and opportunities for integrating more neglected things, which are emotions and feelings.

Finding care in unlikely spaces

Human geographers have long been interested in a relation between space and care (Metzger, 2012; Parr and Philo, 2003) asking at what places are caring, and how to care for spaces. There is an idea of an intimate connection between places and those who share or co-create them. There is also an idea of spaces enabling to become for example, caring and conversely uncaring for something or someone. But overall, there is a recognition that spaces are fluid, contested and belonging to more than one person, more than one animal (Whatmore, 2002). But considering performative and feminist approaches to the understanding of science and care which I outlined earlier, what matters most is paying attention to practices (Mol, 2002). As Law, writing about veterinary practices in times of foot and mouth disease in the UK put it, “what may sometimes appear to be simple from the outside never is in practice” (2010:67).

The point of looking at complex phenomena, such as science and care, as a practice is that it opens the field of vision and in doing so demystifies spaces which are closed or misunderstood. For example, as Mol et al. (2015) argued in a letter to their critics, care can and should

be extended to places such as slaughterhouses and farms because there too caring can be observed. Law (2008), for instance, noted that by looking at veterinary practices on farms during the foot and mouth epidemic in 2001, he was able to note multiple objects of care despite the mass culling of livestock animals across the UK. Law noted that veterinarians cared intensely for animals, farmers, the self and the bigger picture even though they were taking an animal to mass slaughter. Similarly, Miele (2017) argued that by looking at practices, even in laboratories, unlikely spaces to find attunement to animals' emotions, caring can be observed.

Myers (2008), for instance, showed that care involves “giving life” to a molecular model by scientists working in laboratories that are shut to the public. Myers exposed that for a model to exist, it needs ongoing care and affection, not after it is out there but throughout the process of revealing it. By focusing on the processes, Myers altered the vision that scientists are dispassionately manipulating objects (de la Bellacasa, 2011). Similarly, Greenhough and Roe (2018), Davies et al. (2016), and Pihl (2018) writing about lab technicians i.e. those working with animals in labs, put forward an argument that contrary to what has been said so far, lab technicians are not dispassionate either. Although technicians are those who prepare animals for experimentation, they also look after animals ensuring they are in good health. They are the ones who spend time with animals and develop close relations, which, from the outside looking in, seem sinister. Being able to capture those moments,

prompts the researches to consider practices in labs or slaughterhouses as practices of sharing suffering (Haraway, 2012). Roe and Greenhough (2010) argued that Haraway's take on practices in labs as sharing suffering is "opening to shared pain and mortality and learning what that living and thinking teaches" (p.43).

So what lessons can one take from finding care in unlikely spaces? The point is that by exploring practices in places, even the ones that seem contested and problematic, one can learn to appreciate that even in the most challenging spaces, caring happens. It does not then follow that all difficult places are caring and therefore good (Mol et al., 2015). It means that by looking at practices, one can learn more about being in contested spaces and therefore consider the challenges that come with it. Finding care in unlikely spaces provides a more nuanced version of spaces of science not just as spaces of power, privilege and influence (Shapin, 1995), but also as spaces of attachments as well as attunement to animals (Greenhough and Roe, 2018) and spaces of grief.

Although the literature suggested that lab technicians and junior researchers develop strong bonds with animals they feed and nurture (Greenhough and Roe, 2018), research by Davies (2010) and Friese et al. (2019) suggests that care for animals is central to senior staff too. In fact, *Science* magazine published a story on the 23rd. of March 2020 about the mass culling of lab animals which had to be performed due to COVID19 lab closures by all staff regardless of seniority and the affects

this had on everyone. Hopi Hoekstra an evolutionary biologist and one of the informants for the article said, “When you do behaviour experiments, you need to watch these animals for hours—you really get to know them. We care a lot about these animals. It’s giving me gray hair.” (Grimm, 2020). Finding care in unlikely spaces thus provides an opportunity to build an emotional bridge between insiders and outsiders such as the public and scientists, or even, between lab technicians and students who need animals for research. So, from the practical standpoint, finding care in unlikely spaces allows to explore uncertainties mindfully which goes back to the issue of getting short-sighted by big science and ethics of care.

Caring for beings other than humans

Another way of thinking about care, which proliferates in the literature, follows the insights just mentioned. It involves caring for beings other than humans, either by interacting with or writing about them. It is impossible to cover everything here, so I will focus on areas of the literature that helped me with regards to this research.

When it comes to caring for beings other than humans, there is an assumption that avoiding harm when dealing with all kinds of being should account for care. However, care also encompasses paying attention to two significant areas. First is the placement of beings other than human on the tangled tree of life (Quammen, 2019) which stems

from words used to describe them. Second is the role of actions that either contribute to or result from descriptions of beings other than human. I will now focus on these two areas because they are central to the topic of genetic modification of animals.

Representations of animals, scholars such as Baker (2001) argued, may indirectly reveal something about how a culture regards and thus treats living animals. Scholars in sociology, geography, history and literature thus turned to animals and began to consider the relationship between representations of animals and humans seriously (for an overview, see Franklin, 1999; Tovey, 2003; Wolch and Emel, 1995; Urbanik, 2012; Buller, 2014; Fudge, 2004). Although there have been many insights linking the development of human identities and behaviours with the use of animals either as symbols or in the flesh, I am more interested in the line of research that considers the material consequences for animals based on ways they have been represented.

Scholars such Franklin (1999), Hobson-West (2007), Fudge (2004), Haraway (1991) to name but a few, argued that representations of animals have profound effects. Therefore the task of scholars in humanities, is to pay attention to ways in which animals have been portrayed in the past and present. Evans (1906), Hassig (2013), Tyler (2012), White (2011), and Lawrence (2015) noted that for example, medieval literature and folklore depicted animals as beasts and monsters that ought to be domesticated and/ or displayed for human gaze as a warning. Ritvo (1987) for instance, argued the role of animals

was to personify the difference between danger and impurity. Thomas (1983), Franklin (1999), and Fudge (2004) pointed out that Christian teachings played a big part in navigating humans into the different treatment of animals.

The argument put forward by scholars in history and political ecology is that Christian teaching, especially on the origin of life, resulted in positioning humans as stewards responsible for animals. The much more relevant argument in terms of today is that the notion of stewardship is still present in the language of farming and conservation. Overall, scholars argued, throughout the centuries animals were made "other" to justify their roles in human society as agricultural and medical tools, sources of food or wonder. However as Birke and Michael (1998), Franklin (2007), Ung-Lanki (2014), Asdal (2008), Urbanik (2012), Gerber et al. (2001) noted, animals as "other", or alien, invasive, or as objects can still be found in the media and scientific texts.

The task of animal geographers is to expand the research to get to know animals that are still categorised as unpleasant, transgressive, small, or even mundane (Gorman, 2017; Nagy and Johnson, 2013) who also deserve a shift in treatment and understanding. So, not just the charismatic apes but also the chickens (Miele, 2011), sheep (Franklin, 2007; Miele, 2017; Despret, 2005), rodents (Davies, 2011), insects (Bear, 2018, 2019), bacteria (Shrader, 2010) and monstrous and hybrid (Lorimer and Khortals, 2011; Haraway, 1991; Davies, 2004). Caring here literally means to include the neglected. Geography, therefore,

began to investigate not just the changing identities of animals, but also how both human and non-human identities are connected, or seen as a hybrid. The task of “hybrid geography” is, therefore, to investigate the sites of blurring and invite to a dialogue on how to live with the monstrous (Lorimer, 2014:40).

From the perspective of the literature I mentioned earlier, this line of research puts a finer, empirical point on the concept of controversies as learning because it asks how to talk about the troubling and misunderstood. A good example here is Lorimer and Driessen’s (2013) paper on scientific efforts of bringing an ancient breed of Heck cattle back to the fields, which attracted the badges of monster, other, and hybrid. They proposed that monstrosity is an invitation to a dialogue, rather than debate or disagreement. They ask to in a way learn from monstrosity about the ways we make sense of the world. Here is how they put it:

> [...] an emergent effect of particular orderings of normality and difference, monsters and monstrous for crossing categories (e.g. living/dead, human/nonhuman, etc.) or straddling species groupings. Posing risks as much by being a physical threat by endangering the cultural order through which we make sense of the world. (Lorimer and Driessen, 2013:251).

They go on to suggest that, at least in the case they described, the Heck cattle are “monstrous only in so far as they unsettle the modern division between the wild and the domestic; falling somewhere along a continuum rather than at the end of this false divide” (Lorimer and

Driessen, 2013:257).

Similarly, Gail Davies (2013), writing about transgenic mice noted, noted, "'the monster' is a deconstructive icon for exploring what might count as nature, challenging totalising conceptions of both nature and culture in contemporary biology" (p.269). The progress in biological sciences, for Davies, is therefore seen as an invitation to expand theoretical horizons in geography by working with life sciences, while at the same time bringing to attention the laboratory lives of animals (Davies et al., 2016) and a possibility of changing human-animal relations inside the laboratories and beyond. Writing about laboratory beings other than humans for example, rats, fruit flies, nematodes, bacteria etc. is also about uncovering their history in the making of modern sciences, including medicine, psychology and agriculture. Because of their inclusion of all animals and a critique of ways in which they have been represented, researchers can move into a mindful consideration of all things that seem unsettling. Therefore, some argued to be mindful of how we describe a non-human world is to look for new ways to "write" animals. But, as Erica Fudge (2004) who dedicated a whole book to this issue wrote, "rather than attempting to find new metaphor, then, what I think is necessary is a relocation of how we live with animals on the day-to-day basis" (2004:12). In making this comment, Fudge (2004) aimed to say that practices and words are world-shaping and need to be looked at together.

Looking at practices and relations

Indeed, as scholars in STS noted, practices primarily scientific are world-shaping. However, when it comes to animals, practices and words matter significantly, especially when they do not correspond. There is no point in rewriting stories about animals to spark love and appreciation, Fudge (2004) argued even of the most monstrous, or to use Nagy and Johnson's (2013) term, "trash", when every day millions of animals continue to be treated as tools, beasts, and pests. The mismatch between what we say and what we do gives rise to confusion at best. At worst, the mismatch gives rise to ambivalence, where according to Carolan (2012), it means to "possess feelings, attitudes, and beliefs that are in tension with each other" (p.111) causing internal conflicts and inability to move or act in an uncertain world. But, as Halkier (2001) argued, ambivalence can also have additional roles beyond an inability to solve the inner conflict. These roles are to accept risk; to normalise tensions which emerged as a result of accepting risk; and to escape tensions and risks altogether. The point here is that by looking at the mismatch we can also note the affective states and consider what their impacts are on those who are confronted with a mismatch.

The literature on shifting identities of animals opened up a space for thinking about the possibility of animals being and living differently – not consigned to human imagination and constrained knowledge of what

animals are at a given time and place. In other words, research about the history of animals highlights it is essential to ask, “Why is a pig a widely traded commodity?” (Mizelle, 2012) or “How did chickens become popular as healthy meat” (Miele, 2011) rather than accepting that a pig is a pig, and chicken is a chicken. In a way, research in animals throughout history is akin to unpacking scientific facts.

White (2011) writing about pigs noted the link between practices, places and identity of animals. Having traced the development of pigs through history, he saw the change of pig identities. For example in Europe, through medieval times, pigs maintained special symbolic and cultural statuses linked with seasonal and ritual feasting, with fertility rituals and magic (White, 2011:97), but later due to land pressure pigs moved to cities and became known as scavengers. Only in the early 19th century did pigs in Europe begin to be seen as “...prolific, sooner made fat... upon less provisions, and cut up, when killed, to more useful and convenient portions” (White, 2011:108) But their status as magical creatures or animals who can kill humans (as in medieval trials indicate, see Evans, 1906) was lost in the system of conveyor belts at modern slaughterhouses (Cronon, 2009). Tovey (2003) and Bulliet (2005) also observed that the domestication of animals played an important role in shaping identities of animals. They stressed the domestication process left little space to recognise animals as reflexive actors, self-conscious and reasoning beings (Tovey, 2003, p.211).

Lien and Law (2011) as well as Pierce (2013) writing about salmon,

noted that when looking at practices surrounding salmon, salmon emerged as multiple. From salmon in rivers where they are caught, from salmon on farms where they emerge as hungry, to laboratories and regulations where it emerges as both natural and unnatural. In fact, Barack Obama, former president of the United States, made a joke about it. He said:

> The Interior Department is in charge of salmon while they're in fresh water, but the Commerce Department handles them when they're in saltwater (laughter). I hear it gets even more complicated once they're smoke (laughter and applause). (www.npr.org, 2011[6]).

His salmon joke was about excessive bureaucracy, but for me this spoke to places and spaces as well practices surrounding animals. Even a joke like this illustrates that there is not one animal but many which comes with different ways of handling and attending to them. But there is a lot to be gained from looking at emplaced practices surrounding animals, namely learning about the animals themselves and human priorities. As Pierce (2013) argued, by looking at how salmon is enacted in different texts, we can go beyond scientific and utilitarian ways of thinking about the fish that belongs to rivers, oceans, farms, bears, indigenous cultures, environments, and of course themselves. By looking at these multiple enactments we learn there is

6 https://web.archive.org/web/20200806084212/https://www.npr.org/2011/01/26/133249608/The-Salmon-Bureaucracy-From-Egg-To-Table

not one but many ways of thinking what is, and therefore what could be. I contend that the same can be done with all phenomena that we seem to know and have decided about, but in fact we must learn about.

This is where literature about re-reading spaces, representations of animals and science come in together to address this problem. Caring would mean paying attention to how an understanding of beings other than human are enacted in practice. This would involve looking at places, people, and practices as they happen, to look at these complex human-animal encounters and animals themselves. In other words, this would imply connecting the above insights from the literature into one. A material-semiotic approach, as noted already, is a way to do it because it allows following a controversy through places, texts and people, and indeed all other beings. In doing so, it allows us to pay attention to all of the things that might not usually be included.

In summary, to address radical uncertainties and learn from controversies, the literature suggests exploring “things” with care. One is a way of exploring a topic by adhering to a material-semiotic approach through an exploration of enactments as well as encountering controversial scientific innovations. Second is a way of incorporating the neglected things as part of making science and as part of researching how science is made. This would include paying attention to how, and what, things are being written about and enacted. The overall aim is to bring to live both human and non-human stories of science as practice.

Although material-semiotic is often accused of being dispassionate by treating everything as if the same, whether rocks, microbes or humans, I would say that what's missing is the attention to feelings and emotions which de la Bellacasa (2011, 2017) urged researchers to consider. I am not saying that the material-semiotic approach is insufficient. Instead, I am saying that when it comes to controversial topics which include animals who attract a badge of monstrosity, it might be worth considering as to whether emotions and feelings can complement the explorations. The hope is that rather than running away from feelings, they can become part of solutions to knowing how to act in an uncertain world.

2.4 Turning to affective explorations of controversies

Throughout the last few sections, I have been referring to feelings and emotions as things that circulate discussions about radical uncertainties. For instance, in the introduction, I mentioned feeling love or hate for abstract or living phenomena. In the section about radical uncertainties, I noted that scientific knowledge alone might not be able to address radical uncertainties, in particular, the feelings and emotions that emerge alongside physical risks from unprecedented events. In the section about exploring controversies with care, I noted that investigating practices, even in unlikely spaces, one might build an emotional bridge. Lastly, I noted that a mismatch between

representations and practices surrounding animals can lead to concerns, anxieties and conflicts. But, following arguments made by de la Bellacasa (2011, 2017) I also noted that to include the neglected things means to include affective states such as love grief, shame, happiness etc. too. In this section I want to discuss the notion of feelings and emotions a step further and evaluate them from the perspective of radical controversies.

Thinking back about the literature reviewed so far about ways to address radical controversies, one could argue that there is no way of improving on the work that has been done to this point. But, a growing body of literature that deals with theories and concepts of emotions and feelings is a promising addition to the line of research I have reviewed so far.

Broadly referred to in the literature as “affect theory” shares lots of insights with the concept of caring as theorised above. But, my takeaway is that affect theory pays slightly more attention to affective states and all those unseen but felt forces which speak to radical controversies and all those things that are provocative, unsettling and problematic.

I start by providing an overview of the so-called emotional and affective turns in the literature to give the reader more clarity, as these two concepts are used at times interchangeably. While I do not mind that, it

is worth pausing and considering what strengths and weaknesses these two concepts have. Given the breadth of opportunity which these concepts offer, I move on to clarify that I found a material-semiotic reading of affect most in sync with the literature I have reviewed thus far. For this and other reasons which I am about to discuss, I developed a framework of affective enactment. This section therefore discusses the last of the central themes that framed this research.

Understanding emotions and affect

Do you ever hear yourself saying: “I *love* my dog, cat, pig, fish etc.”? Do you ever come across others saying: "I *hate* dogs, cats, pigs etc, especially those small ones"? Or "I *am scared* of GMOs, vaccines, nuclear power etc." or, "I feel *safe* when an expert in public heath, a teacher, my mum etc. tell me what to do”? It is likely that you hear or think those words on a daily basis. Therefore, in this section I want to talk about emotions or affective states, as de la Bellacasa (2011, 2017) calls them. More precisely, I want to talk about emotions being at the forefront of relations to animals, technology and concepts such as love itself, and therefore becoming useful in engagement with radical uncertainties.

The rise of emotions

Emotions and affect travel together, and it is hard to distinguish which

one entered the vocabulary first. Both concepts have been of interest to philosophers although words, emotions and feelings proliferate more strongly in everyday language and behaviour, media, art and non-fiction (Hipfl, 2018; Huggan, 2016).

Emotions and feelings have also been described as markers or even a property of humans, which in recent decades has been challenged (Miele, 2017; Bekoff, 2002; Buller, 2014). Building on research in ethology, animals are now understood as sentient and feeling beings with agency. Animals are not just companions serving emotional needs (Franklin, 1999) because they are now equally considered as beings who express and process emotions (Bekoff, 2010; Miele, 2017, 2010; Masson, 2004). Thus, the boundary between human and animals has been blurred once again not only in terms of genetics (Margulis and Sagan, 2000), agency (Latour, 1983) but also in terms of emotions.

Ironically, emotions and feelings, even though once markers of humanity and a subject of neuroscience and psychology, are still considered out of place when it comes to scientific knowledge (Parr, 2014). As mentioned earlier in this chapter, scientific knowledge tends to be viewed as more objective than lay or emotional knowledges because emotions and feelings are meant to be put aside when science is practised. But this too has been challenged and more research is now discussing the role of emotions in making science (Lorimer, 2008; Latimer and Miele, 2013). For instance, Lorimer (2008) in a study about the efforts of ornithologists and bird surveyors to gather census data on

corncrake, he noted that emotional sensitivity and attunement with birds were as important as surveying methods that rely on all forms of knowledge and skills. Here is how Lorimer (2008) described one of the surveyor's named Craig:

> It soon became apparent during my time with him in the field that, for Craig, counting corncrakes was deeply affective. At different times, it could be enchanting or even euphoric when, for example, the first corncrake of the season arrived, an individual was identified in a previously unrecorded location, or the total of the previous census was exceeded. For him (and many other amateur and professional naturalists) these emotional energies compel him to get involved in the census (as a profession, corncrake surveillance is not well paid). When I asked him why he did what he did he replied that the corncrake fascinated him, he found surveying fun and it allowed him to live in the islands. For Craig, the corncrake performs types of non-human charisma. (p.35).

Lorimer suggested that the feeling of being with the birds was joyful (as well as sad) to surveyors, which worked as a "glue" (Massumi, 1996) in human-corncrake interaction, a glue that cemented the surveys. In doing so, Lorimer (2008) noted that researchers studying scientific practises should be paying attention to the role of emotions as it can offer greater insights about their place, use and/or lack when establishing scientific knowledge. A turn to emotions can offer a richer and compassionate account of science, leading to a greater and perhaps, better dialogue between opponents and proponents.

Latimer and Miele (2013) who also placed an emphasis on affect and emotions, noted that researchers of scientific practices might be able to tune in with lab technicians and scientists who in turn also tune in with animals, people, and artefacts creating attachments and removing divides. Those attachments open a way of seeing that we live in a world populated by cyborgs (Haraway, 1991) and bundles of interspecies naturecultures where not one, but many, contribute to knowledge. So, scientists on their own do not create scientific knowledge, but rather they co-create it with and alongside (Latimer, 2013) animals, neutrons, elements, tools, computers, viruses, pipettes and other countless human and non-human beings. The discussions Lorimer (2008) as well as Latimer and Miele (2013) have taken up around the topic of emotions and/or affect thus circled back to the core theme of affirming what is knowledge, which knowledge is more valuable, and who is in possession or capable of knowing.

It can thus be argued that emotions have been at the peripheries of interests to both geography and STS scholars. But, in the recent years there has been a much greater uptake. Owning to insights from feminist thinking (Haraway, 1991; de la Bellacasa, 2011) and human geography, STS moved to consider emotions more fully. In particular, research is now focusing on the link between feelings for and in spaces, and the role of emotions in research, governance (Jupp et al., 2016), bioethics (Sales and de Mel-Martin, 2012), societal norms (Windram-Geddes, 2013; Broomhall, 2015) and human- animal relations (Gheaus, 2012;

Herzog and Foster, 2010).

With regards to bioethics and science, Sales and de Melo-Martin (2012) for instance, argued that appeals to emotion are frequently used by the public, policymakers and opponents of technologies. They have argued that disgust has been used as a rhetorical device to endanger opposition and to dismiss concerns of others resulting in a continuous dismissal of emotions as visceral gut reactions to be a legitimate source of knowledge. Disgust in particular, Sales and de Melo-Martin (2012) argued, is considered by scholars to be unreflective yet ever so useful in discussions around food. Disgust is said to warn against danger and transgression and yet, they argue, it is damped down with logic and scientific facts. Failure to include disgust and emotions in general, they argue, is a failure to be democratic and reflective about science. Although Sales and de Melo-Martin (2012) did not offer a precise way to address it, research in public understanding of science offers a direction.

Campbell and Fitzgerald (2001) for example, asked to follow negative emotions such as fear through media but also right up to laboratories and scientists to realise that fear is on both sides of debates about biotechnology. Cook, Pieri and Robins (2004), although not setting out to study emotions, were surprised to see that scientists view themselves as thinking more than feeling selves. But, upon closer inspection, emotive language was used to describe others but supressed when talking about themselves.

Engdahl and Lidskog (2012) proposed that even trust is based on emotions rather than logic and information, thus if scientists are to build trust, they need to consider its importance and make others feel emotionally engaged. Garcés (2020) in her fascinating story about working closely with chicken farmers, did exactly that. To address lack of animal welfare on industrial farms, Garcés began seeing farmers in different light once she realised they too, like chickens, are locked-in and unable to escape. She began to build a trust by appealing to a common goal – animals – and creating human-to-human connection. She opened her heart as well as her mind and in doing so, began turning enemies into allies. Garcés (2020) exemplified “hearts, minds and hands” (Rose, 1983) approach mentioned in the earlier discussion around care.

With regards to animals, attention to emotions has taken two routes. On the one hand we see a proliferation of studies showcasing animals as feeling beings able to show emotions back to humans. Here we see a proliferation of studies where animals are seen as therapists and companions who actively take part in healing and making connections (Gorman, 2017). On the other hand, there are studies considering the role of emotions in caring for animals and understanding their needs.

For example, Gheaus (2012) argues that love and affection toward animals should be added to ethical considerations about all animals. Ethics infused with love for example, would mean loving all species wherever and whoever they are without necessarily humanising them.

Attention to emotions, as research by Miele (2017, 2011) suggests, allows us to consider how animals' emotions are shown in practice and evidenced. Miele (2017) noted that not just the scientists, but a wide range of objects, publications, institutions, marketing and so forth take part in evidencing what animals feel and how they become as a result of that. Miele (2017) also showed that attention to animal emotions promotes a stronger involvement in animals' lives and increases awareness of conditions they live in and feelings they could have if farmed differently.

With regards to qualitative research, attention to emotions has two important values. Widdowfield (2000) and Rager (2005a,b) for example, noted that their own emotional responses highlighted their prejudices and lack of awareness as to what it means to live in poverty, or with cancer. Attention to emotions exposed their vulnerabilities and inability at times to face the challenge of doing research, which can at times be heartbreaking. But, attending to emotions of ourselves and others allows us to bridge a gap between outsiders and insiders, to create connections and trust.

All these lines of research provide great insights into possible ways of addressing radical uncertainties. The value of emotions, studies suggest, is promising and fruitful if done well. The studies I just mentioned, whether they were about scientists, animals or researchers themselves, all point to the value of opening hearts to see anew and create connections. But opening hearts, connecting, loving and

evidencing emotions is not without its downsides. Some of those studies stumbled upon the feelings and emotions while doing research, while others were more deliberate in their approach.

Parr (2014) noted that despite the wealth of research, emotions present the challenge of capturing and representing them. They are too fleeting and too individualistic. They also cannot be put into words, or they can be misread and misrepresented.

When it comes to animals and their emotions, this too comes with a challenge. The assumption is that emotions can never be reconvened in words, thus either a different approach is required, one that would not rely solely on biomarkers such as levels of hormones in a body, salivary responses and behaviour. Thus, as Miele (2017) suggested, it is worth looking at the plethora of things that contribute to the understanding of feelings we and animals feel.

Given the challenge of capturing emotions, some scholars proposed that affect might be a more appropriate term, especially when it comes to animals. Nyman and Schuurman (2016) for instance, suggested that the concept of affect is considered to be more inclusive than that of emotions when human encounters and communication with non-humans are subjected to investigation. Based on the debates which I am about to introduce, I view affect also as inclusive and connecting, but not necessarily better than that of emotions. I think these two concepts play an important role in expanding research into the realm of

emotions. However, from the perspective of radical uncertainties, affect is a promising concept because it allows to treat text, practices and living or dead beings as affect without needing to name the feelings and their location. But of course, this all depends on the ways in which one understands affect.

In the next section, I move on to talk about interpretations and uses of affect which have guided my overall approach to this study.

From emotions to affect

Affect, as Parr (2014) summarised it, is a non-representational approach, that concentrates on performative “presentations” and manifestations of everyday life rather than words, or indeed, biomarkers. Parr’s words capture the essence of affect, but there are many more interpretations which I will now summarise before I move on to talk about its uses.

"Affect" entered the vocabulary of humanists, anthropologists, geographers, and animal study scholars through at least two routes (Hipfl, 2018; Rutherford, 2016; Figlerowicz, 2012). The first was through the works of a psychologist, Sylvian Tomkins (1984), and the second was through philosopher Baruch Spinoza (1677), and subsequent interpretations of affect by Deleuze and Guitarri (1988) as well as Massumi (2015). Approaches to the understanding of affect in the case of Tomkins are inspired by the physical, and in particular, neurological

reading of humans and emotions. Whereas Spinoza's reading concentrated on the philosophical conceptualisation of mind, emotions, bodies and knowing the world. The uniting theme though is recognition of things other than words, practices, mind, and body in an orientation toward oneself and the world.

To Tomkins, affects (nine to be precise) are innate, universal and seen as primary motivations of human behaviour. His neurological approach was interpreted in multiple ways but can be mainly found in the works of Eve Sedgwick and Lauren Berlant, known as the foremost affect theorists in critical theory. To Spinoza, affects are understood as forces that circulate between bodies and which increase or diminish its capacity to act, to be affected and affect. Spinozian understanding of affects is found in the works of the main theorists of affect such as Deluze and Guattari (1988), Massumi (2015), Thrift (2008), Seigworth and Gregg (2010), as well as Ahmed (2004).

Affect theory is also characterised by its approach to a boundary (or lack of) between emotions, feelings and affects. Thus theorists, especially those that follow Massumi (2015) and Deluze and Guattari (1988), draw a sharp line between affect and emotions. It is argued that emotions and feelings are too complex and fleeting to be represented and captured.

Thus for now it suffices to say that the difference between emotions, feelings and affect is centred around defining where they are located

and what is their function. But on the whole, affect has been used to talk about the invisible forces between bodies, places and things. It has been noted that although affect is experienced differently (Archambualt, 2016), and that not everything and everyone is moved the same way at the same time, affect nevertheless allows to create connections.

It is understood that affect happens before or after emotion and it is the emotion that is named, not the affect. Thien (2005) understands affect as emotions in motion and critiques non-representational approaches to affect as side-lining the individual and situated experiences. In contrast, others, for example Thrift and Anderson, view affect as a product of relations between things: one body (human or otherwise) acts on other bodies, something passes between them, and this is the moment of affect (Creswell, 2013) that is of interest to theorists.

Critique of affect, therefore, is to do with how it is theorised. If psychological and neurological roots of affect are applied, then it is critiqued for being a universalist, pre-subjectivist, innate force different from emotions (Martin, 2013) that wipes away the importance of place, space, embodiments and context. If affect is approached from the Deluzian perspective, it is critiqued for being too conceptual, fleeting and impossible to capture when affect moves and is moved by. Affect can thus be critiqued for being, on the one hand, individualistic, and on the other universalistic (Tolia-Kelly, 2006).

Nevertheless, affect theory has been used in every context from labour (Ahmed, 2004; Hardt, 1999), media (Barnhust, 2011; Hipfl, 2018),

education (Zembylas, 2006), zoos (Parrenas, 2012), plants (Archambualt, 2016), animals and science (Latimer and Miele, 2013; Lorimer, 2008; Shaefer, 2015), and farms (Kaarlenkaski, 2015) to name but a few. Although affect theory in the literature (see for example, Gregg and Seigworth, 2010; Anderson, 2017; Hardt, 1999, Ahmed, 2004a,b; Windram- Geddes, 2013) quite often deals with human stories of pain, loss, labour, longing and (not) belonging there are also shifts into non-human experiences.

With regards to animals, Rutherford (2016), a cultural anthropologist, argued “there is nothing new about the links that the multispecies literature draws between animals and affect” (p.293). “Passion”, she added, “has long marked the spot where the animals and the human converge along an "an animal hierarchy" leading from rocks to men” (p.293). In other words, feelings about, for and between human and animals have been of interest to scholars for some time. But, Rutherford (2016) and a growing number of scholars in anthropology and animal studies began to notice that the concept of affect in relation to animals is more than the question of whether feelings mark the difference between human and animal. “Today”, Rutherford writes, “they [anthropologists] are approaching animals as actors with a central role to play in the worlds humans create. Recent work in this vein shifts attention from how humans think to how animals feel: the feelings they evoke in humans and the feelings they feel themselves” (2016:293). Nyman and Schuurman (2016) echoed this shift by saying that many

studies placed their focus on human and animal encounters to foreground the affective agency of animals.

Affect is thus being discussed as a framework for exploring ways that: can capture how animals move others; allow to get to know animals; and can explain complexity of human-animal relations. Very often, affect allows to tackle these different ways at once. The source material also varies but overlaps too. For instance, Nyman and Schuurman (2016)'s assertion that "animals attract and move human being, both on screen and in real life" (p.1) speaks to this.

> The term affect refers to the experience of being affected by the other bodily and emotionally, an aspect of the human-animal encounter that cannot always comprehensively understood through language (Ahmed 2010). As such, affect is epitomised in the practices of companion animal keeping, where animals, by entering into individual relationships with humans, serve the emotional needs characterising life in late modern societies (Franklin 1999:57). (p. 2).

They point to two things as to why affect is needed or fitting. The first point is that, not all is text and practice. Some encounters i.e. when bodies meet, see, read each other, cannot always be fully understood, accounted for, explained, measured, and observed. Sometimes, all there is left is text, media and images and so scholars who work with affect, mix and match methods. The second point is drawing attention to places of affect, noting that animals that live with humans (mostly

pets) are the best examples of affect, or as Nyman and Schuurman (2016) called them, affective animals. However, research is also shifting to consider all animals in different times and settings, as affective.

For example, Kaarlenkaski (2016), tried to capture affective relations between cows and Finish people in material from the last century describing cattle tending. Kaarlenkaski (2016) had only human accounts of cows which did not explicitly described emotional bonds but gave clues to emotional attachment that was, at times, suppressed leading to familiar, to the current's century, feelings of ambivalence and conflict. Parreñas (2012) on the other hand looked at affect, as it happened, within an orangutan rehabilitation centre called Sarawak in Malaysia. As an anthropologist with interest in affect, Parreñas (2012) considered movements between staff, volunteers and animals, emotions and feeling they evoked in each other. In a commentary about the study on Sarawak centre, Rutherford (2012) noted that "each partner had to take a leap of faith to know whether the other would bite or embrace, offer a beating or a mouthful of food. (…) What gave these encounters their charge was a shared experience of alterity" (p.689).

Thus, affect has been used to speak to emergent properties of affect upon encounter whether in real or virtual spaces. For example, Huggan (2016) in writing about affect of polar bears in media, navigated the reader into discussions about science of climate change, in particular public understanding of climate change and affect of bears on human behaviour. He noted how different images and stories of polar bears do

different kinds of work, while one story might increase an understanding of climate change, other stories and images might not impact affect (as emotional states) or behaviour. In doing so, he alluded to the core of STS literature i.e. different ways of knowing (Wynne, 1991) but at the same time, accentuated the role of emotional states anchored in images and stories of polar bears as facilitators in public engagement. In his own words:

> Anchoring climate change in particular icons [...] can prove to be an effective mechanism in facilitating public engagement with climate change issues, although the effectiveness of these icons also largely depends on the stories that are told around them, which operate in turn within larger discursive and ideological frames. (p.15).

Here, Huggan (2016) refers directly to a large body of animal studies literature, especially on how animals are written about (Fudge 2004) and perhaps also to enactments of particular narratives. However, I argue, in part he is highlighting that to be attentive to use of emotional states and animal in facilitation of public engagements. In other words, while affect can be and perhaps should be recognised in discussions around science, it should be approached with cautions and awareness of the messiness and liveness of human-animal relations augmented by text, practices, places and emotions.

But, Shaefer (2017) for example, noted that “politics of affect come into view when we recognise the deprivation of non-linguistic ingredients shared by humans and non-humans alike such as, colours, shapes,

textures, faces, friendships, communities, loves, food, motion, images, places, spaces, structures" (2017:27), to name but a few. Although research in interspecies communication and ethology (for example, Grandin and Johnson, 2005 on cows; Patterson and Linden, 1981 on Koko the gorilla) provides incredible evidence showing animals experience of grief, despair joy and love, affect offers a qualitative way to come closer to understanding how animals might feel. Teittinen (2016) who re-read Agee's *A Mother's Tale*[7] from the perspective of affect, noted that although the use of anthropomorphism in fiction and non-fiction can never fully grasp animal emotions, it can create affective connections. So, "we might not have a biological understanding of how animal feel" (Teittinen, 2016:155), but we can have a shared understanding of suffering, feeding, and nurturing to name but a few. Affective connections that make possible the formations of new attitudes toward animals. So here affect echoes many of the insights from the literature about care I mentioned earlier.

The uniting theme in the literature reviewed here is thus connecting and moving character of affect, i.e. that affect happens upon encounter, in relations between people, things and places and bodily capacities to affect and be affected, and a way to show how animals might feel.

7 A Mother's Tale (Agee, 1952) is a short story about a dam who is confronted with the task of explaining cattle their destiny.

Affective enactment

What these debates show is that both concepts are critiqued along the same lines. Presumably though, whoever uses these two concepts, and however they are used, they aim to shine a light on the power of the invisible and fleeting moments that circulate between bodies, spaces and objects. I would rather focus on the connective aspect of affect rather than the difference between affect and emotions. It is the connecting capacity of the affect theory that I found quite intriguing, which is why I will now move on to discuss it.

In reading affect theories from the material-semiotic perspective, affect itself is being enacted. As Rutherford (2016) observed, affect is becoming a boundary object moving in-between places, spaces and understandings. It therefore raises questions such as: what is it that moves us, what and who becomes, how and where. It can, therefore, be understood as an opportunity to examine how human- animal relations move, incite, elicit and excite, whether in scientific practices or everyday life (Latimer and Miele, 2013). It is also a way into seeing how things, humans and animals and concepts are being enacted.

To illustrate it, I would now like to introduce the work of Sarah Ahmed, who is known for the theorisation of affect and emotions. Ahmed (2004 a, b) who built on both theoretical approaches to affect (psychological and Spinozian-Deleuzian), incorporates emotion and feeling into affect.

Her book *The Cultural Politics of Emotion* (2004) concentrates heavily on emotion, tracing it back to Descartes, and disputes over what emotions and their roles are. Here is how Ahmed describes affect and emotions:

> So let's think about how it feels to be comfortable. Say you are sinking into a comfortable chair. Note I already have transferred the affect to an object ('it is comfortable'). But comfort is about the fit between body and object: my comfortable chair may be awkward for you, with your differently shaped body.
>
> Comfort is about an encounter between more than one body, which is the promise of a 'sinking' feeling. It is, after all, pain or discomfort that return one's attention to the surfaces of the body as body. To be comfortable is to be so at ease with one's environment that it is hard to distinguish where one's body ends and the world begins. One fits, and by fitting, the surfaces of bodies disappear from view. The disappearance of the surface is instructive: in feelings of comfort, bodies extend into spaces, and spaces extend into bodies. The sinking feeling involves a seamless space, or space where you can't see the 'stitches' between bodies. (p. 25).

What Ahmed is doing then, is focusing on contact, bodily experiences, fitting into, being at ease, being together with objects, but emphasises these changes do not happen exactly the same way to everyone. Affect, at least in the above description, is the name we give to a feeling, but it is also what it does i.e. it creates expectations and gives an illusion of sameness and universalism. To further illustrate it, Ahmed (2004) talks about heteronormativity as affect that emerged out of being presented with ideas of the comfortable norm (posters, media) and living in

environments that are designed for expression of heterosexuality (allowed to hold hands in public, seeing heterosexual couples in the media). The effect is, therefore, packaged into semiotics and materialities infused with emotions and feelings. This is what she calls "stickiness" - bundles of text, things, context, bodies, culture, nature and emotions. Stickiness here is not too dissimilar to the idea of emotions as glue (Massumi, 1996) that binds experiences and things together. However, unlike Massumi's glue which binds emotions with practice and things to generate knowledge, Ahmed's stickiness binds emotions with practices and things to create a feeling that is undetected and cannot be shaken off easily. It permeates and catches attention without anyone knowing.

Thinking back about the caring in spaces and caring about words that are used to describe things, Ahmed (2004) takes on affect as "stickiness" and in a sense explains why it may be so hard to shake off some of the assumptions and expectations about things we explore. Although the literature which I reviewed has done a great job of showing that definitions and meanings are not born in a vacuum, or created by human actors alone, Ahmed explains that the invisible glue that holds together some of the normative notions is affect. For example, questions such as 'what is love, or fear' turn into 'what or who is, and how it becomes loving and lovable, or fearful and fearsome'.

I will once again rely on Ahmed. I have deliberately chosen a more extended quote because it is so well explained, and I don't want to ruin

Ahmed's thinking process. However, I will add that in the following hypothetical situation about a child encountering a bear, one should pay attention to different understandings of what it means to love or fear, and to be lovable or feared.

> The child sees the bear and is afraid. The child runs away.
>
> Now, the 'Dumb View' would be that the bear makes the child afraid, and that the bodily symptoms of fear are automatic (pulse rate, sweating, and so on).
>
> Functionalist models of emotion, which draw on evolutionary theory, might say that the fear has a function: to protect the child from danger, to allow survival. Fear in this situation could be an instinctual reaction that has enhanced successful adaptation and thus, selection. Fear would also be an action; fear would even be 'about' what it leads the child to do.
>
> When we encounter the bear, we already have an impression of the risks of the encounter, as an impression that is felt on the surface of the skin. This knowledge is bodily, certainly: the child might not need time to think before she runs for it. But the 'immediacy' of the reaction is not itself a sign of a lack of mediation.
>
> It is not that the bear is fearsome, 'on its own', as it were. It is fearsome to someone or somebody. So fear is not in the child, let alone in the bear, but is a matter of how child and bear come into contact. This contact is shaped by past histories of contact, unavailable in the present, which allow the bear to be apprehended as fearsome. The story does not, despite this, inevitably lead to the same ending. Another child, another bear, and we might even have another story. (p.8).

What lessons can we take from this? In writing, "bear is not fearsome on its own, it is fearsome to someone or someone", I argue, Ahmed

recognises the phenomena that, in this case, animals, are relational: they need something or someone to become something, in this case "fearsome". In doing so, Ahmed points to not only the making of emotions (fear) but also to the making of those that "exude" or are assigned to this or other emotions. In other words, what is enacted is an emotion and an animal at the same time. So not just "natural", "unnatural", "wild" or "captive" bear, but also "fearsome" and "scary". Thus, what is produced is affect of the bear that does something to a child - makes it run away - but it is not determined. Affects can be different to different people. They are not determined and not universal, although they appear so.

In writing about emotions, Ahmed points to differences in which these are understood as we see in the literature by Mol (2002), Lien and Law (2011). Here, Ahmed explains, fear can be understood from the perspectives of: dumb view ("bodily symptoms of fear"), functionalist model of emotions ("fear has a function"), culture ("bear as an animal to be feared, as an image that is shaped by cultural histories and memories"), embodiments ("an impression that is felt on the surface of the skin", "this knowledge is bodily"), and finally, material-semiotics ("another child, another bear, we might have another story"). Fear, to use Mol's (2002) words, is then multiple.

This line of thinking can be extended to all other animals and abstract

concepts, especially those that are presented as "monstrous" or "unwanted" as a way of unpacking how they came to be enacted as such, and what made those enactments "sticky" (Ahmed, 2004) or to use Latour's (1983) words, durable. The strength of this approach is that it adds emotions to conceptualisations of enactments and caring without identifying specific emotions or representing them.

Now that I have explained what affect is and which version of affect I subscribe to, I want to expand on the idea of the strength of this approach in learning from controversies how to act in an uncertain world. No longer a side note, feelings and emotions are taking centre stage. So no longer irrational; gut and perhaps other feelings of hope, fear and desire should also be explored too when thinking of animal futures (see Garnett, 2015).

2.5 Animal biotechnology

Now that I have explained the value of affect, it is time to finally talk about its relevance to the topic of my research. Although I have mentioned genetic modification a few times already, I think it is crucial to outline what this topic is about, how is it understood, and why it might benefit from affect as well as the material-semiotic approach.

In 1995, Lynn Margulis and Dorion Sagan published *What is Life*? a book that has redefined the meaning of what it is to be human. As a feast of scientific endeavour and philosophical insight, their account of microbes has contributed to an equivalent of the animal turn, namely "microbial turn" (Paxson and Helmreich, 2013:2). Donna Haraway, when thinking about the 90% bacterial side of humans, wrote in her *When Species Meet*:

> I am vastly outnumbered by my tiny companions; better put, I become an adult human being in company with these tiny messmates. To be one is always to become with many. (2008:4).

Becoming-with-many meant the arrival of a new way of seeing human as a more than body and mind detached from non-humans and environment. It opened up seeing humans as connections, entanglements, and companions with many. Posthumanism challenged the anthropocentric account of the world and took into account non-humans and their experiences of being in the world.

But now, genetically engineered livestock animals are providing a timely twist into multispecies thinking because they are not just inhabited by bacteria and viruses in their guts or cells, but also other, distant species forming their DNA. It is an unprecedented moment for scholars interested in multispeciesism because, for the first time, it allows us to ask 'what is a GM animal' by looking into more-than-human, more-than-one animal. It is also an undoubtedly unprecedented moment for regulators and assessors of genetically modified livestock animals who also ask, 'what is natural'. But, for the public who knows animals from a distance and farmers who know animals up close, the questions might pertain to knowing how to relate to these animals and how to live with them.

In this section, I want to highlight that farm animal biotechnology provides a timely and empirical opportunity to look at those questions from the perspective of affective exploration. In other words, the case of animal biotechnologies relates directly to the questions which I have been highlighting throughout this chapter.

Concerns about farm animal biotechnologies

Numerous scholars have argued that genetically modified crops

displace nature, unsettle the public and spark distrust in science and policy-makers (for example, Wynne, 2001; Campbell & Fitzgerald, 2001; Horlick et al., 2007; Jasanoff, 2006; Bowring, 2003; Whatmore, 2002). But relatively less research has investigated whether the effects of animals that have been genetically modified would be similar. The growing body of literature suggests that effects of GM animals will be similar when it comes to trust in experts and fear of the unknown. However, as Gaskell et al. (2000) and numerous Eurobarometer surveys (1977, 1991, 1993, 2003, 2010) noted, GM animals will spark new areas of concern. Animal biotechnologies are said to be possibly unsettling to the public because of how these animals have been created (deliberate insertion of a foreign DNA) and what are they are being used for, how they will be eaten and related to by all parties involved, not just the public. But first, what is it about the GM animals that is unsettling? Let me start with the definition.

Just like GM bacteria and plants, animals can now also be genetically modified using a wide range of techniques. Animal biotechnology is thus an application of molecular science and tools to animals, but not all animals are classed as GMOs. The term genetically modified (GM) animals, according to the Royal Society, refers to animals that are:

> …modified either via a technique known as transgenesis (when individual genes from the same or a different species are inserted into another individual) or by the targeting of specific changes in individual genes or chromosomes

> within a single species – targeted removal of genes (knock- outs) or targeted addition of genes (knock-ins). New technologies are constantly arising, and 'chromosome engineering', which creates GM animals carrying large-scale DNA rearrangements, is now being used. Transgenesis does not include the techniques of radiation, chemical or viral mutagenesis, selective breeding techniques which exploit pre-existing mutation/genetic variation, nor does it include cloning. (2001:3).

Genetic modification, I need to stress, occurs outside of laboratories, for example, viruses and bacteria perform a process called horizontal gene transfer which gave rise to understanding genetic modification (Quammen, 2018). For this reason, it is often compared to natural processes. But, as the definition suggests, GM animals end up becoming products as a result of deliberate attempts to modify them.

Going back to the notion of science as practice, one of the core concepts used in this research, it is worth considering what is the purpose or what is it that definitions are doing. The jargon of these definitions is, as Lien and Law (2011) would have it, "matter-of-fact, concise and to the point" (p.67). It can be argued that these definitions aim to explain what a GM animal is to avoid further speculations, controversies, ambiguities and misunderstandings. These definitions instruct the readers who these animals are and how they are ought to be treated, whether through regulations, ethical approvals or through discussions in the media. Potentially, these definitions make it easier to relate to such animals i.e. to know who they are and how to feel about them.

But looking more closely, these definitions, also introduce other animals and show these animals are not singular, they are somewhat mixed and full of culture as well as nature (Whatmore, 2006). This definition draws on things done to an animal, it talks of their origins but in doing so invites questions as to what led to this, what's their history, who these animals would be if it were not for these techniques, who is performing these changes and what is the future of those animals, how does it feel to be such an animal and how does anyone else feel about them.

But there is more to the definition of GM animals. If we are to consider the second central theme in this research, which is attention to all animals and the role of other framings, contexts, practices and so forth, then we are beginning to see a conflict and emerging controversies.

As Einsiedel et al. (2002) predicted after the lesson from the development of Dolly the Sheep, debates and controversies will really start when and if the GM animal ends up being created for consumption rather than medical use. Indeed, they were right. So far, a few developments in GM livestock intended for medical use sparked some interest, but not as great as one would assume. Innovations such as GM cows (Bloomfield and Doolin, 2011; Väliverronen, 2004) that produced human hormones did not strike that chord globally, because these solutions applied to a small group of people and only those who might benefit from the use of hormones produced by the animals. Dolly is the exception because Dolly lends itself to human issues centring around cloning as a form of reproduction that anyone could relate to.

Nevertheless, the attention to farm animals echoes the recognition of "mundane" animals present in the literature outlined earlier.

But it is also worth pointing out that the context in which farm animal biotechnologies are proposed will fuel new debates and concerns. For example, in the context of demand for food, animals may be understood as an answer and solution to the growing appetite for meat, which Twine (2010) referred to as molecularisation of sustainability. The concern in respect to living with the new species is that the public might be split in their opinion as to whether GM is, in fact, a good solution given that animals can be created so that they grow faster. In the context of risk assessments and regulations, where judgment as to what makes an animal depends on looking at DNA as a string of information (Birke and Michael, 1998), GM animals might seem like any other species, perfectly natural (Humphries and Sanderson, 2015; Sanderson 2015). The concern is that without access to labs, tools and scientific knowledge, different views might be disregarded as insufficient (Wynne, 1991). Alternatively, understandings of animals based on, for example, farming practices (Holloway and Bear, 2017) might shift from evaluating animals by eye to by genome or genetic marker (Morris and Holloway, 2009). In respect of living with the new species, this may add to the existing discord between scientists and the public in general (Simis et al., 2016) and especially surrounding GM controversies (Lezaun and Soneryd, 2007; Kearnes et al., 2006).

I will now turn to the literature which explores the complexity of those

factors in greater detail. However, I must stress that only a handful of researchers focused purely on GM farm animals intended for food. Farm animal biotechnologies, as mentioned already, covers a wide range of tools and techniques in addition to transgenic animals, which I am mostly interested in. Nevertheless, the views presented here are of value as they suggest that even if animals are not entirely genetically modified, the techniques and tools, such as cloning and genetic markers, are already revealing effects on animals, farmers, and consumers.

Return to the animal as "other" with implications for farmers and consumers

"Modern biotechnology," Bowring emphasises, "allows a human being to disregard animals' natural form of life, and even to create them a new telos - which means, by implication, a new type of being altogether" (2003:135). Morris and Holloway (2009) argued that biotechnology "implies new intervention in animal life based on new ways of knowing and evaluating the bodies of livestock animals" (2009:314). Twine (2010) noted that the practices of animal genomics are removed from the sensual presence of animal bodies which results in the creation of the so-called black box (Latour, 1990). The animal body is then treated as a closed system. Animal genomics then tries to ascertain what is going on inside the black box by monitoring inputs and outputs as if was

a machine where each cell “is an assembly line in a factory” (2010:93). As one of the informants in Twine's book put it:

> If you think about it, it boils down to the identity of that little piece of sequence. Now my personal view is that it is 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 put it into a mouse. Now they are both pig genes? They are just a piece of DNA; to me, it is just a piece of DNA. (2010:91).

The above quote illustrates an encounter with animals via genetic analysis, which according to Twine (2010) bears consequences on the ways of dealing with new animals. The concerns about animals becoming as if a piece of information or even code, relates back to the notion of material consequences of representing animals as “other” that has justified in the past their use as tools and objects. Information, as Birke and Michael (1998) noted, became an organising concept in biology. But, because science progressed toward genomics, aided with developments in statistical and computer science, the concept of information led to seeing animals as a string of genetic information removed from a context.

The concern here is that having shifted views of animals to sentient, affective and feeling beings, biotechnology is now reversing this view and potentially adding another dimension. The material consequences of this reversing move have already been observed in studies of transgenic mice in labs which then prompted researchers to investigate

how to add care to lab practices (see previous sections). However, the material consequences of animal biotechnologies applied to farm animals are far more worrying.

The main concerns associated with that are to do with seeing animals on farms as strings of data. This then leads to a loss in farmers' confidence in knowing animals, thus leading to ambivalence and conflict, which Halkier (2001) observed when talking about consumers making food choices. The cases of genetic markers in cattle, as shown in studies by Lonkila and Kaljonen (2018) as well as Morris and Holloway (2009) suggest that farmers too may feel less empowered. More importantly, though, farm-based knowledge also diminishes in favour of scientific knowledge, which as I explained in the previous sections, reduces the ability to deal with unforeseen events.

Lezaun and Porter (2015) made very similar observations in their study of transgenic chickens and mosquitoes to combat avian flu and malaria, respectively. However, their concerns were about responsibility as to what should be "fixed". Lezaun and Porter suggested the "transgenic option" takes away a duty to prevent diseases from happening, and instead shifts efforts to surveillance and control. In other words, rather than changing chicken farming practices to being less intensive or educating the human population and governments about low-cost malaria prevention, the technology offers to alter the animals themselves and reduce the burden on humans. Such concerns mirror the "end of pipeline" approach to environmental pollution criticised by

Giddens and Beck (2004) and echoed in literature concerned with plant biotechnology.

Knowledge and consumers

As Coles et al. (2105) and Frewer et al. (2014) pointed out, social sciences have been slow if not almost silent in exploring what the public thinks, and how it feels and responds to animal biotechnologies destined for food. Until now, only a few studies have focused explicitly on transgenic animals for food (transgenic pig and salmon). For example, Castle et al. (2005) found that 'consumers were not vigorously embracing either of these technologies, but their response is equal, if not enhanced when disclosure occurs' (p.214).

In another study, Schuppli and Weary (2010) devised an experimental online survey that analysed whether support for the use of pigs, for a reduction in agricultural pollution and an improvement in organ transplant success in humans, changes when a new line of GM animals is created. The results confirmed their hypothesis that the attitude towards the two types of applications of pigs would become negative once it was disclosed that they were GM. Interestingly, the authors concluded that gender and education, age and the availability of expert advice (which was part of the survey) did not have a profound and significant impact on the results. Nevertheless, some interesting patterns emerged. For instance, younger people would seek less expert advice, but meat eaters and those specialising in biomedical research

would support the use of animals for both applications. The authors acknowledged the complexity of the factors influencing the public's attitude (see pages: 687, 692-695) like morality, human-animal relationships, and societal acceptance although these were not explored further.

Macnaghten (2004) in his focus group-based research noted that participants had mixed feelings about GM animals but mostly rejected them as going "against nature" (2004:547), i.e. transgressing the boundaries. However, his research also suggested that the participants questioned the known and unknown risks associated with the innovations as well as the requirement to prove a genuine and authentic need for undertaking such procedures (Macnaghten 2004:547). The misgivings people express towards the applications of GM animal technologies, he argued, appear to be reflections of broader syndromes of mistrust towards those institutions seen as responsible for such applications (Macnaghten 2004:547).

The approach in policy documents could be a reason for the lack of research on public perception of biotechnology, claims Macnaghten (2004). In policy documents, he notes, consumers' concerns tend to be regarded as matters of individual conscience, to be appropriately addressed through market mechanisms such as labelling, rather than conceived as a matter for genuine public or 'citizen' debate (p.236).

The story of the Enviropig and Aquabounty salmon would suggest this

is the case because the debate about the Enviropig was limited to one university debate[8] organised in 2010 by the NGO campaigning against the research on Enviropigs. In the same year, the FDA organised a public hearing on Aquabounty salmon[9]. However, neither of the two events took into consideration a genuine public debate because the debate on the Enviropig was between two opposing camps - the NGO and the scientists - therefore leaving out some in-between opinions and views. The FDA's hearing asked the public for views only on two matters. These were:

> 1. Which facts about the AquAdvantage Salmon seem most pertinent for FDA's consideration of whether there are any "material" differences between foods from this salmon and foods from other Atlantic salmon. (Keep in mind that the use of genetic engineering does not, in and of itself, constitute a "material" difference under the law.)
>
> 2. If FDA determined there are "material" differences, how would that difference be described on a food label in a way that is truthful and non misleading? (Keep in mind that it is the difference in composition or in functional, organoleptic or other material properties that must be described, not the underlying production process[10].

The public hearing left no room for other concerns to be voiced, as the FDA was interested only in views on facts, which should or not go onto labels while prompting the public into ways of interpreting the meaning of facts such as a "material" difference between GM and non-GM

[8] http://criticalguelph.blogspot.com/2010/11/enviropig-questions.html
[9] https://www.fda.gov/ForConsumers/ConsumerUpdates/ucm222608.htm
[10] https://www.fda.gov/ForConsumers/ConsumerUpdates/ucm222608.htm

salmon. In thinking about the stories of these two animals while keeping in mind the view of Macnaghten (2004), the research should, therefore, investigate the other voices and concerns about the effects of animal biotechnologies.

Greenhough and Roe (2006) being interested in the unexplored concerns noted more attention should be paid to effects of biotechnology on the day-to-day practices. Greenhough and Roe (2006) were particularly concerned with peoples' ability to negotiate biotechnological foodstuffs when faced with the materiality of a given GM product. In other words, consumers might be asking about the shape, taste and colour of GM foods because this is how, Greenhough and Roe argue (2006), consumers test whether foodstuffs are (in)edible. Similarly, Davies (2006) and Halkier (2001), argued that embodied sensibilities or embodied ethics do follow a moral code, but instead they are translated through affect between bodies and the lifeworld (Greenhough and Roe, 2006:278). Thus, biotechnology when encountered as meat, could potentially bring embodied concerns.

In my MSc study about the perception of the Enviropig I noted these embodied concerns were expressed as questions about taste, while safety was put against questions about farming, future of food and the planet Earth. The effect, regardless of a preference to buy or not buy the Enviropig meat, was a feeling of entrapment and ambivalence (Rucinska and Miele, forthcoming) because of the tensions between concerns about oneself and others (non-human animals, the

environment, future generations).

The concerns about the public and their responses to animal biotechnologies mirror some of the long-standing debates in a much wider body of the literature concerned with public understanding of science. These debates pertain mostly to deciding what counts as knowledge, who is classed as expert and public, and finally the debates pertain to choosing effective methods and approaches to communication of science.

But with the rise of technological (inclusive of biomedical and biotechnological) innovations these debates are even more heightened. Leach et al. (2007) for instance argued there is a greater need for understanding of the complex interfaces and intersections between science and citizenship. In their words:

> Globalisation is changing the nature of science and technology, as it is being shaped by their developments: altering the intensity of innovation of new technologies, and the resulting constitutions and flows of knowledge and expertise, and the character and scope of risks and uncertainties. [...] Moreover, as recent analyses of molecularisation of the life sciences suggested (Rose 2001), politics and citizenship are themselves ever more intimately connected with the subtle shaping of human subjectivities that form the cultural undergrowth and underpinnings of the forms of politics of late-modern, globalised times." (Leach et al.2007:3)

With this context in mind, Leach et al (2007), expand their longstanding critique of 'deficit model' approach to public understanding of science. This model holds that lack of scientific awareness allows for subjectivities (as discussed earlier in this chapter) to take over during a decision-making process. However, studies in public understanding of science (PUS) (see Morris et al. 2001; Horlick-Jones et al 2007; Wynne, 1991) noted that the decision making process is not only governed by objective assessment of information handed down from the scientific community but can also be governed or co-governed by multiple factors which together form different ways of knowing.

Over the years the criticism of the 'deficit model' led to innovative approaches to public understanding of science with a view to inform policy decisions and to redefine academic approaches to the subject matter. One of the examples is the deliberative approach, which includes the public in decision-making processes before or during the design or proposal of a technology.

Despite a rise of public deliberation exercises such as citizen juries, consensus conferences and workshops (Evans and Kotechkova, 2009; Evans and Miele, 2010) prominent STS scholars such as Latour, Strangers, Leach et al advocate further refinements. By refinements, they do not mean an understanding of countless conflicts between scientific and lay knowledges as '[...] epistemic conflicts between ways of knowing, but as reflections of different ways of being, of practicing

and relating - of ontologies' (Leach et al 2007:5). In so doing, better methods can follow which allow for not merely "tapping on" lay knowledges in order to influence the publics but to allow for mutual learning and exchange.

Subjectivities, as mentioned, extend beyond religious or ethical beliefs as they encompass embodied and situated knowledges (Miele and Evans 2010, Haraway 1995, Hutchins 1995). However, STS and anthropological laboratory studies (see Latour and Woolgar 1983) especially centred on work with animals (Greenhough and Roe, 2018; Lynch 1988; Birke 2003; Davies, 2013) illustrate that subjectivities in understanding of science are also seen in the works of scientists and animal technicians. Although in previous chapters subjectivities and the making of scientific claims were mentioned, understanding of science by scientists was not. Why does this matter? Firstly, the literature and events around the world show a stark contrast between the public and scientists. It is assumed, that while public is subjective, the scientists are not. However, keeping STS literature in mind and treating science as sociological practices it is worth extending an STS line of thinking in order to know how scientists understand science and technological innovations. It is somewhat accepted that scientists understand science because they practice it and support it and yet there are scientists who oppose genetic modification of plants and there are those who approve it.

Notable studies carried out in laboratories illustrate that scientists and technicians working with animals act in accordance with their own subjectivities such as relating to either an animal as a being with emotions and feeling or/and a tool used to carry out research, are not reported (Lynch 1988). While these studies have focused on the role of non-humans in the co-production of knowledge, they also reveal scientists' positions and relations to animals they work with. Their position is not evidenced only in the fact that they carry out experiments but in their relation to certain animals, as experiment*able* animals, prior to experiments. Studies which show the making of laboratory animals (see for instance Birke 2003; Davies 2013 on rats and mice) are of huge value in seeing how non-humans became normalised in the scientific community. Extending this line of thinking to the issue of genetically modified animals, it would be of interest to this study to know how scientists perceive genetically modified and scientific innovations.

Lessons stemming from the literature about the wider concerns

My main takeaway from the existing literature is that farm animal biotechnologies will necessitate discussions about public acceptability (Lezaun and Porter, 2015) of new kinds of farmed animals and animal products. I contend that the above areas of concern are closely linked because a change in animal bodies will change ways of knowing who they are and how they should be cared for, which leads to a change in choosing who is equipped to decide about their future. But the question

is how to do it.

Looking back at the character of radical controversies – complex, unknown, ex ante, encompassing nature and culture, involving the public – farm animal biotechnologies meet these criteria. With this in mind, the topic is ripe for being looked at from a perspective that allows to unpack it, care for it, and include all of the neglected things.

Follow the affect

One of the key analytical tools for understanding the implications of biotechnology on human and non-human lives used in the literature is biopolitics. The term was adopted by Michel Foucault (1981) to mark a shift from territorial power and corporal punishment delivered by governments to a new self-disciplining regime dictated by statistics and norms. Biopolitical thought has been applied to almost every topic due to its potency in a realm of objectification of humans and creation of self-disciplining subjects, although many have noted its applicability – despite its core anthropocentrism (Wolfe, 2012) – to animal geography.

Biopolitical thought has become especially useful in making a more detailed connection, as Coppin (2003) points out, between the social, the natural, the legal, and material in the ordering of humans and non-humans to a particular practice or a system. Coppin (2003), writing about animal farming from the perspective of biopolitics, emphasised that knowing the painful remaking of animal bodies is what might affect

the politics of animal farming, welfare and food because: we do not like seeing anyone getting hurt; we do not like objectification; we do not like the use of power over bodies and minds. Instead, we (researchers) like to hear the neglected voices of animals and humans so we can redirect conversations and therefore change the regime.

The literature on animal biotechnology, which I reviewed here aimed to do precisely that: bring to attention what happens to animals and humans when animals are subjects to biopolitics.

Although the analysis of transgenic animals through the concept of biopolitics contributed to a discussion about ethical, political, economic drivers to modification of animals, the analysis fell short of unpacking transgenic animals and beastly spaces.

Many biopolitically inclined works I mentioned thus far, unlike those that used the concepts of assemblage (see Sanderson, 2015) or body multiple (Franklin, 2007), became perhaps not flexible enough to explore a controversy which is required to step away from the normative definitions, assumptions and simplistic categories of “good” and “bad”.

As Asdal et al. (2017) noted, there is a tension about liveliness within the field of biopolitics when applied to the topic of animals. Biotechnology presents possibilities for livelier politics in which engagements and entanglements can force us to hesitate and to think again about the obligations we have to others.

Although the authors mentioned above have critiqued what has been

done to animals and questioned power relations, the reading of animals in these publications gives an impression these animals are either suffering or resisting. But, there is more to say about animal biotechnologies because it is not only about control, othering, making animals killable, good or not good enough, visible or invisible, close or distant. As Asdal et al. (2017) argued, biopolitics can be too fixated on the concept of power and agency forgetting that power and agency, like affect, are dispersed and decentralised. As Hichncliffe et al. (2017) noted, biopolitical thinking should start asking itself questions on topics such as how lives (of humans and non-humans) been normalised, and less so how power has been created over life. Biopolitics should be more about “powers of life” and “liveliness” (Hinchliffe et al. 2017:214) than just exposing that life has been reconfigured and diminished. A good example here is Barua’s (2016b) paper about mobilising elephants and lions as lively commodities. Here he showed that despite these animals being used in tourism sector, their liveliness came through. The animals were attuned to by animal keepers in order to create a working relationship with them and generate an encounter value. In other words, Barua aimed to shift from a strict biopolitical reading of animals that sees animals as commodified and resisting to a lively biopolitics that sees animals as lively and affective despite the controlled circumstances. In doing so, as Barua (2016b), Asdal et al. (2017) and Hinchliffe et al. (2017) showed, we can come closer to practices and species we find unsettling thus open up doors to new

sensitivities.

So, in this vein, I also do not concentrate on the animal agency to show animals resisting biopower and I am also not interested in steps taken to build power over animal lives. Rather, I am interested in showing how lives came to be, how to live with controversy, what it means to be a beastly, boundary-crossing animal in uncertain times. In doing so, I hope to come close to lively science and technology as well as to the animal and its world.

As noted in the opening to this section, animal biotechnologies not only create animals that are transgenic, they are also enacting them in multiple ways. But as argued earlier, multiplicity can be viewed as an opportunity to learn about how “nature” is done in the age of genetic modification. For example, Humphries and Sanderson (2015), who explored the case of GM salmon, showed that different regulatory regimes – one for patenting and one for approving the fish is safe to eat – enacted in fact a two-way salmon. The paradox thus lies in GM salmon becoming, in Humphries and Sanderson’s (2015) words, unnaturally natural. The paradox of nature illustrates that one animal can be enacted in multiple ways and that as Humphries and Sanderson (2015) further argued, “genetically engineered animals cannot be judged by a single standard. There are different ways of looking at genetically engineered animals, each being dependent on legal, political, social, economic and practical conditions” (p.207).

But the learning, as I argued already, needs to consider the lessons about emotional and feeling responses to the ways in which nature as well as culture have been enacted. Given the potential of affect theory, I propose that it is worth considering what affects are enacted and vice versa, what role does affect play in the enactments?

To illustrate it, I want to use examples from the literature on the topic of biotechnology. Although these scholars did not mention affect in their approaches, I think they put a finer point on the controversies surrounding GM which prompted me to explore those points further.

Buttel's (1988) paper on bovine somatropin (BST) - a growth hormone - is an interesting way of discussing the making and unmaking of biotechnology in animal farming, because he focused on how the opposing groups are enacting biotechnology. He saw BST as a "lightning rod" for crystallising broad but diverse discourse coalitions involving groups and many viewpoints along the dairy commodity chains (1998:1159). He emphasised that both opponents and proponents made appeals to 'nature' repeatedly, and about farming, place, origins, production processes, and milk itself. Opposing groups therefore constructed naturalness at all times and enacted in research, labelling, approvals, bills and protests. Buttel noted the opposition anchored its claims in concern for family dairy farming rather than animal welfare claims (mastitis and increased burnout of cows). The reason is that in wanting to attract farmers as allies, the BST opposition would not be able to work with farmers if animal rights activists were

involved.

Julie Urbanik (2007) just like Buttel was interested how animal biotechnologies are being enacted by proponents and opponents of transgenic animals on a local level, because 20 years later, the research expanded and could no longer be contested successfully at a federal level in the United States. Therefore, opposition moved to a lower level, that of county, city and community. Urbanik focused on the role of "place" in animal biotechnology activism (for and against) in Massachusetts. Through a series of interviews with stakeholders whom she identified as key players; her research concluded that the narrative of protecting the community (which was deployed by BST opponents in Buttel's paper) worked in favour of proponents of animal biotechnologies. This paper is relevant to discussions about animal biotechnologies because empirically it shows politics about a place can shape a debate on animal biotechnologies. However, her findings regarding the role of place also pointed out that invisibility of animals and their biotechnological bodies (because they were in guarded laboratories) curtailed anti-biotech activism. The literature suggests bodies of animals are important for proponents and opponents of a given technology because they are being used as sites of demonstrations of (un)naturalness, un(ethical) technology, and (un)fairness.

These claims were echoed by Bloomfield and Doolin (2011) who studied the controversy surrounding New Zealand's transgenic cows

(whose milk would have more myelin to be used for MS treatment). In the case of a transgenic cow, the notions of naturalness and motherhood were played out by both the proponents and opponents of the technology, as well as hopes and "imaginations". Both camps appealed to human emotions surrounding caring for children (should they be fed with milk from transgenic cows) but not animals.

The point is that we see the role of emotions such as loving and caring as well as fear and reluctance to go beyond the status quo. We see that enactments of animals either as good or not, were not in the hands of scientists alone, but in the hands of multiple groups appealing to emotions while disregarding their value. In fact, very little was said about the animals other than they have been used by multiple groups to tell their own stories.

So, going back to the issue of caring for representations and practices, there is still room for looking at how all of the parties contribute to the enactment of these animals, technologies and those who are affected. I am trying to say that if we are to engage, we need to look at who is being mobilised when GM animals are enacted. As Latour (2011) put it:

> When we fear genetically modified foods we call them Frankenfoods and Frankenfish. It is telling that even as we warn against such hybrids, we confuse the monster with its creator (…) Moreover, just as we have forgotten that Frankenstein was the man, not the monster. Dr Frankenstein's crime was not that he invented a creature through some combination of hubris and high technology, but rather that he abandoned the creature itself. (Latour, 2011:

19).

Thinking back about Ahmed's girl and a bear, we can see that Latour also is urging us to think carefully about not confusing the monsters which to him require love and attention. Loving monsters then is about wanting to listen, engage with, and care. Love here is to do more, rather than just to abandon, ban, eradicate the creatures. But, monsters show that we are already entangled (Hodder, 2012) with all non-humans and there is no such thing as nature or culture (Latour, 1991). To love monsters is therefore to show the spaces of connections between wanted and unwanted aspects of science-animal-society relations which one can no longer walk away from. Loving monsters, which is what he is advocating, is about wanting to listen, engage with and care, all of which point to the role of affect.

Without a shadow of a doubt, the literature is concerned with the emergence of GM animals, but I also think there is room to care for the monsters. Linked to this, the question of what happens when things are called monstrous? They get a PR person, or they hide. Places are closed. Things develop in isolation. There is no communication out of fear of communication. There is no public discussion, and if so, it is managed and narrowed down to technical aspects. We are back to square one, which is the seclusion of science (Callon et al., 2009).

Campbell and Fitzgerald (2001) argued that to understand debates about GM, we must follow the fear. To do so, they have looked at how

fear has been used to talk about GM whether by media, consumers, policymakers or the scientists. In doing so, they were able to show that policy-makers would resolve to logic to combat fear, whereas the public refers to food scares to make sense of GM, and lastly, anti- GM groups rely on the broader concerns over modern technology interfering with nature. Although these arguments are well rehearsed, the interesting angle here is the attention to the feeling of fear which chimes with calls to consider disgust made by Sales and de Melo-Martin. In particular, where and how it circulates, how it is being addressed and by whom, what fear refers to, and how it connects. In closing, Campbell and Fitzgerald (2001) argued that fear should also be followed right up to spaces of science and as well to regulations, where fear can also be encountered. By following the fear, they argued, “all these disparate sites can become linked threads in an emerging understanding of the breadth and complexity of GM food” (p.221).

From the perspective of the literature of affect, their line of enquiry is quite intriguing because it mirrors the material-semiotic approach and affect by following a feeling through discourses and practices. It allows to look at a contested issue as an emotion which is felt by everyone; therefore, it connects, but also as an emotion that is used by different parties. So no longer irrational; gut and perhaps other feelings of hope, fear and desire should also be explored too when thinking of animal futures (see Garnett, 2015). Emotions, as Zinn (2009) noted, can be used in the understanding of risk and uncertainty in the form of a referee

and the form of a guide too.

2.6 Chapter summary

I opened this chapter by arguing that radical uncertainties are on the rise, and in fact, they have always been with us. The real issue, as the literature which I reviewed here argues, is that while aiming to make things certain and robust, we have created separate and artificial categories which fail to stand on their own. What we are seeing is that nature is full of culture, that emotion are part of logic, that humans alone do not make scientific discoveries, and that knowledge is based as much on being in the world as much as exploring it. I also pointed out controversies, challenges and things that seem problematic show us, the researchers of controversies, that it is worth to include the "things" that so far have not been neglected, as de la Bellacasa (2011, 2017) argued. So, by the neglected things, I mean here emotions, feelings, places, humans, and animals that have been seen, by big Science, as distractions and/or objects. Building on feminist approaches to care as well as the literature on affect, I, therefore, noted it is worth to incorporate feelings and emotions into explorations of controversies. In particular, I argued that emotions sit right at the centre of academic and everyday discussions about science, animals and acting in an uncertain world.

Having set the stage, I then moved on to talk about farm animal

biotechnology, because it is a topic that continues to polarise the public, raise concerns about human and animal lives and involve emotions. I noted that the literature has done an excellent job of pointing out what the potential concerns could be. However, whether it is about the transgenic animal (not) being "normal", transgenic meat (not) being "natural", or farmers and consumers (not) being expert "enough" to leverage their opinion, or (not) reconfiguring a whole system to molecular science, the literature of transgenic animals sends a clear message: animal biotechnology is a concern, full stop.

To reiterate, I agree with the arguments presented in the literature so far. In particular, I side with Lezaun and Porter (2015) who said that the transgenic option might remove both individual, commerce and policy responsibilities about alternative solutions to food-related issues. I also agree with Twine (2010) that livestock biotechnology rests on the promissory discourse of sustainable futures, which, as Lonkila and Kaljonen (2018) noted, further locks in farmers and consumers into the biotech option. I also agree Holloway and Morris (2009) who noted that biotechnology shifts thinking about animals from bodies in the environment to bodies as data removed from a broader context. I also agree with Roe (2006) as well as Macnaghten (2004) and Gaskell et al. (2002) that biotechnology when encountered as food, will cause new concerns for consumers who are already overwhelmed by information about health, animal welfare and climate change amidst worries and necessities of daily life. But in thinking about the themes I outlined in

this chapter namely, controversy as learning, care, affect and emotions, there is something somewhat missing.

Reading animal biotechnologies in the literature, it would suggest the account reviewed here falls short of celebrating the controversial aspect of animal biotechnologies as a lesson to engage with the neglected things i.e. the possible emotional lives of human-animal relations as performed in spaces and places of biotechnology.

Firstly, not enough research has focused on the spaces and places where these innovations are created. Access to laboratories, often funded by private institutions which may wish to remain competitive (thus not entirely transparent) is constrained (Phil, 2017). With that in mind, research into the places, spaces, people, artefacts and non-human actors and impacts on an interaction between those mentioned was often accessible via analysis of documents, visuals and archives. This can often lead to a discursive reading of animal biotechnologies. However, as Franklin (2007) or Sanderson (2015) showed, reading of archives and official paperwork does not need to rely solely on discursive accounts.

Secondly, while aiming to attend to the animal, I argue the literature which sees animals as reconfigured and digitised did not achieve it in a way that would let the reader encounter, for example, animal biotechnologies with history, feelings and emotions but instead, the reader encounters biotechnological animals as a topic of ethics, politics

and science. In a way, caring here understood that respecting was not fully accounted for in a way that has been done in the literature on animals and animal history of science thus far.

While I agree with many of the concerns about the effects of animal biotechnologies, for example, impacts on seeing animals as designable and an end-of pipeline approach to rising meat demands, I am still intrigued by getting to know those new animals as subjects on their terms. I raise a hand to say this is a futile endeavour, but I still want to stay with the trouble (Haraway, 2016) of doing so.

So in thinking about the new animals then, how are they enacted? What does it mean then to be a pig in the age of the genome? What role do emotions play in the enactments? From the perspective of the literature which I set out in Sections 2.2 to 2.4, what role do these new animals have in the era of genetic engineering, editing and modification? Are they merely describing the social, or are they actively participating? Are they just monsters, or are they, in fact, more than that?

Unlike most of the broader literature on animals, I am not engaging with a cuddly pet, a stunning butterfly, or a protected wild species, but rather unwanted animals yet protected by patents. Unlike other unwanted or trash animals (Nagy and Johnson eds., 2013), such as the rats of the sewers that entered laboratories (Davies, 2013) or bonobos trashing houses in South Africa (Green, 2016), animal biotechnologies have familiar rural or urban faces but unfamiliar laboratory bodies and lives.

So, I want to approach the transgenic kind in line with the teachings channelled through the works of Callon et al. (2009) and perhaps try to address the big question of “How can we live with animal biotechnologies?”.

Chapter 3. Empirical setting

3.1 Introduction

Much of what has been said so far about the effects of farm animal biotechnology in Chapter 2 could be viewed as a hypothetical situation to some extent, as many of the developments have not come to fruition. However, GM technology such as cloning is widely used in research fields, but less in a farming setting. The exception here is technology mentioned by Lonkila and Kaljonen (2018) and Morris and Holloway (2009,) namely genetic markers used in the breeding sector.

However, in the last years a lot has changed because genome editing is gaining traction, and also because two GM proposals in animal farming have "left" laboratories and one of them (GM salmon) has been commercialised. By saying this, I do not want to set the alarm bells ringing, but rather, I want to use this as an opportunity to explore new uncertainties by looking at the case of the Enviropig.

I start by providing a matter of fact (Lien and Law, 2011) definition of the Enviropig and then I move on to talk about the context, the success, and the contestations of the Enviropig. In doing so, I am illustrating the point I made earlier that scientific definitions enact biotech animals in a universalising way – a way which does not necessarily remove ambiguity or concerns about GM animals. I bring forward views from the literature that further illustrate this point and mirror arguments put forward by scholars mentioned in the previous chapter.

Toward the end if this section I signal a need to move beyond thinking

about the effects and impacts of farm animal biotechnologies as being predetermined, and instead consider affect.

3.2 The Enviropig as a matter of fact

If one were to look up the Enviropig in an Encyclopaedia, or its web cousin Wikipedia, two go-to sources of information, one would not find any entry about the Enviropig. And yet, the Enviropig has been defined by the Oxford English Dictionary, and Environment Canada – a governmental agency responsible for evaluation of novel organisms, in the following way:

Figure 3. Definition of the Enviropig of by the Oxford Dictionary (left) and Environment Canada[11] (right)

Enviropig, n.	**Organism Identity:**
Origin: Formed within English, by compounding. Etymons: ENVIRO- comb. form, PIG n.[1]	
Etymology: < ENVIRO- comb. form + PIG n.[1]	The Cassie line of transgenic S. scrofa domestica of the breed "Yorkshire" or "Landrace" that, as a result of genetic modifications, has had the phytase gene from Escherichia coli strain K12, under the control of a mouse promoter, introduced into chromosome 4 of its genome (EnviroPig™)
A genetically modified variety of pig that is able to digest phytic acid, producing manure with a reduced phosphorus content and hence less environmental impact. The pigs express introduced genes for a bacterial phytase and for a mouse promoter gene enabling its secretion in the saliva. A proprietary name in Canada.	

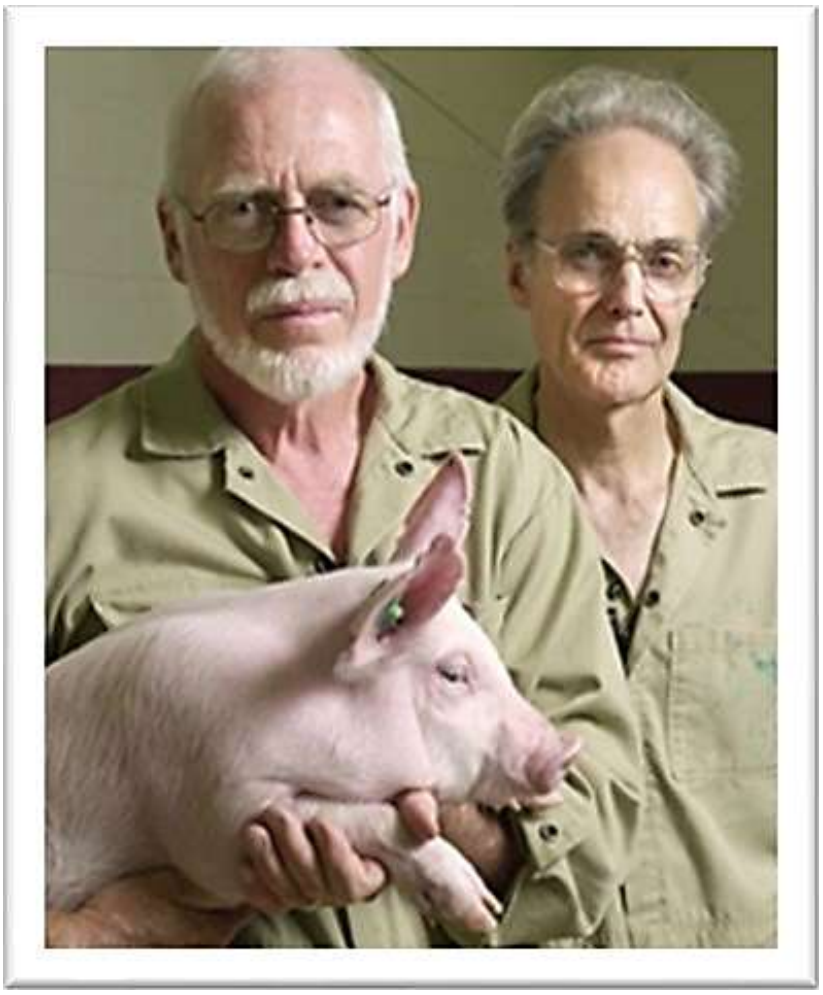
[11] https://web.archive.org/web/20200516140514/https://www.canada.ca/en/environment-climate-change/services/managing-pollution/evaluating-new-substances/biotechnology-living-organisms/risk- assessment-decisions/summary-15676.html

In other words, the Enviropig was of an organism of the Yorkshire breed of domestic pigs widely used in the meat industry. The Yorkshire is one of the most familiar breeds of pigs with pink skin, coarse hair, a large and long body, short legs, small beady eyes and a characteristic snout. If one was to draw a pig, it is most likely the picture would resemble the Yorkshire breed.

But, this is where the similarity arguably ends because the definition also indicates that the Enviropig genetic make-up has been altered by an introduction of genes from *E. coli* bacteria via a mouse promoter. To put it even more simply, the genetic make-up of the Enviropigs consisted of a genetic material of distant species, namely the E. coli bacterium and mouse. In light of a definition by the Royal Society (see Chapter 2) the quote indicates we are dealing with a genetically modified organism. This also means that the animal, although it appears singular, is in fact multispecies, lab made. The symbol "TM" indicates that the animal has been patented and trademarked. All of this suggests that the animal was worth protecting as if it were the property of a corporation.

The arrival of the Enviropig is attributed to two scientists, Cecil Forsberg and John Philips (pictured in Figure 4 with an Enviropig piglet[12]) as well as Sergei Golovan who was their PhD student, all of whom were employed at the University of Guelph, Ontario Province, Canada.

Figure 4. The Enviropig piglet held by John (right) and Cecil (left). Source: Guelph Mercury, 2010

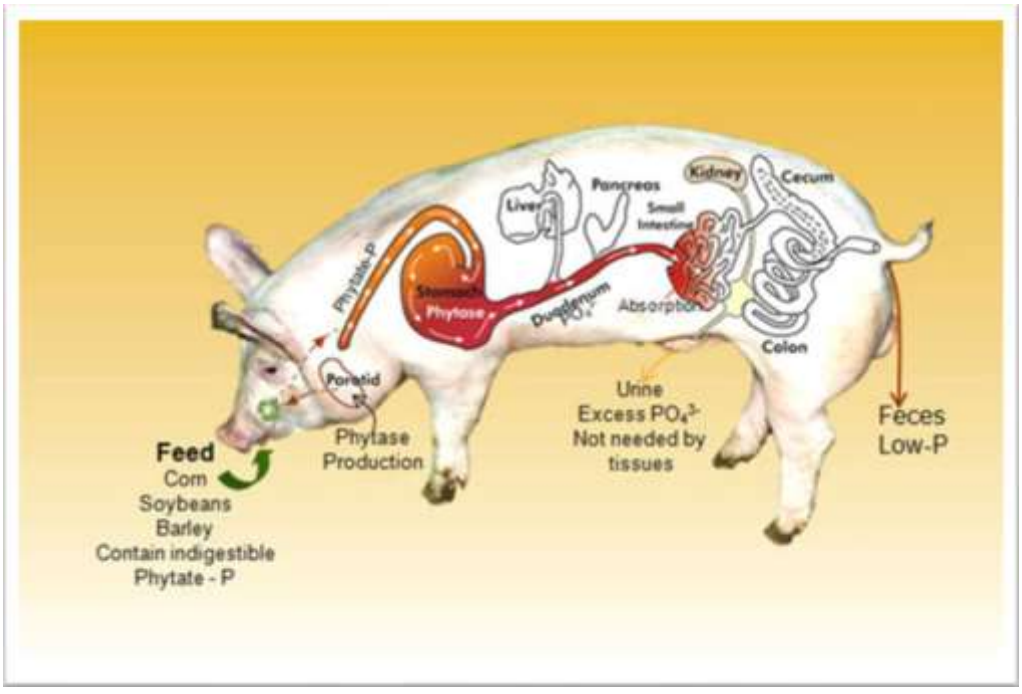


12 https://web.archive.org/web/20200515071535/https://www.guelphmercury.com/news-story/2677548-if- genetically-modified-salmon-is-ok-d-can-enviropig-be-far-behind/

The now-archived webpage hosted by the University of Guelph indicates that 1995 was the year when these two scientists conceived the idea of the Enviropig. The Enviropigs were envisaged to be bred as any other Yorkshire breed. The only difference was that the Enviropigs would not be required to be given the feed additive called phytase because they would be able to produce it in their salivary glands.

Figure 5 illustrates the so-called Enviropig model because it depicts the pig from the perspective of an internal phosphorus cycle. To use Twine's (2010) observation (see Chapter 2), the Enviropig in Figure 5 is like a black box, with an input (feed) and an output (faeces).

Figure 5. The Enviropig model. Source: University of Guelph

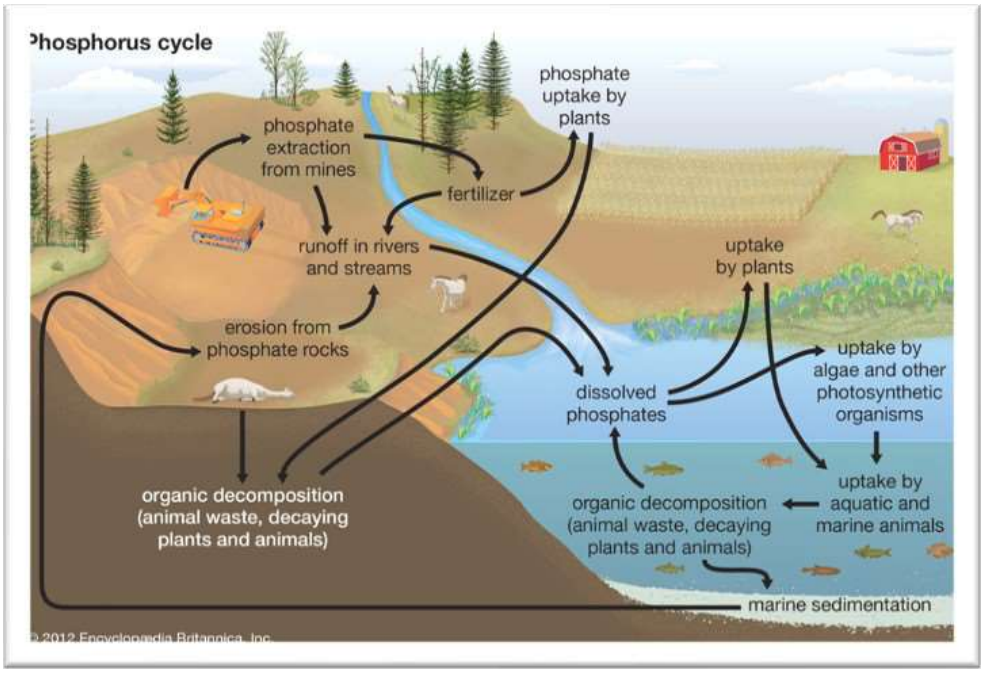


The emphasis here is on the phytase and its secretion by the pig. So, why phytase and what is it?

Phytase is an enzyme that breaks down phytate (also known as phytic acid). Phytate is a storage form of phosphorus which in turn is required by virtually every living cell. Phosphorus is a chemical element found mostly in rocks and soil which plants remove as they grow, which then needs replacing by adding phosphates i.e. fertilisers (natural or chemical) to restore the balance. Phosphorus is required for growth by any organism so depletion of phosphorus can halt the growth of all organisms. However, too much phosphorus in a body can be toxic in two ways. Firstly, it can lead to damage of the liver. Secondly, its excess in soils and water tables leads to algae growth (known as eutrophication) and removal of oxygen in the marine environment.

The phosphorus cycle (see Figure 6) needs therefore to be in a balance and it begins when plants are digested by humans and animals (and other living forms that in turn are digested by either humans or animals) and phosphorus (or rather phytate) is absorbed in a body. But, some animals, mainly pigs and poultry, cannot even digest phosphorus (phytate) found in plants (mainly grains) because they do not produce a phytase enzyme on their own. To restore the balance (at the livestock level), an organic or inorganic enzyme, phytase, is added to animal feed.

FIgure 6. Phosphorus, which cycles primarily through the terrestrial and aquatic environments, is one of the most-important elements influencing the growth of plants.
Source: Encyclopædia Britannica, Inc



A phosphorus rich diet is recommended for swine production because it allows better bone mineralisation, growth and leanness, but the excess is not digested by pigs (Clark, 2010). Pigs cannot absorb enough phytate (the storage of phosphorus) to grow fast and without damaging the body and the environment. Pig feed that fattens them quickly such as barley, corn or wheat, which are rich in phytate, therefore needs to be supplemented with an inorganic phytase enzyme (also now genetically engineered, see Clark, 2010) or organic (microbial) phytase. In other words, the scientists created the Enviropig to skip the last part of the cycle i.e. putting an enzyme in feed, and took a step back i.e. reconsidered the animal as the enzyme producer rather than the phosphorus extractor.

So far then, what we know about the Enviropig is that the animal is genetically modified by two scientists and a student in a Canadian university. The Enviropig's lineage and body is similar to that of a Yorkshire breed, which is one of the most popular breeds in the meat industry. But from the inside, the Enviropig is showing that it is able to produce an enzyme which other pigs cannot. The ability to secrete this enzyme allows the pig to take part in the phosphorus cycle and act as the one that helps it to keep in balance.

The next section, though, gives a sense as to why this animal is worth attention beyond its transgenic body, and why the pig ended up being called the Enviropig.

3.3 The Enviropig in a global context

Livestock farming is highly concentrated and integrated. A high level of concentration is observed in the Global North i.e. the economically developed countries of Europe, North America, Australia and Israel, amongst others but also in the Global South e.g. China, South Africa and Brazil. Concentrated livestock farming is dominated by a few big players. They include retailers, processors and breeding companies who dominate and influence the ways of farming. Increasingly, farmers are tied to those big players because they struggle to find their own market. An example from the U.S. is that big companies demand poultry contractors invest in infrastructure, but contractors report that their compensation of US$.04 to US$.06 per pound remains constant (FoodTank, 2014:5). Production of food is highly standardised and on a large scale yet, removed from the urban based customers who do not directly experience the impact of farming as rural dwellers do.

And while production of animals is growing, so is pollution. In 2006, the Food and Agriculture Organisation of the United Nations (FAO) published a report on this matter. Under the title of Livestock's Long Shadow, the report estimated that animal farming is responsible for 18% of greenhouse gas (GHG) emissions measured in CO2 equivalent (FAO, 2006: xxi) and 41% of total greenhouse gas emissions (Stern, 2007), while in Europe, nitrous oxide alone accounts for 70% of total

GHG (Harabin, 2011). It has been noted that livestock farming leads to the loss of biodiversity, water pollution, desertification and deforestation.

Numbers of livestock and pollution are projected to rise due to population growth, higher incomes and the growing demand for meat in developing countries that tend to adopt the styles of consumption of inhabitants of developed economies (Steinfeld, 2006; Stern, 2007). The Agriculture Outlook for 2019- 2028 by OECD and FAO (2019) projects that demand for meat will continue to grow and prices will go down, while demand for animal protein will shift from pork to poultry and beef as well as to plant protein. The demand for meat in developing and developed economies will nevertheless continue to rise. The demand for meat in developing countries “is expected to be approximately four times that of developed countries” (OECD FAO report, 2019: 175)

While pork has been a dominant meat in developing countries, devastating outbreaks such as Porcine Respiratory and Reproductive Syndrome (PRRS) and African Swine Fever (AFS) between 2007 and 2008 and 2018 and 2019 respectively, have reduced capacity of the supply chains in China. Other countries increased production of pork, but on the whole, it is projected that pork production in the next 10 years will decline, giving way to poultry.

Although the intensive production of meat, as observed in the USA,

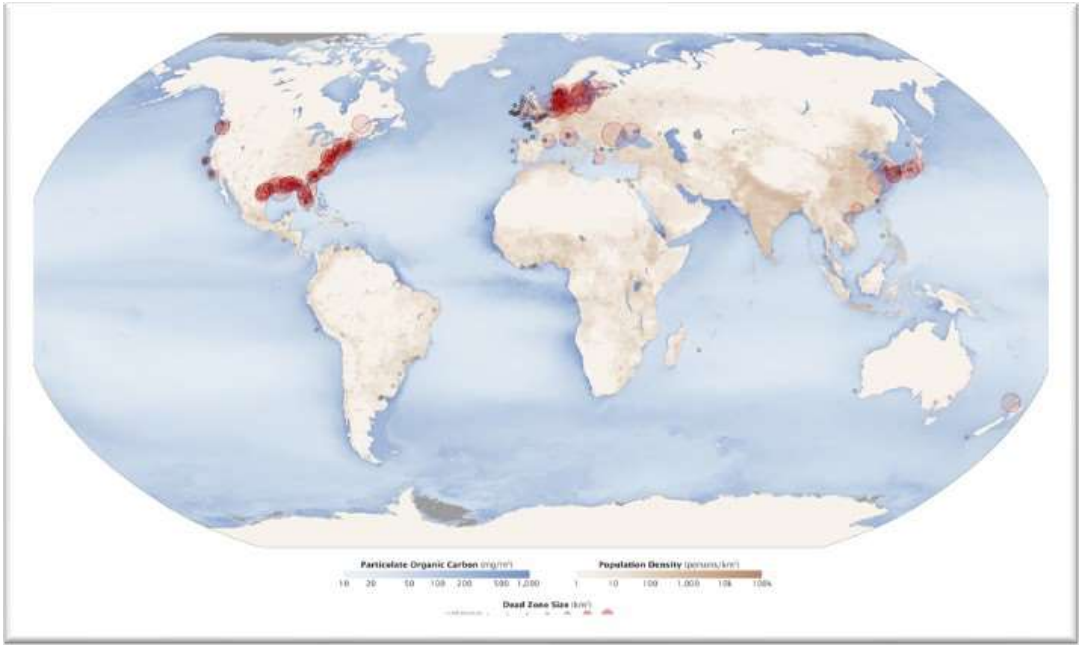
China, Brazil and Europe, requires large quantities of feed (e.g. soy, corn), land and water resulting in shortages of arable land and water globally, intensive livestock farming is being promoted around the globe as a solution to poverty and hunger.

Set against this global outlook, the Canadian swine industry, which contributes highly to the country's GDP and accounts for 21% of world pork exports (Ontario Pork, no year, p.13), looked into ways of sustaining its large operations while adhering to regulations. A comparatively small 600-sow farrow- to-finish operation will produce more than three million gallons of liquefied waste annually (Novek, 2003). This waste contains large quantities of nitrogen, ammonia and phosphorus which leads to water contamination and eutrophication. Manure management regulations placed a cap on the amount of manure produced by an operation that may be legally applied on site (Clark, 2010). Any manure above the cap must be managed in other ways (e.g. hauling to other farms or use of microbes) all of which adds cost to pig production. Therefore, the Enviropig, whose manure was reported to be lower in phosphorus, could be applied on site while meeting regulatory requirements.

Given that pigs cannot digest phytate and therefore excrete phosphorus, large pig operations are known to be a source of pollution. Pig producing countries such as Canada, USA, China, the Netherlands have the largest marine "dead zones" meaning that water is not suitable for sustaining life for fish, fit for swimming or irrigation. Figure 7 shows

areas of the globe where dead zones exist illustrating the link between pig producing countries and pollution of ground water, which flow into seas and oceans where the damage is the most severe.

Figure 7. Red circles on this map show the location and size of many of our planet's dead zones.Map by Robert Simmon & Jesse Allen; based on data from Robert Diaz, Virginia Institute of Marine Science (dead zones); the GSFC Ocean Color team (particulate organic carbon); and the Socioeconomic Data and Applications Center (SEDAC) (population density).



With this in mind, the Enviropigs' ability to produce this enzyme in their saliva was deemed important to an industrial funder who represents Canadian pig producers based in the Ontario province.

The Enviropig, in this context, was understood and enacted as a clear winner because the pigs would allow producers to keep feed costs and compliance with environmental regulations in check (Clark, 2010). The animals would allow producers to keep production at the high output needed to meet demand without changing feed and manure management practices. Given the scale of dead zones, the modified pigs gained the Enviropig moniker, which was then trademarked by the funder – Ontario Pork.

3.4 The Enviropig as success and failure

The newly developed pigs were a remarkable example of a genetic breakthrough (expression of enzyme) without a compromise to health and welfare of animals (Forsberg et al., 2003) which was not reported in other examples of transgenic animals.

Considering the pressure from communities amidst increasing expansion of the pig sector, in the early 1990s, even before pigs were born, significant investment (at least $1.371 million[13]) in the research of

13 https://web.archive.org/web/20200516142303/https://cban.ca/gmos/products/ge-animals/enviropig/Enviropig-Background/

the Enviropig was made by Ontario Pork, a pork producer association based in Guelph, Ontario, Canada Ontario Pork “represents the 1,549 farmers who market hogs in the province in many areas, including research, government representation, environmental issues, consumer education and food quality assurance”[14] The investment in the Enviropig aimed to boost the success story on home ground (as well as in China or the USA where the Enviropig stock would be exported to) by reducing costs and meeting environmental regulatory requirements.

Although the technology that enabled the expression of phytase is now outdated, the work of those scientists - Forsberg, Philips, and Golovan (their PhD student) - was highly regarded within the scientific community. They achieved exactly what they wanted to i.e. synthesis of phytase, and where they wanted to i.e. in a pig’s salivary glands. They created an animal able to express a new trait as they planned. The method used at that time often led to failure because the microinjection of the genetic material could not target specific areas of the genome. This meant that even if pigs with modified genes were born, they would experience early death or severe deformations and mutations. So it was a remarkable success for these molecular scientists at that time. Many before, including the Roslin team which produced Dolly the sheep, failed. However, Clark (2010) writing about the Enviropig noted that:

> What we know is that the production process

[14] https://web.archive.org/web/20200513051828/https://ontariopork.on.ca/About-Us

> was inefficient, requiring thousands of embryos. While conducting the research that led up to the publication of the 2001 article in Nature Biotechnology, the scientists injected the transgene into 4,147 embryos, but only 33 transgenic founder piglets were born, for an efficiency rate of 0.8%, which is within the range cited in the NRC report. (p.213).

In other words, the success came at a price paid by animals even if it was a breakthrough among the scientific community.

So, in 1999, the first Enviropig, called Wayne, was born, which was soon followed by Jacques and Gordy and Cassie and later 30 other transgenic pigs with the same construct. Naming the first boars suggests they were of significance and importance.

But before anyone got a glimpse of these animals, the creators and the investor needed to ensure that the pigs were patented. So, in 2000 patents were submitted to the USA and China which are the biggest importers of pigs, as well as producers. The next success took place in 2007 when the Enviropig technology was issued with a patent by the USA and China. The patent meant that the technology was protected and the status of the pigs as unique and markedly different was sealed. The animal became in a sense unique even though it was claimed to be regular. The Enviropig, like the fast-growing GM salmon, became unnaturally natural (Humphries and Sanderson, 2015) which the subsequent successes and simultaneous contestations further confirmed.

In 2007, the Enviropig team submitted applications to two agencies responsible for evaluation of novel organisms. Environment Canada is a Canadian governmental agency whereas the Food and Drug Administration (FDA) is an American agency. The applications meant that the project leads were seeking approvals that would deem the Enviropigs safe to farm and consume. In other words, the project was clearing the path to commercialisation.

In 2010, the Enviropigs were approved by Environment Canada for production. An approval by Environment Canada meant that transgenic stock could be raised, but only under certain conditions, but it did not mean that it would enter the food chain. The Enviropig was assessed under Part 6 of the Canadian Environmental Protection Act, 1999 (CEPA, 1999) on which basis it was decided that the transgenic line of commercial pigs "does not cause harm to the Canadian environment or human health[15]." The environment is understood here as the wild population of pigs, so the assessment meant that breeding with wild boars would not cause further alterations to wild pigs.

In the meantime, the creators of the Enviropigs were still seeking approval from the Food and Drug Administration (FDA) in the United States to be cleared as safe to eat. Previously, the FDA approved

[15] https://web.archive.org/web/20200517094135/https://www.canada.ca/en/environment-climate- change/services/managing-pollution/evaluating-new-substances/biotechnology-living-organisms/risk- assessment-decisions/summary-15676.html

transgenic goats for production of a human enzyme, and a genetically modified growth hormone of dairy cattle. This was the first time in the history of the FDA that transgenic species for human consumption were being considered for approval in the United States.

At the announcement of the approval, the animals were visited by major news broadcasting channels such as the BBC and CNN and written about by American and Canadian newspapers (see Figures 8 and 9).

Figure 8. BBC news clip

Figure 9. Clip from CNN

The Enviropigs are housed in a swine research facility one hour away from Toronto, in rural Guelph. The facility belongs to the University of Guelph and, as the clips show, follow strict biosecurity rules that require

one to remove all items of clothing, shower and change into overalls before meeting any of the pigs or staff working inside. The pigs are housed in a separate area of the facility away from non-transgenic pigs that look like any other Yorkshire breed. The pigs are still young with the characteristic pink skin, beady eyes and flappy ears. Pigs here are showing a bit of curiosity by headbutting the visitors. The video report by the BBC also features the creator of the pigs, Professor Cecil Forsberg who explains his surprise about the fact he and the team were able to create the Enviropigs. These video reports are rare occasions of an encounter with these animals as well as their creators. This is because research facilities do not provide access to visitors due to concerns over the health of animals and possible microbial or viral outbreaks.

But, as progress has been made to move the Enviropig from labs to farms and supermarkets, the animals began receiving quite a different verdict. In 2010, around the time when the Enviropig was approved by Environment Canada for production (under strict conditions), CBAN and the National Farmers Union of Ontario (NFU) (the only farm organisation in Canada with its own federal charter[16]) passed a resolution against the Enviropig. It reads:

[16] https://web.archive.org/web/20200516140506/https://nfuontario.ca/about/

> THEREFORE BE IT RESOLVED that the NFU oppose the commercial production of the Enviropig in Canada and request that Ontario Pork and OMAFRA [Ontario Ministry of Agriculture, Food and Rural Affairs] withdraw support for the Enviro Pig and U[niversity] of Guelph shut down the project immediately. Further, that NFU-O request that these financial resources be redirected to research that fits the real needs of hog producers in Ontario and Canada[17].

CBAN and the NFU, although aware of environmental issues in pig production, based their opposition to the programme on the premise of other solutions: disperse pig operations and the supplementing and changing of feed. Furthermore, they argued that the Enviropig might "undermine domestic and consumer confidence in Canadian pork products."[18]

On February 9, 2011 at the University of Guelph, Canada, students, farmers and consumers joined a rally against the Enviropig programme. Over 150 people participated in Pig Rally: Stop UofG's Enviropig™. Protesters wore pig snouts (Figure 10) and together made the sign "UofG Stop Enviropig™". People also had signs that said "No GM Pork on My Fork" (Figure 11), "This Pig Has Been Greenwashed", "We 'heart'

[17] http://www.cban.ca/Press/Press-Releases/Rally-to-Stop-University-of-Guelph-s-Genetically-Modified-Pig

18 https://web.archive.org/web/20200517085432/https://cban.ca/gmos/products/ge-animals/enviropig/Is- Enviropig-An-Environmental-Solution/

Pigs", "I don't accept GMOs" and a banner reading "UofG: Changing Pigs, Selling Life" (Figure 12) which is a spoof of a much-used slogan of the University: "Changing Lives, Improving Life".

Figure 10. A protester. Source: CBAN

Figure 11. Slogans at the rally. Source: CBAN

Figure 12. Slogans at the rally. Source: CBAN

A number of concerns had been raised regarding impact on the Canadian market, trust in educational institutions, and labelling. For example, an NFU representative said:

> I'm very worried that a decision by Health Canada to approve the GM pig will trigger a consumer backlash against eating pork. It's down to the University of Guelph to cancel their request for approval. This is the only way to protect our markets. (CBAN)[19].

The event was organised by Canadian Biotechnology Action Network (CBAN) which campaigned against the Enviropig, and many other genetically modified organisms, for a number of years. CBAN, with a head office in Ottawa (capital city of Canada), was established to "promote food sovereignty and democratic decision-making on science and technology issues". Lucy Sharatt, the coordinator of the network, featured in the BBC video report arguing against the Enviropigs.

To achieve these aims CBAN works with a number of other groups and organisations to carry out research on a given topic, inform the public, and campaign at all levels of Canadian government. For example, with regards to the Enviropig, CBAN has published reports, interviews and press releases on their website to inform the public about the transgenic pig.

[19] ttps://web.archive.org/web/20200517085549/https://cban.ca/gmos/products/ge-animals/enviropig/Do- Farmers-Need-Enviropig

Around this time, the Enviropigs gained the Frankenpig moniker, which featured in major newspapers, for example, *the Daily Mail in* the UK (Figure 13). Frankenpig here refers to “Franken foods” which is a metaphor first coined in the 1990s to signal frivolous use of science and its unintended consequences.

Figure 13. Example of a headline from the Daily Mail.

In 2012, just two years after Environment Canada approved farming of these genetically modified pigs under strict conditions, funding was pulled reportedly due to pressure placed by the NGOs (CBAN, 2012; Clark, 2015; Sanderson, 2015) on the funder to abandon research. The main line of attack – one which the local NGO (CBAN) used in the campaign - was the possible impact on the Canadian pig industry if Ontario pig producers decided to commercialise the Enviropigs.

But, when the decision was made to close the Enviropig programme, the public campaigned to save the pigs[20]. The pigs became worth saving, thus proposals were made to give pigs a place in a sanctuary for lab animals (Wallace, 2012). Farm sanctuary representative, Bruce Friedrich, who wanted to take the pigs, said:

> The university [Guelph] shouldn't treat these animals as though they were widgets. They have a moral obligation to allow these pigs to lead out their natural lives. They wouldn't kill 16 dogs or cats or dolphins or chimpanzees. (Wallace, 2012).

However, the fate of the Enviropigs was already sealed. The Enviropigs, despite calls to save them, were euthanised on the 24th of May, 2012 in accordance with the University of Guelph regulations, which many disputed. It was argued that they had the right to live as any other animals rather than be disposed of when they were no longer needed.

Thinking about the successes and contestations of the Enviropig shows the struggle to grapple with these animals. On the one hand, they were heralded as a success from a scientific point of view. From a project management of academic projects perspective, the Enviropigs moved from a proof of concept, illustrating a willingness to create an impact that goes beyond academia. The scientists sought approvals to confirm that there was no risk to other pigs, and humans wishing to consume them. Unlike GM crops, the Enviropigs were said to benefit the wider

[20] https://www.theglobeandmail.com/opinion/save-the-enviropigs/article4204498

context, especially the dead zones, rather than the pockets of big corporations.

But on the other hand, the Enviropigs were not welcomed by a public led by the NGOs' concerns that GM pigs would impact Canadian pig exports and pigs farmers from across Canada. The animals were also not welcomed as a potential meat product and yet upon their impending death, calls were made to rescue the animals by offering them a place in a farm sanctuary.

The success and contestations introduced new places like Ottawa, and organisations, as well as the public, the NGOs, news agencies, and governmental agencies. All these new places and actors, defined the animals in a different light to scientific definition, illustrating that an understanding of what the Enviropig is varied from place to place, from person to person and from text to text, making the Enviropig multiple and perhaps even elusive in some sense. After all, what does it mean to be an Enviropig, or even what does it mean to be a pig in the age of genetic modification?

Before I move on to conclude this chapter, I want to bring forward a few insights about the Enviropig from the literature concerned with genetic modification of animals. Here I want to highlight that the

Enviropig has been mentioned by a handful of scholars and that there is still an opportunity to explore the Enviropig with care and affect.

3.5 The Enviropig in the literature

Morris and Holloway (2009) noted that despite an increase in critical thinking about the rise of genetics in knowing of an organism, little attention is being paid to "how animal lives and populations, and their geographies, are being reshaped by genetics" (2009:314). The Enviropig as a living and breathing animal thus offered an opportunity to explore this but, in fact, only a handful of scholars, including Morris and Holloway, did so. Although they suggested that these innovations cannot be ignored or treated as purely scientific ideas, they have mentioned the Enviropig only once. They wrote:

> [...] the genetics revolution can be associated with further rounds of investment in productivist agriculture based on what some have seen as an emerging 'life sciences' paradigm in agri-food systems (Lang and Heasman 2004), in some cases involving cases to mitigate environmental impacts of agricultural productivism - for example, 'Enviropig', a pig genetically modified so that its excreta are less polluting. (2009:314).

Their point is that the Enviropig exemplifies a life sciences paradigm in agri-food systems which in practice involves molecular, genetic knowledge as opposed to localised and traditional.

Similarly, Twine (2010) who has given a critical (from animal studies and sociology perspectives) overview of developments in farm animals, mentioned the Enviropig only in passing. He presented the Enviropig within the context of a broader policy shift towards sustainability via genomics, which he called "molecularisation of sustainability"

(2010:137). In one of the chapters on the rise of promissory discourse of genetics for sustainable farming, he wrote:

> [...] in highlighting the (not yet commercialised) 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. (2010:139).

Twine here echoes Morris and Holloway's view that stressed the Enviropig emerged within the life sciences paradigm which is heralded by the British funding landscape as potentially useful in reducing emissions. In other words, the technology applied to animals is said to reduce pollution, meaning that instead of changing the agri-food system so that it is less polluting, the system changes the animal.

Clark (2010, 2014, 2015) an environmental sociologist writing currently in the animal studies field, is the only author that I know of who dedicated most of his work to the Enviropig. In his PhD thesis (2010) he examined three technological solutions to phosphorus pollution - one of them being the Enviropig. He drew on environmental law; a perspective of rural sociology; and the concept of "technoscience" wanting to understand how the latter affects compliance costs with regulations in pig and poultry sectors. By "technoscience" he meant an implosion of science and technology into each other (after Haraway, 1997).

In his thesis he examined the Enviropig by attending in detail to science, physiology and regulations. He was sceptical of the benefits the

Enviropig's creators alluded to. He wrote:

> These [environmental] claims [of scientists] are flawed [...] ordinary swine are not inherently unfriendly to the environment any more than Enviropigs are inherently friendly to it. Rather, the ecological assemblage in which it is enrolled. The same breed can have different impacts in different production systems. (2010:194).

Clark did not hide his view on this matter ("these claims are flawed") however, his attention to the ways in which the "same breed can have different impacts in different production systems" shows Morris and Holloway's influence. Clark therefore is not saying that the Enviropig is "bad" (although he does not support the idea) but rather he stresses the importance of looking at the context in which she was created - the systems of production. In line with that, he argues that the danger of looking in the wrong place - swine body - in order to fix environmental issues leads to "molecularisation of livestock". In his own words:

> In my view, the Enviropig is perhaps one of the best examples of how the need to overcome (socio)ecological obstacles to the accumulation of capital is driving the production of nature (p.216-7). [...] What the Enviropig in particular suggests, I argue is that nature - in this case, the body - is being physically reconstructed to overcome (socio)ecological obstacles to capital accumulation. (pp.219-220).

Clark uses Twine's (2010) argument that the biotechnological project is an attempt to legitimise industrial livestock and poultry production in an era of increasing environmental concern (Clark, 2010). Clark therefore

goes with Twine and Morris & Holloway in arguing strongly against the technoscientific gaze that redesigns animals rather than the systems that brought them into being. Clark continues with this line of thinking in a 2012 journal article. He writes:

> Instead of aiming to create “shifts in the subjectivities of those undergoing regulation” (Agrawal 2005, p. 17), the animal scientists whose work I describe in this article have sought to create shifts in the anatomy and physiology of farmed animals. They have sought to create environmental bodies, not environmental subjects. (Clark 2012:117)

The essence of his argument is that the animals are being turned into bodies that do the environmental work without appreciating that they are subjects in their own right who can contribute wilfully to the environment. In other words, Clark is disputing the fact that pigs are not being considered to be part of the environment, but rather opposed to the environment.

And lastly, reflecting on the end of the Enviropig project and the killing of the animals, Clark (2014) noted that their death revealed a new category of lab animals who are “ineligible for life after the laboratory” (2014:2). Given that lab animals such as apes, dogs and cats are offered a space in a sanctuary or are rehomed, the transgenic pigs that were meant to be farmed, did not fit this category of lab animal. Instead, they have not been allowed to live as other pigs because they were too transgenic to mix with other species freely. Clark also noted that the adoption of transgenic pigs into a sanctuary might lead to their

normalisation which is not the outcome the NGO wanted. This is how he worded this issue:

> Adoption policies have important implications for efforts to normalize transgenic farmed animals. Until they are approved for use as food, transgenic animals like the Enviropig will remain laboratory animals. Making these and other transgenic laboratory animals categorically ineligible for life after the laboratory only serves to reinforce the notion that they are radically different from their non-transgenic conspecifics. This surely presents a challenge for institutions seeking to assuage public concerns about these animals. Their policies may ultimately end up backfiring, exacerbating the public's concerns and unwittingly reinforcing the Frankenfood frame. (2013, p.11).

The essence of this argument is that regardless of where and how the animals live, the outcome might be detrimental to all parties involved. The animals, if viewed as transgenic, might end up being locked away or feared whether living in a research facility or farm sanctuary. The outcome might also be detrimental to the NGO should the public engage with the animals as if there were like other non- transgenic pigs. I agree that restricting access to transgenic animals reinforces their Enviropig difference which industry and scientists wanted to avoid.

And finally, Sanderson (2015) whose work on GM salmon I mentioned earlier, also reflected on the death of the Enviropig. He analysed the Enviropig from the perspective of assemblage, where not one, but many things contributed to the making and unmaking of this animal and that

patents alone do not make the Enviropig or cement its future. Rather, patents, and so the Enviropig, are formed of heterogeneous actors who form something that might be undone. Sanderson (2015) argued that there is no such thing as linearity and impacts and that things can become otherwise. He suggests that things can change even if they seem certain and irreversible.

Sanderson thus differs greatly from other scholars writing about the Enviropig, because having considered the rise and fall of the Enviropig, he was able to show that nothing is really certain, one and unchangeable. Sanderson is arguing that even though patenting and approving the Enviropig might feel like the flood gates are open for all other transgenic animals to follow, the story of the Enviropig shows this is not the case. This is because according to him, nothing ever can be forever certain, because all phenomena are multiple and heterogenous. In other words, there is not one thing that defines something and predicts what happens.

Ultimately, what I take from the scholarly views about the Enviropig is that there is a concern as to what happens to the animals during their lives, how they are perceived, what they become, what they represent and what are the material consequences. The literature, especially by Clark (2013) also suggests that there is a tension between wanting to save the animals without normalising them and saving them without reinforcing their difference. Despite the concerns over the animals, the literature seems to view them as examples of a much larger shift within

the agri-food sector toward genetics. But, as Sanderson argued, there is no certainty whether any of these developments are predetermined because even the Enviropig, the patented and approved transgenic animal, did not stay untouched. What I take from Sanderson (2015) is a glimpse of hope that things can be otherwise and that perhaps we do not need to fear the impending life sciences paradigm.

Nevertheless, the arguments are loud and clear that the ways in which the Enviropig was presented had material consequences. But at the same time, there are opportunities to look away from fear and immediate danger. To understand and to fully make sense of what it means to be a transgenic animal is to learn about them by following each enactment, retelling their story and to ask what it is like to live with them, care for them, create them, rally against them and so forth. In doing so, we might learn what it means to be around an animal that to some is unsettling, and to others wonderful or ordinary.

3.6 Toward affects of farm animal biotechnologies

The context in which these innovations emerge is important, and so are the concerns shared by the scholars I mentioned earlier. But the context

and the innovations themselves also point to multiplicity, fragility and affectivity. For example, the ways in which these animals have been debated changed from document to document. More than one animal was enacted in all of the different documents, from medicine cow to Franken cow, from a friendly pig to unwanted and monstrous. In a sense, these animals are multiple because they consist of more than one species, but also because many versions of them proliferate in the media, labs, documents and in practices. These multiple versions thus have to be coordinated with care to ensure robustness (Latour and Porter, 1996) of those different versions irrespective of who is, as if, looking after them (de La Bellacasa, 2011, 2017).

Furthermore, the ways in which these animals were presented and developed suggest an element of emotions, feelings and subjectivities coming into the scientific picture that to some seems clear and well defined and bounded. While emotions are commonly seen as the antithesis of objectivity (Latimer and Miele, 2013; de La Bellacasa, 2011; Damasio, 2006; Ahmed, 2004; Cook et al., 2004),

examples of GM animals and GM foods indicate that beyond expertise (however defined), emotions sit right at the centre of those debates, scenarios and concerns. Fear is often the most quoted reason as to why the public does not approve of GM foods (Campbell and Fitzgerald, 2001; Gaskell et al., 2002). But how about love for animals, care or distrust for science, and passion or indeed monetary motivation about seeking solutions to the growing appetite for meat? What about feelings for animals that are already GM? What about the feelings these animals feel?

3.7 Chapter summary

The purpose of this chapter was to provide more information about the Enviropig as a case of the recent innovations in animal farming, which I use in this research as a case that shines a light on new, radical uncertainties.

I have started with providing a definition of the Enviropig which explained the animal is transgenic, meaning multispecies and lab made. The definition, however, introduced the problem of pollution, the involvement of two scientists, the techniques used and so on. I then talked about the wider context that led to the first success (funding) as well as the contestations. I also showed that the Enviropig has been talked about in the media as well as in the literature and that there are

opportunities to get to know the animal a bit better and to learn from it.

But the whole point of this chapter was to show what I found so special about those animals. I would now like to summarise it. Firstly, the animals were transgenic, which sparked my curiosity as to what it means for pigs and the public accustomed to non-transgenic pigs. Secondly, little was really known about these animals, their story, their origins, how they lived and the full reasons as why they have been born. Thirdly, the animals went from wanted to unwanted, from heroes to villains, as if following one of the most popular emotional arcs of stories found in the literature which is the rise and fall of Prometheus (Reagan et al, 2016). And lastly, the animals were euthanised yet preserved as if waiting to be resurrected or to be listened to, just like Shelley's (2009,1818) Creature in *the Modern Prometheus, or Frankenstein's monster.*

But, from the perspective of concepts such as learning controversies, caring for beings other than human no matter how monstrous, and the role of affect (see Chapter 2), the Enviropig is a great animal to think about, think with and care about. For instance, considering the socio-technological context in which the Enviropig was created, how the animals were represented and by whom, and the contestations and uncertainties that the Enviropig evoked in Canada, I think the Enviropig is a very good controversy to explore. However, unlike many scientific innovations, this one evokes new concerns and care too, possibly due to the lengthy history of not only human-technology, but also of human-

animal relations. It can therefore be argued that it's a perfect controversy, as it contributes to the discussion on human-animal relationships in the age of science, a discussion which is rich in social studies of science and technology as well as in geography.

Chapter 4. Methodology

4.1 Introduction

This chapter explains how I researched an animal that is no longer in the flesh and went about addressing the research questions while implementing the concept of affective enactment.

In Section 4.2. Doing affective enactment, I give an account of what affective enactment meant in practice. To do so, I move on to the building blocks of this research that are methods, data source and collection. In this section, I also concentrate on positionality and motivation as essential and affective ingredients for this study. Based on that, I talk about the ethics of doing research that considers emotions. I then focus on a mix of methods I used to address three research questions.

In Section 4.3. Analysing and writing I talk about the analysis of the data. In particular, I concentrate on the ways in which I made sense of the data and what motivated my interpretation. This section aims to address the challenge of how to bring the animal in, and how to write about affect, animals and science.

In Section 4.4. Chapter summary I reflect on the process of the research and summarise the chapter's main arguments.

4.2 Doing affective enactment

Affective enactment, as explained in Chapter 2, is a moving multiplicity. Affective enactment gives accounts as to what and how a phenomenon for example, the Enviropig came to be, and with what affect rather than effect. Affective enactment prompts a researcher to shift attention from the consequences of becoming, to how for example, the Enviropig moved others and was moved by outside forces, practices and people. So affective enactment also focuses on what was done and what emerged out of multiple texts and practices, in the way it is described by Lien and Law (2011), but with additional focus on emotions and feelings. Affective enactment is an enactment with a force that holds things in shape until it does not. It is also understood as a methodology of sense-making or sensing the world (Evans and Miele, 2010).

Paying attention to what is affective can be done in many ways. Archambault (2016) uses the concept of affective encounter by taking "the everyday engagement with other human beings and things seriously, while also paying attention to what such encounters produce" (p.250). To Archambault "affective encounters, like any other encounters, never take place in a vacuum, rather they are shaped by the particular sociohistorical geographies within which they are embedded (p.250).

MacLure (2013:170-172) suggests paying attention to phenomena that are often overlooked in qualitative research: the anecdotal, accidental, and contingent. To focus on those fragments of data that do not fit into neat and succinct codes, and also to listen to our “gut feelings” and to moments of discontent. Hipfl (2018) noted that to do affect is to consider “in which ways are the capacities of bodies we [researchers] are engaged with, diminished or enhanced through our research?” (2018:12). These varied approaches to the affective highlight a preference for embodied and performative methods that can also be augmented by technology, senses, and being with others (Simpson and Brigstocke, 2019).

My take on working with affect as much as with enactments is that it can be fluid, adaptive, and as Franklin (2007) put it, on the hoof. This means that as one moves and explores, one picks up and discards method while being open to changes, twists and turns as well as failures.

The choice to apply a variety of approaches and methods, however, is in practice, restricted by the context in which the study is taking place. As I am about to explain, being with animals was difficult to incorporate in this study due to the death of the Enviropigs. The affective enactment in this research therefore relied on a mix of reading, feeling, and writing.

The critical step was to design a study such that I could explore the Enviropig while developing and experimenting with a theoretical approach as well as the methods. For this reason, I considered a case study design which I discuss in the next section.

4.3 Design

In Chapter 3, I outlined the story of the Enviropig where I introduced the timeline, the main actor, places, successes and contestations. Toward the end of Chapter 3, I noted that the Enviropig is a unique case of a controversy to learn from about living with radical uncertainties (Callon et al., 2009). To reiterate, this is because the Enviropig offered more than just an ability to digest phosphorus – it was an animal that embodied science, hopes, dreams, fears, multiple animals, visions of tomorrow, and fears of today. The responses thus captured the ingredients of new, radical uncertainties as theorised by Callon et al. (2009) in Chapter 2.

Given the gap in the literature about farm animal biotechnologies, especially the development of transgenic animals, it was essential to explore the Enviropig. However, rather than thinking about the Enviropig as a representative sample of biotech animals and biotech projects, I approached the Enviropig as the opportunity to shed empirical light (Yin, 2014:40) on some theoretical concepts and principles outlined in Chapter 2. The case study design was appropriate as it allowed me to focus in detail and explore it, while reflecting on the theories and concept that inspired the research.

Case study research is, according to Yin (2014), “an empirical enquiry that investigates a contemporary phenomenon (the "case") in depth and

within its real-world context, especially when the boundaries between phenomenon and context may not be evident" (p.16). Case study research is unique is its availability to deal with a full variety of evidence - documents, artefacts, interviews, and observations - beyond what might be available in a conventional historical study (Yin, 2014). The goal of case study research is to expand and generalise theories and not extrapolate probabilities (Yin, 2014:21). There are many types of case study to choose from, but for this research, the exploratory type was the most suitable. The exploratory approach is used for cases surrounded by controversies and where questions are meant to open the door for further examination.

4.4 Finding and following actors

When I started planning this research in the first year, I did not have many names or contacts. So, I began with the CBAN coordinator (mentioned in Chapter 3) whom I first contacted in 2011 for my MSc thesis in which I explored public perception of the Enviropig. In 2013, I reached out again to the CBAN coordinator, Laura, asking for a face-to-face interview and recommendations as to whom I could contact with links to the Enviropig.

In other words, I have used a respondent-driven sampling method (Hackathorn, 2011) which, unlike its close cousin, the snowballing

method, it is most useful and appropriate for studying hard to reach populations. Given that the world of biotechnology is controversial and that not many researchers are given interviews, I had to rely on the respondents. Thanks to her, I have been introduced to another contact – the Technology Transfer Officer at the University of Guelph who subsequently opened more contacts for me including scientists and staff at the Department of Agriculture and Food, Ontario Pork, and staff at the research facility. As far as I am aware, apart from major newspapers and news broadcasting services such as the BBC, CNN, ABC or Reuters, I am the only researcher in social sciences who was given access to the scientists, the funder, staff at the Canadian government Departments, and the research facility.

Interviews with available and critical persons to the Enviropig programme were arranged during the last days of October and first week of November 2014. I travelled between Toronto, Ottawa and Guelph to meet those involved in the Enviropig project. These were as follows: lead scientists (John and Cecil); one public servant who approved the Enviropig (Anthony) and another who liaised with scientists and the public (Jake); the funder (Ontario Pork's representative, Carol); an NGO campaigner (Laura); a Technology Transfer Officer (Nathan) and six agricultural officers (Una, Brad, Henry, Matt, Steve, and Clive) who worked at the research facility and looked after the Enviropigs. So in Canada, I interviewed 13 people. All interviews were conducted face-to-face and lasted 1 to 1.5 hours each.

Table 1 (see Appendix I) contains a list of names, dates and locations as well as further information about the participants such as their backgrounds and specific roles in the Enviropig project. I will remind the reader, throughout the chapters, who I am referring to and what role they have in the project.

Actors who were not part of this research were the Enviropigs themselves, farmers, and citizens in Canada. I will now explain why this was the case.

The Enviropigs, as I mentioned in Chapter 3, were buried behind the research facility so I could not engage with the transgenic pigs as others could while they were alive. However, I was able to stay in the facility, visit the place where the Enviropigs lived, and explore what Enviropig's life looked like in there. I was able to witness how other pigs live in the research facility, what their day looks like, what they are used for, how they are treated and what for.

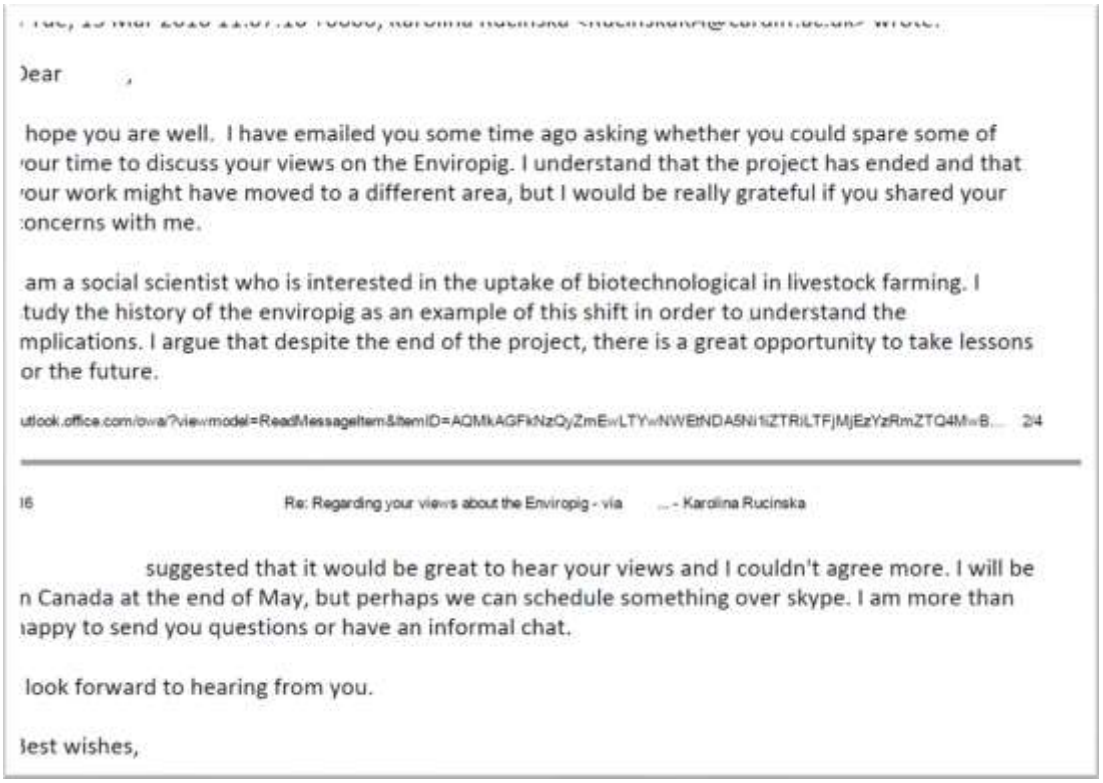
I also relied on policy documents, websites, transcripts of speeches, press releases, news articles and blogs which mentioned the Enviropig project. The written material was essential to the case of the Enviropig because the making and unmaking of the animal and the project took place in written form. This is where the Enviropig was firstly encountered - on the Web rather than in research facilities. The written material was, therefore, performing the Enviropig as much as the scientists, the advisers, the agricultural assistants and the NGO. In other words, I

relied on a mix of text, observations and interviews to learn more about creating, contesting and looking after the Enviropig.

With regards to farmers and a wider group of citizens in Canada, I was not successful in arranging interviews despite using the respondent-driven sampling which worked earlier. I relied on the farming unions' representatives to introduce me to farmers and citizen groups in Canada, but I did not receive a response the first-time round. I returned to Canada in late May 2016 to attend a conference in Calgary, and so once again I attempted to visit the representatives of the Farmers Union (see Figure 14) but I was not successful.

Figure 14. Email sent to Farmers Union representative dated 15 March 2016

In fact, the interview was declined on the basis of feelings (see the response I received in Figure 15.



)ear ,

hope you are well. I have emailed you some time ago asking whether you could spare some of 'our time to discuss your views on the Enviropig. I understand that the project has ended and that 'our work might have moved to a different area, but I would be really grateful if you shared your :oncerns with me.

am a social scientist who is interested in the uptake of biotechnological in livestock farming. I tudy the history of the enviropig as an example of this shift in order to understand the mplications. I argue that despite the end of the project, there is a great opportunity to take lessons or the future.

utlook.office.com/owa/?viewmodel=ReadMessageItem&ItemID=AQMkAGFkNzQyZmEwLTYwNWEtNDA5Ni1iZTRiLTFjMjEzYzRmZTQ4M=B... 2/4

16 Re: Regarding your views about the Enviropig - via ... - Karolina Rucinska

suggested that it would be great to hear your views and I couldn't agree more. I will be n Canada at the end of May, but perhaps we can schedule something over skype. I am more than iappy to send you questions or have an informal chat.

look forward to hearing from you.

lest wishes,

Figure 15. Response from Farmers Union dated 15 March 2016.

I replied asking to elaborate on this, but I have not heard back. It was rather interesting that the feelings were not legitimate enough in this context, and yet in other cases, asking for one's feelings opened doors for me.


From:
Sent: 15 March 2016 16:32
To: Karolina Rucinska
Subject: Re: Regarding your views about the Enviropig - via .

Hi Karolina - I think I will decline the interview. Your questions seem to be about "feelings" and not about power analysis.

Without the backing of the Farmers Union, I was cautious not to cause any discomfort while researching in a country I was not part of. It was important for me to gain trust and build good relationships, without which exploration of difficult conversations with the communities that boycotted the Enviropig could not be explored. Considering the time constraints i.e. lack of sufficient funding to extend my stay in Canada, I was not able to explore ways to work with the Farmers Union and given that online correspondence did not yield any results, I made a decision not to pursue engagement with communities using surveys or questionnaires without the backing of the citizens and farmers groups.

Given that one of biggest lessons for the interviewees in Canada was the concept of public engagement, I wanted to explore this further. So in 2015, I reached out to Cecil and John (the lead scientists of the

Enviropig project), but I have not heard back and later I was told by Nathan that they would prefer not to take part in interviews again. I respected their decision, knowing that they are retired and feeling "sanguine" about the past. I explore this in Chapter 7.

With the above in mind, I contacted scientists in the UK working at the Roslin Institute specialising in transgenic farm animals. I wanted to hear about their experiences of working with the public communicating research, and views about the future of animal biotechnologies. I emailed the group leader (Ben) who not only agreed to talk to me, but also helped me arrange interviews with his group members: Harriet, David and Mark. I travelled to the Roslin Institute in Edinburgh to hear their stories in person. Their stories helped me to gain a sense of what it means to be working in this area of research and how this can impact their personal and professional lives. Detailed information about the UK-based scientists can be found in Appendix II.

In the next section, I focus on my position in this research, which I consider an important aspect in this study. Given that the topic is divisive and evocative, it is crucial to talk about the role the mix of emotions and views had, as it prompted me to be mindful of who I talked to (or was not able to), how I talked and how I ended up making sense of the world of the Enviropig.

4.5 Positionality and motivation

Positionality is a term used widely in social sciences as a way of acknowledging one's place in the world in relation to the topic of research and research subjects. Positionality reflects a shift in social sciences that began to question the objectivity of scientific knowledge (as discussed in Chapter 2), but also its own practices. Over the last few decades, researchers began acknowledging that their assumptions and privileges impede their ability to understand complex issues such as poverty, disability, happiness, grief, domestic abuse, sexual labour, living with cancer, and working with animals in laboratories, to name but a few. Research thus turned to a much greater reflexivity and situated analysis (Rose, 1997; Haraway, 1988) of knowledge produced by those who are studied and those who conduct research.

Positionality however is not just about acknowledging one's privilege and assumptions about a topic. In other words, it is not just about revealing how one's class, education and ethnicity have impacted analysis and an understanding of a given research problem.

Given the insights about the importance of emotions and affect in making sense of the world, positionality should also incorporate the role they play in all aspects of research. Indeed, as I noted in Chapter 2, Rager (2005a,b) and Widdowfield (2000) argued that if it weren't for their vulnerable emotional states, they might have not been able to appreciate those living in so-called low-income areas and those living with cancer. Acknowledging emotions allowed them to bridge a gap between themselves and those they have studied, although at some

cost. Rager (2005a) noted that she needed to undergo counselling to deal with the grief and pain she witnessed when researching cancer care patients. She noted that apart from the research labour she was doing, she was also doing emotional labour (Ahmed, 2004) that in Rager's case left her vulnerable, exposed, and unable to carry on.

The challenge described by Rager goes back to Rose's (1997) experiences of feeling like a failure at doing positionality. But acknowledging the bewildering world of feelings and informed opinions can be quite fruitful and impactful, Rose (1997) further argued. Most recent examples of working with feelings are found in a publication by Garcés (2019) in which she described how she used emotions to understand others and eventually get adversaries to be on her side.

What I take from these insights is that positionality means to be aware of the entire process of research, from motivations to do research, interest in a topic and defining a research problem, through accessing and collecting data, to finally analysis and interpretation. In other words, it is about bringing awareness of oneself to all stages of the process. The outcomes are two-fold: discovering oneself (Rose, 1997) as much as discovering others.

When it comes to complex issues surrounded by debates, controversies and uncertainties, positionality I understand, needs to be laid out front and centre, open for everyone to see, and needs to be transparent regardless of how vulnerable one might feel, or how difficult the process

may be. This is why I would now like to state that my position and the mixed feelings I had about myself, the research topic, the people I hoped to talk to and animals I meant to write about, motivated the way I approached this topic and further prompted me to consider the role of affect theory.

This project came out of my sheer curiosity regarding an innovation which unsettled me, but I did not know for what reason. However, I was aware I had an opinion about genetic modification which had to do with the rhetoric of power, corporations, and greed. Thus, when it came to the Enviropig, I had the impression that there are other ways of addressing pollution in groundwater. I also felt that fixing farming problems should not be done on the level of the animal body. Instead, we (although I did not know who we were) should start asking questions as to why we eat animals; why aren't there other ways to feed people without destroying the environment and causing harm to animals? I also did not think that genetic modification is a precise breeding method without consequences. On the contrary, I felt it had serious consequences and I did not want to see genetically modified animals in my lifetime, or ever. And yet, when the death of the Enviropigs was announced, I found myself wanting to see them back for the selfish reason of wanting to do research with them I wanted to see how others interact with them to learn what it means to be with transgenic pigs, and what it means to be one.

I also had a strong opinion about science being irresponsible and

detached from a world populated by people and animals who are grounded in every day. And yet at the same time, I knew very little about how science is developed, how genetic modification works, where it is used, and what for. I knew nothing about genomes, genes and what it means to create an animal in a lab. I have never been strong in STEM subjects which meant that I had little confidence in being able to describe how biotechnology works, but I was still interested in its history and developments.

Moreover, I have had a romantic view as to what farming should look like and how animals should be treated, and yet I was, and still am, consuming meat, while acknowledging that animals including pigs are sentient beings. I can't seem to stop eating, for example, chickens raised on industrial farms. As a researcher investigating farmers' perceptions of welfare directives, I have visited chicken sheds and so I know perfectly well how chickens are treated on farms. I have been with those animals. Words fail to express how I feel, but conflict is what comes to mind when I try to explain my relation with animals.

I also had very little confidence in myself given that my research was not approved by a research council so I had to tell myself over and over that I can do this. I remember feeling plain stupid and unworthy, but a friend sent me an article about part-time and self-funded PhD students who experienced the same feelings. Knowing that I am not alone gave a sense of ease and connection. However, I was alone in a different sense. As a Polish national living in the UK, I had no family support or

stable job to sustain my research, thus I often had to choose between earning enough to pay for my PhD programme and having time to do research. I remember feeling bitter that others have time to study every day, and so this time, I used my emotions to disconnect from other students.

The mismatch between needs and wants, good and bad feelings, connections and disconnections meant that over time, I lost hope as to whether I can keep going. But my personality, which is one of perseverance when faced with difficulties, helped me to push the research while working full time or handling multiple jobs at once. My perseverance to do research and curiosity about the topic opened the doors to the world of the Enviropig. So, when I was told, “Nobody will give you an interview” or “This is interesting but so what?” I kept sending out emails for an interview anyway.

And so when I was given a chance to interview the participants in the study, I would say “I want to know how you feel” and “I want to hear your story” which surprisingly worked. So, I was being myself – honest, curious about people and, in hindsight, naïve.

But, as a researcher who was emotionally disconnected from the research culture and not supported through grants, I felt I was not good enough to take this research forward, to execute those questions, to analyse the answers and make sense of all this. Eventually, my doubts as a researcher engulfed my sense of self, giving way to negative

feelings in need of counselling. But, deep down, somewhere where words do not exist, as affect theorist would say, I felt there was something different about what I have done. But was different good enough to be able to talk about learning how to live with radical controversies?

As mentioned in Chapter 2, more and more scholars and activists (e.g. Garcés, 2019) embrace emotional states as crucial parts of conducting research when interviewing for example, but also in making sense of what is being studied. It was important that I do not lose sense of those conflicts and my own assumptions and stay with the trouble of coming to terms with them. It was also important for me to approach this research by simply being curious. Thus, I approached this case study from affect theory and the concept of enactment. Affect theory, as a force of encounters (Seigworth and Gregg, 2007), prompts the researcher to look into the material as well as semiotic changes, exchanges, moments and movements, between human or non-human actors, including oneself.

Coming back to positionality then, Moser (2008) argued that it should even be extended to consider personality and affective states of a researcher, because these too impact on all aspects of research. Here is how she put it:

> While there are surely researchers among us

> who are viewed to varying degrees as outgoing, shy, domineering, neurotic, paranoid, hot-tempered, impatient and so on, such observations about oneself do not appear in discussions of positionality, even though these traits may have a far more significant impact on the research process and product than being, for example, a feminist, white, a post-structuralist or middle class (2008:386).

The point Moser is making is that we should be more explicit about the kind of people we are before going into research, and more explicit while we are doing it.

But, from the practical standpoint it was difficult to do so, and even more so from a theoretical standpoint. Thus, these tensions, as well as other feelings and opinions, were at times censored by myself and at times showed me a way to engage with and bear witness to them. The conflict I have experienced, I also sensed in the topic itself as well as the literature, awash with debates and uncertain how to move beyond an impasse.

Nevertheless, my positionality thus made an impact on the ways in which I approached this research from analysing the literature, engaging with research, and dealing with strong views and opinions. This is why my work is looking at the concepts of feelings and learning from difficulties and controversies as to how we can live with radical uncertainties that will only keep coming.

But, to open up a discussion about controversies and feelings, I needed

to focus on the Enviropig with feelings right at the centre but also kept at bay. In other words, I needed to explore the evidence while paying attention to affect. Given the rise and fall of the Enviropig (see Chapter 3) and the balance between evidence and affect which I wanted to keep, I asked three research questions: How was the Enviropig enacted? How was biotechnology practised around the Enviropig? and What is the potential role of the Enviropig in learning about radical uncertainties?

From the methodological point of view, these questions are far from simple, even though they appear "naïve". After all, many methodological approaches could be applied, and many methods deployed.

Also, as some would argue, there is the danger of positionality coming into answering those questions and selecting and gathering data prior to that. But as I outlined earlier, positionality is not detrimental to research; instead, I considered positionality as an important, affective ingredient in the understanding of farm animal biotechnologies.

So, in the next sections I will move on to describe how I kept that balance while aiming to address the three research questions.

4.6 Ethics

As mentioned in Chapters 2 and 3, research on the topic of animal biotechnology, especially when it involves access to laboratories, is

limited. As Greenhough and Roe, who investigated caring practices in labs (2018), noted:

> This is a sensitive area in which to conduct research, and it takes time to build relations with an animal research community for whom the threat of infiltration by animal rights extremists remains a fairly recent memory (p.370).

In making this comment, they signalled that one needs to be mindful of ethics and accept that access might not always be given, interviews arranged, recorders used, and photos taken. I agree with their comments because my experience confirms it. I too, was mindful as to how to take care of participants and myself, which goes back to the balance I mentioned earlier. Ethics, therefore played an important part in making sure I did not jeopardise anyone.

Thus, before I initiated research and reached out to CBAN, the research had to go through an ethical committee at the School of Geography and Planning. The committee looked at the nature of research (quantitative, qualitative), the type of participants to be interviewed (e.g. age, vulnerability), location (e.g. online or in situ), and data storage. As part of the process, I prepared the project information sheet and consent forms (see Appendix III and Appendix IV). The purpose of these two documents was to communicate the aims of the research and the rights of participants. For instance, the right to withdraw, the right not to record an interview, and the right to be anonymised.

The information sheet was used at the point of contact with interviewees and the consent forms were used before the interviews. Given the

sensitivity of the topic, these two documents signalled that I was protecting participants (Yin, 2014) from being identified. However, it must be stressed that the creators of the Enviropig (John and Cecil) are widely recognised and so their identities could not be easily protected. Two copies (one for me, one for participants) of the consent forms were signed before the interviews took place and were kept. If participants did not allow me to record an interview or take photos, this would then be made clear and noted on the consent form.

Given the sensitivity of the case study, it was important to develop a good rapport and get to know everyone and understand their motivations as well as mine to do research about the Enviropig. So the content of the information sheets and consent forms needed to reflect that. As mentioned already, it was important for me to develop a good rapport, and so it was important that the interviews were conducted in person rather than over the phone or Skype.

Another way to ensure that the participants are protected, was to be open about the research, my intentions and my commitment. With this in mind, it was important that I travelled to Canada, that I met the participants in person, that I adhered to their schedule and listened carefully. If the interviews were to take 1.5 hours, I would use that time, and conversely, if the interviewee would not like to engage, I would not press. Also, I had to make sure that my wellbeing was not affected.

For instance, I found that an interview with the CBAN coordinator,

Laura, who helped me arrange the interviews, was relatively short and charged. I found myself in a difficult situation because the atmosphere felt tense. Laura would answer phone calls while talking to me and would divert from questions about her background. On the contrary, those who worked directly with the Enviropig would spend time with me, outlining the story and answering every question about their past, duties, and worries as well as hopes.

With regards to ethics and discomfort, three issues were difficult to balance: anonymity; lack of consent from animals; and my wellbeing when spending time at the research facility emerged during the research.

Anonymity, in single and small case studies like this, is paramount. Given that the sample of participants is small, and the case has been mentioned in the global media, the names of the scientists are widely known. Their names, as well as the whole story of the Enviropig were in the public domain. This goes back to the radical character of new uncertainties, namely that it is not possible to contain them. So, one way of protecting the scientists was to ensure their personalities come through by being careful how I quote them, how I discuss their work and experiences. Everyone else was anonymised because many of the people I talked to were not mentioned in the media which made it easier to protect their identities.

With regards to animals, the ethics committee did not ask questions

pertaining to my plans of attending to animals. The emphasis was ensuring that human subjects are protected, not animal subjects. Given that I spent time at the research facility where I witnessed death, I questioned the ethics of my research as well as my wellbeing. As I will explain in Chapter 7, I was in conflict at all times, not knowing what to do, how to behave and how to capture the pain which, if it were human subjects, I would never have been given consent to witness, to describe and publish (Lonkila, private conversation, 2017). And yet, as a social scientist my work around animals was not put to much scrutiny by the ethics committee. The question is then not whether I have complied with ethics, but whose ethics I complied with.

And lastly, my wellbeing. Given that I was not funded and had to balance work and studies, given that I was dealing with a sensitive topic and witnessed the death of animals, worries of humans, and travelled to Canada but for a short time (due to lack of funding), I questioned the validity of my research and the role of ethics. Thinking about Rager's notion of a broken heart when doing research, and a wider research that deals with affect and topics that are contested and sensitive, I fully agree that ethics should apply to all involved. This is why this chapter and the whole thesis also emphasises my emotions and the challenges of exploring this topic. What seems as a failure to me (not having enough time in Canada, not being given an opportunity to talk to the public in Canada) was a triumph in staying with the trouble (Haraway, 2016) and going where others could not.

4.7 Methods

This study aimed to explore the making of what Callon et al. (2009) call a new controversy, of which the Enviropig is an example. The exploration could have been done in multiple ways - comparing innovations, talking to the public, analysing archives or marketing material, interviewing scientists, sitting in a laboratory to name but a few. There is a breadth of methods one could use, but in order to address the gap in the literature with regards to farm animal biotechnologies, I wanted to approach this case study in ways that would open up, rather than narrow down, an understanding of this innovation to learn from it.

As signalled in the literature review, I am inspired by affect theory, which largely speaking, pays attention to encounters, belongings, the in-betweenness, the not-yets, and impacts, however slight, of a (human or non-human) body onto another, of one's feelings and emotions onto another (Seigworth and Gregg, 2009). Affect is fleeting, subjective and context-dependent, and can be thought of as a way to come closer to phenomena, and/or as a threat - as it can open up sites we do not want to see, touch, open - thus being affected. I have argued that it might be a useful theory when getting to grips with new controversies, which unsettle deeper than can be admitted. This theory enhances the

material-semiotics schools of thought, in a way that pays attention to the material and the semiotic, but does not shy away from talking about emotions and feelings, the uncomfortable, and the unwanted, from an open space.

To do that, I chose a mix of methods to be able to explore the new controversy while paying attention to their affective performativity. In the next sections, I outline which methods I used, and then I focus on their analysis.

Media and documents

Scientific innovations, as well as animals, can often be presented in the media in terms of risk, fear and uncertainty, but also love, progress and rationality (Gerber et al., 2011; Liakopolous et al., 2002; Gaskell et al., 2002). Animals, in particular, are presented as the ultimate monstrous other, or a canvas onto which human worries are being painted. Scholars such as Haraway (1991), Ung-Lanki (2014), Davies (2010), Fudge (2004), Birke (2003), Väliverronen (2004), Morris and Holloway (2009), and Twine (2010) to name but a few, argue that representations and stories about animals and science and technology can have a profound impact on the public's perception of animals, science and technology.

The media, as the literature argues (Potter, 2012; Hipfl, 2018; Gerber et al., 2011) plays a significant role in how stories are being told about

both the roles of animals (Fudge, 2004; Ung-Lanki, 2014) and science (Gaskell et al., 2000). The concept of roles, as Gerber et al. (2011) explain, focuses on the analysis of the relationships between humans and animals as well as between animals and the media. Scholars in affect argue that media is the site of affect as it works only by drawing the reader in by referring to emotional states. As Hipfl (2018) wrote "media can touch us, can move, make us feel, it can also be seen as blocks of sensations that represent a collective feeling of angst, fear or joy" (p.9- 10). The use of animals in the media is a powerful way to represent and evoke collective feelings. The use of polar bears (see Chapter 2) is an example of media affect in action: the body of the bear stranded on ice is calling on us to change unsustainable human behaviour while performing the bear as lonely and helpless.

The Enviropig, being an example of a contested farm animal innovation, offered an opportunity to explore how the media represented the Enviropig.

Since 2002, when Einsiedel et al. published research on a representation of Dolly the Sheep in the mainstream European media, the field has been somewhat stagnant. Although animal biotechnologies have become a subject of critical engagement (see Morris and Holloway (2009) in animal geography; Twine (2010) in animal studies; Lezaun and Porter (2015) in STS; Franklin (2007) in anthropology) very little research has been done on representations of farm animal biotechnologies in the media.

In thinking about the notion of ”care” (de la Bellacasa, 2010; Mol et al., 2011; Atkinson-Graham, 2015) and ”helpful monsters” (Latour, 2011) discussed in Chapter 2, I took the opportunity to focus on the representations of the Enviropig away from discussion about control over animal bodies, commodification or politics. Instead, I wanted to see how the Enviropig was written about, what was being enrolled to talk about the Enviropig, what relations were brought forward, whether a message about the Enviropig has changed over time, and what kind of discussions and feelings the Enviropig gave rise to. In other words, I followed Hipfl' s (2018) advice with regards to affect in the media which is: do not look for negative or positive feelings, but rather ask what affects do: do they increase the capacity to act or to connect? The point here was to read as a reader of Web 2.0 does, which is to scan-read (skim) information from various sources.

I searched for articles using databases such as Nexis, Scopus, Web of Science, Google Scholar and Google. The only common threads between the various texts were that I searched for material written in English and with reference to the Enviropig. In other words, I used the term “the Enviropig”. I decided to span my research across time but starting from 1990 to 2016 so that I could see whether the story changed, and if so, how.

I also looked at a wide range of publications reflecting the readership in the world of Web 2.0 - online, mainstream media, blogs, magazines, opinion pieces, grey literature and academic articles. This was

motivated by the fact that studies in the representation of GM animals in the media tend to focus on one type of publication, either trade, scientific or broadsheets (see Einsiedel et al., 2002; Väliverronen, 2004). For example, Einsiedel et al. (2002) followed up the news coverage of Dolly the Sheep but only in the established European broadsheets and magazines. Similarly, Väliverronen (2004) explored the representation of transgenic cows in the Finnish broadsheets only. Bloomfield and Doolin (2010) on the other hand, analysed policy, marketing and campaign material used to describe GM cows in New Zealand. Similarly, Morris and Holloway (2012), Lonkila and Kaljonen (2018), and Lezaun and Porter (2015) used marketing material and policy documents in their studies of farm animal biotechnologies. However, no research analysed animal biotech or specific animals looking at a wide range of material from across the Web.

While previous research was also interested in ways in which animals are being represented, the results are narrow with regards to the readership. The readership of Web 2.0 entails a wide range of resources to which readers are exposed and interact with, often at once. In recent years, Web 2.0 has, in many ways, replaced traditional media such as TV and newspapers, thus, as Skalski et al. (2017) argue, researchers may not analyse stories in daily newspapers, but they will need to analyse the universe of individuals' personalised (e.g. Facebook feed) news content.

I gathered 149 documents, blogs, articles and news items, which I then categorised based on: type of publication (e.g. academic, blogs, online newspaper, educational material, lifestyle magazine, other); location of the material (e.g. UK, Canada, US); type of coverage i.e. was it about the Enviropig or was the Enviropig just a headline; references made (e.g. regulations, environment, trade, farming etc.); and representations of the Enviropig (e.g. friendly, threat, an example of GM, Frankenpig etc.). These categories were not preassigned but evolved while scanning text. I did not make any preference as to which text is more valid, rather I was interested in the overall feel, the origins and place of the text, and the connections and enactments it makes.

In the Section 4.3 I discuss in more detail how I analysed the text.

Interviews

Web 2.0 documents were important in the initial stage of exploration of controversy. However, as noted already, it was also important to follow the lead and go a step further. By this, I mean interviewing people who were close to the case of the Enviropig and consider how these interviews were conducted.

Bryman (2012) notes that depending on whether a researcher is beginning an investigation with a clear focus, rather than a very general notion, it is likely that interviews will be semi-structured so that the more specific issues can be addressed. Semi-structured interviews, as the

name suggests, are guided by a researcher's focused interest which allows and encourages flexibility and input from an interviewee. Having said that, as Bedsworth and Keil (1992) observed, the interview programme is not based upon a set of relatively rigid pre-determined questions and prompts, but rather, the open- ended nature of interviews is permitted (in Bryman, 2012:472).

With this in mind, semi-structured interviews were the most suitable for this research for two reasons. Firstly, I wanted to focus on the history of the Enviropig; regulatory processes; and decisions that were taken. At the same time, I wanted to keep interviews at a conversational level so that interviewees felt at ease when prompted to talk about personal views, experiences and feelings. Furthermore, I wanted to learn about the Enviropig stories from the interviewees rather than relying on available but limited information. In other words, I wanted to use these interviews as an opportunity to tap into the multiplicity of the Enviropig story.

Secondly, considering the short length of time available for me to spend in fieldwork (1.5 weeks in Canada) an element of structure in data collection was needed. Having said that, semi-structured interviews allowed me to keep both interviews and fieldwork to time. Interviews were arranged and secured prior to arrival by telephone conversations and email exchanges. In so doing, I created a good rapport, which was

felt at the time of interviews.

The interviews started by asking questions about their current roles and their backgrounds, and only after establishing that am I getting to know the participants (Jacob and Fugerson, 2012) would I move on to their experience and involvement with the Enviropig as well as the lessons they have learnt. So, the interviews took a form of storytelling (Roe and Greenhough, 2018; Starkweather, 2012) and self- reflective exercise which shed a light on the role of emotions in research (Parr, 2014) on a contested topic.

Group Interview

While establishing connections in preparation for fieldwork, I was given a rare opportunity to meet with the swine research team. Their job title is "agricultural assistants", but their role is to look after animals at the research facility as they would on an industrial farm. However, unlike industrial farms, at the swine research facility the team of assistants also carries out research projects on a researcher's behalf.

This group of people was involved in the Enviropig project, where they took care of animals on a daily basis. This team of six people (five men and one woman, age group 20-40, with professional and academic backgrounds in livestock) joined the Enviropig project at different stages, but essentially, they spent more time with the Enviropigs than others involved in the project.

Keeping in mind the team's involvement with the Enviropigs from a non-scientific, regulatory or NGO perspective, it was essential to arrange a meeting. Due to security reasons, I could establish a connection only through a gatekeeper i.e. the manager of the swine research facility. Initially, I planned a focus group, which, as Bryman (2012) informs:

> [...] is a form of group interview in which there are several participants; there is an emphasis in the questioning on a particular fairly tightly defined topic, and the accent is upon the interaction within the group and the joint construction meaning (p.502).

In this sense, I wanted to use the focus group to talk about participants' experiences of working with the Enviropig; their views and feelings. However, knowing little about the group, I had to use the focus group as a "breaking the ice" activity, learning about participants' roles and gathering basic information. Having said that, the focus group turned into a group interview.

A group interview (Frey and Fontana, 1991), similar to a focus group, is semi-structured and allows flexibility and welcomes interaction between participants; it does not allow, to a great extent, for observing how points of view are being formed within a group setting. Group interviews, as Starkweather (2012) argued, are most useful in a setting where individuals know each other already and belong to a team or family. The group interview participants, unlike focus groups, Starkweather (2012)

further argued, “have an intimate knowledge, shared experiences and long-established patterns of interactions” (p.290) which can create a safe space to open up.

Given the nature of this research, I wanted to ensure that the participants felt safe. So the group conversation was on their terms, by which I mean it was arranged when it suited them i.e. before their duties began. So after I changed into new clothes provided by the research facility, I joined them in the staff room for breakfast. I was definitely slightly nervous because there were six of them in “their space” whereas I was on my own with a recorder only.

An interesting aspect, again something that I have not explored given that I have not been given any consent to, was that the interview was attended by two children who joined their fathers for a “work day”. I wanted to say how sinister it was, but honest at the same time, to show their children what kind of work their fathers carry out every day.

Despite the group interview and the feeling that this is their space, not all participants were outspoken. Based on the ways in which the team saw itself ("We only do what we are told") they did not, perhaps, feel they could elaborate any further And yet, the group interview gave me a sense of their presence, their work and their role in the story of the Enviropig.

Observations

In addition to individual and group interviews, I carried out observations in the research facility. Ethnography is a type of participant observation that is enhanced by the immersion, sometimes covert or overt, of a researcher in a setting particular to a group of participants e.g. work, home, street, shop etc. for an extended period of time (Bryman, 2012; Atkinson, 2014).

Its purpose is to reveal the ways in which participants operate in their own setting, in comparison with what they say, or is said about them. Being in a setting is often referred to as being in a social setting (Bryman, 2004, p.63) that is familiar to participants. By doing so, a researcher does not abstract participants from the places and practices about which the latter are asked to elaborate on.

One of the advantages of an ethnographic study is to observe and/or join participants in their practices thus reportedly being able to understand how particular views are formed, whether they contradict or support participants' oral accounts. In a way, early ethnographers especially, argued that their studies reveal" a reality" of a particular group of people (Bryman, 2012). With the rise of" reflexivity" in research, the" realness" of ethnographic accounts has been contested. It has been argued, as the first part of this chapter informs, that a researcher is immersed in his/her own world before entering participants' worlds. Having said that, ethnographic studies gave rise to inward as well as outward observation, thus strengthening its usefulness in studies

adopting an affective approach.

The rise of ethnographic studies of laboratories is relatively recent in comparison with ethnographies of indigenous cultures and reflects the rise of interest in science and science-based controversies (see Chapter 2). Given the various approaches in STS as to what constitutes a controversy and an expert, ethnographies of laboratories are split along those lines too. Knorr-Cettina (1995) argued there are at least two broad types of ethnographies of labs. The first is interested in how scientists assert their legitimacy (see for example, Collins, 1975). The second is a detailed exploration of what is happening inside the labs (see for example, Latour and Woolgar, 1986) as a study, as if, of a distant culture that creates a form of knowledge.

The detailed exploration pays attention to bodily movements, places, use of objects, use of animals, relations with animals, smells and sounds, geography, clothes worn, gender, conversations and the most mundane activities such as having breakfast (Stephens and Lewis, 2019). The common theme is that there is no preference and hierarchy as to who or what creates science (as a form of knowledge) in labs, and so all objects, animals and humans are treated as crucial actors (Latour, 1983) and the most mundane practices are storytelling. Given that this research is interested in science-based controversies and the making of science, I adopted the second type of lab ethnography.

However, ethnographic work in laboratories can be difficult due to

biosecurity measures (if it is a wet lab), secrecy (if it is a classified lab, for example government), ethics (if it is a clinical setting) and distrust toward researchers especially when animals are involved (Greenhough and Roe, 2018). With this in mind, I relied on the contacts made earlier to ensure the staff knew why I am coming and what I was doing. I took a very soft approach i.e. did not pass judgement or a comment, but instead asked open-ended and probing questions. It was important to me to feel less of an investigator or researcher, and more of a curious and empathetic guest.

Case and ethnographic studies, as any handbook on qualitative research suggests, need to be lengthy to qualify (Emmerson, 1987, in Bryman, 2012), yet a degree of immersion might also be enough to call a study ethnographic. Gusterson's (1996) study of a nuclear weapons laboratory in the USA was not as long or in-depth as other studies because the top-secret nature of work at the establishment did not allow it (Bryman, 2012:465). Instead, a mix of interviews and document collection was used as methods in a laboratory. The strength of this method for this PhD research was in the fact that I was allowed to observe the work (discussed prior to going into the actual facility) being carried out. It allowed me to see how lab animals were being treated, maintained, kept, looked after, and under what conditions, by whom and for whom. Laboratories or research facilities are highly contested and almost impenetrable spaces which explains the gap in empirical research when it comes to farm animal biotechnologies.

Building on studies by Miele (2011, 2017), Davies (2010), Greenhough and Roe (2018) and Pihl (2016) which I mentioned when talking about care in unlikely spaces (see Chapter 2), I aimed to follow their footsteps. In other words, I aimed to pay attention to every single object, layout, movements, sounds, smells to get the sense of what it means to be an animal in a place like this and what it means to work in a place like this. So, the observations were meant to tell pig and human stories of farm animal biotechnologies.

My day started with an introduction to the facility's manager and followed with undergoing the same procedures as any other team member at the facility. This meant a full shower and complete change of clothes including personal items. I was not allowed to change the team's work schedule, which allowed me to see their work as it would be on any day. Having said that, I had a breakfast during which a group interview took place. It was followed by being taken for a tour around the facility and told what is being done there. I was able to see animals in all stages of their lives from birth, to weaning, castration and feeding.

I was lucky to witness the work of agricultural assistants because, on the day of my visit, a team of scientists and PhD students from the University of Guelph came to collect their data. By collecting data, it meant that work was carried out on piglets. This gave an opportunity to see how science is being conducted with animals.

Keeping STS literature in mind, especially the laboratory studies, I paid

attention to as many details as possible. Literature suggests that notes taken during the fieldwork are likely to be the most common component of ethnographic research (Yin, 2014). Referred to as "fieldnotes" they encompass initial thoughts, detailed descriptions, personal views and comments. Their purpose is, as Gorman (2017a) put it, to "turn the situated, ambiguous and fleeting into a representable and analysable format" (p.223). Their purpose is also to prompt self-reflection, feelings and bodily experiences such as smell, sound and touch (Philippi and Lauderalle, 2017).

In anthropology, where they are mostly used and originated, fieldnotes are as important as the data collected. Although fieldnotes can take different forms, from jotting ideas during or after fieldwork to the use of drawings or recorders, there is an ongoing debate as to what should be captured and when given the shift in technology from pen and paper to mobile phones (Gorman, 2017c).

The agreement though is that fieldnotes become data which can be analysed further and that noting things down enacts a “proper” researcher who gives a sign, through notes, that what is being said is noted and taken seriously (Jackson, 2016).

While I agree on the value of fieldnotes, I found that noting things down during a visit to the laboratory was intrusive and it felt like I was not paying attention if I was not maintaining eye contact. My experience reflects the experience of other researchers who continuously needed

to balance the needs of the research versus care for the research subjects (Emerson et al., 2010; Pope, 2005). While some choose to write after, some write notes during the interviews or observations. A good practice is to ask the participants whether notes can be taken and explain why (see Gorman, 2017c).

Given that I wanted to listen carefully and bridge the gap between myself and participants who are rarely given an opportunity to tell their stories, I did not take notes during the interviews or observations. Notes made me feel like an outsider (Thomson, 2014) who comes in and takes giving nothing back. Also, the research facility was closer to a farm and a slaughterhouse meaning that there was manure, straw bedding, dust and blood at times. I tried my best not to touch too many things because I was not wearing protective clothing or gloves. I tried to draw the facility and animals inside. However, I was not able to capture this well.

I did however have a phone in a pocket, but I did not use it apart from on two occasions which were consulted upon with the team leader. I took a photo of the changing room and a picture of the Enviropig model (same as in Chapter 3). The aspect of fieldnotes though, came down to the notion of conflict over the ethics which I mentioned earlier. All forms of data capture felt intrusive at the research facility, as if I crossed a boundary that was intimate. Given that all aspects of animal lives took place there, many of which were difficult to bear witness to, I did not want to take more than I was already given. And yet, as I will expand on in Chapter 7, this was a rare occasion not to witness and capture

everything. But, I did not ask animals for their consent to partake in this research and so, my words and my feelings are all that I took from them.

Lastly, and most importantly, there was the challenge of knowing what to do with my emotions as far as fieldnotes were concerned. Thompson (2014) argued, that although emotions seem essential to what happens in field and how the field is written about in fieldnotes, there is limited scholarship regarding the tension of admitting emotions in fieldnotes. Diaries seem to be more appropriate since they deal with one's feelings and they are personal, and not for anyone to see. But thinking about the value of positionality, it suggests that revealing one's inner psyche might be appropriate. And yet, I agree with Thomson (2014) that when we write personal things, we don't always write just about ourselves. There are ethics associated with how that personal thought is going to be received. When is personal too personal? So even though I aimed to work with the affect, it was difficult to know what it is that I am allowed to mention, what would my emotions say, and how will I be judged based on that.

Autoethnography

In addition to observations of others, I also observed myself. I did not set out to do it, but over the course of the research I began to notice that my relation to this topic changed and the relationship with myself changed too. But I did not give it a name (or make it explicit) until 2016,

so a few years into my research, when I gave a presentation titled “Love your GM monster” at the Spaces of Attunement (2016) symposium in Cardiff. Here I made a courageous argument as to why dealing with myself prompted me to consider loving “real” monsters and question the concept of monstrosity (which I have already explored in Chapter 2). In my conference paper I wrote:

> Love your inner monster, the new zen slogan teaches me. But which of the monsters I am ought to love : the one in my head or the one I study? While loving the monsters in my head I began to love my other monster- in its corporeal form - the Enviropig. I never gave her a name, oddly enough, but this one is called Geordie.

I have already explained my positionality in section 4.5 and my own story as to how I got to do this research and what it costed me mentally so I will not repeat it here. But, what I am trying to say here is that my positionality, my own self (or the ego) and the process of research were intertwined and influencing “each other”. In other words, it was hard to know where I ended, and the research began. This prompted me to adopt an autoethnographic method.

Autoethnography is interchangeably referred to as auto-anthropology, auto-biographical ethnography, personal or self-narrative research and writing (Anderson, 2006). It emerged as a result of postmodern and post structuralist sensibilities toward subjectivity in qualitative research. In

particular, a greater emphasis was placed on the importance of emmeshing oneself into the world of people studied which run contrary to prevailing approaches. For example, in the 1920s Robert Park, from the Chicago School of Sociology, encouraged students to live with and like people they set out to understand. This signalled a shift from being a detached observer who takes notes and does not interact with the "other" to attached and emmeshed researcher.

The tension between attachment and detachment in ethnographic research continues to this day but it is more subtle. With the rise of various theoretical approaches and methods, researchers can play around with the notion of autoethnography.

However, Anderson (2006) noted that despite its acceptance and the proliferation of autoethnographic methods there is still a misunderstanding as to what it is for and how it is done in practice. He argued there are two subgenres of autoethnography: evocative and analytical. In his view, analytical autoethnography is more consistent with qualitative enquiry. I will now examine his claims because they are useful in positioning my own approach.

Evocative autoethnography is a way of exploring oneself either as a research subject or as an observant. For example, autoethnographers have studied their own experiences of illness, divorce or homelessness

to understand these topics. Equally, autoethnographers studied others while bringing their own feelings into the narrative and research. Evocative autoethnography is therefore about the value of emotions to bring readers closer to understanding a given problem. In other words, the goal here is to create an emotional resonance with the reader. This method requires creative writing skills and self-awareness. When executed well, evocative writing blurs the boundaries between fiction and non-fiction. It can be critiqued as too subjective as a research output.

Analytical autoethnography, on the other hand, emphasises a researcher's reflexivity about the data and the process of doing research, as well as about themselves. As Atkinson, Coffey, and Delamont (2003, 62) observe,

> [Auto]ethnographers-as-authors frame their accounts with personal reflexive views of the self. Their ethnographic data are situated within their personal experience and sense making. They themselves form part of the representational processes in which they are engaging and are part of the story they are telling.

The point here is that analytical autoethnography requires a multi-level analysis, which is challenging. However, the impact is much greater as analytic autoethnography opens the doors to multiple worlds and offers wider and often new perspectives. The researcher needs to stay visible and present in the text, whether through notes, writing, observations and interviews. In other words, an autoethnographic researcher is

another actor in the study, shaping and performing the research. And so the defining characteristic of analytic autoethnography is to use empirical data to gain insight into some broader set of social phenomena and wider literature than those provided by the data themselves.

Given the affective dimension of the topic of this research, I chose to blend these two approaches. Building on animal laboratory research, I wanted to bring an element of emotional work (mine and others), but I also wanted to explore the tensions between a researcher and the topic. As I noted in Chapter 3, many scholars writing about farm animal biotechnologies have strong voices about those they study. But these scholars rarely reflect on their position, their role in the research and the moral worlds they themselves disclose and produce. And as Davies (2003), Mol (2002) and Law (2008) noted, we do need to be mindful about the ways we study complex topics such as care, animal research, biomedicine, and biotechnology to name but a few. But there is also a need to be mindful of the inner monster too (Richardson, 1996; Plows, 2018). As Law (2018) put it, we need to engage with the politics not only of who and what, but also the how of research. That is, how we engage with others and as well as others in the process. If done well, autoethnographic research transforms the researcher and the reader too.

This additional method brought a new perspective to this complex topic because it highlighted the presence of vulnerability, tensions, and personal sacrifices. My self-reflexivity brought me closer to understanding my own sacrifices and those in the Enviropig world. By highlighting my own insecurities, I was able to empathise with insecurities I witnessed which resulted in honest and engaging interviews about controversial innovations.

In the next section I focus on the analytical challenges associated with this and other methods I used in this study.

4.8 Analysing and writing

Once the data was collected, I set out to analyse it. The exploratory case study approach dictates that the analytic generalisation may be based on either a) corroborating, modifying, rejecting, or otherwise advancing theoretical concepts that a researcher referenced in designing the case study, or b) new concepts that arose upon completion of the case study (Yin, 2014).

As mentioned earlier, the case study and its accompanying data are not meant to be treated as a representative sample, but rather to shed light on existing theories. It was, therefore, important to keep the analytical part of the research open to new concepts and ideas even if I planned on contributing to specific areas of the literature.

Grounded theory is one of the analytical approaches that lets the researcher stay flexible and open to new insights. It is particularly useful for exploratory case study research. Grounded theory is the preferred choice when the intent is to "generate theory that explains a phenomenon of interest to the researcher" (Birks and Mills, 2015:18). Case study research allows exploration, and then grounded theory allows for explanation of what was explored. A key characteristic of traditional grounded theory research is that the researcher enters the field of study "without the narrow research questions or hypotheses" (Birks and Mills, 2015:21).

With this in mind, It was important to be aware of my assumptions when designing this research and then analysing it. This is why this chapter began by outlining my views. Furthermore, it was important that I was aware of my philosophical position and how it related to both the topic area of the study, and my application of grounded theory methods and principles; what I knew already about the topic of my research from both formal and personal/professional experience; what I expected I would find from my research; what my concerns and fears were in relation to my study; and how my strengths and limitations might have impacted on the process.

Thus, when I began analysing, I asked myself both theory and soul-searching questions which, to a large extent, resemble counselling methods. This, as I go on to show in Chapter 7, emerged to be an important concept and outcome of this research.

The inventory I took resulted in the production of the following Q&A with myself:

> How do we define ourselves?
>
> > By a relationship with others, by experiencing the world, by unfolding with things, people and place.
>
> What is the nature of reality?
>
> > It is in flux, changing, relative, uncertain, a mystery.
>
> What can the relationship be between researcher and participant?
>
> > It can be close, can change, can evolve although it shouldn't, but it can be close or shaped by the experience of being together, listening to each other.
>
> How do we know the world, or gain knowledge of it?
>
> > Through experience, through becoming with others. It is nice to read about the world, have the foundations, but ultimately that can and will change.
>
> Nov 2017

These answers suggest a leaning toward theories that accept the changing "nature" of the world, but also tension and even some discomfort which emerges over and over again through analysis of the data and confidence in the data. But, as Corbin and Strauss (2008) suggested, it is sometimes necessary to accept what is available in terms of data. Birks and Mills (2015) seconded them by saying:

> Acknowledge in your published work the limitation that you faced while undertaking your research and the impact this has on your final theory (p.70).

To make sure I had gathered enough data, I worked closely with

participants who were enrolled in not just by the case itself, but also through my orientation toward my research. Fieldnotes were important too, but I often censored myself and didn't write much. I was too moved to describe what happened. Through questioning myself and fully opening to the data and the process of analysing, I noted this was one of the effects emerging from this research with a potential to contribute to the literature (Atkinson-Graham, 2015).

This goes back to the ethics of research and the idea of a broken heart and fragile state of researcher. For example, after an interview with the scientists, I was so moved, almost shaking and in need of a break because the interview was intense with respect to their feelings, their memories and their hopes as well as failures. I remember that I asked my host, Professor Blay-Palmer, not to collect me after an interview because I needed time to be alone. This meant that I had to find my way to her home without her address and barely remembering where she lived. I remained withdrawn for the rest of the time there and really wanting to end this research. I blocked this feeling but it kept coming back and creating connections with Cecil, the lead scientist who described his similar experience of needing to walk away from his emotions after an encounter with the public (described in Chapter 7).

This effect of self-censorship translated into a lack of confidence in making sense of the data. One of the ways to tackle it was through coding (Yin, 2014; Glaser, 2005), conceptualising and categorising. In

this thesis, I refer to coding (initial and intermediate) as labelling the activities (initial coding) and feelings (intermediate) of participants.

Initial coding is synonymous with open coding, referred to by Glaser (1978, 2005) and Strauss and Corbin (1990) as descriptive, in other words, relating to the who, what, where and how of the story. The initial coding is not predetermined, hence open, because it evolves through reading of the transcripts, notes, pictures or any data that is used in research (Birks and Mills, 2015). The initial coding let me take note of the practices around the Enviropig and told a story of what happened. These codes were marked and labelled around explaining, comparing, showing and situating, and were based around practices. I also noted connections to issues such as farming, public understanding of science, regulations, food, and environment. The initial codes helped to explore the details of the Enviropig's enactments.

Intermediate coding is referred to by Charmaz (2014) as focused, and by Straus and Corbin (1990) as axial. In practice, it means going back to transcripts and asking further questions as to what is happening there, what feelings arise, and what is not being said. Intermediate coding can be influenced somewhat by theoretical insights, but rather it is used as a way of having a conversation between the data and the wider aims of the project or theories that became more relevant as the analysis progressed. Intermediate coding thus helped to highlight conflicts, connections, fear, joy and so forth.

But my theoretical sensitivity and reflexivity (as explained earlier) meant that I felt tension around the emerging concepts that were to do with emotions and so I kept going back to the data so as to make sure I was not missing out on anything.

With regards to media analysis, initially I engaged with the concepts of framing and anchoring to make sense of the data . Framing as well as anchoring, are both terms widely used in media literature on social representations (Moscovici, 2001). Framing refers to patterns of interpretations, and representations to organise a story (Einsiedel et al., 2000). Anchoring the frames refers to naming, making the subjects of the frames ordinary and classified, based on an existing order of concepts which are meaningful to the audience (Washer, 2006:463; Bauer and Gaskell, 1999). Research that deployed those analytical approaches noted that frames of doom and progress are most commonly used to talk about biotechnology in media.

However, framing strategies used in media analysis constrain the analysis. In other words, framing does not reflect the grounded theory approach. However, anchoring was a useful concept because it reflects the concept of enactment (Lien and Law, 2011). In particular, I was interested in how the unfamiliar Enviropig was made familiar; in other words, how was the animal anchored (Washer, 2006) in text i.e. what objects, ideas, and feelings were used to explain what the Enviropig is.

Feeling or reading affective enactment?

The challenge of analysing the data was on the one hand difficult, but on the other hand it was suggesting how to do it. In other words, affective enactment is both read and felt.

For example, when reading transcripts or documents, I was paying attention to what and who is being performed, and with what, while looking at the emotional aspects. Affective enactments meant that I am following the actors, looking at the connections and how things coalesce but also how they can be felt or what feelings these actions exude. This was particularly prominent in Chapters 5 and 6 where I paid attention to how both animals and biotechnology are being done and undone. I was following the footsteps of Kaarlenkaski's (2016), Teittinen' s (2016) and Huggan's (2016) affective reading which meant conducting content analysis while paying attention to emotional descriptions of animals.

Emotional descriptions do not necessarily mean positive feelings of happiness and joy. These can also mean feelings of fear, worry or discomfort which are perhaps a bit louder than others. For example, fear can be easily read in a description of the Enviropig as a Frankenstein, but the question is whether the fear is of the animal or something else?

Is the animal, as Ahmed (2004) noted, the one to be afraid of or is it the thing or person who made it so? Thus, the reading of affective enactment means looking at the relations, connections and disconnections (Law, 2002; Lien and Law, 2011) that make something/someone fearful or frightening.

Reading affective enactment evokes feelings too. Reading feelings off the page is also accompanied with feelings arising. This is how media works (see section above) (Hipfl, 2018) as it produces and induces feelings at the same time. Therefore, feeling the affective enactment is quite necessary to pay attention to, or give account to, when conducting research.

The attention to affect as one of the non-representational theories thus gave rise to going beyond reflexivity of doing research by actively participating and giving accounts to feelings as they arise, as they break your heart (Rager, 2005a) when doing research.

The feelings thus needed to be noted, written somewhere down, felt and captured, as it is not just positionality that shapes research but also the associated feelings that come with it. In this research, I battled with it and I did not know what to do with the mood (Anderson, 2009) of biotechnology, but I knew I had to follow it. Thus, in Chapter 7, I specifically give an account of my own feelings and the feelings of others, while trying to capture the feelings that animals feel. I will return to this contentious issue in the next section.

As mentioned earlier, fieldnotes did not always include my personal struggles. The dilemma as to what counts as valid was present throughout my writing. I kept erasing any form of personal style, any form of feeling, and any form of personality showing through this thesis.

Where is the feeling animal?

In this thesis I foregrounded the animal as sentient and affective being and so I aimed to bring the animal into the discussion about biotechnology. In other words, I wanted to demystify but not normalise the animal that was truly multispecies. I also wanted to address the call in the affect literature that asks to shift attention from how humans think to how animals feel: the feelings they evoke in humans and the feelings they feel themselves (Rutherford, 2016:293).

Bringing the animal in meant that I paid attention to how the media and interview material portrayed the animal, and lastly the observations were meant to show how animals were treated, used and tended to. But the story was always too human. The voices were too human. The feelings evoked were also too human. The agency of the Enviropig was not easily captured because, as noted earlier, I was dealing with an animal that was gone. Unlike Miele (2017), Davies (2010), Bear (2011), I could not touch or observe the Enviropigs in the flesh.

Following the footsteps of Lawrence (2015) writing on the extinct Dodo; White (2011) writing on the history of pigs; Fudge (2017) on 15th-century

cows, and Karlenkaaski (2016) on cows in 19th century, Huggan (2016) on polar bears in the media, I looked for affective connections between humans and animals, as well as feelings and/or actions that animals give rise to in others. I also paid attention to the emotional registers used to describe the Enviropig in the context of media representations of GM. I also paid attention to mundane practices surrounding maintenance of the Enviropig. I hoped that by incorporating the affect into exploration of the Enviropig I will also be in a position to show what it means to be an Enviropig and how did the Enviropig feel. But like many scholars working with affect in the context of animals, I soon discovered it is a difficult task.

But, in not being able to give account of the Enviropig's feelings, I showed that the animal was, in fact, affective even if gone. The agency of the Enviropig, as I show in the next chapters, is attributed and evidenced in the controversy, in the number of documents written about it, in asking questions what is, in evoking feelings of familiarity or fear, in questioning and being questioned. So, the animal stayed silent and noisy at the same time, which led to the challenge of how to write about the animal. What should be included and how to give account for the second part of the call, which is what are the feelings the animal feels? How to do that, and using what?

So far, scholars (e.g. Miele, 2010, 2017) reported on the use of technology (cameras), and or/ biomarkers (cortisol in the blood) and movements to check what animals feel in their bodies and through

behaviour. Others, like Parrenas (2012) looked at the interaction between animals and different people (visitors and staff) and again paid attention to performativity to attempt to show animal feelings. How to do it without anthropomorphising and side-lining the animal? How to do it while giving a non-fiction account?

Although there are many ways to address this question, here I am more concerned with ways of writing about the feelings. The inspiration came from scholars in creative writing such as Kathleen Jamie, who in Findings (2005), reports on her travels around Scotland by paying attention to nature, landscapes, animals, and non-living matter like rocks, earth, soil, technology, buildings etc. Her aim was to enrol the reader into nature, technology, science, animals, and her own feelings of being with them, that exude affect of objects and animals. For example, when describing the walls of Maeshowe (a Neolithic chambered cairn) she wrote:

> …the stone bears down on your spine (….) when you are admitted to the cairn two sensations come at once: you are glad to stand, and the other is a sudden appreciation of stone. You are admitted into a solemn place which not a heart at all, or even a womb but a cranium. (…) There is a thick soundlessness, like a recording studio, or a strongroom. A moment ago, you were in the middle of a field with the wind and curlews calling. That world has been taken away, and the world you have entered into is not like a case, but a place of artifice, of skill (p.12-13).

The writing transports the reader into the spaces Jamie (2005)

describes, while letting the reader feel with all senses the other; here the cairn a very inanimate object. I tried to follow this line of writing especially when describing my visit to the swine research facility to let the reader feel the spaces of research, being with animals, and the feelings they felt and provoked in me.

When writing about the animal, I relied on written evidence but also memories of those who knew the Enviropigs. I have tried to capture the multiplicity and multispecies as well as the affect of the animal in its many forms. But there were serious shortcomings in writing about the animal. Without the lyrical language throughout, without knowing how to account for the animals' feelings, I was left with a dry, scattered account in which the animal ended up being talked about by humans, an animal that carried on giving without being asked for data, information, motivation and insights for all involved, during and after pigs' death. But as Garcés put it: "solving difficult problems is always about connecting with people" (2019:14), just like affect is about movements, relations and flows. Thus, if we cannot empathise with GM animals directly, perhaps one way we can do it is by working with feelings of other humans which we, the human-animal species who read stories about GM animals, can understand and relate to.

4.9 Chapter summary

The purpose of this chapter was to explain how I incorporated theoretical insights into the design of the research. To do so, I outlined

the building blocks which are design, participants, and methods as well as positionality. I stressed that being open about research processes and feelings that accompany them, and exploration of radical controversies, is deeper but also difficult. I pointed out that working with affect presents a challenge beyond the process of gathering data, but also evidencing it and making sense of it. Toward the end of this chapter I noted that without the animal in flesh, the affectivity of the Enviropig was not easily captured, or at least not in the ways affect theory has been applied in relation to animals. But in my failure to explore the feelings felt by the Enviropig, I had to remind myself that affect is not just about evidencing the feelings of animals. Affect is also about the movements, relations and flows and seen as such, it is about creating connections and thus form new attitudes toward animals (Teittinen, 2016), humans and technology.

Chapter 5. The Enviropig: an animal story

5.1 Introduction

This chapter addresses the first research question, which asked, 'how was the Enviropig enacted in around the contested notion of porcinity?' In doing so, this chapter tells the animal story of the Enviropig which is centred around the three affective enactments which emerged out of the analysis. These enactments are friendly, ordinary, and monstrous and are affective in two ways. Firstly, they exude ideas and feelings of familiarity, normativity and risk. Secondly, they seem to be calling to actions - to accept and to reject - with material consequences for the animals.

Starting with the environmentally friendly version of the Enviropig in Section 5.2, I show a busy, more-than-pig world coordinated in spaces and places. Such a vibrant world serves to discuss heterogeneity (Mol, 2002) of animal biotechnology as a springboard into a critical attitude to know more, not less, about controversies (Sanderson, 2015 after Latour, 2004).

Moving on to the ordinary version of the Enviropig in Section 5.3, I show that ordinary was made in relation to the practise of eating food, and an understanding of pigs based on their bodies and behaviours but within specific places and times. I also show that an ordinary version of the Enviropig revealed the absent pig history. These themes serve to discuss embodied understanding of animals and its potential role in making sense of biotechnological animals as well as pigs themselves.

Finishing on the monstrous version of the Enviropig in Section 5.4, I concentrate on the efforts taken to create a sense of a not-needed animal. In making the Enviropig monstrous, these practices and discourses, I argue, revealed attempts at drawing boundaries around what should be understood as a pig. This serves to discuss the affectivity of GM animals as ways into contestations of farm animals and science. I use this research as an opportunity to deal with the question 'what does it mean to be a pig in the age of the genome?' I address this question in the conclusion to this chapter.

5.2 Performing environmentally friendly

Studies of public perception of genetically modified food and animals (Bauer et al., 2002; Macnaghten, 2004; Frewer et al., 2014) suggested that the public feels uneasy due to affinity with animals and fear of the unnatural. However, some suggested (e.g. Bauer et al., 2002; Castle, 2005) that if the risks and fears were outweighed with tangible benefits,

maybe then the public would accept genetic modification of animals destined for food.

As explained in Chapter 3, the Enviropig was genetically modified to produce an enzyme (phytase) to aid digestion of phytate, and in doing so reduce the amount of phosphorus going into lagoons and groundwaters. In turn, algae growth in lakes, rivers and seas could be reduced. The costs of adding an enzyme would be reduced for farmers, and the health of the animal would not be compromised.

This new species, therefore, was in a sense a testbed for portraying the new as beneficial and of value. The environmental aspect, as the name of this new species, indicates - The Enviro-pig - was envisaged to be the most effective and affective. It was aimed at increasing acceptance by playing on notions of sustainability, goodness, familiarity, and protecting aquatic life.

For example, in 1999, *the Sunday Times* (Sunday edition of the Times, aimed at the “centre-right” British audience) presented these animals as “environmentally friendly” and “being watched with interest” by British hog producers. Quoting Cecil Forsberg, the lead scientist behind the Enviropig, the author in the *Sunday Times* wrote:

> It's been described as the biggest breakthrough in pig farming since the invention of the trough. This will be of great value to the environment - phosphorus pollution is a serious problem. (Sunday Times, 27 June 1999)

The Guardian (the British daily newspaper aimed at the “leaning to the

left" audience), in an article titled Science's Brave New Worlds, simply described the Enviropig as:

> …genetically engineered by researchers at Canada's University of Guelph, was bred to produce manure far less harmful to the environment than normal manure, making farm operations cleaner and more cost-efficient. (20 May 2000).

Nature Biotechnology (a biotech division of the Nature journal, which is the most recognised scientific publication in the world) in 2002 thought that the Enviropig would be an "easier sell than other GM animals". Even in 2010, just around the approval from Environment Canada, the Enviropigs were still part of the green narrative. *National Geographic* (an American monthly magazine and TV network) in the article titled Gene-Altered "Enviropig" to Reduce Dead Zones? wrote:

> MOVE OVER, BACON. Here comes something greener.
>
> A genetically engineered pig recently approved for limited production in Canada makes urine and faeces that contain up to 65 per cent less phosphorous, officials have announced.
>
> That could be good news for lakes, rivers, and ocean deltas, where phosphorous from animal waste can play a role in causing algal blooms. These outbursts of algae rapidly deplete the water's oxygen, creating vast dead zones for fish and other aquatic life. (30 March 2010).

Over time, the Enviropigs were only mentioned as one of the phosphorus management tools, without the promise to revolutionise pig

farming. For example, the United Nations report Phosphorus and Food Production (2011) argued that the Enviropig is “a significant step towards enabling its [phosphorus] processing” (p.43).

The Enviropig appeared to be rather unique in a sense that it was not a contributor to the demise of aquatic life, but a step in the direction of letting other non-humans live and continue providing meat. The relation to environment was important to maintain as it made the animal more attuned with environmentally conscious customers – the meat-eaters, but also commercial consumers – the pork producers.

But what I am interested in here is how the affect of environmental friendliness was performed – who was part of this, where and what acts needed to take place to make sure the Enviropig is friendly to the environment.

Performing environmentally friendly with polluting pig

Although pigs have been equated throughout history as dirty, impure, and transgressive (Harris, 1989; Malcomson and Mastoris, 1998; White, 2011) the 21st notion of polluting pig that needs greening is a different tale. It shows that unlike in Judaism and Islamic religions, polluting pigs are not to be avoided, but rather encouraged to be eaten in millions but requiring state-of-the-art facilities to keep them disease-free, as well as intervention in genetics to keep their bodies and manure pure.

One of the ways to perform the affect of friendliness was to compare it with something quite the opposite. The Enviropig was a trademarked animal, meaning its name was distinguished from other pigs as something else, a different kind. It emerged in relation to other pigs, pigs that are conventional and unable to digest the feed. Here is the lead scientist, Cecil Forsberg, explaining the Enviropig early in 1999 to a reporter for a US-based independent environmental news and information programme *Living on Earth*[21].

> The cereal grains, for example, the barley, the oats, the corn that the pig eats, contains this indigestible material called phytate. And the pig is unable to digest it normally, so that they, the farmer, will add in a mineral phosphorus material to get the right proportions of nutrients in the ration (Living on Earth, 02 July 1999).

In the Sunday Times, the Enviropig is called a "sweeter smelling hog that's less polluting than its conventional cousins" (27 June 1999). Whereas the longest running sustainable lifestyle magazine *Mother Earth News* said that "an Enviropig can digest the phosphorus in cereal feed with greater efficiency than run-of-the-mill swine" (March 2000). In 2002*, Environmental Science and Technology*, a journal of the American Chemical Society wrote:

> Because swine cannot digest phytate, the most common form of phosphorus in their feed, giant pig farms that house thousands of pigs produce

[21] Living on Earth is located at the School for the Environment at the University of Massachusetts. https://web.archive.org/web/20200525074905/https://www.loe.org/about/about.html

> tons of phosphorus-rich waste. Of the 100 million pigs slaughtered annually in the United States, each produces ~17.5 pounds of waste per day, according to U.S. EPA reports. (01 Jan 2002).

I chose those examples because to perform the friendly pig it needed another pig that is unable, inefficient and polluting and emplaced on large farms.

But this also suggests as if pigs are not part of nature, that they are part of something else, namely industrial farming. In doing so, the transgenic pig becomes better and efforts to modify animals, as Holmberg and Ideland (2009) suggested in their study about transgenic mice, are legitimised. Transgenic then becomes special and a valuable treasure with hopes and expectations of improving unsustainable farming practices (Holmberg and Ideland, 2008; Twine, 2010). So the enactment of the Enviropig as green, speaks to the concerns raised in Chapters 2 and 3 about biotechnology raising expectations while abstracting animals.

But the environmentally friendly pig found in text was performing not just the affect of those animals as either polluting or green, but also a particular history of their domestication. The making of the environmentally friendly pig with polluting pig, as I am about to illustrate, also shines a light on legitimising processes of domestication of animals and humans: from a feral, humble pig and hunters and small farmers, to concentrated spaces of human and animal specialised labour

(Novek, 2005).

During the interview at Environment Canada, I was referred to the Risk Assessment of the Enviropig. At its very core, the risk assessment aimed to de-risk the Enviropig and make the animal acceptable. To do so, it performed the making of the Enviropig not just as a scientific animal, but as cultural and historical. I am mentioning it here because the assessment performed a lineage of these transgenic animals and history of domestication illustrating how pigs found their way out of nature to large industrial farms. The risk assessment next describing the creatures reads:

> They are found throughout Europe and continental Asia as far south and east as Peninsular Malaysia, as well as to the islands of Sumatra and Java. Members of the species include all domesticated *S. scrofa* breeds as well as the ancestral Eurasian Wild Boar from which all domesticated breeds descend.
>
> Feral populations of the Eurasian Wild Boar have been established in many parts of the world such as Australia, Brazil, Argentina, the United States and Canada as a result of intentional release for hunting purposes or escape from game farms. (Risk assessment summary No. 15676, Environment Canada, 2010[22]).

It is hard to believe how a wild boar became Eurasian, or why one would bother releasing these animals that first had to be caught and shipped

[22] https://web.archive.org/web/20200516140514/https://www.canada.ca/en/environment-climate- change/services/managing-pollution/evaluating-new-substances/biotechnology-living-organisms/risk- assessment-decisions/summary-15676.html

across to other continents. Why those countries in particular? Weren't there enough other animals to hunt? While the answers to these questions are not answered in the risk assessment, it shows that scientific language actually contains a somewhat selective, human-centred history of pigs, their location, and history of humans who intentionally released them to the far corners of the planet Earth. It is packed with nature, by giving classification of pigs, and culture, by telling (although somewhat unwittingly?) how pigs found their way to North America.

The next sentence in the same assessment reads:

> Major centres of domesticated pig production are mainly found in temperate climates with approximately 61.8% of production taking place in Asia, 20.0% in Europe, 9.2% in North America, 5.4% in South America, 2.4% in Africa and 0.5% in Oceania. In Canada, *S. scrofa* is an introduced species and does not have a natural, broad geographic distribution outside of production facilities. Most pigs are produced in Manitoba, Ontario, and Quebec although there is a trend to increased production in the Western provinces. (Risk assessment summary No. 15676, Environment Canada, 2010).

The paragraph above also tells a lot about a pig which is no longer free roaming but housed only in production facilities. A pig that does not have a natural, broad geographic distribution. A pig that is not feral and Eurasian and living in Malaysia or Sumatra. Instead, the main centres of production are in the USA, Canada, China, and Europe where the polluting pigs are now housed. According to Canadian Pork

International in 2010, there were around 20 million pigs slaughtered for domestic consumption, around five million live exports to other countries, and over a tonne of offal, frozen [meat] and fat (data from 2014).

The movement of a pig from the wild into the production centres was also captured in the interview with Carol, the spokesperson for the main funder of the Enviropig, Ontario Pork, who said:

> **Carol:** [...] Generally we have lots of pigs here.
>
> **KR**: What is lots of pigs?
>
> **Carol:** It is a lot of pigs in the fact that we have more pigs produced here than we have shackle space and slaughter planned for them.
>
> **KR**: So how big is the production in Ontario on its own?
>
> **Carol:** About four million to four-and-a-half million hogs a year. (06 Nov 2014).

Indeed, many pigs (or hogs) are being produced. According to Success Story (n.d.) by Ontario Pork, Canada is ideal for pig production. In the publication, it reads what a phenomenal change it was:

> Three decades ago, many of the country's hogs were raised on mixed farms (mostly farrow-to-finish operations) with annual sales of about 50 head. As the industry evolved, small farms were replaced by larger, more specialized operations (500-sow barns) that produced upwards of 10,000 pigs per year. Many of the newer systems (1,200-sow operations) produce more than 28,000 pigs annually, with some 6000-sow operations producing in the range of 140,000 pigs per year. The industry is moving toward a production trend in which fewer barns produce greater numbers of pigs. (Ontario Pork, No year,

p.10).

The trend of higher concentration is a legacy of Chicago stock markets (Cronon, 2009), but it is a trend that has given a way not only to a loss of jobs (fewer farmers) but an increase in number of pigs, thus higher concentration of manure and consequently higher complaints from the living communities nearby. It is a trend that gave birth to the Enviropig, as at that time there was no other alternative to manure management - other than a change in modes of farming and de-concentration of production. But that didn't happen, after all, Canada was based on agriculture and its success still depends on it. Instead, as the publication reads:

> Many new operations today are state-of-the-art, scale-efficient facilities that specialize in either farrowing or finishing. These facilities embrace the latest in technological development and science-based information in all facets of production. Farms that raise pigs to market size will often move all the growing animals through different sites (a technique called all-in, all-out operations) to control disease. (Ontario Pork, No year, p.12).

The success of the pig industry meant that technology and science began to play an important role. The workforce required training; pigs required improved genetics, testing, management and further research into feed and genetics to ensure management of pigs.

What emerges here is a specific kind of domestication – one that is continuing but also needs buildings, skills, people and specialised

production sites. It is a human activity that silences other forms of domestication (Lien and Law, 2011) but also other ways of being a pig.

The pig that is enacted in this account, is a pig that is removed from a pig history where the animals co-existed with humans and were ferocious, magical creatures (White, 2010). The environmentally friendly pig mobilises not only a polluting pig, but also one type of domestication that silences other ways of being a pig and living with them. To use Lien and Law's (2011) words, what is being done here is distinction between culture and nature.

Although it may seem that these enactments are of concern to academics interested in the representations of animals in text, the findings above should in fact concern anyone interested in animals. Although these texts may seem distant and irrelevant, after all the Enviropigs are euthanised, the enactment of a pig is close and relevant. These official documents, the most read journals and newspapers found on the web, enact the meaning of "pigginess" and domestication even if they seem to be talking about a transgenic pig. These texts are universalising acts and views as to what a pig is

i.e. housed on large farms, and polluting. These enactments that proliferate in the media, rather than the technology itself, reinforce an image of a pig housed on large scale farms as much as an image of GM animals as, so far, friendly.

With enzyme, bacteria and mice

The second way in which the affect of environmental friendliness was performed is linked to genetics and the non-human actors that helped to achieve it. The Enviropig was a transgenic animal, meaning that her new body was made of more than one species, namely bacteria and mice, but it was not just these species forming the genetic make-up of the Enviropig.

When analysing text and interviews with affective enactment in mind, it emerged that phytase (an enzyme), phosphorus (a chemical element), *E. coli* (bacterium) and mouse promoter, were equally crucial in actively performing the affect of a friendly-to-environment pig. However, it needs to be stressed that these actors were also used as a reason to reject the Enviropig. I return to this in Section 5.4. but in this section, I want to illustrate their importance as lively, although behind-the-scenes, contributors to the environmentally friendly pig.

The references to enzyme, bacteria and mice as important actors in the Enviropig story can be found on the official site (now archived) about the Enviropig. Here, the *E. coli* is portrayed as a good candidate to produce a phytase.

> A gene from *Escherichia coli* coding for acid phosphatase, also called phytase, was identified as a good candidate to produce phytase endogenously.[23]

[23] https://web.archive.org/web/20160129044142/http://www.uoguelph.ca/enviropig/technology.

In the *Boston Globe* (a daily newspaper located in Massachusetts) in 1999, the *E. coli* was called a common bacterium, whereas mice and enzymes featured somewhat neutrally.

> In a surreal bit of genetic engineering, the University of Guelph scientists took a portion of gene from a common intestinal bacterium, *E. coli*, and fused it to a fragment of mouse gene, creating a so-called transgene.
>
> The mouse gene contained material controlling production of a protein secreted by salivary glands. The bacteria gene manufactures a fungal enzyme called phytase, which aids in the digestion of phosphorus found in ordinary plant foods. Together, they should allow the new breed of pigs to absorb the phosphorus contained in natural food. (24 June 1999).

The Digital Voice (an independent student publication at Thomas Jefferson University) similarly, described these actors somewhat biologically.

> The way Enviropig works involves a transgene construct containing two vital elements: murine parotid secretory protein promoter gene sequence (mouse) and the *Escherichia coli* phytase gene, which is injected into the pig chromosome. The injection acts as a promoter that directs the continuous production of the active phytase enzyme in the salivary glands. The phytase is secreted in the saliva which then is mixed with the feed being consumed. The phytase begins to really work in the stomach where it is supported through the acidic environment of the stomach. There the enzyme digests the phosphorus-rich phytate molecules.

shtml

(11 April 2016).

However, what is quite telling here are the actions taken by these actors in the creation of the Enviropig. The examples above show the actions of the small enzyme, bacteria and mice such as coding, breaking down, digesting, promotion of DNA, and so forth. The Enviropig, it suggests, is not just a green pig, but a multispecies pig made of co-existing, little but mighty elements and species that are doing things behind the scenes.

The mouse model, for example, was the one that cemented the future of the Enviropig. As Carol, the Ontario Pork spokesperson said:

> Their first try [with mouse model] was successful, and I think it amazed everyone. (06 Nov 2014, Guelph).

What we also see in the case of the Enviropig is that the bacteria and mice models speak for a pig. So these animals do not only stand for human models, but also for other species. This prompts questions about relations between transgenic and non-transgenic pigs but also relations between pigs and mice as well as bacteria.

These actors are lively in a sense that they actively assemble networks and contribute to the making of new species, even if they remain invisible to the naked eye or anyone who benefits from medical research and safe food. However, in the case of the Enviropig, their abilities came to the fore. The genetic make-up of the Enviropig was

made transparent by explaining how it was achieved on the main page of the research, publications and the media.

The reason I am mentioning those here is that these actors have been playing an important role, not just for the greening of the Enviropig, but also in the creation of food sciences, biotechnology and modern medicine. These actors have undergone incredible transformations throughout history (see for example Birke, 2003 on rats; Latour, 1993 on pasteurisation; Quammen 2018, new history of genetics), often behind the scenes yet supported by vast international networks of research labs, regulations, production centres, people, artefact, other animals and plants (Davies, 2010).

For instance, bacteria, as von Hemboltz (2007 quoted in Hird, 2010:37) said, are the less glamorous backstage machinery that produce the show. However, upon hearing the name *E. coli,* there is a sense of a mutual anxiousness based on stories of food-related outbreaks. But what is it and what does it do? Interestingly, there are many ways of being *E. coli:* from infectious bacterium to a laboratory helper (echoing mice helpers).

E. coli - also known as *Escherichia Coli* - was discovered in the human colon in 1885 by Theodor Escherich, who observed that certain strains of bacteria were responsible for infant diarrhoea and gastroenteritis, an important public health discovery (http://www.about-ecoli.com/, 2014). Named in his honour, this bacterium is currently the most studied living

organism to date due to its potentials toward both ill and good health. E. coli is also becoming with others and within particular places. E. coli and its numerous strands can exist in rumen causing havoc, as it can exist in the laboratory aiding researchers to make scientific breakthroughs. The multipresence and multibody of this and other bacteria renders them - as mice and animals - perfect models for scientists, as Paxson and Helmreich (2013) observed:

> Microbes embody potential not because of their brute materiality, but because they can be enrolled in modelling and thereby shaping new food science and politics (p.9).

In other words, elusiveness matters, but it is also used according to preconceptions or expected outcomes. For this reason, *E. coli*, and specifically the K-12 strand, is used in biotechnology and in medicine (EPA, 2014). This bacterium, due to its long history within the laboratory setting, has been selected as the best candidate for experimentation within molecular science (Russo, 2003). In 1972, professor Robert Cohen reported an ability to introduce plasmid DNA (a small DNA molecule that is physically separate from, and can replicate independently of chromosomal DNA within a cell) into E. coli, which allowed researchers to propagate and clone the plasmids in the bacteria (Russo, 2003:456). At the same time, Herbert Bayer - who worked with an enzyme that could cleave the double-stranded DNA - produced single-stranded ends with identical termini, and that’s how the two propagated the idea of genetic engineering (Russo, 2003:456).

What is interesting in this story of biotechnology is the very role of a non-human entity that played a crucial part. Currently, the K-12 strand of *E. coli* used within science, as in the case of mice and rats, is sterilised and removed from its environment. Its newly made "goodness" has its very own risk assessment (EPA, 2014) to prove it. As such, it is therefore not surprising that *E. coli* and muriatic genomes have found their way into pigs, but this time not into rumen, but into an embryo.

With regards to rodents (mice and rats), since the 1920s, Gail Davies (2010) writes, they have played a "critical role in understanding human and animal genetics" (p.33), and in the 1930s, nude, immunodeficient mice were bred for use in transplantation studies (Davies, 2012). Isn't it ironic that rats and mice, or - collectively speaking - laboratory rodents, have become integral to research for the benefit of public health, when they were once the very source of millions of human deaths? Today, mice are bred in their millions and mutated for research purposes in centres such as the Mutant Mouse Regional Resource Centres across North America, and the Knockout Mouse Project which spans many continents (Davies, 2013). These facilities use different methods to produce genetically altered animals, mutating genes using chemical mutagens, and developing new genetic forms through a collaborative cross of older, inbred strains (Davies, 2013, p.278). By doing so, such animals can be used as a model for any human diseases. The number of animals used in laboratories is in the millions, yet the masses

don't speak for themselves. Similarly to livestock animals, they are out of sight and thus out of mind. Their stories, Davies argues, are not told in the social story of scientific progress (2013: 269) despite their crucial role, their numbers and their "double otherness" (Birke, 2003) as tools and as non-humans.

So by looking at the ways in which environmental friendliness is performed, we are being introduced to other beings. These actors were accounted for and brought into the parliament of things (Latour, 2003), which would suggest a move into a multispecies, hybrid world that in turn would require novel deliberation and engagement with the public. So, what emerges from this, which has not been picked up in the literature on farm animal biotechnologies, is that all species that are part of a GM pig or a GM cow (as illustrated in Table 1, Chapter 1) need to be mobilised in discussions about living with the new.

With distinguishing practices

Transgenic pig, the green pig, had to be made unique not just as a mouse model with an enzyme that does all of the digestion action, but as pigs in flesh.

As mentioned in Chapter 3, in 1999 Cecil and John created the first phytase pig called Wayne, which was soon followed by Jacques and Gordy and Cassie and later 30 other transgenic pigs with the same construct. *The Boston Globe*, in the same year, wrote the "three little Enviropigs, were named in best Canadian tradition after hockey stars"

(1999). Acts of naming or not naming of animals in experimental settings, literature suggests (see Pihl, 2017, but also Birke et al., 2007; Phillips, 1994; Shapiro, 2002) are acts of attachment and detachment. Names can foster emotional attachment and care, point to relations in a given place between animals and humans, or signal importance of a given animal as environmentally friendly and special. Not naming animals and instead referring them as numbers, is said to detach humans from animals, foster greater objectivity toward experiments and repeatability, as well as transparency of research. Naming the first Enviropigs, I argue, illustrates a significance that is recognisable by Canadians, but also as first and special animals. However, naming animals is also pointing to practices of attending to, being with, and arguably in, places: somewhere, not just in Canada (as *The Boston Globe* suggested), but on a farm or a specific lab in Canada.

In this section, I therefore concentrate on the third way in which the green pigs were enacted. I want to show here how green animals were maintained, where, and by whom.

The Enviropigs as an idea that is now in the flesh attracted media attention, but only a few journalists were able to visit. Reporters from the UK (*BBC News*) and the *CCN* presented the viewers with images of clean, pink pigs, and scientists in white lab coats. The video that

captured my interest in the Enviropig was made by BBC America[24] and showed an encounter between the reporter Jeremy Cooke and the facility in which the animals were kept, and with the scientists and the animals themselves.

The clip aimed to give a rounded and balanced picture of what the Enviropigs are. Thus, views were given by opponents and proponents of the animals, as well as the technology that made them. However, I was captivated by an encounter with the Enviropigs and the facility in which they lived. Firstly, the journalist had to shower and change clothes which was shown with a twist of entertainment and even a musical background with a reference to a British classic, The Full Monty. But the reporter changed the mood of the video by saying “But these are not laughing matters, these are biosecurity measures”. Then, an encounter with the scientists wearing white lab coats, and finally, the animals - large, clean pigs living in a straw-filled pen.

Animals attract and move human beings on screen, in real life, in literature and in the media (Nyman and Schuurman, 2016). What is conspicuous is the use of affective language and images that appeal to the emotions of humans. The pigs, as the video captured, were inquisitive about the visitor. They nibbled on his Wellington boots and headbutted him playfully.

[24] www.bbc.co.uk/news/world-us-canada-12113859

Their friendliness was not just environmental, and it was performed here as a way to get acquainted and familiar with the Enviropigs. The clip was affective in a sense that it created a tactile feeling that pigs are fun and friendly. The encounter was done in a way that can be relatable and therefore connecting with those watching. So, here we see that the friendliness is achieved in relation to the reporter, boots and camera without a need to devise experiments. The depiction of pigs as curious and playful reflects "interspecies play" (Driessen et al., 2014) prompting questions (reflected in the literature about lab animals) about whether lab animals, such as the Enviropig, can also be pet-like.

Years later, I arrived at the same Swine Research Facility to find out what it meant to create the Enviropig on a day-to-day basis i.e. what was done to ensure the animals remain environmentally friendly. I wanted to talk to those who took care of those animals on a daily basis, because contrary to what the video showed, the chief scientists were not there at all times and I did not want to have this narrated only through scientific practice (Miele, 2017). There was a wide range of other forms of expertise, artefacts and practices that contributed to the making of the Enviropig.

I had arranged the interview months before my arrival to Canada. I had no idea how many people would talk to me and what I would be able to do. I arrived at 7am, on November the 5th, 2014, and had to do exactly what was shown in the video by the *BBC* reporter. After taking a shower and changing into fresh but old clothes, I went to the common room

where five men, one woman and a few children were sitting.

It was “bring-a-child-to-work day”[25]. I thought it was an unusual place to bring a child to, but at the same time, rather forward-thinking considering how children and in general city dwellers know relatively little about animal farming, let alone pig research facilities. From the perspective of the literature about care in unlikely spaces (see Chapter 2), the presence of children then puts into the question what kind of enclosure these spaces enact, and for whom? Does the presence of children make a space more caring and safe? Does it make it more friendly?

In the staff room, we started with a relaxed conversation about their role in the research facility and day-to-day duties. While they were eating bacon sandwiches and drinking tea and coffee, I started off with the introductions. I wanted to know what day-to-day looks like. Keith, who was the team leader, started off.

> Everybody here is called agricultural assistants, so we run the maintenance of the general herd here, so we produce animals for research projects. We do not run research projects; we just maintain the herd and supply the pigs and support those researchers. (05 Nov2014, Guelph).

Agricultural assistants and pigs are at the centre of the research facility

[25] As I mentioned in Chapter 4, due to ethics, I did not include children in the interview and so I was not able to explore their views about their understanding of pigs and work done in this facility.

and do what is required of them when it comes to specific projects. But as the research facility raises pigs to reach a certain age, they then follow the same procedures as on industrial farms such as farrowing and castration. Una, the only woman in the group, explained their duties in more detail:

> We come in, and we feed all the animals, and we do a health check, and then once that is done, we clean the pens, and then we treat anyone that needs to be treated. We do batch farrowing, and we farrow every four weeks. So, one week we are busy farrowing, and we farrow every breed, and then the next week we castrate and then the next weeks we are catching up on maintenance cleaning, that kind of stuff. (05 Nov 2014, Guelph).

What these words illuminate is not just the day-to-day practice but also an enrolment (Novek, 2005) in the lives of animals and dictated by what animals do, or a supplier might want, as well as what the research project requires. Here is Matt, one of the assistants, explaining this further:

> We don't work on any projects generally. We do have welfare standards set that we generally keep, sometimes environmental enrichment and things like that. We try to be ahead of the industry with certain things, and if the funding is not there to update our equipment, we just have to make do with what we have. (05 Nov 2014, Guelph).

The research facility, therefore, acted as a place where different types of pigs are performed, from those that feed better, digest better or farrow better. The research facility also performed the teaching pigs because

the facility was also used a classroom where university students would learn about being a pig.

One of the projects the research assistants were required to work on was, of course, the Enviropig. I wanted to know whether they were aware of the animals and how they learnt about them. Una, for example, learnt about the Enviropigs at the university. Other assistants joined the research facility when the Enviropigs were already present in flesh, as live animals. Matt, who has been working at the facility the longest (13 years), explains learning about the Enviropig:

> They didn't say anything, it was just a trial from a researcher, so our job was to maintain that pig as long as they say. If it was sick then we let them know, and we would treat it if they wanted to euthanise them, we euthanise. If they wanted them to be feed a certain amount of feed, that is what we do. (05 Nov 2014, Guelph).

Clive, who started toward the end of the project, explained how he learnt about the animals:

> The Enviropig was in a separate section of the barn; there were separate and new facilities and all that sort of stuff. We were informed that it was a different species, and we couldn't mix it with others. Any kind of euthanising it had to be segregated and composted. The pig looked the same as any other pig, so you could not tell the difference. If you were assigned to that pig, you could not tell the difference. (05 Nov 2014, Guelph).

The above excerpts illustrate that the Enviropig, although when using the sense of sight appeared to be as any other pig, demanded

separation even after euthanisation. The ability to produce phytase and thus allow the Enviropig to remain environmentally friendly required a specific set of practices that enacted them separate to other species. In doing so, they enacted purity not just of manure but also species. This, however, prompts a question as to how a difference as new species can be sustained (Morris and Holloway, 2009) when, by looking, animals appear as other pigs.

Clive answered it by saying:

> All the pigs had special forms, special tattoos and all the forms had to be sent to CFIA [Canada Food Inspection Authority]. We sent the paperwork to the researcher, and they had to be backed up there, and it was double backed up on the computer, and there were multiple copies. Every pig born, every pig that died – how, why, type thing – so every individual pig was accounted for. [...] There was a lot of actual work just to maintain the pig in our facility, living there, just sitting there enjoying life.

The above two excerpts give a snapshot of what it must have been like for the team when Enviropigs were alive: more work, more paperwork alongside the daily routines keeping animals healthy.

These accounts also give a snapshot of what it must have been like for the Enviropigs: attended to, recorded, separated, living in one place while the data they were producing was backed up on paper, a computer, and in publications.

The Enviropigs, in this case, were living until it was time to kill them, but they did not travel as far as the data they produced. As friendly to the

environment, these animals were unable to join other pigs that looked as them. Their role was to produce an enzyme as well as the data which enacted them as different species yet as models for other pigs.

This double act, as unique data and models for other pigs, reflects the findings in the literature about mice and rats being used as both, the tools and spokespersons for humans (see, for example, Davies, 2010; Birke 2003). However, the enactment of the environmentally friendly pig illustrates that animals – from mice to pigs – can model for non-human species too. Likewise, the separation needs to be maintained using people, buildings, and procedures to ensure uniqueness. However, the enactment of friendly pigs also needs to be dismantled beyond the facilities by comparing it to polluting pigs. But at the same time, the Enviropigs, when examining them by looking at the visible to the naked eye body, appeared to the agricultural assistants to be like other pigs. An interesting point here is that knowing animals by the naked eye and basing the knowledge on the exterior body of the Enviropigs had to be suspended in order to prove they are unique. And yet, when aiming to show the Enviropigs are like other pigs, knowing by eye was encouraged.

I would like to summarise Section 5.2. by highlighting the emerging multiplicity of the Enviropig – from special to polluting, to formed of other species and attended to. It suggests that by asking what is and how was it achieved, a multitude of stories, practices and affects come to light. Whereas some practices point to new actors, some silence them. For

example, on the one hand the environmentally friendly pig highlights other species, such as polluting pigs, mice and bacteria; on the other it hand silences the non-domesticated pigs. Other practices illustrate relations with pigs that are lab-like and pet-like animals, in need of attention, care and looking after. By exploring the affective enactment, a lively, albeit contested, picture of pigs and humans emerges at least in the research facility.

5.3 Performing ordinary pig

The Enviropig, although genetically modified and friendly to the environment, it also appeared in the media (as well as in the interviews) as other pigs, but even more specifically the ordinary pig. Both enactments, although seemingly contradictory, aimed to encourage acceptance of the new species. They aimed to normalise the transgenic (Holberg and Ideland, 2009).

In this section, I am interested in ordinary and how it can be achieved and performed. As in the previous section, I am engaging here with the concept of affective enactment. Affect is quite intriguing with regards to being ordinary as it does not rely on explicit and loud acts, images and narratives. Rather, ordinary relies on implicit, familiar, intangible, quiet yet steeped in mundane practices which makes it “sticky” and taken for granted. Ahmed (2004) illustrated this by saying that, for example, heteronormativity is an affect of feeling familiar achieved through seeing inconspicuous images of couples and acts of holding hands in public, all of which are permitted. The ordinariness of animals as for example, meat, game or an object can be also understood as sticky when considering the bundles of text, contexts, mundane acts and images circulating in the media, shops and films (Fudge, 2004).

Based on the analysis of the text, oral accounts and observations, I posit

that by alluding to practices such as eating, cooking and farming, an image of an ordinary pig emerges - a Yorker - farm-based, destined for food, happy, little. Arguably, from the normalising practices, one can learn something about being an Enviropig, but perhaps only in relation it its destination - slaughterhouse and dinner tables. However, as Holmberg and Idelman (2009) rightly observed, by doing so, the normalising, sticky practices and words, silence the transgene making it part of taken for granted practices.

In the summary to this section, I posit that asking, “what is ordinary and how is it achieved”, is relevant beyond the field of transgenic animals.

With food

In this section, I want to talk about an act of normalising the Enviropig through references to food, meat and eating. Although an appeal, especially in the media, to food and meat created a shock value (Hipfl, 2018; Lee et al., 2017) to draw readers in, the references to meat, food and eating practices normalised or at least aimed at normalising Enviropigs as pigs and pigs as pork.

Eating, cooking and preparing food is deeply material and visceral practice (Evans and Miele, 2010) mixing bodies, natures and cultures all at once. In so doing, food orientates humans in the social world, thus it can be a highly religious (Harris, 1989; Miele and Rucinska, 2017), political (Lien and Neirlich, 2004) and personal and gendered affair

(Probyn, 2003). Food, by which I here refer to as meat, is used to tell a story about ourselves and certainly the animals as well as other cultures, nations and so forth. It can distance, attach, detach and move toward a cause, practice, and identity.

One the of the most effective vehicles to deliver a message of Enviropigs, as pigs and pork, was through affective and catchy headlines which are quoted below:

Genetically engineered meal close to your table *The Toronto Star*, 22 Nov 2008

Genetically Modified Pigs: Coming Soon to Your Dinner Plate? *Genetic Watchdog*, 06 Oct 2010

Genetically modified pork one step closer to the dinner table *CANWEST NEWS SERVICE, 19 Feb 2010*

Green egg and ham *McLeans,* 21 Oct 2011

GM pigs: Green ham with your eggs? *BBC,* 04 Jan 011

Is Canada's genetically engineered "Enviropig" headed for your plate? *This Magazine,* 10 Sept 2010

Pigging out on genetically modified pork *Global News*, 24 Jan 2011

Enviropig: the other white meat. Are consumers in the loop on their genetically modified food? *The McGill Daily*, 17 Feb 2011

The Enviropig is made here in relation to food and dinner tables which enacted norm but at the same time a "mood" (Anderson, 2009) of imminent arrival. The role of eating and table bring up ideas of "home" and closeness thus making the Enviropig quotidian (Franklin, 2007) and intimate. This highlights the affective use of "anchoring" – a mechanism of naming, making the subjects of stories told in the media ordinary and

classified, based on an existing order of concepts which are meaningful to the audience (Washer, 2006:463; Bauer and Gaskell, 1999). At the same time, this highlights the role of embodied and sensory ways of relating to a phenomenon – ways which are important in public engagement with science and technology (Wynne 1991; Huggan, 2016).

As Thompson and Sanderson (2015) observed in their study of GM salmon's approval, the eating practice was very crucial as it proved that salmon is “ordinary”. Similarly, in the context of “new” foods more generally, eating, tasting and smelling new products (see Sexton, 2018) so they are like animal food products is of focus to start-ups and established meat companies (see CB Insights Nov 2019 research brief on the meatless market[26]) and even turned into a spectacle (Stephens et al., 2018). In the case of the Enviropig, eating practice was crucial too which is illustrated by the fact that the animal was submitted to FDA with a view to being accepted as “regular” pork i.e. to be approved for human consumption, and in doing so, make the animal ordinary.

To give an example of the nature of the approval of transgenic animals as food, I bring to the fore the observations from Cecil, the lead scientist. It is worth reading this in detail to get the sense of submitting an animal for approval as edible, safe meat. This longer excerpt shows the

[26] https://www.cbinsights.com/research/future-of-meat-industrial-farming/

complexity of assessing Enviropig as food in comparison not just to other pigs but also specific meat cuts and GM fish – which in this regulatory system appears to be seen as a single tissue animal. The emphasis, from a regulatory perspective, was in assessing how animals - seen as tissues - are eaten.

> **Cecil:** When you submit fish for regulatory approval, how many tissues are there in the fish? For human food consumption – there is one – you fillet the fish and you eat the fillet. And then you have heterozygous and homozygous – do you understand?
>
> **KR**: No, can you explain?
>
> **Cecil**: Well heterozygous is when you have one copy of the genes, homozygous is when you two copies or where you have a pure system which copies something of the gene. We submitted animals with one copy going through the system, and we thought that we would only have to do a few things with the animals with two copies of the genes to show that they were healthy and leave it at that.
>
> But what we discovered in the submission was that as soon as we got this submitted, then the regulators started saying that there would be some animals with two copies going in and you are going to have to do the same thing for two copies.
>
> Now, how many tissues are there in the pig? Well, some people eat tongue and lots of it, some people eat the heart, a lot of people eat the liver, people eat the muscle and then they have kidney pies, so you have all of these different tissues and each one has to be analysed the same as the fish.
>
> So, you can see the problem with submitting a pig becomes an order of magnitude more complex than submitting a fish and showing proof of safety. It is much more complicated, so that is going to be an issue for the first food animal to go through in comparison to the

> AquaBounty setup which now is shown to be simpler. So it is much more complicated to get it through the regulatory system. (04 Nov 2014).

The above excerpt is also telling a story of discovery or rather a clash over what (or even in which tissue) a pig is when submitting the Enviropig for food safety - an animal which unlike salmon is formed with more than one edible tissue. The role of food played a significant role in normalising the Enviropig, but at the same time, the practice of eating was not fully accounted for. This highlights two things: on the one hand, the regulatory assessment illustrates that the Enviropig was looked as an edible body, but on the other hand the act of consuming as embodied sense-making were not incorporated into the design of the Enviropig (which I return to in Chapter 6).

Highlighting edibility of transgenic animals creates a dilemma as to whether it is appropriate in public engagement with science as exemplified via media and interview. While the sensorial understanding of science is drawn upon, at the same the carnal appetite is potentially reinforced, thus keeping animals distanced from humans as objects of science and industry. As Acari wrote, "…normalised discourses surrounding animals as food are both product and productive of normalised practices of meat consumption" (2017:72-73).

One thing that needs to be stressed here is that the NGO, which campaigned against the Enviropig, did not refer to the Enviropig by

appealing to food. However, a pink pig, a toy pig, was used in the campaigns (see Figure 16). The efforts of the NGO concentrated on the economy, trade and democracy (which I return to in Section 5.4).

Figure 16. The Enviropig toy at CBAN. Source: K. Rucinska

But, I argue, by appealing to the body as a commodified pig, was in itself was performing normalisation. NGO was not the only one doing

that which brings me into the next section where I talk about normalisation of the Enviropig through the body.

With bodies and behaviour of pigs

The concept of "the body" has received serious, critical attention in sociological literature since the 1980s. It meant that scholars moved into thinking with, through and about a body as product and productive of society, identity, otherness, humanness and being in and knowing the self and others. With regards to animals, a bodily turn borrowed heavily from Foucauldian conceptualisation of bodies as sites of biopower, which resulted in an analysis of animal bodies as factories and information. An example of this can be found in Twine (2010) who noted that:

> …the practices of animal genomics removed from the sensual presence of animal bodies" (2010:93) 'result in a black box where the animal body is treated as a closed system and methodologically tries to ascertain what is going on inside the black box by monitoring inputs and outputs', whereby a 'cell is an assembly line factory. (2010:93).

In this section, I would like to move away from the interpretation of animal bodies as sites of accumulation of capital (Clark, 2010) and instead engage with a notion of the animal body as practice (Lien and Law, 2010). Here, practice means movement and behaviours of pigs as captured in the media, as well as a way of seeing based on roles and responsibilities.

While the Enviropigs were normalised as an edible body, they were also normalised by referring to the aesthetics and behaviours of “regular” or “normal” pigs. For example, a reporter for the Sunday Times wrote, “they seem like any other piglets, guzzling down their feed and rooting around in their own muck” (27 June 1999).

The Salon, a political magazine aimed at the American audience, in 2008 had a piece about the Enviropig titled, “Should biotech piggy go to market?” in which the author wrote:

> Behind locked doors, past a shower, where humans are required to rinse, more than 25 pink pigs crowd into hay-covered pens at the University of Guelph in Ontario, Canada. They look like regular Yorkshire pigs: Their eyes gleam like black marbles, they snort, and they scarf dinner from a trough. “These pigs behave like pigs; they do everything a pig would do” says John Kelley of Mars Landing, a Canadian agricultural development program. Except for one thing (04 March 2008).

Similar views were expressed by both CNN and the BBC:

> But what could be environmental about a pig? I mean, after all, a pig is a pig. They look just like pigs (CNN, 26 Sept 2010).
>
> The animals inside the clean, warm barns look like normal pigs and behave like normal pigs, but they are living, breathing wonders of modern science (they [the Enviropigs] look like regular Yorkshire pigs: Their eyes gleam like black marbles, they snort, and they scarf dinner from a trough (BBC, 04 Jan 2011).

There was, I argue, an element of assumption in that the readers know what regular pigs are like and therefore perhaps hoping to bring the

reader closer to the Enviropig i.e. normalise them. This was achieved through referring to their bodies, the way they move, what they do (rooting around in their muck, snort, scarf dinner), how they look (eyes gleaming) and what they are like. The pigs here are normalised through their evocative and curious behaviours. In other words, normalisation of the Enviropig is based on their bodies and behaviours, that can be witnessed by looking (Morris and Holloway, 2009), and in relation to a normal, regular pig. What this gives rise to, is the question not just of what the Enviropig is, but what is normal and how to know.

In the enactment of the environmentally friendly pig owing by looking was suspended in favour of separation, tags, paperwork and daily tending to. But in the enactment of the ordinary pig, the more sensorial and mundane knowing what is normal (in relation to one's work) comes into the picture.

For example, to agricultural assistants who took care of the Enviropigs daily, they described it within categories of well-performing and Yorkshire-like looking. Clive, for example, was a bit disappointed with the Enviropig because, he thought, "they [the Enviropigs] would grow faster, and all kinds of things like this, but I don't think that they did much more in performance and things like that. It looked exactly like another pig. It was like a Yorker, just another pig" (Guelph, Canada, 04 Nov 2014). Matt seconded it was a "just a regular pig" (Guelph, Canada, 04 Nov 2014) and Stephen echoed him by saying "… it looked like a normal pig when you euthanised it" (Guelph, Canada, 04 Nov 2014).

Thus, what can be initially drawn from these descriptions of a normal pig is that their understanding was closely linked to their lines of work, tools they used and the knowledge they had about those animals. Considering they have worked with pigs on farms and in a research facility, their view of what a pig is drew upon the industrial, on-farm type of pigs. At the same time, agricultural assistants, as well others with access to data, also knew the pigs from the inside out due to their role in euthanising and assessment of pigs after death.

Nathan, the Technology Transfer Officer who was responsible for commercialisation of the Enviropig, described this animal also within the category of a good performance, plus anatomy and digestion. Because, in his words, “all that has really been done with the Enviropig is that a couple of genes have been inserted to produce a protein that natural pigs are already fed”. Therefore, in his view,

> …there is no difference in the way the pig lives, grows. It might grow a little faster, it might be a little bit leaner, but in general, it is exactly the same pig, except that it has its own phytase in its saliva. All its anatomy is the same; all the proteins in its blood are the same – it is essentially the same pig. (04 Nov 2014, Guelph).

The above understanding of the Enviropig was echoed in an interview with the officer at Agriculture and Health Canada, a geneticist by training. He said:

> Even if you take a single gene construct and insert it to change some production in a solitary

> gland and the pig is the pig, is the pig – it is not a different pig! Aside from it is producing a particular enzyme that is not common in the natural pig [...]. (31 Oct 2019).

Here, similarly to agricultural assistants, the view on the Enviropig as normal is coming from the perspective of the inside out, by assessing and comparing anatomy, genetic material, tissues and proteins in the blood. But access to laboratories, pigs and tools to "see" them is not available to everyone. Understanding of pigs, therefore, changes based on who and where and practices. Here, apart from being able to work with pigs, we can also say that their understanding of based on a pig – i.e. commercial, industrial pig.

To sum up this section, with many practices, come many interpretations and understandings of ordinary and normal. However, by and large, ordinary was achieved through practices linked to particular orientations toward animals – like meat, like pork, pink, farm-based – circulating widely in popular culture, everyday life, literature and the human story of farming and domestication (Fudge, 2004). Because of their common and prevalent use, these bundles of text, images of bodies are "sticky" (Ahmed, 2004) and therefore affective because they silence (Holmberg and Ideland, 2009) the transgene.

At the same time, the making of the ordinary was done in comparison to other pigs using inside know- how with tools, tissues and DNA kits. The swapping between modes of knowing whether the animal is unique

and ordinary at the same time makes it paradoxical and difficult even for the scientists involved. Holmberg and Ideland (2009) noted this paradox and double-being transgenic animals as “ordinary treasurers”. It means that animals are like treasure due to their ability to deliver medicine (transgenic mice), cleaner agriculture (the Enviropig) or feed the world (GM salmon) and ordinary because they are like other animals and therefore familiar and accepted. For them, this is a great cause for concern because animals are then justifiably used for research neutralising technology and human intervention in the lives of animals.

However, Clark (2014, 2015) noted that the Enviropig as transgenic livestock animals, unlike transgenic mice or other laboratory animals, might be of a different kind entirely. Clark made this point based on the events that followed the closure of the Enviropig project. The animals were euthanised rather than given a chance to live in a sanctuary because they were too laboratory-like, meaning they were transgenic, but not laboratory-like enough because they were of farming lineage destined for food. This could suggest that the Enviropigs fell victims to what Despret (2005) after Rowell refers to, a hierarchical scandal in ethology. The scandal here means that not all animals, for example, farm animals and the so called trash animals (Nagy and Johnson, 2013), were given a chance to be known beyond the human gaze, human-designed places and human-decided roles as meat, game or tools.

Indeed, the Enviropigs, as I have shown above, despite crossing

boundaries as species, becoming with many and being multiple were still confined to the sticky affect of being farmed animals destined for food. However, these animals should, as Haraway (1997) and Franklin (2008) argued, remain unique especially because they cross boundaries between past and present, lab and farm as well as modes of knowing. They lead the way when asking what stirs beneath the "ordinary" or "friendly" and how it is performed.

5.4 Performing monstrous pig

In the previous sections, I noted that the Enviropig's multispecies body was performed in relation to polluting as well as normal pigs in order to evoke a sense that these GM animals are better, yet familiar. These affective enactments drew on notions, bodies, histories and practices that are prevalent and taken for granted, thus as Ahmed put it, "sticky" (2004).

I start this section by focusing on the ways in which the green and ordinary pig were undone. Firstly, I show the contestations of the Enviropig were done with the use of hogwash and the Frankenstein metaphors. These, in turn, reflected wider concerns over the role of science in society, distrust in expert knowledge as well as lack of transparency in decision-making (Bauer and Gaskell, 2002; Horlick-Jones et al., 2007; Nerlich et al., 2018).

On the whole, this section however, reflects views from the literature (e.g. Ten Eyck, 2005; Bauer and Gaskell, 2002; Macnaghten, 2004;

Frewer et al., 2014) and large studies of public perception such as Eurobarometer's (2001) view that any scientific progress in biotechnology, if it is intended for consumption, will be overshadowed by the complex relations human have toward animals. By complex, I mean a mixture of affection, ambivalence, and love, as well as conflict as to how farm animals should be treated: meat, sentient beings, rural or pet, friend or beast. However, this section also confirms that only some aspects of these complex relations were present. In other words, what emerged were concerns over food, agriculture and control, rather than animals themselves.

Becoming monstrous

Biotechnology, in its early days, was abstract and highly technical. Up until the late 1970s modification of organisms from bacteria to large mammals was still in its infancy and discussed within closed circles of expertise. The mood of the technology was positive as it carried ideas of progress, including economic. But plans of scaling up and releasing the organisms into fields and supermarkets were met with resistance initially driven by NGOs.

Initially, NGOs questioned environmental and health risks assessments of biotechnology especially in the context of agriculture. But from the late 1970s onwards, as Bauer and Gaskell (2002) noted, biotechnology was highly contested beyond the scope of evidence-based risks

assessments. The BSE crisis in the UK as well as the eroding trust in experts who were divided in opinion about GM, plus the birth of Dolly the Sheep, set the tone for the ways in which biotechnology was contested.

Thus, the 1990s saw a shift from economic progress and evidence-based risks to consumer concerns, consumer rights and in general distrust in policy, experts and the food industry. When the Enviropigs were born, the consumer backlash was taking place, but mainly in European countries. In North America, the view was to regulate GM products as other, non-modified foods to enable the growth of the biotechnology industry. Despite that, the resistance to biotechnology was taking place in the media, whether in Europe or North America. The framing of biotechnology as either doom or progress (Einsiedel et al., 2002) was prevalent. The frame of doom, along with the use of evocative metaphors and images set the tone and mood about biotechnology, and eventually the Enviropig.

Here is Carol, the Ontario Pork spokesperson explaining the shift in the mood:

> From the producers' point of view, we didn't hear a call to stop this proposal. Yes, at different times we went out with media information on it a number of times. The first time I don't know, I wasn't involved the first time that they went out, and I don't know if they had any response to it other than 'Oh, Enviropig?' Yes, that makes a lot of sense. And it wasn't just to producers, it went out to mainstream media and really it was in the last, I don't know how many years, whether it

> was five, six years that it started to… As the GMO movement started, we started to hear the noise of ”Oh we don’t like GMOs, Frankenfood” that type of thing that we started to hear much more. Prior to that, not anything significant at all. (06 Nov 2014, Guelph).

When the Enviropig began to be contested, the metaphors of greenwashing and Frankenstein’s monster were already in circulation as a result of decades of public backlash taking place in European media, courts and streets. The mood (Anderson, 2009) around biotechnology was already shifted. The role of metaphors is to communicate and connect various discourses and topics (Hellsten, 2003) or as in the case of the Enviropig (and previously Dolly the Sheep), make unfamiliar (i.e. the Enviropig itself) familiar (i.e. dangerous, monstrous, Frankenstein). Metaphors, when established, provide an anchor for the readers to make sense of the new.

In the next sections, I, therefore, want to concentrate on how monstrous was enacted, in particular in relation to what kind of ideas and with what language, imagery and affect. I argue that the Enviropig’s monstrosity reflects wider use of monster as a cultural body and runway science (Cohen, 2007).

Hogwash and technofix

In this section, I want to concentrate on efforts to contest the Enviropig’s green credentials. I want to draw attention to words, moods and feelings

used to support a view as to why Enviropig is not green or friendly, but the monster that is as a cultural body (Cohen, 2007:4). This implies that a monster embodies a certain cultural moment – a feeling, a mood, fear and anxiety as well as utopia – it projects the worries and preoccupations of a generation. In the case of the Enviropig, the concern was the technofix (Twine, 2010) i.e. applying technological, mechanistic, steady-state thinking to complex, heterogeneous issues such as climate change and indeed livestock farming.

Mother Jones, a progressive magazine aimed at the American audience, in 2001 had a piece about the Enviropig titled, *The Next Pig Thing.* This would be one of the first opinion pieces illustrating the emerging contestations over a solution to water pollution. It reads:

> The three pigs in question, developed by researchers in Canada and already patented as 'Enviropigs', represent a unique dilemma for environmentalists.
>
> Major green environmental organisations are virtually unanimous in the view that genetically modified products should be banned. But the Enviropigs address a major environmental problem -- one those same groups have been fighting for years. Environmentalists aren't buying it. The Sierra Club, which has made lobbying for controls on pig manure pollution a centrepiece of its clean water campaign, calls the Enviropig a load of hogwash. (26 Oct 2001).

"Hogwash", meaning nonsense, here delivers not one but two messages. One, it broadcasts that the Enviropig is not a feasible and sensible solution for farming. Two, the use of hogwash creates a link to

widely used terms by environmentalist movements, such as greenwash and greenwashing. In so doing, the term hogwash makes the Enviropig familiar to the readers by going straight into other examples of greenwashing.

As one senior scientist belonging to the Union of Concerned Scientists, a non-profit organisation based in Washington, DC, wrote:

> Applying genetic engineering to clean up large-scale pig farming is 'like using a screwdriver when a hammer is needed for a nail'. (2002:12)

The Enviropig at some point "sound[ed] like a good idea" (a blog entry, Sustainable Food, 2010), but over time began to be presented as a threat to other visions of farming – a sustainable one. As one of anonymous blogger put it:

> Enviropig and its counterparts in other livestock and animal groups spell trouble for sustainable food. Sure, it may be more environmentally sustainable for CAFOs to use such altered pigs, but why not find other, more organic ways to make our food and agriculture system for sustainable? We should be seeking alternatives to CAFOs, not encouraging their continuation as a cornerstone of our food system. (10 Oct 2010).

Similar views were expressed in *Green Biz*, in which the author argues that the Enviropig is not a solution to large scale farming. The real concern is not the new animal, but ways in which pigs in general are raised. Small scale farming, as the author here argued, does not pose the same threat to environment.

> After all, small-scale farmers don't have a problem with several dozen or even a few

> hundred pigs polluting waters and causing massive dead zones in the Gulf of Mexico. It's only when you scale it up to CAFOs with thousands of farm hog farms with 5,000 or more pigs represented more than half of U.S. hog farms in 2004 that you see the highly polluting effects of their controllable output. (01 April 2010).

Similar arguments were expressed in *Minnesota Daily* (2001), however, here the Enviropig is presented as one that exacerbates the problems associated with large scale farming. Here, the author clearly argues against the Enviropig:

> These pigs, however, have nothing to with cleaning up the environment and everything to do with increasing profits. Currently, the hog industry poses a grave threat to humans (...). The large hog farms emit greenhouse gasses and nitrogen gas, which can radically change the surrounding ecosystem. The increased number of Enviropigs will exacerbate these problems.

Although the majority of people I interviewed saw the Enviropig as a good solution, two people shared the “hogwash” concerns. One of them was Jake, the adviser working at the Agriculture and Food Canada, who was not officially employed in the Enviropig project. However, due to his “understanding [of] the industry, the research side, and the regulatory” he acted as an in-between person. The second person was the Laura, the coordinator of a grass-root organization, CBAN, who run the anti-Enviropig campaign “Stop the Enviropig”. Laura, although an outsider to the project, was aware of the Enviropig “since it was recorded for the first time in the media”, and proactive since 2008. Both of them, unlike the rest of the participants in this study, understood the public’s concerns from the very beginning (more on this in Chapter 6).

For Jake, who was a geneticist by training and understood the science of the Enviropig, the solution caused concern for two reasons. In his own words:

> First, I did not necessarily agree with the approach being taken. When I saw this application came along, I said ‘this is another application to fix the problems the government already created!’ So, I have seen this multiple times in my career where the government creates one problem and tries to fix it with another one. So, my first perception was because of the reason why they had to do it, not necessarily good. And second, I guess I share some of the concerns of the general public about GMOs and biotech applications, and I had been very protective and careful of the animal side. (31 Oct 2014, Ottawa).

Whereas Laura, the campaigner against the Enviropig, was not just using toys of "ordinary-looking pigs" (see the previous section) and banners to make her point. As a coordinator, she also helped to deliver a specific argument to ban the Enviropig.

> **Laura**: On Enviropig, the specific technical issue was around what other options exist for farmers. So, in that way, we talked to people in the field and people who understood the technology of the phosphorus supplements or the phytase supplements. In terms of is it a health risk, even the question of is it an environmental risk, they were not as relevant – I mean they were relevant, but they were not as relevant for the campaign – as the main issue of that this technology is not useful, it is not needed. We already have a simple solution that is cheaper and far less risky.
>
> **KR**: So those were your main concerns that you shared within the network and with the public?
>
> **Laura**: That is the main concern that we shared

> with hog producers; we also shared that with the public. But the public care less about this or that supplement – they don't want to eat the GM pig, so for the public, our main communication was 'this GM pig could be approved soon. Do you want it? No? OK, let's stop it.' For the farmers, it was more like 'this pig is a waste of time and money'. (29 Oct 2014, Ottawa).

Both Laura and Jake shared concerns about the Enviropig as a solution to a problem that can be solved otherwise. While Jake's opinion has changed because of his direct insight and involvement with the Enviropig team, Laura's did not. The campaign centred on issues of consumer choice and pig farmers affected by the Enviropig which tapped into the existing arguments against food biotechnology. However, animal welfare and health were not of priority. However, for Jake, it was. Here is how he explains it:

> It [the enzyme] also improves the welfare of the pigs, but most people see it as an economic benefit for the producer, and that is a difficult one to sell for the public. 'I don't care if they make more money' well in actual fact they do not make much money. So everyone thinks that the farmers are getting so rich on these farms, but that is just not the case. So that is why I point out that there is a welfare benefit and the University of Guelph is part of what I explain too. There is a benefit to the pigs because it is a more complete ration. (31 Oct 2014).

Jake is a person who looks after animal welfare across the country, but he finds it difficult to navigate the industry, ministers and the public through a different way of recognising animals. In thinking about the hogwash metaphor used in the media, Jake was aware that the public

might not be keen on caring about the financial aspect (as it might have strengthened the image of the Enviropig masking commercial gains, as seen in the example of GM cows in New Zealand and Finland mentioned in Chapter 2). Hence, he concentrated on reasons as to why expressing an enzyme is also good for a pig.

Animal welfare, as explained to me by Jake and Laura, is in a vacuum in Canada but she knew that talking about animal welfare will not shift the mood. The financial aspect on the other hand, especially discussing disadvantages to pig producers would and it certainly did.

Genetic modification, as Väliverronen put it, “meets the criteria of a good news story” (2004:263) as it talks about breakthroughs and impacts beyond the gene, the cell and single organism. As a story, genetic modification captures imaginations and sparks debates well beyond a lab. The hogwash metaphor is an example of how genetic modification as a story was done because it captured concerns about a farmer, nature, small scale farming and the consumer. These actors are relatable to readers in North America as well as in Europe who stand against large corporations, the commodification of nature, undemocratic decision-making and lack of choice. Proponents of biotechnology see the opposition to GM as emotional and dogmatic, and standing in the way of data. But as informants in Halliwell et al.’s study (2017) of NGO tactics argued, they are concerned about how the problem of food and socio-economic issues are framed. However, I

argue, these are still evocative as they play on human rather than animal-centred issues.

The ways in which the Enviropig was portrayed and contested mirror examples found in the literature about GM in the media (Bauer and Gaskell, 2002; Clancy and Clancy, 2016), as well as transgenic animals in the media (Väliverronen 2004; Bloomfield and Doolin, 2011). For example, the contestation of the Enviropig using the hogwash metaphor suggests concern about human not animal, which has been reported in studies about GM cows (Väliverronen, 2004; Bloomfield and Doolin, 2011) destined for the production of medicine rather than food. In particular, the emphasis was about what GM animals do to others, how humans are constrained and affected, rather what is being done to animals. The animal, a humble and sentient pig within the Enviropig, remained invisible in those contestations even in the NGO campaign. And yet, they were more profound in the enactments of a friendly pig. The NGO, although it did not evoke the Franken metaphor, portrayed the pigs as toys rather than living and breathing animals that one tends to every day. In thinking about monstrosity, the Enviropig here emerges as a trash animal (Nagy et al., 2013) – unwanted, ugly and of no monetary value. But in doing so reflects human concerns and imaginations as to what nature, as well as farm and animals, should be like: small, family farms, animals not housed in large farms, but producing, nevertheless. Here a monster embodies greed and control over nature. Read as such, it does not invite to a deeper understanding

as to what this creature is, but only what it represents and why it should be abandoned. In doing so, the notion of “pigginess” is not re- examined in those contestations, but locked in the utilitarian, commercial values.

Runaway monster

When the Enviropig was beginning to be contested, the Frankenstein metaphor was already embedded in the media language and image of biotechnology. It emerged in 1992, when Paul Lewis, a professor of English at Boston College, Massachusetts, USA, wrote a short letter titled Mutant Foods Create Risks We Can't Yet Guess to the New York Times in response to an Op-Ed about GM tomatoes. His letter, scholars, argue (Turney and Haynes, 1998; Hellsten, 2003), kick-started the circulation of the “Frankenfood” metaphor. William Saffire, the New York Times columnist, summarised the development of the metaphor with the following:

> Since then, bio technophobes and other members of the anti-genetic movement have denounced Frankenseeds, Frankenveggies, Frankenfish, Frankenpigs and Frankenchicken, lumping them together as fearsome Frankenscience (2000).

The metaphor of Frankenstein is one of the most powerful messages found in the media writing about biotechnology (Turney and Haynses, 1998; Helsten, 2003). The Frankenstein metaphor, scholars (Einsiedel et al. 2000; Hammond, 2004) suggest, aims to highlight the resistance to modernity. It has been implicated in anti-science movements, urging

to take action or warn about the slippery slope of science and technology.

Unlike in the previous role of the Enviropig (see “like a normal pig”), the role of the Frankenstein metaphor was clear about distinguishing between “normal” and “not-normal” pigs. The monstrosity is understood here as corporal, deformed and different. Here is another example:

> But this is no ordinary farmyard animal. The specially-bred Yorkshire pig is the first of a new generation of 'Frankenswine' genetically modified hogs designed to be cheaper and greener. (*The Star*, 22 Nov 2008).

Even though the “normal” pig is still tied up to an industrial image; the Frankenstein metaphor makes it clear there is no ambiguity about which animal is normal. The “paradox of nature” as described by Humphries and Sanderson (2015) does not feature in the accounts where the Frankenstein metaphor is mobilised. The clarity of what pigs are and aren’t in these media account makes the Frankenpig version of the Enviropig the most straightforward. This reflects the idea of a monster policing the border of the possible (Cohen, 2007) that should not be transgressed.

But, the Frankenstein metaphor is also not just to show an embodied monster, but to warn against something, namely runway and irresponsible science (Cohen, 2007; Einsiedel et al., 2002). As ABC in 2011 wrote: “depending on whom you ask, these frightening

Frankenswines represent science overstepping its bounds" (06 Jan 2011). The Enviropig represented "a genie out of a bottle" (singularityhub.com, 2010) and a "slippery slope" to GM animals and life in general.

> Dairy cows are being genetically tested for breeding, and flowers are being engineered to have different smells - the genie's already out of the bottle. It may be that GM foods, including pigs, will continue to form an increasing portion of our diets. Or we could jump ahead and just start eating artificial meat. Either way, we are soon to find out just how tasty. (singularityhub.com, 2010).

The monstrous Enviropig was also enacted in relation to purity where the GM pigs represent a danger as in polluting, transgressing and disturbing pure breeds. The next two excerpts from a Canadian newspaper and British anti-GM campaigner exemplify the notion of GM animals as a danger to purity.

> A key concern with transgenic animals is they will escape captivity, breed with their conventional cousins and pass on the engineered genetic trait. Transgenic faster-growing salmon, for example, could out-compete wild salmon for food and mates, endangering native fish stocks. (*The Star,* 22 Nov 2008).
>
> Alarmingly, the Enviropig research team has already proven incapable of properly disposing of its experimental errors. As the Toronto Globe and Mail reported in 2002, when eleven Enviropigs were born dead or sickly enough to require euthanasia (a common result of GMO reproduction), regulations required that the animals be destroyed by incineration. But

> compounding their error, the researchers instead sent the mutant GMO pigs to a rendering plant, where the untested GMO animals were illegally made into poultry feed. Confronted with the breach, the University overseer of the Canadian research team offered the scientists' best defence: 'Things you don't expect to happen can happen'. (*GM Watch*, 16 March 2010).

The monstrous emerges here as one that escapes and mingles with us and other animals. The monster is a mutant that slips through food systems unnoticed. Being a pig helps to deliver the message of transgression and impurity. As Malcomson and Mastoris (1998) wrote:

> A pig in art or literature commonly conveyed a sense of transgression, of crossing the line between what was acceptable and what was unacceptable, of moving from safe into polluted territory (p.4).

The Enviropig is, therefore, a continuation of such a transgressing pig that served to define refined and unrefined, safe and unsafe, clean and unclean. Thus, the enactments of Enviropig were affective due to inheritance of such a framing of a pig. It helped to clean up a pig that was assumed unclean throughout history, as well as enrol the notion of Frankenswine to demarcate safe from unsafe by contrasting ordinary from monstrous pigs. This reflects wider use of animals as risk and danger – that continues to be used in the media (Gerber et al., 2011) – which renders animals killable and unlovable.

Reading the Enviropig as a "monster" I would also like to borrow Gail

Davies's words to say that that the Enviropig is indeed "most recognizable in a corporeal form; in the bodily destabilisation of expected physiology, or hybridisation of separate species" (Davies, 2013:268). But, similarly, to Davies, I am not willing to stop at such description, but rather I want to go further. The Enviropig at first glance unsettles, and stories of enactments clearly illustrate that, but in so doing she invites to thinking beyond a simply oppositional critique that points to the limits of the ideologies and practices of the life sciences (Rajan in Davies, 2013:23).

The monster as impure and dangerous, however remains misunderstood and demonised just like in Shelley's novel about the creature that indeed escapes. But the true issue was that the creature was abandoned, thus an opportunity to come close to it, and in fact to its creator - as a detached form of the world scientist - was lost (I concentrate on this in Chapter 6).

The monstrous pig was effective as it used an animal body to draw attention. It was one of the most "sticky" enactments as it enrolled fear of technofix and a roll-out of undemocratically approved lab monsters. The monstrous reflected fears about letting animals slip away and escape despite measures and risk assessment. The fear of the monster thus can be interpreted as fear of being out of control, but on another level, the case of the Enviropig points to more than this.

The role of the monster, as mentioned earlier, is to police the borders of possibilities and to ensure there is no transgression. The monstrous pig, as shown in the examples above, was to draw boundaries around normal pig by referring to the monster out there, but without changing the meaning of the normal. The Enviropig, like the Heck cattle example by Lorimer and Driessen (2013) “is monstrous only in so far as they unsettle the modern division between the wild and the domestic; falling somewhere along a continuum rather than at the end of this false divide” (p.251). The pig remained “locked-in” on a farm, away from nature as monstrous and as an ordinary pig.

5.5 Chapter summary

The aim of this chapter was to explore how the Enviropig was enacted in text and interviews and what role did affective language play. In this chapter I therefore looked at practices (Mol, 2002) and emotional registers (Huggan, 2016) in text and interviews.

A material-semiotic interpretation showed a busy, more-than-human history of the Enviropig which included phytase, a mouse protein, an E. coli bacterium, pigs called Wayne, Jacques, Gordy and Cassie, patents, publications, and food. I have shown practices of extracting, publishing, submitting and consuming, among others. In each of them, I focused on how these were done and what made them sticky (Ahmed, 2004).

With regards to the emotional registers, the analysis revealed that by evoking the notion of a pink, happy and ordinary pig, pig as food, and

pigs as unclean, and pigs as transgressive the idea of what a pig is was not challenged. In other words, the idea of raising pigs for food consumption was not challenged; only raising animals and addressing pollution was. The affectivity of pigs within the Enviropigs challenged biotechnology, but not the farming practices.

The larger and emerging question is then, how could animal affects (or animal icons, see Huggan, 2016) be used to mobilise the public to act on issues concerning uncertain animal farming futures (Garnett, 2015), in which biotechnology is presented as one of the multiple options? If animal affectivity dismantled the Enviropig, then how can it be used to dismantle more than just biotechnology and instead address the pressing issues of animal farming amidst climate change and growing meat demands.

This question, however, is illustrative of the problem of being a pig in the age of the genome. As shown, especially as the making of the monster, pigs are materially and semiotically “locked” within the roles, identities and bodies they have been portrayed over centuries. No matter whether it was ordinary or monstrous animal, the notions of polluting, transgressive or farmed, the edible animal was returning over and over again. In other words, being a pig in the age of the genome, as far as these accounts are concerned, means going further away from knowing pigs as pre-domestic (Bulliet, 2005) magical creatures.

But, I also noted that the Enviropig was truly multispecies (Helmrich,

2010) with its bodily composition prompting us to rethink what a pig is and where it “belongs”. The Enviropig also emerged as multiple despite that some of the practices aimed at conserving the farm-based version of a pig. Multiple here means that being the Enviropig changed from place to place, from practice to practice. Thus even though there were overlaps, thus creating a patchwork (Lien and Law, 2011) of culture and nature, there is a hope that should there be more practices, there might be more versions of the Enviropig that shed a light on being a GM animal.

The Enviropig, therefore, offers a springboard to think about animal biotechnology as a vibrant and complex world in which demarcations between what is and what is not GM are being blurred, rather than a black and white world with pro and anti-GM sentiments. The chapter illustrated that the Enviropig has been enacted by all parties involved: some performed distinctions, some performed resemblance, and some silences. In the next chapter, I will focus on affective science enactments which will, in part, help me address the question I posed earlier that is, how can we use those insights to dismantle more than just the Enviropig and tap into the debates about addressing radical uncertainties through learning from controversies.

Chapter 6. The Enviropig: a fragile practice story

6.1 Introduction

In this chapter I am interested in answering the question 'how biotechnology was enacted in practices involving the Enviropig'. Following a turn to care and affect (see Chapter 2) in scientific practices, I am also paying attention to all those invisible, concealed things such as logics, intentions, and hopes (Franklin, 2007), human-animal relations, materiality, as well as spatiality behind the Enviropig's making and unmaking. In doing so, and building on the literature in Chapter 2, I develop an argument that the Enviropig was a fragile practice, meaning that it was too dependent on, rather than attached to (Latimer and Miele, 2013) other factors, places and spaces, but also too secluded, too poorly translated (Callon et al., 2009) at the same time. Despite having the right ingredients, such as passion about science and awareness of other forms of knowledge, fragility emerged out of efforts to make it robust (Taleb, 2012) and sound enough to stand on its own (Latour and Porter, 1996) rather than inclusive, flexible, relatable and able to respond to ongoing changes. By demonstrating fragility, this chapter extends the work of Callon et al. (2009) and contributes to the literature on controversies and affective science (Lorimer, 2008; Latimer and Miele, 2013).

In Section 6.2. I set the scene for the argument by situating it around the history of biotechnology and the literature on affective science (Latimer and Miele, 2013; Lorimer, 2008) as well as uncertainties and making of science (Callon et al., 2009). I then talk about the reasons that ended the Enviropig as symptoms of fragility. In the subsequent sections, I flesh out my arguments of how biotechnology enacted in practices around the Enviropig became fragile. I demonstrate fragility, with the use of interview material, through acts of depending, moving and engaging half-heartedly. This chapter is based on the interview material with the creators of the Enviropig, the support team (technology transfer officer, the adviser, the assessor), the funder, and the opponent.

6.2 Becoming fragile

Biotechnological innovations are commonly referred to as innovations of molecular techniques to study or alter organisms. According to the UN, biotechnology is “the broad area of biology involving living systems and organisms to develop or make products, or any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (UN Convention on Biological Diversity, Art. 2). The definition suggests biotechnology is all three things: science, tools and the application.

But, the word “biotechnology” dates back to the early 20th century,

where it was first used in relation to the fermentation process – zymotechnology – on a larger, industrial level (Bud, 1993). Over time, its original meaning has been shifted to molecular processes whilst keeping the original notions of natural processes in production of food and medicine (Bud, 1993).

Research in the history of biotechnology indicates that molecular biotechnology, as we know it today, has its origins in two events (Bud, 1989, 1994). Those events are the discovery of the DNA structure in 1953, and the discovery of a recombinant DNA technique by which a section of DNA was cut from the plasmid of an E. coli bacterium and transferred into the DNA of another in 1973 (Bud, 1994). These two events made it possible for biotechnology to achieve desired mutations in animals, plants, bacteria, and viruses faster and now more precisely (see an overview of CRISPR animals by Reardon, 2016 and Tan et al., 2016). But the shifts and changes required firstly efforts to firstly move from one term to another and secondly to keep biotechnology going, maintained, and growing.

The making of biotechnology thus required spaces, places, animals, molecular scientists, biologists, animal technicians, knowledges, microbes, pipettes, data, computers, PhD students, history of domestication, publications, Darwin, as well as opponents, governments, regulations, markets, marketing, media, outreach, engagement, consumers, feelings of novelty, familiarity as well as fear and more. From the performative (Callon et al., 2009; Latour and Porter,

1996; Mol, 2002; Lien and Law, 2011) and affective perspectives (Latimer and Miele, 2013; Lorimer, 2008; Puig de la Bellacasa,2011, 2017; Ahmed, 2004) biotechnology can be conceptualised as multiple, but also needy in the sense that it requires a network to maintain it not just as an animal (see the previous chapter) but as a concept, as science, and as robust and certain science.

However, in needing all these actors, spaces, places and artefacts, biotechnology is dependent and at the mercy of all the ingredients holding together. It can be argued it is in fact fragile – hypersensitive (Taleb, 2012; Latour, 1996) to any change occurring within and outside of its network, too dependent on all of the parts to be maintained, too dependent on views and opinions, but also too secluded (Callon et al., 2009), and too poorly translated (Latour, 1983).

The repercussions are material for those involved, but also beyond that. In not wanting to be fragile, efforts are taken to handle everything arguably with care, not to overstep the boundaries, and perhaps even to abandon a project (Latour, 1996, 2011). But perhaps the challenge is to stay with the trouble, with uncertainty, and how to make something not robust, but hybrid (Callon et al., 2009) and more affective (Latimer and Miele, 2013; Lorimer, 2008). Hybrid would mean involving more than expert knowledge and understanding, whereas affective would mean attached, moved and in a process of becoming with emotions, engaged with oneself and others.

The Enviropig as biotechnology had the right ingredients to be both hybrid and affective because the project came out of dreams and hopes, involved the public (although not in an open way), involved farm animals and other species. However, on its way to becoming robust and sound it did not utilise those ingredients and instead became hypersensitive, and in a sense, vulnerable. This does not mean innocent and without faults, but rather incomplete and naïve.

The Enviropig offers a timely insight into this line of thinking. I start by providing observations from the interviews on why the Enviropig ended to illustrate the symptoms of being fragile. Building on this, I close this chapter by drawing lessons as to what being fragile means for living with radical uncertainties.

Symptoms of fragility

The closure of the Enviropig project, along with euthanisation of animals (see Chapter 3), suggests that despite all the efforts to keep it going, some part must have been broken, or that something must have contributed to its ending. On the surface it would appear so because the reasons I am about to list were arguably out of the Enviropig team's control.

Firstly, what emerged over the years was the fact that the public was not involved, and governmental approval brought this matter to light. Lack of public involvement manifested itself in the lack of acceptability

of the Enviropig and ultimately the closure of the project. In Laura's (NGO representative campaigning against the Enviropig) own words:

> It ended because the public didn't want this product on the market [...]. There were hog farmers [...] who didn't support it, but they didn't have the same decision-making power that Ontario Pork did [...]. (29 Oct 2014, Ottawa).

But from the scientists' point of view, and those in favour of the Enviropig, the lack of public acceptance came to the fore a bit later and much stronger. Unlike the NGO, the Enviropig team argued that there were other reasons. They were linked to the emergence of a new technology (GM feed with enzyme, cheaper GM enzyme).

Another reason contributing to the end of the project was technology. At the time when the project attracted funding and support there was no technology that would keep existing production levels and minimise phosphorus pollution without damaging pigs' health. In Carol's (Ontario Pork representative) words:

> Initially it was cost benefit, in the fact that we were concerned about the environmental footprint and over that period of time phytase became available, you could feed that to a pig and the economics didn't make sense any longer.
>
> Whereas when we first started there was an economic advantage to having the pig do it versus having an additive, either supplementing with more phosphorus in the diet, so they got what they needed out of it, or the phytase enzyme came along and you could feed that so they could make use of the phytase they were digesting. (06 Nov 2014, Guelph).

In the context of expanding pig production at the cost of environment, and dissatisfaction from local communities, the solution offered by the Enviropig was feasible, but only until another technology came along. Chief scientists, technology transfer officer, and representatives from the Department of Agriculture and Food Canada shared the same views. Below, I provide an excerpt from one of the scientists and the adviser:

> **Cecil**: But over the years, now that they have expressed the same enzyme in corn, for example, it is much cheaper to make and as a consequence the value of that trait expressed in the pig has decreased over time, so that now it is very marginal in relation to what you can do by simply feeding the enzyme, and that we are very well aware of. (05 Nov 2014, Guelph).
>
> **Jake**: There are solutions to the phosphorus that are already out there, farmers right now are feeding phytase which is an extra step, an extra cost, it is a solution, but a temporary solution that doesn't really solve the problem that the pigs can't digest phytate. There is a solution in that China has produced a high phytase corn so it is embedded in the crop, so if you trust China to produce something that you want to eat or want the pigs to eat, there is another solution there. (31 Oct 2014, Ottawa).

Although they agree that new technology made the Enviropig obsolete, it needs to be stressed that technology was in fact the same. After all, it was still genetic modification but applied to crops rather than animals. However, Jake, who remained an avid advocate for the Enviropig, arguing that GM corn with an added enzyme is only temporary and, according to him, cast in the shadow of geopolitics and, I would argue,

global trust.

In thinking about additional reasons contributing to the closure of the project, the technical aspect of GM played a part too. The technique that was used to create the Enviropig became too cumbersome, and almost obsolete when compared with CRISPR, a precise gene editing tool. When speaking to a technology transfer officer, I was informed that the technique used to create Enviropigs was old- fashioned:

> **Nathan:** ... technology we used to create Enviropig now is probably not used any more, it is very old-fashioned now: CRISPR is the new way to create things, you can just go into an organism into the somatic cells, the body cells, or your gamete cells, actually your sperm and ova and you can go in and modify the genes. So essentially, you could make whatever you want of it and once you make that it is a very simple way to create genetic modifications. (04 Nov 2014, Guelph).

CRISPR, or CRISPR-Cas9 is a tool for genome editing which is now widely discussed. In 2014, when Nathan first told me about it, CRISPR has not made yet any headlines and was of interest only to researchers working in the field of biotechnology. But overtime, and especially after an announcement that genome edited children have been born in China without any regulatory oversight and in secret, CRIPSR has gained interest of policymakers and regulators. In terms of crops, the Court of Justice of the European Union in July 2018 already ruled that genome edited plants are subject to the same regulations as other GMOs (Callaway 2018). However in terms of livestock the verdict is still open

(see call for evidence on genome editing in farm animals by the Nuffield Council on Bioethics 2019 http://nuffieldbioethics.org/news/2019/call-evidence-genome-editing-farmed- animals). The verdict is not yet out because CRISPR, unlike old-fashioned GM might not be regulated as GMOs depending how a resulting organism is classified. If animals involve a transgenic trait, then they will be classed as genetically modified. But, if genome is edited, literally edited, then animals might not be regulated as GM. In the light of CRISPR, the technology used to make the Enviropig, became outdated, obsolete and classed as GM. However, if CRISPR was used to create the Enviropig, perhaps the future of the pigs and farming, would be very different.

And lastly, lack of time and funding to go through the Food and Drug Administration (FDA), and Health Canada approvals contributed to the project's closure. In the scientists' words:

> **Cecil**: We got funding for making a submission and basically we just kept on going until we ran out of money and also to the point when we felt that really the industry should be paying for it, not producers per se. The other aspect that was encroaching was now you can provide an additive to the feed which pretty much does the same job. Game over. (05 Nov 2014, Guelph).

> **John**: We ran out of money; we ran out of time: we are now retired, and we ran out of gas. We just did not have the energy to keep going. (06 Nov 2014, Guelph).

In summary, the most cited reasons were the public and the world not

being ready, lack of commercial interest, development of new technologies, solutions and competition. To use Sanderson's words, the Enviropig was:

> [...] cut by a mixture of actants including the complexities of regulatory frameworks, environmental and animal welfare concerns, and organised resistance from activists and anti-GM advocacy groups. (2015:261).

However, the reasons as to why it ended suggest something much larger, namely seclusion and hypersensitivity. Here I use Latour's (1996) explanation as to why something, for example, Aramis, a transportation system, fails:

> You had a hypersensitive project, and you treated it as if you could get it through under its own steam. But you weren't nuclear power, you weren't the army; you weren't able to make the ministries, the Budget Office, or the passengers behave in such a way as to adapt themselves to Aramis' subtle variations, to its hesitations and its moods. And you left Aramis to cope under its own steam when it was actually weak and fragile. You believed in the autonomy of technology. (p.292).

As I go on to show, the Enviropig as biotechnology was not simply "killed" by the outside reasons listed above. Its demise, I argue, was in its effort to become robust, to become sound and to speak for itself (using the Enviropig as its embodied version). The most tell-tale sign of this argument is captured in the words of Cecil, the creator of the Enviropig, who said:

> It's time to stop the program until the rest of the world catches up. And it is going to catch up. (Quoted in the New York Times, 03 April 2012).

Two years after these words were documented, I interviewed both Cecil and John who have had time to reflect on the project, their role, and what they have tried to achieve. In their own words:

> **John:** We were naïve when we started that.
> **Cecil:** Well everyone was naïve.
> **John:** And we were just two little scientists who had a big idea.
> **Cecil**: Not too little scientists! (06 Nov 2014, Guelph).

In Chapter 7, I return to matters of reflection and feelings, but for now I want to point out how these words reflect the story of Aramis, the failed transportation system and the efforts of its engineers to bring it to the public. In particular, the words of the scientists suggest that somewhere along the line, despite all the efforts taken and passions about the Enviropig, the project did not involve "the world" from the beginning. The sense of being naïve reflects that the programme was outside of it, created somewhat away from the world (Callon et al., 2009).

To illustrate my argument, I revisit the story of the Enviropig as efforts to create, maintain, and translate biotechnology. In doing so, I follow what Nathan the technology transfer officer said when asked where the project is now:

> …there is no real story scientifically to tell, the

> story is more of an historical story, of an attempt to do something. (04 Nov 2014, Guelph).

Perhaps that something was not just the Enviropig as an animal that could have been raised as any other farmed pig, but rather an attempt to move the world (Latour, 1983). To tell this historical story, I concentrate practices that did and did not take place, people and places, skills and knowledges, hopes and dreams, as well as human-animal relations.

I start with explaining the beginnings of the Enviropig and then I move to efforts to bring it to the world, although not completely. Here I show personal stories, accidental discoveries, passions, as well as efforts to keep going.

Biotechnology as dependant

In this section, I want to talk about those initial phases when biotechnology was still in its infancy and unprepared for what came after the late 1990s. I am focusing on the scientists here to bring to light the inspirations and process of making the impossible possible i.e. creating an animal that expresses a trait exactly where it was intended (salivary glands).

Here I argue that biotechnology is dependant, which means it does not stand on its own but rather needs others, whether human or non-human. I demonstrate it by telling a story about the scale of the

operation and involvement of people and places. This section supports my earlier argument that biotechnology is fragile as it needs more than an idea to hold.

Up until the late 1970s, biotechnology was within laboratory walls and the scientific community (Bauer and Gaskell, 2002) was interested in the role of genes and the possibility of altering them. In Europe, plans to scale up biotech research as well as the importing of GM products from the United States began to be contested from the late 1970s, and more strongly in the 1990s. However, in Canada the early 1990s were, as Jake, the policy adviser said, “the exciting times because they [scientists] were developing a new technology, (...) but also lots of promises about how it would help things, how everything was going to change completely” (Jake, policy adviser, 31 Oct 2014, Ottawa).

The reason for the excitement was that, unlike other breeding methods, the transgenesis technique (one of the biotechnological techniques) allowed the introduction of completely novel traits to genetically distant species. The notion of transgenesis (horizontal gene transfer occurring spontaneously) was already known to the scientific community through a study of microbial lifeforms, but the technique of transferring DNA from one organism to another was in fact performed in a lab on E. coli bacteria in 1973 (Bud, 1996).

Cecil and John, the chief scientists behind the Enviropig project, were among those who experimented with the notion of altering genes of living beings and applying some of the new techniques being developed

since 1973. They did not know each other even though they were both at the same university. Over the course of their careers they joined their research interests. The following excerpt from the interview talks about their initial interests, but more importantly, their upbringing on farms, which influenced their research careers as well as the Enviropig project.

> **John:** I was raised on a farm in northern Saskatchewan. I did a degree in Dairy Science, which is making market milk, butter and cheese, then I went on to study Human Microbiology, which I did for many years after moving to Guelph, and that led indirectly to our collaboration, back in about 91-92, and thoughts developed from there.
>
> **Cecil**: Oh yes, like my colleague, I was also born and raised on a farm, I think that actually circles around ultimately my involvement with the Enviropig. My undergraduate and graduate studies were in basic genetics using the fruit fly and I continued to do that throughout my academic career in Guelph, specialising in what was called 'reactive oxygen' asking questions about eugenics and ageing and lifespan. (5 Nov 2015, Guelph).

When they finally joined their research strands they looked into cows, in particularly the microbiology of digestion in the cow. Due to their training in biotechnology, they wanted to modify rumen microorganisms, which as Cecil said, "proved to be very difficult" (5 Nov 2015, Guelph). They then moved on to mouse models and coagulase enzyme but "it just didn't work at all", said Cecil. Coagulase enzyme reacts with prothrombin which then produces another enzyme which allows the conversion of fibrinogen into fibrin that clots the blood. In other words, if successful with coagulase they would have contributed to secretion of

an enzyme for therapeutic, human uses and as I argued in the previous chapter, biotechnology in medicine, although contested, is not as moving as biotech in agriculture. Perhaps, if they were successful, nobody would have heard about them as the creators of Frankenpigs. Unaware of what was to come, through the scientific exploration of uncertainties they looked for a different model i.e. an animal model, and a different enzyme. Through more failures and literature searches, as well as a stumbling upon a British scientist, they were led to phytase.

Their story is not too dissimilar to that of Ian Wilmut and his colleagues at The Roslin Institute. They too were interested in the idea of expressing a trait in lifeforms that do not express it. At Roslin, interest was equally tied to dairy cows to create a “manimal” – an animal that expressed human enzymes (Franklin, 2007). The frustration with not being able to efficiently produce such transgenic animals led The Roslin Institute to experiment with techniques of nuclear transfer developed by a Dutch academic in the 1970s. The technique was used to expedite the process of making transgenic animals, rather than to create cloned animals. Through the failures and frustration, Dolly (and predecessors) was born and “rewrote” the biological rule book (Franklin, 2007:36) because cells developed into an embryo rather than the udder cell lines from which they came.

Unlike the Roslin team, the Guelph team developed a transgenic animal – the Enviropig – to their surprise. They achieved what others could not, although pigs and phytase were not initially considered. But the notion

of expressing traits was. This was a scientific success from the perspective of achieving what is not possible, but of a different kind to that of Dolly the Sheep. However, upon the closer inspection, as this and the following sections show, the Enviropig was a heterogenous endeavour (Law, 1991).

It would suggest, especially when thinking about the previous chapter, that the animal made a difference to achieving the scientifically impossible in a few ways. Firstly, the pigs mattered to the biological success because of the familiarity and confidence being around pigs since farm days:

> **Cecil**: I think that I said larger animals, but indeed we were focused on the pig straight away because that was the animal that John has the confidence that we had a chance we could be successful. (05 Nov 2014, Guelph)
>
> **John**: I had a little bit of preliminary work on embryo recovery from pigs and I could do which end of the pig to work from and that helped for a while to get us started and give us confidence. (05 Nov 2014, Guelph).

Secondly, the success was possible because of the pig facilities at Guelph, and also veterinarians, animal technicians, agricultural assistants and the pig knowledge they all held. It is worth illustrating this point with the following view from John:

> You could not recreate that moment now at the University of Guelph. Those partners are just not there, the [unclear] government has pulled back funding for the animal research station, Ontario Pork are gone and onto other things, so it was a moment in time that happened to occur. It was a

> big operation; I was shocked how many people we had involved. I couldn't enumerate them now, and the extent of the animals and all of it, people who were caring for all of those animals and the veterinary procedures: it was shocking. (05 Nov 2014, Guelph).

Thirdly, the success was made possible due to the pig industry having an environmental problem, which was recognised by Ontario Pork. The connection with the outside was built upon a coordination of resources, which appeared to the scientists, as if spontaneously. At the same time the scientists emphasised that research facilities, staff, veterinarians, a talented PhD student, industry funding, backing from the Director of Animal Research at the Guelph University, and technicians made the programme possible. Familiarity of the pigs, knowledge of animals, and access to facilities made for pigs had to be in place in order to make the expression of trait successful.

The project converged and developed slowly over years through failures as well as alignment of spaces, places, people and animals. The scientists agreed that the Enviropig moment could not be recreated as it was a unique opportunity not because of scientific leaps but of the level of involvement of animals and people.

Unlike the official timeline posted on the University of Guelph webpages[27] (and described in Chapter 3) the beginnings of the Enviropig programme, at least as told by the scientists, were not as

[27] https://web.archive.org/web/20160130104858/http://www.uoguelph.ca/enviropig/index.shtml

deliberate as it seemed. Biotechnology as a novel science was here made in relation with mice models, familiarity with pigs, livestock, and the promise of a livestock animal able to produce an enzyme. Here then, biotechnology is made with being raised on farms, through searching for enzymes, concepts, and models, to having hopes, dreams and others who cared for animals and the project that is hard to replicate. Here it is not just viewed as “big science” that rewrote the rule books, but embedded, and grounded in spaces, places, people, and human animals which some but not all integrated in the research and development.

Here, the beginnings of the Enviropig as biotechnology embody affective scientific practices (Latimer and Miele, 2013). For instance, the scientists had, as Keller (1983) and Myers would put it (2008), a “feeling for an organism”, which means giving attention and care throughout the process of “giving life”: experimenting, doing things to cells, embryos, having labs and bringing people and animals in but also pushing scientific boundaries, caring for the science and technology and being curious. Their accounts suggest an element of attachment to animals and their own hopes. Their accounts also point out that they were equally moved by things that did work and things that did not. However, at the same time their story suggests all this needed an effort and engagement to keep it going, to keep it sound and exciting and to keep everything coordinated. This also needed an effort to keep some parts enclosed to some ideas and people which in a sense led to a blind spot:

not seeing that the pollution could have been solved otherwise, that genes can be copied and that the market is not ready.

The problem here is that the Enviropig project, as the scientists explained, was unique for Canada and beyond that the moment could have not been recreated. Indeed, without the funding, the facilities and animals, their project could not continue. The spatial enclosure of the project was not the culprit here, but rather a conceptual enclosure. The project did not bring, as Latour (1983) would say, all of the farm with it to the lab. Even though familiarity with animals, especially pigs, was in place, and staff knowledgeable about animals, the understanding of the market being tied to public opinion was not included. The project was not fully integrated with the outside, even though it was open in terms of what was displayed on the webpage. Here is how Jake, the adviser working at Agri-Food Canada put it:

> They put information up on their website that absolutely was not needed for them to do, but they did it because they thought it was a responsible thing to do. I think that is excellent, I really, really appreciate that. (31 Oct 2014).

Indeed, the webpage about the Enviropig explained the genetic making but not the day-to-day making of biotechnology (which I have documented in the previous chapter). In other words, the communication with the public did not contain the embodied and affective science, but rather, included science as a topic devoid of story,

feelings and certainly devoid of human-animal relations. The science, from technical perspective appreciated by molecular experts, was sound, and successful, but not integrated and engaged with how it is perceived, understood, and contested by others.

Biotechnology is moving

Having mouse models and a promise of unique yet ordinary pigs expressing an enzyme was not enough to keep the momentum of amazement going. The project had to move (Latour, 1983) physically and affectively. This implies transformation and becoming in relation to something else i.e. that one thing (for example an actor such as a mouse model) may stand for another (for instance a network such as “good” or “bad” biotechnology) (Law, 1992, 5-6). The project needed to be translated into replicable science, sustainable technology, and a product. In a sense, a story had to be built around science that affects beyond the lab.

To move physically and affectively, the Enviropig as an idea had to find a common ground amongst various groups of people. To do so, the Enviropig enrolled others with the help of new actors: a policy-in-between person; a technology transfer officer, and an NGO coordinator. The end goal of these new actors was not the same but the techniques they used were similar. Unlike actions taken in the lab (described in the previous section), here, moving practices were planned to some extent. But to move the Enviropig as biotechnology also required the "right"

sets of skills and tools, which were offered by Jake, Nathan, and Laura.

It needs to be noted that moving was not just in the hands of the scientists or in fact those on the side of the project. Here, I focus on the practices, people and processes that aimed to make the early mouse models stand for the working science and both friendly and unfriendly to the environment Enviropig. In other words, I focus here on biotechnology as enacted in the practices that aimed to translate enthusiasm and rejection about biotechnology to the world.

I will now introduce them by focusing on their sets of expertise and their roles in order to show that enactment of biotechnology is done by those who are for and against technology, but who were equally concerned about the same thing: the economy and democracy. The material presented here reflects and enriches the arguments (outlined in Chapter 2) made by Buttel (1998), Urbanik (2007) and Bloomfield and Doolin (2010) about both the opponents and proponents contributing to enactments of biotechnology.

Jake is a geneticist by training, with a longstanding work in the industry as well in the public sector, therefore, he acted (informally) as a liaison between the science and the public. In his own words:

> I play an in-between role and also being a geneticist is does help a little bit that I can relay some information. Sometimes you need people who will do that and make the connections that help out both understanding the industry, understanding the research side, understanding the regulatory and I am able to be in-between. (31 Oct 2015, Ottawa).

When I interviewed Jake, he worked at the Department of Agriculture and Agri-Food Canada. He was never mentioned by the scientists or the funder, but he was in fact one of the key people who helped to translate the research to the public given his previous experience and expertise. The reason he was not mentioned was that Jake, as he put it, was an in-between person, and so not formally a team member of the Enviropig project with clearly defined duties. In this department, he also worked as a secretary for the National Farm Animal Care Council, which is outside the federal government, but he represented animal welfare issues to the federal government via the Council. Jake used to be Swine Improvement Standards Officer to Canada and coordinated evaluation of breeding pigs. Because of his awareness of the pig sector as well as the policy and science, he worked closely with the Enviropig scientists, the government, the funder and the public. He continues to do this work with regards to GM salmon. He was also very eager to share the Enviropig story with me, along with his personal views about the project.

Nathan, the technology transfer officer, on the other hand, was responsible for translating the Enviropig science to the industry with a goal to commercialise animals. Academically, he was a trained mechanical engineer but then moved to the pharmaceutical industry. In addition, he is a trained veterinary and comparative pathologist with a PhD. A technology transfer officer is a person who takes the innovation outside of laboratory walls in order to create products and services,

advance society, and bring funds back to the university. Here is how Nathan described his role:

> I evaluate research for commercial opportunity and then I protect that research, usually through patent applications. And then I look for mechanisms to transfer that opportunity and technology to industry so that they can create services and products to bring forth in the world to advance their business and to advance benefits to society and hopefully bring benefits back to the university as well, both financial, social and environmental. (04 Nov 2015, Guelph).

Laura only partially rejoiced in the excitement part of innovation. I have been in contact with Laura since 2011 when I first reached out for views and opinions on my MSc thesis. Her background is in political science and she has been with the NGO for six years. In the following excerpt, Laura describes herself as a coordinator and more importantly an authorised spokesperson for the Canadian civil society:

> I work as the coordinator, so I do the bulk of the research and campaign plan and outreach two different organisations. I am the only staff person in Canada with a dedicated mandate on this issue, on the civil society. (29 Oct 2014).

On the whole she was interested in “the larger issues of how decisions get made and how is it that companies end up with a disproportionate amount of power over decision-making in a Canadian context” (29 Oct 2014, Ottawa). In addition to that, she has researched bovine growth hormone, which led her to continue the coordination of these issues in Canada.

Jake was crucial in ensuring the Enviropig was taken seriously by multiple regulatory departments, agencies, the research team, the industry, as well as the media. It appears that his in-betweenness and good contacts helped in facilitating conversations. But apart from his expertise, it was unclear how he ended up playing this crucial role. To which he replied:

> If there is ever anything that might cause a problem for the marketplace, and this is some of the stuff coming up in the news, it ends up coming to me to answer the questions and to develop responses, such that the Minister might use even in the House of Commons and so on.
>
> Or often it would come to me to work on how we would address these issues and provide the input coming from the regulators and everybody else, to say here is how things work and here is what we do. So that is why I am kind of the in-between person. (30 Oct 2019).

Laura's role was not too dissimilar to that of Jake, because just like him, she would respond to the news about the Enviropig and provide a response, using her public mandate and expertise. Here is how she put it:

> So, every couple of years there is a story about Enviropig and then as it got closer to approval and we were in a position to bring it to the public's attention, then it became part of our public discussion with people. (29 Oct 2019, Ottawa).

Nathan, on the other hand as a technology transfer officer, had to move others using word of mouth, by emails, phone calls and face-to-face

encounters. Articles, graphs and images don't seem to suffice. Communication channels even in the most advanced science can be the most mundane, but indeed necessary.

With regards to the Enviropig, this process can be seen in another excerpt below from the interview with Nathan. Here one can see what needed to be put in place, what needed to be enrolled for the Enviropig - unique yet ordinary - to carry on travelling (to around 12 to 15 countries), to become more than a scientific breakthrough, and more than biotechnologically modified animals for the pharmaceutical industry (known as pharm animals). The countries visited by the lead scientists, as Nathan put it, were “Argentina, lots of places in the States, China, Europe. He did a lot of presentations in a lot of places. And that is probably too many countries, but he did a lot of presentations in a lot of places” (04 Nov 2014, Guelph). The listed countries, in other words, reflect the map of the aquatic dead zones illustrated in Chapter 3.

It was an exercise of network building, of looking for a problem and offering a solution (the Enviropig) which was done face-to-face at conferences:

> Using a patent application and then we basically contact through any means – face-to-face, emails, phone calls, conferences, we contact companies who are in that space and say are you looking for new technologies?
>
> We do other things, we try to advertise and have a web page and use that, but the reality is that the best mechanism is either a face-to-face meeting which is hard, because you can't travel all over the world, or getting somebody on the

> phone or email, who is the right person, who is looking to expand their technology portfolio and say we have a technology here – it is early-stage technology, are you interested in this space? And if they are, they will licence it and invest the money in their own development to bring it to market. (04 Nov 2015, Guelph).

In thinking about biotechnology as a set of practices, what these excerpts suggest is that biotechnology is performed with different methods far from the methods performed in the laboratories and the research facility which I described in Chapter 5. These methods had to be performed to coordinate the multiple Enviropigs as well as emerging biotechnological techniques.

What this suggests is that an understanding of what biotechnology is, depends on what these translators are doing. While the enzyme was digesting and pigs expressing, scientists were developing ideas and making the impossible possible; here we see someone picking up a phone, talking to someone about a market, there we have a chat with policy-makers to explain what all this might mean to voters and customers in Canada and beyond. Graphs, proteins, charts, photos and blood samples – the many forms of evidence – need a spokesperson (Latour, 1983), someone who can tell a story that moves.

The skills alone, or the graphs and mouse models, do not move the world. The history of penicillin, the first antibiotic, by Alexander Fleming, is an excellent example of it. Fleming was a famously bad communicator and failed to translate the penicillin mould he accidentally

grew, let alone show the value of it. It took different scholars in another institution to move the world (Latour, 1983:143).

Unlike Fleming, the scientists behind the Enviropig knew what technology can do, but to move a novel technology out of laboratories they needed to relate it to those outside of the scientific community. Thus, after the initial success, the Enviropig began moving from a mouse model to a patent, then applications, and finally approvals. The skills were in place, but at the same time the science of the Enviropig had to find a common ground.

Biotechnology had to capture interest beyond the cluster of experts and those immediately drawn into the Enviropig project. John, one of the scientists, for example, envisaged Enviropigs as being fully integrated into the current pig markets.

> We envisaged, on the one hand, the scale of the whole of North America, saturating the North American pig market – why not? If it does what it says, why not? (05 Nov 2014, Guelph).

Nathan was of a similar view:

> It would be the same as any other commercial operation. Yes, you would produce baby pigs, and then somebody would grow them up into big pigs and slaughter them and send them for food. (04 Nov 2014, Guelph).

Their optimistic views suggested they wanted to appeal to industry and demonstrate that biotechnology would be easy to integrate. This was further supported with ways in which the Enviropig was enacted as meat

and ordinary pig (see previous chapter).

However, the vision of a future where Enviropigs are raised on every farm was not without the risk. But for Nathan, the risk was due to having a potentially expensive and separate food supply chain for GM pigs. Here is Nathan explaining the consequences of commercialising GM pigs:

> **Nathan**: The problem is that unless the government said otherwise, you would have to designate them as a different production line in a production facility so that you could keep control that all of this meat was of this type.
>
> Unless it was de-regulated, if it was de-regulated the way that genetically modified corn is in North America when you buy corn, you don't know if it is genetically modified or not; they don't separate the production food lines, they don't package it differently: it is deemed safe and healthy the same as normal corn. So it can be integrated equally, but the Enviropig would not be commercially developed and sold that way.
>
> **KR:** Was that one of the concerns as well?
>
> **Nathan:** Oh, sure, it is a huge cost. (04 Nov 2014, Guelph).

To reduce the risk as well as the costs, the animals would have to be regulated as any other animals destined for human consumption. That would require a process of normalisation whereby the Enviropigs would be equated with farmed pigs yet marketed as "boosted" versions of their non- modified cousins. This double-being was also not without challenges, as shown in the previous chapter.

So far, the presented practices suggest that biotechnology was spread across different people, channels of communication, and appeals to

market, food, and farming. These practices, however, lend themselves to contentious discussions about the scientific method being subjective, infused with the social, personal, outside, commercial, and political.

As Laura put it:

> [...] it is endemic in Canada that university researchers undertake their own exciting research, which is great. They try and make it relevant to the world and our government - is very clear that they want research to be commercialised. But there is a disconnect, because we need academics to be doing research on various questions that aren't necessarily commercially relevant. But if they are doing research on technologies or products that they want to bring to market then they definitely need to have that dialogue with farming communities. (31 Oct 2014, Ottawa).

What we see here are two things. Firstly, these multiple practices and voices of biotechnology illustrate it is a dispersed activity. As Mol (2002) argued in her ethnography of atherosclerosis, "medical [or other, my addition] practice is never so certain that it might not be different; reality is never so solid that is singular. There are always alternatives" (p.164). It means that it depends not just on things and human-animal relations (see previous section) but also interpretation of what is.

From the perspective of the people moving the Enviropig, it suggests that biotechnology is tied to market, and regulations which defined its status and transparency. For Laura, the Enviropig provided an impetus

to bring the biotechnology closer to the public and make a room for it. Biotechnology was therefore enacted in practices tied to how biotechnology was performing under regulatory regimes. The more it was approved, the more urgent it was becoming. Here is how Laura put it:

> So we keep on top, politically and practically, what products are going to be released onto the market, but what are the more immediate threats. If we spent our time monitoring the minutia of who is tinkering around with what we would get lost in the morass. You know people talk about GM animals waiting to be commercialised, we are interested to make sure that we know what is coming forward, but there are endless projects inside universities and the relevancy of those should be tied to public opinion: that is where our work comes in. (29 Oct 2014, Ottawa).

It is also worth pointing out that while pigs were in a research facility acting as other pigs (see previous section) and in Laura's office embodied in a plastic toy, biotechnology was also dispersed. For Nathan and Jake, biotechnology was embodied in application, in telephone conversations or patents, while for Laura it was embodied in files, petitions and posters.

In fact, both said, that the Enviropigs are literally (as shown in Figure 17) and figuratively (see excerpts from the interview) on the shelves and can be picked up at any time – either to be commercialised or contested:

Figure 17. The Enviropig on the shelf at CBAN HQ.

Laura: It is literally on the shelf, so theoretically at any time a corporate investor could revitalise the project and invest in a new stage of research and development. (29 Oct 2014, Ottawa)

Nathan: The idea is on the shelf and the animals are all dead and semen from the ninth and tenth generation (…) is in storage in a government facility in Saskatchewan and it will probably stay there for 20 years unless somebody has a possible use for it. (04 Nov 2014, Guelph).

What this suggests is that not only was biotechnology multiple and enacted variously, it was also emplaced in multiple headquarters or centres of translations from which they were moving. This is not too dissimilar to a study by Bloomfield and Doolin (2011) who noted that both proponents and opponents were active in defining what is, plus what is needed in biotechnology to bring forward their own arguments as to what is right – not just in terms of science, but agriculture,

community, democracy and even (as their study showed) good motherhood.

Following from that, and in the light of multiples views as to what biotechnology should be, I argue this section also pertains to the notion of what is good biotechnology. As Laura put it:

> Just because you have some good and exciting research about genetically engineering an organism doesn't mean that it needs to be commercialised to be a success. (29 Oct 2014, Ottawa).

But, thinking about calls for research to go beyond lab and into the society and markets (the Research Excellence Framework's impact agenda in the UK comes to mind) her view mirrors much wider contestations as to what counts as good, responsible biotechnology and science at large (see Nerlich et al., 2018; Owen et al., 2012). Biotechnology, however, is particularly affected by a debate as to where it should stop – at fundamental research, at discoveries, or in fact delivering products to the public that fund research through taxes and governmental research programmes.

The Enviropig as biotechnology took the risk of going beyond research in labs, beyond fundamental research, and aimed to be commercialised. The research team believed they had a good product, a product that benefits animals, farmers and aquatic life, thus from *their* perspective biotechnology met the criteria of good.

However, as Laura, and indeed the events that followed suggest, this

was not enough. To be good biotechnology means to include the neglected things (Puig de la Bellacasa, 2011, 2017) such as concerns of the public, feelings of fear, a long-term view about impacts on production of food, impacts on relating to animals as black boxes devoid of feelings and their history. In other words, doing good biotechnology it is not just about delivering a safe product or being open to auditors and journalists and even researchers like me, or explaining how it all started. Good biotechnology would stop and consider the feelings that arise and concerns that follow, no matter what. The reasoning, as Whatmore (2009) said, would be "forced to slow down", creating opportunities to arouse "a different awareness of the problems and situations that mobilize us" (p.588).

The right ingredients, the willingness and awareness were there, but not fully. I feel for the project and I feel for animals not being with us anymore (in Chapter 7 I will go back to the point of feeling the affective, in more detail). But, as I will explain in the next section, the missing ingredient was the inclusion of other ways of knowing.

To sum up, the multiple and dispersed practices of biotechnology prompt a rethink of what biotechnology is, and coordinates it in multiplicity (Mol, 2002). The making and coordination of the multiple suggests Enviropigs as animals and biotechnology pointing to instability (Latour, 1996; Sanderson 2015) despite efforts to hold it as unique with patents, regulations and backing up with data, as well as skills and searches for common ground. Unstableness of the Enviropig points not

to science being flawed, unnecessary and scary, but of its fragility in the quest of becoming robust.

In the next section, I will turn to the practices that enacted a version of biotechnology which emerged as further signs of fragility.

6.3 Biotechnology as engaging half-heartedly

As mentioned at the beginning of this chapter, when the Enviropig was being tinkered with in labs, biotechnology as science was not disputed in Canada as strongly as in Europe. The GM issue along with the agri-food and animal welfare, as I show later, are still not at the forefront of public concerns in Canada.

Awareness of the public feeling uneasy about GM was there, but not engaged with fully, perhaps to avoid controversy. Hence, this section talks about half-hearted engagement not as a formal consultation (which happened only with the farmers belonging to Ontario Pork) but as lack of engagement with different types of expertise (Callon et al., 2009) and different experts within and outside of the Enviropig. Half-hearted here symbolises affect and emotions that were not appreciated.

Affect in this section refers to affective aspects of public understanding of science i.e. fear, embodiments, human-animal relations; understanding of the opposing and multiple groups mobilised, not

mobilised and enacted. The lack of engagement, or rather affective engagement, with the Enviropig project, points to biotechnology being fragile - secluded yet sensitive to change. I base this argument on the interview material around the notion of engagement, science communication and public understanding. I start with excerpts illustrating what kind of engagement took place and what kind did not. I would like to draw attention to enactments of the public – the farming communities, the public as a concerned citizen, consumer and uneducated "public".

Enacting the publics

In this chapter I have already mentioned that a consultation with "the public" did not take place early in the project. Only the farmers signed up with Ontario Pork, potential pork breeders and the industry at large across the world were engaged with. Arguably, the conferences, telephone calls and patents (see previous section) could be considered as tools of consultation with the industry. However, I would resist that and instead continue viewing these tools and skillsets as forms of moving the world, informing the world, but not necessarily consulting. While analysing the material and discussing the reasons (symptoms of fragility) that ended the project, I focused on the underlying issues that led to the end of the Enviropig. For example, I was drawn not just to the scale of the operation and its instability, but mobilisation (Driessen and Khortals, 2012) and enactment of different groups, different publics.

It emerged that a formal consultation with farmers took place (which I go on to talk about) but that consultation, as well views about it (as shared by Laura, the NGO coordinator who campaigned to stop the Enviropig), mobilised different groups of farmers and "the public". The further question thus emerged as to who the public is in the Enviropig as biotechnology story.

The affective enactment analysis of the material thus pointed not just to mobilised farmers, but enactment of the public as farmers, public as concerned citizens, public as consumers and uneducated consumers. I will explain them one by one (using excerpts from the interviews) and then summarise the section about half-hearted engagement as an ingredient of fragile biotechnology.

Building on Lezaun and Soneryd's (2007) argument that the definition of the public matters greatly, I show that indeed, the public being defined in various ways led not just to failure of the project. From the perspective of the literature, the enactment reveals a moral world by design and production of the "useful" publics.

The public as farmers

The funder, being a representative of pork producers, engaged with them via consultations and project reports and in doing so, Ontario Pork gave a social licence for the technology. This was achieved through ongoing involvement of the board and research committee. Together, as Carol, an Ontario Pork representative, explained, there were 10-12

people representing the producers who, through a mandate, agreed on the project. The decision was made on the basis of economic value. In her own words:

> Yes, there always has been [consulting]. At that time, we had 14 members on the Board of Directors, and I think there were five Board of Directors sat on the research committee and we also pulled in producers to sit on that committee and some industry representatives.
>
> So, it was a collective committee of about 10 or 12 people with representation from the different organisations that would have evaluated it and said that we can see value in this research, it is something that we should fund. (06 Nov 2014, Guelph).

Laura, the NGO representative, acknowledged this (see excerpt below) however her words here clearly mark a distinction between the farming community and the public by the Ontario Pork producers:

> … any kind of dialogue with the public, and particularly the farming community, was missing from the research and development of Enviropig.
>
> I guess in Enviropig they did have a measure of consultation and consensus from Ontario Pork. So, Ontario Pork had given them the social licence, or certainly licence within the farming communities to say go ahead with this project. (29 Oct 2014, Ottawa).

The farming community to Laura, as the interview with her explained, was a community not located in Guelph, but a wider, larger community not belonging to Ontario Pork, one resisting the developments that could affect them. The farming community which the scientists and

Ontario Pork engaged with were not just those that belonged to Ontario Pork, which Laura sees as tight knit (see excerpt below) and at that time, in favour of genetic modification:

> … the community in Guelph is quite tight knit and it is a very early and a very adamant supporter of genetic engineering, so you could see that a commodity organisation which is based in Guelph and integrated in the community would decide early on that this is a very exciting type of technology and that they should get on board because there is only a bright future for genetic engineering. (29 Oct 2014, Ottawa).

However, when I asked who she worked with, she mentioned the National Farmers Union (who did not engage with me, see Chapter 4) and hog producers, not the scientists John and Cecil, but "other people in the field and people who understood the technology of the phosphorus supplements or the phytase supplement" (29 Oct 2014, Ottawa). In addition, as indicated in Chapter 5, Laura, although working with a different community to that at Guelph, also focused on economic aspects of the Enviropig – not as gain, but as loss. She also did not focus on environmental or animal welfare aspects.

Jake, however, worked with the farming community and yet the focus was also on economy and trade:

> The industry concerns were if something like this could be approved in Canada for release in use in food but not yet in other countries. We are an exporting nation, I believe that we are the third largest exporters of pork in the world – can you imagine what would happen to our export business if it got into the export stream, just because it was approved in Canada, but not

> approved in any of the other countries? (31 Oct 2014, Ottawa).

Engagement here emerges as being focused on a similar aspect - economy - just with different groups which are represented by proponents or opponents. Community, the farming community, thus emerges here as both local and much wider, somehow in opposition and with different outlooks on aspects of GM. The Enviropig as biotechnology, through engagement, assembled farming communities of different kinds, in different places and standing for different visions of pig farming, but with the same goal. In other words, pig farming was still a goal for both proponents and opponents of biotechnology.

However, Laura as well as Jake, even though they cared to keep the pig exports unaffected by the GM label, were both equally concerned about farming in Canada in general. Jake, who oversees animal welfare in Canada, spoke about finding a balance between trade and animals, which he cares about:

> I grew up and I worked on farms that were quite different from some of the farms today, and some of the things that I see happening out there that I don't like either.
>
> Some of the practices, in fact some of the farmers, don't like them, but this is something that may be necessary in terms of the overall productivity and the economics and this is why on the welfare side we are trying to put in place national standards that make sense, that are good for the animal, good for the productivity but also address some of the welfare issues that are obvious and that nobody wants to accept in the industry. (31 Oct 2014, Ottawa).

Similarly, Laura, when speaking about those commodity organisations i.e. producer association such as Ontario Pork, recognised the resistance to change existing in the farming community at large, irrespective where they are on the issue of GM:

> They are constantly fighting back against public opinion that is asking them for change and they are very defensive about their production methods, so there is also a dynamic there in the farming community where there is deep resistance to consumer trends, but also certainly evolving and consistent consumer opinion on certain issues. There is very little room for reconciliation. (29 Oct 2014, Ottawa).

What the above excerpts suggest is that they both cared about farming, animal welfare and the economy, therefore they should be working together united by their concerns. I will come back to the issue of farming, and especially its future of in Chapter 7.

However, in thinking about half-hearted engagement, this section suggests, especially in terms of Jake and Laura, that an opportunity was lost to connect opponents and proponents of GM over the main issue, which is farming - livestock farming. This is, I argue, an example of half-hearted engagement: two sided despite mutual care about animals, farmers and consumers. A full-hearted engagement would unite over the mutual concerns and incorporate different ways of thinking, rather than differences in opinion.

Concerned citizen

Coming back to who was the public, the interviews about lack of engagement indicate that in addition to the farming communities, “the public” was enacted in a similar manner by both opponents and proponents. In Chapter 5, I mentioned that opponents, proponents and the media appealed to “the public” by referencing to food, environment, polluting pigs and pink pigs.

Thus, what these references, frames, anchors, and on the whole, enactments of the Enviropig in relation to pigs suggest, in light of this section, is that the public is enacted as a consumer, aware of animals, and afraid, uneducated about technology. I will now turn to the interview material to illustrate my argument.

In the interview with the NGO, there was no focus on how the public makes decisions, but they were aware of the views of the public and what the public should care about (recall Laura’s words in Chapter 5: “The public care less about this or that supplement - they don’t want to eat GM pig”). I asked how she knew about what “the public” thinks to understand the way in which this NGO works and enacts the Enviropig (see previous chapter) and different groups. This longer excerpt thus captures the work of this NGO and enactment of the public.

> **Laura**: Because we work consistently over the years with communities in Canada we can see what people are saying about the GM pig, but by the time we were engaging most actively on the issue there were a lot of public opinion polls from the United States about the GM fish and we had some older polls about general GM acceptance.
>
> And we asked those organisations that have an investment in this technology what market research they had done. Obviously, they had not done any and if they did do some, this is the conclusion they came to – Enviropig was no fun. So, we didn't have the money to engage our own public opinion poll, I am sure if we had, we would have come up with the same conclusion as the scientists. (29 Oct 2014, Ottawa).

The interesting point here is that Laura did not rely just on work with the public in Canada, but on the polls in the United States. The public in Canada was therefore also enacted in relation to the public in the United States, specifically the public that does not want GM. However, Laura's view or the source of her knowledge about the public runs in contradiction to the literature on public opinion of GM in the USA (Mintz, 2017; Gaskell et al., 2001). This opens the question as to which polls were used, who was the public in the United States, and how the public was enacted in the polls mentioned by Laura. In addition to these, Laura shared concerns over regulatory aspects with the wider public. In her own words:

> … so for the public, our main communication was 'this GM pig could be approved soon. Do you want it? No? OK, let's stop it'. (29 Oct 2014, Ottawa).

The public, at least in the interviews, emerges as a concerned citizen (but also fearful and uneducated one which I will illustrate later) who does not want GM products approved.

A concerned citizen also appears in the interviews with Jake. Jake, the adviser at Agri-Food Canada. He also worked with the public in Canada but through different routes. He was responsible for interpreting letters sent to the Ministry, and communicating the science of the Enviropig. In the following excerpt, Jake paints a picture of the public as weighing pros and cons but fearful of the arrival of numerous "others":

> Many times when I see letters going to the Minister, I have to interpret what are the real concerns? One of the concerns is 'OK we might agree that the Enviropig is a pretty good solution to this problem and it addresses the welfare of the pigs, it addresses some of the environmental contamination, it will reduce the costs of production – all good things, but I am afraid that as soon as you allow the Enviropig they will allow a whole bunch of others to go through'.
>
> So that is the general fear, people imagine that as soon as scientists get involved and they are going to be genetically engineering – people still go back to Frankenstein – and that is why they use the term Frankenfood, they automatically attach a very, very negative connotation to anything being developed. (31 Oct 2014, Ottawa).

With Jake and Laura, although working differently with the public - one involved in, and the other interpreting letters - the enactment of the public is rather similar. The public is concerned and afraid of not just one GM product, but the fact that more products developed by scientists in labs will be approved. So, the concern is over the regulatory process

as well as science being irresponsible. However, as Nathan, the technology transfer office (and also Jake to some extent) argued, the fear of GM products and science stems from ignorance. Here then, the concerned public is also done in relation to an uninformed public:

> The world is still afraid of genetically engineered foods, mainly because of misinformation, or they don't understand the real risk assessment. And so, in the lack of understanding, or in the lack of verifiable information, they take a precautionary principle and they say they are just not going to eat genetically engineered or modified foods.
>
> If they [the public] truly feel that they understand the science and they are making an educated decision, then they are entitled to do that. But if they are making decisions based on a lack of understanding then that is a totally different problem. (04 Nov 2014).

His words echo what the literature refers to as "the deficit model". It holds that if people were more educated, they would more easily accept it (see Castle et al., 2005). In the excerpt used here, there is a picture of a citizen who is entitled to decide based solely on their level of knowledge. Education, to clarify, would have to equate to scientific knowledge.

The public as a consumer

The public was also enacted as a consumer motivated by price and, as Jake noted, affinity with animals. Jake, as mentioned already, also views the public as a concerned citizen who needs to be told how

science works, but he stressed that the challenge lays in how this is done. In other words, he still aimed to engage with the public irrespective of their views and knowledge. He saw it as his responsibility as a public servant. Jake noted that the public's perception (in addition to being insufficient in knowledge) is influenced by their (lack) of proximity to farms and animals:

> In the 90s when the first GMOs (I do not even like the term) for plants came about, it was basically for grains and oil seeds. So genetically engineered corn, soybeans, those are the ones that were being dealt with at the time, not animals, not vegetables and fruits, but grains and oil seeds. But all grains and oil seeds are always further processed, they are bulk handled, consumers do not go and buy a bucket of grain from a store, so it is very different.
>
> So, if people reacted strongly and negatively to genetically engineered grains and oil seeds, we know it is likely to be stronger on the animal side, and in particular on the animal welfare side. (31 Oct 2014).

With regards to what counts as valid public knowledge, the above excerpt indicates that the Enviropig team recognised other factors influencing the public's views but have not engaged with it early enough. Animal welfare, as mentioned several times already, was not much of interest to the public because the majority of the campaigns related to trade and price.

However, what emerges is an awareness of the public as shoppers who make decisions as to what they buy. This came out rather strongly in the interview with Nathan, the technology transfer officer working at

Guelph University. His view about the public was linked to shopping, being moved by price rather than causes like animal welfare or environment protection:

> [...] If the product was significantly cheaper, like you could buy pork for 10% of the cost of normal pork, it would probably sell.
>
> Because even though consumers, and I don't have data to support this, even though consumers often say they care about the environment, they care about health, they care about the ingredients, they care about everything else; in consumer surveys on consumer responses if you equate that to consumer behaviour, price is the largest driving factor.
>
> So, they say that they want something healthier but, in the end, they buy the cheaper one. If by chance we were producing pork extremely cheap I think both companies and consumers would adopt it a lot more readily. (04 Nov 2014).

The excerpt is suggesting a curious shift, from seeing the public as an uneducated group to a consumer motivated by a price. Studies of the public perception of the Enviropig indicate there is a myriad of other concerns, with price being one of them, but what this excerpt shows is a prevailing outlook of the public as a "dupe" (Gabriel and Lang, 2009).

By demonstrating the types of publics that were enacted in the interviews, I have extended the argument of Lezaun and Soneryd (2007) who, having analysed two types of public engagement, noted that the public counts as one as long as it is useful. In other words, the public as a consumer who is arguably motivated by price only, confirms

the assumption of the decision-makers that the public has no other interests therefore all decisions should be left to the market. The public as a concerned citizen is understood as one that is engaged in politics, therefore decision-making should be expressed through voting.

But, as Gabriel and Lang (2006) argued, concepts such as citizens and consumers are no longer separate, as well as there is no difference between the producer and consumer. A farmer for instance, is not a single concept either, because as this section shows, the understanding of what a farmer is was enacted in various places and in relation to the market and the environment. From the perspective of engagement with the public, the idea of "people, farmers, the public" as enacted is very important because it sets the tone of how these "publics" are engaged.

As enacted, so engaged

Thinking about science-public engagement literature on farm animal biotechnologies, the material presented here puts a finer point on the meaning of the public and ways to engage with it. I showed that the term public meant specific people (e.g. farmers who are part of Ontario Pork) or public as consumers of pork, or public as citizens of Canada who exercise their democratic rights. The repercussions of this undisclosed segmentation is that it dictated specific engagement styles deployed by both the opponents and proponents.

For instance, formal consultation via research committee boards took

place, but only with farmers who are members of the Ontario Pork, indicating that not all farmers and the wider farming and livestock communities were involved. To address this gap, the NGO engaged with farming communities not just in Ontario but beyond, and mobilised the farming communities that think differently about GM.

The public as a concerned citizen was engaged with, but only by Laura and Jake, whose role was to interpret letters sent to the Minister of Agri-Food Canada. Their engagement however was different in terms of the concern in focus – Laura was stressing the issue of decision-making and democracy, but less animal welfare. Jake on the other hand was interested in animal welfare but focused somewhat on the fear of GM animals being approved. Both, however, shared concern over agriculture and livestock farming and communities that do not respect animal welfare.

The public as a consumer was not engaged with at all, even though awareness of other ways of knowing, motivations and relations to animals as opposed to plants was there. Instead, the proponents emphasised the importance of scientific knowledge, pointing out that public is ignorant. While it seems obvious that a grain differs from a pig, and the interview with Jake show he was aware of it, there was, and still is, lack of practical and critical engagement with this topic. It was exemplified as “one size fits all” regulation, and general misunderstanding of the issues from a non-scientific point of view.

One of the biggest lessons for the proponents was lack of know-how when it comes to dealing with the public and, in general, lack of engagement with who the public really is, what it is that should be discussed, and how to communicate without sparking fear. For example, Anthony, the environmental risk assessor put it this way:

> I think that is a challenge that the scientific community as a whole, faces. In the day and age where we are, where news clips are instantaneous, twitter with 130 characters, or 126, whatever. It is a lot easier to create fear with 126 characters than explain why something works in 126 characters. We have to find as a community, a means by which we can address those fears, with that many characters. I don't know how to do it. (29 Oct 2014).

However, Anthony as well as the others recognised there is a need to introduce other aspects into the assessment portfolio of GM, but the problem once again boiled down to a lack of knowledge regarding how to do it. The problem, however, I argue, is not just about not having the right tools or knowledge, but about knowing how to think with the others. As Laura noted, introducing other voices and concerns is messy and perhaps even obstructive. In her own words:

> Our [Canadian] entire regulatory system is designed to facilitate the approval of genetically modified products; introducing democracy into the decision making is unpredictable, it is messy, and it could stall or stop certain products. (29 Oct 2014).

To sum up, in response to Laura as well as this section, I want to stress

that engagement no matter how messy is crucial to avoid controversies and to create innovations that truly find a common ground among all types of the publics, including animals. However, the question is when to start doing it?

The story of Enviropig as biotechnology illustrated that lack of engagement early in the programme was indeed not the only problem, but rather who was and was not mobilised. This section mirrors the cases of pig towers and in vitro meat in the Netherlands (Driessen and Khortals, 2012) where similarly, proponents engaged with some but not all communities. For example, the pig tower concept involved farmers and nearby communities in close proximity, while the in vitro meat concept did not engage farmers at all but, engaged the wider public and the NGOs. In doing so, these concepts, as Driessen and Khortals (2012) argued, disclosed moral worlds by design that revealed who is a political subject, decision maker and so forth. However, the lesson stemming from the Dutch examples, as well as the Enviropig, is to consider novel technological developments as prime occasions for all kinds of public deliberation rather than a threat to existing processes (Driessen and Khortals, 2012: 799).

Following on from that, enactment of the public matters greatly as it reveals the politics of public- science dialogue. As Lezaun and Soneryd (2007) observed, just because the general public was allowed to voice an opinion in the *GM Nation?* deliberation programme, it did not mean that each member of the public in the UK was considered the right kind

of the public. The evaluation of *GM nation*? showed that only those without prior knowledge and involvement in GM counted as the ones who are allowed to speak out. The reason was that any prior knowledge would sway the public's opinion.

And yet, when analysing the interviews with the Enviropig team (those for and against) it emerged that the right public was the one with knowledge and motivated by price. The story of the Enviropig thus shows the enactment of the publics is not just about the right ingredients of deliberation methods, but who is allowed to deliberate, or as Lezaun and Soneryd (2007) put it, who counts as the public in the eyes of those who create the spaces for deliberation.

6.4 Chapter Summary

The aim of this chapter was to address the question 'how was biotechnology enacted around the Enviropig'. By attending to practices, I noted multiplicity of agents, hopes and dreams, lack of time and energy, familiarity with pigs based on upbringing, skillsets, views and opinions in relation to one's work. I have interpreted them as heterogenous practices of science-making: multiple, personal and changing. But, the practices around the Enviropig, also indicate that biotechnology emerged as fragile.

Fragility, in everyday language, implies handling something with care to avoid damage during transport. It also implies that a fragile object needs to be protected from an outside environment.

Handling with care, thus means being gentle with an object by following instructions such, as “this way up”. But, fragility, according to Taleb (2012), means that an object is secluded from the outside forces, wrapped up, and kept in the dark to avoid any damage. In the same way, the Enviropig project was secluded from the outside ideas as to what sustainable farming might be, wrapped up in scientific language to make it safe, and in a way, was also kept in the dark (research facility) away from the public. In the light of the literature reviewed in Chapter 2, handling with care would imply engagement with different types of knowledge, with different experts. Handling with care, would mean opening the doors to the story of science as practice and showing how really biotechnological animals are created. It would also imply engaging with alternative solution, and, of course, engaging with the public and what they care about.

This chapter, in many ways, reflects stories of science and technology familiar to scholars and readers of STS about “things” failed to be translated, hold themselves together, to speak for themselves. On the one hand, those against GM farm animals can feel confident these animal innovations do not end up on dinner tables - yet.

The lessons, however, are still to be explored to avoid fragility and instead become fully affective (Latimer and Miele, 2013) and hybrid (Callon et al., 2009). The aim of affective and hybrid science is to create the kind of science, that uses, rather than avoids, uncertainty and randomness to learn from. As Latimer and Miele (2013) put it, affective

science leads to good science that is:

> … recognising, being open to and even promoting in any research design how human non-human relations affect and what knowledge is produced. (p.8).

In other words, if good science is clear about its interests and concerns, it then becomes more reflexive about its own "products" whether it's the tools, the science itself, the way of looking, or the things that left laboratories be it knowledge, patents, animals, microbes, drugs, or expertise.

By demonstrating the fragility of the Enviropig project, I extended Callon et al.,' (2009) argument that secluded research fails as a scientific research but also as research that aims to benefit others. If science, Callon et al., (2009) argued, is to create a better world than it must open the doors, engage in conversations and listen to others. It needs to be created with others in mind and must incorporate concerns that go beyond market regulations or genetic risks to feral population of animals (as it was the case in the Enviropig, see Chapter 5). In doing so, science that is hybrid and affective, has got the potential to enrich both, democracy and science.

In the next section I therefore ask how affect can be found, and how can it be added into science- making to avoid spill over effects and causing radical controversies (Callon et al., 2009). To do so, I continue to learn with and from the Enviropig.

Chapter 7. The Enviropig: a moving story

7.1 Introduction

This chapter addresses the third and the last research question, ‘what is the Enviropig’s potential role in navigating through controversies surrounding GM animals?’ This question, in many ways, emerged out of, what I thought was a personal failure to define the Enviropig and learn from the case study.

I remember, vividly, being upset by my inability to pin the Enviropig down. Was the Enviropig an animal, and if so what kind? Was the Enviropig a project and if so, what kind? Was the Enviropig a reflection, as some would argue, of society? Was the Enviropig an example of molecularisation of sustainability reflecting a life sciences paradigm in the livestock industry? Or, was the Enviropig, to borrow from Sanderson (2015), an assemblage? Or, was the Enviropig a misunderstood monster and a hybrid (Haraway, 1991)? Or, was the Enviropig a mixture (Franklin, 2007)?

Given that Chapter 3 showed that the Enviropig was more than one animal, more than a pig, and went through cycles of acceptance and rejection, it was important to revisit the story of the Enviropig. In particular, as postulated in Chapter 2, it was crucial to engage the neglected things such as, animal and emotional histories of science as practice in mind.

This is why Chapters 5 and 6 looked at enactments of the Enviropig in the media, in practices, and in memories with emotions in mind. The Enviropig emerged as a multiple animal who was not only friendly, ordinary and monstrous, but also rich in history of domestication and stories of other species. The Enviropig emerged both as an animal and science that was in need of attention, in need of translation and maintenance by both opponents and proponents. Chapters 5 and 6 offered insights that pertain to the value of dismantling “sticky” bundles of text and practice that reinforce vision of pigs as industrial pigs, science as robust and public as uninformed.

But, thinking about the aim of this thesis, which is finding ways to live with radical controversies, I set out to learn from the Enviropig. As I noted in Chapters 2 and 4, feelings and emotions needed to be taken under consideration too, given their presence in discussions around GM but also around science, animals, positionality and care.

However, as I argued in Chapter 2 and again in Chapter 3, when it comes to farm animal biotechnologies, there is still a scope to bring emotions into the analysis. More specifically, there is still potential to rethink the role of GM animals from the perspective of affect as a force that connects (Ahmed, 2004) rather than disconnects. So far, the literature on farm animal biotechnologies does not speak explicitly about the role of GM animals as a force that connects. Rather, as I have shown in Chapters 2 and 3, as well as Chapter 6, the role of GM animals is to warn the reader about growing concerns and to exemplify

mechanisation of animals. Although I don't dispute those concerns, at the same time I argue that there is a room to rethink the role of GM farm animals.

Therefore, In Section 7.2 I outline some of the most common roles assigned to animals. I then focus on the affective roles of the Enviropig where I note that the animal, even though it is already gone, has in a sense, moved me and others.

In Section 7.3 I discuss the material presented in this chapter and ask whether the Enviropig's role could be associated with that of a counsellor.

7.2. The helpful roles of the Enviropig

In art, literature, and mythology, it is not uncommon to find references to animals as ones that help and serve (Alves and Barboza, 2018; Franklin, 1999; Fudge, 2004). Their role is often depicted as utilitarian helping the mankind, albeit without ever being asked whether they are willing to offer their flesh and services. But animals in mythology also play a role in explaining the mysteries of the world when they are depicted as ones that created the world and ones that can destroy it. The role of animals is also to offer lessons about recognising what or who is good and bad. As mentioned in Chapter 2, stories about animals can have a great influence on ways in which we, human species, relate to animals and how we then affect their lives and deaths. So, how we

tell the stories about animals and how, as Ahmed (2004) in writing about a girl and a bear noted, the stories are interpreted, is important.

In this section, I want to temporarily suspend a critical reading of animal labour from the perspective of an exploitation. Instead I want to think of the Enviropig as an animal that moved others. In other words, I extend Law's (1991) notion of a hopeful and Latour's (2011) notion of a helpful monster. To recap, a hopeful monster speaks to the idea of things being connected and heterogenous, rather than disruptive and controversial. The hopefulness is about the affect of monsters: they show that "inconsistencies and overlaps [can] come gently together (Law, 1991,p.19). Helpful monsters speak to the notion of "new" things teaching us how to care about technologies (Latour, 2011).

The idea of the Enviropig as one that is moving others, emerged during an interview with John and Cecil, in which they shared with me one of most interesting and puzzling ways to describe the Enviropig:

> The Enviropig is an avatar. (05 Nov 2014, Guelph).

I was intrigued by the idea of avatar, but for a long time, I could not understand what he genuinely meant by that. I did not expand on this during the interview, which I regret. As mentioned in Chapter 4, at times, my courage was not always there. Instead, I said:

> The Enviropig is a proxy. (05 Nov 2014).

By saying this, I meant that the Enviropig is acting on behalf of others.

At the time of the interview, I was not yet fully aware that both of us were thinking that there was something special about the Enviropig. Special, here, did not mean being transgenic or environmentally friendly as shown in Chapter 5, but special in a sense that it is transcendental i.e. going beyond itself, and in doing so, offering insights.

Having engaged with the interview material, the Enviropig as an avatar started to make more sense and so did the idea of a proxy. Avatar, in Sanskrit, means to descend, to embody something greater. In popular culture, especially gaming, avatar means donning a different persona, an alter ego. In Hindu mythology, the third of the ten avatars of the Hindu god Vishnu is called *Varaha*, (Sanskrit: “Boar”). In painting and sculpture, *Varaha* is represented either in full animal form or with the head of a boar and the body of a man. As it reads in Encyclopaedia Britannica, *Varaha* raised the Earth out of the water with his tusks[28].

First, given that the Enviropig donned a body of earthy pigs as well as science, E. coli bacteria, ideas of sustainability, Frankenstein, hopes, fears, pollution, environment, progress and more, there was no doubt that the Enviropig is in some way an avatar.

It would appear that the Enviropig, as a descendant of a boar aiming to

[28] https://web.archive.org/web/20200604063921/https://www.britannica.com/topic/Varaha

address water pollution, could prompt Cecil to say that the Enviropig is an avatar coming to lift the Earth out of the polluted waters (see Chapter 3). Avatar has roots in a verb *avataran,* which means to descend, transcend, but also to help and to save humanity in crisis. In other words, it relates to acts of doing and having a role to play. But, contrary to the environmental credentials of this transgenic animal, I read the act of saving from a perspective close to that of therapy, which brings me to the next point. The second point is that, as I noted in Chapter 4, the Enviropig held a mirror, at least for me and maybe for others too.

The signs that the Enviropig was doing something on the affective front were signalled in Chapters 5 and 6 as both animal multiple and science. As animal multiple, the Enviropig was moving and drawing people, pointing to multiple ways of being a pig, standing for various forms of farming, and embodying fears of risk and transgression. In a sense, the Enviropig was creating a value upon encounter with the multiple enactments, which was exemplified by rounds of both approvals and rejections. The Enviropig was also resisting categorisation as well as emplacement (Philo and Wilbert, 2000) as it continued to cross boundaries and transgress. In doing so, the Enviropig was perhaps prompting to be conceptualised differently, and in doing so, pointing to its affective rather than modelling role for humans.

However, in Chapter 6, where I talked about the Enviropig as fragile biotechnology, I was signalling the lessons that have been drawn from the experiences of becoming a robust science and accepted product.

The lessons, I argue, indicate further examples of teaching and guiding work of the Enviropig – what went wrong, what should have happened, who was included, how farming communities and the publics were enacted.

The Enviropig's uniqueness lays in what the animal was doing (Lien and Law, 2010) as a genetically modified body, swine history, frozen semen, failed innovation, public-science dialogue and so on. In particular, the Enviropig as animal multiple and fragile biotechnology pushed discussion on the definitions of "right" and "wrong" in livestock farming; ignited imaginings of the future of farming; questioned the role of science; inspired thinking about human-animal-technology relationships; drew to debate about the role of animals in science; opened up discussion on the underlying issues in livestock farming; attempted to bring opposing views together; guides us to understand and befriend her "otherness" as well as ourselves.

In the next sections, I therefore concentrate on the roles of the Enviropig. Firstly, I show that the Enviropig allowed me to witness attachments to one's labour, feelings of loss. In other words, the Enviropig allowed me to relate to others, to see their views and be touched by their experiences.

Secondly, the Enviropig opened the doors to spaces of research, while at the same time allowed me to be aware of my own thoughts and feelings while witnessing animal lives. The Enviropig gave me an insight

into spaces of research prompting me to ask whether care, as defined in this thesis, was witnessed in places of scientific practice.

Thirdly, the Enviropig gave me an insight as to how it feels to come across different ways of understanding science. This is exemplified through the accounts of the scientists who talk about their experiences of encounters with the "wild" (Callon et al., 2009) while the Enviropigs were still alive. Here, I argue, the Enviropig was not guiding the scientists, but rather providing, as it were, shock therapy. In other words, uncomfortable experiences provided lessons about themselves. And lastly, the Enviropig allowed to explore visions of the future.

The following sections illustrate the Enviropig's role as a force that connects rather than disconnects even though, on the surface, all that can be witnessed are feelings of tension and conflict. But in witnessing the human and animal moments, I am sharing with the reader not just their stories. I am sharing their stories so we can join them with our own (Birke and Hockenhull, 2016). In doing so, I offer a hopeful reading of animal farm biotechnology as one that is moving, is being moved by, and is being affected. Hopeful here means offering a vision of GM, which although is very complex, is also ready to change.

Sensing loss

As I moved from one interview to another trying to explore the story of the Enviropig as an animal and biotechnology, I sensed a great deal of disappointment and loss from the participants, and not just of resources,

time and energy.

By sensing rather than just analysing, I was becoming attuned (Brigstocke and Noorani, 2016) to ways in which I and others were feeling while talking about the Enviropig and what they have learnt. In doing so, the Enviropig was also helping me to situate science production (Haraway, 1988) which refers to the notion that knowledge can be partial, located and embodied as well as becoming with others, including feelings and non-human actors (Parr, 2014).

Here I want to focus on situating scientific practises in feelings about one's work, as exemplified in the words of Una and Clive (the assistants):

> **Una:** I would like to see it approved for human consumption, after all that work. They put all of that work into it, the idea behind it was good, if they can prove that it is safe for consumption, I would like to see it go somewhere. (05 Nov 2014, Guelph)
>
> **Clive**: I was disappointed, we expected to progress to a level of sustainability or marketability, but it just stopped: all those years of research just dumped. It was disappointing, the fruits of your labour. (05 Nov 2014, Guelph)

Right after I have heard those words, and many times later when reading the transcripts, I felt they were insensitive, that all they cared about was just the amount of hours and years they have put into the project. I did not hear them saying, "these poor pigs, we miss them so much". In making those comments, we see that Una and Clive, two of the assistants, confirm that it was indeed about their labour as well as

the labour of the scientists that they were saddened. Caring, as if just about one's work rather than animals, was also witnessed initially in the interview with Carole, the funder of the project. When asked about what she learned from the project, she answered:

> To be careful. You put a lot of money into a projects and peoples' sense of what was going to be part of the project. (06 Nov 2014).

Having an interest in the success of the project was expected from those who worked with the animals, but somehow, I felt they should care more! However, as I continued to analyse the data and write (although with difficulty) about their work and my experiences in the research facility, I was realising that I had expectations they will say something else. Even though, I agreed with the literature (Mol et al., 2010, 2015; Roe and Greenhough, 2018) that caring can be found in all spaces and take many forms, upon encounter with the assistants, I found myself displeased by what I heard. But, as I outlined in Chapter 5, the assistants attended to the Enviropigs every day, more so than any other pigs in the facility, named them, logged their stats, uploaded the data about the animals and ensured they live well. So, it is in the actions, more so than words, that attachment to work as an act of looking after the animals and the people involved (as in the case of Carole), was coming through.

Having an interest in a project's success could also be interpreted as detachment from animals and their death, especially in spaces of

experimentation. Twine (2010) as well Ung-Lanki (2014) emphasised that molecular scientists, as well as researchers working with lab animals, think of farm animals as well as mice and rats, as strings of genetic information, rather than subjects in their own right. Such views are strongly echoed in Morris and Holloway (2009) as well as Clark (2011) who argued that genetic modification renders animals object-like and exploitable (see Chapters 2 and 3).

Although I grant these views, based on this research, I agree here with Greenhough and Roe (2018). In particular, I agree with their argument that if one is to look with care into the spaces of laboratory research, one might find that attachment to one's labour, feelings of doing a good job, amidst contestations as to what this labour does, can foster great care toward animals. This goes in line with Pihl (2017) who suggested that thinking in numbers and referring to animals as numbers does not diminish caring relations with animals in research spaces. Thus, passion and care about research projects, although often misunderstood, are important aspects of delivering responsible innovations, especially when they address complex notions such as the future of food. But the difficulty lays in telling the story of animal research spaces without the fear of falling into the trap of being one-sided and blinded by big science (Franklin, 2007). In the next section, I want to focus on a challenge of witnessing what goes on in research facilities.

Experiencing a discomfort

As noted in the literature review and the introduction to this thesis, empirical research about farm animal biotechnologies is still relatively thin on the ground. One of the reasons is that access to laboratories is not easily granted. Building trust is another often cited reason. Franklin (2007) writing on Dolly the Sheep, and many other scholars who carry out ethnographies of labs (see Stephens and Lewis, 2007) and animals in labs (Roe and Greenhough, 2018) noted those reasons in their publication.

Given how rare opportunity this was, I want to return to the visit at the swine research facility and focus on the challenge associated with bearing witness to animal and human moments. In Chapter 5 I talked about the research space where the Enviropigs used to be kept and where they are buried. There, I gave an account of how, where, with what and by whom the Enviropigs were created.

Here, I want to draw attention to my own conflicts and discomforts when bearing witness to human and non-human labour in enclosed spaces of knowledge production. I pay attention to the role of animals – as on one hand, playful creatures, to bodies that give data – bodies that are discarded and forgotten. Bodies that move even after death.

From the beginning of doing my research, I planned to visit the Swine Research Facility at Guelph. It was only when I entered the building that I realised plans don't always pan out, and so I was either extremely lucky or good at drawing people into my research. I was the only person, apart from news reporters, who was given full access.

But as soon I entered, I wanted to leave. The weight of responsibility as a PhD student, as a researcher in this field, farm animal admirer (from a distance) and meat-eater, a guest and a human being were upon me. I had so many mixed feelings as to what to do, say, how to act and be to deliver this project, but more importantly, to tell the story with care. So, just like Una, Clive and Carole, I too cared about a project, so I felt rather ashamed of demanding others to care more about animals, while I just observed their work without getting my hands dirty!

After the group interview with agricultural assistants about their duties around the Enviropig, as well as their views and understanding of this animal (see Chapter 5) I was taken on a tour. As we were walking, Keith (the team leader) was explaining each room was designed to test different things or house animals going through various stages of their facility lives, lives meant to represent current or experimental farms. Keith was showing me layout after layout, pig after pig. Here is an old layout, here are the finishing pigs, here are sows, here are piglets, and here is the room where pigs are given specific feed at time intervals – Keith was pointing out enthusiastically.

Each room thus acted as a window into different animals at different stages of industrial pigs: weaning, fattening, castrating etc. I was not able to see each room and what was happening because each of the assistants got on with their duties at the same time. But from time to time, as I was walking around, I saw assistants I spoke to earlier, simply cleaning the rooms, some were castrating piglets, some carrying out

the checks and noting things down.

Still feeling out of place, I did not know how far I could venture on my own. My senses were overwhelmed by a strong smell, sounds, and sites of animals I didn't find cute upon live encounter. "What a hypocrite", I said to myself, "You go on about pigs being so special and now you are scared"! Truth be told, I did not want to touch them despite being given permission and encouragement by Keith. These pigs were large, dirty, with a coarse skin of pink colour. The noise they made was unbearable. They were not as clean as the Enviropigs in the video footage. I was scared of them. I stroked one of the boars anyway, although reluctantly. I did not want to give the impression that I was afraid.

I finally got up the courage to explore the facility on my own. I saw Una, so I walked up to her. She was the girl I met earlier in the biosecurity zone and whose act of choosing clothes I followed. I felt somewhat safer around her. Was it the fact that she was the only girl there which made me feel comfortable? I feel OK amongst both men and women, but here, in the space that was so unfamiliar to me and made me feel somewhat odd, I gravitated toward her. I felt, as if, a relief of seeing a girl.

This place made me somewhat vulnerable, perhaps because of the fact that I had to take off my clothes, take a shower in a changing room (see Figure 18) and frantically look for clothes and undergarments (see Figures 19 and 20) that fit me.

I wanted to say “thank you” for remembering that the female body needs items of clothing that men don’t need. But I said nothing. I felt stupid to point out such trivial matter. Bras, who cares, right? I did. I wanted to blend in rather than stand out with my body unprotected without a bra. That place made me conscious of my gender in ways I have forgotten about.

Figure 18. Biosecurity showers. Source: K. Rucinska

Figures 19 and 20. Past the biosecurity showers are bras, overalls, caps, and t-shirts. Source: K Rucinska

Back to Una though. She said I missed out on castration while I was following Keith, but I was later shown what had been done and how. As a meat-eater, I already knew about castration, so I felt I was armed with knowledge and therefore less emotional. Part of me, as an ambivalent farm animal lover, was glad I did not see any of it. But, as a researcher, I felt I should see, touch, feel, and do everything and anything to make this encounter count. It was the only chance I had, and I was worried

that I would waste it. I wish I could just be there rather than theorise my experience.

Unlike me, Una was fond of the piglets in a way that allowed her to touch them and yet carry out procedures, whereas I liked reading about them. So, she picked them up gently and turned around to show me how she would use a small knife and simply castrate many piglets. I knew, and she confirmed, there would be no anaesthetic. Apparently, it was a quick procedure and the pigs, she assured, were fine. Did she normalise this procedure?

I could not tell what was fine and what was not. I felt that if I knew about welfare standards, I would then be able to report on good or bad care. But this was not meant to be that type of encounter. I had to remind myself that I was merely watching, walking around, taking everything in, including my insecurities, the feeling of being out of place and uncomfortable. I was not there to judge and argue, as others would, that this is a place of pain and objectification of animals, and a place that no longer feels the feelings of others.

But I knew enough to know that industrial animals, or rather, animals raised at an industrial site, live in cramped, filthy conditions that reflect the human design of farms, not the animals' behaviour (Novek, 2005; Miele et al., 2013). Castration reflected the human preference in taste (non-castrated animals give away a strong smell that permeates meat cuts). Small spaces reflected human motivation to house as many

animals as possible to profit from farming. The size of animals reflected human demands for pig products. The research facility was a miniature version of what goes on in farms, many of which are not visited by pork eaters. But, unlike other farms in Canada, this one was practicing European welfare standards, as reassured by Keith. It meant that it was of higher standard than anywhere else in Canada.

More people arrived at the research facility but they, as opposed to the full-time members and me, were wearing blue boiler suits. I realised the unspoken rule of who wears what. I looked like the assistants who wore t-shirts and baseball caps while others wore the blue boiler suits.

Those in blue were PhD students from the University of Guelph. The clothing marked the difference between type of labourers present in the research facility. From those who tend to pigs every day and reared them for those wearing blue boiler suits who use animals for research.

The blue boiler suit wearers were chasing piglets with plastic spoons trying to scoop excreta. They seem to be having fun with those piglets. I asked what they do.

> **Student**: We are collecting manure.
>
> **KR**: Ok, I see this is a completely different doctoral work in comparison to what I am doing, and I thought that my work is hard.

We laughed. They told me they knew of the Enviropig as the animals are discussed in modules related to pig physiology. This research facility acted as a classroom. As one of the assistants said:

> They [students] come through with a tour, basically to show the vet students what a pig is.

A research facility is an interesting place, acting as a farm, a test bed, a classroom, and a laboratory. To support this view, I would like the reader to stay with me as I walked through the same corridor, I walked through the first time. But this time, the light in the room behind the window I saw earlier was on. There was a group of men and women in blue suits being busy. Someone said to me:

> You are lucky; they are killing the pigs today.

I was not sure whether I could call this luck or whether I could enter the room, but I was permitted to do so. The smell of hot blood mixed with manure hit me even stronger than any other room. I saw a pool of blood, two men, a piglet gutted and hanging upside down. Another piglet was under a student's arm. The sound of pigs was not pleasant, but this one was loud and worrying. I was about to walk away as I was not sure how much I was allowed to see. I walked in. There was a large container, almost up to my shoulder in height, full of piglets whose innards were emptied. I could not tell how many piglets were in there, maybe 50 or more.

I was not sure how this container got filled with so many piglets, so I carried on watching. I walked up to the piglet under the arm of a student. The piglet was squealing loudly, almost piercing my ears, while an assistant used a little, cylindrical, glass container with a needle at the

end. The needle went into the eye socket of the piglet so that blood could be collected. After that, the piglet was killed by getting a shot of Euthasol. It took seconds for the animal to stop moving. Immediately after that, without any hesitation, the piglet's throat and belly were cut open while hanging on a hook so its guts could spill out. And they did, like a waterfall of internal organs. It reminded me of a painting by Bacon in Tate modern, which, disturbed me greatly – I walked away and hated every second of the dark room painted with a pig hanging. But here, in a different room, I was disturbed too but I could not move. I stared, frozen. In the meantime, the body of the piglet with its guts opened was transferred to another room. The process was repeated many times until they had killed enough animals for data collection.

To the left, a team of students and lab assistants were cutting and butchering the bodies of the piglets I saw minutes earlier, very quickly. Pieces of organs were cut out; the guts were cleaned. On the other side were a scientist, a female chief investigator of a project, and her students and researchers. They were placing test tubes filled with manure onto a tray. It was messy, not in a disorganised way, but it was messy in dirty, manure everywhere way. I realised that this was the manure they collected earlier from the piglets they were chasing with the plastic spoons. I walked out to visit the rest of the facility. Castration was over. Killing the pigs was coming to an end too.

I wanted to leave immediately. Everything seemed stuffy. I was exhausted from the smell, sound, the pressure of needing to do

something and say something without saying and doing something wrong. I thought I would not be moved by any of it, and I certainly did all I could to give that impression. At some point, I was just watching thinking “I have had enough”. As Bauman put it, “emotion marks the exit from the state of indifference lived among thing-like others” (Bauman, 1995: 62). I could not agree more. I wanted to leave and stop watching the lively piglets I saw moments earlier being turned into thing-like others. I felt that the longer I watched them being turned into data, the more dispassionate I was becoming. And so, despite being given this rare opportunity to stay, I felt it was the time to go.

I bid farewell to the agricultural assistants and asked whether they had kept any images of the Enviropig. To my surprise, as I didn’t spot it earlier, a framed model of the Enviropig was hanging on the wall. I took a photo (see Figure 21) with their permission.

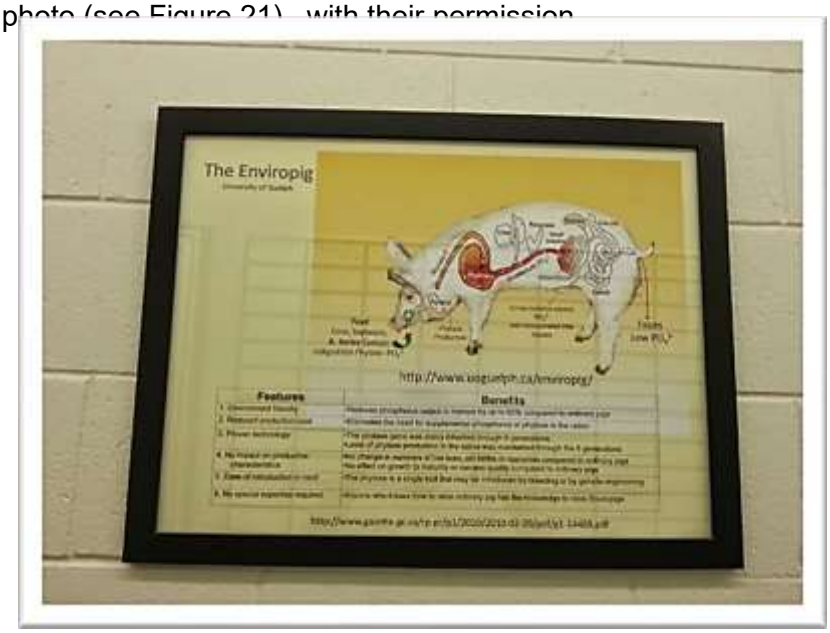


Figure 21. The Enviropig "model" in a frame. Source: K. Rucinska.

It left me thinking that the Enviropig was not forgotten and somehow still present in the research facility. As mentioned earlier, the staff here were proud of what they had done. Looking after those pigs, day to day, is hard work, work that I do not envy.

My visit time was over. I took a shower. I changed my clothes. The smell was still with me and on me. Upon leaving, I asked one of the students what he studies. His work was on bacteria in the gut. There was a long and scientific explanation of the things he was looking for.

I asked:

> **KR:** Is this how you collect your data as well?
> **Student**: Yes.
> **Student**: Do you mention this in your publications?
> **Student**: No, I don't.

Immediately after he said it, I felt like an intruder. I could not ask more questions, and I did not want to. I felt I was the last person to say something. I also felt these questions were not mine and did not come from within. After all, I was merely standing and watching, keeping my cool, arguing that this is my role to observe. How much different was I from them who also, as it were, removed their feelings from publications?

Alison, my host, was already waiting in her car. This was finally over.

Now, I understand how difficult it is to bear witness to the animal

moment, so I could not agree more with Emel and Wolch who said:

> When we do break through these surfaces, the resulting visibility is often excruciating. But, seeing and understanding the vast extent of animal suffering and death is unavoidable if we are to transcend the invisibility of animals, engage in corrective struggles, and bear witness to the animal movement. (1998: 527-8).

However, while attending to my own experiences and feelings, as well as to moods, acts, moments of laughter, connections, and actions at the research facility, I hope I have demonstrated that the conflict has a teaching potential.

Being in spaces of research, as illustrated above, has a capacity to lay all of us bare, exposed and vulnerable. In other words, it can give us an insight into being in someone else's shoes, whether it is doing one's job, receiving a treatment, being a research subject. Parr (2014) writing about emotional geographies, used the example of Widdowfield's (2000) research to say that while acknowledging one's emotions is not always appropriate, it allows some insight into the reality of others' circumstances (Parr, 2014:751). Hence, despite the feeling of discomfort, I also was given an insight into doing work that is hands on, lively and deadly, yet untold in scientific papers. It is a kind of work that requires an effort, a skill, and dedication but also rationalisation and normalisation. It is the kind of work that creates life which is soon taken away not to feed people, as it happens on farms, but to among many other things, educate students, create new research, award PhD degrees and employ people.

Thinking about the role of the Enviropig it was twofold: it allowed to open the spaces of research, as well as to open myself to being troubled. The Enviropig helped me to realise there was no escaping from the challenges of doing research, finding out what unsettles us as researchers, as well as the readers, the viewers, the public and the scientists.

The Enviropig allowed for these people to share their views, and I argue that exploring those places by attuning to the affective states, whether surprise, fear, happiness, pride, feeling judgemental or judged, has the capacity to shine a light on the existence of emotions, moods, and passions among all that care, whether against, for, or neutral about technology, a concept or a person. Despite being challenged physically, mentally, and personally, I agree with Puig de la Bellacasa (2011, 2017) that to care means to include our feelings, judgments, and motivations. To care also means to include those who are rarely encountered and actions that are hard to put in words and hard to justify. In the case of the Enviropig project, the animals themselves and the people who took part in it, the neglected things are the caring relations, hard work, pride in one's work, feelings of accomplishment as well as death, blood and mud. To quote Puig de la Bellacasa (2011):

> Caring is more than affective-ethical state: it involves material engagement in labours to sustain interdependent worlds, labours that are often associated with exploitation and domination (2011:198).

In other words, caring means to actively engage in the types of labours that are uncomfortable and viewed as oppressive. More importantly, it means to consider these labours as labours that give life even when appear as quite the opposite. The caring approach calls into question the predominant narrative of biotechnology as exploitative and life-altering practice.

Although research places are not often associated with care (Greenhough and Roe, 2018; see critique of care in slaughterhouses or labs by Piras et al., 2011), the visit to the research facility as shown here, suggests otherwise. If care is understood as set of practices in a world full of complex ambivalence and shifting tensions (Mol et al., 2010, p.14) then care as a form of affective labour was witnessed. For example, the swine research facility left an impression of a space of being with animals away from the politics of GM. It was a place pivotal to the lives and deaths of the animals. It was a place that gathers data, that makes science. But it was also a space of work, a place of knowing what to do and how. While the research facility killed animals to gather data, it was also a place that took care of them daily. There, animals were tended to, cleaned, focused on, and known individually. The pigs were visited by familiar faces every day.

But perhaps doing this kind of work was normalised and appeared as care and attunement to the lives of animals. Perhaps the practiced care, which I described, further instrumentalises animals (which is what it felt for me at that time) and justifies the necessity to keep them alive and

sacrificed. As two of the agricultural assistants at the research facility, who grew up on farms and with pigs, put it:

> **Matt:** It is not just our duty; it is our livelihood and we do generally do what is best for the animal all the time.
>
> **Una**: Unhealthy animals do not give you any money back. (Guelph, 05 Nov 2014)

As Greenhough and Roe (2018) noted, the literature on lab animals and experimentation is split as to what care is and what it is for. On one hand, care can produce better animals, better models, and healthy animals, but on the other hand justifies and perpetuates the use of animals. What can in fact be witnessed, is what Greenhough and Roe (2018) call a contested morality, at least when looked at it from the outside. But, here, as well as in the examples of many experimental spaces, the agricultural assistants are the ones who continuously need to operate within this contested morality, or as others would call, instrumentalised care.

Unlike the students who I mentioned, or scientists who require animals for research, the agricultural assistants look after pigs all the time. The division of emotional, caring yet contested labour is quite stark. Animals and agricultural assistants, as noted above, are required to do what they are asked. Whereas the students and research staff come in to collect the data and when they leave, they leave the animals behind and only the samples leave the research facility.

Caring here is in a sense unequally distributed. Looking after animals is

practiced by a handful of people who care for animals and the work they carry out. The justification as to what care is for is bound within their day-to-day duties of cleaning, feeding, castrating and so on. Caring by the research staff and students is of a different kind – here it emerges as caring for the data these animals will produce. It is not black and white or methodical care; it is simply practiced differently and within different time frames. But, what the Enviropig case showed (as explained in Chapter 5) is that the Enviropigs required more attention than other pigs in the facility. Agricultural assistants were enrolled into the care of not just the animals, but also for the science they contributed to. Both forms of care are not simple or unproblematic, but they need to be told and accounted for (Greenhough and Roe, 2018). The human-animal relations, the anxieties, justifications, and labour should be embraced no matter how difficult they seem.

Revaluating

Gilbert and Mulkay (1984) argued that scientists working in an area of controversy, for example, biotechnology and animal experimentation, utilise two discursive repertoires to support their views. These discursive repertoires are empiricist selves and contingent others. The first means that a scientist is presenting himself/herself as an objective, evidence-based person, while the second refers to the “other” such as the public, NGOs, and the media who rely on feelings and emotions and less on evidence and research. The reason for using those repertoires

is that it helps to tell an evidence-based story in contradiction with a feeling-based story.

Although in my research these repertoires came to the surface, especially in Chapter 6, where I illustrated that despite awareness of a potential backlash, the public was not engaged with early enough. The end of the Enviropig project, and with it the end of labour and animals, the end of hopes and dreams produced interesting and quite profound learning affects which I want to focus on here. I want to also draw attention to my affective encounter with the scientists and their encounter with other ways of knowing.

John and Cecil, whom I introduced in Chapters 3, 4, 5 and 6, were the chief scientists of the Enviropig project. At the time of my research, both were retired. As John put it:

> We look at things happening in the world, newspapers, and so forth, regarding science and agriculture and so forth, but there is nothing creative or institutional about our activities. (5 November 2014, Guelph).

I met them in a local diner in Guelph. I arranged the interview before I arrived in Canada, and I was pleased with their responses. Both scientists were eager to speak to me. The diner was charming, with not too many customers. I was bit nervous; after all, I considered this a rare opportunity. I only knew them from photos in which they were dressed in lab coats looking serious, as scientists, I thought, tend to.

Perhaps it is the assumption that they are serious, perhaps they were asked to look serious in front of a camera. I recognised them immediately. Both were kind, well spoken, calm and attentive. I couldn't help but think that they are not scary, but why would they be?

The longer I listened, the more I realised the importance of speaking face-to-face with an open mind, eager to know more, eager to hear their views. Interestingly, this is exactly what one of the scientists was curious about, my reasons to travel all the way to Canada just for one interview. I remember saying (before I started recording the interview) that I wanted to get to know them in person rather than rely on media accounts.

They were very easy to approach about their experiences in the facility and throughout their field work, as they were the last people I would speak to while in Canada. In particular, after more than an hour of the interview, I felt comfortable enough to say to them how distressing the killing was (see the previous section). Having summarised my experiences, I was then able to show my vulnerability and reveal my own assumptions, which they empathised with. The following excerpt illustrates an affective encounter with the scientists as feeling selves who, as I go on to show, were familiar with self-exploration:

> **KR**: So, if I hadn't gone there, if I hadn't seen what was happening, I would have assumed something completely different. So there is an academic road to move the geography into animal or to the geography with animals – you need to be a witness of that – you need to

> witness that animal moment, and it takes guts to do that and I am very thankful for those people letting me see that and to you two letting me talk about it.
>
> **Cecil**: You have got a very interesting road ahead of you, and you are going to learn a lot about yourself.
>
> **John**: This whole relationship between animals and people for me is one of the most fascinating things to try and figure out. It is not simple, and there are lots of possible conclusions. (5 November 2015, Guelph).

The Enviropig – as the subject of both my research and theirs –offered multiple ways in which these learnings came to the surface. Perhaps, if it were not for the end, my approach to the topic as well as their outlook on me would be quite different. The timing of encounters points perhaps also to their fragility in terms of being able to capture things like vulnerability, sense of naivety, loss and personal discomfort.

The end of the project offered an opportunity to explore these affective states. The longer excerpt (see below) illustrates how scientists understand themselves, others and what to them the real issue was, namely the difference between fact and belief, evidence and belief, probability, and possibility. However, their reflection also illustrates the personal, feeling repertoire of scientists which is rarely captured, especially in the field of biotechnology.

> **KR:** So, what have you learned from that project?
>
> **Cecil:** Learned? Exactly what you are looking at, that is the issue of the difference between fact and belief. We work with fact and the people that

> we are dealing with work on the other side, go on belief. And most of them, it is interesting, even if people know the facts and understand the facts, it depends upon their beliefs – their belief affects how they approach the issue.
>
> **KR**: What is a belief to you in that context?
>
> **Cecil**: I will pass that onto John because I am not very good at discussing ethics.
>
> **John:** It is the same thing that is operating right now in terms of climate change; it is exactly the same thing. It doesn't matter what data the scientific community comes up with now; people want to believe. It is the same thing in accepting things like evolution; evolution is not accepted by some people.
>
> They see the facts, it doesn't matter you can come up with more and more data, belief will over-ride, and the same thing pertains in religion – belief over fact. Science deals with probability, what is probable; religion deals with possibility, what is conceptually possible.
>
> Probability and possibility are very different things, to me that has been the biggest lesson and personal eye-opener, how belief can stand firm in the presence of overwhelming evidence against it. That is important for us all to know.
>
> **KR**: Have you accepted that fact?
>
> **Cecil**: We have – I have always accepted that I just didn't know it as deeply as I know it now.
>
> **John:** This understanding has come about; I didn't anticipate that as being a primary personal lesson. (05 Nov 2014, Guelph).

Arguably, John and Cecil (although said to be less confident discussing ethics), emerge here as empiricist selves who are in opposition to anyone who is not standing in for science. But I would argue, what emerges out of their experience, is a reflection and understanding of the differences in which the scientific world operates.

In the excerpts from the interview, they are not discounting any other forms of knowing; they simply accept they exist just next to what they call the probable and evidence driven. I would also argue, based on the above, that they find it is important to know that "belief can stand firm in the presence of overwhelming evidence against it" in order to be aware of it when dealing with views that differ from their own. The lessons were profound because, as they said, they were "naïve when they started" and unprepared for what came later.

John and Cecil, although anticipating some backlash, were affected not just because of the difference between evidence and beliefs, but also due to being exposed to the media, the public and tactics used by the anti-GMO movement. Here are John and Cecil recalling their experiences of encountering other ways of knowing and practicing resistance to the Enviropig:

> **John**: And we began receiving emails, I never kept them, but there were a lot of hate emails, but that was to be expected – sort of – on such a hot issue as GMOs were at that time. (05 Nov 2014, Guelph).
>
> **Cecil**: I was invited to speak at an organic conference in Toronto, and you would have been amazed, the criticism that I received at that meeting. I was on a panel and when it was my turn to speak for 15 minutes to tell them about the Enviropig, one fellow got up and told me that I was a liar and that I was the next thing to evil. He interrupted me with those sorts of comments and there were many other insinuations and when I left there I was so upset I walked home to my daughter's place which I think was about five or six or seven kilometres, just to wear it off me, as it was just plain evil. (05 Nov 2014,

Guelph).

These experiences suggest a great deal of personal impact, such as being hated and called names. Should they have been more prepared, or more in tune with others' ways of thinking about the world to avoid such bad experiences? In one sense, yes, they could have benefited from lessons in engagement with the public in the wild. But how well would they fare? What would they have to do to counterbalance the affective state of hate? Here is what John had to say:

> When you think about it, when you ask about the public's response on this, I think the public's response was led by the anti-GMO. They were the ones who were out there saying 'Look, everybody, the evil that is being generated here under your very noses,' that is what led public opinion. They know what they are doing, they are very good at that, they instil fear in the absence of knowledge and if you put knowledge against fear, fear will win every time; or knowledge against belief, belief will win every time. You can't counter belief or fear with data: it just doesn't work. (05 Nov 2014, Guelph).

Here, the affective states are on the negative end of the scale, and thus quite potent when circulating in spaces of public engagement highlighting the charged, bipartisan approach. Latour (2004), in a story about monstrous SUVs, advocated to stop hating and instead embrace the feelings, concerns, and those who care about the monstrous, in this case, the scientists. These experiences thus illustrate Latour's (2004) concerns over ways the criticism of science and technology takes place in the wild.

However, an interview with Harriet at Roslin Institute of Technology, made me realise that John and Cecil had an opportunity to take a different course of action. According to Harriet, the Enviropig team could have spoken to experts in different fields like nutrition and engage with the public. But the real lesson could have been taken by learning from the case of Dolly the sheep in a way that Roslin did. Here is Harriet explaining how Dolly benefitted their openness.

> **Harriet**: I guess we benefitted from Dolly, because it is 20 years since Dolly and before that we had other projects involving GM animals. In the run up to Dolly it was a definite decision to be open about things and that we had to make information available and be available to the press and all that stuff and that has stayed our attitude ever since. We try and put everything out there in an informative and controlled way and that is something that we have always done. (22 Nov 2016, Edinburgh).

Although Roslin Institute communicates openly about their innovations and still celebrates Dolly, they do a lot of public engagements and view the public as curious willing to learn and “make their own mind”. Here is how she put it:

> There are a lot of basic things and I try to present it as providing knowledge and understanding and information but not saying ‘you must have it’. I think people have to make their own minds up. In the States there are colleagues in the GM animal field who are much more zealous you know, ‘people are holding us back and that is really bad’. That might be true, but you are going to persuade anyone by telling them they are stupid. (22 Nov 2016, Edinburgh).

I am not saying that John and Cecil were one of those scientists, but

even they have admitted that they were naïve and unprepared. So, in a sense, Harriet's words echo their real lack of engagement and show that the real issue was not just lack of openness. It was about the mindset and lack of knowing how to talk.

Similarly, Ben, who leads research on transgenic farm animals at Roslin, is quite active in public engagement which gave him enough confidence to know how to engage with the public. He spoken at length about his experiences which prompted him to think what constitutes the right dialogue and the public. I illustrate his thinking below.

> Who is the public? Is it with the politicians, or with the government; is it with the regulatory system or with companies? Is it with scientists; is it with the public? And if it is with the public, then who are the public? And how do you get access to the public – you know to the citizen?
>
> So what is the right dialogue? Well, unfortunately to my mind it is everything. You have to speak to all these people and you have got to be in that discussion. It has to be a dialogue. (…) And the most important part of it is that it is a dialogue, that you actually have the time and opportunity to listen to someone else's thoughts and then debate it at the end. But at the end of the day that is just two people discussing, that is not really communicating with the public. (22 Nov. 2016, Edinburgh).

As mentioned in Chapter 6, regardless of an interviewee's view on biotechnology, there were moments of not knowing how to solve the issues they face. Even at Roslin, with years of experience of discussing science openly, as Ben said, they know what the wrong engagement is, but they don't know what is the right one because each option has it

limitations. He noted that “geeky” audience that likes science or an audience that does not ask questions or has different views is not the most useful as such an engagement does not allow for learning from each other, He, as well as Harriet, were OK with not always being an expert. They wanted to learn but knew also this is not comfortable to not know what to say.

Anthony, the risk assessment office from Canada, was unsure how to reconcile his scientific training where 100% certainty does not exist, with the need to provide answers and make a point on social media. He asked:

> We work with probabilities of 95%. And right there and then a scientist confirmed that everything the other person had said could possibly be true. So how do you counter that? It goes against the training of most scientists, at least my cohort, to say it differently because we are told that that is the reality of science, we don’t deal with 100%, you go with the probabilities. So, it is hard. (29 Oct. 2014, Ottawa).

That this suggests is that there was awareness of being limited and not knowing what to do and how to do it. The question then is, as highlighted in Chapter 2, how to talk about something that is so contentious and critiqued so heavily, so emotional and affective (Latour, 2004; Puig de la Bellacasa, 2010, 2017)?

Ben, who also had his share of being shouted at and called names, said that deal in such situations, in cases where one speaks of GM modification on animals, one needs to be a bit more feeling human:

> Absolutely in a dialogue you have to be brave enough, or honest enough to say what you believe and when it comes to working with animals many people have a mental and physical feeling that they just don't like it. 'I can't explain to you Ben why I don't like it; I don't like it' and that is fine, that is absolutely fine.
>
> You can ask questions and say 'Is it because of this, or because of that?' and they can come back yes or no and you can have a dialogue about – you can find some area and you can have a dialogue and you can try and say 'I am concerned about that too' or 'I can tell you this, and this is what I think'.
>
> I think you have got to stand up and say 'this is my feeling; this is my opinion - I am not telling you to have it – I am just saying this is my opinion, and this is why I think that'. For interaction to work it has to be two-way. (22 Nov. 2016, Edinburgh).

As Chilvers (2012) observed, to engage with the public, scientists and institutions working within controversial fields of science and technology need to be reflexive in their learning from dialogues with the public and about themselves and others. I would argue that Ben, like others at Roslin, had a view on the public as one that has feelings and concerns but is also willing and wanting to learn. So these interactions, although unpleasant at times, revaluated their view on the public. It was not as black and white as in the case of the Enviropig team. So, I side here

with Chilvers (2012) and others writing on this issue (e.g. Burchell, 2007; Mogendroff et al., 2012; Cuppen et al., 2009; Wynne, 1991) that knowing how scientists learn from or are affected by what they encounter might be useful toward greater, more affective reflexivity.

The team working around the Enviropig also learned a great deal about themselves having been exposed to different ways of being, different beliefs and acting in the world. *But it was too late.*

As John poignantly put it:

> Gradually you sort of learn to live with that, now I am *fairly sanguine* about the whole process. It was a lot of fun, and maybe it laid the groundwork for something in the future, I don't know, but the edge is taken off the negative personal side. (05 Nov 2014, Guelph).

To sum up this section, the Enviropig helped me to understand, that like in the case of contentious care or feelings of loss, reflection can be interpreted in many ways depending on the experiences of one who is witnessing and one who is reflecting.

The Enviropig provided an insight about doing biotechnology and speaking about it. The Enviropig let me realise that despite efforts to eliminate a view on scientists or research spaces, I carried some assumptions with me. The encounters I have described provided me with an opportunity to reflect on how I relate to others. By focusing on their experiences as well as mine, the emotional aspects of practicing biotechnology came into the picture.

These experiences, as well as theirs, I argue, changed the ways in which I and they relate to others. For the scientists, what these interviews suggest, is that the enthusiasm and a belief in data and science was put into question. They also learnt that to fully accept there are other ways of knowing and that the public can and will decide how they orientate themselves toward GM. Encounters with the public in the wild made them question the role of science in shaping the world, which they compared with Climate Change believers and sceptics.

In the next section, I focus on discussions about the future of GM animals. I will pay attention to the reflections and worries, as well as hopes which the Enviropig helped to put into perspective.

Doubts and conflicts

Moods and feelings were not the only “things” emerging out of the interviews which I found difficult to orientate myself toward. The weight of the critical literature about farm animal biotechnologies was felt. I was torn between the criticism of technology-oriented animal futures (e.g. Wheale and McNally, 1995; Bowring, 2003; Twine, 2010; Morris and Holloway, 2009), scientific reviews about biotechnology (e.g. Royal Society, 2001; Nuffield Council on Bioethics, 2016; see Chapter 2), possible tomorrows of animal farming (e.g. Garnett, 2015; World Economic Forum, 2017) as well as public attitudes toward future animals (e.g. Macnaghten, 2004).

But, as Garnet (2015) argued, thinking about the future of, in her case,

meat, even if scenarios and future planning are inherently uncertain and impossible, is useful. “Scenarios are mirrors”, Garnett wrote, “ they magnify and make manifest the fears, hopes, beliefs and ideologies that underpin discussions today and whose unstated nature leads to misunderstanding and hostility. Of course, they are also the caricatures of particular ideologies. (2015:.25).

Her emphasis on the affective states (Bellacasa, 2011, 2017) of future planning chimes well with the literature on affect in general, but also in media and in the context of GM (Campbell and Fitzgerald, 2001) and science-public engagement (Callon et al., 2009; Cook et al., 2004; Chilvers, 2014). She has used the concept of scenarios to explore gut feelings about the narratives of the meat problem. Her exploration of possible tomorrows shines a light onto current fears of hunger, unnaturalness, control, and hopes around equality, inclusion, care for animals and freedom of choice.

In this last section, I demonstrate another affective labour of the Enviropig, by bringing forward discussions about the future of genetically modified livestock as to whether it is feasible. I highlight the dreams and hopes circulating the future of genetic engineering, as well as fears that stand in the way. I then move on to wider concerns about the future of farming; in particular, I talk about the fear of hunger as a fear of losing control. I close this section by saying that in the view of the interviewees, the future of farming is not biotechnologically determined, but the verdict is still out as to what to do next.

In 2018, I came across an intriguing article in the New Scientist, which the author opened by saying:

> When humans have vanished from the planet, one of the most enduring marks of our impact on Earth will be the sudden appearance in the fossil record of copious chicken bones. (Wong, 12 Dec 2018)

Immediately, I recalled the interview with the scientists in Guelph, where one of them (Cecil) said:

> Poultry is going to be the last animal standing. (05 Nov 2014, Guelph).

The vision of the future, even with the possibilities of CRISPR, from their perspectives was not an easy one. It is not just about feeling sanguine, not worth the effort, because it is unlikely to happen in one's lifetime. It was about, as the excerpts are about to show, the wider and bigger picture of meat demands.

The idea of poultry being the last animal has impacted the way I viewed farm animal biotechnologies and how I was to write about it. The more I learnt about it, the more I read, the more I was left with an impression that regardless of what any technology offers, demand for meat as it stands and as forecasted, will cause immense degradation of the environment which will impact on animals beyond anything we have seen up to now. I was not afraid of GM, genome editing or anything that resembles modification, even precise breeding methods. I began to see GM as Halal slaughter – a tip of the Iceberg, where the iceberg is

demand for meat not the method of creating animals or killing them.

The gloomy outlook on resource allocation was shared amongst everyone, even Laura, the activist campaigning against GM products. The fear of future, in general, is worth highlighting here although, as many critics pointed out, these visions need to be read with a bit a caution. The danger here is not that one starts falling for technology, but rather blaming the uneducated consumer, the concerned citizen, and the meat-eater, which have been mobilised in campaigns for and against the Enviropig (see Chapter 6). But first, I bring forward some of the excerpts from the interviews.

Nathan, the technology transfer officer, it needs to be stressed is a real advocate and enthusiast of technology and would pay a premium for transgenic meat. But, his views about the future of farming, on one hand, reflected wider concerns about resource allocation, but on the other hand, he was in favour of envisaging completely different solutions (more on this later). Nathan said:

> I think that it is just a resource allocation, we are going to have too many people on the planet and everything we have to do, we are going to have to it smarter. And it might be nice to have free-range pigs and free-range chickens, but you will not be able to feed your world in 2100 if you produce all your animals that way. (04 Nov 2014, Guelph).

John, the chief scientist of the Enviropig, was of a similar, dilemmatic sort of opinion. Here is how he put it:

> Moving from large scale so-called intensive to

> smaller, more dispersed agriculture – is that value? I don't think that anybody really knows that, arguments are made on both sides, but to me, it is an unsettled issue, and to me, it is probably a minor issue in terms of the scale of the appetite for animal protein and the capacity of the planet to produce it. (05 Nov 2014, Guelph).

Ben, who leads a research group at the Roslin Institute where he investigates transgenic option for livestock farming, shared the resource allocation worry. In his own words:

> Many people will tell you that we currently have 7 billion people on the planet, perhaps less well known is that one in seven of them are malnourished, which is a billion people, double the size of America [United States]. If we don't do something to our food chain, when we get to the 9 billion, we will have 2 billion people malnourished – that is one third of our population. I don't think that will lead to a harmonious world, and I don't want to see that, and I don't want my children to see that. (22 Nov. 2016, Edinburgh).

Resource allocation, feeding the world and the meeting demands of future populations are often used to justify the need to roll out biotechnology (Twine, 2010). Although Ben, as well as Nathan and Carole, was more enthusiastic about the technology than John and Cecil, neither of them considered GM to be the only option. Instead, they have been trying to say that the issue is overconsumption and high demand for meat which cannot be sustained in the long term. The catch 22 is that without considering the viciousness of the demand-supply cycle, we are left with a few options, one of which is and eventually lead

to an alteration of animals to suit the environment.

When speaking to David, also at the Roslin Institute, I also noted the conflict about the role of technology in addressing resource allocation. He is also a molecular biologist although his specialisation is in epigenetics, meaning he is interested in an interaction between the environment and genes. His view was that the environment should adapt to animals, but the current trajectory is worrying to him as it suggests that the opposite might happen.

> I try to be diplomatic about this, but the planet is changing constantly because of human activity; think about the population – the human population is getting seriously dense. So, what we need to do is to feed all those people and the environment is changing in terms of human pollution and all their stuff and the demand in food is getting seriously important. So, the only way to face this is to improve the production, which means to improve the production mass. It means making these massive cows and so on and obviously reducing infectious diseases as well. It is an endless process because I think we are victims of our success. (22 Nov. 2016, Edinburgh).

The vision of the future in which the population rises, reflects ongoing fears about hunger that plagued humans (Montanari, 1996). However, as Vernon (2009) observed, understanding of hunger and how it should be addressed changed scientifically in the last 200 years. Hunger used to be understood as a natural and inherent part of the human condition (Vernon, 2009:2) often left to the gods to solve. But over time hunger became a collective social problem whereby hunger is not just the

responsibility of the other, but also the environment and oneself. Eradicating hunger, as a social phenomenon, was a project of “the Moderns” (Latour, 2013) with science leading the way. Read as such, the vision of the future does not mirror fear of nutritional hunger but mirrors the fear of losing control, and indeed, fear of uncertainty.

Despite the belief in technology, the interviewees did not think transgenic animals hold the key to meeting demands for meat. The global picture of growing population, finite resources, energy demands, pollution and of course inability of animal bodies to cope amidst rising zoonotic diseases, is understood as wicked and too complex to solve with science and technology alone (Stengers, 2015).

For example, Ben, who leads a team in the UK, said the following about biotechnology against the backdrop of the global picture:

> It is unlikely that we will have one single biotechnological impact that changes the whole sector of the field. It will be a combination if we manage to make animals more resilient to a virus, but they still need to use vaccines, in fact, we may be able to use vaccines which currently are not efficient, not effective enough. We need to look how we distribute food, how we supply water to it. We need to look at disease resistance, reproduction, we need to look at everything and how we come out.
>
> But what I do in genetically engineering genome animals is part of that overall solution. It is not the only solution, there may be cases where we can create a resistant animal, but it is much more likely that we will make the animal resilient. (22 Nov 2016, Edinburgh).

His words, unlike many accounts found in the literature, do not, I argue, suggest a technocentric future, but rather a future where biotechnology is just one of many options available, or not even envisaged yet. It is important to note here how he is seeing livestock animals – from resistant to viruses to resilient. This would mean selecting strong, indigenous breeds that fare well under harsh conditions rather than modifying animals to suit the environment. The work of his colleagues thus centres exactly on making sure breeds of poultry are preserved to ensure the liveliness and richness of animal species.

John and Cecil, on the other hand, perhaps due to the challenges they have faced, felt far less optimistic about biotechnology. They have talked about China, also the increase in meat demands, as well as the inefficiency of livestock production (ratio of feed to meat). Having listed many examples, John said:

> What you are **not** hearing from us is that transgenic animals are key to the success of the planet. (05 Nov 2014, Guelph).

Cecil echoed him by saying,

> Genetic modification of animals is sort of a dead end. (05 Nov 2014, Guelph).

The scale of the problem seemed too big to tackle. John saw “compulsory vegetarianism” (05 Nov 2014, Guelph) as being the only option. Mark, who works in the UK on preserving strains of chickens,

envisaged insects being the future in line with a reduction of meat consumption. But, for Nathan, the real solution is political as well as personal. In his own words:

> The real solution is a political solution, get people to change behaviour and maybe, let's have less people on the planet, those are political solutions, not technological solutions.
>
> And eat less meat, just because you are rich doesn't mean that you have to eat meat. Most of us get fat because it is our own doing because we have access to more food than we probably need. (04 Nov 2014, Guelph).

What these discussions suggest is in one way a move to new, non-technological solutions, but on the other hand, these visions of tomorrow are probably not innovative enough yet. These, as Garnett (2015) noted, reflect today's ideas of how the world is. One of these is a belief in individual, perhaps rationally and informed, decision-making. It reflects an understanding of the world that satisfies individual choices while aiming to care about the other. But, amidst the changing landscapes and rising uncertainty, will a rational outlook on the consumer, as willingly reducing meat consumption, suffice?

To sum up this section, I want to stress that exploration of affective states with the help of the Enviropig, navigated me through challenging conversations about biotechnology, which now, seem less imminent and yet still present. The Enviropig helped me realise that whatever solutions are being presented, at least in the interviews, reflect current modes of thinking that are yet to fully embrace affect in discussions

about how to solve the problems of tomorrow that need to be actioned now. The interview material presented in this section therefore shows a much more conflicted outlook on the future of biotechnology in comparison with the literature (Twine, 2010). Exploration of affective states puts the vision of tomorrow under a question mark.

7.3 Reflecting on the affective roles of the Enviropig

In this section, I want to rethink the role (outlined in Section 7.2) of the Enviropig from the perspective of affective labour and therapeutic animals (see Chapter 2), I develop an argument that the Enviropig's role was akin to that of a counsellor; the Enviropig guides us into a discovery, but indirectly, prompting us to redefine how we are conducting ourselves in the world (McLeod, 2013).

To recap, affective labour has been conceptualised by Hardt (1999) as well as Ahmed (2004b) as immaterial, and hard to capture in words (Anderson, 2009; Thrift, 2008). Affective labour, however, can be witnessed when services, knowledge and care are produced. It is often associated with the work of women, minorities (Greg and Seigworth, 2010) and animals serving emotional human needs (Franklin, 1999:57; Barua, 2018). Scholars writing on this topic aim to highlight the scale of affective economies (Ahmed, 2004b), the neglected value of emotional work, as well as its burden on those who perform it. Affective labour, similarly, to the affect itself, does not belong to an entity, but rather it is

distributed and circulating between various actors, places and spaces (Thrift, 2008; Ahmed, 2004; Pile, 2010; Anderson, 2010). In other words, affective labour is performed in a non-linear way and might not always be noticed. Thus, it is important to bear witness to affective labour as much as it is to pay attention to affective workers in the shadow (Porchers and Schmitt, 2012), such as farm animals, microbes, and laboratory mice to name but a few.

With regards to animals then, affective labour can also be witnessed when animals provide therapeutic services (Gorman, 2017), create value upon encounter (Barua, 2018) but also when they teach (Latour, 2010) and provide reflection about ourselves and them. However, with regards to animals, affective labour opens itself to contestation and criticism, as yet another form of labour done by animals, but it can be seen as a further illustration of animal agency (Nyman and Schuurman, 2016) and a demonstration of their emotional capacity to affect.

Animals, as Gorman (2017) illustrated, can be active participants, actants and makers of therapeutic spaces when they move people into conversations, allow expression, move into action, and contribute to understanding of themselves and others. An encounter with animals whether negative or positive, is a sign of animals being active in producing affect, in generating affect.

The therapeutic effect of animals can however be unpredictable, uncertain, and indeed multiple and registered very differently by

different people. The spaces, senses, bodies of animals, and stories about given animals matter too, thus not all animals, as Gorman (2017) observed, can be seen as therapeutic. An example here are birds in spaces of care like hospitals – what kind of bird species are welcome and generate the effect of healing? Not all animals, he argued, are perceived as therapeutic. The role of animal geographers is therefore to challenge what counts as therapeutic and in relation to what. To recall the story of the bear told by Ahmed (2004), it is important to note how these affective categories are being done, and with what.

Arguably, transgenic animals do not fit into this category either because they exude fear and the notion of monstrosity. But, as noted in Chapter 5, monsters are often abandoned before a chance is given to get to know them. In this chapter, I therefore want to say that the Enviropig, although not therapeutic as in healing, is at least affective in a sense that is guiding, provoking, and prompting self- reflexivity.

The Enviropig, like the animals on care farms (Gorman, 2017), allowed me to speak up, to say things. I could also say that the Enviropig was therapeutic, but maybe more cathartic than just therapeutic. Therapeutic relates to ease, betterment, nice feelings, cuddliness, relaxation. The Enviropig, in the flesh or as an idea, or as a ghost, was doing something that is hard to put in words.

From this perspective of affective labour, this chapter offers a new take

on the role of GM animals, but at the same time lends itself to further criticism. Was the Enviropig really active in helping me and others?

The answer is yes and no. Unlike many of the scholars who were able to capture the ways in which animals evoke feelings in others, I was merely using the Enviropig as a focus of our conversation. But, at the same time I was not. There was a great sense of loss when talking about the Enviropig. There was a great sense of heaviness and the feeling that at any point someone will say something wrong. I could not bring to life the feeling of these conversations. Yes, they seem dry and do not seem to be going deep enough. But, I argue, it is in dryness and shallowness of words that the moving and helping role of the Enviropig emerges.

Feelings are not always expressive. They can also be submerged, suspended and hidden from view. So, when John and Cecil talked about the vision of the future, they were hesitant and saddened by their own knowledge and an outlook on the future. David in Roslin, when talking about the dark side of medicine, was conflicted, and overwhelmed, questioning his work. Harriet expressed the heaviness when she said she prefers to work on fundamental science to avoid the big discussions, although she knew that engagement with the public is important. Laura showed her feelings too by being reluctant to talk to me. Jake too was hesitant to offer his “real” concerns. The untold, unspoken words captured me and held me, equally, suspended, upset even. I wanted to take that burden off them, for this is how I could

describe it – a burden. Just like Cecil and John, I had to walk off the *feeling* of feeling sorry about their experiences, the feeling of loss, the feeling of doubts and conflicts. On many occasions, I did not even want to read the transcripts and I certainly did not want to listen to them. I felt the story, the places, the animals, and the people should be left alone. It was an intimate world which I entered and which I do not want to join again. It was all too personal and literally, too bloody. The affective labour was, as I mentioned, not just done by the Enviropig, but by all involved, including me.

But, where there is a conflict, a controversy as argued in Chapter 2, there is a window of opportunity to stay with the discomfort and to learn from it. This is why, the role of the Enviropig could be potentially likened to that of counsellor.

As Shapiro (2010) argued, animals hold an important, albeit problematic, place in the development of counselling and psychology. On one hand, animals who have been used as models (rats, mice, monkeys and apes), reference points (humans are not like them), and symbols (Ratman in Freudian psychoanalysis). But over the last decades, as McLeod (2013) and Knight and Herzog (2009) noted, the view has shifted from seeing animals as models to assistants in therapy. An example here is the burgeoning field of Animal Assisted Therapy, which originated in ecopsychology (Roszak et al., 1995) as well as child development psychology, which works with humans and animals to heal, and in general to help humans to be in the world.

A counsellor is one that works with a client to help him/her reflect and become autonomous (Arribas-Ayllon et al., 2011). The work of counsellor centres on making sense of oneself by exploring past and current circumstances, and (mis)understandings of feelings that are attached to places, actions, and people. It can use various forms of therapies and tools to do that (Mind.org.uk[29]), but it does not always rely on analytical theories (e.g. Jungian, Freudian) as a psychologist would (Jones and Wilson, 2006).

In other words, counselling focuses on explorations rather than defining what it is that troubles us. So, unlike therapy or genetic, career or educational counselling, counselling for the "problems with living" (McLeod, 2013), is done through guidance toward self-reflections using talking therapies, art, movement and being with others, including animals.

One of the ways in which the feeling of being counselled emerged in this study was through discussions about the project and the animals. What I noted was affection, care, sense of loss about the project, about the animals, about hopes and dreams. All of this was intertwined, connected and messy but talking about it gave an opportunity to unpack and perhaps appreciate the difficulty of living with animal biotechnologies. The living with means exploring, writing about it,

[29] https://www.mind.org.uk/information-support/drugs-and-treatments/talking-therapy-and-counselling/about- talking-therapies/#.XgiHW0ewnRk

making, and unmaking and wondering what to say and not to say. The wider implications stemming from this chapter for public-science dialogue are to do with the invitation of affect into science communication. If affective states are present in ways in which animals are related to and science is made, then they could be incorporated into science communication.

In this chapter, I emphasised that feelings and emotions form not just an intrinsic part of research but are indicative of affective labour of the Enviropig and its role as a counsellor.

As I have shown in this chapter, *opening of the doors,* and *opening to me* was possible. Can both forms of opening be done again? If so, does it matter what topic, animals, and spaces one engages with? Looking at the emerging cases found in the literature, it suggests that a mindset (perhaps even a *feel*set) matters more. For instance, Leah Garcés, the author of *GRILLED: Turning Adversaries into Allies to Change the Chicken Industry* (2019) described her encounter with a chicken farmer in the US who changed her mind about farmers. She noted that like animals, farmers are locked in a system of no escape, pain, and misery. Garcés noted that empathy rather than judgmental outlook and agenda, was the missing ingredient in previous examples of engaging with livestock industry. Archambault (2016) who studied love for plants by unemployed and single men in Mozambique, showed that a focus on love allowed her to explore vulnerability of these men and consider love for plants as a real feeling, manifested through time and energy, toward

other species. Sheller (2004) on the other hand, went as far to say that emotions circulate between humans and cars which, if taken seriously, can aid to re-evaluate the ethical dimension of car consumption and use. Sheller argued that without inclusion of emotions, any discussions with car lovers and haters about the future of mobility, will remain superficial and ineffective. These examples and many others suggest that emotions, feelings, affects - that "stuff" that is hard to put in words – are being engaged with in research regardless of the topic.

By saying that the Enviropig's role could be equated with that of a counsellor, I echoed the examples in the literature, which proposes to take emotions, given to, and by, beings other-than-human seriously.

7.4 Chapter summary

Building on Chapters 5 and 6, this chapter further explored the concept of affect into discussions about controversies surrounding GM animals.

Here I have expanded the concept of helping role to the Enviropig to help me make sense of the moving forces of this animal. I noted that the Enviropig, as animal multiple, biotechnology and now dead animal, was not monstrous, but rather, hopeful (Law, 1991) and helpful. Given the gap in the literature with respect to the role of GM animals, I showed that the Enviropig helped me and others to open up, show conflicts, reveal assumptions as well as hopes, dreams and fears about the future of farming.

In the next chapter, that is the concluding chapter, I revisit the questions that guided this research as well as the ones that emerged as a result of it.

Chapter 8. Conclusions

8.1 Introduction

In this last chapter, I provide a short summary of the findings and evaluate them in relation to the literature. I take stock of limitations and lessons learnt (contributions) and show where to go next.

8.2 A simple story in three chapters

The aim of this research was in my mind always rather simple: to tell a story of the Enviropig. But, telling a story is never that easy: you have to choose a character, think what to say, what matters to the readers and create, as Puig de la Bellacasa (2011) argued, a caring account too.

So in the last three chapters (5, 6 and 7), I explored the case of the Enviropig – the first transgenic animal destined for human consumption and an example of GM technology for livestock production - by drawing from the media, interviews and observations. The aim of these chapters was to revisit the story of the Enviropig and explore the untold animal, human and emotional stories within. The reason for doing so, was motivated by the ups and downs of the Enviropig story (Chapter 3), my limited yet judgmental understanding of GM technology (Chapter 4), and a gap in the literature on this topic (Chapters 2 and 4). I noted that despite well articulated concerns about GM farm animals, they still present us with a challenge of knowing how to live with, and care for them. I drew parallels between the case of farm animal biotechnologies

and the notion of radical controversies (outlined in Chapter 2) by essentially saying that phenomena are inherently complex, heterogenous, and hybrid therefore uncertain. This implies that, farm animal biotechnologies are also heterogenous, but as Law (1991) and Callon et al. (2009) put it, heterogeneity is hopeful as it teaches us how to think, live and feel differently.

Building on caring and affective (Puig de la Bellacasa, 2011, 2017) accounts of salmon (Lien and Law, 2011; Pierce, 2015), chickens (Miele, 2011; Garcés, 2019), sheep (Miele, 2017), polar bears (Huggan, 2016), orangutans (Parreñas, 2012), laboratory animals (Davies, 2013; Greenhough and Roe, 2018, Pihl, 2016), science and technology (Lorimer, 2008; Latimer and Miele, 2013), I noted that the topic of GM farm animals as the case of radical uncertainty also deserves a caring exploration.

Therefore, in Chapter 5, I focused on the animal story within the case of the Enviropig. In other words, I focused on the ways in which the Enviropig was enacted in relation to the contested notion of porcinity. To put it plainly, I wanted to explore how the Enviropig was enacted in relation to non-transgenic pigs. The analysis of the text, interviews and observations showed that while the Enviropig was compared to pigs, the animal was also enacted in relation to specific pigs, bacteria, food, wild pigs, Frankenstein to name but a few. But, regardless how the Enviropig was portrayed, the idea of porcinity, the notion of a pig was “locked” in the industrial image of piginess. To put it differently, it did

not matter whether the Enviropig was *friendly* to environment, looking and behaving like an *ordinary* pig*,* or *threatening* farming practices, the notion of a pig in all of those accounts, did not change. So, being a pig in the age of the genome, means being locked in the industrial farming vision and pig as meat understanding of what a pig is. The material consequences (Lien and Law, 2011) of such enactments are worrying for the animal within because solutions to growing demands for pig as meat are not addressed. However, in the midst of all these enactments, the results also showed that the Enviropig was a truly multispecies animal, an animal that held not just one piggy story, but a story of other species including humans. Thus, to speak of a pig in the age of the genome, is to speak of a multispecies animal that needs to be cared for. Although it is controversial to say that the clue as to how to do it lies in the research facility, I would argue it is worth pausing for a minute and consider it. When the Enviropig was alive, the animal was tended to, looked after and considered as an animal no different to others. Yes, the view was still that the pig is to be eventually eaten, but the animal was cared for with more attention that many would ever be able to give. It was, as I later elaborated, a contested care, but it was a care that was practiced, with hands getting dirty, and hearts broken.

I stayed with the animal story in Chapter 6 and 7, but the focus was slightly different. In Chapter 6, I explored the Enviropig from the perspective of science as practice. In other words, I wanted to tell the story of things and people who took part in the making and unmaking of

the Enviropig. Here, I showed that an understanding of what is biotechnology was built by both opponents and proponents of the technology. This runs contrary to the prevailing outlook in the literature, that only the scientists make science. Here I mirrored views of Bloomfield and Doolin (2011), Buttel (1998) and Urbanik (2007) who, unlike other scholars writing on the topic, considered the technology to be enacted by more than one party. However, the fact that the creation of the Enviropig was spread across the centres of translation (Callon et al. 2009) it did not mean there were no controversies. Quite the contrary. The real issue was that neither of the party fully engaged with each other, the various publics and incorporated other ways of knowing. The main issue was that the technology was too dependent on particular things holding together, and so it was too fragile, too naïve to speak for itself. It was done in seclusion, not just physical, but conceptual too. The story presented here is consistent with accounts by scholars such as Callon et al. (2009) who view the seclusion as one of the reasons as to why there are emerging controversies.

Chapters 5 and 6 helped me to situate the practices of farm animal biotechnologies and ways in which an understanding of the publics, animals, and risk emerge. Given that the topic was controversial, I noted it is worth to include the emotions and affective states into the analysis. I made that point in Chapters 2 and 4, but in Chapter 7 I hoped to put emotions into action and therefore, learn from, and with, the Enviropig. Drawing on interviews and observations, I tried to show the feeling

nature of doing biotechnology and talking about it. I highlighted the sense of loss experienced, the sense of discomfort of witnessing animal moments. I talked about the reflections which I witnessed, and reflections experienced by those I spoke to. I argued there were doubts as to how to move on and how to address the problem of overconsumption, demand, and environmental degradation. This chapter addressed the last research question by showing, although imperfectly, that the role of the Enviropig even after death was to make a connection, to force me to listen, to feel troubled and conflicted and to show that others felt that too.

8.3 Learning from

Considering previous research on farm animal biotechnologies, I have suggested that engagement with emotions in this area of research is needed. I argued that by engaging with emotions (during the design, collecting data, analysis and writing) might provide us – “students taught by controversies” (see p.38) with an insight into how to live with radical uncertainties. Siding with feminist approaches to animal research and laboratory studies as well as affective literature, I argued that to explore things that unsettle us, research needs to engage with emotions. In doing so, research can make sense of intricate and complex ways in which care is enacted even in the most unlikely spaces.

My key contributions, however, are to do with the fact that I brought emotions, feelings and affects into the exploration of controversies. Till now, feelings were circulating in discussions about biotechnology, but

have not been fully explored. The reason, as I have argued in the literature review, methodology and empirical chapters, is that emotions are hard to capture and, as scholars writing about the neglected things, difficult to justify. This is why affect is often deployed so that that force, that something that is hard to put in words, is somehow presented. To do that, I traced the development of the story in the media and memories to capture the affects of the Enviropig. Here I contributed to the literature on affect of animals in the media by showing how a character of the Enviropig was performed. I also explored my own experiences to bring to life the emotional states of research and in doing so, I have extended the calls of scholars who argue that to situate knowledge practices means situating ourselves too. The main insight provided by this study, is about relating to things that are problematic and challenging. So, following feminist approaches to exploration of science and technology, I have adopted a caring approach. This meant caring with others and recognising that caring shows up in the most unlikely spaces. It allows us to recognise that like power, caring is not held by one person, it is redistributed and so it has got a capacity to connect.

So, in Chapter 7 in particular, I have given (at least I have tried to) an account of the connecting capacity which caring can have in relation to this, and I hope, other topics. I might have not given the full justice to the affects of the Enviropig, but as I mentioned, it was not easy to know what is right to feel. So, telling a story as an animal, science as practice

and moving story was challenging. But, as the participants in the study noted, they want to know more, they want to work with others, they don't know what to do. This means it is an opportunity to explore the worlds of feelings surrounding science and technology. Acting in an uncertain time could then literally mean feeling in an uncertain times, where feeling encompasses caring and doing. I know that I am bit naïve here, and like John and Cecil, I believe in the power of emotions, in the same way as they believe in the power of data.

But my research was not about just showing that good feelings, and good care can be found in animal laboratories. Rather, by including feelings and emotions in research (regardless of the topic) I showed that one can then start making connections because the feelings of loss, pride, shame, pain, love, happiness and more are potent and universal. Even the most oppressive spaces, as I hope I have shown, are fragile in two ways: they need artefacts and actors to hold in place and they operate on fear, hopes, loss and even love. That said, this research comes back to the question "what is the value of ethnography and laboratory studies?" to which many scholars continue to respond defensively. The value is in building bridges and making connections between secluded worlds, and in exposing practices invisible and unaccounted for in standard operating procedures and publications. The value is in unmasking the complexity of controversial topics which as I have shown here are full of material and affective relations. And lastly, the value in ethnographic laboratories is in building a culture of

openness toward oneself and others.

In summary, this research answered the animal research and STS literature's call to bring emotions into explorations of animal and science spaces. I have combined two concepts proliferating in the STS and Cultural Geography literature: namely, affect and enactment. I have brought these concepts into a discussion about biotechnological innovations in animal farming. I have demonstrated that an exploration with care and feelings shows a multiple, fragile and moving world of biotechnology. And finally, I have shown that by working with feelings, the atmosphere of secrecy can give way to the atmosphere of connection and openness. For example, I saw a vulnerable side of the so-called powerful scientists who with me were able to openly say how unprepared they were, how little they still know and how worried they are about the future. I also saw the acts of killing and acts of caring for animals in spaces which are rarely open to an outsider. However, my original contributions are to do with reflexivity and honesty in relation to myself, the research itself and the characters in the Enviropig story. I have taken the emotional angle quite seriously and left no stone unturned and as a result showed that talking about things that scare us has a capacity to create connections and open a full-hearted dialogue about living in an uncertain world.

8.4 Paths to be taken

As of 2020, nobody has resurrected the Enviropig by using the frozen sperm which was deposited in a Canadian laboratory located in remote Saskatchewan.

However, Chinese scientists have developed a new line of transgenic porcine species able to digest phosphorus (just like the Enviropigs) and starch polysaccharides. The animals can, therefore, contribute to a reduction of phosphorus and nitrogen, which they absorb for growth rather than excrete (Zhang et al., 2018). Petersen (2018), commenting on these new transgenic kinds, echoes the appeal of the late Enviropigs:

> By growing fast, requiring less food and producing fewer damaging chemicals, the pigs developed by Zhang et al. might create a win-win situation for both farmers and environment. (p.2).

This suggests that even if the same Enviropigs might not come back, other scientists are already looking at solutions that could address rising demands for meat, and lower pollution associated with pig production.

This means that despite ending one programme and killing innocent pigs, the main issues of demand for meat and pollution caused by industrial farming have not been addressed. The only lessons that have been taken are that technology can be improved so that animals are not

affected and even classed as GM, thus rejected and rallied against.

I want to stress here that while genetic modification was being disputed, a much more radical innovation emerged which is quietly revolutionising the approach to animal breeding. I am speaking here of a form of genetic modification called genome editing, or CRISPR. Genome editing is a precise type of genetic modification where new DNA is inserted exactly were intended thus offering boundless opportunities. But, genome editing, and CRISPR-Cas9, the most promising tool so far, is controversial precisely because of the abundance of, or even unlimited, possibilities. In 2016, *Nature* published a piece pertaining to this with a poignant and somewhat dystopian title “Welcome to the CRISPR Zoo” (Reardon, 2016). The news article talks of all organisms, from bees to extinct mammoths, that can become CRISPR animals to: control diseases in livestock animals or indeed humans by stopping mosquitos being vectors of malaria; producing hormones (which I mentioned already); and even revive animals that have gone or are about to go extinct.

Genome editing and its associated editing tools such as CRISPR-Cas9 mean that understanding what GM animals are and public-science dialogue will enter a new era. As the Nuffield Council on Bioethics report about genome editing poignantly observed:

> Food production not only deals with one of the necessities of human life, but is also a matter of

> deep social significance, and one that is rooted in many characteristic cultural, ethnic, religious and social practices. Many of the questions relating to genomic manipulation of the foods that we eat are common to both plants and animals. They do not, however, simply invite empirical answers, however complicated but, rather, open up a complex of moral, political and scientific judgements. (2018: 65).

The quote from the report was to do with the new era that genome editing has already led to. It shines a light on the necessity to go beyond the technical questions, which is echoed by Callon et al. (2009) and which I tried to echo here.

But the quote also highlights the tricky issue of being moved by developments in biotechnology. On the one hand then, there is recognition that GM food will invite complex sets of judgments. But on the other hand, I am concerned the invitation might matter only because it ends up being a human issue. In a sense, the concerns over genetic or genomic modification reflect an ongoing debate in the literature on farm animal welfare. One the one hand, it is being recognised that farm animal welfare invites lay and scientific knowledges (Evans and Miele, 2019). But on the other hand, there is a concern that animals matter only as far as good welfare links to better human health, and when they provide a return on investment. The question is then how to relate to animal issues without talking only about the human? How to address controversies and debates so that all things are included? As I mentioned in Chapter 1, these questions are already being debated by experts, but the next step is a public dialogue. Not a debate, not a

consultation but a good, full-hearted conversation. We need to go back to “hand, brain and heart” (Rose, 1983) approach which feminist scholars speak of. Did I do it?

The case study was single and explorative, so my contributions are also singular and tentative. The case study of the Enviropig was complex and difficult to pin down. There were so many avenues I could have taken. The study should have compared the story of the Aquabounty Salmon to get a better sense of what it means to act in an uncertain world. The “paradox of natural unnatural”, which Humphries and Sanderson (2015) showed in the study of the GM salmon, could have been explored more to get a sense of performing natural salmon. So, I could have followed the affect a bit further and go to places where not just science is created, but also the feelings about science. I could have tested a feeling public dialogue. Instead, I wrote a book section titled Eating information Together (2019) in which I have started playing with the idea of embodiments and dialogue. However, just like Ben said, who are we to engage? Who is the public really and what do we want out of the engagement? Put the fire out, get rid of controversies or create science that is truly heterogenous and affective? Considering that we are at war with a virus, I think the next step is to realise that the virus is not out there, but rather that we are feeling multispecies. We should instead say, we are at war with the idea that we are separate and objective.

But in thinking about the next areas of research, I side with Davies et

al. (2020) who suggested that “research needs to explore the affective relations of animal research at a range of scales and temporalities (p.506). In other words, if I were to do another study, I would include more animals, institutions and international context over time, as well as incorporate the public sensibilities. The next area of research could incorporate affective states into science-public engagement as a force that connects and leads to constructive dialogues about the future.

Epilogue. A story without the ending

I seem to be going in circles. I seem to be going back to data. One day there is a story to tell about more significant debates and care, but another day, like Nathan said, there is only a story of trying to do something. And so I go round and round in circles. The story has no end, just like the story of food systems.

A new hero or a villain is being introduced, shakes things up, but for a moment only. There is applause. Well done, the dragon is killed. The monster is gone. But wait, there is another one. Let's fight it. What else can we do? Change the way we live? This is too hard. We would need to really change! No, let's fight that dragon. Let's fight that monster. The story has no end. There are no Okjas here. There are a few lessons to draw from, but they are not strong enough.

This is a story of trying. This is why I can't seem to be able to close it and to conclude. This is what worries me not as a PhD student who attempted to make sense of a story about a rea transgenic pig. What worries is me really is that there will be another like the Enviropig. More will come. It is fine. They won't harm us. We will harm them. They will be banned and unloved. More will come, but like Dr Frankenstein, we will not draw any lessons. We will simply abandon the creature and fail to recognise that is our doing, our incapability to think with others, to consider other ways of being, to consider we are merely scratching the surface with our shiny toys and our shiny theories.

This will happen again. And it did. It has got a different name, but the

idea is the same: Change the animal but do not change the system that brought the animal. Remove the enemy. Remove the one that mirrors our fears.

With the end of the Enviropig, we momentarily closed the doors to understanding what it means to live with things/people/ideas that trouble us. I have tried to open up this world. Peek inside. Extract data. Feel the pain. Feel the love. This too was a story of trying for I cannot draw ground-breaking lessons from it.

Perhaps I need a new theory. Perhaps this is simply not over?

I wish I could do more. I wish I could say to you, the reader, that when you adopt a caring outlook, you will know how to deal with uncertainties. I am afraid you will be depleted, unable to speak, unable to talk about your experiences of looking at death. Maybe that's the point. This needs to be felt. Feel the pain. Feel the joy and do nothing with it. Don't write about it as it will amount to being stuck in a prison of words, a prison of thoughts that are not yours, a prison of theories not designed to show us the way out of the impasse.

So, what really are my contributions here. I have shown that phenomena are done in practice. I have tried to bring a caring perspective into analysis and observations. In doing so, I have added to the canon of the literature that aims to unpack practices, definitions and ideas. The point of doing so is to realise that nothing is black and white, that conflict, tensions, killing, and saving are all bundled up

together. This means that things are tangled and messy. Failure to accept it is a failure to accept life.

This is all exciting, but what can I do with it. What can I do with all this data? Design another study? Offer a solution on how to talk to the different publics? Engage emotionally, and if so, which emotions am I to draw upon? Where is the end to all this? I am afraid there are no answers to these questions. We live in times of radical uncertainty, and no amount of data, models, analysis and interviews is ever going to address the question how to prevent the next biotech revolution, the next tech revolution, the next pandemic. I certainly, based on this study, cannot say what to do and how to do it better. All I can say is that if you do have emotions, use them. Talk to your partner. Talk to your colleague. Talk to yourself. Cherish the moment of being alive. Don’t analyse it. Feel the pain. Feel the love. Feel joy. Walk away if must. Follow your gut. All this will be gone, including the things that scare you.

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Appendices

Appendix I

Name	Gender	Role in the Enviropig project	Date and Location of the interview	Background
Cecil	Male	Lead Scientist, now retired	05 Nov 2014, café, Guelph, Canada	In his own words: “I was raised in a farm in northern Saskatchewan. I did a degree in Dairy Science. Then went on to study Human Microbiology.”
John	Male	Lead Scientist, now retired	05 Nov 2014, café, Guelph, Canada	In his own words: “I was born and raised on a farm. I did undergraduate and graduate studies in basic genetics using the fruit fly. I continued to do that throughout my academic career in Guelph, asking questions about eugenics and aging and life span.”
Nathan	Male	Technology Transfer Officer at the University of Guelph	04 Nov 2014, University of Guelph, Canada	Academically, he is a trained mechanical engineer, but then moved to the pharmaceutical industry. In addition, he is a trained veterinary and comparative pathologist with a PhD.
Anthony	Male	Adviser, government official	29 Oct 2014, Ottawa, Canada, at the Environment Canada building	He is a geneticist by training, with a longstanding work in the industry as well in the public sector, therefore he acted (informally) as a liaison between the science and the public. He used to be Swine Improvement Standards Officer to Canada and so coordinated evaluation of breeding pigs. Because of his awareness of the pig sector as well as the policy and science, he worked closely with the Enviropig scientists, the government, the funder and the public. He continues to do this work with regards to GM salmon.

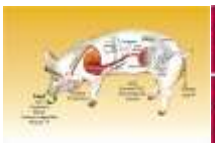
Name	Gender	Role in the Enviropig project	Date and Location of the interview	Background
Jake	Male	Risk assessor, (government official)	31 Oct 2014, Ottawa, Canada, at the Department of Agriculture and Food	He is a trained biologist familiar with the Enviropig due to his studies at the University of Guelph.
Carol	Female	Funder's representative	06 Nov 2014, Guelph, Canada, at the Ontario Pork HQ	A research project coordinator for Ontario Pork who administrates and works with the committee deciding on which areas and types of projects to fund

Name	Gender	Role in the Enviropig project	Date and Location of the interview	Background
Laura (NGO)	Female	Coordinator of a campaign against the Enviropig	29 Oct 2014, Ottawa, Canada, at the CBAN HQ	Her background is in political science and she has been with CBAN for six years. She has done research on bovine growth hormone that led her to continue the coordination of these issues in Canada.
Brad	Male	Agricultural assistant, looking after pigs	05 Nov 2014, Guelph, Canada, at the Swine Research Facility	He did an undergraduate in Bachelor of Science of Agriculture. In his own words: “I always worked with pigs.”
Henry	Male	Agricultural assistant, looking after pigs	05 Nov 2014, Guelph, Canada, at the Swine Research Facility	In his own words: “I dealt with pigs, beef cows, dairy cows, the last while it is mostly pigs and I have a Diploma in Agriculture.”
Matt	Male	Agricultural assistant, looking after pigs	05 Nov 2014, Guelph, Canada, at the Swine Research Facility	In his own words: “I guess my background has been almost primarily pigs. There is a little bit of chickens in there, but mostly pigs.”
Una	Female	Agricultural assistant, looking after pigs	05 Nov 2014, Guelph, Canada, at the Swine Research Facility	In her own words: “I grew up on a dairy farm and I grew up with pigs and now I have some sheep and I also have a university degree in Animal Biology.”
Steve	Male	Agricultural assistant, looking after	05 Nov 2014, Guelph, Canada, at the	In his own words: “primarily hogs or pigs for my whole life and I have been here about five years so I have not a lot of involvement with the Enviropig, but more on the paperwork side of it I

		pigs	Swine Research Facility	guess.”
Clive	Male	Agricultural assistant, looking after pigs	05 Nov 2014, Guelph, Canada, at the Swine Research Facility	In his own words: “I grew up on a beef cattle farm. I have been involved with poultry, turkey most of my life and I have been involved with pigs for the last three years.”

Appendix II

Name	Gender	Role	Date and place of interview	Background
Harriet	Female	Molecular biologist, working in the field of transgenic chickens	22 Nov 2016, Edinburgh, at the Roslin Institute	"I'm a group leader; I run the research group here. I guess I am one of the senior people here – I have been here a long time! [laughter] So I run the research group – my aim has been to develop and apply technologies for genetic modification of chickens."
David	Male	Molecular biologist	22 Nov 2016, Edinburgh, at the Roslin Institute	"I am a molecular biologist, that is the most important thing to say. I am trying to understand how genes are being related."
Mark	Male	Molecular biologist working in the field of transgenic chickens	22 Nov 2016, Edinburgh, at the Roslin Institute	"I have a research group and we study poultry, chicken, and we are developing tools to gene edit chickens, for three purposes: 1) investigate useful genetic ideals for poultry production 2) to study developmental biology and the role of genes in development and 3) to find out and develop new tools to biobank and freeze down flocks of chicken."
Ben	Male	Molecular biologist working in the field of transgenic chickens	22 Nov 2016, Edinburgh, at the Roslin Institute	Research Group Leader.

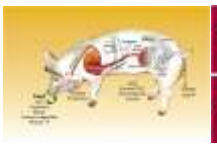


Appendix III

Participant information sheet

Study title: The Enviropig effects. A qualitative study of a biotechnological innovation in livestock farming.

- This study attends to the history of the Enviropig. This transgenic animal, now euthanized, is a remarkable example of a genetic technology applied on livestock and even though the Enviropig was short-lived, it continues to spark debates and controversies about the role of GM in livestock farming.
- This study is interested in the ways in which the Enviropig is understood, presented and debated. In other words, this study is not seeking right or wrong answers but explores socio-cultural uncertainties.
- By understanding different viewpoints, the study aims to shed light on the complexities of human-animal-technology relations.
- Through this, it aims to explore the networks that brought the Enviropig into being and brought about its demise, and to consider the wider impacts of the technological developments.
- As such, the study will inform future science and policy around the role of GM in livestock farming.
- The research is based on documentary analysis and interviews with those who created, contested and regulated the Enviropig.



Why have you been chosen?

You have been chosen due to your involvement in the creation, maintenance and closure of the Enviropig project.

Do you have to take part?

It is up to you whether or not you take part in this study. If you agree to take part, I will ask you to sign a consent form to show you have agreed to take part. If you want to leave the study, you can at any time. You do not have to give a reason to leave the study.

What will happen to me if I take part?

If you decide to take part, you will be contacted by the Lead Researcher (Karolina Rucinska) to arrange an hour long (max) interview to talk about your knowledge, experiences, feelings and views as a person involved in the Enviropig project.

Prior to the interview you will be asked for your consent to audio record the interview which will be then transcribed. You may request anonymity. You have a right to see the transcription. The interview material will be analysed and used in my thesis and future academic journal publications.

What will you have to do?

No preparation is needed. However, if you wish, you can bring additional material, such as photos or data to illustrate your points.

What are the possible disadvantages and risks of taking part?

I don't foresee any possible disadvantages and risks in taking part, although if talking about the history of the Enviropig makes you uncomfortable the interview can stop at any moment in time.

What are the possible benefits of taking part?

The possible benefit of taking part is that your views will be given a fair chance to be heard and expressed and communicated to the larger audience. Your views will be put in the context and not used against or for any cause. This study aims to inform future (qualitative) research and policy around the role of GM in livestock agriculture.

Will your taking part in this study be kept confidential?

Yes, your taking part will be kept confidential although the material will be quoted and it is possible that based on what you disclose one can identify you.

What will happen if you want to leave the study?

Interview material will not be used without your permission.

Who is organising and funding the research?

The project conducted by Ms Karolina Rucinska, a PhD candidate at School of Planning and Geography, Cardiff University, the UK. This project is solely funded by the Researcher, who has not received any stipend, bursary or financial endorsement from any institution.

Karolina is a social scientist who has already written an MSc thesis about public perception of the Enviropig based on findings from focus groups with lay persons. She also has wide research experience, having worked on projects funded by European Governmental institutions. She has interviewed members of the livestock industry, policy makers and farmers.

Who has approved the study?

This study has been approved by the School of Planning and Geography at Cardiff University.

Contact for Further Information

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CONSIDERING TAKING PART IN THIS STUDY

THANK YOU FOR

Appendix IV

Consent Form

RESEARCH TITLE

The Enviropig effects. A qualitative study of a biotechnological innovation in livestock farming. Parts 1 and 2.

Name of Researcher(s):

Ms. Karolina Alicja Rucinska

	Please initial
1. I confirm that I have read and understood the purpose of the interview for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason.	
3. I agree to take part in the study.	
4. I consent to the audio recording of interview in which I participate.	
5. I consent to the video recording of the premises.	
6. I consent to the photo taking of the premises.	

Name of participant	Date	Signature
Name of person taking consent	Date	Signature

Your responses to all questions will be treated confidentially and any material used within the published report will not be attributed to any named individual or groups.