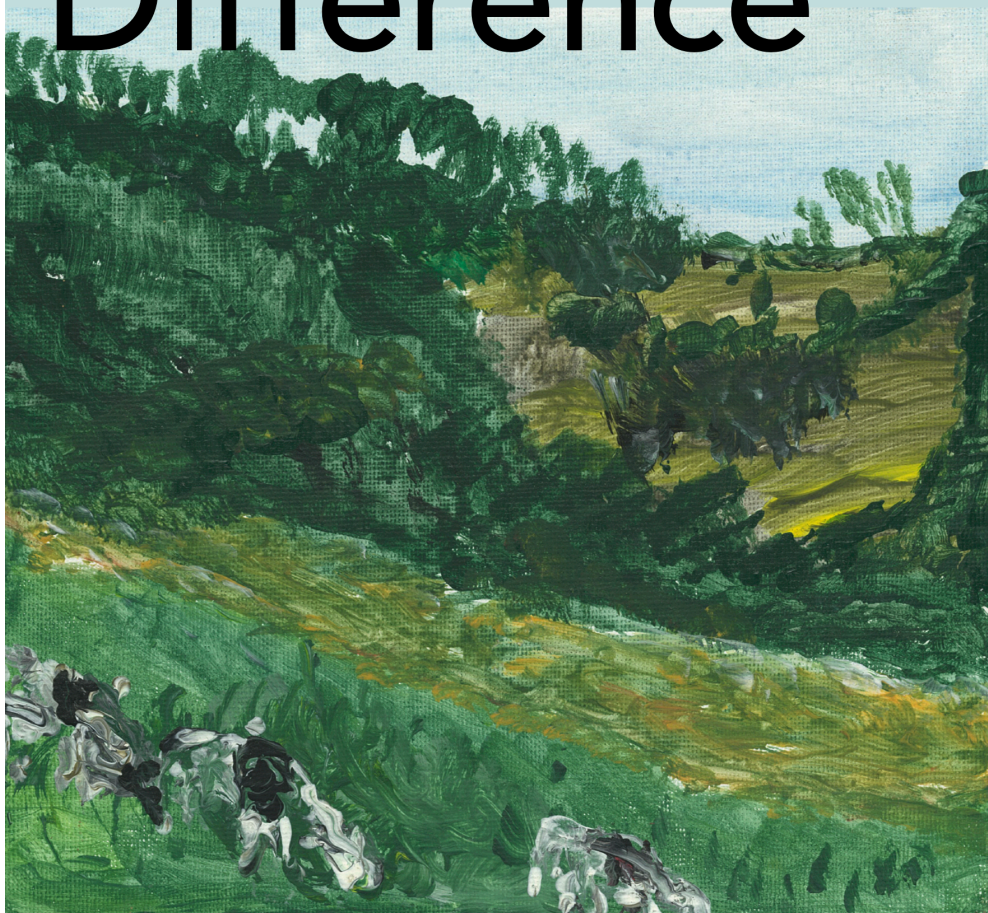


Breeding

Conserving and farming with native Dutch cattle
breeds in times of ecological trouble

Difference



Jenske Bal

Breeding Difference

Conserving and farming with native Dutch cattle breeds in times of
ecological trouble

By Jenske Bal

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Chapter 1

Introduction



Introduction

‘Better Cows>Better life’ – this striking slogan waves at me on a line of flags. After a drive on a sunny spring morning in 2025, a building emerges from the green flat fields of Friesland. Today, I am visiting the Nucleus of the largest cattle breeding company in the Netherlands, *Cooperatie Rundvee Verbetering* (Cooperative Cattle Improvement, CRV). The Nucleus building includes an office, a laboratory and a barn with 280 cows. My guide for the day is Jos, a breeding technician responsible for selecting cows and bulls at CRV.



Figure 1.1 Heifers at Nucleus. Photograph made by the author.

The animals here belong to the *Holstein Friesian*, a breed renowned for its milk production. Yet these heifers (female cattle that have not given birth yet) are not here to produce milk. They are here to produce the future generation of Holstein cattle. Every two weeks, their oocytes are ‘sucked out’ and fertilised in the attached lab with carefully selected semen from

CRV's top bulls. The resulting in-vitro fertilised (IVF) embryos are then inseminated in surrogate cows at collaborating farms all over the country. Their male offspring are genomically tested, and those deemed genetically promising return to CRV. These bulls become the next generation of sires whose sperm is sold all around the world.

Unlike on other dairy farms I have visited, where I could walk in and out of the barn and meet the cows up close, I am not allowed to enter the barn at the Nucleus. Jos explains that this is for biosecurity reasons and to avoid stressing the animals. These heifers and their breeding potential are extremely valuable to them. Instead, we enter the 'Skybox', an elevated viewing area overlooking the barn. The term conjures up images of a sports stadium, portraying the Holstein heifers as top athletes. From above, I see rows of black, brown and white bodies, grouped according to age. What strikes me is their uniformity, their apparent conformity to a model or an ideal.

The sameness I observe here is the outcome of decades of breeding aimed at producing animals with desirable traits. These cows are a selection of a selection. Their bodies become a site of intervention, mediated and transformed by breeding practices that allow cattle to be compared with increasing precision. Their value is defined through Estimated Breeding Values (EBVs), statistical predictions of an animal's genetic merit, which create an 'abstracted version' (Calvert, 2013) of the bovine body. These form part of the *genomic infrastructure*,¹ which mediates between data and bodies, and encompasses a material and epistemic infrastructure comprising technologies such as genomic sequencing chips and bioinformatic software, as well as epistemic communities including breeding collectives, companies, research farms and scientists.

¹ The notion of the *genomic infrastructure* derives from The Body Societal (BoS) project, which this PhD is part of. The BoS project questions: *How are values such as health, environment or biodiversity incorporated in cattle selection and reproduction? How are bodies transformed by these values, and through which techniques and practices?*

The development of this infrastructure forms part of a longer process of agricultural intensification and specialisation that took shape from the nineteenth century onwards, shaped by logics of standardisation, homogenisation, simplification, and rationalisation (Theunissen, 2020; Scott, 1998; Van der Woud, 2020; Bieleman, 2000). Through infrastructures of selection and reproduction, dairy farming increasingly produced sameness across bodies, genes, and landscapes.

Within this development, the high-yielding Holstein Friesian breed takes centre stage. Originating from the Dutch *Fries-Hollands* breed, the Holstein underwent targeted selection in the United States towards high-quantity and quality milk production (Theunissen, 2020). Afterwards, the breed spread all over the world, including ‘back’ to the Netherlands. Today, more than 90% of cattle in the Netherlands are from the Holstein breed. Over the past century, dairy production per cow increased over threefold (CBS, 2023), and farm size increased from mixed farms with a few dozen to 110 cows on average (CBS, 2022).

This intensification and homogenization raised several concerns. For one, experts have since the 1970s been warning that inbreeding is causing a loss of genetic diversity among cattle populations (CGN, 2011). As the popularity of the Holstein breed increased since its (re)introduction in the Netherlands in the 1970s, the population of breeds considered native² (see Figure 1.2) to the Netherlands declined as they were favoured less due to the breed’s moderate dairy production (Verkaaik, 2021; Theunissen, 2020). Furthermore, the rise of breeding technologies such as genetics and artificial insemination has led to the insemination with semen from a few desired bulls, which increases a risk of inbreeding and its associated consequences, including genetic defects, reduced fertility, and higher risk of zoonotic diseases (Doekes, Bijma & Windig, 2021).

² Figure 1.2 shows the breeds defined by the *Center for Genetic Resources, the Netherlands* as native. They also portray the Holstein Friesian (nr. 4 and 8) as belonging to the Netherlands but define the breed as locally adapted.

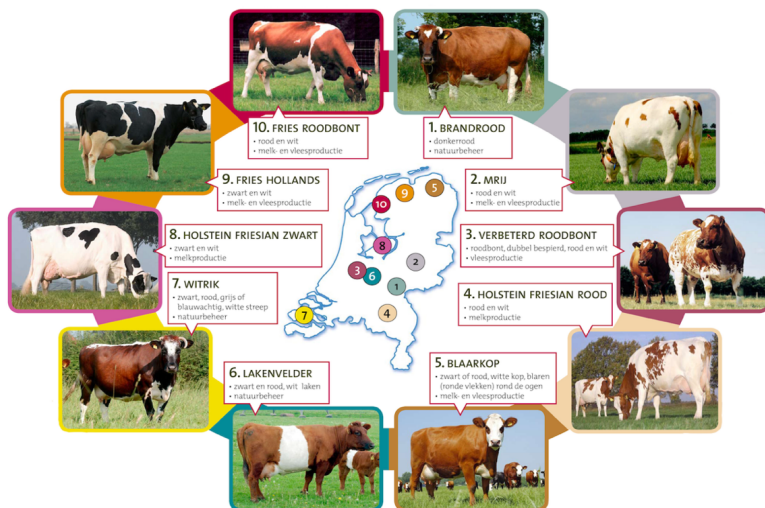


Figure 1.2 Local Dutch cattle breeds (Source: image produced by CGN)

Moreover, this loss of diversity among cattle breeds is part of a broader pattern of biodiversity decline caused by agricultural intensification – spanning species, breeds, genes, ecologies, and farming practices (FAO, 2022). There are growing global concerns about the ‘ecological hoofprint’ (Weis, 2013) of cattle farming, which contributes – through cows’ burping, defecating, eating and drinking – to runoff from phosphate and nitrate, deforestations, and nitrogen and methane emissions, together fuelling climate change and biodiversity loss (Chemnitz & Becheva, 2021; Cusworth et al., 2022; Govindrajan, 2022).

In the Netherlands, too, these problems have increasingly preoccupied ecologists, conservationists, policymakers, and environmental scientists. For instance, a report assessing the poor state of biodiversity in the Netherlands, highlights “the intensification of agricultural production” as its “main cause” of long-term decline (Sanders, Henkens & Slijkerman, 2019, p.2). Furthermore, while the Netherlands is one of the world’s leading agricultural producers, this productivity relies on extensive use of land,

resources, and livestock populations. The country houses 3.7 million cows, 10 million pigs, and 100 million chickens. 60% of Dutch land is used for agriculture, 73% of which is used to feed livestock (CBS, 2020). A further 2.8 million hectares of land abroad are used to feed all these animals (Daalders, 2026).

This thesis engages with the concerns about how sameness across bodies, genes, and landscapes affects the environment, health, and well-being of humans and more-than-humans. Drawing on ethnographic research conducted between 2021 and 2024 with conservation and breeding scientists at Wageningen University & Research, nature-inclusive farmers, enthusiasts of native Dutch cattle breeds, herdbook holders, breeders, and breeding companies, it engages with the emergence of breeding practices in laboratories and on farms that shift away from the uniformity of intensified agriculture towards the diversification of ecologies and practices. It investigates how these practices shape more-than-human relations, bodies and lives.

Difference making

While highly standardised animals are selected in facilities like the Nucleus, other actors across the Netherlands are breeding cows in ways that do not necessarily align with intensified agricultural practices. One of them is Suzanne, a young and enthusiastic farmer who took over the farm in Eastern Netherlands from her father only a few years ago. I visited her on a bright early-summer day in 2023. As we entered her house, she paused in the hallway to show me a photograph of her grandfather proudly standing in a field with his herd of MRIJ cows, a cattle breed native to the Netherlands. She explains that when her father succeeded her grandfather, he started breeding with the more productive Holstein Friesian breed and scaled up dairy production.

When Suzanne took over the farm from her father, she reverted from what she calls an ‘intensive’ to a more ‘extensive’ approach to farming,

aimed at reducing external ‘inputs’ and increasing biodiversity. This meant milk production decreased, but cows could be almost entirely fed on the grass available on the farm. She noticed that in this new system, the Holstein Friesian breed requires “*te veel kunst en vliegwerk* [too much effort] to keep it on its feet”. According to Suzanne, the Holstein had been bred to produce too much milk: “That does not fit here, and I do not want to ask that of a cow”. After delving into the history of the region and the farm, she decided to ‘bring back’ the MRIJ cattle breed her grandfather once farmed with.

Over the course of my research, I heard many stories from farmers like Suzanne who (re)introduced breeds they define as ‘local’ and ‘native’ to their farms. This is not merely a nostalgic return to the past; it can instead be seen as part of a wider reconfiguration of cattle farming, in which concerns such as biodiversity loss, climate change, human and more-than-human health are redefining agricultural practices. Diversity is often invoked as an alternative to the uniformity produced in agricultural systems across bodies, genes and landscapes. Yet, diverging from intensified agriculture is not merely an alternative to standardisation; it is realised through breeding, conservation and farming practices. It involves establishing differences between cows, farm ecologies, and farming practices to make a difference.

In this thesis, I research such practices of *difference-making*. Rather than assuming differences to be fixed or given, I examine how they are actively made, emerge in situated practices, and come to matter differently across conservation and farming contexts. Next to examining how differences are valued, I trace these valuations back to practices of differentiation. I analyse how differences are established between cattle, landscapes, and ways of farming, how these differences come to matter, how differences make a difference, for whom, and what sustaining differences requires. In short: how differences are bred, and how that breeds difference.

I situate difference-making, first, in conservation and farming practices concerned with the diversity amongst the Dutch cattle

population. Since the (re)arrival of the Holstein, some breeders, farmers, and scientists in the Netherlands who are concerned about the disappearance of native Dutch breeds have initiated a programme to conserve these breeds through herdbook registration, breed associations, subsidy schemes and cryopreservation in gene banks (CGN, 2011). These efforts align with broader global and EU strategies to safeguard farm animal genetic resources (FAO, 2013; EU, 2016). Although most of these breeds are categorised as rare³, they continue to live in small populations on farms like Suzanne's and in the form of frozen semen. I analyse how native breeds are valued and differentiated, and how their differentiation makes a difference.

Second, I situate difference-making in practices that create space for biodiversity within agricultural settings where native Dutch breeds are deployed. Over recent decades, the Dutch agricultural field has seen the emergence of alternative, more sustainable farming practices, designated as 'nature-inclusive', 'extensive' and 'circular' farming practices. These farming methods reduce 'inputs' to the farm and "integrate natural processes into farming practices" while also supporting the "quality of its environment" (Erisman et al., 2017). I follow how native breeds are valued, known and employed in 'nature-inclusive' farming.

Enacting 'the bio'

Conservation practices often reduce what is worth conserving to biological or genetic difference alone: the genes of a breed or a species, contained in materials such as eggs, sperm or blood. During my research, I noticed that what is being conserved and cared for exceeds this. 'The bio' is not just these biological or genetic differences, but also multispecies relations, ways of farming, genealogy, and attachments to landscapes and places. Reducing

³ A breed is classified as rare based on the number of remaining female animals within its population. In the Netherlands, the threshold for this classification is set at 5000 cows in line with the FAO guideline on species conservation (2013).

the bio to a biological or genetic object hides a diversity of stakes: what is considered valuable to conserve, for whom, and through which practices. These shape what conservation protects and what it does not.

Though questioning what is the ‘bio’ that is being conserved and cared for, I move beyond approaches that treat it only as ‘nature’ or ‘biology’ – instead opening up ‘the bio’ by analysing how it is *enacted* through difference-making practices. That is, I attend to how ‘the bio’ is worked with, understood, regulated, cared for and governed in everyday practices. I thus engage with the politics of ‘the bio’. This follows a longstanding concern of social scientists inspired by the Foucauldian understanding that ‘the bio’ is captured by the political, which Foucault describes as the power to ‘make live and let die’ (2003). This literature, concerned with ‘the politics of life itself’ (Rose, 2001), has explored the multiple ways the bio is enacted.

The bio analysed in this thesis includes relations of humans with cattle, soils, plants, trees, and landscapes. Drawing on *more-than-human biopolitics* scholarship (Asdal, Druglitrø & Hinchliffe, 2016; Biermann & Anderson, 2017; Lorimer & Driessen, 2013), I trace how certain landscapes (are left to) disappear, neglected or are conserved, how certain ways of farming are sustained or pushed out, and how certain bovine individuals or breeds are favoured over others. The power through which these politics unfold is not centrally imposed, but “relational and multiple, crossing species and involving lively more-than-human activities” (Vogel, 2025, p. 56).

By analysing how differences between animals are enacted through infrastructures, practices and values, this thesis contributes to multispecies scholarship, conservation research and science and technology studies. Tracing how native cattle breeds move between conservation and farming, I analyse how they are valued as, for instance, companions, genetic resources, ecological actors, and living heritage. I analyse what the enactments of the bio in difference-making practices mean for what emerges as good cows, good farmers, good landscapes and good products. This is in

alignment with scholars who analyse how ‘goods’ and ‘bads’ emerge in practice (Mol, 2002; Heuts & Mol, 2010; Pols, 2023; Vogel, 2025). In researching how these valuations emerge and are negotiated, I approach the bodies of cows as sites of intervention. These interventions are shaped by the ways bodies and ecologies are understood and enacted. In this thesis, I thus view cows not only as actors in multispecies relations but also as part of infrastructural configurations (Barua, 2021; Friese & Clarke, 2012) that mediate conservation and framing practices.

Thus, I explore the practices, logics, values, and infrastructures of cattle breeding to understand how native Dutch cattle breeds are valued and known, and how more-than-human relations take shape in difference-making. I ask the following questions:

How are cattle breeds native to the Netherlands known, valued, and mobilised in difference-making practices in conservation, breeding and farming in times of ecological trouble?

- How are sameness and difference problematised in conservation and farming practices?
- How is difference established, measured, and legitimised, and through which practices, knowledges, and infrastructures?
- How are differences valued, and how do they come to matter?
- How are differences worked with and sustained?
- What difference do these differences make for cattle, ecologies, and agricultural and conservation practices?

Contextualising and problematising sameness

In the next sections of this introduction, I will contextualise and problematise the development of sameness across lands, genes, and bodies through the intensification of agricultural production. Afterwards, I will continue by relating to literature concerning the values, infrastructures,

logics, and more-than-human politics at stake in conservation and farming practices aimed to make a difference through enhancing biodiversity.

Sameness of land

From the second half of the nineteenth century onward, Dutch lands were drained, uprooted, and transformed from *woeste grond* [wild, waste land], such as marshes, heathlands, and sandy plains, into arable land for cultivation (Bieleman, 2000; Van der Woud, 2020). Peat was excavated to produce fuel and fertiliser, heathlands were claimed, and forests were cleared, to accommodate rising agricultural production. With dykes and pumps, land was claimed from the sea to create polders, fertile areas suitable for farming. A well-known saying captures this history of environmental remaking: “God created the world, but the Dutch created the Netherlands.”⁴

Large-scale *ruilverkaveling* [land consolidation] further reconfigured the countryside into parcels resembling a Mondrian painting, optimised for mechanisation and specialisation. The project of land consolidation was a lengthy process that began around 1900. The land back then was divided into small parcels, which was seen as not efficient for farmers: the fields were impractically shaped, difficult to access, and too scattered. “The Dutch landscape needed to be rendered more time-efficient” (van der Woud, 2020, p. 365). Initially, the consolidation of land mostly involved buying out ‘small farmers’. In 1924, the Consolidation Act came into effect, enabling the purchase and exchange of plots of land. Land consolidation was a long, complex, but ultimately effective project: by 1985,

⁴ During a presentation about the reconfigurations of metabolic relations (chapter 5 of this thesis), Else Vogel and I made this introductory pun: “It is not God nor the Dutch that made the Netherlands, it is cows!”

already 837.000 HA had been consolidated, which is 20% of the total surface of the Netherlands⁵ (Bieleman, 2000; Van der Woud, 2020).

Such rationalisation, reorganisation and standardisation rendered land increasingly manageable and amenable for intensification. The soil profile was improved, topsoil was levelled, and water was managed (Bieleman, 2000). Furthermore, grassland productivity has been enhanced by mowing, the removal of hedges and trees, and a strong reliance on fertilisers and grassland monocultures (Runhaar et al., 2020). English ryegrass, valued for its high protein content and predictable growth, came to dominate Dutch lands (Van der Woud, 2020). This not only produced efficiency in land use but also sameness across fields.

As Van der Woud shows, intensification was justified by the Netherlands' limited land area and high population density. He quotes engineer D.J. Maltha, who wrote a book about the beauty of the Dutch landscape and the necessity of efficiency: "what we miss in space, we must make up in depth, that is to say, in the intensity of farming" (Maltha, 1946 in Van der Woud 2020, p. 297). The move to efficiency and homogenisation allowed for bigger farms, higher yield and more productive cattle breeds. Moreover, from the 1850s onward, export-oriented agricultural policies promoted intensification as a means of maximising contributions to national welfare (Van der Woud, 2020, p. 308).

In accounts of agricultural intensification, its origins are often located in the period following World War II, particularly in response to the Dutch Hunger Winter⁶, with the widely invoked slogan 'Never Hungry

⁵ A detailed account about the whole land consolidation process in the Netherlands can be read in chapter 42, 43 and 44 of *De mensen, het landschap* (Van der Woud, 2020) and in chapter 4 of *Techniek in Nederland in the Twintigste Eeuw: Landbouw en Voeding* (Schot et al. 2000).

⁶ The 'hunger winter' took place in the winter of 1944-1945 in the occupied parts of the Netherlands. Shortages in fuel caused by blockages, transportation disruptions and harsh weather caused food shortages (see e.g. Barbauw, 1999).

Again'.⁷ However, Auke van der Woud (2020) demonstrates that agricultural intensification in the Netherlands began well before the war. For example, by 1935, the country already had the highest use of artificial fertilisers worldwide. Intensification continued after World War II, and Van der Woud argues that, since the 1850s, economic considerations, rather than hunger, have consistently been the primary driver of agricultural intensification. Securing consumer demand was a continuous struggle for the dairy sector and the state. To protect farmers, the state invested in campaigns such as '*melk is goed voor elk*' [milk is good for everyone] (Chorus, 2025). Moreover, farmers organised themselves into cooperatives, which later became big dairy companies such as Campina. This centralisation in the concentration of dairy products and trade again demonstrates a history of producing sameness.

According to Van der Woud (2020), this sameness is the consequence of rationalisation, which entails a narrowing of ecological variation in favour of uniformity. This concern of reduced variation resonates with the work of Anna Tsing (2012) on scale. She conceptualises the pursuit of sameness as the process of rendering the living world scalable, through its *pixelization*, which allows "us to see only uniform blocks, ready for further expansion" (p. 505). Scalability depends on the rejection of ecological and cultural diversity.

The same rationalisation logic was also implemented in Dutch colonies. Cattle breeds from the Netherlands were introduced under the heading of development. For example, in Papua, Dutch cattle breeds were deployed by the Dutch to be cultivated in a monoculture plantation system, reflecting a belief that Papuan livestock systems should follow European

⁷ This slogan also echoed in my fieldwork, especially when farmers explained why their grandparents and parents had scaled up dairy production. However, in WWII cattle farmers were encouraged to sell part of their herd to make land available for crop production to ensure food security.

models (Kadir, 2026). This required a remaking (and destruction) of local ecologies to make them more ‘productive’.

In response to the intensification of agriculture, the extraction of resources and urbanisation within the Netherlands, the nature protection movement started (van der Windt, 1995; Van der Woud, 2020; Dirx, 2023). In 1905, the Dutch Society of Nature Preservation was founded to protect certain valuable areas from agricultural development. The protected areas became ‘islands’ within the increasingly intensively farmed landscape. This island logic of nature protection reminds of the Mondrian-like landscape and the pixelization from Tsing (2012), where separate areas are dedicated to ‘city’, ‘nature’, or ‘agriculture’. However, unlike pixels, which remain uniform and separate and cannot bleed into or transform each other (Tsing, 2012, p. 508), fencing off an area does not automatically protect it. Nature reserves have suffered greatly due to activities taking place outside their boundaries (van der Windt, 1995; van der Woud, 2020; Dirx, 2023). As critical conservation scholarship has demonstrated, this approach to nature protection and conservation also has its own political implications, influencing what is conserved, for whom, and how (e.g. Biermann & Mansfield, 2014; Orlove & Brush, 1996; Parreñas, 2018).

Sameness of cows

The intensification and expansion of land use are reflected in breeding practices, which have also created genetic uniformity across the Dutch cattle population. From the 19th century onwards, breeders began organising and introducing systematic recording of milk production. In 1874, the *Nederlands Rundvee Stamboek* (Dutch Cattle Herdbook, NRS) was established to administer a national herdbook that categorised cows by breed, enabling more targeted breeding (Bieleman, 2000; Theunissen, 2020). One breed, the black and white *Fries-Hollands*, was already renowned globally for its high milk production. Bert Theunissen (2020) notes that, at the end of the 19th century, breeders from the USA and

Canada imported 7,500 of these cows. These cows became the foundational stock of the Holstein-Friesian breed and formed the basis for the worldwide Holsteinisation of dairy farming and the production of sameness across the cattle population.

The Fries-Hollands, originating from Friesland, a province in the north of the Netherlands, were not only imported by farmers overseas, but also by farmers from the east and south of the Netherlands. However, these highly productive cows “were delicate and needed high-quality food and careful management [...] to prevent them from deteriorating under unfavourable circumstances” (Theunissen, 2020, p. 17). Cows from the Fries-Hollands breed were said to become weak and more susceptible to disease because they had been bred exclusively for milk production – a portrayal that currently echoes in the field about Holsteins. A considerable number of farmers on the sandy, less fertile lands in the east and south of the Netherlands thus preferred to use the MRIJ breed, a more robust ‘black and white’ type from the provinces of North Holland and Groningen. Fries-Holland breeders, in response, reconfigured the breed also into a ‘double purpose’ type, bred for both milk and meat production, with the MRIJ serving as a model breed.

Until 1974, the intensification of cattle farming in the Netherlands was particularly evident in the increase in the number of cows per farm, rising from an average of 7.1 to 22.7, and from 1.15 to 1.69 cows per hectare. However, the increase in production per cow was not as significant, despite the availability of artificial insemination and more targeted breeding since 1939. Initially, breed societies were reluctant to promote the use of artificial insemination. They wanted to protect commercial breeders: the technology’s success, after all, would mean that fewer bulls, and thus fewer breeders, would be needed (ibid., pp. 35–37). Theunissen (2020) demonstrates that the use of artificial insemination only began to increase in popularity in the 1970s. From then on, priority was given to breeding for production with the help of agricultural experts from Wageningen, who

developed breeding indexes and introduced quantified breeding practices. The development of artificial insemination and data-based breeding practices created uniformity across cattle populations.

As a result, the preference for ‘double purpose’ more ‘robust’ cattle shifted in the mid-1970s,⁸ paving the way for the Holstein breed to make its re-entrance into Dutch dairy farming. The sector’s transition to Holsteins was rapid: by the late 1990s, almost 100% of the genes in the Dutch national herd were from the Holstein Friesian breed (Theunissen, 2020, p. 58). Dutch breeding organisations also faced international competition in breeding the Holstein Friesian. For instance, the Dutch-bred bull Sunny Boy set a record by selling more than two million semen straws. Today, *Coöperatie Rundvee Verbetering* (Cooperation Cattle Improvement, CRV), the largest breeding company in the Netherlands, is the world leader in Holstein semen development and production.

By performing artificial insemination with semen from superstar bulls such as Sunny Boy, dairy farmers produced sameness of inheritance and genetics. Some conservation researchers and geneticists have expressed their concerns since the 1970s about the loss of genetic diversity (CGN, 2011). They highlight that the increased use of a small number of elite bulls for breeding has led to higher rates of inbreeding and an increased risk of zoonotic diseases, genetic defects and reduced fertility and production, a phenomenon known as *inbreeding depression* (Doekes, Bijma & Windig, 2021). Furthermore, the Holsteinisation of dairy farming has led to a uniformity in the breeds farmers breed with. Populations of breeds other than the Holstein have decreased, which is a concern because a multiplicity of breeds are “generally assumed to represent unique contributions to the diversity of livestock” (Felijs, Theunissen & Lenstra, 2015).

Moreover, breeding for intensified agricultural practices meant not only the same genes and breeds, but also sameness of bodies. To optimise

⁸ For a more detailed description of what this shift pushed and what it involved see p 51-58 in *Beauty or Statistics* (Theunissen, 2020).

production, cows were selected to fit certain physical infrastructures, such as barns and feeding systems, or to have udder shapes that were compatible with automated milking. This also created sameness of behaviour in cows. Clemens Driessen and Leonie Heutink (2014) show how the co-evolution of cows, farmers and milking robots during the transition to automated milking machines implied a new milking regime requiring new skills. Cows are expected to walk to the milking machine of their own accord, lured by feed and by their own desire to be milked. Rebellious cows emerge as a jeopardy and therefore risk being sent off, producing through selection also sameness of characters.

Yet, reproduction never results in perfect replication (Thoreau, 2023). The practice of breeding even depends on genetic variation and difference-making. Moreover, even under regimes of standardisation, breeding remains a practice in which farmers can diverge, by selecting, experimenting, and making a herd their own. Breeding is not only a specialized herd-improvement project but also what keeps regular milk production going – as every cow needs to reproduce regularly to lactate. What is at stake is which calves stay on the farm, producing the next generation. Farmers continue breeding with animals they are attached to, for example, because it is their children's favourite cow. That there is always room for divergence raises the question which differences come to matter in practice.

Differences in conservation and farming

Although sameness is never fully achieved, the pursuit of sameness of land, genes and bodies has raised concerns about biodiversity loss, genetic diversity, and human and more-than-human health. Both conservation and agricultural practices have aimed to enhance the diversity of ecosystems and practices. The valuations and politics at stake in how differences are enacted in these practices give form to and are shaped by the *epistemic infrastructure* of breeding and biodiversity conservation: how knowledge is produced,

shared and used. These developing infrastructures have a mediating role in how cows, ecologies, landscapes, genes, and multispecies relations are understood, governed and cared for.

More-than-human politics of conservation

Since the 1992 Convention on Biological Diversity (CBD), which explicitly recognised the global value of genetic resources and biodiversity, including in agricultural contexts, attention has increasingly focused on the loss of biodiversity and genetic diversity in relation to agriculture. The United Nations Food and Agriculture Organisation (FAO) outlines that conservation practices include the sustainable use of food and agriculture, the conservation of biodiversity both *in situ* and *ex situ*⁹ and restoration practices (2022, p. 19). Enhancing biodiversity in the context of agriculture, they argue, entails understanding the organism composition of local ecosystems, which necessitates a knowledge-intensive and context-specific approach (p. 23). This entails both a reconfiguration of practices and the way in which animals and land are understood.

Scholars in STS and anthropology have critiqued conservation practices for seeing biological diversity merely as a resource, taken out of its situated contexts in time and place (van Dooren, 2010; Bowker, 2000; Orlove & Bush, 1996). Furthermore, conservation practices are criticised for having a human-centric understanding of biodiversity as the importance of biological diversity is mostly expressed in values relevant to human well-being, economic development, and food security (Taylor et al., 2020). Such understandings reproduce a boundary between nature and culture, positioning biodiversity as an object external to and in service of human life.

⁹ *In situ* conservation refers to the maintenance, the protection, recovery and evolution of organisms in their ecosystems. *Ex situ* relates to the conservation of components outside of their habitats such as the cryoconservation of animal semen, or embryos in genebanks.

Rather than seeking to determine if biodiversity should be understood as belonging to nature and/or culture, in this thesis, I examine how ‘the bio’ is variously enacted in practice, how it is worked with, understood, regulated, cared for and governed. To do so, I engage with the *more-than-human biopolitics* of breeding and conservation in agricultural contexts. Michel Foucault’s concept of biopolitics presents possibilities “for a livelier politics” that does not only concern humans; instead, it attends to “an assemblage of matters of life” (Asdal, Druglitrø & Hinchliffe, 2017, p. 2). By taking a more-than-human approach, I move beyond a human-exceptionalist valuation of biodiversity. More-than-human scholarship instead foregrounds the relational character of life, in which humans, animals, plants, microbes and landscapes are co-constituted (Haraway, 2007; Tsing, 2015).

Social science scholarship on conservation makes clear that different enactments of difference come with their own biopolitical considerations and standards. Christine Biermann and Robert Anderson (2017) highlight conservation sciences not as a homogeneous field, but rather one “replete with debates about which lives must be fostered, who or what is killable and why” (p. 2). They demonstrate how various conservation strategies, such as area protection, rewilding, and genetic resource conservation, assign different values to life.

One of the conservation strategies they discuss is breeding, which involves “the biopolitical management of lineages, reproductive practices, and bodily and genetic forms” (p. 5). In the context of conservation, breeding is usually about preserving a species, prioritising the care of a species over that of individual animals (e.g. see Braverman, 2021). Jamie Lorimer and Clemens Driessen (2013) foreground that, in the case of cattle, the biopolitics of conservation are related to efforts to conserve breeds. These efforts are based on a re-evaluation of traditional forms of animal knowledge and the use of new genetic techniques.

While Biermann and Anderson (2017) argue that the conservation of protected areas and rewilding both focus on the landscape milieu, breeding and the conservation of genetic diversity emphasise bodies as genetic resources. In this thesis, I foreground that the intersection between breeding and conservation in the case of native Dutch breeds is not only about conserving the diversity of bodies but also involves the conservation of wider ecologies and ways of farming. This implies another biopolitics, that of a valuation and potentialisation of cows attached to ecologies, lands, landscapes, farmers and farming practices.

Good farming

As environmental regulations on national and EU levels tighten, farmers across the Netherlands are compelled to rethink their farming practices. They are asked to engage with the reconfigurations of their lands, animals, and in- and outputs of their livestock and farms. The differences that emerge are localised and situated, shaped by soils, landscapes, breeds, histories, and personal attachments. Difference-making is not about fragmentation or complete divergence, but about reconfiguring practices within a changing farming landscape. Farmers experimenting with nature-inclusive or extensive farming practices often emphasise the importance of remaining part of a shared agricultural community, rather than setting themselves apart.

In the Netherlands, there are ecological concerns about methane and CO₂ emissions, nitrate and phosphate pollution affecting water quality, and nitrogen depositions. The latter puts pressure on protected nature reserves and is identified as a key driver of biodiversity decline (Sanders, Henkens & Slijkerman, 2019). The primary regulatory context shaping agriculture today is the ‘nitrogen crisis’, a legal, political and ecological crisis that has become a contested issue shaping Dutch agriculture – in which new versions of good cows and good farming emerge.

Literature on ‘good farmers’ has emphasised the connection between farming practices and values, identities, aesthetics and forms of recognition (Burton et al., 2020). More recently, Westerink et al. (2021) have questioned whether a good farmer can also be ‘nature-inclusive’. This farming approach combines food production and nature conservation to benefit both agriculture and biodiversity (van Doorn et al., 2016). Westerink et al. highlight that a good nature-inclusive farmer is innovative, responsible and has a good work-life balance. While Burton et al. (2020)’s farmer-informants describe the farm of a good farmer as tidy, the nature-inclusive farmers studied by Westerink et al. (2021) emphasise that biodiverse land should be allowed to look messy. This literature is interested in how good farmers are perceived and how farmers get recognition, which places good farming in line with economic, social and cultural capital. In thesis, I rather attend to how the ‘good’ is enacted in socio-material practice.

Before the Holsteinisation of dairy farming, a farmer’s status was linked to the beauty of their cows, as Theunissen (2020) states: “Beautiful cows were good cows; beautiful animals contributed to the status of their owners as good farmers” (p. 24). The Holsteinisation process further embedded cattle selection and reproduction in the economisation of life (Asdal & Huse, 2023). This process effectively rendered the bodies and labour of animals as capital (Shukin, 2009). Since the intensification of dairy farming, what constitutes a good cow has thus shifted. Beauty remains important but is defined through productivity. Traits such as well-shaped udders are valued as they are attached to efficient milk production. Their production is evaluated not only by their appearance, but also by their numbers. For example, cows that produce 100,000 kilograms of milk in their lifetime are celebrated and receive an award.¹⁰

In times of ecological trouble, what constitutes a ‘good cow’? As Frank Heuts and Annemarie Mol (2010) argue, valuing concerns both

¹⁰ <https://crv4all.nl/nl/service/tien-honderd-tweehonderdtonners>

assessment of what is good as well as improvement. How are cows valued both through judgment and through interference by modifying certain qualities? Social science scholars have demonstrated how ecological considerations have altered expectations of cows, leading to concepts such as ‘clean cattle’ (Cusworth et al., 2022), ‘low-carbon cows’ (Folker & Opitz, 2022), ‘flexible cows’ (Vanderstraeten, Bal & Thoreau, forthcoming), ‘climate-friendly cows’ (McGregor et al., 2021) and ‘good cows for a good Anthropocene’ (Searle, Turnbull & Oliver, 2024). These authors show that these differences are created through the lives and bodies of cows, which act as ‘zones of encounter’ between human, animal, plant, microbial, chemical, and technological assemblages (Govindrajana, 2020, p. 198). Building on these arguments, in this dissertation I analyse the enactment of ‘good cows’, ‘good farmers’ and ‘good landscapes’ in relation to the infrastructures and practices of breeding, farming and conservation.

Differentiating the epistemic infrastructure

This dissertation traces how knowledge and infrastructures of genomics, agriculture and conservation shape our understanding of the world – of animals, nature, kinship and belonging in particular. It is situated in a subfield of Science and Technology Studies (STS) that studies the making of knowledge in practice. Following the laboratory studies of the 1980s, this approach shifts the focus to the process of knowledge production, the practices by which knowledge is produced across different sites, to how epistemic objects are made and facts manufactured (Latour, 1987, 2005; Knorr-Cetina, 2008; Bueger, 2015). In this field, Karin Knorr-Cetina (2008) introduced the concept of *epistemic infrastructures* to not only understand epistemic practices, but also how knowledge is exchanged and circulates on different scales.

STS scholars point out that infrastructures are material structures that shape and mediate social practice, and that they are performative, enacting certain realities (Star, 1999; Bowker & Star, 2000; Barua, 2021).

They are “objects that create the grounds on which other objects operate”, being both things and the relations between them (Larkin, 2013, p. 329). Furthermore, infrastructures provide a framework through which to ‘recast the political’ (Barua, 2021), as they represent both the ‘matter of government’ and the ‘government of matter’ (Lemke, 2015, as cited in Barua, 2021).

Scholars of more-than-human relations argue that infrastructures facilitate the mobility and immobility not only of humans but also of non-human life (Morita, 2017; Barua, 2021). They show how animal bodies and labour are mediated by infrastructures, and how non-human life becomes infrastructural. In this thesis, I examine how animal bodies and lives become part of the epistemic infrastructure and consider how infrastructural reconfigurations entail a shift in knowledge of non-human bodies and lives through difference-making practices that allow animals and landscapes to emerge in new ways.

Agricultural knowledge traditions are an important way in which such non-human bodies and life are known, ordered and evaluated. With the rise of intensified and rationalised agricultural practices in the Netherlands in the 19th century, infrastructural changes were driven by data-based approaches centred on maximising output per hectare and per cow (Van der Woud, 2020). The intensification of agricultural and breeding practices required “surrendering to the laws of rational reality, figures and statistics” (Van der Woud, 2020, p. 317). The transition from visual assessment to statistical estimation meant a transition in bodily evaluation. This does not render other ways of knowing cattle obsolete (Halloway, 2005). Farmers and breeders needed to learn about cows in new ways, shifting from a visual to a statistical understanding of breeding.

The rise of ‘genomics’, the data-driven approach to genetics, introduced yet another way of knowing life; new ways of differentiating and comparing human and nonhuman life, and ways of assessing and improving this life. First introduced in the 1980s with the Human Genome Project

(HGP), genomics gained momentum following the completion of the human genome sequence in 2003. While the project showed that 99,5 percent of the human DNA is similar, Amade M'charek (2005) argues that most political and research attention has focused on differences. Since the completion of the project, genomic technologies have progressively been extended to non-human species. The sequencing of the bovine genome was completed in 2009. The technology is currently being used in industrial cattle farming, promising to create the 'cow of the future'. Genetic tests combined into large data sets have made it possible to predict traits in cows, such as their build and milk production.

In this thesis, I examine the reconfiguration of the *epistemic infrastructure* of breeding and farming to promote biodiverse and sustainable agricultural practices. This infrastructure relates both to the infrastructure of breeding as to the epistemic infrastructure of conservation. I thus analyse how the 'datafication of nature' (Nadim, 2021) aims to reconfigure agricultural practices to make them more biodiverse.

Like breeding, biodiversity conservation also relies heavily on data. Geoffrey Bowker (2000) has argued that biodiversity cannot be considered in isolation from data diversity. He shows that biodiversity can only be understood as a loss through data. This also represents life in certain ways. Furthermore, according to Tahani Nadim (2021), datafying nature implies that connections and scales are gained and lost. Entities and phenomena are transformed into transcriptions that "can circulate, be aggregated, and become the target of policy interventions" (Nadim, 2021, p. 64). This makes species, processes, ecosystems and relations matter, and makes them subjects of intervention. Following these authors, I analyse how 'the bio' is enacted and becomes an object of intervention through datafication practices that establish, sustain and breed differences.

Methods: Situating difference in practice

To understand how breeds native to the Netherlands are valued, known and mobilised, my main research method is to *situate differences* in breeding, conservation and farming practices. I examine where differences emerge, how differences are made, contested, and stabilised in practice. The methodological approach adopted in this dissertation is informed by traditions in science and technology studies (STS), anthropology, and more-than-human scholarship that attends to how realities are *enacted* in practice. Different practices make certain weavings in which certain objects are enacted as such.

This sensibility derives from *material-semiotics*, which, according to John Law (2019), is a set of tools to explore how practices are woven from threads that are relational, that carry meaning and are also material. Moreover, it assumes that “there is no single social structure or form of patterning because these material and social webs and weaves come in different forms” (Law, 2019, p. 1). Mol (2002) has called this *multiplicity*. Objects, she argues, come into being and disappear with the practices in which they are manipulated. Since practices differ, objects emerge differently too: reality multiplies (p. 5). This does not mean that reality is fragmented; multiplicities are also related.

Moreover, multiplicity carries political implications: realities are being enacted in particular ways which could also be otherwise, raising questions about “what is, what should, and what might be realised” (Law, 2019, p. 10). Different enactments enable different possibilities, in this case, for what cows, farmers, and landscapes can become in conservation and farming practices. I attend to various difference-making practices that come with their own values, logics, infrastructures and concerns, shaping realities in certain ways and with certain effects.

As an ethnographer, I also participate in difference-making. By foregrounding certain elements in my analysis, I decide “which differences matter” (Vogel, 2021). My interest lies not only in identifying the

differences articulated by my interlocutors but also in analysing and *contrasting* (Vogel, 2021; Laurent et al., 2021) different practices of differentiation. This involves teasing apart elements that might otherwise remain unarticulated. In this way, my research moves continuously between the difference-making practices encountered in the field and my own ethnographic attention to difference and multiplicity.

The methodology that allows me to trace the socio-material multiplicity is *praxiography* – to study how different forms of difference-making enact ‘the bio’ in different ways. This methodology was developed by Mol (2002) to conduct ethnographic research that attends to practices. Praxiography shifts the attention from what people say they value to what they *do*: valuation is done in practice. In the interviews, observations, and participant observation I conducted, I focused on how things were done and which ‘goods’ were cherished, cultivated, and grown, and which ‘bads’ were avoided, eradicated, or cast aside.

Attending to multispecies relations

This thesis engages with multispecies relations. Since the more-than-human turn in the social sciences, “creatures previously appearing on the margins”, according to Eben Kirksey and Stefan Helmreich, are being foregrounded (2010, p. 545). Multispecies ethnographers have started “to follow genes, cells, and organisms across landscapes and seascapes”, tracing how elements of humans “are creating becomings in the bodies of other species, and vice versa” (p. 555). While nonhuman beings were once “confined in anthropological accounts to the realm of *zoe* or ‘bare life’ – that what is killable,” they have recently “started to appear alongside humans in the realm of *bios*, with legibly biographical and political lives” (p. 545).

Scholarship studying multispecies relations attends to the way agency, care and response-ability are distributed across actors (Haraway, 2016; Puig de la Bellacasa, 2017). In material semiotics, an actor is, in the words of Bruno Latour (2005) “*any thing* that does modify a state of affairs

by making a difference” (p. 71). Agency in my analytical framework does not involve the question if someone or something possesses subjectivity, which makes distinctions between humans, animals and things. Instead, agency emerges in practice. Actors “are relationally linked with each other in webs. They make a difference to each other: they make each other *be*” (Law & Mol, 2008, p. 58). The actors involved in the difference-making practices I study include beings such as cows, grasses, soils, landscapes, and technologies and infrastructures such as herdbooks, databases, and freezing technologies.

Although my research focuses less on the daily lives and perspectives of non-human beings (cf. Cornips, 2025), I question the categories, classifications and differentiations at the core of multispecies relations that establish differences between humans, animals, species and breeds. As Emily Yates-Doerr (2015) states, despite a widespread classification into fixed natural order, “there is no register of equivalence on which bodies and beings can be steadfastly pinned” (p. 310) – instead, they form through “a dance of kin and kind” (Haraway, 2008, p. 17, as cited by Yates-Doerr, 2015). I consider how these differentiations shape notions of relatedness and belonging. Humans make animals and animals make us, not only in the sense that humans reproduce animals or that animals feed humans, but also in a material-semiotic sense, through the very categories of species and kin (Mol, 2021). Categories, classifications and differentiations are made through fragile and situated practices (Latour & Woolgar, 1987; Haraway, 1988): species and breeds “do not exist outside the practices through which they come into being” (Yates-Doerr, 2015, p. 319). In my research, this entailed attending to the “techniques that make things visible, audible, tangible, knowable” (Mol, 2002, p. 33).

Fieldwork sites

The emphasis in praxiography is not on how institutions or individuals interpret the world, but on how, in everyday activities, realities are brought

into being (Mol, 2002). Therefore, my research design has been both cross-cutting and multi-sited, following practices and actors across different locations and contexts through interviews and participant observations.¹¹

To understand how diversity amongst cattle is conserved, I started doing ethnographic research at the *Centre for Genetic Resources, the Netherlands* (CGN) in Wageningen in December 2021. This centre plays a key role in providing the infrastructure and knowledge exchange supporting the conservation of crop and farm animal genetic diversity at national and international levels. It forms part of Wageningen University & Research (WUR), a top-ranked agricultural university involved in policymaking and the agricultural industry.

After my first meeting with the director of CGN, he gave me a list of names and contact details for all CGN members and other researchers working in the Animal Breeding and Genomics group. Through interviews and observations with seventeen participants, I explored how and which values and understandings concerning the conservation of cattle diversity emerged, and how these materialised in infrastructures for collecting, freezing and analysing. It was important to become familiar with the technical language and methods to understand how genetics and diversity were understood and practised.

These early engagements revealed native Dutch breeds to be central to conservation concerns. To continue examining how differences are created in the valuation and mobilisation of native breeds, I extended my fieldwork to include the breed associations established for each of the native Dutch breeds. I interviewed seven board members in person, either on their farms or over the phone. I also visited a cattle museum exhibiting the native

¹¹ All interviews conducted for this thesis were recorded and stored in the University of Liège's secure database. I transcribed all the interviews and analysed them using the qualitative analysis software Nvivo. I wrote fieldwork reports for each of the observations. All participants were asked to consent to the use of quotes and their names or pseudonyms.

Dutch breeds. I attended a few events organised by the breed associations, which took place on farms and brought together farmers and enthusiasts of the breeds. During these events, members of the breed associations came together to celebrate and discuss ways to improve their breed. Through these interactions, I learned how to recognise what constitutes a good cow or bull for them, based on their *skilled vision* (Grasseni, 2004). This involved learning how differences between cows were identified and discussed. I examined not only how differences were made between cows and practices, but also how Dutch native breeds are valued for making a difference.

To research how differences are established between cows and how cows are made to belong to a breed, I conducted fieldwork at two herdbook organisations that oversee the registration of cows. The first was the *Fries Hollands Rundvee Stamboek* (FHRS) in Leeuwarden, which is associated with the Fries-Hollands breed association. As well as their registration practices, they are invested in conserving the Fries-Hollands breed and support the conservation efforts of other native breeds. The second organisation is *Coöperatie Rundvee Verbetering* (CRV), which is based in Arnhem. CRV is divided into a commercial part that develops and sells semen and a cooperative part that registers most cattle in the Netherlands.

At CRV, I also interviewed a breeding expert to gain a better understanding of breeding practices associated with intensive dairy production, especially those centred around Holstein-Friesian cattle. I also visited their Nucleus, my visit there is detailed in the opening vignette. These visits enabled me to observe the breeding and selection infrastructure through which cattle are evaluated and selected. They also showed me how the dominance of Holstein-Friesian breeding shapes systems of valuation and breeding strategies.

To research the work invested in the reconfiguration of the epistemic infrastructure towards biodiversity aims, I followed the

DubbelDoel Natuurlijk project¹² between 2022 and 2024. This public-private collaborative research project, funded by the Dutch Ministry for Agriculture, Nature, and Food Quality, asked how to breed cattle for nature-inclusive farming. I followed this project by attending the bi-weekly project meetings and participating in several phases of the research.

The first phase of the project involved a data analysis based on information from several farms, comparing Holstein and native-breed farms in terms of milk production, cow health, and farm characteristics, such as farm size and soil type. Following this data study allowed me to observe how interventions on cattle and other more-than-humans were mediated through datasets. The second phase consisted of interviews with eight nature-inclusive farmers, for which I collaborated in developing, conducting and analysing the interviews. Each of the visits involved a sitting-down part at farmers' kitchen tables and a part in which the farmer showed us their cows and land. These visits allowed me to observe how cattle were bred and valued within nature-inclusive farming. The third phase involved group discussions with farmers about breeding goals, knowledge gaps, and experiences with breeding native breeds. During these sessions, I observed how values were negotiated and how differences between cows and farming practices were articulated.

Navigating positions

The position of the ethnographer shapes the encounter with participants: how people interact, what they do, what they say, and what they don't say. Ethnography unfolds through relationships, which occur in "complex and uneven spaces" where the researcher is situated (Selka, 2020, p. 93). Jane Calvert (2024), in discussing the roles STS researchers take on in certain

¹² Partners include *Stichting Zeldzame Huisdierrassen* [SZH, translation: Foundation for rare pet and farm breeds], *Coöperatie Runveeeverbetering* [Cooperation Cattle Improvement, CRV], the largest breeding company in the Netherlands. Lastly, partners include all the breed associations for breeds native to the Netherlands.

rooms, like the lab, the conference room, and the artist studio, highlights that by moving between different sites ethnographers need to renegotiate identities (p. 9). She invites us to reflect on how the position of the ethnographer shifts when we move sites.

In the DubbelDoel Natuurlijk project, I switched between participant observer and collaborator, which meant navigating different roles and positions. On the one hand, I observed their practices, analysed those and wrote a paper for an STS audience about these practices. This gave them a space for reflection when reading along. On the other hand, I positioned myself as a social scientist with methodological tools in qualitative research that were useful for them. They had already planned to conduct interviews and focus groups, so I was happy to give something back in return for allowing me to observe their practices. This also allowed me to go along to the farm. Together, we wrote a final report (Bonekamp et al., 2025), for which I contributed mostly to the analysis of the interviews and focus groups.

On the farm, I conducted the interviews with the nature-inclusive farmers together with Gerbrich Bonekamp, alternating roles as interviewer and note taker. Gerbrich is a researcher who studied in Wageningen and grew up on a dairy farm herself. This made her very knowledgeable about agricultural practices and the language used by the farmers. Although we all spoke in Dutch, there were many words I had never heard of, such as the different words there are to describe manure, ways to ferment hay, and different types of barns. In the car back, I took the opportunity to ask her about the meaning of these words, and we also reflected on the politics of farming in the heated, politicised climate of the nitrogen crisis.

My position in the field was heavily shaped by the political situation of the nitrogen crisis, which rendered the 'bio' created and cherished as political, and became a question of survival for my farmer-informants. My position in this context was mediated by the different roles I had in the field. For the interviews within the Dubbeldoel Natuurlijk project, we entered as

researchers from Wageningen. The farmers all signed up for participation themselves as they are invested in the development of knowledge about breeding with native breeds, and about breeding for nature-inclusive farming practices. Therefore, we had no difficulty negotiating access. Farmers sometimes expressed their worries and discontent with the politics around the nitrogen crisis, thereby expressing some trust in us. These discussions revealed how their practices are embedded in broader political contexts.

In writing the articles for this thesis, I took care not to portray the farmers in a manner that could potentially harm them. The farmers in this thesis are part of the same circles and networks, making it difficult to achieve full anonymity. One farmer, after careful negotiation, even withdrew his participation from one of the papers forming part of this thesis because the location of his farm was under threat following area planning negotiations in the context of the nitrogen crisis. These negotiations rendered my (and the farmer's own) portrayal of this farm as 'different' vis-à-vis 'regular' (production-oriented) farmers politically sensitive. The political and tense situation of the nitrogen crisis creates tensions amongst farmers.

Outside the context of the DubbelDoel Natuurlijk project, negotiating access occasionally proved more challenging. While the breed organisations were all very welcoming, there were instances in which farmers were a bit more careful, because they feared critical engagements from outsiders. During this time there were farmers protesting the government's plans for restricting nitrogen emissions. Entering the field with an interest in breeding proved helpful, as it opened these conversations from the entry point of how different concerns such as sustainability, tradition, production and animal welfare are negotiated and balanced.

Rather than evaluating these concerns, this thesis examines how different versions of 'good' are enacted. My aim is not to criticize individual farmers, my intervention in this thesis is rather concerned with the ecological trouble and production of sameness caused by intensified

agriculture. My own difference-making practice engages in focusing on practices that move away from those, by analysing and making visible how more-than-human relations and politics take shape, and the logics and infrastructures that shape those – strengthening different valuations and ways of relating beyond dominant logics of intensification that have led to the production of sameness.

Organising the chapters

In the chapters that follow, I analyse how difference is bred across different settings through epistemic, breeding and farming practices, which bring differing stakes, languages, ways of knowing cows, farmers and environments. I ask how native Dutch breeds are valued and mobilised in farming and conservation practices that concern difference-making.

In chapter 2, I explore the practices of enthusiasts of old Dutch native breeds that make cows belong to a breed, thereby questioning how Dutch breeds are differentiated and what that is good for. Rather than examining how breeds are valued or why farmers choose particular breeds, I trace such valuations back to the practices of differentiation through ‘kinship measurement practices’ (Thelen & Lammers, 2021). These are key sites where value is produced and contested, shaping what constitutes good cows, good landscapes, good products, and good farmers

In chapter 3, I explore how the practices of genebanking *potentialize* native breeds. I question how the differences between breeds come to matter, and how the native breeds are made valuable through conservation practices. I do so by analysing two different logics of conserving genetic diversity, one grounded in a politics of extinction and loss, and the other in the valuation of native breeds in the anticipation and production of sustainable agricultural practices.

In Chapter 4, together with Pauline Chasseray-Peraldi and François Thoreau, I analyse data practices within the DubbelDoel Natuurlijk project in which native breeds are attached and attuned to

certain ecologies. Drawing on collective expertise in media studies and science and technology studies, we examine the mediating role of data practices, aimed at reconfiguring the epistemic infrastructure, in the remaking of biodiversity on nature-inclusive farms. We thereby question how practices of differentiation make a difference.

In chapter 5, together with Else Vogel, I analyse how farmers rewrite the metabolic scripts on their farms with cow breeds native to the Netherlands. We show that farmers are responding to the breakdown of ‘the Holstein script’ by loosening the demand for production and reconfiguring the division of labour between farmers, soil and cows. This does not just entail a switch in breed or practice, but a reconfiguration of the land and farm ecology through new alignments between bovine bodies and their environments. We thereby question what breeding difference requires.

Lastly, in chapter 6, I draw together the insights about how difference is bred, and question what difference breeds difference, for farmers, for cows, and for the landscapes they bring into being.

Chapter 2

What breed is good for

Making cows belong to native Dutch breeds
through kinship measurements



Abstract

Cows come to live and die not only as members of the cattle species, but also as members of breeds (Nash, 2024). Anthropologists (Nash, 2024; Kroløkke, 2021; Münster, 2022) have demonstrated how certain breeds are valued for difference, for national identity building and for multispecies belonging. In this paper, rather than examining how differences among cows are valued or why farmers choose particular breeds, I trace such valuations back to the practices of differentiation. To do so, I analyse different ‘kinship measurement practices’ (Thelen & Lammers, 2021), technoscientific tools that measure and establish belonging: tracing genealogy, testing genetics, and evaluating looks. I argue that these are key sites where value is produced and contested, shaping what constitutes good cows, good landscapes, good products, and good farmers. I do so based on ethnographic fieldwork conducted between 2022 and 2024 with enthusiasts of ‘local’ and ‘native’ Dutch breeds.

Keywords cattle, breed, valuation, differentiation, kinship measurement

Submitted J. Bal (n.d.) What breed is good for: making cows belong to native Dutch breeds through kinship measurements.

This chapter is under embargo pending publication

Chapter 3

Potentializing native breeds
Conserving genetic cattle diversity
in the Netherlands



Abstract

Genebanks, established to counter the decline of biodiversity, preserve what is threatened with loss for potential use. Based on ethnographic fieldwork at the animal department of the *Centre for Genetic Resources, the Netherlands* (CGN) of Wageningen University & Research, I explore what it means in practice to conserve diversity, with a focus on conserving the genetic diversity of cattle. Drawing on literature in STS and Anthropology on potentiality, I analyse how the conservation of cattle genetic diversity is potentialized based on two logics. The first logic is grounded in the politics of extinction and loss. Genetic material is frozen as ‘fire insurance’ against the risk of declining breed populations and extinction. The second logic centres on the value of native and rare breeds whose characteristics are conserved to anticipate and produce ecologically sustainable futures. Genetic diversity is seen as a ‘painter’s palette’ or ‘toolbox’ to breed ‘future-proof’ cattle. By analysing these logics, I contribute to our understanding of how potentiality is not merely a latent quality of frozen life but is actively shaped within the infrastructural and political conditions of the genebank, thereby shaping how bovine life is valued and which agricultural futures are made possible.

Keywords genetic diversity, genebanking, conservation, potentiality, infrastructure, cattle

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Introduction

On a sunny day in the spring of 2022, I joined Henk Sulkers, semen collection and cryopreservation specialist and laboratory technician, at a farm in the south of the Netherlands with 12 *Brandrode* [Dark Red] bulls. When we arrive, the farmer and his two assistants have put up fences around the barn for the day, and two cows are already standing there, tied up with ropes. Each bull is brought to the back of a cow to smell it, and when the bull jumps, Henk skilfully grabs its penis to collect the semen in a prepared plastic mold²² with the right temperature and pressure while the farmers hold the cow in place. I am put in charge of the administration, so when Henk shouts to me how many millimetres are in the tube, I note it down on a printed form. After this dance is repeated for a few hours, Henk and I return to the laboratory, where he starts preparing to freeze the semen (observation April 2022).

The semen Henk collects is frozen at the *Centre for Genetic Resources, The Netherlands* (CGN). Genebanks²³ have been established worldwide to restore biodiversity and contribute to conserving the globe's flora and fauna. The biological material that is carefully stored holds the potential to become life again when needed (Radin & Kowal, 2017). Following the signing of the *Convention on Biological Diversity* in 1992, 168 nation-states agreed that the conservation of biological diversity is a shared global responsibility. The treaty defines the present and future value of biodiversity in terms of its ecological, genetic, social, economic, scientific,

²² This is referred to as a “semen collection device” or “bovine artificial vagina”

²³ The term *genebank* refers here to places where genetic material of animals and plants is stored in nitrogen tanks and storage rooms for nonhuman species for conservation. The most famous plant genebank is the seed bank in Svalbard. Plant and animal breeding companies also keep their commercially valuable genetic materials in seed storage or cryo-storage (liquid nitrogen tanks). The term *biobank*, which also refers to a place where genetic resources are stored, is more commonly used for the genetic resources of humans.

educational, recreational, and aesthetic purposes, as well as its value in the food system (United Nations, 1992).

In this article, I explore how life is potentialized in the conservation of genetic diversity, with a specific focus on cattle. This is based on ethnographic fieldwork conducted in 2022 at CGN, the national genebank for livestock species, which includes cattle. The Netherlands is one of the world's largest exporters of agricultural products and is internationally known for the efficiency of its agricultural infrastructure. Over half of the country's land is used for agriculture, 45 percent of which is dedicated to dairy cattle farming (CBS, 2020; 2022). Dutch and international biodiversity experts warn that the intensification and specialisation of agriculture have led to declines in ecosystem biodiversity and have also contributed to the loss of genetic diversity within livestock populations (Sanders, Henkens & Slijberman, 2019; FAO, 2022). This increases the risk for the rapid spread of diseases²⁴ and genetic defects, which motivates CGN to engage in both in situ and ex situ conservation. Ex situ conservation involves conserving the biological material outside the habitat, for example, through freezing. In situ conservation is the conservation of organisms within their ecosystem (FAO, 2015).

In earlier research on genebanks for nonhuman animals, STS scholars have questioned what is stored in genebanks and the purpose of conservation in this context. Geoffrey Bowker observes that material that is frozen is a snapshot of a specific time. He offers the critique that: "what we need to understand about biodiversity is not to freeze the present...we need to understand processes of change in order to favorably inflect our future" (Bowker, 2008, p. 102). Ben Orlove and Stephen Brush argue that by freezing genetic material, genebanks only conserve certain species, not the

²⁴ At the time of the research, this is a huge concern for the Dutch sheep population, which is suffering from a "Bluetongue" outbreak resulting in the loss of sheep on more than 5,000 farms. For more information see:

<https://www.nvwa.nl/onderwerpen/dier/blauwtong>

environments in which they live, nor the farmers' knowledge of how to care for these species. Genetic material is thus removed from its context (Orlove & Brush, 1996). Similarly, in an article about seed banking, Thom van Dooren critiques the practice of genebanking as a *conservation proxy*. According to van Dooren, banks do not treat the material they store as individuals or species that “carry in and with them possibilities for ways of living and knowing the world,” but merely as resources (van Dooren, 2010, p. 386).

By preserving what has been lost in the past for potential future use, genebanks serve as technologies that mediate various temporalities. In the introduction of a recent special issue of *Science, Technology & Human Values* on cryopreservation, Veit Braun and colleagues reflect on the temporal effects of cryopreservation as going *beyond* the halting of time (Braun et al., 2023). Freezing genetic material is world-making and practices “prepare for and anticipate—but they also produce—futures to come” (Braun et al., 2023). Here I approach genebanks as “future-making institutions that have the potential to create new ecological, social, and economic realities” (Breithoff & Harrison, 2018), exploring how temporalities are enacted and how this shapes conservation.

Following the scholars above, in this article I articulate what is stored in genebanks of nonhuman animals, and particularly how *potential* is created in different ways. While I also consider which life is imbued with potential, I am primarily interested in the practices of *potentializing* that shape the future of cows. I argue that how potential is staged shapes the practices and infrastructures of conservation. I thereby approach the genebank as an infrastructure that informs and mediates practices (Kanoi et al., 2022; Star, 1999; Larkin, 2013), and shapes human and nonhuman life (Barua, 2021). Furthermore, I analyse how genebanking practices in the case analysed shape what emerges as a breed, a cow, and as biodiversity.

I ask what it means to conserve the genetic diversity of Dutch cattle in practice, which potential is created through genebank infrastructure,

how, and with what limitations. To answer these questions, I first address how anthropologists and STS scholars have explored the concept of potentiality within scientific practices, and more specifically, within the practice of genebanking of nonhuman genetic material. Then, after setting out the methods used for this research, I analyse how the genebank functions as an economically and politically embedded “future-making institution” (Breithoff & Harrison, 2018), detailing how my informants work with two different ‘logics’ to conserve genetic diversity. The first logic is grounded in politics of extinction and loss. Genetic material is frozen as “fire insurance” against the risk of declining breed populations and extinction. The second logic centres on the value of native and rare breeds whose characteristics are conserved to anticipate and produce ecologically sustainable futures. Genetic diversity is seen as a ‘painter’s palette’ or ‘toolbox’ to breed ‘future-proof’ cattle.

Theorizing the potential of genetic materials and technologies

Material stored in genebanks has *potential*. Although frozen life has not yet been transformed into actual life, it does have the potential to become so. This material has potential for the future, the present, and for restoring the past. This potential is framed in certain ways and shapes practices and infrastructures. Potential is ascribed to genetic material that is valued. In this article, I focus on how life is valued, and how these valuations are enacted: how they are potentialized. Following Charlotte Kroløkke (2019) and Mette Svendsen with Lene Koch (2013), I transform potentiality into a verb, ‘potentializing’ or ‘making potential,’ thereby directing attention to practice. By analysing the practices of making potential within the infrastructure of genebanking, I build upon the work of Stefan Helmreich and Thomas Lemke, by expanding the scope of analysis “to include the actual practices that bring along a new “form of life”” (Helmreich, 2011, as cited in Lemke, 2022).

In the fields of STS and anthropology, the concept of potentiality in biomedical science was introduced in a special issue of *Current Anthropology*, edited by Karen-Sue Taussig, Klaus Hoeyer, and Stefan Helmreich (2013). The authors emphasize that potentiality is framed as a promise and a “hopeful idiom to imagine the benefits of new medical interventions” (p. 4). The authors relate potentiality to the sociology of promises, differentiating promises from potentiality. While promises refer to the people making them—a person making a promise should keep it, potentiality “makes moral claims for others to act” (p. 10). If a specific technology or biological material has the potential to transform medicine, then others should fund and donate; when something has potential, it would be a shame not to fulfil it. The authors emphasize potentiality as a future-oriented concept and highlight the political nature of potentiality by emphasizing that its etymology derives from the Latin *potential*, meaning “force” or “power” (p. 5). Focusing on potentializing thus requires analysing the power dynamics at stake—the different abilities to potentialize among different actors.

The notion of potentiality in the STS literature on genebanking has less to do with making grand claims about the future or framing certain technologies as having potential. Instead, scholars are primarily interested in understanding life in a frozen state. This literature also focuses less on the promises of technological innovations and more on the genetic material itself. When conceptualizing frozen life as having potential, scholars have characterized the potentiality of frozen life as one of “suspension” (Hoeyer, 2017; Lemke, 2022), “latency” (Radin, 2013; Dalyan, 2018), and “plasticity” (Landecker, 2007). By contrast, I argue that potential is not only to be ascribed to frozen life, but it is actively made. The question is not *how* we understand frozen life, but rather how and which life is potentialized, which invites questions about the bovine biopolitics (Lorimer & Driessen, 2011) of freezing and conservation, that are relational and multiple (Vogel, 2025).

These biopolitics of conservation (Biermann & Anderson, 2017) play out in the technoscientific practices and infrastructures through which material is potentialized. Lynn Morgan points out how techniques are required to *actualize* what has potential. In her article, she argues that in the case of embryos and IVF, potential life does need ‘technoscientific actualization’ (Morgan, 2013). Technoscientific developments then also contribute to what can be granted with potential, transforming which lives can have potential and which cannot. These technoscience developments are part of wider infrastructures. STS scholars who are part of the “infrastructural turn” have shown that infrastructures are material systems of circulation and flow that are relational and embody political, economic, social, and ethical choices that make and sustain social organizations and mediate and shape practices (Kanoi et al., 2022; Star, 1999; Larkin, 2013; Jensen & Morita, 2015). Following Maan Barua (2021), I approach infrastructures as an analytical site in tracing not only the mobility and immobility of humans, but also of nonhuman life. Connecting that with the literature on potentiality, I look at how potentiality is made within certain infrastructures, which afford certain valued genetic material, within the possibilities and limits, to be granted potential.

Studying the making of potential at the Centre for Genetic Resources

To understand how genetic resources of cattle are potentialized, I situate my ethnographic research at the animal department of the only nationally recognized farm animal genebank for conservation purposes, which is *The Centre for Genetic Resources, The Netherlands* (CGN). The staff of around 8 people includes geneticists, cryopreservation researchers, managers, support staff, and lab technicians. CGN has become an infrastructural hub in the conservation of genetic diversity in the Netherlands, mediating between governmental institutions, breed organizations, farmers, and

breeders. As a government-funded organization,²⁵ they set out the direction of conservation practices in the Netherlands.

The centre is located at Wageningen University & Research (WUR), whose animal department is affiliated with the Animal Breeding and Genomics (ABG) department. CGN and ABG staff hold their offices and labs in the Radix building on the WUR campus. The WUR is a top-ranked university that specializes in agriculture. It is known for being involved with both policymaking and the agricultural industry. The ABG department focuses on innovations for the agricultural sector and on developing novel methods for genetic improvement of livestock, including cattle. The department mostly supports and collaborates with the conventional agricultural industry and commercial breeding sector, which focuses on the more specialized and highly productive breeds, such as the Holstein Friesian dairy breed. This breed is commonly used in the Netherlands and is renowned for high milk production. Social science scholars refer to the Holstein as the “turbo cow” (Orland, 2004), or “top sport cow” (Verkaaik, 2022). WUR researchers support the breeding industry to increase the efficiency of milk production, improve animal health, and reduce methane and nitrogen emissions through breeding. In contrast, CGN primarily focuses on conserving rare Dutch breeds and distinguishes itself from the rest of the department by advocating for enhancing biodiversity in the agricultural sector. Next to further specialization and sustainable intensification of the agricultural sector, they also advocate for integrating biodiversity conservation into agricultural practices (“landsparing” and “landsharing”).

The role of CGN in the ex and in situ conservation of Dutch genetic resources was made official in the national policy document *Sources of our existence* (2002). This mandate follows the Convention on Biological Diversity (United Nations 1992), which sets out the responsibility of

²⁵<https://www.rijksoverheid.nl/contact/contactgids/centrum-voor-genetische-bronnen-nederland-cgn>

nation-states for the conservation of genetic resources. CGN carries out *Wettelijke Onderzoekstaken* (Statutory Research Tasks, WOT) and is funded by the Ministry of Agriculture, Fisheries, Food Security, and Nature to conserve genetic material. CGN also functions as an advisory institution on the conservation of genetic resources to the Ministry. The centre has the authority to decide which cattle are conserved and, due to its regulatory position, plays a significant role in shaping what kinds of agricultural futures are made possible.

For research projects, funding from the Ministry is limited, and therefore, other sources must be sought. In the field of cattle breeding research, CGN frequently collaborates with private institutions such as breed associations, the *Foundation for Rare Domestic Animal Breeds* (Stichting Zeldzame Huisdierrassen, SZH), and breeding companies like *Coöperatie Rundveeverbetering* (Cooperation Cattle Improvement, CRV). Furthermore, since 2023, CGN has led the EU Reference Centre for Endangered Animal Breeds (EURC-EAB), providing scientific and technical advice to the European Commission, national authorities, and breed societies to harmonize the conservation and breeding programs of endangered breeds within the EU. This establishes CGN as a leading centre for cattle conservation at the EU level.

Eager to learn more about cattle conservation and genetic material storage practices, I began my research by gaining access to the centre's laboratory. There, I observed the practices involved in freezing, recording, and assessing genetic material. As the freezing is only one aspect of the work carried out at CGN, my research into cattle conservation took me to other places as well, such as offices, farms, Zoom meetings, and networking events. During the interviews (n = 17) and observations²⁶ I focused primarily on

²⁶ The fieldwork was conducted both in English and Dutch: the quotes from Dutch speakers are translated into English. Some of the interviews were conducted online, as the research started when there were still COVID-19 lockdowns. Fieldwork was conducted in accordance with the ethical framework of the ERC and with the ethical

the daily work of the staff, attending to how values concerning the conservation of genetic diversity of cattle were enacted in practice. Focusing on the genebank as an infrastructure, I examined how technologies, knowledge, values, and relationships are formed and transformed.

In the next section, I present the first empirical part of this article, focusing on the genebanks' history and infrastructure, and what is stored in the genebank and why. I then distinguish between two different logics of genetic diversity and temporalities, and how these logics shape conservation practices.

Conserving cattle genes in the Netherlands: potentializing native and rare breeds

The history of conserving cattle genes in the Netherlands dates back to the 1970s. At that time, cattle breeding had already developed toward a dairy industry of specialization and intensification, as part of the “modernization project” in agriculture initiated by the Dutch government in cooperation with agricultural scientists from Wageningen (Theunissen 2020). A group of Dutch breeders and scientists observed the environmental consequences of these developments and became concerned about the state of the genetic diversity of farm animals and crops in the Netherlands. In response, they established the *Foundation for Rare Domestic Animal Breeds* (Stichting Zeldzame Huisdierrassen, SZH) in 1976. The foundation pointed to the threat of extinction for certain breeds they noticed were favoured less by farmers due to the breeds' moderate dairy production. The SZH also pointed to the dangers of artificial insemination²⁷, which had led to the insemination with semen from only a few desired bulls, causing a loss in

framework of the *Body Societal* project, with ethical advice from Dr. Nathalie Grandjean. All research participants have given their consent to be quoted and named in this article.

²⁷ Artificial insemination and the use of frozen semen is widely implemented in commercial cattle breeding. This technology also allows the long-term storage of genetic materials in genebanks.

genetic diversity through inbreeding. The two main concerns—loss of genetic diversity within populations due to inbreeding, and the loss of diversity due to the risk of disappearance of breeds that are perceived as less economically productive—remain the most prominent concerns for conservation practices today.

In the 1980s, in response to these concerns and in an effort to preserve genetic diversity, researcher Durk Minkema began freezing cattle semen in the freezer at the *IVO Schoonoord* institute where he worked (CGN, 2011). Later, in the early 1990s, the cryopreservation of genetic material became institutionalized. Since then, nitrogen tanks containing genetic material have been moved to various research facilities in the Netherlands, finally arriving in Wageningen in 2014 (see Figure 3.1). Currently, the genebank conserves frozen genetic material (especially semen) from all kinds of domestic animal breeds “with a function for agriculture or that are of cultural-historical value,” such as pigs, chickens, horses, goats, sheep, ducks, dogs, rabbits, and cattle.²⁸



Figure 3.1 Photograph of nitrogen tanks for storing genetic material of animals. The technician holds a plier to place or remove semen straws. The screen displays the temperature and operation options. (Credits: Center for Genetic Resources, the Netherlands)

²⁸ <https://www.wur.nl/en/cgn>

In conversations with CGN's staff, I soon noticed that, beyond their motivation to contribute to the preservation of the genetic diversity of Dutch animals in general by preserving a wide range of breeds used in livestock farming contexts in the Netherlands, they also showed a particular enthusiasm for certain breeds that they categorize as *native* and *rare*: Brandrode, Fries-Hollands, Lakenvelder, Groninger Blaarkop, Maas-Rijn-IJssel (MRIJ), and the Verbeterd Roodbont. These are all “dual-purpose” breeds, used for both milk and meat production. Since the 1970s, these Dutch cattle breeds have been replaced by the Holstein breed. The Holstein breed originates from the Fries-Hollands Zwartbont, which was renowned in the early 20th century for its quantity and quality of milk production. The breed was exported to the US, where it was genetically selected for milk production, developing the Holstein Friesian breed (Theunissen, 2012). Subsequently, this “high-input, high-output” Holstein spread all over the world, including back to the Netherlands. This process is referred to by scholars as the *Holsteinisation* of dairy farming (Labatut & Tesnière, 2018; Theunissen, 2012). Currently, the Holstein breed constitutes around 95 percent of the Dutch cattle population, amounting to approximately 3.8 million animals (CBS, 2022).

CGN emphasizes that due to the increased prevalence of animal diseases and zoonosis, the risk of extinction for rare breeds becomes even higher. When a contagious virus circulates within a region, that could mean that one of the breeds can go completely extinct. One of the researchers at CGN told me that with the foot-and-mouth disease²⁹ at the beginning of the 21st century, many farms were culled in the region where the MRIJ is very present, and so this could have led to the disappearance of Dutch native breeds (interview 7 March 2022). To prevent this, CGN stores enough material to ensure that when a breed becomes extinct, there is enough material left to revive a breed and do ‘back crossing.’ They use the software

²⁹ The foot-and-mouth disease was reported in 2002 in Great Britain, followed by an outbreak in the Netherlands a month later (Bouma et al. 2003).

program *Conservation Planner* to calculate how many samples need to be stored. So far, none of the Dutch cattle breeds have gone extinct, but if it does, CGN is prepared.

Beyond the concern for extinction, conservation efforts for native breeds are also motivated in other ways, emphasizing affective relations and love for breeds (Verkaaik, 2022; Nash, 2024). In some of the offices, I found a poster hanging on the wall with images of all the different breeds that exist in the Netherlands. One staff member showed her affection by telling me that “they look nice” (interview 23 February 2022) and that their diverse appearance is appreciated. Some of the breeds also have a regional connection to specific ecosystems or regional identities. One of the researchers at CGN explained, for example, that there are farmers who believe a specific breed should be kept in a certain region, exemplifying that by talking about her grandfather: “he had cows from the Fries-Hollands breed, and thinks, in Friesland, there should be Friesian cows” (interview 24 March 2022). So, next to the official mandate and the risk of a breed disappearing, there is also the hope that these native breeds can live on. This is not only to ensure the genetic diversity of cattle herds, but also because a cultural, regional, and aesthetic value is attached to these breeds.

The preference for *native* breeds aligns with CGN’s official mandate, rooted in international policies such as the Convention on Biological Diversity (United Nations, 1992), to preserve the Netherlands’ unique biodiversity. In accordance with the FAO definitions of species (2013), CGN has identified which breeds can be defined as *native*. To acquire this status, a breed requires a registered herdbook³⁰ and a dedicated breeding program spanning at least four decades and six generations. This temporal frame not only gives “the breed sufficient time to adapt

³⁰ Herd books are kept by official herd book holders. Dutch breed societies can apply for official recognition and approval of their breeding program, based on EU breeding legislation (EU 2016/1012). The largest cattle herd book holder in the Netherlands is *Coöperatie Rundveeverbetering* (Cooperation Cattle Improvement, CRV)

(genetically) to one or more traditional production systems, environmental factors,” allowing them to become “naturalized” in the Dutch ecosystem, but according to CGN, it also leaves enough time for the breed to adapt to the “social and cultural aspects of the Netherlands.”³¹ Hence, the assumption is that native breeds that have been around long enough come to embody a kind of *Dutchness*. The valuation of these breeds thus encompasses their potential economic value as animals that can function well within the Dutch ecosystem and farming systems, as well as their cultural significance, which is framed as national heritage.

Thus, CGN’s bovine biopolitics (Lorimer & Driessen, 2011) is based on their valuation of ‘native’ and ‘rare’ breeds. This is shaped by global and national politics, as well as through appreciations of adaptation, aesthetics, identity, and biocultural heritage. In what follows, I differentiate and analyse two logics of potentializing that shape the materialization and infrastructures of conservation practices.

Potentializing genetic material as fire insurance: securing diversity for survival

In our first conversation, Sipke Joost Hiemstra, the director of CGN, explained that the centre’s most important task is “securing genetic diversity in crops, livestock, trees and aquatic species for future generations” (24 November 2021). One of the support staff members mentioned: “The storage in the genebank serves a kind of fire insurance” (interview 15 March 2022). This striking metaphor³² for genetic diversity as insurance is an extinction narrative, and points to CGN’s directive to safeguard diversity for the anticipated loss of cattle breed populations. Following this logic,

³¹ <https://www.wur.nl/en/cgn>

³² Scholars have already pointed to the role of metaphors in biology (Kay, 2000; Haraway, 1976; Keulartz, 2007; Väliverronnen, 1998). More specifically for genetics, Evelyn Fox Keller shows how the development of genetics is rooted in the field of computer science (Keller, 1995).

genetic material is valued for holding the potential, the promise that a breed will survive into the future even if farmers cease to breed with native breeds, or if there is a viral outbreak. By conserving genetic diversity, farmers can recover the diversity if a ‘fire’ ever occurs.

CGN sees the extinction of native breeds as a pertinent risk and therefore keeps track of population sizes. They classify breeds as rare or vulnerable based on the number of females remaining in each breed population, since females are critical for the reproduction and thus survival of the breed. For the *Brandrode* breed, for example, only 243 female animals remain (see Figure 3.2).

Cattle breeds	Year of last update	Number of female breed animals	Inbreeding increase per generation	Trend past 15 years (>20%)
Brandrode rund	2024	243	Unknown	decreasing
Fries-Hollands vee	2024	1.787	0.25-0.5% (2021)	decreasing
of which Roodbont Fries vee	2024	370	Unknown	increasing
Groningen Blaarkop	2024	1.098	Unknown	decreasing
Holstein Friesian	2024	1.000.719	Unknown	stable
of which Red Holstein Friesian	2024	160.490	Unknown	stable
Lakenvelder	2024	1.515	0.25-0.5% (2019)	increasing
MRIJ (Maas-Rijn-IJsselveen)	2024	7.197	0.5-1% (2023)	decreasing
Verbeterd Roodbont	2024	68	Unknown	decreasing
Witrik, Vaal and Baggerbont (Dual purpose register)	2024	450	Calculation not possible	increasing

Figure 3.2 Dutch breed list and risk status CGN from August 2024. Green means no risk; orange means endangered; red means critical. (Credits: Centre for Genetic Resources, The Netherlands)

The breeds that are given an orange or red label in Figure 3.2 are at the greatest risk of disappearance, so they receive the most attention in collection and freezing practices, sought out more earnestly to produce specimens from. Their conservation is staged as urgent. The fourth column shows the estimated inbreeding rate per generation, with rates above 1% being considered too high, 0.5-1% as high, 0.25-0.5% considered as somewhat high, and below 0.25% as low. The final column provides an overview of whether the population size has increased, decreased, or stayed

stable over the previous 15 years. The table and the risk assessment become a performative technology for determining how much action is required for each breed and serve as a tool to potentialize the genetic material stored.

The fire insurance of genetic diversity relies on freezing a wide range of genetic material. Henk Sulkers, collection and cryopreservation specialist, after collecting the semen from participating farms, assesses its quality based on the movement of the spermatozoa. When it is ‘good enough,’ the material is then placed step by step in different freezers with increasingly lower temperatures until it reaches the final stage in a nitrogen tank at -196 °C. During a tour of the laboratory, Henk pointed to the various tanks: “These are the tanks for the animals we work with: cattle, sheep, goats, let’s see, horses, in there is the boar semen” (24 March 2022). The room gives me a somewhat mechanical impression, between a hospital storage room and a large kitchen. In a sink in the middle of the room, some metal cups are attached to each other. When I asked about them, Henk explained that he used them to remove cups from the tanks to check the straws. He opens the cattle tank, and we see lots of different cups stacked neatly on top of each other and filled with coloured straws. Henk explains that each bull is given a different colour and that information is printed on the straw. He takes one from the sink and explains: “Here, this is the name, the registration number, the owner, this one is from a Belgian company, you see, this is where it’s from” (observation 24 March 2022). All this information is also recorded in a publicly accessible database³³ so that farmers know what material is stored at the genebank and can potentially use it to breed their herd.

To guarantee the storage of as much genetic diversity as possible, the cryopreservation researchers at CGN are developing protocols for *ex situ* conservation by freezing genetic material. This mostly centres on semen because it is easy to freeze due to the simplicity of the cells. Furthermore,

³³ Database: <https://dutchanimalgenebank.nl/>

the freezing protocol for semen has already been well developed within the commercial industry: frozen semen is transported all over the world (Schrepfer & Scranton, 2004). Recently, researchers at CGN also started working on developing protocols for freezing oocytes and embryos, because that way, the female line can also be conserved. This makes it easier to revive a breed: “if you only get the semen, one part of the genetic material, you need to do back crossing, which means you need several generations if you want to retrieve an endangered breed” (interview 12 April 2022).

The cryopreservation researchers told me about all the small steps they need to research and optimize for the freezing process: “Which substances, which medium, which cryoprotective agents are tolerated by the living cells, and at which concentrations. Also, which freezing rate is optimal, how does the freezing rate interact with the cryoprotectants used, and so on” (interview 9 March 2022). Freezing oocytes is much more complicated, the cryopreservation researchers continue to explain, as they are larger and “more intelligent”³⁴: they have a metabolism, produce protein, and grow. Oocytes contain a lot of fat, which hardens when frozen and then damages the cell. It is easier to freeze embryos:

If we consider an embryo, for example, that contains more than a hundred cells. When 10 percent of these cells are injured or killed by the freezing and thawing, you may still have a viable embryo, perhaps even when 30 percent of the cells die. But in the case of cryoconservation of an egg cell, if it dies, it is obviously lost completely (interview 9 March 2022).

They need to continue working on the defrosting protocol for cattle embryos, “because of these cryoprotectants, an embryo may explode when you defrost it and use it immediately.” After seeing my amazed expression,

³⁴ Gendered stereotypes in science might seem at work here, as analysed in Emily Martin’s (Martin 1991) article “The Egg and the Sperm.”

the researcher continues: “Yes, that sounds weird, but it could literally explode. The embryo quickly absorbs water, causing it to swell to roughly twice its original volume. It may then pop, and die, which would obviously be an unwanted outcome” (interview 9 March 2022).

The difficulty arises here that not every form of biological life can be frozen and revived so easily. While semen samples consist of cells that are easy to freeze, more complex cells do pose difficulties. The desire to conserve maximum genetic material reaches its limits: not everything can be stored, so choices must be made, and not all life affords to be frozen. Given these infrastructural limits to what can be stored, I wondered which material they store. One of the geneticists explained that if “what you want is to preserve as much as possible, then you have to make sure that the animals you put in the genebank are as different as possible” (interview 8 March 2022). Hence, they prefer materials from animals that are not related to each other. Furthermore, CGN believes it is important to maintain separate breeds: “CGN is very much in favour of preserving genetic diversity within and across breeds” (interview 15 March 2022). CGN is concerned that if all the breeds are “huddled together” on one “big pile,” certain diversity would get lost, and thus a certain level of “breed purity”³⁵ is required.

To determine whether animals are related and whether they are purebred, they first examine their pedigree. If the pedigree of an animal cannot be traced back using herdbook registrations, a DNA test developed by CGN can be performed (Hulsegge et al., 2019). Ina Hulsegge, a researcher involved in developing the DNA test, explained how they conducted their analysis. The analysis started with animals that were already present in the genebank and had already been genotyped. From these

³⁵ Margaret Derry (2023), is critical about ‘purity’ and argues that it is considered by many people as morally objectionable in any breeding activity. Derry shows in her article that purity has played an important role in livestock breeding. She unpacks the historic connection between animal breeding and eugenics and focuses on livestock breeding from 1880-1920.

animals, a reference population was built containing purebred animals from which the pedigree and breed of origin were known. This included genetic material from six local Dutch breeds and the Holstein Friesian. The researchers then carried out an analysis “to see which of the 54,000 Single Nucleotide Polymorphisms (SNPs) contained the most information to discriminate among breeds.” They found that “we only needed a small set of SNPs, when accurately chosen, to differentiate between the Dutch local cattle breeds” (interview 6 October 2022). Once the reference population was established, Ina Hulsege explains: “We did a comparison against the reference population to estimate the ancestry of animals with unknown origin. An animal is then assigned to the seven genetic clusters from the reference populations, based on the individual proportion of membership” (interview 6 October 2022). The researchers can then allocate an animal to a breed based on the overlapping SNPs.

This DNA test transforms the way to categorize the native Dutch breeds. Breeds are not only defined by assessing the phenotypical characteristics of the animal or which ancestors it has, but also by their genetic inheritance. Breeds become defined and perpetuated based on the overlap of alleles with previous generations. A genetic notion of breed becomes important in an institution that anticipates a future where ancestors might not be traceable and where appearance cannot be assessed, as there are no living members of a breed left.

All in all, potentializing the genetic diversity of native and rare breeds, fuelled by an extinction narrative, which I have described here as the logic of fire insurance, means that genetic material needs to be stored to potentially revive a breed. To achieve this, CGN focuses on technoscientific developments to freeze—also the female line—making reviving easier. In practice, especially because of biological and scientific limitations, not all material can be stored, and not every life is afforded potential. The focus lies on ‘purebreds,’ indicating a bovine biopolitics (Lorimer & Driessen, 2011) that foregrounds purity. ‘Breed’ defines what an animal is, and with the

DNA test, this definition broadens. On the other hand, breeds are more defined and perpetuated. Conserving the breed within this logic becomes a good in itself, for future biodiversity and survival in a threatened habitat.

Potentializing breeds as tools: aspirations in times of ecological trouble

In this section, I will discuss the second logic of conservation, which potentializes native Dutch breeds as holding future value in the context of challenges due to climate change, ecological sustainability, and biodiverse landscapes, as well as the changing regulatory landscape for farming. As the head of CGN Sipke Joost Hiemstra explained: “For many people a cow is a cow, but it has never been like that. There is always a need to breed cows that fit the cow into the farming system”. He adds that next to that the genebank “is a security for the future,” pointing to the first logic, “there is also the idea that the material has added value” (interview 24 November 2021). Understanding what this value is, which legitimizes the conservation of native breeds, emerges as CGN’s potentializing practice.

Two metaphors I believe are useful in understanding this second logic were mentioned by one of the cryopreservation researchers when explaining why conserving genetic diversity is important: “Our ‘painter’s palette’ or ‘toolbox’ becomes increasingly limited. Ideally, breeders would still have a rich palette of gene variants (alleles) at their disposal” (interview 9 March 2022). These two metaphors—the painter’s palette and the toolbox—point to specific colours or tools that can be found in DNA, which can be used to build the cow of the future. Potential in that sense can, to an extent, be “engineered” or “designed” with the right tools or colours. This metaphor is a continuation of the mechanistic enactment of DNA (Keller, 2000; Kay, 2000), and of biology as an engineering discipline (Schyster, Frow & Calvert, 2013). In this logic, there are certain ‘elements’ or ‘characteristics’ assigned to the native rare breeds that are valued not only for anticipating, but for producing a future.

The “system” that the head of CGN referred to should, according to him, shift to more sustainable ways of farming. CGN contributes to this system change and various “transition pathways,” by anticipating and advocating for “circular” and “nature-inclusive” farming and by thinking about which cows are, in the words of the head of CGN, “future-proof” and could “fit the system we envision” (interview 24 November 2021). To achieve this future, cows must be adapted accordingly, with the tools and colours that are available.

Rather than reviving a lost past, genetic material, in this second logic, holds the potential to create new futures. The native breeds, both their genetic material *ex situ* and the living cows *in situ*, are thought to hold certain characteristics that can contribute to change. By identifying differences between cows and between breeds, CGN can determine which cows possess which qualities. The DNA test discussed in the previous section serves as a tool to differentiate between breeds. With the DNA test, animals with missing pedigree information can be added to the herdbooks. When used *in situ* for living cows, the DNA test even further redefines breeds. It performs the Dutch cattle population as a reservoir of unknown treasures and diversity, leading CGN to aim also for conserving genetic diversity within the living populations.

The test makes it possible to attribute certain genetic variants and characteristics to specific breeds, thereby demonstrating the value of the stored genetic material. For example, one of the main ‘traits’ which could benefit the aspired future is ‘resilience,’ a quality often ascribed to the native breeds: “it is kind of known that those local breeds are a bit more resilient” (interview 6 October 2022). Resilience is seen as an important trait to being able to adapt to ‘stresses,’ such as heat stress or changes in the environment. The argument is that the native breeds are better adapted to lower or variable quality feed in more extensive production systems, and do not need to produce as much as the more ‘fragile’ Holsteins. Farmers often tell the staff at CGN, for example, that they require the veterinarian less often with

the native breeds, emphasizing the overall health and resiliency of their herds.

One of the geneticists initially shared his hesitations with me about the idea that the native breeds would be more resilient than the commercial breeds, stating that “the native breeds, just like the modern breeds, are selected mainly on production characteristics” (interview 4 May 22) rather than on factors that could enhance the animals’ resilience. The geneticist questioned whether the native Dutch breeds could all be seen as representatives of resilience, or if resilience is the outcome of selection and breeding. Later, however, the same researcher pointed out that a ‘resilience index’ was created through a collaboration between the breeding company CRV and researchers at the Animal Breeding and Genomics department in Wageningen. The calculation is based on lactation performance. Resilience is determined by how quickly milk production stabilizes after a decrease in production and how severe the decrease was after any ‘stress.’ This index shows that the average calculated resilience ‘value’ of different breeds differs. The geneticist at CGN highlights that the Holstein breed overall scores lower than some rare native breeds, such as the MRIJ and the Fries-Hollands (Oldenbroek & Calus, 2024). This convinced him that some of the native breeds are more resilient.

Another important characteristic for future cows in biodiverse farming is the native breeds’ ability to endure different quantities and qualities of feed. In contrast to commercial breeds such as the Holstein, “the native breeds are adapted to a leaner diet, they can handle that better” (interview 3 August 2022). This is considered a useful trait in circular and nature-inclusive or low-input farming, which aims to increase biodiversity in the soil and for the vegetation. Although this way of farming also means lower grass production and thus less available feed, the farmer can “ask less” from the system, minimize costs, and give more space to all kinds of biodiversity in the grassland. This is contrasted with intensive farming, where English ryegrass fills the pastures. This grass grows very quickly and

is good for milk production, but it produces a landscape that is “also sometimes called a green desert” (interview 3 August 2022). To produce biodiverse landscapes, another cow might be needed, for which the native rare breeds are put forward.

In addition to highlighting the differences between the native breeds and the commercial breed in terms of feed efficiency and resilience, cattle breeds are potentialized by investigating their methane emissions. If CGN could prove that the native breeds emit less methane, one of the main ecological challenges facing the cattle industry, this could mean a possible bright future for the native Dutch breeds, as expressed by one of the researchers:

If we can take methane samples [from the native and rare breeds] at least from a few farms, and the microbiome, and DNA information. Then we can see if that’s different [from the Holstein breed]. Well, if our cows emit much less methane, then you have a kind of wild card up your sleeve (Interview 23 February 2022)

For the commercial breeds such as the Holstein, much research has been conducted on how to reduce methane production, such as intervening on the gut by experimenting with feed, which scholars call “symbiotic engineering” (Folkers & Opitz, 2022) and “metabolic interventions” (Searle, Turnbull & Oliver 2024) but also by breeding (eg. de Haas et al., 2021). For the native rare breeds, there is less research funding and less data available, as populations are smaller. This infrastructural hindrance makes it difficult to establish a genomic infrastructure for native breeds. Nonetheless, the aspiration remains, as this would mean contributing to a ‘big problem,’ while at the same time, potentializing the native breeds as a ‘wild card.’

Potentializing native breeds requires breed populations to grow. This means that the breeds must first become more popular. During a few

conversations, I encountered ideas to rebrand the native breeds. One idea was to market these breeds as local: “I would rather go to a local breeder who works with a small herd of animals than go to the supermarket” (interview 12 April 2022). This emphasizes that ‘native’ could tap into the trend of local food production. Another idea is to market the native breeds with a distinct exterior, such as the Lakenvelder as organic cows: “that people take a bike ride at some point and that they see: ‘oh those are our organic cows.’ They are very recognizable, also by the pattern. It’s not because those cows would produce so much better, but that you make a concept of it” (interview 15 March 2022). Here, using the appearance and the nativeness of the cows for marketing purposes, potentializes the rare breeds in new ways, while also fostering organic and local food production.

Potentializing breeds in this second logic, as part of farming systems, also requires the living population to remain “healthy.” For each of the native and rare breeds, CGN occasionally assesses the status of a whole living population. This assessment is conducted using software programs to calculate inbreeding rates within the population. The outcomes are shared with the accompanying breed association. During the time of my research, they had just finished the assessment and advice for the Lakenvelder population. The researchers who worked on the assessment formulated the problem with the Lakenvelder breed: there are not so many animals left, “just a few bulls were deployed for breeding.” This causes an inbreeding threat, which is the result of strict breeding strategies by Lakenvelder breeders. The Lakenvelder³⁶ has black or red skin and has a white belt around their waist, and if that belt “is 1 cm too far forward or back, you have those very strict breeders that say, nope, that is really not allowed” (interview 23 February 2023), and then those individual cows or bulls will not be used for further breeding. The assessment based on current breeding practices

³⁶ For a picture of the Lakenvelder, the website of SZH can be consulted: <https://szh.nl/dieren/rund/lakenvelder/>

revealed that inbreeding rates were too high, and thus CGN recommended a less strict breeding policy, so more bulls would be suited for breeding.

Potentializing genetic material from native and rare breeds that represent certain ‘colours’ or ‘tools’ for the aspired future not only involves the freezing of genetic material but also extending the conservation infrastructure to other actors and contexts outside of the genebank. The limitation for CGN to sustain the diversity within living populations concerns dependency on others, such as breed associations, breed companies, and farmers, each of whom can take their own breeding decisions. A professor at the Animal Breeding and Genomics department aptly calls this a “tragedy of the commons” (interview 15 March 022) as there is a shared responsibility to prevent inbreeding, but different actors can have different priorities.

Overall, in this second logic, the native breeds are potentialized by differentiating characteristics that could be of use in future farming practices, considering a presumed future full of ecological troubles. Conserving and potentializing material from different breeds, both in the lab and in the field, allows for breeding ‘good cows’ for the future, where changing regulations and environmental impacts will ask different things of cows and farmers beyond mere productivity. The genetic configuration of breeds has a different effect in this logic. It differentiates cows based on characteristics, and through the DNA test, more cattle can be added to the living population. Conserving the native breeds is not a ‘good’ in itself, but a way of working with what an animal can become for a biodiverse and sustainable future.

Conclusion

In this article, I have shown how potentiality is not only ascribed to frozen life but, within possibilities and limits, it is actively made. Based on fieldwork at the *Centre for Genetic Resources, the Netherlands* (CGN), I have shown how, in response to the Holsteinisation of cattle farming, breeds

defined as native and rare are potentialized. CGN's authority as the national institution for the conservation of Dutch national genetic resources, and as a key actor in international and EU policy, allows it to play a significant role in shaping which cattle are conserved, how they are valued, and what kind of agricultural futures are made possible. Conservation at CGN happens at the intersection of state policy, academic research, and private industry. CGN carries out a governmental mandate while also being embedded at Wageningen University & Research (WUR) and collaborating with private partners such as breed associations and breeding companies. This positions CGN between public and private interests, making cattle conservation inseparable from the cultural and economic value of cows in the Netherlands.

Central to the conservation politics is potentializing breeds defined as *native* and *rare*, which, alongside CGN's valuation of the native breeds for biocultural heritage, adaptability, identity, and aesthetics, also aligns with CGN's official mandate, rooted in international policy frameworks such as the Convention on Biological Diversity (United Nations, 1992), to preserve the nation's unique biodiversity. These breeds are maintained *ex situ* (in nitrogen tanks) and *in situ* (in the living population). Breeds are potentialized to achieve genetic diversity, as they become valued for the diversity they represent. I characterize CGN's biopolitical governance as grounded in two different logics.

In the first logic, conserving native breeds and the genetic diversity they represent speaks to the aim of avoiding the risk of extinction of the living native breed population. Potentializing involves the freezing of semen, oocytes, and embryos, which depend on technoscientific innovations and infrastructural possibilities that make the cryopreservation of (complex) cells possible. The conservation of farm animal genetic diversity centres on purebreds, ensuring that genetic diversity is maintained through the distinct breeds. Conserving a breed in this logic is a good in itself, for genetic diversity and for survival.

In the second logic, fuelled by an ecological sustainability narrative, native breeds are potentialized through showing their value for future agriculture. In the aspired future, not only ‘productivity’ reigns: ‘biodiversity,’ ‘sustainability,’ and ‘biocultural heritage’ all become valued goods. Potentializing here involves showing the worth of the native rare breeds for these aspirations, through genetic research and through economic revaluing. Breed emerges here as a way of working with what a cow can become. A specific relationship with the landscape is anticipated, which does not necessarily aim to restore a ‘traditional’ landscape, but rather to cultivate a ‘biodiverse’ landscape.

Departing from other cases documented in the STS and anthropology literature, in this example genebanking potentializing efforts are not primarily concerned with large investments or biomedical promises for a spectacular future. Rather, potentializing is about creating the possibility for certain nonhuman life that is valued by geneticists, farmers, and breeders to have the potential to live on, within the possibilities and limitations of the infrastructure. As Morgan (2013) stated, the potentiality of life requires technoscientific actualization and is always intertwined with materialities and techniques. However, working with technologies, life, and infrastructures also affords the potential of certain lives and ways of living. In this case, the infrastructure depends on the functionality of oocytes and semen, and on developments in cryopreservation science and technology. It also depends on the people involved, who have different knowledge, values, and interests. Zooming in on the practices and techniques regarding cattle at the Dutch national genebank for animals contributes to the literature on genetic material conservation by highlighting not only what is stored, but also how and what is made important within these practices, and how potential is granted.

Scholars in STS have critiqued genebanking for decontextualizing genetic material, neglecting ecological and cultural knowledge, and treating genetic materials as mere resources (Bowker, 2008; Orlove & Brush, 1996;

van Dooren, 2010). While the conservation of animals for human ‘use’ warrants critiques, this case shows how genebanking can also support agricultural futures that go beyond mere productivity. By reimagining and potentializing native breeds, new attachments are made to agricultural heritage and to future farming in ecological terms. Which pasts and presents are brought forward, and which futures are made possible, actively shape the bodies and lives of cows—in all their diversity.

Chapter 4

Biodiversity in the making

Epistemic infrastructure towards nature-inclusive
cattle farming with native Dutch breeds



Abstract

The intensification and specialisation of agriculture have led to the loss of ecosystem biodiversity and genetic diversity within livestock populations (FAO, 2020). This calls for a shift in farming practices and the supporting *epistemic infrastructure*. We draw on ethnographic fieldwork (2022-2024) within the *DubbelDoel Natuurlijk* project at Wageningen University & Research, Animal Breeding and Genomics (WUR-ABG), which aims to enhance biodiversity in Dutch cattle farming by formulating breeding goals for nature-inclusive farming practices and biodiverse agricultural landscapes, and investigates through data practices if native Dutch breeds are a potential fit. In the reconfiguration of the epistemic infrastructure towards biodiverse agricultural practices, new *attachments* emerge. This not only contributes to our understanding of how biodiversity is understood and enacted, but also how the reconfiguration of epistemic infrastructure for nature-inclusive farming is a process of mutual transformation: valuations of farmers and researchers reshape what the infrastructure measures, while the infrastructure simultaneously legitimises these attachments through data. This creates alliances between scientific and experiential knowledge, while scientific authority remains structurally dominant. Native Dutch cattle breeds cannot simply be understood as the opposite of high-yielding Holstein breeds; rather, they represent a different scale of intensity within the farming system. This difference becomes apparent through reoriented data practices that support biodiverse practices. Here, biodiversity emerges as a continuous process in which animal bodies become sites of negotiation where knowledge infrastructures, farming values and multispecies relations are enacted and transformed.

Keywords Epistemic infrastructure, biodiversity, data, native breeds, agriculture, cattle farming

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Chapter 5

Rewriting Metabolic Scripts
Dutch Diary Farming Beyond the Holstein



Abstract

Dairy farming in the Netherlands reflects a history of selective breeding and industrialization, particularly through the rise of the Holstein-Friesian cow. This paper contributes to STS and ecological Marxist scholarship on metabolism and more-than-human eating by conceptualizing intensive dairy farming as following a particular *metabolic script* – an arrangement of land use, resource availability, feeding practices, labour division, health management, and market dynamics. The ‘Holstein script’ entails a relation to land and animals that prioritizes metabolic efficiency and enrolls a geographically distributed network of resources and labour to generate value, but that externalizes its burdens on land and nutrients. Empirically, we focus on Dutch ‘nature-inclusive’ dairy farmers farming with native Dutch cattle breeds. We argue that these farmers are developing new metabolic scripts, emergent, situated arrangements of labour and life on farms. First, we show that farmers loosen the demand for production and reconfigure the division of labour between farmers and cows. Second, we argue, their metabolic rescripting does not just entail a switch in breed or practice, but a reconfiguration of the land and farm ecology through new alignments between bovine bodies and their environments. Questions of which cows and breed traits ‘fit’ which landscape, and how their metabolic capacities (grazing, foraging, digesting) can be harnessed to foster, rather than erode, its ecologies, recast nature and belonging in metabolic terms. We situate the re-scripting of dairy farming within a contentious metabolic politics (Vogel, 2025, Barua 2025) that currently frames cows, farmers, and their environments in the Netherlands, suggesting the metabolic scripts of our farmers may come to shape a ‘postindustrial’ metabolic politics that responds to the ecological hoofprint of industrial farming by reconfiguring eaters and their relation to place.

Keywords: Metabolic relations, nature-inclusive farming, native breeds, metabolic script

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Chapter 6

Conclusion



In this dissertation, I have examined how cattle breeds native to the Netherlands are known, valued, and mobilised in conservation, breeding and farming practices in times of ecological trouble. I followed the everyday practices of conservationists, breeders, and farmers who are working to make a difference in terms of biodiversity on their farms and in the diversity of cattle populations in the Netherlands. Across the chapters, I have shown that these efforts involve practices of difference-making. My research participants establish differences between cows, farm ecologies, and farming practices, potentialize these differences, and work with and sustain them.

These practices are political, as differences are cultivated for certain purposes and effects, while foreclosing others. The practices by the farmers, breed lovers, and researchers I studied make certain realities possible. The politics at stake here extend beyond human actors alone and involve also more-than-human relations across species, landscapes, and infrastructures. This thesis thus engages with questions of *more-than-human politics* in agricultural and conservation contexts (Asdal, Druglitrø & Hinchliffe, 2016; Biermann & Anderson, 2017; Lorimer & Driessen, 2013).

A more-than-human perspective on infrastructures and practices of difference making shows how multispecies relations take form through classifications, categorisations, and differentiations. Rather than attending to the daily lives of animals, I have examined how cows and multispecies attachments are known, governed, and worked with in conservation and farming practices.

The main argument in this thesis is that ‘the bio’ encompasses not only a biological or genetic understanding of life, but also ways of farming, multispecies relations, genealogies, and attachments to landscapes and places. Through questioning what is the ‘bio’ that is being conserved and cared for, I move beyond approaches that treat it only as ‘nature’ or ‘biology’. I open up ‘the bio’ by analysing how it is *enacted* through difference-making practices.

In the following sections, I will first distil the different ways difference-making emerges in this thesis. Differences are established, potentialized, made to matter, and made to work. I then examine what these differences imply about what emerges as good cows, good farmers, good landscapes, and good products. Next, I turn to the mediating role of epistemic infrastructures of farming, breeding and conservation. Finally, I will discuss what this implies for conserving ‘the bio’.

A difference in the making

Across the papers that form the basis of this thesis, I have engaged in different but related forms of difference-making. These form the basis of the formulated sub-questions. The first question I posed was how sameness and difference are problematised. Differences, I notice, become partly enacted through the problematisation of sameness. An important way to do so is by *contrasting* (Vogel, 2021; Laurent, 2021). For many of my informants, a key point of contrast revolves around the Holstein breed, which not only stands for a type of cow but also for a broader network of knowledge, practices, and values. The *Holsteinisation* of dairy farming (Theunissen, 2012; Labatut & Tesnière, 2018), as some members of native breed associations argue, has led to the erosion of qualities they value in cows, including connection to land, biodiversity, tradition, authenticity, and forms of sustainable agriculture. They do not claim that farmers working with Holsteins necessarily disregard these values; rather, they criticise the dominant logic associated with Holstein-based farming systems.

Native Dutch breeds are positioned as an alternative. Through breeding with native breeds, my informants seek to cultivate both renewed and novel relations between cows, people, and ecologies (Lorimer and Driessen, 2013). Conservation, in this context, is not about remaking the past, but about making space for new relations. Breed functions here as a way through which contrasts are articulated and sustained, allowing different logics and practices to take shape, such as nature-inclusive farming

and conservation. A cow emerges “as a complex entity that weaves innumerable non-humans together with human beings in mutual life-shaping conditions.” (de la Cadena & Martínez Medina, 2020). In this thesis, ‘breed’ signals differences in such weaves that crucially alter life for all involved.

Second, I questioned how difference established, measured, and legitimised, and through which practices, knowledges, and infrastructures. I examined how differences are *established* as practices of differentiation are key sites where value is produced and contested. Differences are produced in registration practices, data-based research, through genetic tests, and through different ‘kinship measurement practices’ (Thelen & Lammers, 2021). Researching these required attending to the techniques (Mol, 2002) that shape cows, and the relations and landscapes they bring into being (Lorimer & Driessen, 2013). Differentiations are not merely classifications but are shaped by and produce relations and valuations.

Third, I questioned how differences valued, and how do they come to matter. I analysed how differences are *potentialized* to make a difference, to make space for a multiplicity of goods. In the context of conservation, differences between cattle are rendered meaningful within both a logic of extinction and loss, and a politics of adaptability. A ‘fire-insurance’ logic prioritises maintaining broad diversity to adjust to threats and uncertainties. Breeding difference, in this sense, entails sustaining variety as an insurance for the future. Alongside this, a ‘painter’s palette’ logic foregrounds the value of specific traits suited to particular contexts. It entails a search for specificity: determining which cow fits which soil and farming system. Breeding difference entails knowing and working with these differences. Diversity emerges here as both bio-flexibility and bio-specificity: as adaptability to a wide range of circumstances, and as specificity and alignments, based on the idea that there is a ‘right’ fit between organisms and environments.

Fourth, I questioned what it entails in practice to *work with and sustain* differences, which entails the reconfiguration not only of breeding practices, but also of the alignments between cows and their environments. This includes the reworking of epistemic infrastructures, labour relations, and the farm's economy. It also reshapes what is asked from animals, grasses, soils, trees, and of farmers themselves. The nature-inclusive farmers analysed in this thesis are rewriting *metabolic scripts*, emergent, situated arrangements of labour and life on their farm.

Finally, I have asked what difference these differences make for cattle, ecologies, and agricultural and conservation practices. Different modes of difference-making shape what emerges as a good cow, a good farmer, a good landscape, and good products, and the reconfiguration of epistemic infrastructures. What does it mean for each of those to breed difference, and what differences these practices, in turn, breed. How do more-than-human politics take shape? How are relations differently ordered for cows, landscapes, labour, and agricultural and conservation practices, and which differences come to matter, and to whom.

Good cows

Through the *genomic infrastructure* of reproduction and selection, differences are established between cows. Bovine bodies emerge as sites for intervention and become part of wider infrastructural configurations (Barua, 2021; Edwards, 2019). Within breeding practices, cows are not only assessed as good but also improved: these improvements are not a matter of imposing an ideal, but of experimenting with the possibilities by attending to what is good (Heuts & Mol, 2021).

This thesis has engaged with how cattle are valued in relation to *breed*. For the breed enthusiasts that I have followed, a 'good cow' emerges in relation to whether they belong to a breed. Cattle are made to belong to a breed through different measurements: tracing genealogy, genetics, and by evaluating looks. Each of these practices produces forms of belonging, *good*

for something else. While tracing genealogy is good for a historical understanding of breeds and for the conservation of (cow) family lines, a genetic understanding is good for understanding cattle on a molecular level. This can potentially add cows to the herdbook if their genetic profile shows breed purity. Through evaluation of looks, cattle are recognised as belonging to a breed, good for an ideal picture of the cow in relation to the landscape.

Native Dutch breeds are valued as good in contrast with the Holstein, which, in the practices of my informants, comes to represent sameness across bovine bodies, genetics, and landscapes. For the conservation scientists in Wageningen, native breeds are good for conserving genetic diversity amongst the Dutch cattle population. The native breeds are considered at risk of disappearance, and their genetic traits are valued as potentially useful for farming systems and environments that differ from those associated with Holstein-based production systems. For the enthusiasts of the native Dutch breeds, the contrast with the Holstein is also articulated in relation to their Dutchness. While Holsteins are understood to originate from breeding programmes in the United States, native Dutch breeds are portrayed as belonging to Dutch landscapes and histories, making them part of 'our' biocultural heritage. For the farmers who breed with native breeds, however, different values can also clash. For farmer Diederik, for instance, the value of an 'easy cow' may override the value of achieving the perfect visual image of the Lakenvelder's distinctive white sheet.

The differences between cattle that are valued are potentialised to make a difference. At the Centre for Genetic Resources, the Netherlands (CGN), this entails working on the material infrastructure that can freeze genetic material, and it concerns researching the potential of these breeds to fit certain environments and ways of farming. Conservation practices thus involve both keeping possibilities open and searching for specificity: maintaining diversity while identifying meaningful alignments between

cows, landscapes, and ways of farming. With the *DubbelDoel Natuurlijk* project, through data, native Dutch breeds were differentiated from Holstein cows. However, the data analysis could not prove that Dutch breeds are a better fit for certain production systems or lands. The researchers highlight that native Dutch breeds cannot be understood as opposite to Holstein, but as a different scale of intensity.

In the remaking of metabolic scripts in nature-inclusive farming practices, cows are increasingly asked to care for themselves, to forage, and to be flexible (Vanderstraeten, Bal & Thoreau, forthcoming). The rewriting of the metabolic scripts casts cows in metabolic terms: as grazers, as wild animals, as part of a balanced system. The *bovine biopolitics* (Lorimer & Driessen, 2013) of selection practices for biodiverse farming not only implies which cow is rendered expendable, but also what is expected from cows and bulls: what kind of work and metabolic labour (Beldo, 2017; Barua, 2018), they are supposed to perform, what they are required to eat, digest and produce, and how they are required to behave.

This thesis shows that what counts as a good cow is not defined by larger overarching ideologies or cultural meanings, but made and negotiated in situated practices of breeding, conservation and farming, in which these meanings are present but also remade. Good cows are in certain contexts not only productive animals, but also carry genetic potential, embody heritage, and perform ecological work. Through practices of selection, cows are enacted as certain kinds of actors (Mol & Law, 2008), such as grazers, reproducers, or heritage, aligned with certain farming and conservation concerns. Breeding difference not only produces different cows, but also different expectations and valuations of bovine bodies and lives.

Good farmers

The culmination of the present environmental crisis is a cause of uncertainty for many in the farming sector. Dutch farmers are increasingly being asked to meet sustainability targets to reduce emissions and close nutrient cycles on their farms. This entails carefully considering

fundamental aspects of their work: which types of cows fit their land, which farming practices comply with national regulations, and how to balance the interests of the farmer, nature and livestock in a viable economic model. This context reshapes the role and responsibilities of farmers.

Research on good farming has shown how farming identities are shaped through aesthetics, recognition, and moral orientations (Burton et al., 2020; Westerink et al., 2021). This thesis similarly examines how valuations of farming practices shift alongside changing ecological and political landscapes. While the farmers in this thesis seek alternatives beyond what they describe as a Holstein way of farming, positioning their work as ‘alternative’ is politically complex. Contrasting their practices with *gangbaar* [conventional] farming opens possibilities for differentiation but also generates tensions in times of regulatory uncertainty.

Farmers are increasingly expected or wanting to localise their practices, tailoring farming systems to specific landscapes and ecological conditions. This localisation entails diversification, both of ecologies and farming practices. Within this context, a ‘good farmer’ emerges as a flexible and attentive practitioner who collaborates with animals, soils, grass, farmers’ collectives, conservationists, and policy frameworks. This also entails a reworking of the farm’s economy, reiterating what Burton et al. (2020) describe as the entrepreneurial identity of the farmer.

Throughout this thesis, I have traced how the potential of nature-inclusive farming is realised through the reconfiguration of the epistemic infrastructure on which breeding and selection practices are based. Farmers’ attachments reshape what the infrastructure is designed to measure, while the infrastructure simultaneously legitimises those attachments through data and indexes. This also involves crossovers between scientific and farming communities, as well as the legitimisation of various forms of knowledge and skills beyond breed and genetics alone, in which new correlations between breeds, regions, soil, practice, data, and epistemic infrastructure are made.

In the shift towards nature-inclusive farming and participation in organic dairy markets, farmers are increasingly expected to reduce reliance on conventional inputs such as imported feed, antibiotics, and artificial fertilisers. To compensate, farmers therefore search for alternative forms of support, ‘dietary prostheses’, ‘buffers’, or ‘fixes’ (Overstreet, 2018; Vogel, 2025; Cseke, 2024), that can sustain productivity while aligning with ecological concerns. In practice, this entails ongoing tinkering, improvisation, and experimentation with what is available on the farm. Rewriting the *metabolic script*, we analyse, entails a reconfiguration not only of farming techniques, but also labour relations, divisions of work, and forms of knowledge. While tinkering is not unique to nature-inclusive farming, as conventional farmers also experiment and adjust, the alternative scripts associated with nature-inclusive farming entail different kinds of adaptations, oriented toward more-than-human relations on the farm rather than external inputs. Farmers become responsible not only for food production, but for managing ecological relations across species and environments.

The metabolic scripts of the farmers in this thesis may come to shape a ‘postindustrial’ metabolic politics that centres on the unintended material and bodily transformations associated with production and ecological risks of this industrial metabolism (Landecker, 2013). Following the farmer’s metabolic scripts, this politics will not only work to reduce waste by restricting the number of eaters and digesters in a space, but also by reconfiguring these very eaters and their relation to place.

Good landscapes

Industrial livestock farming has played an important role in the formation of the Dutch landscape. The history of intensification knows the uprooting and consolidation, unification of land (Bieleman, 2000; Van der Woud, 2020; Runhaar et al., 2020). Good landscapes in this logic are productive, fertile and tidy (Burton et al, 2021). In the emergence of practices that shift

away from intensification and sameness, what emerges as good landscapes? Who and what is welcome on the land? And do nature-inclusive practices shape what is required from a landscape, and what does that reconfiguration entail?

In the DubbelDoel Natuurlijk project I followed, differences between landscapes are established through data. Various farming systems were differentiated through data to understand the relation between certain ways of farming and production, and the landscape in which the farm is located. This especially relates to the size of the farm and the types of soil: sand, clay or peat. Lands and landscapes emerge here as datapoints representing the socio-material orderings of nature-inclusive farming. By identifying the signs and correlations that are important for a biodiverse agricultural practice, new breeding values can be formulated for the genomic infrastructure.

The emergence of good landscapes in this thesis is, according to my participants at CGN, embedded in discussions on land sparing and land sharing: using the most fertile and agriculturally suitable land for farming, while large areas containing valuable natural habitats should be protected, or sharing the land of extensive agricultural production and nature services (Bos et al., 2023). I have shown how the emergence of practices that shift away from intensification does not mean that there is no space for notions of productivity, but rather that there should be a fit with the specificities of the surroundings, and its ability to adapt to changing circumstances.

Good landscapes, as enacted in my field, are required to bounce back when left alone and be resilient. For example, one farmer mentioned that when he left a pasture alone for a while without using artificial fertiliser “you will have 70 species in no time”. They also need care, however. For example, the farming system of Luuk and Annemiek relies on grass growing well to provide their cows with high-quality feed. The grass on their farm is not allowed to be shortened too much to give enough rest to the soil and grass. Landscapes consist, in their case, of good grass, with enough water,

sustained by irrigating the grassland and planting trees to reduce wind, trapping moisture on the pasture to create their own microclimate. Difference making involves here taking care of the multispecies relations within the landscape, but also with the bio-specificity of the region in which the farm is located. For example, farmers in the east of the Netherlands plant trees on the edges of parcels to contribute to *coulisselandschap* [bocage landscape], and in the west, farmers take care of the ditches around their farms to contribute to a polder landscape.

This also fits certain images of what a Dutch landscape should look like, how a landscape is good in the Netherlands. In breeding practices, the metabolic fit of cattle was often more prominent, but the attachment with locality and aesthetics of the cows and landscapes produces forms of Dutchness. The perfect picture relates to broader imaginaries and marketing pitches of what is envisioned as the Netherlands and its landscape as a place in which native Dutch cows inhabit the fields. These were sometimes driven by nativist politics (Münster, 2021) to create a nostalgic, often exclusionary image of a traditional Dutch landscape (Lorimer and Driessen, 2014), as producing these landscapes as such does help to sell. Rather than holding that these broader imaginaries as *reflected* in the cows and the landscapes, I argue that the practices I studied mediate, negotiate and shape such imaginaries.

Good products

The process of Holsteinisation, which emerged through industrialisation, technological innovations, the globalisation of the animal market and the scientification of animal husbandry of the late 1800s, embedded cattle selection and reproduction firmly in the *economisation of life* (Asdal & Huse, 2023). This process effectively rendered the bodies and labour of animals as capital (Shukin, 2009). But what emerges as ‘good products’ in the valuation and mobilisation of native breeds in conservation and farming practices? How are their lives valued? What becomes of their bodies?

Before herdbook registration, most cows in the Netherlands were ‘double purpose’ cows, bred for both dairy and meat production. Since the industrialisation of livestock farming from the 1850s onwards, when demand from neighbouring countries for food products grew, the sector became export oriented. Experience had shown that high prices were paid abroad for livestock registered in a herdbook (Bieleman, 2020, p. 131). Through herdbooks, breeders could achieve more targeted breeding. Cattle were divided into breeds, which enabled targeted breeding for cows to either improve the quality and quantity of dairy or meat. The breeds defined as native to the Netherlands, however, remained double purpose throughout this development.

In this thesis, I have shown how native breeds are valued and potentialised as local animals well-suited for the organic market. According to *Stichting Zeldzame Huisdierrassen* (Foundation for Rare Pet and Farm animals, SZH), the native Dutch breeds are valued for being attached to a certain landscape, which is thought to lead to unique products. This framework transforms the breeds into heritage goods that can be marketed to consumers seeking a connection to the rural landscape. One of the researchers at Wageningen University & Research proposed marketing native breeds with a distinctive appearance, such as the Lakenvelder, as organic cows: “that you make a concept of it”. Here, using the appearance and the nativeness of the cows for marketing purposes, potentializes the breeds in new ways, while also fostering organic and local food production.

These potentializing practices resonate with the making of *terroir*, understood as the attachment of ‘taste to place’ (Paxson, 2010), which is, in this case, done through breed. In the Netherlands, unlike in France or Italy, there are no well-established markets for *terroir* products. The emphasis “has been on quantity rather than quality” for a long time (Verkaaik, 2020, p. 294). Farmers of native breeds create narratives that connect the breed to the ‘Dutch’ landscape, and to the consumption of ‘local’ products. This also shapes what emerges as a good farmer and a good producer. Moreover,

terroir is rooted in the moral values of eating and producing local products (Paxson, 2010), which resonates with Kroløkke's (2022) case of the Nordic cow, where the slogan 'Eat it to save it' circulated, making conservation efforts belong to good consumers. As farmer Diederik explained, he chose to breed with the Lakenvelder because of the breeds' story, and because it "has fantastic meat quality". What conserves 'the bio' is also the consumer's taste. This taste is made through the differentiation of the breeds, through which the consumers can learn to be affected. The native breeds and their eaters configure each other in complicated ways; they make each other be (Mol, 2021).

The reconfiguration of breeding practices gives rise to other forms of value that extend beyond agricultural products. Native breeds are also valued as providers of ecosystem services and as contributing to what is described as 'encounter value', the affective experience of seeing and engaging with animals and nature (Nash, 2020; Haraway; Lorimer and Driessen, 2014). An example of this is Ben's farm, whose cattle graze in the riverbeds of the IJssel: Ben's cattle are cast here as a 'keystone species' (Lorimer, 2020): their eating and digesting are staged as crucial in shaping the landscape. Next to the milk produced by the cows and the meat produced by the cows and oxen in the reserve, Ben's farm also produces ecosystem services and contributes to the production of encounter value, which is both for the cows themselves and for other species such as birds and rare ecosystems.

The difference-making practices analysed here enact native breeds as more than double purpose, next to their valuation for both milk and meat production, they are valued for their attachment to local ecologies, as organic, as nice to see and engage with, and as ecosystem workers. By attending to difference-making practices, the attention lies in how native breeds become products, the 'goods' they bring into being.

Epistemic infrastructures

By engaging with the epistemic infrastructure of breeding, farming and conservation, this thesis shows that knowledge production and circulations not only shape how humans understand cattle, practices and ecologies, but also mediate more-than-human lives, bodies, ways of farming and multispecies attachments. I have shown how the valuation and mobilisation of native Dutch breeds in conservation and farming practices entails the differentiation of the epistemic infrastructure and the knowledge and communities that shape it. This requires mediation between scientific and farming communities and the legitimisation of forms of knowledge and skill that extend beyond breeds and genetics alone. In this way, new connections can be forged between breeds, regions, soils, farming practices and datasets.

I have shown that the genomics infrastructure of breeding and selection works within the boundaries of a breed, with individual animals in a population serving as the reference population. As there are not many individuals left of the native Dutch breeds, deploying genomics becomes difficult as it lacks statistical power. Breeding native breeds relies on experiential knowledge from farmers, which is shared in epistemic communities. The farmers and breeding associations that engaged with the *DubbelDoel Natuurlijk* project asked scientists in Wageningen for help in ‘scaling up’ their knowledge.

Although their desire for ‘scientific backup’ appears to imply a hierarchy of knowledge, scientific data-driven knowledge is, in practice, intertwined with experiential knowledge concerning the relationship between cows and land. Researchers’ evaluations are partly shaped by farmers’ preferences and experiences, while what counts as ‘making sense’ emerges from situated forms of practice and experience. These dynamics foster alliances between datafied and experiential knowledge. Yet within these alliances, scientific authority remains structurally dominant, even as farmers’ values reshape the objects of measurement.

Data-driven forms of analysis continue to dominate the formulation of global standards and guidelines. The scientific documents

have the power to legitimise native Dutch cattle breeds and shift agricultural practices towards more biodiverse farming (Nadim, 2021). The recently published report by the DubbelDoel Natuurlijk project, *Fokdoelen en Runderrassen voor Natuurinclusieve Melkveehouderij* (2025), introduces new calculable ‘breeding values’ for nature-inclusive farming and has the potential to encourage policymakers to adopt biodiversity-friendly farming practices and support the breeding of native Dutch cattle breeds. It does so by demonstrating the suitability of different breeds for different landscapes and ecosystems, while also facilitating exchanges of knowledge across communities to build more diverse datasets. Importantly, the capacities of different cattle breeds are not understood solely through statistical correlations, but also in relation to farming practices and forms of management.

Whereas Holstein farming appears to be supported by a stable and well-established metabolic script, the scripts of nature-inclusive farming with native breeds remain more open ended. The practices analysed in this thesis do not point towards a single model of farming, but towards a more open-ended process of aligning cows, landscapes, and practices in ways that remain attentive to ecological relations and their ongoing transformation. The question then becomes: how to make space for this in the epistemic infrastructure? How can different epistemic registers exist at the same time?

Implications for conserving ‘the bio’

Conservation is often imagined as the safeguarding of what already exists or ‘restoring’ a breed, a species, gene pool or landscape. As an ideal, conservation seeks to return to a state ‘before’ the trouble caused by intensive agriculture or to preserve the world as it once was (Bowker, 2008; Lorimer, 2015). This thesis shows that conservation instead is an active and performative practice. Farmers, geneticists, conservation scientist, breed lovers, and breeders need to reconfigure their practices to sustain the conditions that allow them to continue working this way.

Conservation therefore involves change, and requires adaptation, experimentation, and the continuous making of differences. Biodiversity emerges as the product of the infrastructural achievement under certain conditions of possibility. These conditions are historically shaped by processes of Holsteinisation, through which certain bovine bodies, genes, landscapes, knowledge, markets and valuation systems have become dominant. Conserving biodiversity requires redefining and negotiating with the established infrastructures through which agricultural life is organised. This involves cultivating and nurturing the ecological, social, and infrastructural conditions that enable certain forms of life to persist.

Conserving the bio is not only about caring for breeds, genes or landscapes, but also for the infrastructures, forms of knowledge, and communities of care that make them possible. The 'bio' that is worked with, governed and cared for cannot be reduced to genetic or biological differences alone. Rather, the bio is enacted through practices of difference-making in which cattle, landscapes, farming practices, infrastructures, and multispecies attachments are brought into relation. Following Tsing's (2012) work on scale, relations are "the medium for the emergence of diversity" (p. 507). Diversity is therefore not simply something that exists prior to conservation; it emerges through the relations that conservation practices and sustain.

At the same time, these conditions cannot be fully designed. Conservation ideals cannot just be imposed onto cows and farms. Data, freezing technologies, bovine bodies, cells and landscapes all shape differentiation, 'resist', and have agency. Therefore, conserving the bio also entails attending to the agencies and limitations through which practices unfold. Conserving native breeds entails coming up with strategies, narratives, data, etc. This involves no 'magical thinking', but rather a series of trials and experiments that are costly in terms of time, money, labour and entail the reconfiguration of epistemic infrastructures, imaginations and

attachments. Along the way, the breed and the conditions in which it can flourish are constantly evolving.

This thesis has thus shown that diversity, just like sameness, is enacted through practices that make, negotiate and care for differences. Sameness and difference are not opposite outcomes, but different configurations of difference-making. Both depend on establishing differences, valuing these differences, potentializing differences and working on sustaining them. To conserve the bio is to care for the more-than-human relations, infrastructures and conditions through which forms of life are made to flourish.

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Summary

For over more than a century, the intensification and specialisation of agriculture, through standardisation and rationalisation, caused for an increasing production of sameness across bodies, genes and landscapes. While the productive Holstein Friesian breed has come to dominate the dairy sector, the populations of Dutch breeds decreased. This has raised concerns about the genetic diversity and the loss of breeds. Furthermore, the intensification of agriculture raised concerns about its environmental impact, including biodiversity loss, climate change, and the health and well-being of humans and more-than-humans.

This thesis examines how cattle breeds considered native to the Netherlands are mobilised and valued in breeding, conservation and farming practices. Through ethnographic research conducted between 2021 and 2024 with scientists at Wageningen University & Research, nature-inclusive farmers, conservationists, enthusiasts of native Dutch breeds, studbook holders, breeders, and breeding companies, I explore practices that shift away from intensive farming towards practices that aim to foster diversity of bovine bodies and ecologies.

Drawing on scholarship in science and technology studies (STS), anthropology, valuation studies and more-than-human studies, I analyse what is being cared for and conserved, and how. Conservation efforts often focus on biological and genetic characteristics. My research shows that what is cared for and conserved is broader than this. It also includes relationships between farmers and cattle, ways of farming, family histories of breeding, and the connections between cattle and specific landscapes and places. What counts as worth conserving is therefore not a given, but takes shape through caring, valuing and work with cattle, landscapes and other more-than-humans. These practices also shape what is allowed to disappear, what is sustained, and what is brought into the future. By tracing these practices,

I analyse how good cows, good farmers, good landscapes and good products are enacted in practice.

To analyse that, I introduce the concept of *difference-making* as central to my analysis. I examine how differences are established between cattle, landscapes, and ways of farming, how these differences come to matter, how differences make a difference, for whom, and what is required to sustain them. In short: how differences are bred, and how that breeds difference.

In **Chapter 2**, I focus on how cows are differentiated and made to belong to breeds. I do so based on ethnographic fieldwork with enthusiasts of ‘local’ and ‘native’ Dutch breeds who value these cows e.g. for their looks, taste, nativeness, character. While anthropologists have shown that the valuations of breeds are related to, for example, national belonging or heritage, in this chapter I do not only focus on these valuations themselves, but on the measurements that render valuations possible. I analyse three different measurement practices and the technoscientific tools used to establish belonging: tracing genealogy, genetic testing, and evaluating looks. I argue that these are key sites where value is produced and contested, shaping what constitutes good cows, good landscapes, good products, and good farmers.

In **Chapter 3**, I explore how practices of genebanking *potentialize* native breeds. I question how the differences between breeds come to matter, and how the native breeds are made valuable through conservation practices. The analysis is based on ethnographic research at the animal department of the *Centre for Genetic Resources, the Netherlands* (CGN) of Wageningen University & Research. I analyse how the conservation of cattle genetic diversity is potentialized based on two logics. The first logic is grounded in the politics of extinction and loss. Genetic material is frozen as ‘fire insurance’ against the risk of declining breed populations and extinction. The second logic centres on the value of native and rare breeds whose characteristics are conserved to anticipate and produce ecologically

sustainable futures. Genetic diversity is seen as a ‘painter’s palette’ or ‘toolbox’ to breed ‘future-proof’ cattle. I argue that potential is not merely a latent quality of frozen life but is actively shaped within the infrastructural and political conditions of the genebank. Differences are not only conserved, but their practices shapes which differences are valued and which agricultural futures become possible.

In **Chapter 4**, together with Pauline Chasseray-Peraldi and François Thoreau, we analyse the data practices of the Dubbel Doel Natuurlijk project, which aims to develop new calculable breeding values for nature-inclusive farming practices and questions the potential fit for native breeds. We examine how data practices reconfigure the epistemic infrastructure of nature-inclusive farming and, in doing so, contribute to the remaking of biodiversity. We ask how practices of differentiation make a difference by making certain distinctions between animals, practices and ecologies visible and actionable. New *attachments* emerge as farmers’ and researchers’ valuations shape what the infrastructure measures, while data gives legitimacy to these attachments. This brings scientific and experiential knowledge together, although scientific authority remains dominant. We argue that biodiversity emerges as an ongoing process of negotiation in which animal bodies, knowledge infrastructures and farming values are continually reshaped.

In **Chapter 5**, together with Else Vogel, we analyse how farmers rewrite the *metabolic scripts* on their farms with cow breeds native to the Netherlands. Empirically, we focus on Dutch ‘nature-inclusive’ dairy farmers farming with native Dutch cattle breeds. We show that farmers are responding to the breakdown of ‘the Holstein script’ by loosening the demand for production and reconfiguring the division of labour between farmers, lands and cows. This does not just entail a switch in breed or practice, but a reconfiguration of the land and farm ecology through new alignments between bovine bodies and their environments. We thereby question what breeding difference requires. We suggest that these new ways

of organising dairy farming may contribute to a ‘post-industrial’ metabolic politics: one that responds to the ecological impacts of industrial farming by rethinking what cows eat, how they are farmed, and how they are connected to places.

Lastly, in **Chapter 6**, I bring together the insights of this thesis by asking how difference-making practices shape the enactment of good cows, good farmers, good products and good landscapes. The conservation of diversity, like the production of sameness, is enacted through practices that make, negotiate, and care for differences. Sameness and diversity are therefore not opposites, but different configurations of difference-making: both depend on establishing distinctions, valuing them, and creating the infrastructures and conditions through which they can persist. Conservation involves caring not only for breeds, genes, or species, but for the more-than-human relations, knowledge practices, and infrastructures through which forms of life can flourish.

Samenvatting

Al meer dan een eeuw worden de veehouderij gekenmerkt door intensivering en specialisering. Door processen van standaardisering en rationalisering zijn daarbij steeds meer uniformiteit onder koeienlichamen, genen en landschappen ontstaan. De productieve Holstein-Friesian is het dominante ras in de Nederlandse melkveehouderij geworden, terwijl de populaties van inheemse Nederlandse rassen sterk zijn afgenomen. Dit heeft geleid tot zorgen over het verlies van genetische diversiteit en het verdwijnen van rassen. Tegelijkertijd groeit de bezorgdheid over de bredere gevolgen van intensieve landbouw voor het milieu, waaronder het verlies van biodiversiteit, klimaatverandering en de gezondheid en het welzijn van mensen en andere levensvormen.

In dit proefschrift onderzoek ik hoe koeienrassen die als inheems aan Nederland worden beschouwd, worden ingezet en gewaardeerd in fokkerij, natuurbeheer en veehouderij. Op basis van etnografisch onderzoek dat tussen 2021 en 2024 plaatsvond met wetenschappers van Wageningen University & Research, natuurinclusieve boeren, natuurbeschermers, liefhebbers van Nederlandse koeienrassen, stamboekhouders, fokkers en fokkerijbedrijven, onderzoek ik praktijken die afwijken van intensieve landbouw en die gericht zijn op het bevorderen van diversiteit tussen de lichamen van koeien en hun omgevingen.

Voortbouwend op inzichten uit wetenschap- en technologiestudies (STS), antropologie, waardering studies en meer-dan-menselijke studies, onderzoek ik waar ervoor gezorgd wordt en wat er behouden wordt en hoe. Behoud praktijken richten zich vaak op biologische en genetische kenmerken. Mijn onderzoek laat echter zien dat datgene waarvoor wordt gezorgd en wat wordt behouden veel verder reikt dan genetisch materiaal alleen. Het gaat ook om relaties tussen boeren en runderen, manieren van boeren, familiegeschiedenissen van fokkerij en de

verbindingen tussen koeien en specifieke landschappen en plaatsen. Wat als waardevol geldt, ligt daarom niet vooraf vast. Het krijgt vorm in de praktijken van zorg, waardering en omgang met runderen, landschappen en andere meer-dan-mensen. Deze praktijken bepalen bovendien mede wat mag verdwijnen, wat behouden blijft en wat wordt meegenomen naar de toekomst. Door deze praktijken te volgen, laat ik zien goede koeien, goede boeren, goede landschappen en goede producten in de praktijk worden vormgegeven.

Om dit te analyseren introduceer ik het centrale concept van *verschil-maken*. Ik onderzoek hoe verschillen tussen runderen, landschappen en manieren van boeren worden gemaakt en vastgesteld, hoe deze verschillen betekenis krijgen en voor wie ze ertoe doen. Ook vraag ik wat ervoor nodig is om verschillen in stand te houden. Kort gezegd onderzoek ik hoe verschillen worden gefokt, en hoe fokken verschil maakt.

In **Hoofdstuk 2** onderzoek ik hoe er onderscheid wordt gemaakt tussen koeien en hoe ze tot een bepaald ras worden gerekend. Ik baseer mij hierbij op etnografisch veldwerk met liefhebbers van inheemse Nederlandse rassen, die deze koeien onder meer waarderen vanwege hun uiterlijk, smaak en karakter. Antropologisch onderzoek heeft laten zien dat de waardering van rassen bijvoorbeeld verbonden kan zijn met nationale identiteit of erfgoed. In dit hoofdstuk richt ik mij niet alleen op de vraag waarom bepaalde rassen worden gewaardeerd, maar ook op de praktijken waarmee wordt vastgesteld welke koe tot welk ras behoort. Ik analyseer drie manieren van meten en de technologisch-wetenschappelijke instrumenten die daarbij worden ingezet: het reconstrueren van genealogieën, genetische tests en het beoordelen van uiterlijk. Deze meetpraktijken vormen belangrijke plekken waar waarde wordt geproduceerd en betwist.

In **Hoofdstuk 3** onderzoek ik hoe het opslaan van genen het *potentieel* van inheemse rassen vergroot. Ik bevraag hoe de verschillen tussen rassen uitmaken, en hoe de inheemse rassen door behoud praktijken waardevol worden gemaakt. De analyse is gebaseerd op etnografisch

onderzoek bij Centrum voor Genetische Bronnen, Nederland (CGN) aan Wageningen University & Research. Ik laat zien dat het behoud van genetische diversiteit bij koeien vanuit twee verschillende logica's wordt vormgegeven. De eerste is verbonden met de politiek van uitsterven en verlies: genetisch materiaal wordt ingevroren als een 'brandverzekering' tegen het risico dat raspopulaties afnemen en rassen uitsterven. De tweede richt zich op de mogelijkheden die inheemse en zeldzame rassen bieden voor ecologisch duurzame veehouderij. Genetische diversiteit wordt daarbij voorgesteld als een 'schilderspalet' of 'gereedschapskist' voor het fokken van 'toekomstbestendige' koeien. Ik laat zien dat dit potentieel niet simpelweg besloten ligt in het ingevroren genetische materiaal, maar actief wordt vormgegeven door de infrastructurele en politieke omstandigheden van de genenbank. Genenbankpraktijken bepalen daarmee niet alleen welke verschillen worden behouden en gewaardeerd, maar ook welke landbouwtoekomst mogelijk worden.

In **Hoofdstuk 4** analyseren Pauline Chasseray-Peraldi, François Thoreau en ik de datapraktijken van het project *Dubbel Doel Natuurlijk*. Dit project ontwikkelt nieuwe fokwaarden voor natuurinclusieve landbouw en onderzoekt daarbij of inheemse rassen hiervoor geschikt zijn. We laten zien hoe datapraktijken worden ingezet om de kennisinfrastructuur van natuurinclusieve landbouw te veranderen, waarmee tegelijk ook vorm wordt geven aan hoe biodiversiteit wordt begrepen. We onderzoeken hoe praktijken van differentiatie verschil maken door bepaalde onderscheidingen tussen dieren, landbouwpraktijken en ecologieën zichtbaar te maken. De waarderingen van boeren en onderzoekers beïnvloeden wat de infrastructuur meet, terwijl de daaruit voortkomende data deze verbindingen vervolgens legitimeert. Zo worden wetenschappelijke en ervaringskennis met elkaar verbonden, al blijft wetenschappelijke kennis een dominante vorm van autoriteit. Biodiversiteit verschijnt daarmee niet als een vaststaande eigenschap van dieren of ecosystemen, maar als het resultaat van voortdurende onderhandelingen

waarin de lichamen van dieren, kennisinfrastructuren en land waarden elkaar wederzijds hervormen.

In **Hoofdstuk 5** analyseren Else Vogel en ik hoe boeren de *metabole scripts* van hun bedrijven herschrijven met lokale Nederlandse koeienrassen. We richten ons op ‘natuurinclusieve’ melkveehouders die met deze rassen werken. We laten zien hoe zij reageren op het vastlopen van ‘het Holstein-script’ door de nadruk op productie te verminderen en de arbeidsverdeling tussen boeren, land en koeien opnieuw vorm te geven. Dit vraagt niet alleen om het introduceren van een bepaald ras, maar om een bredere herinrichting van het bedrijf en zijn ecologie, waarbij nieuwe relaties ontstaan tussen lichamen en omgevingen. We bevragen wat er nodig is om verschil te fokken en in stand te houden. We stellen dat deze nieuwe manieren van melkveehouderij kunnen bijdragen aan een ‘postindustriële’ metabolische politiek: een politiek die reageert op de ecologische gevolgen van industriële landbouw door opnieuw te kijken naar wat koeien eten, hoe ze worden gehouden en hoe ze verbonden zijn met specifieke plekken.

In **Hoofdstuk 6**, het laatste hoofdstuk, breng ik de inzichten uit dit proefschrift samen. Ik onderzoek hoe praktijken van verschil-maken vormgeven aan wat geldt als een goede koe, een goede boer, een goed product en een goed landschap. Het behoud van diversiteit blijkt, net als de productie van uniformiteit, het resultaat van praktijken waarin verschillen worden gemaakt, gewaardeerd en onderhouden. Uniformiteit en diversiteit zijn daarom geen tegenpolen, maar verschillende manieren waarop verschillen worden gemaakt. Beide zijn afhankelijk van het maken van onderscheidingen, het toekennen van waarde en het creëren van de infrastructuren en omstandigheden waarin verschillen kunnen voortbestaan. Behouden betekent daarmee meer dan het bewaren van rassen, genen of soorten. Het vraagt ook om zorg voor de meer-dan-menselijke relaties, kennispraktijken en infrastructuren die het mogelijk maken dat bepaalde levensvormen blijven bestaan en kunnen floreren.

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For more than a century, cattle farming in the Netherlands has been shaped by standardisation, producing increasing sameness across landscapes, genes, and bodies. The rise of the highly productive Holstein-Friesian breed was accompanied by a decline in the populations of breeds native to the Netherlands. These developments raise growing concerns about biodiversity loss and the ecological consequences of intensive agriculture. Based on ethnographic fieldwork, *Breeding Difference* examines how native Dutch breeds are valued in breeding, conservation, and farming practices that seek to foster diversity. It traces how differences between cattle, landscapes, and ways of farming are established, valued, and sustained. Conservation, the dissertation argues, involves more than preserving genes or ecosystems: it entails caring for the more-than-human relations, infrastructures, and conditions through which diverse forms of life can flourish.

