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# Designing Cattle: The Social Practice of Constructing Breeds

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**ABSTRACT** This paper explores how cattle breeds are constructed through social practice—which we conceptually develop as "designing" cattle. We show how breed varieties are designed, informed by the social, material and moral embeddedness of cattle breeding associations' visions of the future and how they draw on science and technology in their breeding strategies. Based on an analysis of the trade magazines of three different breeding associations, we illustrate how breeding associations are working to establish four different varieties of Swedish Mountain Cattle (SMC). We conclude that the concept of designing cattle enables us to unpack how breeds are socially constructed and institutionally stabilized through sociotechnical imaginaries.

**Keywords:** breeding, cattle, human–animal interaction, rare breeds, science and technology studies (STS), sociotechnical imaginaries

Since it first began to gain momentum in the mid-nineteenth century, modern cattle breeding has achieved astonishing results in terms of milk and meat production levels. A high-producing dairy breed produces at least four times as much today compared with when modern breeding began, and so the modern dairy cow constitutes what Orland (2004, p. 167) calls one of the "most efficient sectors" in agriculture. The same argument could be made for meat production: larger and larger cattle bodies are bred to maximize meat production. However, maximal milk production and maximal meat production cannot be achieved in the same individual. Whereas cows in the mid-nineteenth century were used as all-round producers of milk, meat, and leather (and bulls as drought animals), ambitious breeding plans and new breeding technologies, such as artificial insemination, sex selective sperm, and various performance and evaluation indicator instruments (see Holloway, 2015 for a discussion on the geneticization of cattle breeding through the use of EBV, Estimated Breeding Value), have been employed to create distinct and highly specialized dairy or beef breeds.

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The further developed these breeds have become, the larger are the phenotypic differences between them which seemingly points to there being a larger variation of cattle. However, biologists point out that these achievements have come at the expense of genetic variability *within* the breeds (see, e.g., Taberlet et al., 2008), raising concerns about increasing levels of inheritable diseases and defects, as well as a loss of breeds deemed as less productive (see, e.g., Felius et al., 2014). This paper focuses on the resurgence of interest in keeping, breeding, and preserving purebred Swedish Mountain Cattle (SMC) that began in the 1980s, in line with similar trends elsewhere in Europe when the disappearance of old local breeds became a concern of policymakers, scientists, and breeders (Felius et al., 2014, p. 734).

The SMC originates from northern Sweden, where it was the most common local breed or landrace in the late nineteenth century and considered the best-suited dairy breed for the region. The first development plans for SMC were made in the 1890s, which were also successful in increasing its milk production. Still, within a couple of decades the SMC was outcompeted by imported high-producing dairy breeds. The SMC has since re-emerged as a rare breed, but the breeding and keeping of SMC has become politicized and what was once considered a single breed has been divided into four distinctly different varieties.

In this paper we take as our starting point that breeds are socially constructed, achieved through artificial selection and established through breeding associations (see Derry, 2003; Humanimalia Roundtable on Breed, 2017). This view has support not only among social science and humanities scholars but also in the science community. As an example, geneticists have shown that despite animal breeding generating spectacular phenotypical variations, particularly in the case of dogs where the differences between breeds are arguably greatest, these breed differences account for less than one-third of the total genetic variation (Parker et al., 2004). Thus a breed is, rather than a genetic category, the outcome of the intentional or unintentional "design" of animals that breeding associations and individual breeders carry out. In this paper, we explore the visions and rationales behind the design of the abovementioned breed varieties of SMC.

We approach breeding through the lens of science and technology studies (STS), acknowledging that breeding technologies (or their outcomes in terms of animal bodies), like any other technology, are "integral components of social order" (Jasanoff, 2015a, p. 2). We employ Jasanoff's concept of "sociotechnical imaginaries," which focuses how social, material, and moral aspects are woven into decisions on what (breeding) technology to use and what visions lie behind that choice. Our examples show how the purposeful design of animal bodies is based on particular judgements and visions, which illustrates how breeds are constructed as a social practice. The SMC designs reflect different desires in terms of what cows' bodies should look like, how they should behave, and a vision of what purpose they should serve to their owners and to society, today and in the future.

### *Conceptual Framework*

Our theoretical approach is aimed at improving understanding of how breeds are socially constructed as social practice and how breeding technologies and decisions are socially, materially, and morally embedded. Our point of departure is Jasanoff and Kim's (2009) "sociotechnical imaginaries," a concept which they originally developed to explain a puzzling empirical observation, namely why different nations follow different technological trajectories, in their case regarding nuclear power, despite sharing similar challenges and opportunities. In their analysis of how technological trajectories become institutionalized, they paid close attention to how technological development is linked to collective beliefs on how society

functions and how it ought to be, grounded in ideas of the nation. Thus sociotechnical imaginaries describe desirable futures and favored technologies preferred by state actors: they comprise a normative or moral stance (Jasanoff & Kim, 2009).

In later work, Jasanoff (2015a) expanded the concept of sociotechnical imaginaries to include actors other than the state in order to recognize that other groups, such as corporations or social movements and professional societies, can articulate and propagate sociotechnical imaginaries. A sociotechnical imaginary, Jasanoff argues, can originate in an individual but rises to the status of an imaginary when communally adopted, although she acknowledges that "multiple sociotechnical imaginaries can exist in a society in tension" (2015a, p. 4).

Sociotechnical imaginaries are defined as "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff, 2015a, p. 4). Thus the concept of sociotechnical imaginaries facilitates closer analysis of the relationship between imaginaries and social practice through a focus on the material outcome of what is imagined: "by inquiring into imagination as a social practice, we follow the embedding of ideas into cultures, institutions, and materialities, whereby the merely imagined is converted into the solidity of identities and the durability of routines and things" (Jasanoff, 2015b, p. 323).

Jasanoff and Kim (2009) point out that science and technology studies have been fruitful in terms of explaining how expert communities and consensus building emerge within the science and development sphere when developing technological innovations. However, much focus has been on the technological innovations themselves, while there have been few wider studies on how technologies are applied once they leave the laboratory (Jasanoff & Kim, 2009, p. 120). Jasanoff (2015a, p. 3) calls for research that situates sociotechnical imaginaries not only within their social aspects but also within their material and moral aspects, at the level where they are implemented. We attempt to do so in this paper by exploring the question of how breeds are socially constructed, through an analysis of "designing" cattle as social practice within and between breeding associations.

Breeding associations have, across species, played an important role in promoting, developing, and preserving various breeds. Generally they emerged in the late nineteenth century as scientific breeding programs spread throughout Europe and North America as cattle exhibitions, but also, for example, dog shows became both fashionable and common (see Ritvo, 1987). The role of breeding associations is and has been to "formalise the ideas and social networks associated with the breeding of farm animals" (Yarwood & Evans, 2006, p. 1315).

In the present study, sociotechnical imaginaries are used as the point of departure for analyzing collectively held beliefs of social order and societal (agricultural) development among animal breeding associations and the response to this: cattle breeding taking specific forms. We focus here on how this is demonstrated in breeding plans, showcasing the ideal cattle envisioned as a response to an imagined future. Compared with the much broader literature on imaginaries in social theory, sociotechnical imaginaries pinpoint the importance of materiality in ways that are especially fruitful when studying breeding.

For the purposes of the present analysis, we introduce the concept of "*designing*" cattle, enabling us to use precise terminology when we examine how sociotechnical imaginaries are done through designing (social practice) cattle breeds and what ideal *design* (material outcome) is constructed in terms of animal bodies. This enables us to show how cattle bodies are made by breeding associations as material manifestations of sociotechnical imaginaries:

embodied visions of what cattle should be and how they should be achieved, as well as what environments and social orders they are to be part of.

Our idea of using "designing cattle" as an analytical concept builds on the work of other scholars on animal breeding in which the intentional crafting of animal bodies is compared with designing objects; in particular, studies by Franklin (2007) and Grasseni (2005). However, those studies do not use designing or design as analytical concepts but rather to illustrate how new breeding technologies, such as artificial insemination (Grasseni, 2005) or stem cell research (Franklin, 2007), speed up the process of achieving the sought-after characteristics in animal bodies in a way that resembles designing objects. Thus, implicitly, designing or design has been used for breeding endeavors carried out using high-tech technologies that have been especially successful in achieving rapid results. However, we argue that, in the case of SMC, farmers who want to develop the breed and those who want to preserve it both use selective, or strategic, breeding and thus design cows, albeit selecting differently and not necessarily involving high-tech methods.

## Methods

This paper is based on text analysis of the magazines of three local associations breeding SMC as a purebred rare breed: *Fjällkon* by Svensk Fjällrasavel; *Allmogekon* by Föreningen Allmogekon; and *Fjällnära* by Föreningen Äldre Boskap (Table 1). In addition, material on the three associations' websites was analyzed and two books on the history of SMC, one published by one of the founding members of Svensk Fjällrasavel (Nilsson, 2007), the other by the Association for Swedish Polled Cattle (SKB, 1988). Together, these materials enabled an analysis of the visions, expectations, and negotiations on the different SMC designs, as described below. When needed for clarification, the chairman or person responsible for the herdbook at each association was contacted by mail or telephone.

A digital archive was set up comprising all issues published from when each magazine was launched until the last issue of 2016 (Table 1). All issues were scanned, converted to editable text, and imported to and coded in Nvivo, software for organizing and coding qualitative data. The magazine issues were read and coded in chronological order to help follow breeding debates as they unfolded over time through, for example, editorial pieces to which members responded by submitting letters to the editor. The process of coding was inductive

**Table 1.** Swedish associations actively breeding Swedish Mountain Cattle (SMC) today in order to preserve it as a purebred breed and qualify for EU support for rare local breeds, their respective trade magazine, and the scope of material analyzed from each association.

| Associations Breeding the SMC as a Rare Breed Today | Active | Magazine Issued | Issues Analyzed |
|---|---|---|---|
| *Svensk Fjällrasavel* (Swedish SMC Breeding) | 1995– | *Fjällkon* 1996– 4–5 issues/year | 1996 no. 1 to 2016 no. 4 In total 87, approximately 2000 pages. |
| *Föreningen Äldre Boskap* (Association for Old Cattle Breeds) | 2007– | *Fjällnära* 2016– 2 issues/year | 2016 no. 1–2 In total 2, approximately 25 pages. |
| *Föreningen Allmogekon* (Swedish Association for Old Local Cattle Breeds) | 1993– | *Allmogekon* 1994– 3–4 issues/year | 1994 no. 1 to 2016 no. 4 In total 89, approximately 900 pages. |

and iterative in the sense that new codes were continually added as new debate topics appeared or topics emerged as important, sometimes giving cause to revisit and re-code earlier issues. All magazines are published in Swedish and excerpts used here were translated by the main author.

## Results and Discussion

### *The Four Designs of Swedish Mountain Cattle*

When analyzing the material used for this paper, we found four different breeding plans for SMC which are kept separately with differing breeding goals and ways of defining what animals should be registered in the herdbook. In our analysis we refer to these as four different designs: (i) the Dairy SMC, the largest population of SMC held as a rare breed, which is bred for (moderate) production in commercial dairy production systems; (ii) the Bohus SMC, a small population of SMC that caught the attention of people interested in rare breed conservation in the early 1980s bred under a distinct name: Bohus Polled Cattle; (iii) Household SMC, and (iv) Conservation SMC, two versions of *Fjällnära* cattle, a population that stems from herds of SMC "discovered" in the 1980s and 1990s on farms that had used live bulls from their own or neighboring farms instead of artificial insemination by bulls recommended by the breeding associations. These animals are smaller and display features considered to be typical of landraces and are regarded as an "unimproved" version of the SMC, which is true also for Bohus SMC. The Household and Conservation designs differ in that the associations which register them acknowledge six original populations for Household SMC but only three of those for Conservation SMC (Table 2).

The four designs of SMC are acknowledged to share the same genetic variability but continue to be designed differently and kept separately. However, there are potential overlaps between the herdbooks. The most widely inclusive design is the Dairy SMC which allows any SMC with medical statements on hypoplasia in the testicles/ovaries (a known hereditary condition in the SMC population) into their herdbook. Bohus and Conservation SMC have the strictest rules on inclusion as they only approve offspring from a few specific herds each.

**Table 2.** All associations in Sweden currently breeding Swedish Mountain Cattle (SMC) as a rare breed, the names given to the breeds by the associations themselves, the total population of each breed, and the design name we allocated to them. Note that individual animals can be registered in more than one breeding association, which is most likely to occur between the categories Household SMC and Conservation SMC.

| SMC Breeding Association | Breed (the association's own terminology) | Total Population of Cattle (year) | Design (our terminology) |
|---|---|---|---|
| *Svensk Fjällrasavel* (Swedish SMC Breeding) | *Fjällko* (Swedish Mountain cattle) | 2,300 (2016) | Dairy SMC |
| | *Fjällnära*, including animals from Lillhärjåbygget, Biellojaure, Klövsjö, Fatmomakke, Funäsdalen, and Särna | 300 (2016) | Household SMC |
| *Föreningen Äldre Boskap* (Association for Old Cattle Breeds) | *Fjällnära*, limited to animals from Lillhärjåbygget, Biellojaure, and Klövsjö | 127 (2013)<br>175 (2016) | Conservation SMC |
| *Föreningen Allmogekon* (Swedish Association for Old Local Cattle Breeds) | *Bohuskulla* (Bohus polled cow) | 14 (1994)<br>27 (2004)<br>91 (2015) | Bohus SMC |

Ritvo (1992) has demonstrated how the importance of a particular breed can gain momentum through myth building. In our case, describing the breeding history of SMC is challenging as two processes unfolded in parallel which have different narratives when it comes to describing the importance of the SMC. One way of portraying the breeding history of SMC is to focus on the resistance that emerged among commercial farmers keeping SMC as the breed became threatened by extinction due to crossbreeding practices. To them, the unique qualities of the SMC in terms of their phenotypic traits, behavior, and milk quality were the main reasons to preserve the breed. Another way is to focus on how conservationists discovered a few unimproved herds of SMC that had not been part of any elaborate breeding program and thus were seen as genetic remnants of a pristine cattle breed.

In the next two sections, we go into more detail of these two parallel stories as the formation of two different sociotechnical imaginaries within two separate communities: a group of dairy farmers who decided to take control over breeding in response to what they consider to be malpractice among breeding professionals steering breeding along an undesirable path; and three different groups of conservationists aspiring to preserve pristine traits found in a few selected herds of cattle who have worked to establish three separate designs of SMC, even though we argue that they collectively share one sociotechnical imaginary.

We then turn our attention to what collective beliefs are demonstrated through how the future is envisioned, how the SMC designs are negotiated, and what technologies are favored in the design of these breed varieties. We argue that what has been seen as the most important breeding goal and how this has been negotiated over time within and between different breeding associations illustrates how breeds are constructed as a social practice. In doing so we focus on material aspects such as phenotypic features, milk quality or genetics, social aspects such as what agricultural and social system the animals are to be part of, and moral aspects such as what cattle ought to be used for and what values or virtues define a breed.

### *A Bull with Horns: The Tipping Point for Creating a Purebred Society*

The understanding of what is meant by “a cow,” or in our case “an SMC,” shapes conceptions of which modifications to its body are considered acceptable or not (cf. Noll, 2013, p. 274). There is a limit to when one can still call a cow a cow or when an individual is no longer considered to be a typical SMC. In Sweden, as in many other countries, modern high-producing dairy breeds are crossbreeds. As an example, the two most commonly used dairy breeds in Sweden, the Swedish Holstein and Swedish Red-and-White, are the result of mixing Holstein with Swedish Lowland and Friesian with Swedish Red cattle, respectively. Today, commercial dairy production in Sweden is dominated by these two breeds, each of which accounts for roughly half of the total production. In 1968, the Association for Swedish Polled Cattle, at the time the only association breeding SMC, started to crossbreed SMC cows with Friesian cows, and in 1970 crossbreeding became its official breeding program (SKB, 1988). The Association for Swedish Polled Cattle aimed at breeding SMC as a robust, productive dairy cow and its experiment with crossbreeding proved very successful in terms of increasing milk production levels (SKB, 1988).

However, at farm level there was resistance to the crossbreeding practices and so a group of farmers continued to use purebred SMC bulls to inseminate their cows. During the 1980s the lack of such bulls became so critical that the remaining purebred SMC herds started to be inbred (Svensk fjällrasavel, 2017). Throughout the 1970s and 1980s, there were fierce internal discussions in the Association for Swedish Polled Cattle, later described as “cross-breeding

chaos" and "civil war" by Svensk Fjällrasavel (Svensk fjällrasavel, 2017). The Association for Swedish Polled Cattle described the dissenters as a group of people who do not understand the importance of breeding a productive cow that will meet the demands of the dairy sector in the future (SKB, 1988, p. 6).

In 1989, a picture of the bull 931 Veman was published in semen distributor Nordavel's breeding catalogue and was presented as a new SMC breeding bull (Nordavel, 1989). This seemingly mundane publication prompted a number of people who had been mobilizing against the crossbreeding strategies of the Association for Swedish Polled Cattle to take action to form a new association (*Fjällkon*, 1996(3), p. 17). The problem with this particular bull was that he had horns. Since the first breeding program for SMC was established in the mid-1890s, SMC had been characterized as naturally polled: hornless. So to protesters his horns symbolized everything they believed was wrong with crossbreeding, where breeding for increased milk production through blending in more productive breeds meant that the SMC did not look like it "should" any more.

Protests against bull 931 Veman led to the formation of a new breeding association, Svensk Fjällrasavel (Table 1). Its overarching goal was to preserve the SMC as a purebred dairy breed, as an expression of resistance to crossbreeding practices but also to wider issues such as loss of cultural heritage due to commodification in the dairy sector. This represented a major shift in the breeding of SMC and the formation of a new sociotechnical imaginary tied to breeding SMC as purebred cattle, in order to take control over breeding practices, preserve cultural heritage, and achieve robust cows for an envisioned future that needs to be more sustainable.

From the outset, Svensk Fjällrasavel defined itself as a resistance movement not only in the sense that it was created out of discontent with crossbreeding practices aimed at maximizing milk production, but also because the farmers involved wanted to take control over breeding practices. Unlike the "big breeds" such as Holstein, where "decisions are taken by desktop bureaucrats on the other side of the globe, only taking economic gain into consideration," Svensk Fjällrasavel wanted "ordinary farmers" to be in charge of breeding and thus of the appearance and behavior of their cows (Fjällkon, 1997(5), p. 3). Over time, Svensk Fjällrasavel has come to define what we label the Dairy SMC as a dairy breed that should be developed to find a niche market in commercial milk production:

> There have always been, and still are, farmers who live off SMC. And successfully so. For that reason, we must prioritize the SMC's capacity to produce competitively in our preservation endeavor, and make sure that it will not decrease. However, we still have to avoid the treacherous path that the "big" breeds have taken. (*Fjällkon*, 1997(4), p. 3)

This distinguishes the Dairy SMC from the other designs of SMC, which are all bred for preservation without expectations that they will be commercially viable. During recent decades, Svensk Fjällrasavel has frequently discussed the benefits of the high protein levels found in SMC milk, which is an advantage when producing cheese. One of the ways farmers can increase their profitability is through engaging with the growing artisanal cheese production sector in Sweden (see Eriksson & Bull, 2017).

Svensk Fjällrasavel and the Dairy SMC thus represent a sociotechnical imaginary where (dairy) farmers are in control of breeding. They seek to create more sustainable futures through breeding for high-quality milk and (relatively) high milk yields to be used in artisanal cheese production.

### *Preservation: The Discovery of Unimproved Herds*

In parallel to the revolt against crossbreeding within the Association for Swedish Polled Cattle, which was mainly an arena for commercial dairy farmers, attempts were made to identify unimproved SMC on small farms that had not been part of the commercialization of the dairy sector, which transformed dairy farms and dairy cows in the 1950s–1970s. The efforts to preserve unimproved SMC gave rise to two additional breeding associations, Allmogekon and Föreningen Äldre Boskap, which have their own designs of unimproved SMC, in addition to Svensk Fjällrasavel, which maintains a separate population of unimproved SMC (Table 2). These preservation efforts were initiated by two separate events.

The first was the discovery in the late 1980s of four herds on farms in the county of Bohuslän on the Swedish west coast that had not been part of any breeding program. These animals were taken up by Allmogekon, a breeding association founded in 1993 and which thus predates Svensk Fjällrasavel. It enrolled a total of 14 animals (three of which were bulls) from the four different herds into a herdbook which they named the Bohus Polled cow but which we refer to as the Bohus SMC (Table 2). The association considers the Bohus SMC to be a south-western, unimproved version of SMC. It has very similar features to the Household SMC, since it is smaller as a result of not being part of a breeding program and is used on marginal land with meagre feed resources.

An article in the very first issue of the magazine *Allmogekon* tells the story of the discovery of the breed and reports that some farmers who keep this breed refer to it as SMC, while others refer to it as the Bohus Polled cow. The association chose the latter name because it decided to preserve that cattle population as a separate breed (*Allmogekon*, 1994(1), p. 4). This provides a very clear example of how breeds are social constructs (compare with Grasseni, 2005), as these animals were chosen to be preserved separately from other SMCs although they in no other way than their geographical origin were seen as distinct from other SMCs. Thus, the place of origin is crucial in deciding what is considered a breed, as the discovery of herds outside what is seen as the birthplace of the wider SMC (northern Sweden) was decisive in keeping the west-coast lineage separate from other SMC designs.

The second influential event was a project called “Save Swedish Mountain Cattle” (*Rädda fjällkon*) initiated by the Swedish branch of the World Wildlife Fund (WWF) in 1993. The project aimed at creating an inventory of remaining purebred herds of unimproved SMC and collecting semen from bulls found in such herds. Three herds were found, one each in Lillhärjåbygget, Biellojaure, and Klövsjö, which became the basis for a separate group of cows for which Svensk Fjällrasavel created a breeding plan and which it named *Fjällnära* (Table 2). So, from the start, the association dealt with two separate cattle populations, which we refer to as two separate designs: Dairy SMC, the purebred SMC dating back from the Association of Swedish Polled Cattle, and the Household SMC, originating from the three founder herds. Household SMC are generally smaller and produce less milk than Dairy SMC, which are bred for (commercial) dairy production. Dairy SMC produce around 6,000 kg milk per year on average, while Household SMC might produce around half as much but are not kept as commercial dairy cows, which means their production levels are not reported in official records. They are typically used for household production of beef and milk, which is why we refer to this design as Household SMC.

The work of establishing breeding plans for both Bohus SMC and Household SMC was characterized by two contradictory breeding goals: reducing the level of inbreeding, which is considered challenging (*Fjällkon*, 1997(1), p. 8; *Allmogekon*, 1994(1), p. 4), and a desire to

preserve the genetic diversity in the founder populations without crossing in lineages of the "wrong" type. In the case of Household SMC, Svensk Fjällrasavel's breeding plan suggests that more or less all fertile animals can be used for breeding. On occasion, members have advocated crossing in new strains from Dairy SMC into Household SMC, but that has never been accepted by the Household SMC committee, which steers the breeding plan for Household SMC within Svensk Fjällrasavel. The committee instead aims to limit inbreeding through crossing the animals from the three different herds with each other and through continuing to look for new herds of unimproved SMC that can be included in the Household SMC herdbook (*Fjällkon*, 1997(1), p. 8). Since the discovery of the first three herds, three new populations have been identified and entered into the herdbook: a bull found in Funäsdalen in 1996, a cow from Fatmomakke found in the early 1990s, and three cows and a bull found in Särna in 2010.

*Allmogekon* has a similar approach for Bohus SMC. It explicitly adheres to gene bank preservation, meaning that it is dedicated to collecting semen from all bulls to store in a gene bank (*Allmogekon*, 2003(1), p. 4). While remaining open to the possibility that new founder populations might be identified, Föreningen Allmogekon has only found one cow to add as a new founder animal since 1993. Its first breeding plan (1993) recommended using Household SMC bulls, as they are also an unimproved strain of SMC, if a Bohus SMC bull cannot be matched with a certain cow (*Allmogekon*, 1996(1), p. 6). However, in the 2007 breeding plan this option was taken away and since then only Bohus SMC bulls may be used if animals are to be registered in the herdbook. The Bohus SMC herdbook holds the smallest cattle population of all SMC designs. However, its conservation work has been successful, since between 2007 and 2016 the total herd more than doubled in number, from 35 to 91, while the number of herds increased from 14 to 21 (*Allmogekon*, 2016(4), p. 7). The 2007 breeding plan for Bohus SMC states the goal of conserving traits that were characteristic of founder herds (*Allmogekon*, 2008(1), p. 10). It is worth noting here that, through this phrasing, the association avoids claiming that it wants to re-create the characteristics of the breed from before modern cattle breeding began in the nineteenth century. Thus, it is not a question of re-establishing historical genetic material or behavior (as in the case of Heck cattle analyzed by Lorimer & Driessen, 2013 or Norfolk Horn sheep discussed by Derry & Palladino, 2018).

However, it could be argued that re-creating pre-modern cattle is what Föreningen Äldre Boskap, the latest addition to breeding associations for SMC, sets out to do. The association arose out of discontent with the way that Svensk Fjällrasavel was breeding Household SMC. According to the founders of Föreningen Äldre Boskap, Household SMC should be limited to the three herds discovered in the 1980s and they aim to preserve pristine traits in what they see as the last remnant of pre-modern cattle. Its breeding plan excludes adding material from other lineages (Föreningen Äldre Boskap, 2015), which is why we refer to its design as Conservation SMC. Just like Allmogekon, Föreningen Äldre Boskap considers the Conservation SMC population to make up a living gene bank and refers to the herds discovered in the 1980s as "founders." It consistently stresses the importance of *in situ* conservation, clearly drawing on research within conservation biology in its approach to preservation. However, it has negotiated what it sees as a Conservation SMC that may hold up to 25% heredity from the Fatmomakke herd in breeding bulls and up to 12.5% of the Funäsdalen herd, although this is seen as crossing Conservation SMB with Household SMC (*Fjällnära*, 2016(2), p. 11).

Unsurprisingly, the formation of Föreningen Äldre Boskap generated much opposition in Svensk Fjällrasavel. In a number of articles in its magazine, *Fjällkon*, Föreningen Äldre Boskap is described despairingly as an inbreeding club (*inavelsklubb*), "Scanian enthusiasts"

(*entusiasterna från Skåne*) or "enthusiastic inbreeding Scanians" (*de entusiastiska inavelsskåningarna*). "Inbreeding club" in this case refers to how the new association refuses to add any genetic material to the three founder herds, while "enthusiast" has connotations of being unskilled or unprofessional. "Scanian" is disparaging in the context of the breed originating from northern Sweden, since Scania, the seat of Föreningen Äldre Boskap, is in the southernmost part of Sweden, which again illustrates how place matters in negotiating authenticity and power within the wider SMC breeding community.

Thus the preservation efforts by Svensk Fjällrasavel with Household SMC, Allmogekon with Bohus SMC, and Föreningen Äldre Boskap with Conservation SMC distinguish themselves and their sociotechnical imaginary from that of Svensk Fjällrasavel's Dairy SMC through focusing on genetic diversity and preservation and drawing heavily on conservation biology. The Dairy SMC is seen as a productive dairy cow bred by dairy farmers in opposition to mainstream commercial animal breeding, and all additional designs are seen as a living gene bank of critically important genetic material meant to preserve unimproved cattle. No keepers of Bohus, Household or Conservation SMC deliver milk to commercial dairies, although there are examples of farmers who produce a limited amount of dairy products from their milk. Rather than looking for affinity with other cattle breeding associations, Allmogekon and Föreningen Äldre Boskap identify and compare themselves with associations preserving other species of animals, such as goats and pigs, in the same way that they want to preserve their SMC designs.

### *Desirable Futures: Breeding SMC as Preparation for a New Social Order*

These two parallel stories of how the SMC designs came into being might make us think that the sociotechnical imaginaries of the dairy farmers in Svensk Fjällrasavel, and the conservationists in Allmogekon and Föreningen äldre svensk boskap in particular, are attempting to re-enact history through reproducing "past" animal bodies. However, a shared trait among all three breeding associations is their emphasis on their version of SMC being the best-suited for the future. They share a view that the current agricultural system is unsustainable and will collapse sooner or later. Thus SMC can be read as cattle designed to help create or, at least, cope with a future social order brought by a collapse of the current agricultural production system.

This desired future social order clearly draws on "advances in science and technology," as Jasanoff (2015a, p. 4) puts it. In science literature on climate change and environmental change there is no lack of support for the claim that rare breeds are more resilient to various threats. For example, Madzimure, Chimonyo, Dzama, Garnett and Sander (2015) argue that preservation of rare breeds is necessary to mitigate the effects of climate change, as they show that native pig breeds in South Africa are more resistant to heatwaves. Similarly, Hanotte, Dessie, and Kemp (2010) call for new sustainable breeding programs based on large-scale genomic mapping of rare breeds in Africa, as they are proven to be locally adapted to tolerate diseases (see also d'Ieteren, Authie, Wissocq, & Murray, 1998; Piedrafita, Raadsma, Gonzalez, & Meeusen, 2010) and to generate more robust milk production systems. It is reasonable to assume that the individuals involved in the breeding associations are well informed of these research fields, as similar research is occasionally referred to in trade magazines.

The most common reasons behind the inevitable collapse of the agricultural production system cited by the associations are the dependence on fossil fuels and the unsustainable breeding practices and production systems employed in mainstream dairy production—here the Holstein breed is singled out as a particularly bad example, which we will return to in the section "Favored technologies" below. However, some differences can be seen

between the associations when it comes to *how* SMC can help people cope in a post-collapse agricultural system.

A recurring theme for Föreningen Äldre Boskap and Allmogekon is the need to return to self-sufficiency farming, which provides an argument for preserving unimproved strains of SMC as that is in line with their historical use (see also *Fjällnära*, 2016(1), p. 10; *Allmogekon*, 2010(4), p. 8):

> Rare breeds and other old farm animals were the most efficient and generated the greatest economic trade-off in a more self-sufficient farm system than that we have today. The question is not *if* we need to return to a more ecologic and sustainable agriculture. The question is when (*Allmogekon*, 2003(1), p. 5).

The breeding of the Dairy SMC, on the other hand, represents an example similar to Grasseni's (2005) Alpine Brown, as farmers claim they stand out from mainstream dairy breeds owing to high quality milk in terms of protein and fat content. In an opinion piece in *Fjällkon* (2015(1), p. 25), a member paints a picture of a future catastrophe caused by climate change and rhetorically asks:

> Does anyone doubt that it is the productive abilities in rare breeds that will be in demand then? Who do you think will call and ask to buy the least productive cow? Is that the cow we should aim for?

So, while Föreningen Äldre Boskap and Allmogekon might consider the alternative to be household-level self-sufficiency, where a low-producing household cow is the ideal, Svensk Fjällrasavel considers a commercially viable, relatively high-producing Dairy SMC to be the best option to preserve the SMC for the future. Thus it is within an imagined future post-Holstein and post-fossil fuel agrarian system that the associations' current work with breeding SMC is expected to pay off, with the SMC predicted to be re-valued as a rational choice in a radically different post-fossil fuel mainstream farming. This means that breeding SMC aligns with views often voiced among alternative agriculture movements, centered on a critique of productivist agriculture (see Vanderplanken, Rogge, Loots, Messely, & Vandermoere, 2016). The future agricultural system and social order that these cows are envisioned to be part of is not only significant at a rhetorical or a political level but will also affect their bodies because different visions result in different breeding strategies.

The SMC as a response to an inevitable collapse of the agricultural system is thus a shared foundation in the different breeding associations' sociotechnical imaginaries, as they position themselves as political actors responding to a call for a transition to more sustainable farm practices. In doing so they draw on science, such as ecology and conservation biology, but also on the work of other resistance movements in opposition to mainstream commercial animal breeding.

### *The SMC as a Publicly Performed Vision: Negotiating What an SMC Ought to Be*

The cultural value of rare breeds has been well documented. For example, Gandini and Villa (2003) discuss local breeds as historical witnesses by looking at their presence and role in the landscape, gastronomy, folklore and handicraft, and Palladino (2018) discusses the importance of photographs and stories in creating local breeds' value. For the SMC, its cultural value is less in focus as the breeding associations focus more on preservation of genetic diversity on the one hand (the Conservation, Household and Bohus SMC) and developing specific traits that are useful in dairy production on the other (Dairy SMC).

However, the importance of genetic diversity is clearly negotiable, as illustrated by how Svensk Fjällrasavel chose to preserve Household SMC as a separate design. They made their decision to preserve Household SMC as separate from Dairy SMC based on a belief that it was a different, older pedigree that pre-dated modern cattle breeding methods and thus possessed a different set of genes to Dairy SMC. Thus, they saw the Household SMC as a genetic remnant of an original, pre-modern SMC. There were also discussions about using Household SMC bulls on Dairy SMC cows to reintroduce older genetic material back into the Dairy SMC population to invigorate the breed, but this never materialized.

In 2006, an article in *Fjällkon* (issue 3, pp. 17–18) reported findings from a research project showing that the genetic material in Household and Bohus SMC does not contain any genes that are not also found in the larger Dairy SMC population. The article author concludes that the rationale behind keeping Household SMC as a separate population is based on an unfounded genetics argument. Interestingly, while this new fact generated much debate in *Fjällkon*, it had no impact on the subsequent breeding plans for Household SMC. This shows that the cultural history regarding the importance and distinctiveness of Household SMC, coupled possibly with concern for the people keeping Household SMC, weighs more heavily than its factual genetic value, which once was used as a rationale as to why this variety should be preserved.

For another case that shows how what an SMC ought to be is negotiated, we return to the promotion of 931 Veman, the SMC bull with horns that has already been presented as one of the key reasons Svensk Fjällrasavel came into being. His horns were seen as proof that the breed was no longer SMC but something else: a diffuse crossbreed. Svensk Fjällrasavel made lack of horns an absolute requirement for being listed in its herdbook (*Fjällkon*, 2004(3), p. 12). However, just over a decade later, it changed its position on horns as it found out through archival work that the early SMC in fact occasionally had horns: not only the bulls but also the cows. In addition, the offspring of Lage, seen as the best bull in use over the last 30 years, turned out to often carry horns. Today, individuals born with horns can be seen as displaying a pristine (*ursprunglig*) trait, rather than as being atypical for the breed. In fact, the cover of *Fjällkon* issue 3, 2016 shows an SMC cow with horns.

This illustrates one way in which phenotypic traits and the ideal appearance of cattle can be negotiated and changed over time while also demonstrating the importance of authenticity for judging which characteristics to breed for or, in this case, tolerate (see Colombino & Giaccaria, 2015 for an account of how the "double muscle factor" of the Piedmontese cattle was re-interpreted as an important trait to be preserved from having been considered monstrous).

However, it is not only discussions on genetics or phenotypic traits that sparks debates on what a SMC ought to be in SMC breeding associations. One example that illustrates how social matters come into play is a conflict within Svensk Fjällrasavel over what a Dairy SMC should be used for. The background was that the number of Dairy SMC had increased continually since Svensk Fjällrasavel started breeding them, but the number of commercial dairy herds had steadily decreased. In other words, a large proportion, estimated to be around half the population, of Dairy SMC were in fact not being used in dairy production (*Fjällkon*, 2009(3), p. 5). This caused a rift between dairy farmers, beef farmers, and hobby farmers within Svensk Fjällrasavel. The founding members of Svensk Fjällrasavel were mostly dairy farmers, who earn their livelihood from dairy production, whereas an increasing number of newer members keep SMC for semi-commercial beef production or as household cows with low economic returns (or in many cases a loss rather than a profit).

Why keeping SMC for beef production rather than dairy production is seen as a problem revolves around not only what it implies for future milk production capacity but also what it implies for how farmers manage the cattle. In dairy production, farmers typically handle the cows several times a day, which enables socializing them and making them tame. For some, this is mostly a matter of caring properly for the animals, while beef production is considered a detached production system, similar to what Bock, van Huik, Preutzer, Eveillard, and Dockes (2007) has reported. Others argue that this detached handling of the animals also has implications for breeding, as they reference scientific findings regarding the importance of epigenetics: how phenotypic traits are inherited without causing changes to their DNA. Discussions in *Fjällkon* have focused on the consequences of epigenetics both on, for example, the udders of dairy cows and also possibly on their behavior: fearing that behaviors such as calmness, kindness, and manageability, which are associated with dairy cows, are at risk of disappearing (see also Petitt & Eriksson, 2019).

At its 2009 annual general meeting, new rules were introduced by Svensk Fjällrasavel concerning which Dairy SMC bulls would be used for semen collection, stipulating that only bulls born from SMC cows registered in the national dairy cow recording scheme would be used and only such offspring should qualify for EU support in the future (*Fjällkon*, 2009(3), p. 5). In effect, this excludes all herds that are not commercial dairy farms and represents a step towards developing the breed as a dairy breed—a move away from lineage, pedigree, and genetics that was the rationale of Svensk Fjällrasavel when founded.

The issue of whether or not Household SMC had any unique genetic diversity, whether or not it is an inherent quality of SMC to be hornless, or whether or not an SCM should be a dairy cow or used for meat production illustrates how what is considered a real SMC is negotiable. In these negotiations, material, social, and moral judgments are clearly at play as the SMC designs, in their material form (i.e., their bodies), are the focus of discussions on what they ought to contain and look like and what role they should play for their owners and society.

### *Favored Technologies: DNA Sequencing as a Technology to Boost Milk Proteins*

As has been noted previously, the technologies used when breeding the four different SMC designs are not necessarily involving high-tech instruments. Technologies used include artificial insemination, which is common on dairy farms; semen collection of bulls that are considered valuable for their genetic value based on heredity or their production value based on their offspring's dairy production; and gene bank preservation schemes, advocated most clearly in the preservation of Conservation SMC and Bohus SMC but to some extent also for Household SMC.

Rather than being characterized by seeking out specific technologies that are considered favorable, the attitude towards technology among the breeding associations could be better described as being in resistance to some of the breeding technologies used in mainstream dairy cattle breeding that they see as causing genetic depletion, especially in Holstein cattle. A typical argument is that Holstein cows, the dominant commercial dairy breed globally today, will eventually have to be abandoned due to poor health and dysfunctional behavior resulting from inbreeding caused by rapidly developing breeding technologies that allow for narrow selection (see, e.g., *Fjällkon*, 2004(2), p. 22; *Allmogekon*, 2009(4), p. 10). This is another example of how the reasoning of the breeding associations is in line with that of the science community. For example, see Felius et al. (2014) for an account of how modern breeding has brought genetic isolation to breeds that have been developed; meanwhile, locally adapted but less productive breeds have declined or disappeared (p. 724).

However, there are many examples of how Svensk Fjällrasavel seeks to improve the Dairy SMC that illustrate how breeding technologies are used to develop the breed in ways that is intended to improve its profitability. In *Fjällkon* there are frequent discussions on the importance of different forms of protein in the milk, such as kappa-casein B, facilitated by DNA sequencing, becoming more affordable. The main argument is that a high level of kappa-casein B in milk is favorable for cheese production, as it generates more cheese per liter of milk. Coupled with higher-than-average fat levels in SMC milk, there are grounds for marketing SMC as an exemplary breed for artisanal cheese production (see, e.g. *Fjällkon*, 1996(4), p. 18; 2004(3), p. 12; 2005(3), p. 5).

High levels of kappa-casein B and high fat levels have also been reported in other rare breeds, such as the Alpine Brown (Grasseni, 2005, 2007) and Finncattle (Ovaska & Soini, 2017). It is worth noting that there are several examples internationally of rare breeds being premiered for quality meat (see, e.g., Mitterer-Daltoé, Ramos, Martins, Martins, & Queiroz, 2012), but within the breed associations for SMC the issue of meat quality has generated very limited interest in comparison with milk quality.

An explicit goal to breed for kappa-casein B is included in the breeding plan of Svensk Fjällrasavel but only since 2015. In effect, this means that the overarching goal of preserving purebred SMC as a dairy cow is complemented with developing the breed as a dairy cow specifically for artisanal cheese production. The argument used to support this change is that the total population of Dairy SMC has stabilized and that it is no longer the most acute issue to consider (*Fjällkon*, 2016(1), p. 16). The new breeding system means that, starting from 2016, the bulls used must be proven to carry genes for high protein levels in their daughters' milk, in order to achieve higher levels of kappa-casein B and other caseins important for strengthening the Dairy SMC's competitiveness as a dairy cow (Svensk fjällrasavel, 2016).

## Conclusions

In this paper we have regarded the Dairy, Household, Conservation, and Bohus SMC as "publicly performed visions of desirable futures," the phrase Jasanoff (2015a, p. 4) uses in her definition of sociotechnical imaginaries (previously quoted in the Conceptual framework section). Further, we consider them to be "animated by shared understandings of forms of social life and social order" and "attainable through, and supported of, advances in science and technology" (Jasanoff, 2015a). This is demonstrated in our account of how the four different SMC designs have come into being and how their breeding strategies and subsequent breeding plans have become institutionally stabilized and (re)negotiated over the past three decades.

We conclude that understanding breeds and breed varieties as the material outcomes of sociotechnical imaginaries interwoven by social, material, and normative beliefs among their creators helps unpack complex and nuanced breed histories. Further, understanding breeding strategies and breeding plans as purposefully designing cattle helps unpack how breeds are socially constructed. Designing cattle thus constitutes a social practice in which there is interplay between aspirations for a specific social order, material outcome in terms of animal bodies designed for, for example, preservation or production, and normative judgments on, for example, phenotypic traits and authenticity.

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## Conflicts of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; membership, employment, consultancies, stock ownership, or patent-licensing arrangements) in the subject matter or materials discussed in this manuscript.

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