Milking Welfare:
Agricultural Technology and Subject Formation on the Industrial Dairy Farm
by
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Abstract:

Agricultural intensification and animal welfare are being pursued simultaneously in the dairy industry through a range of technologies, including sensors, machine learning, robotics, biotechnology, and more. Through this process, the subjective experiences of cows (e.g., pain, pleasure, comfort, fear, stress) become included in the commodification of dairy products in the market. I aim to understand how the use of these technologies in relation to the subjective experiences of cows shapes industrial modes of production. I examine scholarship, government publications, and journalism regarding welfare and technology in the dairy industry to identify how production is being structured by welfare technology, and how this is impacting relationships of power between cows and humans. I draw a theoretical foundation from Giorgio Agamben's philosophy of biopolitics to conceptualize cows as political subjects in relation to humans through the conferring of rights to welfare and the demanding of duties of productivity. I argue that, rather than limiting or reducing violence on the farm, the operationalization of these technologies changes the experience of industrial modes of production by cows and consumers, and reorients the conditions for the exploitation and disciplining of cows to perpetuate these practices in the industry.

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I. Introduction:

The American dairy industry is rapidly consolidating and intensifying. The number of small dairy farms fell from almost 150,000 in 1987 to under 50,000 in 2017; the median herd size in 1987 was 80 cows, while in 2017 it was 1,300. (MacDonald, 2020) These industrial changes have been accelerated by volatile milk prices attributed to shifting political economic conditions causing the fluctuation of global consumption of dairy products (Charles, 2016) as well as shifts in feed costs. (Donnay, 2021) Large-scale farms can weather these changes, but smaller-scale farms have greater difficulty surviving them. (The Counter, 2021; Kirwan, 2020) Furthermore, the amount of milk being produced from each cow has increased, with there currently being half as many cows as in the 1950s but twice the amount of milk production. (Bowden, 2017) This industrialization of agriculture has coincided with negative animal welfare impacts which have been documented by a range of advocacy organizations, scholars, journalists, artists, and more. (Jacobs, 2020) The dairy industry's accelerating process of intensification and consolidation would thus suggest a further decline of animal welfare in order to maximize profits in an industrial context.

However, dairy products increasingly feature labels indicating they are produced in conditions of high quality animal welfare, (Crawford, 2021) and various certification schemes have been developed to ensure animal welfare, as demand for it has increased among consumers. (Organic Themes Dev, 2021; van Eerdenburg et al, 2021; Krueger et al, 2020) This purported "win-win" scenario between animal welfare and economic growth has been facilitated by the implementation of agricultural technologies which are

thought to enhance welfare, such as breeding techniques, genetic modification, robotics, computation, and sensors. (Twine, 2015)

The persistence of the industrialization of dairy production within this context of increasing welfare suggests that technology is facilitating the transformation of the ways cows are coerced into performing labor and behave within the norms set by the industry. These techniques of disciplining cows to behave in particular ways also likely change to ensure the performance of high welfare based on scientific metrics along with maintaining high productivity. The subjective experiences of dairy cows (their experiences of pleasure, pain, comfort, stress, and other affects and emotions), along with how their subjective experiences are interpreted by human actors and represented in the marketplace and industry, thus becomes instrumental in the production and consumption of dairy commodities. In this way, the subjective experience of cows is political both in its role in facilitating flows of capital and in structuring human behavior as producers, consumers, regulators, scientists, activists, engineers, and more.

My research question in this paper is: *how is welfare technology* (technologies implemented to enhance animal welfare) *shaping the disciplining and exploitation of cows on dairy farms?* This question is crucial to understanding how the operationalization of welfare frameworks in industry shapes the sociopolitical landscape of agricultural production. This can contribute to evaluating the quality of these welfare frameworks in improving the quality of life of cows, as well as enhancing an understanding of how these technologies facilitate the establishment of norms and logics which may perpetuate the exploitation of and violence against cows in the dairy industry.

To answer this question, I analyze agricultural technologies implemented in the dairy industry to understand how they shape both the routines of production on the farm and cows' experiences on the farm. I center my investigation and analysis in academic scholarship (particularly in the fields of veterinary science, dairy science, animal science, and animal studies), government and industry publications, and journalism to observe not only how these systems are shaping cows' experiences, but also how they are being represented in industry, regulatory bodies, advocacy organizations, press, and academia. I argue that, as opposed to eliminating the presence of coercive discipline and violent exploitation on the industrial dairy farm, *the use of welfare technologies changes how these practices are experienced by cows and humans, and establishes new conditions for exploitation and discipline by facilitating the social construction of cows as subjects in human political community.*

This paper is structured in several parts. First, I begin this analysis with a review of the literature on the politics of welfare and subject formation, considering the topic in the fields of political economy, biopolitics, justice, science and technology studies, and phenomenology. I then consider how agricultural technologies facilitate the emergence of welfare as a performative category through the use of labels to represent subjective experiences of cows and the replacement of physically coercive cow handling techniques with nudging mechanisms. I continue by examining how welfare technologies establish new conditions for discipline and exploitation through the setting of biological and behavioral norms and conditioning cows' access to welfare on their productivity. Finally, I synthesize these politics of welfare technology to theorize the political subjectivity of dairy cows, drawing from Giorgio Agamben's philosophy of biopolitics, to conclude that

welfare technology functions to produce a new category of subject who experiences violence not due to social exclusion, but rather due to social inclusion.

II. Literature Review:

Various scholars have aimed to understand the relationship between public morality, economic productivity, and the formation of subjectivities. Political economic considerations of these topics regarding animal welfare have focused on the framework's role in the performance of agricultural commodities in a market context. Animals have been posited as both commodities and laborers, deployed as raw materials to be harvested while also engaging in labor in the form of metabolic activity and biological growth. (Wadiwel, 2018) Animals are theorized as being alienated from their labor through the frustration of their attempts to creatively appropriate their environments to meet their needs and desires. (Blattner et al, 2019) Animal welfare has thus been considered a 'public good' and associated with market failure requiring government intervention, based on consumers' willingness to pay. (Harvey and Hubbard, 2013) Other economic methods of facilitating increasing animal welfare include the representation of animal experience through labeling practices, educational programs, and certification schemes. (Tonsor and Wolf, 2019) Producers may choose not to improve animal welfare in order to invest in other facets of their operations with a higher potential return on investment, (Tonsor and Wolf, 2019) presenting the dilemma of the "trade-off" of welfare and productivity. (Harvey and Hubbard, 2013) It is thus both consumer behavior and the economic landscape of costs and returns which orient possibilities for and logics of animal welfare; the literature recognizes animal welfare as one factor among many in farms' pursuit of economic/institutional survival. The political economy camp centers the role of welfare in facilitating consumer and producer behavior, and suggests that technologized welfare might function to produce subjects that increase profits.

Biopolitical analyses of organizing welfare concerns the establishment of norms which function as mechanisms for social discipline and subject formation. Critical animal studies scholars have employed Michel Foucault's idea of biopower to conceptualize the ways in which farm animals are designed and disciplined to be docile and productive subjects. (Taylor, 2013) Scholars have particularly focused these considerations in the context of dairy farms, considering the ways that a range of technologies have shaped farmer-cow relations to produce these subjects. (Holloway, 2007; Calvert, 2018) Giorgio Agamben's biopolitical concept of bare life has been operationalized to analyze the affordance of animals with rights due to their role in systems of production on the farm and to challenge assumptions of human-animal difference. (Hudson, 2011) The biopolitical perspective of welfare thus centers its role in organizing hierarchies and regularizing relations of control and domination within modes of production. This perspective suggests that technologized welfare would serve to produce subjects that are docile and tolerant of human domination.

Justice frameworks of animal welfare consider the systemic domination of animals by humans as injustice, with animals being recognized as moral beings with moral entitlements. (Jones, 2015) This literature frames the farming of animals as a system of oppression which ought to be ameliorated or abolished. (Jones, 2015) Scholars in this field have argued against animal cruelty based on social justice principles of opposing arbitrary discrimination, supporting the marginalized, and respecting autonomy and individual rights. (Shooster, 2015) Initiatives are organized to approach animal welfare through a framework of decolonization, focusing on the ways that animal welfare movements intersect with other movements of social justice, including disability justice,

environmental justice, gender and sexuality justice, and racial justice. (Lenkins Jr. et al, 2022) Justice perspectives of animal welfare and subjectivity thus emphasize its relation to human systems of domination and oppression. The justice of welfare technology has been analyzed in humans, with major concerns including privacy, alienation, access, and dignity. (Hofmann, 2012) Translated to considerations of animal welfare technology, the camp might analyze the technologization of welfare for its capacity to marginalize and alienate animals by discursively distancing them from human systems of domination.

Science and technology studies (STS) scholars have analyzed animal welfare by conceptualizing how scientists produce knowledge of animal subjectivity. This scholarship emphasizes the role of social values in producing scientific metrics of animal welfare, with actors centering different criteria with which to understand welfare, including: 1) health and function, 2) affective states, and 3) natural behavior and environments. (Hemsworth et al, 2015; Fraser, 2007; Fraser, 2009) These varying criteria are noted to stem from conceptions of human welfare and are driven by conflicting values of naturalness and simplicity, versus values of progress and productivity. (Fraser, 2007) Scholars note that these competing framings of welfare are based in culturally specific philosophies of "the good life," which cannot be resolved with scientific inquiry. (Fraser, 2009) It is further identified that there are a range of approaches to assessing and addressing animal welfare which regularly change and evolve, although science is typically the vehicle for these approaches. (Mellor et al, 2009) Scholars have identified that animal welfare has become commodified as "value-added," or having increased in value due to specialized treatment, (University of Maryland Extension, n.d.) through various social and technical mechanisms which converge in a market economy; through

this process, animal welfare concerns may be obfuscated through labeling schemes which mislead consumers regarding welfare quality of animals on farms. (Buller and Roe, 2012) Thus, the STS literature on animal welfare emphasizes the role of social values in the scientific interpretation of animal subjectivity, as well as in how these frameworks are communicated in society and industry. In this perspective, technologized welfare becomes a social project as much as an economic one.

Finally, scholars have sought to understand how technologies and ecologies shape experience in the philosophical field of phenomenology, which takes experience as its object of analysis. In particular, Maurice Merleau-Ponty's concept of the 'body-schema' rejects notions of mind-body dualism to argue for the mutual influence of mind and body in experience; the body is asserted as structuring the way in which beings come to know and experience the world through particular perceptual possibilities. (Merleau-Ponty, 2010; Grosz, 1994) Following this emphasis on the body, two subfields of phenomenology are helpful in building perspective on the technologization of welfare: postphenomenology and ecophenomenology. The subfield of postphenomenology posits that the way subjects experience the world is mediated by technologies. (Ritter, 2021) The subfield of ecophenomenology points to how because objects are perceived only by their sensible aspects to a subject, they remain withdrawn, or resistant to being exhaustively known; in this way "nature" becomes not only a construction of ideology, but of embodied parameters of sensibility. (Toadvine, 2010; Wood, 2001) These two subfields of phenomenology call attention to how the experience and subjectivity of beings is structured by their bodies, tools, and environments. This has been reflected in the phenomenological literature on animal welfare, which centers qualitative approaches

to understanding animal health and wellbeing. (Veit and Browning, 2021; Shapiro 2003) This literature suggests that technologized welfare shapes not just the subjects (both cows and humans) behavior, but their general subjectivity, including their co-constructive species identities of bovinity and humanity.

These five literatures of political economy, biopolitics, justice, science and technology studies, and phenomenology take distinct approaches in understanding the role of technologized welfare in shaping cow subjectivity and modes of production, emphasizing themes of economic value, social control, ideology, materiality, and experience in varying degrees. I build from this constellation of disciplines to examine how welfare technology in the dairy industry shapes the performance of ethical production and consumption, and the disciplining and exploiting of cows. By bringing these fields in conversation with one another, I argue that the implementation of welfare technologies change how industrial modes of production are experienced by cows and humans, and establish new conditions for exploitation and discipline through the establishment of cows as subjects in human political community.

III. Welfare as Ideology, Welfare as Capital, Welfare as Performance

The phenomenon of animal welfare is established through material networks of production and communication between producers, consumers, and regulators, and is oriented around perceptions of cow experience. In this section, I demonstrate how technologies facilitate and structure producers' and consumers' expression of their economic priorities and moral values. However, before analyzing these technologies, the terms with which consumers and producers each experience and cognize welfare must be examined to contextualize these devices in particular ideologies of utility and morality. I first observe the history of welfare within civil society, before turning to analyze how this has shaped contemporary philosophies and frameworks of welfare in industry. I then analyze how welfare is communicated between consumers and producers before turning to examine the role of technology in this performance.

A. Welfare from the Perspective of Consumers

In American civil society, animal welfare was initially situated within religious customs and norms before being adopted into formal policy, with animal welfare being historicized as part of Protestant moral culture in the 1600s. (Davis, n.d.) In the 1800s cruelty in the treatment of animals came to be seen as a reflection of human moral character, with the gentle treatment of animals becoming constructed as a marker of a more advanced civilization by animal protectionists; these activists were mostly affluent, white Protestants, although Black ministers, educators, and activists were involved with the American Humane Education Society, connecting issues of animal welfare with exploitative agricultural systems like sharecropping. (Davis, n.d.) It was in this time

period that Societies for the Prevention of Cruelty to Animals (SPCAs) emerged. (Davis, n.d.)

This advocacy facilitated the enactment of policymaking to address animal cruelty in the twentieth and twenty-first centuries. After World War II, the emergence of industrialized agriculture and factory farms caused public concern over the physical and mental well being of animals, causing the British Government to establish a committee to investigate and address this cruel treatment. (Duncan, 2019) The committee established five freedoms that animals were entitled to which were used as the basis for animal care protocols: 1) Freedom from Hunger and Thirst, 2) Freedom from Discomfort, 3) Freedom from Pain, Injury, or Disease, 4) Freedom to Express Normal Behavior, and 5) Freedom from Fear and Distress. (Elischer, 2019)

In the United States, popular publications regarding the cruel treatment of dogs in laboratories and pet dealerships drove the adoption of the Animal Welfare Act of 1966. (Adams and Larson, n.d.) In the late 1900s, activism against cruelty towards animals branched into distinct movements which implied distinct policy approaches: 1) animal welfare, which focused on the prevention of suffering, and 2) animal rights, which aimed to establish animals as moral agents deserving of rights. (Davis, n.d.) In the twenty-first century, the framework of legal personhood has been mobilized to assert the rights of animals with particular cognitive abilities. (Davis, n.d.) Standards, policies, and training programs have also driven the adoption of handling practices aimed at improving animal welfare. (Huertas et al, 2014)

Along with civil society activism and government regulation, consumer behavior is also a major driver of animal welfare practices. Consumers demonstrate high levels of

attention, concern, and willingness to change behavior in favor of quality animal welfare practices in the production of animal agriculture products. (Meadow and O'Bryan, 2019; ASPCA and Lake Research Partners, 2020; Mitchell, n.d.; Alonso et al, 2020; Animal Welfare Institute, n.d.; Olynk, 2012) This consumer behavior in alignment with ideologies of animal welfare is attributed to the availability of scientific information, perceptions of the health value of differently produced foodstuffs, affective responses to and experience with animals, and subscription to particular moral logics. (Matthews and Hemsworth, 2012; de Graaf et al, 2016) However, consumers' capacity to act on these subjective positions oriented around animal welfare is dependent on certification schemes and product labeling that discloses information about the production process. (Mitchell, n.d.) Although there is significant ambiguity in both the term animal welfare and in the meaning of various labels which provide information to consumers, these frameworks have effectively structured consumer behavior and caused changes in the behavior of producers. (Alonso et al, 2020; Mitchell, n.d.) Changes in consumer behavior regarding welfare triggers a range of economic calculations as producers make decisions regarding how to change the marketing of their products and/or behavior to minimize production costs and maximize profit, a response which is structured by existing national legislation and international trading partners. (Olynk, 2012; Mitchell, n.d.)

This analysis of the history of animal welfare advocacy, regulation, and consumer behavior demonstrates that the framework is entrenched in considerations of morality and health, which is a significant difference in the motivations of animal agriculture producers. I now turn to examine this distinction in the perspective of producers.

B. Welfare from the Perspective of Producers

To address animal welfare concerns of advocacy groups, consumers, and regulators, the animal agriculture industry has established frameworks to orient their action to perform welfare. These concepts often have simultaneous purposes of not only performing highly on criteria for animal welfare, but also of maximizing productivity.

In the dairy industry, "cow comfort" is a central framework employed to consider the subjective experience of cows and is connected to both conceptions about their welfare and their industrial performance. While cow comfort is supported for moral reasons, it is also centrally an economic project, demonstrated by the industry phrase: "A comfortable cow is a cash cow." (Endres, 2020) Figure 1 demonstrates how cow comfort is framed as a productive category ("free milk in the tank") by Cainthus, an agricultural technology company:

Figure 1:

(Cainthus, n.d.; Cainthus, 2021)

Cow comfort is economically driven, not morally driven, as a means of increasing milk production and quality, reproductive efficiency, and cow health. (Endres, 2020) Ensuring cow comfort typically entails regulating the time cows spend in various activities,

including eating, resting, standing, and more, with norms being established through "time budgets," which chart the normative time cows spend doing each activity. (Raver, 2020) Farmers take both environmental and behavioral factors into account when attending to cow comfort.

The centrality of economic drivers, as opposed to moral drivers, for cow comfort can be seen in the design of cows' environments. Criteria included in environmental aspects of cow comfort include a clean resting space, shelter from weather, heat and ventilation, lighting, optimum stocking density and flow, and access to food and water. (Endres, 2020) Various indices have been used to determine cow comfort based on their behavior in their environment, including the Cow Comfort Index (CCI), Stall Use Index (SUI), and Stall Standing Index (SSI). (Krawczel and Grant, 2019) CCI measures the proportion of cows lying versus standing; SSI is the inverse, measuring the proportion of cows standing versus lying; and SUI is the proportion of cows lying which are not feeding. Proportions of standing and lying cows, which can be linked to overcrowding, imply risks for health afflictions like lameness. (Bowman, 2019) Stall availability and maintenance has been shown to be associated with cow resting time and milk production, with cows which rested more, in higher quality environments, producing more milk. (Krawczel and Grant, 2019) Severe overstocking of barns can also inhibit routines of feeding, resting, and rumination and thus produce negative productive and health outcomes. (Krawczel and Grant, 2019) Cows deprived of resting time were also found to have increased concentrations of cortisol, which is associated with suppressed immune function. (Krawczel and Grant, 2019) Milk quality has been shown to decline with overcrowding, with milk fat content decreasing and somatic cell count (SCC) increasing.

(Krawczel and Grant, 2019) Furthermore, the materials used to build the environment can negatively impact cow comfort, with concrete being associated with high hoof strain, increased hoof infection, and consequently increased likelihoods of lameness. (Krawczel and Grant, 2019) Flooring traction is also a significant criteria of cow comfort to prevent cows from slipping and sustaining injuries. (Keown and Kononoff, 2007)

Regulation of cows' experience of temperature also exemplifies the simultaneity of welfare and economic concerns by producers. Ensuring sufficient laying time for cows is particularly critical in the summer when cows combat heat stress by standing. (Raver, 2020) Heat stress, a condition which occurs when a cow produces more heat than it can dissipate, can cause decreased feed intake, milk production, milk quality, and reproductive performance, (Liu et al, 2019) as well as increased lameness, vulnerability to disease, and impaired immune function. (Armstrong, 2020) It is typically identified with the temperature and humidity index (THI), (Liue et al, 2019) as well as by measuring respiration rates, body temperature, and milk production, and by observing cows' behavior. (Armstrong, 2020) This condition can particularly affect high-producing cows, as they typically eat more and produce more heat. (Armstrong, 2020) To prevent heat stress in cows, farmers take actions like ensuring sufficient water supply (which also includes testing for water supply safety) and including environmental features such as permanent or portable shade systems and fans, while also minimizing humidity. (Garcia, 2020) The mix and quality of feed is also modified to help regulate cows' temperatures. (Garcia, 2020) Low-pressure sprinkler systems and high-pressure sprinklers are also common environmental features which are used to address this aspect of cow comfort. (Armstrong, 2020) These examples demonstrate that unlike consumers, for whom animal

welfare is primarily a moral category, producers approach animal welfare as an economic issue.

Along with providing a comfortable environment, the behavior of producers is also influenced by logics of cow comfort, with the harsh handling of cows being associated with reduced milk yield and negative cow health outcomes. (Armstrong, 2020) This is partially attributed to high stress levels that cows experience when encountering harsh handling, which in turn can cause decreased growth and increased disease susceptibility; high levels of fear of humans in dairy cow herds, which are connected to handling practices, as well as cows which have experienced harsh treatment such as kicking or slapping, have also been correlated with lower milk productivity. (de Passille and Rushen, 1999) Gentle handling has also been associated with lower cortisol levels in cows and higher yields. (de Passille and Rushen, 1999) Farmers and handlers aim to control cow stress and comfort through handling behaviors such as cognizance of cows' flight zone and point of balance, handling calves closely after birth to acclimate them to proximity to humans, minimizing stress inducing aspects of transportation such as sharp or dangling objects and dark spaces, and assisting calves as they gain control of movement. (Clark et al, 2015)

These examples of farmer environmental planning and behavior regulation demonstrate how cow comfort and welfare is driven by goals of milk yield maximization, milk quality improvement, and cow health and longevity. Welfare is thus an economic category to farmers and handlers, oriented by metrics of productivity. This is distinct from the conception of welfare to civil society and consumers, where welfare is a moral category. This difference in motivations is bridged through product marketing, which

functions to satisfy consumers' moral sensibilities and producers' economic agendas. Thus, a focus on the assessment and communication of animal welfare in the dairy industry is necessary to understand how the biological conditions of cows and the industrial practices of farms are translated to meet consumers' moral tastes.

C. Communicating Welfare Across Producers and Consumers

In the dairy industry, there are a range of ways in which cattle welfare is assessed and communicated to consumers. In Europe, the most extensively used assessment protocol used to measure animal welfare is Welfare Quality® (WQ), (van Eerdenburg et al, 2021) which is based on the criteria of 1) good feeding, 2) good housing, 3) good health, and 4) appropriate behavior. (Botreau et al, 2009) This protocol is voluntary, and offers certification for farms that comply with WQ standards. (Krueger et al, 2020) This protocol has been critiqued for being time consuming, as it requires observations and measurements for each cow in the herd. (Collins et al, 2021) For this reason, efficiency and time effectiveness are features of animal welfare assessment that are problematized on the farm. (Collins et al, 2021)

In the United States, the National Dairy Farmers Assuring Responsible Management (FARM) Program is used and, although it is voluntary, most dairy processing plants require supplying farms to comply with FARM standards; currently, 98% of the U.S. domestic milk supply comes from FARM participating farms. (Krueger et al, 2020) Program-participating farms are subject to various evaluations, although these are built on a model of continuous improvement. (Krueger et al, 2020) If certification is lost, processors and co-ops are prohibited from procuring milk from the

farm. (Krueger et al, 2020) While the European WQ is more strict, it is voluntary, and while the American FARM is more lenient, it is ubiquitous, demonstrating tradeoffs in standardizing animal welfare standards in the industry.

While these certification schemes are used in the industry to maintain welfare accountability, they are not necessarily advertised to consumers; instead, labels are a key mechanism for communicating the welfare of dairy cows in the marketplace. While a wide range of labels are used, some are noted as being misleading to consumers, often branding the product in ambiguous terms that suggest animal welfare, but which do not require meeting rigorous standards or being subject to scrutiny by third-party auditors. (Animal Welfare Institute, n.d.) This has been identified as the tactic of "humane-washing," where corporations attempt to falsely brand their products as coming from farms which ensure high quality animal welfare. (Scott-Reid, 2021) This skepticism in the meaning and accuracy of labels makes establishing trust in labels key in attempting to influence consumer behavior. (Spain et al, 2018) Although trust in animal welfare certification labels is complex, labels are shown to significantly impact consumers' choices of products in the marketplace as well as the price they are willing to pay for animal products. (Kühl, 2017; Janssen et al, 2016; Spain et al, 2018)

In this landscape of assessment and communication, welfare can be seen as performative in that both material networks and discursive themes are engaged to elicit responses from particular audiences. Specifically, these audiences are industry welfare appraisers, appealed to through certification schemes, and consumers, appealed to through labeling schemes. In performing welfare for these audiences, regulators are able to fulfill their commitment to standardization, consumers are able to satisfy their appetite

for ethical commodities, and producers are able to increase the profitability of their product. As opposed to an objective metric representing cows' subjective wellbeing, welfare is thus a fluid category that is contingent upon fluctuating social and economic conditions. The use of agricultural technologies is one such socioeconomic fluctuation that is presenting a paradigm shift in this performance of welfare. In order to satisfy the aims of these different groups, technology has become a way of simultaneously maximizing production while performing welfare by improving cows' health and increasing perceptions of cows' comfort and autonomy. I now turn to examine the ways specific technologies function to meet these ends.

D. Performing Welfare and Decreasing Costs with Technology

1. Improving Health and Reducing Stress

One category of technologies used to pursue animal welfare through improving cow health while decreasing costs in the dairy industry is sensors, which are frequently used to identify health afflictions. Accelerometers, pedometers, pressure plates, cameras, and a range of other technologies are used to detect lameness in cattle, which is argued to prevent severe cases, speed up recovery time, increase productivity, and improve welfare. (Silva et al, 2021) The data collected by these sensors are processed by mathematical algorithms to produce diagnoses of the cows' health status. (Silva et al, 2021) Sensors detecting SCC, electrical conductivity, lactate dehydrogenase, and temperature are used for the early detection of mastitis, which is argued to improve welfare by decreasing recovery time, reducing pain and discomfort for cows, increasing farm productivity, and reducing the use of antibiotics. (Silva et al, 2021) Body condition scoring (BCS), a key

indicator for welfare and herd health representing cows' fat tissue and muscle mass, is also being automated through technologies like thermal, 2D, and 3D imaging; used in concert with Radio Frequency Identification (RFID), farmers are able to continuously monitor cows' BCS and use this information to manage herd health. (Silva et al, 2021) Sensing technologies have also been used to identify ketosis and metritis in cows, which is associated with improved health outcomes and increased productivity. (Stone and Bewley, n.d.)

Along with determining the welfare of dairy cows based on their biology and health, technologies are also used to determine cow welfare based on their behavior within their environment. Cameras and sensors which track location and sound can be used to determine feed availability and identify levels of competition for food between cows. (Stygar et al, 2021, der Kooij and Rutter, 2020) Sensors have also been used to observe how cows physically interact with the space of the farm, including identifying collisions with farm equipment and time spent laying, ruminating, feeding, and more. (Stygar et al, 2021) The observation of cow behavior has also been automated, including play, suckling of calves, social competition, ear postures, avoidance distance, and more, although many of these have been in experimental, not commercial, contexts. (Stygar et al, 2021) Facial recognition technologies, molecular techniques which identify levels of cortisol and serotonin, neurophysiological techniques such as electroencephalography (EEG) and magnetoencephalography (MEG), and technologies which analyze cow vocalizations have also been used to assess stress and pain levels in cows. (Barrell, 2019; der Kooij and Rutter, 2020)

These technological approaches to monitoring and maintaining animal welfare through their biology and behavior have specifically been applied to the frameworks of the WQ assessment protocol, connecting it to existing schemes of welfare standardization. (Silva et al, 2021; Stygar et al, 2021; Maroto Molina et al, 2020) These technologies are especially utilized in the context of large-scale, highly intensified dairy farms, where the automation of the monitoring of the health of large herds significantly reduces labor costs. For example, the automated detection of estrus in cows can eliminate the need for human observers while increasing detection rates, reducing human labor time and improving performance. (Steeneeld and Hogeveen, 2015) This facilitates the intensification of dairy farms by providing the infrastructure necessary to maintain large herds with high surveillance of cows' biologies and behaviors at minimal labor cost. Moreover, these agricultural technologies have been more commonly adopted by larger farms rather than smaller farms, due to their higher capacity to purchase expensive technologies and a more robust infrastructure with which to operate them; furthermore, these technologies have been designed with larger farms in mind, as technology developers identify a larger potential for profit in larger farms than in smaller farms. (Simitzis et al, 2021) These agricultural technologies thus function to increase welfare performance within a particular national certification landscape and market context while simultaneously intensifying the modes of production.

Other technologies which are argued to improve animal welfare while reducing production costs include automatic feed pushers and automatic barn cleaners (both shown in Figure 2). Automatic feed pushers are devices which move feed closer to where cows can access it, stimulating eating and minimizing food waste. (Boumatic, n.d.) The

technology is associated with decreased labor costs as well as ensuring that cows lower in herd hierarchies have sufficient access to feed. (Barrett and Dahl, 2014) A higher number of feed push-ups per day has been associated with higher milk yields. (Siewer et al, 2018)

Figure 2: 

(Carson, 2018; GEA, 2019)

Machines which automatically clean barn floors by scraping away manure are associated with decreased labor cost as well as increased cow health. (Stasewitsch, 2019) The machines have been associated with decreased susceptibility to hoof disease, (Doerfler et al, 2017 January) clinical mastitis, (Doerfler et al, 2017 June) and lameness. (Cunningham, 2019) Researchers have also asserted that the machines do not present animal welfare risks to the cows, as they are able to adjust their behavior to the performance of the robot. (Doerfler et al, 2016) These technologies of feed pushers and robot scrapers demonstrate how a range of robots are being operationalized in dairy farms to improve animal welfare performance as represented by rates of health afflictions, levels of stress reduction, and capacities for herd conflict management, while also decreasing labor costs and increasing yields.

Health improvement and stress reduction in cows is also pursued through technology by altering cows' perceptions of their environment. One of these technologies is virtual fencing, which is specifically used in pasture systems. GPS-connected collars are strapped onto the necks of cows which track their location on the pasture, emitting a sound if they are approaching the pasture boundary and discharging an electrical shock if they reach the boundary. (Lee and Campbell, 2021) Milk yield, cow behavior (e.g. rumination time, time laying or standing, activity level), or cortisol levels (a molecular marker of stress) was not observed to vary between cows with virtual fencing technology or the use of a built electrical fence. (Verdon et al, 2021) However, productivity is noted to increase through the improved utilization of feed and a reduction of overgrazing. (CSIRO, n.d.) Another example of an emergent technology being used to influence cows' experiences of space is virtual reality (VR) headsets which simulate the experience of a pasture for cows in indoor facilities. While the technology has not been implemented on an industrial scale, it is being experimented with on farms as a method of reducing stress in cows in order to increase milk yield. (BBC News, 2019) In both the cases of electric fencing and VR goggles, cows' perceptions of their environment are being manipulated to improve productivity and improve metrics of health and stress. While these examples demonstrate how agricultural technologies are being used to improve performance of welfare metrics based on cow health, they are also used to increase favorable perceptions of cow handling.

2. Increasing Perceptions of Autonomy and Humane Handling

Technologies are also being implemented to increase perceptions of cow autonomy and decrease perceptions of coercion. The Automatic Milking System (AMS), robotic chambers that automatically suction cows' udders to milk them without a human operator, (Andrews et al, 2016) is argued to improve welfare by increasing cow autonomy. These machines were designed to specifically interface with the body of dairy cows through various trials of suction mechanisms, (Nimmo, 2019) and are now being implemented on an industrial scale. The use of these machines is associated with higher yield of milk due to higher frequency of milking (Wagner-Storch and Palmer, 2003) and consistency of milking technique. (Durst, 2012) Furthermore, these technologies have been shown to cause similar, if not decreased, levels of pre-milking stress for cows after getting acclimated to the technology. (Hopster et al, 2002)

Cow autonomy is asserted to be improved due to the routine of cows entering the machines voluntarily at times that they initiate, rather than being forcibly brought into a parlor by a human handler; this mode of production is discursively constructed as being more natural and healthier for cows, as well as being more cost efficient for producers of large farms by reducing labor costs. (Heyden, 2015; Bear and Holloway, 2019; Driessen and Heutinck, 2014; Calvert, 2018; Millar, 2000) This increased autonomy has also facilitated perceptions of cows as being calmer and happier by farmers. (Holloway et al, 2014) The reduction and elimination of force and enhancement of cows' freedom is identified by farmers as a positive aspect of the system which improves the cows' welfare. (Holloway et al, 2014) Along with AMS, automatic brushes are associated with improved welfare through the reduction of stress and provision of pleasure by brushing cows when approached by cows. (Theodore, 2018; Vigors, 2019) The perception of cows

choosing when to approach the machines and receive brushing further perpetuates an interpretation of the technology as increasing the cows' autonomy. This technology is also used to prevent hierarchical conflicts with members of the herd by presenting a distraction from conflicts near AMS robots. (Osowski, 2009)

However, while these technologies are purported to increase cow autonomy and choice, producers employ tactics of environmental planning and technological design to nudge cow behavior. Farmers using the technology have strategically constructed barn layouts so that food and water is only accessible once cows have gone through the AMS. (Holloway, 2007) Furthermore, once the cows enter the robotic milking booth, they are unable to exit the way they entered as the entrance gate locks behind them, making their only movement option forward, continuing the flow of movement through the machine. (Holloway, 2007) The architecture of the barn becomes organized around the facilitation of the technology to increase productivity. Through this environmental planning around technology, cows' behavior is managed without the need for physical coercion by farmers, ensuring high productivity while simultaneously performing high quality welfare for certification and labeling schemes.

E. Discussion

Technologies are thus of central importance in the positioning of cows within the arena of human public life. This analysis demonstrates the role of technologies in synchronizing the priorities of regulators, consumers, and producers through the performance of welfare while simultaneously maximizing production and decreasing labor costs. This performance typically focuses on the improvement of health metrics,

reduction of stress metrics, and the increasing of perceived autonomy and quality handling of cows, even when producers use techniques of environmental planning and perceptual manipulation to nudge and steer cow behavior. With this conceptualization of agricultural technology's role of performing welfare, enhancing producer control of the farm, maximizing productivity, and mediating pluralistic discourse regarding agricultural production, the consequences of these technologies for the exploitation and management of cow life and death can be analyzed.

IV. Establishing New Conditions of Discipline and Exploitation

Unlike physical violence used to coerce cows to behave in ways which are aligned with modes of industrial dairy production, agricultural technologies operationalized to improve both productivity and perform welfare organize new logics for the killing of cows and for the production of cows with particular physical and behavioral traits. This establishes a mode of production where yield can be maximized while simultaneously meeting standards of welfare by focusing on the quality of life of cows physically in the space of the farms, and excluding from welfare considerations the conditions of cows' deaths. This facilitates the maximization of profit by rendering cows killable when they begin to decline in productivity and/or are less compatible with technologized modes of industrial production.

A. Killability

The decision of when to cull a cow, or when to transport a cow to be slaughtered for beef, is complex and multifaceted, although productivity is the central determinant. There are two major categories culled cows fall into: 1) voluntary culling, also known as economic culling, or culling based on low production not attributed to a disease or due to an excess of cows on the farm, and 2) involuntary culling, also known as biological culling, or culling based on some circumstance (e.g. disease, injury, etc.) that could have been prevented; voluntary cullings are seen as being to the economic benefit of the farm and involuntary cullings are seen as being to the economic detriment of the farm. (Fetrow, 1988; Lunak, 2020) Voluntary culling is typically based on factors of the market prices of milk and beef, cow reproductive status and productivity levels, feed cost, cow

replacement costs, and housing capacity. (Edwards-Callaway et al, 2019) In this category, cow value has been framed as a function of their milk production multiplied by the price of milk, then subtracted by the annual cost of feed. (King and Amaral-Phillips, n.d.) Involuntary cullings are typically based on the identification of health afflictions, such as eye cancer, displaced abomasum, lameness, and more. (Edwards-Callaway et al, 2019) The decision of whether to cull or euthanise a cow can vary significantly based on the different health afflictions present, and may be considered differently by particular farmers and veterinarians. (Wagner et al, 2020) Thus, decisions about the killing of dairy cows are based on a range of factors based primarily on productivity and health.

Technologies used to monitor these facets of cows biology and behavior are primarily sensors. Precision dairy farming technologies have been used to track rumination time, activity level, laying time, and milk yields to detect and diagnose the biological conditions of cows. (Stone and Bewley, n.d.) Networks of various interconnecting technologies are being used to monitor and classify the health of cows, including sensors collecting data including temperature and heart rate, electrical nodes, and miniature computer devices. (Faruq, 2019) Technologies used to surveill cows also include RFID and cameras to monitor cows' activity and their behavior within defined spatial boundaries. (Zin, 2018) The category of precision livestock farming (PLF) includes the use of a range of technologies which measure biological and behavioral characteristics of dairy cows. This can include 1) pressure plates/load cells which measure how cows' weights are distributed as they walk, 2) video cameras to analyze cows' posture as they walk, 3) sensors like accelerometers, rumination audio sensors, and magnetometers which analyze cows' movement patterns, 4) SCC which is included in

AMS technology, 5) sensors which measure electrical connectivity and enzymatic concentrations of lactate dehydrogenase by measuring the concentration of ions in milk, and 6) infrared thermography which measures udder temperature non-invasively. (Silva, 2021) PLF thus makes cows' bodies increasingly surveillable not through direct human-cow interaction, but through the translation of cows' bodies into quantitative data that are interpreted by humans to cognize their biological condition and economic value.

The quantification of cow biology and behavior produced through these technologies is used to construct datasets which are used for machine learning to identify patterns in the herd in general and in the behavior of individual cows in particular. Dairy cows continuously produce data that are used to optimize modes of production on the farm and shape breeding decisions. (Calvert, 2018) Big Data has been found to be increasingly relevant as farmers use precision agriculture technologies, as well as lower costing alternatives, (Celozzi et al, 2020) with a prevalence of research around Big Data-V and data analytics emerging. (Lokhorst et al, 2019) Furthermore, these large datasets have been used to construct decision support systems (DSS), which continuously collect data from on-farm and off-farm sources to provide analytical insights for farmers. (Baldin et al, 2021) Health classification systems are used to report whether the cows' health data is "normal" or "abnormal." (Faruq, 2019) The use of these systems includes training the intelligence systems on data collected by veterinarians and a decision tree which is used to classify data based on rules which result in the automatic production of a diagnosis and treatment. (Faruq, 2019) Automatic diagnostic systems have also been used to automatically detect cows' health conditions. (Alsaaod, 2019; King and DeVries, 2018) Machine learning has been used in concert with sensing technologies to identify

heat stress in cattle. (Islam et al, 2021) Thus, the biology and behavior of cows are not only made increasingly visible to humans through sensing technologies, but also through the automated interpretation of this quantitative information by technologies to monitor and diagnose health conditions.

Through their mediation of farmers' and veterinarians' conceptions of herd health and productivity, agricultural technologies are shaping when cows become killable. With the implementation of AMS, emergency cullings have been found to decrease, while cullings due to low production, udder problems, lameness, infertility, and mastitis were found to increase, with general cow longevity being reduced. (Bugueiro et al, 2019; Tse et al, 2017) Thus, with the use of these technologies, cows are being culled earlier and living shorter lives. This is associated with the technology's vigilant surveillance that makes less productive cows more easily identifiable than in conventional systems, as well as the increased time available for farmers and handlers to personally surveil the herd. (Bugueiro et al, 2019) Furthermore, automated decision making tools are being examined to determine the most economical moments to cull cows, (Lopez-Suarez et al, 2018) which could even further decrease cows' longevity due to the basing of culling decisions on statistical projections and predictions of cows' productivity. Some of these programs even include into the datasets data of economic context. (Tronstad and Gum, 1993) Some farmers report observing little or no difference in culling rates, and differences across farms have been attributed to the particular genetic pool of each herd, with some herds being more susceptible to particular risks and afflictions. (Schulte and Tranel, 2011; Tse et al, 2017) This analysis demonstrates that the use of agricultural technologies,

especially AMS, is making cows more vulnerable to culling due to increasingly vigilant surveillance of their productivity and calculation of their economic value using that data.

In the context of welfare, the organization of death in this manner suggests that the implied subject of welfare is the productive cow, the cow that can be exploited by farmers, not the unproductive cow, which is vulnerable to being killed. Through these technologies, "cows" are essentialized as highly productive producers of milk, so that their killings due to low productivity are not seen as violations of their welfare, but an essential part of their nature. Their welfare is conditioned upon their productivity, which is surveilled and ensured through these technologies, so cows can be seen as cullable when they are more productive as beef than as a producer of milk. This construction of the cow deserving of welfare being the productive cow can be seen in the lack of standardization schemes enforcing rules around the welfare of cows that are removed from herds and are transported for culling. (Edwards-Callaway et al, 2019) These cows are frequently identified as experiencing intense violence, including being deprived of food and water, being forced into overcrowded spaces, being subject to violent handling tactics, and experiencing various health afflictions. (Edwards-Callaway et al, 2019; Cockram, 2021; Animal Welfare Institute, n.d.) Welfare technologies are thus not eliminating the exploitation and violence in the dairy industry by monitoring the biological condition of cows for changes in health, but rather relocating it by regularizing the disposability of cows through the increased surveillance of their productivity. Along with this automation of cow death through increased surveillance and assessment for productivity and health, technologies produce herd outliers which become vulnerable to culling.

B. Normalization

Through agricultural technologies, norms of cow bodies and behaviors are established which cows are measured to and evaluated with. This is primarily achieved through the use of biotechnology to produce cows which are compatible with industrial modes of production. Compatibility with industry environments is often based on body types and temperaments which reproduce flows of production. In the dairy industry, these are often couched in terms of health, although breeding and genetic modification practices explicitly for productivity maximization is also occurring.

A range of biotechnologies are used to modify cows' genetic codes, including marker assisted selection (MAS), (Spelman and Garrick, 1997) genomic selection, genetic modification (GM), and somatic cell nuclear transfer (SCNT), (U.S. Food and Drug Administration, n.d.) also known as cloning. (Twine, 2015) These technologies are used to economically assess animals through the framework of estimated breed value (EBV) which signifies the value of a being based on the virtual productivity represented by their genetic code (e.g. milk yield, longevity) to be passed onto offspring. (Twine, 2015) These selection indices have historically been established by actors in governance, industry, and academic institutions. (Cole et al, 2021) These breeding processes are frequently conducted through artificial insemination, which includes the use of technologies to freeze and transport bull semen, making it possible to breed cows in different geographic locations. (Center for Veterinary Medicine, 2008) Eighty to ninety percent of pregnancies in dairy cows are facilitated through artificial insemination. (Zuidema et al, 2021)

Cows are being bred to meet a wide array of industry norms. One common trait that cows are bred for is “robustness,” or their ability to adapt to a wide range of environmental contexts. (Twine, 2015) Breeding for robustness in cows can include improving immunity, (Mallard et al, 2015) fertility, and ability to adjust to varying levels of food supply, (Roche et al, 2018) which each contribute to the productivity and profitability of the cow. Cows are also bred for behaviors and temperament including docility, which is connected to profitability through increased productivity, a reduction of the cost of labor, and increased safety for handlers. (Twine, 2015) The technique of sex selection through sexed semen allows for farmers to make choices about the genetic character of their herd. (Holden and Butler, 2018) A newer agenda for cow breeding exists in genetically designing cows which are more compatible with AMS infrastructures. (Chang et al, 2020) Some traits identified as enhancing cows capacity for productivity using AMS machines include amount of milk produced per minute, time between milkings, and the time it takes for the cow to be habituated to the machines. (Vosman et al, 2014) Other traits under consideration for AMS compatibility include udder conformation, the placement of the cow’s teats, and the cow’s temperament. (Ontario Ministry of Agriculture, Food, and Rural Affairs, 2016)

Furthermore, cows are being genetically modified to increase disease resistance, similarly to other breeding techniques. However, genetic modification technology is used to also include new traits into cows, such as being born without horns, eliminating the need for horn removal and reducing the cows ability to harm handlers. (Franz and Lim, 2016) Female cows have also been genetically modified to produce more beef through the inclusion of physical traits of males cows. (Prabhune, n.d.) Cows have been

genetically modified to specifically alter their milk, with applications being increasing shelf life, removing allergens, increasing the quantity of proteins, and changing the type of proteins in milk. (Whitelaw, 2016) Herds of GM cows have been engineered to produce milk designed to be a substitute for human breast milk, reportedly having 80% similarity to human breast milk. (Fan and Duncan, 2011) Cows in this herd are cloned, (Fan and Duncan, 2011) which is a practice that has become increasingly common in the industry. The practice of cloning is similarly driven by logics of productivity such as disease resistance, climate resilience, body type, fertility, and to accommodate market preference. (U.S. Food and Drug Administration, n.d.)

Establishing norms of cow bodies and behavior puts cows that deviate from these norms in positions of precarity and vulnerability to violence. This is particularly connected to the use of other technologies of the farm, especially AMS. If cows do not behave in alignment with the modes of production, they are subject to disciplinary practices and are at risk of removal from the herd through culling or euthenasia. (Holloway, 2007; Bear and Holloway, 2019) Cows are categorized by farmers as "problem cows" if they do not perform in alignment with these systems, typically due to their temperament or due to the shape of their udders, (Holloway, 2007) which are both notable as traits which are particular focuses of biotechnological intervention. Cows which do not visit the AMS frequently for milking are perceived by farmers as "lazy." (Bear and Holloway, 2019) The violence organized through this establishment of norms through technology can be seen in the impact of transitioning from conventional to automated milking systems, which have caused the culling of cows who were not adapting sufficiently to the system. (Tse, 2018) Through the operationalization of

agricultural technologies, the vulnerability of cows is being shifted to be oriented around the maintenance of new norms of biology and behavior.

C. Discussion

The use of agricultural technologies constructed as improving cow welfare, including sensors, computation systems, biotechnology, reproductive technologies, and robotics, establish new norms of cow biology and behavior. This makes cows which diverge from these standards normalized as the subjects of discipline and/or death on the farm. The high level of surveillance facilitated by technologies makes cows intensively vulnerable to these speculations of industrial value, decreasing their longevity and producing technological infrastructures for humans to regulate their life and death. The automation of these calculations with machine learning based on data collection from sensors and robotics is decreasing human intervention in these decisions, requiring an analysis of whose logics and calculations are being embodied and performed by these devices. Furthermore, this dynamic of exploitation is structured by the naturalization of the conditioning of cows' welfare on their being highly productive without it being registered as an affront to public moral conceptions of welfare. In order to conceptualize how this social construction of the banality of dairy cows' death emerges, I employ Giorgio Agamben's theory of the relationality and fluidity of biological and political life.

V. Subject Formation through Welfare Technology

A. Cows as Political Subjects

In order to understand the biopolitical relationality of cows and humans, the subjective position of cows must be conceptualized. Cows can be considered not only biological subjects, as structured by their biological functionality and sensory faculties, but also as political subjects, through their enjoyment of rights and obligation to perform duties. While cows' rights are not enshrined in formal policy in the United States, cows are entitled to particular standards of treatment through an array of different certification and labeling schemes, as discussed in the previous analysis of welfare as performance. Through these welfare entitlements, cows can be seen as enjoying rights within an industrial context, instead of the context of the nation. These rights of welfare are attached to duties of accumulating capital, as demonstrated in the analysis of cows' welfare being conditioned on their productivity as measured by both health and high milk yields. In this way, the culling of cows does not in essence represent a breach of rights, but rather a fulfillment of cows' political duties, as the cows lose profitability as producers of milk but become more profitable in their commodification as beef. In this way, exploitation is a fundamental component of cows' political subjectivity. With cows' experience of rights and duties, they can be recognized as not only biological subjects, but also political subjects within the governance structures of the dairy industry. With this perspective, Agamben's theory of biopolitics (Agamben, 1998) can be applied to the case of dairy cows to understand their position within systems of biological and political control.

B. Bovis Sacer, Homo Sacer, Sovereign

Agamben's archetype of homo sacer is defined by their inclusion into the social order by their exclusion; they are reduced to bare life, to their biological properties, and hold no citizenship or social value. This status renders the homo sacer as able to be killed by anyone without it being a homicide (as they have no political rights) but unable to be sacrificed (as they hold no social value to make the offering meaningful). Opposite to the homo sacer, the dairy cow *is* sacrificable, as its death has value in their bodies' commodification as beef. Conversely, the cow is *not* killable, in the sense that they are not killable outside of economic logics and not killable without proper socioeconomic authority (ownership as private property). Even when cows are euthanized instead of culled, this provides the economic function of preventing the contamination of the food supply, which maintains the value of the industry. Technologies are central to this subjective position, where sensors monitor the biology and behavior of cows to determine their economic value and health status, and thus their life or death, and robotics facilitate the performance of their duties as members of the political community. The killability of cows emerges not through their *exclusion* from political community, like the homo sacer, but rather through their *inclusion* in community. Technologies function to mediate and regularize these political relations of inclusion. This demonstrates an opposite archetype to the homo sacer, with cows being sacrificable but unkillable; this is the archetype of the *bovis sacer*.

While the homo sacer represents the result of being relegated to the position of zoë (bare life) from the status of bios (citizenship), the bovis sacer represents a convergence of these two categories, where a being's political value is constituted by and

through their biological functionality. This can be observed in the case of cows in the dairy industry, as their political value (i.e. their rights to welfare) are conditioned upon their biological functionality, their high production of milk. Furthermore, if they no longer function to be highly productive in milking, they are socially reinscribed with value as beef, losing rights to life and welfare as this value requires the death of the cow. Cows are subjected to biopower not through a reduction to their biological properties through social exclusion, but rather through their constitution as political subjects being fundamentally constructed based on their biological functionality. In this way, the archetype of the bovis sacer is profoundly mutable as their value is dependent upon their biological functionality within shifting landscapes of economic priority and social value. This is evident in the case of dairy cows, which are regularly genetically modified and bred to respond to changing economic and social context. This social constitution of cows as political subjects of the dairy industry urges the question of how these beings relate to other actors in a biopolitical landscape of the industry. This can be observed by taking account of dairy cows' on-farm relations with humans and devices.

The relation between the bovis sacer and homo sacer is significant, in that one does not negate or challenge the other, but they mutually construct the other. This can be seen in the case of the American dairy industry in the exploitation of human laborers who do not have citizenship in the country. (Panikkar and Barrett, 2021; Sewell, 2021; Perez, 2019) These workers regularly face intense health hazards and social precarity due to their undocumented status. This seems to support Agamben's assertion of migrants and refugees as quintessential examples of the homo sacer archetype; lacking political rights established by citizenship, they are reduced to their biological capacities for production

and are regularly made to be at risk of violence and detention from workers/representatives of the state. (Maphosa and Ntau, 2020; Rajaram and Grundy-Warr, 2004; Young, n.d.) The use of agricultural technologies on dairy farms which facilitate the emergence of cows as political subjects has increased migrant worker precarity by automating and replacing human labor. (Charlton and Kostandini, 2020; Purdy, 2016) In this way, the bovis sacer and the homo sacer can be seen as having an inverse political relationship, as the enhanced automated exploitability of the cow reduces the industrial demand for the exploitation of human labor. As the political rights of the bovis sacer, the cow laborer, becomes increasingly recognized, the social precarity of the homo sacer, the human laborer, increases, (Hudson, 2011) as their labor can be replaced by a socio-technical system that is more easily disciplined and palatable to consumers. Focusing on standardizing animal biology and behavior, frameworks of animal welfare cannot capture these exploitative dynamics across species, further reducing the scope of bioethical analysis present in public agricultural discourse.

Moreover, the bovis sacer is also constructed through its relation with the sovereign. Agamben identifies the sovereign in the subject that can invoke the state of exception, who is outside of community in their capacity to set, and thus embody, the rules of the society. In the context of the dairy industry, those who set these rules about the life and death of cows are dispersed, including farmers, veterinarians, regulators, and consumers. However, many technological devices are being increasingly given more and more authority in these systems through the automation of health and behavior surveillance, as well as algorithms which are built to assist farmers in decision-making through decision trees and machine learning.

These devices are loaded with particular ways of viewing and experiencing the world, including molecularizing life (Braun, 2007) and evaluating life based on economic analysis. Sovereignty in the industry can thus be seen as including not only the human actors who make decisions about the life and death of cows on the farm including the farmers and veterinarians, the consumers demanding particular performances of welfare, the appraisers and regulators who certify and standardize these performances, the human actors who design the technologies used on the farm, the technologies themselves, and the cows themselves. This can raise geographical questions about the control of agricultural systems through technologies, as many AMS companies are based in Europe (primarily Holland, Germany, and Britain) and India. (Fortune Business Insights, 2021)

Similar to Agamben's claim that every citizen in a democratic nation can be seen as being in the position of the homo sacer, being vulnerable to having their rights taken away through a state of exception, the kind of posthuman sovereignty suggested by the latent political activity of technological artifacts suggests that the bovis sacer is not only a subject of power, but is also both an exertion and exert-er of power. They are simultaneously a technology and a withdrawn being, with their bodies being manufactured to desire and perform certain rhythms and have certain biophysical and behavioral properties in alignment with industrial modes of production, while also maintaining the capacity to disrupt these flows through divergence. (Bear and Holloway, 2019) In other words, the bovis sacer both resists human control by behaving in ways that disrupt flows of production, while also reproducing these industrial flows through their biological functions and behaviors which align with the modes of production. Sovereignty can thus be located not only in humans through vertical arrangements of

organizational hierarchy, particularly in corporations and governments, but also in the bodies of organisms and machines within the space of the farm.

C. Bovis Sacer Beyond Bos Taurus

With this establishment of the bovis sacer as a being included in political community that can be sacrificed but cannot be killed, this archetype can be identified in a range of beings beyond the dairy cow. This archetype can be seen, for example, in the consideration of animals performing ecosystem services. The concept of ecosystem services has been used to cognize ecosystems through economic and biophysical metrics, garnering criticism that the framework employs a reductive framing that quantifies and commodifies beings and systems that ought not be reduced to economic valuation. (Schröter et al, 2014; Gómez-Baggethum and Ruiz-Pérez, 2011; Turnhout et al, 2012) The bovis sacer can be identified in this framework by the use of genetic modification in non-domesticated animals for the purposes of preserving biodiversity as part of conservation strategies. (Moore, 2019; Thomasy, 2021) Furthermore, the use of digital technologies and big data to manage conservation projects and influence consumer behavior aligned with particular values is becoming more prevalent. (Jensen, 2021) Non-domesticated beings are made sacrificable in the sense that their life and death are structured by their inclusion in human political community through their economic value, but are non-killable in their position within conservation efforts, increasingly intensified in political paradigms of climate crisis. These animals, plants, and even geological entities are thus legible as examples of the archetype of the bovis sacer through their

inclusion in political community through frameworks of ecosystem services assigning economic value to biophysical functionality.

D. Discussion

Through the use of digital and biological technologies within shifting landscapes of economic priority and social values, the archetype of the bovis sacer emerges through the formation of subjects to meet disparate agendas of various parties. In this position, subjects are simultaneously vulnerable to discipline, exploitation, and death due to their profitability, and entitled to particular qualities of life and protected from killing outside of economic logics. The bovis sacer represents beings who are not the subjects of biopower through their exclusion, but rather by their inclusion, and are thus sacrificable but not killable. I argue that cows present a clear example of this due to their life, welfare, and death being contingent on their economic performance, mediated by the technologies of the dairy industry. The relation between the bovis sacer and the homo sacer can be observed as co-constructive and competitive, while the bovis sacer's relation with sovereignty can be seen as complex, both being subjected to power and asserting power in ways that can both uphold and disrupt industrial governance structures and modes of production. I further argue that this archetype extends beyond cows and can be seen broadly through the use of genetic and digital technologies in organizing ecosystems through economic evaluation. In this context, the bovis sacer becomes legible as a major subject position of the early 21st century. While Agamben takes the concentration camp as the fundamental blueprint for the modern nation, perhaps a more apt political paradigm for a multi-species, industrial polity is that of the technologized farm.

VI. Conclusion

The driving question of this analysis was: *how is welfare technology shaping the exploitation and disciplining of cows on dairy farms?* Through an analysis of the dairy industry, I have argued that: *these technologies change the experience of these practices by cows and humans, and establish new conditions for discipline and exploitation on the farm through the inclusion of cows in human political community.* I first established welfare as performative in that it expresses and responds to shifting landscapes of social and economic values in their articulation by producers, consumers, scientists, regulators, activists, veterinarians, technologists, and cows. I then examined how the use of agricultural technologies to improve animal welfare performance has shifted landscapes of violence to focus on normalizing cow biology and behavior, and replacing cows that decrease in productivity through intensified surveillance. I then considered how this paradigm of biopower produces particular political subjects, arguing that cows within the dairy industry represent the archetype of the bovis sacer, the being which is sacrificable but not killable, and relates to the biopolitical archetypes of the homo sacer and the sovereign in complex ways. I theorize how this archetype might extend beyond the cow through the framework of ecosystem services, where animals, plants, and geological features become mutable and politically included in human community based on their economic value. This analysis suggests that while welfare technologies might represent an improvement of cow welfare by a particular set of scientific metrics, they also orient biopolitical relations that can increase the vulnerability of those subjected to their employment.

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