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The Journal of Peasant Studies

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/fjps20

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To cite this article: Nathan F. Sayre (11 Dec 2023): Corn and the range: rethinking ranching, agriculture and the feedlot, The Journal of Peasant Studies, DOI: 10.1080/03066150.2023.2284973

To link to this article: https://doi.org/10.1080/03066150.2023.2284973

Published online: 11 Dec 2023.

THE JOURNAL OF PEASANT STUDIES
https://doi.org/10.1080/03066150.2023.2284973

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Corn and the range: rethinking ranching, agriculture and the feedlot

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ABSTRACT
Debates about modern beef production suffer from a major historical blind spot. For over a century, the feedlot relied on a closed nutrient loop to sustain soil fertility in the United States Corn Belt. Driven by industrial capitalist urbanization, a *cattle-grain-beef complex* shaped land use, tenure systems, management practices and environmental politics on the expanding frontier, sacrificing the tall-grass prairies and fracturing agrarian resistance to corporate concentration and the Union Stock Yards. Concentrated Animal Feeding Operations (CAFOs) emerged after 1950, breaking the nutrient cycle of the original feedlot and turning the relationship between ranching and agriculture into a dysfunctional one.

KEYWORDS
Feedlots; CAFOs; Corn Belt; rangelands; livestock breeds; ranching; pastoralism; metabolic rift

1. Introduction

Modern US beef production is a tangle of contradictions. '[O]ne of the most multifaceted food systems in the world' (Rotz et al. 2019, 1), it reliably generates prodigious supplies of meat at rates of resource use and greenhouse gas (GHG) emissions that are among the lowest in the world per unit of product (Herrero et al. 2013). Widely denounced for maltreatment of workers and animals, concentrated pollution streams, and heavy reliance on chemical and pharmaceutical inputs, intensive beef production nonetheless displays striking resilience and is firmly entrenched behind the political and economic power of four firms – JBS, Tyson Foods, Cargill and National (Marfrig) – who together control more than 80 percent of the market (MacDonald 2018).

At the center of the beef system and its contradictions is the Concentrated Animal Feeding Operation (CAFO) or feedlot, where roughly 95 percent of cattle in the US beef value chain spend their final months consuming concentrated feed grains, especially corn (*Zea mays*).[1] CAFOs are marvels of efficiency, and the 'livestock revolution' of the last half-century has seen the model spread worldwide for poultry and pigs as well as

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[1]Feedlots with capacities >1,000 head are only five percent of total feedlots, but they market 80–85 percent of fed cattle (USDA 2023).

cattle (Delgado et al. 1999). Paradoxically, CAFOs are also the source of the livestock sector's outsized environmental impacts (Davis et al. 2015). In their influential report for the UN's Food and Agriculture Organization, Sere and Steinfeld (1995) dubbed CAFO-based production 'landless'; Weis (2013) terms it the 'industrial-grain-oilseed-livestock complex,' while Brenner and Ghosh (2022) call it the 'global industrial feedlot matrix.'

This paper argues that contemporary debates about US beef production suffer from a major historical blind spot. Critics and proponents alike present the feedlot as a post-World War II innovation – no less an authority than Vaclav Smil (2013, 125) contends that 'Grain feeding of livestock began after WW II in the US and Canada' – and as an unavoidable tradeoff between efficiency and sustainability. CAFOs accelerate growth rates, thereby reducing inputs and GHG emissions per unit product, but they also open a 'metabolic rift' (Patel and Moore 2017) in the nutrient cycle between where feed crops are grown and where livestock manure ends up. This spatial separation means that efficient meat production appears to require heavy synthetic fertilizer use on farms and hazardous concentrations of manure waste from feedlots (Spiegal et al. 2020); in the words of an analysis published in *Environmental Research Letters,* 'much of the environmental burden of livestock production is due to its heavy reliance on feed and the resources required to produce those crops' (Davis et al. 2015, 9).

Missing from these debates, and from virtually all of the current literature, is any recognition that corn feeding has been integral to beef cattle production in the US for more than 200 years, and that for roughly half of that period, the feedlot relied on a closed-loop nutrient cycle that could maintain soil fertility. Unprecedented levels of productivity were achieved and sustained – per unit of land, labor, animals and time – not on the basis of a metabolic rift but precisely the opposite. The first modern food regime (Friedmann and McMichael 1989) capitalized on ecological synergies between a Native American cultivar and Old World livestock on the frontier of Anglo-American settler colonialism. These synergies remained intact for over a century, giving way only with the advent of hybrid corn and cheap synthetic fertilizers circa 1945. The co-constitution of cattle ranching and corn farming was evident to scholars in the 1920s but was forgotten after 1950, during the very period when CAFOs took over the industry. This warrants explanation in itself, because it has shaped how we see and understand the beef system today.

To explain the genesis and history of both the feedlot and the blind spot, I employ a method of immanent (Postone 1993) or recursive (Nichols 2020) critique, taking inspiration from Luis Andueza's (2021, 1108) call for 'a more textured account of the concrete practical, ecological, and symbolic density of landscapes in which capital is reproduced and resisted.' Under an 'expanded definition of critical theory,' concepts and ideas are understood as 'also themselves the *products or effects* of the very processes they seek to define, explain, and critique' (Nichols 2020, 11, emphasis in original). Ranching, for example, is at once a practical-ecological activity and an idea or concept, and both are products of history. If many of my empirical materials are old, then, it is not only because the mid-twentieth century was a kind of golden era of western US historiography, but also because I am treating them as primary (as well as secondary) sources.[2]

The paper proceeds as follows. Section 1 reviews scholarly theories of ranching and shows that they neglect the feeding of livestock with cultivated grains. Also known as

[2]I am indebted to an anonymous reviewer for this formulation.

fattening or finishing,[3] this step takes place after animals leave the ranch (often upon sale to others). Section 2 examines the historical origins of grain finishing. The original feedlot was a means of utilizing copious corn harvests that could not be economically transported to market, while the animals' manure restored soil fertility depleted by the corn. It was so successful in Kentucky and Ohio between 1805 and 1830 that the earliest modern slaughterhouses developed in Cincinnati to process the resulting bounty of fat stock. More than a century later, corn farmers in Iowa still sustained their fields' fertility without commercial fertilizers by winter feeding of cattle and hogs.

Section 3 argues that corn feeding was not incidental but internally related to US ranching from its origins.[4] The *cattle-grain-beef complex* emerged as both a transcontinental vehicle of US settler colonialism and a centerpiece of the world's first food regime, defined by international trade in staple foods for urban-industrial wage laborers (Friedmann and McMichael 1989). As ranching took hold on the Great Plains after the Civil War, few beef cattle went directly to slaughter in Chicago or other cities. Most stopped for periods of months to gain weight consuming the rapidly expanding corn harvests of the farming frontier. With the replacement of cattle drives by rail shipping, a geographical division of labor emerged connecting Great Plains ranches, Corn Belt farms, the Union Stock Yards in Chicago, and beef consumers throughout the eastern US and as far away as Britain. Debt compelled settlers to produce whatever would yield maximum returns. As land values rose, farmers in Iowa and adjacent states plowed up their pastures to plant more corn, and ranchers came to specialize in young cattle for fattening in the Corn Belt. By the 1870s, Texas Longhorns were being cross-bred with 'improved' British breeds such as Shorthorns and Herefords, which yielded larger and more uniform carcasses and fattier, 'marbled' cuts of beef. The details of this change were complex, but the core of the matter was simple: corn. The farmers needed British breeds to consume and valorize their crops, and the British breeds needed corn to realize their genetic and market potential.

Section 4 considers the implications of corn feeding for ranching. Thanks to corn feeding, ranchers could specialize in calf production and sell their animals at much younger ages, enabling them to destock more proactively and graze more conservatively. But the British breeds were ill-suited to the harsh conditions of western rangelands, which exacerbated grazing impacts and helped motivate fence-building, predator elimination, and investments in water infrastructure and irrigation. British breeds also required significant capital and enclosure of the range, both of which were integral to class formation and accumulation as the frontier drew to a close. Itinerant, landless herders were squeezed out by a land-owning rancher elite, sometimes by violent force and eventually by federal government policies. Meanwhile, struggles over fencing and livestock damage to settlers' farm fields fractured agrarian resistance to emergent corporate consolidation in the meatpacking industry. The conclusion relates these arguments to current debates

[3]In the cattle feeding industry today, a distinction is sometimes made between a 'growing' stage, in which young animals (known as stockers) are fed a mix of grains and roughage to reach full body size, and a 'finishing' stage, shorter in duration and using more concentrated grain-based feedstuffs, to build up fat and improve the quality of the resulting meat. 'Feeding' encompasses both, and a modern feedlot may do both. I use 'feeding,' 'fattening' and 'finishing' interchangeably unless otherwise noted.

[4]*Internally related* in the sense of Ollman (1971) and Sayer (1984). Without going into the details of dialectical materialism and critical realism, the basic idea can be expressed as: ranching would not be what it is without grain feeding, or, one cannot properly understand or analyze ranching without treating grain feeding as inherent to it.

about the sustainability of livestock and proposes that the original feedlot may once again enable production of grain-finished beef without the use of synthetic fertilizers.

2. Theories of ranching

Scholarly definitions of ranching have long emphasized two core elements. First, ranching is extensive: domesticated ruminant livestock graze on large areas of natural (or naturalized) vegetation, also known as rangelands, rather than tame pastures or cultivated feeds.[5] Second, ranching is capitalist, carried out for market exchange and profit rather than subsistence. Both features are captured in the term 'range cattle industry,' which several early historians used alongside or in preference to 'ranching' (Dale 1930; Osgood 1929; Webb 1931).

Anthropologists have echoed these definitions and elaborated on them in various ways.[6] Arnold Strickon (1965, 230f.) defined ranching as 'that pattern of land use which is based upon the grazing of livestock, chiefly ruminants, for sale in a money market.' He noted that ranching emerged concurrently in the 1860s in Argentina, Australia and the US, even though large-scale extensive grazing had begun much earlier in the first two. 'In each of the three areas the efficient cause for the emergence of the complex was the appearance of a market outlet for livestock products outside the grazing area itself' (Strickon 1965, 235). From this he concluded that ranching presupposed 'large urban markets' and 'a massive complex of processing and transportation' to link producers and consumers (230, 236).[7]

In his 1980 monograph, *Hunters, Pastoralists, and Ranchers,* Tim Ingold presented a theory of ranching based on comparative analysis of the social relations of production of large ungulates such as reindeer, caribou, bison and cattle. He concluded that: 'A fully evolved, capitalist ranching economy combines the private ownership of livestock with a division [of pastures] into mutually exclusive blocks of territory' (Ingold 1980, 261). In Ingold's theorization, ranching involves commodified inputs and outputs: ranchers rely on markets to purchase their animals as well as to sell them, and they pay for exclusive use or ownership of grazing lands. Ingold deduced several additional contrasts between ranching and pastoralism, but neither agriculture nor grain feeding played a role in his theory.[8]

Another feature sometimes assigned to ranching is the frontier, reflecting ranching's role in European expansion and settlement in the Americas, Australia and Africa

[5]Many scholars (and countless others) have treated this as a biophysical necessity imposed by the lands' aridity (e.g., Webb 1931), or as a transient stage preceding agricultural development. The environmental determinist and teleological flaws of such claims are by now well established. I leave them aside here.

[6]An alternative conception of ranching defines it in terms of the customs, dress, tools and techniques of horseback cattle raising (Rivière 1972). This lends itself well to diffusionist studies that can be very rich empirically (Jordan 1993; Sluyter 2012). But its circularity renders it effectively anti-theoretical and of limited utility for social analysis.

[7]For Strickon, then, urban-industrial demand is internally related to ranching. He did not place any corresponding qualifications on the supply side, however, other than to note 'the relatively large sizes of ranches as compared with alternative patterns of land use,' required due to the biophysical capacity of rangelands and the limitations of livestock physiology (Strickon 1965, 238). Interestingly, he also noted that the *pampas* was converted to arable beginning in the 1880s, and 'The mechanism was the need for high-grade feeds and forage crops for the new purebred cattle' (Strickon 1965, 249).

[8]Ingold mentions irrigated forage in passing, and he acknowledges (citing Bennett 1969) that ranching relies on cultivated fodder in some regions. But he does not trace any implications from this fact, implying that he views it as inconsequential to his theory.

(Jordan 1993; Rivière 1972). Most scholars conclude that this is only an ephemeral or contingent, rather than necessary trait, given that ranching has persisted in these areas long after the frontier closed. Strickon (1965, 230) acknowledged the frontier context of many early ranching economies, and he compared ranching with plantation agriculture as vehicles of colonial development, calling them 'ecological variants of industrial agriculture.' He astutely inferred that ranching's presence or absence, expansion or contraction depends not on ecological factors but on its relative rate of return as a land use. In a striking passage, he concluded that:

> By about the turn of the twentieth century, the modern ranching complex and its interdependence and interpenetration with modern industrial civilization was established. The 'frontier' into which the cattle complex had expanded in the second half of the nineteenth century was as much the slums of Manchester and Pittsburgh as it was the empty grasslands of Montana or Santiago del Estero. (Strickon 1965, 238)

More often pastoralism, rather than the plantation, serves as the 'other' against which ranching is theorized, especially among scholars in anthropology, rangeland ecology and development. Thus, for Ingold, ranching and pastoralism both treat livestock as private property, but they differ with respect to land tenure; pastoralists rely on kin for labor, and they maximize herd sizes because their goal is subsistence, whereas ranchers employ wage labor and routinely cull and sell animals in pursuit of optimal monetary returns.[9] Subsequent scholarship has complicated the contrast by recognizing that many pastoralists participate in market exchange to varying degrees (Schareika, Brown, and Moritz 2021). But the propensity to conceptualize ranching and pastoralism jointly, as two ends of a spectrum or as variations of one another, remains widespread (Behnke, Scoones, and Kerven 1993; Ellis and Swift 1988). Agriculture features prominently in some discussions of pastoralism, but is absent when it comes to ranching.[10]

Finally, many ranches grow alfalfa hay, tame pastures or other crops, often with irrigation, to provide their herds with supplemental feed. Scholars have treated this as a necessary adaptation to climatic extremes or nutritional deficiencies in range forage, but not as a defining component of ranching itself (Bennett 1969; Osgood 1929; Schlebeker 1963; Starrs 2000). In his comprehensive history of North American cattle ranching, Jordan (1993, 273) argues that 'differences in winter care of livestock,' including both hay feeding and shelter, were the primary reason that 'the midwestern system was better adapted for the Great Plains than the subtropical Texan methods.' But the other systems he traces – Texan, Mexican, Californian, etc. – are equally ranching, even without supplementary feeding. He also notes that 'If the goal was meat production, the normal pattern involved shipping the range cattle to other areas nearer market for fattening' (Jordan 1993, 8), but this 'feeder' role falls outside of his notion

[9]Bennett (1969) and Rivière (1972) also conceived of ranching by comparison with pastoralism, although they highlighted similarities rather than contrasts between the two. It is notable that Rivière (1972, 2–3) explicitly declined to discuss ranching as a concept or a category; by his own admission, his 'subsistence ranchers' might just as well be analyzed as pastoralists, apart from the fact that they think of themselves as ranchers/cowboys. Ingold (1980, 260f.) usefully points out that Rivière's case can be explained historically: ranching persisted in Roraima in a 'fossilized' form after market forces had withdrawn from the region for exogenous reasons.

[10]It is common in West Africa, for example, for pastoralists to graze their livestock on farmers' post-harvest crop residues, exchanging the animals' manure for the farmers' fodder. The ethno-political dimensions of these interactions have been much studied by anthropologists and geographers.

of ranching.[11] Grigg (1974, 243) is unequivocal: 'where sown grasses have been introduced, or grain fed to cattle, then ranching ceases and the mixed farmer takes over, a process to be seen on the margins of all the ranching regions.'

Historians have written far more than other social scientists about ranching, albeit mostly in empirical rather than social theoretical terms. Nearly a century ago, Hopkins (1928), Osgood (1929) and Dale (1930) emphasized the interdependence of ranching and corn farming, as we will see. By contrast, the many ranching histories written a generation later contain little or no discussion of corn farming or feeding (Athearn 1960; Atherton 1961; Frink, Jackson, and Spring 1956; Gressley 1966; Sandoz 1958; Schlebeker 1963). Stegner's (1954) famous 'hundredth meridian' – the western limit of rainfed agriculture – came to divide scholarship no less than regional geography. Environmental historians such as Cronon (1991) have treated ranching and feeding as separate and distinct steps in the beef supply chain, and while Rifkin (1992) recognized the early origins of corn feeding and its connections to British capital, he omitted any discussion of its ecological basis. Tony Weis (2013, 95) astutely notes that 'the dualistic productive environments of the industrial grain-oilseed-livestock complex … must be seen to be organized by a unitary logic.' But he, too, omits the deeper history of the feedlot, as do Patel and Moore (2017). What follows is an attempt to remedy these omissions.

3. The origins of the feedlot

The practice of fattening livestock prior to slaughter goes back at least to the eleventh century in Britain. By the late sixteenth century, specialists known as graziers were found around the perimeter of London, fattening animals from as far away as Scotland. Animals lost weight traveling long distances on the hoof, and fattening was considered necessary for both the quantity and quality of the resulting meat. Pigs were fed on distillers' and starch makers' byproducts as well as acorns, beech nuts and mast, but cattle and sheep were fattened principally on high quality pasture; fodder crops such as turnips and cabbage only gained widespread use in the eighteenth century. Farmers enjoyed higher social status, but some graziers became quite rich (Trow-Smith 1959).

Fattening cattle with corn first emerged as a specialized economic activity in Pennsylvania around 1780 (Clemen 1923; Jordan 1993; Thompson 1942).[12] Earlier in the century, extensive cattle raising had developed in Virginia's Shenandoah Valley and spread throughout the Piedmont savannas as far south as Georgia, where cattle and pigs multiplied prodigiously with minimal human tending. The major markets for these animals were in Baltimore, Philadelphia and New York.[13] Southeastern Pennsylvania was in between, and it had 'splendid pasturage for summer, and an abundance of corn for winter feeding' (Hopkins 1928, 10). A social division of labor emerged between raisers

[11]Notably, Jordan (1993, 269) sometimes seems reluctant to call the Midwest system 'ranching' at all. 'Perhaps *ranching* is not the best word to describe their system, although they happily accepted that designation in the West. Contemporary observers often called their establishments 'stock farms,' 'mixed farms,' or 'improved ranches.''

[12]It should be noted for the record that Thompson's remarkable book, *A History of Livestock Raising in the United States,* was submitted in manuscript to the US Department of Agriculture in 1917-1918, but not published (in abridged form) until a quarter-century later. In the meantime, curiously, it appears to have served as the basis for much of Clemen's 1923 volume, *The American Livestock and Meat Industry*, with only minimal attribution.

[13]Charleston, South Carolina, was another market for these animals, but the surrounding region lacked corn, and the beef there earned a reputation for being tough and distasteful (Thompson 1942; 77).

and feeders of stock (Thompson 1942, 138). Pennsylvania feeders continued to fatten cattle into the nineteenth century, and the resulting manure, along with clover and lime, helped restore the depleted fertility of the region's soils (Hopkins 1928).

The feedlot was invented as a distinct technique of fattening when the frontier crossed the Appalachian Mountains at the turn of the century. Historians have traced it to the Scioto River plain south of present-day Columbus, Ohio; it was variously known as the Virginia, Kentucky, or Ohio system (Bogue 1963, 100), probably because its earliest practitioners hailed from all three states. It employed 'shocks' of corn – mature plants cut whole and piled into conical stacks to cure – in a rotating sequence:

> A ten-acre cornfield was the basic unit, supporting one hundred head of cattle in the late fall fattening season. Twelve to sixteen hills of corn were gathered to provide one shock; one-half bushel of shock corn per head per day was fed from early November to February, when the drive to market began. For each field there were two or three of like size adjoining it, filled with the same arrangement of corn in the shock, through which the animals were changed to fresh lots at every feed, morning and evening. Each lot of one hundred head was fed together and then driven to market together. (Hudson 1994, 71)

The key was feeding both cattle and hogs in the fields, where their complementary digestive systems would thoroughly convert the corn and fodder into manure to replenish the fertility of the soil:

> Feedlots eliminated cattle barns. The considerable amount of corn that passes whole through a steer becomes unusable waste when produced by an animal fed in a barn stall, but in a feedlot that corn becomes accessible feed for hogs. Between one hundred and two hundred hogs cleaning up after corn-fed steers could be fattened simply on the waste. The manure produced both by cattle and hogs enriched the soil of the series of fields through which they were rotated in the feeding season, providing nutrients for the next year's crop. (Hudson 1994, 71)

Different sources describe details of the system differently, and it undoubtedly varied among farmers and over time.[14] It is agreed, though, that the feedlot was highly efficient in terms of land, labor and capital, and enormously productive both biophysically and economically. 'Little effort was required to plant corn and even less to harvest it because cattle could be turned into the fields and allowed to harvest the crop themselves. What the cattle knocked down and wasted, swine could salvage' (Whitaker 1975, 10). George and Felix Renick are credited with driving the first herd of corn-fattened cattle from Ohio to Baltimore in the spring of 1805; by the 1820s, thousands of cattle were driven east to urban centers annually.[15] Until about 1850, Ohio remained the center of what Hudson (1994, 68) terms 'the middle-western system of range-feedlot agriculture.' Corn farmers purchased cattle from the prairies of Indiana and Illinois, fattened them through the winter, and then drove them east. Hogs, which did not drive well on the hoof, were sourced more locally and marketed in such large numbers in Cincinnati that the city became known as Porkopolis. The earliest industrial slaughterhouses were

[14]See McCoy 1874; Clemen 1923; Hopkins 1928; Jones 1955; Henlein 1959; Whitaker 1975; Hudson 1994. Some accounts describe shocks standing amidst the animals; others report farmers replenishing the lots between feedings or hauling corn from the shocks to other lots for feeding; some mention crop rotations with winter wheat, suggesting multi-year sequences; Jones (1955) describes a three-herd rotation, with three-year-old stocker cattle, four-year-old feeder cattle and hogs.

[15]Three-year-old steers were driven to eastern Pennsylvania and fattened there; four-year-olds were fattened in Ohio and driven more slowly (to retain their weight) and sold directly to butchers for slaughter (Clemen 1923, 73).

devised there, processing 330,000 hogs annually by mid-century and sending barrels of cured pork downriver to markets in St. Louis, New Orleans, and the South (Pacyga 2015).

The trans-Appalachian US developed as an agro-pastoral infrastructure for capitalist urbanization (Cronon 1991), a harbinger of global industrial capitalism and modernity (Giedion 1948). Henlein (1959, 130f.) argued more than six decades ago that settlement of the Ohio Valley signaled a new era in economic relations between rural areas and cities, agriculture and industry more broadly:

> for the first time they [settlers] could produce staple crops in real abundance and, concurrently, there was a genuine demand for foodstuff in what was coming to be recognized as a world market. The Industrial Revolution had begun to concentrate the population in great centers, and wheat and meat were in great enough demand to justify long shipment. The population of New York City, for example, rose from 79,206 in 1800 to 4,174,779 in 1860.

Here we have Strickon's (1965) observation confirmed and amended: not only were urban markets necessary for the emergence of ranching; corn-fattening was necessary to convert range cattle into meat at a scale and quality adequate to urban demand. Illinois displaced Ohio as the center of corn-feeding around mid-century, obtaining cattle from Missouri and southeastern Iowa and shipping them to eastern markets on newly-built railroads (Figure 1); herding – and the native prairie suited for it – disappeared from Illinois by the late 1860s (Bogue 1963).

Most noteworthy, for today's debates, is the fact that a closed nutrient loop characterized corn feeding well into the twentieth century. An English traveler in 1819 remarked on the fertility of Ohio corn fields, even after 15 years of continuous cropping (Thompson 1942, 93). Hopkins (1928, 108) observed that the turn to corn and cattle in Iowa helped restore soils that had been exhausted by wheat, marking 'a milestone in the progress of agriculture.'[16] '[B]ecause of the large area devoted to grazing and stock-raising,' wrote agricultural agent Charles Curtiss in 1907 (1908, 66), '[s]carcely any commercial fertilizers have thus far found a market in Iowa, and it is believed that as long as intelligent methods of agriculture are followed no necessity for them will arise.' There was still little or no need for commercial fertilizers in 1939-1940, according to USDA soil surveys of numerous Iowa counties where corn and cattle predominated (e.g. Benton and Geib 1939; 1940; Orrben and Leighty 1939; Orrben and Swenson 1940). Clemen (1923, 209) concluded that 'The proper place and purpose of beef production in the Corn Belt … was to provide a profitable market for the crops grown on the farm, and at the same time to conserve the fertility of the soil.'[17] The original feedlot was the metabolic opposite of the CAFO – in today's vocabulary, it combined efficiency and sustainability.

Before turning to the role of feedlots in the history of ranching, two points bear emphasis. First, corn-feeding was never a subsistence activity. The Renicks and their contemporaries understood themselves as agricultural capitalists, not yeoman farmers; they migrated to Ohio with borrowed capital already in hand to produce commodities for

[16]A very similar discovery, using sheep, was the centerpiece of 'high farming' in Victorian England. 'The remarkable thing is that the careful control over animal wastes and the use of leguminous and other cover crops in this system enabled it to maintain the condition of the land indefinitely even while production levels climbed' (Duncan 1996, 64–65).

[17]Bray and Watkins (1964) attributed declining average US corn yields in the period 1925–1937 to fertility problems, but the declines were concentrated outside of the Corn Belt, in areas where severe drought was also a contributing factor. Hudson (1994) attributes yield declines to indiscriminate cross-pollination among corn varieties, remedied by the rediscovery of Mendelian genetics and the advent of hybrid breeding.

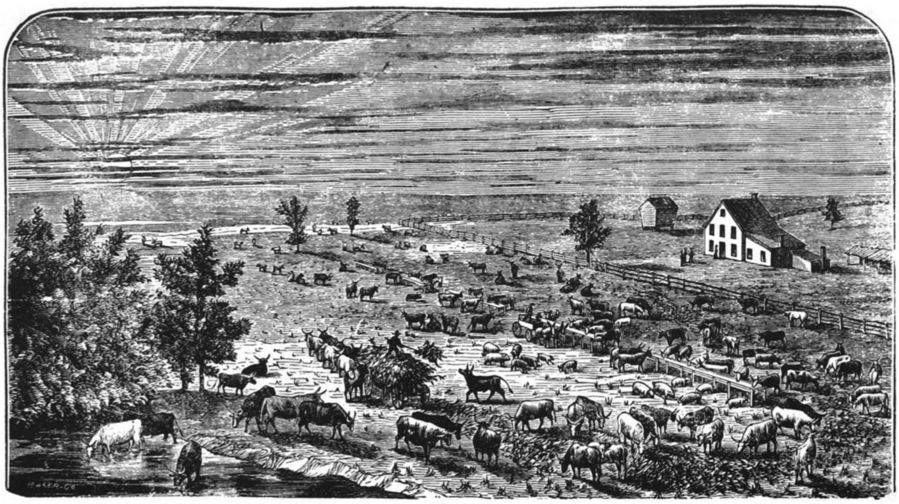


Figure 1. Illinois corn-feeding operation circa 1870. Source: McCoy (1874, 170).

profit. 'In the rush to occupy the "open and undespoiled" land, the concept of self-sufficiency had considerable force, but it was always subordinate to the desire to produce a readily salable surplus' (Henlein 1959, 3). Second and relatedly, the feedlot system presupposed an over-abundance of corn, not as an accident of particularly bounteous years but as an intentional, perennial condition.[18] From the outset, middle-western corn supplies not only exceeded local and regional demand but could not be disposed of economically other than by livestock feeding; at times, corn 'was of so little value as to be substituted for wood as fuel' (quoted in Giedion 1948, 215). This was partially a function of transportation costs, especially before railroads. But it was more basically a matter of absolute over-supply *save for the fattening of livestock,* and it remained the case long after rail shipping had become commonplace: corn prices declined by more than 50 percent from 1866 to 1900, while average yields held steady and the area planted more than tripled.[19] As Cronon (1991, 99) observes: 'corn brought low prices – few Americans, and even fewer Europeans, regarded it as a prime food grain … but animals loved it [and] its crop yields were extraordinary compared with those of other grains.' Just as the livestock would not have been produced in the absence of urban markets, the corn would not have been grown in the absence of livestock.

[18]The other economical use of corn was whiskey production, but its development was initially blocked by high excise taxes imposed in 1791 and enforced by federal troops in 1794 in response to the Whiskey Rebellion. Indeed, according to Thompson (1942, 93), this was what prompted farmers in western Pennsylvania and Ohio to take up livestock raising as an alternative. The taxes were repealed in the early 1800s, but whiskey did not attain a prominent role in the Ohio Valley until after the railroad had enabled livestock feeders further west to enter the market and outcompete the Ohio Valley feeders, taking advantage of their closer proximity to the livestock frontier on the Great Plains (Hopkins 1928).

[19]Planted area in 1866 was just over 30 million acres, compared to nearly 95 million acres in 1900. Prices ranged from \$0.52-0.78/bushel in the period 1866-1870, and from \$0.21-0.35/bu in 1896-1900. USDA data do not go back before 1866. Yields were 20–30 bu/ac throughout the period, with no upward or downward trend (USDA 2019, 28).

4. Feeding, breeding, and the union stock yards

The post-Civil War transformation of the Great Plains was among the most drastic episodes of social and environmental change in world history. In the space of a single generation, tens of thousands of Native Americans were dispossessed of their lands, tens of millions of bison were exterminated, and scores of millions of acres of prairie were plowed up and converted to farms. Military force and market dependency decimated native tribes, while the Homestead Act of 1862 simultaneously subsidized landownership for white citizen-settlers and compelled them to produce cash crops to perfect title and repay loans (Nichols 2020). 'Nothing in American history exceeds the speed of this occupation of the Middle Border,' wrote historian James Westfall Thompson (1942, 145). Throughout these transformations, one geographical pattern remained the same: 'Cattle were born on the western prairies, sold in the eastern markets, and fed to market weight on corn at an intermediate location' (Hudson 1994, 68). More than just a 'cattle-beef complex' (Specht 2019), this was a *cattle-grain-beef* complex; by 1900, it coalesced into an 'integrated system of meat production that reached from the Rockies across the tallgrass prairies of Iowa and Illinois all the way to Chicago and beyond' (Cronon 1991, 221–222). In the process, ranching, farming and feeding were subsumed within a corporate-industrial beef production system anchored in Chicago's Union Stock Yards.

The driving force behind these changes was rapid industrial and urban growth in the eastern US and Europe. 'Across the telegraph wires came the instructions and information that coordinated eastern financial markets and western production sites. Along the railroads traveled the raw materials of the West and the finished products of the East' (White 1991, 236). Frontier expansion and settlement were facilitated by relaxed restrictions on international investment and trade, advances in shipping, and livestock herds depleted by wartime needs in the US and an anthrax outbreak in Europe (Brayer 1949). Both farming and ranching attracted significant corporate investment in the last quarter of the century; after smaller western banks failed in the 1873 panic, larger eastern firms and investors from as far away as Scotland jumped in to capitalize on high regional interest rates and cheap land (Gressley 1966; Harnack 1985). Meanwhile, the invention of refrigerated shipping sparked another boom: monthly dressed beef exports exploded from 36,000 pounds in October 1875 to more than 6 million pounds in March 1877 (Dale 1930, 156 n31). By 1900, 70 percent of British beef imports came from the US (Brayer 1949, 93).

Credit intersecting with land was the flywheel that transmitted this force to farmers and ranchers, who relied on loans and mortgages to finance land acquisition, improvements and herds. Debt compelled them to treat their land as a financial asset, maximizing production of whatever would yield the highest market returns; further expansion and intensification functioned as 'fixes' for chronic aggregate surpluses (Harvey 1982). As land values rose, Midwestern farmers devoted more and more of their land to corn, which they could sell or feed to livestock depending on relative market prices (Bogue 1963). Iowa corn expanded from 1.67 million acres in 1866 to 2.5 million six years later; five consecutive years of abundant harvests in the late 1870s resulted in 'cheap grain and a great deal of it, and consequently a large increase in the production of beef and pork on grain instead of pasture' (Hopkins 1928, 29). The number of beef cattle in Iowa nearly tripled in the 1870s, then almost doubled again, to just under 3.4 million, in the 1880s (Hopkins 1928, 77). Herding and grazing disappeared from southwestern Iowa in the 1880s, and from northwestern Iowa in the 1890s – *there was no prairie left* by then (Bogue 1963). In 1920, the Corn Belt supported the highest densities of both cattle and hogs in the nation (Figure 2).[20]

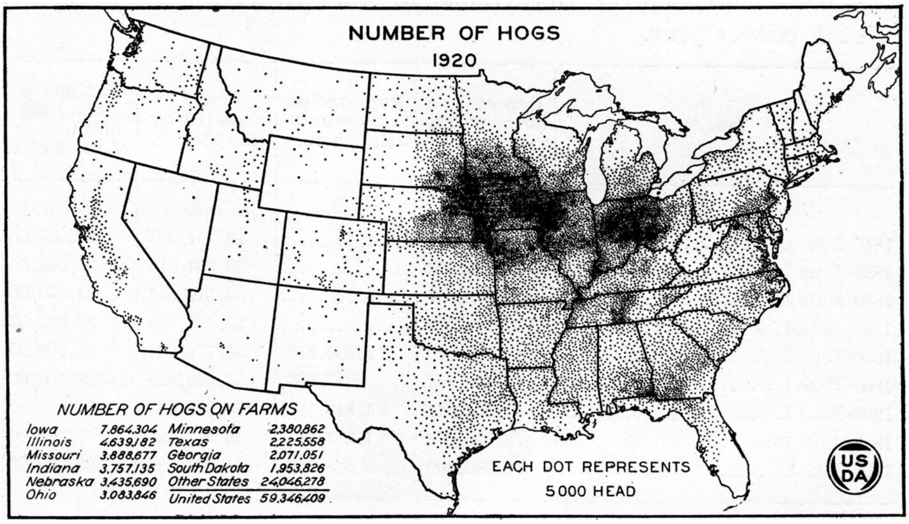
As farmers in Iowa and adjacent areas grew ever-more corn, ranchers to the west sought out cattle that could make the best use of the corn. The historiography of US ranching has long been dominated by the figure of the cowboy and the legendary cattle drives of the immediate post-Civil War period.[21] Texas Longhorns did provide the seed stock for the expanding ranching frontier, but their importance soon waned. Descended from Iberian Longhorns imported centuries earlier, the Texas herds[22] had irrupted during the Civil War, making them a rare source of abundant cattle at war's end. But they were unaccustomed to human handling and 'wholly unacquainted with corn' (Hopkins 1928, 41). Feeders found them 'wild and unmanageable. They ate heavily, but did not put on weight. When shipped to market the returns were disappointing. The cattle were light and butchers and packers did not want them … By 1870 or a little later, most Illinois and Iowa feeders had ceased to purchase Texas cattle for feeding' (Dale 1930, 152–153).

There ensued an abrupt transformation of cattle throughout the West. What feeders demanded were 'improved' cattle, descended at least in part from British breeds that had been selected for rapid growth and fattier, more tender beef. As prairie disappeared in the Corn Belt, farmer-feeders became more reliant on western ranches for animals to fatten. And as the range grew increasingly crowded in the plains, ranchers looked for ways to increase the value of their animals and market them at a younger age. 'It became the function of one region to rear cattle and of the other to fatten them for market. In both the importance of good blood quickly became apparent. In the one in order that the animals might grow larger and reach maturity in a shorter time than did the common Texas cattle, and in the other in order that they might take on fat readily and so utilize to the best advantage the grain and hay upon which they were fed' (Dale 1930, 149). Flush with borrowed funds in the early 1880s, ranchers clamored for improved breeding stock. As the boom crested,

[20]'In 1870, there were three million beef cattle in Texas, and a negligible additional amount scattered across the Plains. In the corn belt, there were a million in Illinois and another 750 thousand or so in Ohio and Missouri each. In the following three decades, cattle production would spread across the Plains and intensify in the corn belt. By 1900, there were roughly 6.5 million cattle in Texas and another 4 or 5 million in the range/ranch country. In the corn belt, there were 2.8 million in Kansas, 2.6 million in Iowa, and another 1–2 million in Nebraska, Illinois, and Missouri each' (Specht 2019, 125).

[21]The canonical text is Webb's (1931) *The Great Plains.* Webb acknowledged the short life-span of the cattle drives and the obsolescence of the Longhorn after 1873. But he described the cattle drives in glorifying detail, while saying almost nothing about corn farming and feeding. As Allan Bogue (1963, 99–100) notes, 'Emphasis on the Texan contribution to the range economy sometimes hides the fact that the entrepreneurial élan, business ability, and capital which built the northern range industry was often midwestern in origin.' Jordan (1993, 221) observes that 'without the Chicago-northeastern market, Texans could not have expanded northward into the Great Plains.' As for the cattle, 'Contrary to popular image, the Iberian longhorn never dominated the central and northern Great Plains' (Jordan 1993, 274).

[22]According to Richard White (1994, 252–253), the Texas Longhorns emerged from promiscuous breeding between English Longhorns brought by migrants from the US South and Spanish criollos present in the region since the 16th century. 'Between 1836 and 1865, fertile, long-lived, pugnacious, multicolored cattle with long legs, long tails, long bodies, and long horns (a trait derived from both parent stocks) developed. These cattle were resistant to the tick-carried Texas fever, and they thrived on grass without supplemental feeding.' Despite the shared name, English and Iberian Longhorns were completely separate breeds.



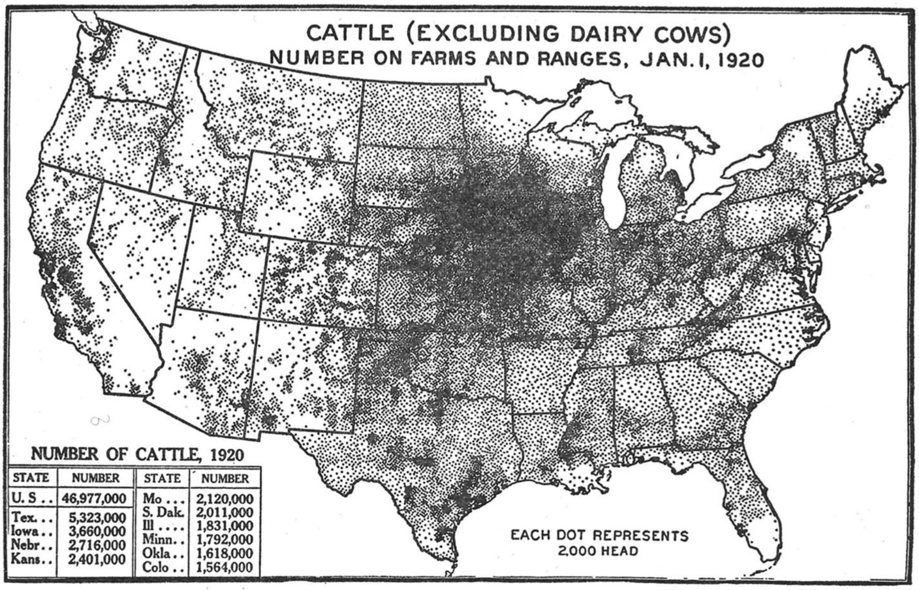


Figure 2. Distribution of (a) hogs and (b) non-dairy cattle in 1920. Source: Dale (1930, 79, 163).

> Feeders found it more profitable to sell to the western cattlemen at the high prices then prevailing, than to buy stock cattle to fatten for the markets … In 1882-1884, there were as many cattle shipped west as east … The throwing of thousands of these young cattle into the newly opened areas increased the risks of the range business tremendously. In the first place, they were more valuable than the Texas longhorns. Second, these eastern cattle were less able to stand the rigors of a northern winter … Finally, these cattle, pouring in by rail, would overstock the ranges almost as soon as they were opened up. (Osgood 1929, 93–94)

It was this influx of animals, on top of the natural increase of ranchers' existing herds, that swelled the region's cattle population to the limits of what the range could support. A series of droughts and severe winter storms produced massive regional die-offs between 1883 and 1893, sending heavily leveraged ranches into bankruptcy and signaling the end of the open range (Sayre 1999).

The connections between improved breeds, corn-feeding and the Cattle Boom have been overlooked by scholars. Osgood (1929) and Dale (1930), who did draw these connections, did not query the parallel social relations effected by improved livestock in Britain and the US. The new breeds demanded ample supplies of high-quality feed: fodder crops such as turnips, cabbage and clover in Britain, corn in the US.[23] And as products of repeated in-breeding and stringent culling, they also presupposed robust enclosure of pastures to ensure strict control of the mating of individual bulls and cows. In both respects, pure-bred livestock was an extension of British agricultural improvement, the animal counterpart to agronomic innovations that accompanied and abetted enclosure. At a time when many estate owners had obtained authorization from Parliament to enclose but had not yet succeeded in achieving it on the ground due to local resistance (Thompson 1993), improved breeds may have afforded a potent new argument to justify their ambitions.[24] It was during the middle decades of the nineteenth century that enclosure was finally achieved and completed (Fairlie 2009), and this was also when a series of newly stabilized breeds – Shorthorn, Devon, Angus and Hereford – swept over the British countryside. British breeds brought the same potentialities, amplified by corn, to the US settlement frontier.

In both Britain and the US, the value of 'blooded' stock combined economic and ideological logics to advance and naturalize private land tenure and capital accumulation. 'These new livestock breeds were creatures of capitalism … designed to maximize their exchange value across global economic space' (Otter 2020, 34). In both countries, the average slaughter weight of cattle increased significantly over the nineteenth century, while the average age at slaughter declined by half or more (Dale 1930, 151ff.; Otter 2020). The rage for pure breeds did not actually improve productivity in Britain due to the prevalence of tenant farming (Walton 1999), but claims of economic efficiency served as discursive legitimation for the 'Barons of Beef' (Ritvo 1987). Leading breeders and their finest animals were treated like famous celebrities, patronized by large landowners anxious to affirm their class privilege in racial and nationalist registers at the same time. Imperial cultural norms valorized both consumption and production, as 'meat – and particularly beef – was regarded as a vital source of British power and stamina, a weapon of war and a tool of conquest' (Otter 2020, 21).

In the US, racial associations between livestock and their owners were more euphemized (Sayre 2018), and British breeds did increase productivity (Walton 1999). But the speed and thoroughness of the transformation in breeding on western ranches was

[23]'The higher levels of nutrition which the new fodders put to the hand of the stockman released the brake upon production, as it were, and let the mechanism of the animal run nearer to its maximum speed. The breeder was, thereafter, able to assess the true, unrestricted potentialities of his stock; and to detect their genetic differences' (Trow-Smith 1957, 258). Ironically, one of the English Longhorn's original traits was thriftiness, which became superfluous with the growing availability of high-quality feed; the Shorthorn gained in popularity, meanwhile, even though it required more feed than any other breed (Trow-Smith 1959, 57, 90).

[24]This proposition warrants further research; I have found surprisingly little mention of livestock breeds in the literature on British enclosure and vice-versa. Struggles over the enclosure of commons and estates had been ongoing for centuries, of course, and the infamous Scottish Clearances had been instigated in the name of converting arable land into pasture for sheep. By 1700, however, wool was giving way to cotton for textiles and demand for new pasture had waned (Fairlie 2009).

not due solely to the demands of farmer-feeders. The stage on which ranchers and farmers acted, and the script from which they read, were increasingly determined by the meatpacking firms that converted their cattle into commodities for urban consumers. From Chicago's Union Stock Yards, founded in 1865, a handful of firms came to dominate the trade in livestock arriving by rail from all points west. Armies of office workers with telegraph machines coordinated a network of branch plants and sales agents who used real-time price information and cut-throat tactics to undercut local butchers and retailers throughout the eastern US (Skaggs 1986). Even as they battled the railroads over their cartel-like control of shipping, the major meat processors resorted to outright collusion to consolidate their monopoly and monopsony power and exert downward pressure on prices paid to farmers and ranchers. The 1893 panic bankrupted big ranch companies and further strengthened the packers' position (Specht 2019). 'By the late 1890s, the packinghouses had largely taken over the financing of the cattle industry. The big packinghouses loaned money to commission agents, who loaned it to farmers seeking to buy feeders from the western range. The agents held a mortgage on both the corn and the steer. Long before the steer ever reached Chicago, Kansas City, or Fort Worth, the packers controlled it' (White 1994, 267).[25] As of 1916, meatpacking was the nation's largest employer (Skaggs 1986), and the Big Five packers (Swift, Armour, Morris, Wilson, and Cudahy) controlled 82.2 percent of the nation's cattle market, 76.6 percent of calves, 86.4 percent of sheep and 61.2 percent of swine (Virtue 1920). It was this dominance that compelled ranchers and feeders alike to produce cattle 'that could turn a minimum amount of corn into a maximum amount of beef in the minimum amount of time' (White 1994, 255).

5. The political ecology of corn-fed beef

We are now in a position to assess the significance of corn-feeding in the evolution of ranching in the American West. In the words of historian Edward Everett Dale (1930, 148), it is necessary

> to consider two aspects of the relations between the range cattle area and the corn belt, since both are of great importance and far reaching influence. The first of these is the sending of large numbers of breeding animals from the corn states to the western plains to improve the quality of the cattle in that region, while the second is the supplying of feeders from the western ranges to consume the surplus grain and hay of the corn belt. The two movements were contemporaneous and each dependent somewhat upon the other.

With the benefit of hindsight more than ninety years later, Dale's thesis can be restated more forcefully. The two regions and industries – farming and feeding in the Corn Belt, cattle ranching on the Western Range – were not just 'somewhat' inter-dependent but co-constitutive. Corn-feeding determined the breeds of cattle that ranchers raised; how they managed their land and livestock; the environmental ramifications thereof; government policies related to grazing and wildlife; land tenure and property systems across the trans-Mississippi west; and, arguably, the very conditions of possibility for ranching itself. Under the overarching hegemony of urban-industrial meatpacking, the *cattle-grain-beef*

[25]Dale (1930, 162–165) provides a more detailed description of cattle financing in this period. 'It is certain that the use of the same credit channels served to draw the range area and the corn belt more closely together' (p. 165).

complex formed a dialectical unity conditioning capital accumulation and class formation across the Great West (Cronon 1991).

As we saw in section 3, it was cattle imported to improve the breeding of ranch herds in the early 1880s that pushed many western rangelands beyond the limits of available forage, resulting in catastrophic die-offs during severe blizzards and droughts. The impacts were made worse by the animals' breeding: 'These eastern "pilgrims" exhibited a dangerous tendency to stand about the haystack in the winter, waiting to be fed, instead of rustling as did the native stock' (Osgood 1929, 217).[26] For the same reasons as in Britain, expensive breeds helped motivate enclosure and fence construction, which made the damage worse by constricting the mobility of herds and trapping them against fences during blizzards (Osgood 1929, 193).[27] Ranchers who had invested in improved breeds and fencing were more likely to double down than reverse course, however. Especially when forage grew scarce, maintaining profitability entailed a shift from quantity to quality – greater returns per animal instead of more animals – and breeding was seen as essential to this strategy.

In principle, corn-feeding provided ranchers with an outlet to reduce the pressure of their herds on finite forage resources (Barry 2021). British breeders had specifically aimed for 'an acceleration in the fleshing rate' (Trow-Smith 1959, 86), and grazing for more than a year or two came to seem wasteful. Cow-calf operations – ranches that specialize in selling calves – soon became the standard. Speed was a virtue for feeders as well; with Shorthorn blood, 'animals could be fed to respectable weights at two years of age, producing a superior quality of beef and returning a greater profit on the overall investment in the animal' (Bogue 1963, 102). It is unlikely that many ranchers significantly reduced their herds in a lasting fashion, however, since both bank loans and public lands grazing leases were written on a per-animal basis, making a ranch's established 'carrying capacity' a capitalized asset (Sayre 2017).

It is difficult to name a single tenet of mainstream range management as it developed between 1890 and 1950 that was not shaped in some way or another by the needs of cattle that had been selectively bred in and for radically different environmental circumstances. Ranchers were urged to adopt management practices and make capital improvements to provision and protect their valuable animals. Cattle were encouraged to graze more evenly by the strategic placement of salt or mineral blocks, or compelled to do so by interior fencing. Crossing pure-bred or high-grade bulls with Texas cows produced offspring that combined traits of corn-readiness and range hardiness. In many regions, though, investments in pastures or hayfields, irrigation, winter feed and water improvements were also deemed necessary.[28] Especially

[26]Application of the adjective 'native' to cattle in North America is peculiar and inconsistent. Here, Osgood uses it to refer to cattle acclimated to the range, in contrast to improved breeds imported from the east. The opposite can also be found: McCoy (1874, 169) used 'native' to refer to 'graded Durhams' found in the eastern states, in contrast to 'the Texan, or southern cattle.' Of course, cattle were not native to the Americas at all, and employment of the term participates in the ideological project of naturalizing Euro-American colonization (Sayre 2018).

[27]'By and large, the consequences of fencing have been deleterious, if not catastrophic, and have underlined the need for drastic destocking if pastures are to be preserved' (Ingold 1980, 258).

[28]The preeminent modern scholar of American ranching, Terry Jordan (1993, 274), described the dominance of the Hereford breed as 'one of the unexplained mysteries' of mid-20th century ranching, failing to recognize that economics, more than ecology, had dictated the choice. 'While he [the Hereford steer] surpasses other breeds as a grazier, he is equally prominent in the feed-lot. All cattle feeds are acceptable to him, and he responds as promptly as any to a ration of grain' (Gudgell 1908, 354).

after 1900, government programs emerged to promote these practices and subsidize the necessary investments, especially in fencing. The wholesale extermination of predators by the federal Bureau of Biological Survey was done in the name of protecting livestock that lacked the innate capacity to defend its young against wolves, lions, bears and coyotes (Sayre 2017).

It is ultimately impossible to estimate how much difference British breeds made to the ecological impacts of cattle grazing on North American rangelands. Judging from recent research with Criollo cattle – a Spanish-descended breed with 400 years of minimal husbandry in a remote area of the Sierra Madre Occidental in Mexico – it is reasonable to believe that it did make a difference and that this difference was, on balance, negative. Even after more than a century on US rangelands, British breeds tend to stay closer to water sources and on gentler terrain, and cope less effectively with predators and drought, than do Criollo.[29] In hindsight, the long-term ecological impacts to rangelands that may be at least partially attributable to the use of British breeds include selective, spatially uneven grazing pressure; riparian degradation; the extermination of many wildlife species (especially predators and rodents) from large parts of their ranges; habitat fragmentation by ubiquitous fencing; and widespread range 'improvement' practices (e.g. shrub removal, grass reseeding, chemical herbicides) intended to create or restore vegetation capable of meeting the nutritional demands of blooded stock. Viewed in light of current ecological theory, the countless artificial water sources installed for livestock may have shifted many rangelands from non-equilibrium to equilibrium dynamics, making them more susceptible to long-term damage by grazing (Illius and O'Connor 1999). These are legacies that ranchers, public lands agencies and environmental groups struggle with to the present day.

Improved breeds also had pronounced ramifications for the social and political relations of ranching. On several levels, breeding was a key driver of divisiveness, conflict and differentiation in emerging class relations. Among livestock producers, improved breeds favored those with access to capital to acquire and care for them. Not coincidentally, such men were likely to be White, Anglo-Saxon Protestants, and much more likely to own private land than the itinerant, non-landowning livestock keepers who also made use of the open range at the time. This cleavage aligns with Ingold's distinction between pastoralism and ranching, and the prejudice, harassment and occasional violence visited against herders by ranchers is best known in the case of sheepherders (Perkins 1992). But owners of 'scrub' cattle were also unwelcome insofar as their animals might dilute the genetic 'purity' of improved herds. Bred cattle favored enclosure, as in Britain, and elite ranchers prevailed decisively in the early twentieth century, when first the National Forests (in 1905) and later the remaining public domain (in 1934) were divided into grazing allotments for exclusive lease, with eligibility restricted to people who owned private, 'base' properties nearby – ostensibly to provide winter feed and forage (Merrill 2002; Rowley 1985).

Similar struggles divided ranchers from aspiring settler farmers, who continued to arrive in search of land for homesteading well into the twentieth century (McConnell 1953). Hopkins (1928, 75) captures this in the shift from herding to corn-farming in Iowa: 'Here was an actual struggle between an extensive and an intensive form of

[29]For details, see Estell (2021) and the other articles in the special issue of *Journal of Arid Environments*.

agriculture. Fences were a needless expense and a nuisance under the earlier system. They were a necessity in the later one.' Whether the onus of fencing lay on farmers (to keep livestock out) or ranchers (to keep them in) sometimes led to open conflict. In the late 1880s in Montana, for example, grangers were known to shoot cattle that wandered onto their fields and then eat them. 'Populism, which had arisen out of middle-western agrarian discontent, began to appear on the Wyoming ranges in the form of "anti-stock" agitation' (Osgood 1929, 245). Instead of uniting in opposition to eastern banks, railroads and corporate power, ranchers and farmers turned on each other, fracturing whatever resistance they might have mounted to the rising political and economic dominance of the Union Stock Yards. The land use, land tenure and property regimes that emerged from decades of struggle instead subserved the emerging cattle-grain-beef complex.

6. Conclusion

There has never been ranching in the US without corn-feeding, and neither the Western Range nor the Corn Belt could have become what it is without the other. Feeding livestock was the reason to produce so much corn in the first place. As settlement advanced, the ready supply of cattle from the range enabled corn farmers to dispense with calf production, while debt and market competition compelled them to plow up ever more prairie to plant crops. Today, an estimated 98 percent of the tallgrass prairie and 67 percent of the midgrass prairie is gone (Samson, Knopf, and Ostlie 1998). Reciprocally, ranching needed corn-feeding to make range livestock 'fit for eastern markets and consumption' (McCoy 1874, 166). Without grain finishing, it was simply not possible to convert rangeland forage into beef in the volumes and qualities demanded by rapidly growing urban markets. The middle-western range-feedlot system was a vast, humanly-devised novel ecosystem that sacrificed its most productive rangelands to the plow while enabling capital accumulation from extensive livestock production – in a word, ranching – on the unplowed, semiarid rangelands to the west.

Events of the late nineteenth century continue to shape the political ecology of US beef production today. Farmers and ranchers remain price-takers in a cattle-grain-beef complex that is even more prolific than it was a century ago, reliably producing affordable meat for a population that has more than tripled in size. Western ranches still specialize in producing calves from improved breeds of bulls and cows, and feeders still use corn and other grains to fatten and finish animals for slaughter. The Union Stock Yards have closed and slaughter facilities are now located in more rural settings in the Great Plains, but meatpacking is once again dominated by four firms whose combined market share exceeds 80 percent. Generally, the price ranchers receive for their calves is inversely related to the price of corn, reflecting the profit needs of feedlots. Many ranchers have sought to capture greater value by fattening and finishing their animals in other ways, but very few have found success. They are working against 200 years of history in a system that reaches from the genetics of their cattle to the expectations of their final consumers.

The major difference today is the CAFO. Responding to ongoing loss of rangelands, ever-increasing grain supplies, and the discovery of ways to accelerate animal growth with hormones and antibiotics, the feedlot parted company from corn farming after

1950 to become a specialized, stand-alone, year-round operation.[30] Some 18 million hectares were taken out of grazing in the 1930s and 1940s (Ogle 2013, 130). Hybrid seeds and abundant, cheap synthetic fertilizer drove national corn output from just over two billion bushels in the 1940s to six billion in the 1970s, while rapid growth in sorghum and soy output exacerbated the glut. (These trends continue; the national corn harvest now exceeds 12 billion bushels.) In a 1958 experiment, 'Scientists fed twin calves on different rations; one on 1908 rations, and one on 1958 rations. The 1958 animal gained 42 per cent faster on 30 per cent less feed at 33 per cent less cost' (Schlebeker 1963, 235). Iowa corn farmers began leaving the cattle business, unable to compete with ever-larger CAFOs and their demands for 'not just more consistent beef but huge quantities of it, far more than the average Corn Belt farmer-feeder could muster' (Ogle 2013, 137). The share of US farms with some beef cattle dropped from 80 to 44 percent between 1940 and 2010; farms with hogs plummeted from 75 percent in 1920 to less than five percent today (MacDonald 2018).

Today's CAFOs are extraordinarily efficient, and GHG emissions from US beef are much lower per unit of output than in the developing world precisely because improved breeds and grain feeding shorten the average cattle lifespan (Herrero et al. 2013). By separating livestock feeding from where the feeds are grown, however, CAFOs have turned a synergistic relationship into a dysfunctional one, transforming both corn farming and cattle feeding into environmental scourges. The rise of CAFOs was concurrent, moreover, with the increasing conceptual abstraction of ranching from farming and feeding. Range livestock and crop agriculture became separate fields among historians, geographers and anthropologists as well as range scientists and agronomists, abetting the historical amnesia that characterizes virtually all of the current scholarship and debates about cattle and beef production. As we've seen, the attributes heretofore proposed as definitive of ranching – exclusive land tenure, commodification of inputs and outputs, and capitalist profit-seeking – should be understood as complementary to or entailed by intensive grain feeding. In other words, feeding may be what best distinguishes ranching from pastoralism and marks a transition between them (Schareika, Brown, and Moritz 2021).

A unified theory of ranching and feeding also helps illuminate the extreme disparities between livestock systems in different parts of the world. One-third of global beef production today relies on grazing alone, and another 59 percent comes from mixed crop-and-livestock farms, but the rapid growth in recent decades has occurred entirely in landless, feedlot production systems (Gerber et al. 2015). The type, location and scale of feedlots will be critical determinants of both food security and sustainability going forward. If the practical ecological knowledge needed to revive the original feedlot can be recovered, the tradeoff between efficiency and sustainability may not be unavoidable: grain feeding based on circular production might replace and repair the metabolic rift. US corn farming might be weaned from synthetic fertilizers – and if this entailed reduced crop yields and harvests, as it almost certainly would, it would actually benefit Midwestern farmers beset by chronic overproduction. In the developing world, meanwhile, many of

[30]Some 'farmer-feedlots' still purchase young calves and grow them out using a combination of homegrown and purchased corn, but about five out of six beef cattle are fed instead in large CAFOs (>1,000 head) on corn and other feedstuffs produced off-site (MacDonald 2018).

the 650 million small-scale livestock producers might begin to 'earn enough to eat their own production' (Herrero et al. 2021, 14).

Acknowledgments

I am grateful to Mark Moritz and Nikolaus Schareika for organizing the seminar of which this paper is an outcome, and to the Wenner-Gren Foundation for supporting it under grant CONF-821. I would also like to thank Jeff Hoelle, Maria Fernández-Giménez, Alex Blanchette, and the other seminar participants for lively discussions and valuable feedback. Seminar participants in the School of Geography and Environment at the University of Oxford and the Department of Geography at UCLA helped improve earlier versions of the paper, and Neil Brenner, Roy Behnke, Sasha Gennet and two anonymous reviewers also provided keen insights and suggestions. Finally, I received timely encouragement from Ian Scoones and Annie Shattuck. I remain responsible for any shortcomings.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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