North American Beef Breeding and the Modernization of the International Cattle Breeding Industries, 1950–2000

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ABSTRACT *This article deals with transformations in beef cattle breeding practices in North America from 1950 to 2000, and the implication of these changes across the Western world. It was a period of profound adjustment for beef cattle breeders, involving battles over genetic defects, the importation of new breeds, changing standards in relation to husbandry, and the extension of quantitative genetic breeding practices. These innovations would be echoed across Europe in the production of beef cattle and would also interact with the way dairy cattle were bred. This article explains the upheaval in beef breeding between 1950 and 2000, as well as how that upheaval affected dairy cattle breeding. Changes in beef breeding, in effect, modified the functioning of the entire cattle breeding world.*

KEYWORDS *animal breeding, genetics, cattle, North America–Europe*

The 1960s and 1970s proved to be a time of great disruption and reassessment of accepted principles in animal breeding and agricultural production. The shifting dynamics of beef cattle breeding between 1950 and 2000 and concurrent modifications in dairying serve as prime examples of this disruption and reassessment. Little has been written about the breeding of beef cattle in the post-1950 period, particularly the years after 1970.[1] Yet changes in the North American beef industry were echoed in other parts of the Western world, causing international reverberations in both beef and dairy breeding that have had lasting effects. Attitudes toward breeds used, ways of evaluating product quality, the incursion of new principles from the science of genetics, and developing technology all played a role in reorienting beef cattle production, first in North America and then in Britain and parts of Europe. These changes, in turn, further modified the focus of dairy breeding, an industry already well along in the acceptance of quantitative genetics by the late 1950s.[2] But certain shifts relating to specialization for a single or dual purpose occurred in dairy breeding between 1970 and 2000, especially in Europe, paralleling new views on specialization in the beef-breeding industry.

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The rising concern with the increased production of a single commodity—a key driver of innovation in beef cattle breeding—also played a role in shaping the dairy world. This article reviews aspects of such transformations in cattle breeding between 1950 and roughly 2000 by, first, focusing on changes (and why they took place) in the North American beef cattle breeding world; second, assessing how those changes influenced (or mirrored) beef breeding in Britain and other parts of Europe; and third, looking at how certain characteristics altering the beef cattle world also affected dairy cattle breeding.

The article starts with a discussion around a critical factor initiating new outlooks in the beef world: the rise of a genetic defect, dwarfism, in North American Shorthorns, Angus, and Herefords. Then the article analyzes three important reactions to dwarfism: the importation of new breeds such as Charolais, Limousin, and Simmental; the way Shorthorn, Angus, and Hereford breeders tried to compete with those new breeds to overcome dwarfism; and the gradual transition among breeders from purebred breeding to quantitative genetics. The article also explains the basics of quantitative genetics and why the dairy breeding industry came to use its principles long before the beef-breeding industry. By comparing innovation in beef and dairy breeding, along with their industry structures, the article argues that certain characteristics relating to the dynamics of industry structure must be in place before animal breeding can adopt new procedures.

The article turns next to the situation in Britain, where the three traditional beef breeds originated, and analyzes reactions in that country to the shifts in North America cattle breeding. In Britain and most parts of Europe, beef meat was produced by breeding dairy cows to beef bulls, while in North America beef meat normally came from the breeding of beef cows to beef bulls. That difference would be important to how both beef and dairy cattle were bred on both continents. Beef animals to beef animals would continue to be the primary beef meat producers in North America, but specialized beef on specialized dairy cows, instead of the more dual-purpose milking cows such as Friesians, would take over the role of beef production in Europe. The article finishes its discussion by looking at the way dairy cattle breeding shifted globally in both geographic areas.

The Rise of Dwarfism in North America

The background to the dwarfism problem that arose in North America was set in motion at least as early as 1820, when British breeders of beefing cattle started a process of trying to create animals that matured earlier, which in part meant producing shorter animals. North American breeders continued over the years after 1850 to emphasize qualities linked with early maturity, such as reduced adult size, because they believed these brought about tender beef and did so in an economical way. As late as 1890, however, despite an ongoing emphasis on characteristics such as shortness, North American cattle were still relatively tall. A critical shift to a more extreme type, which would become increasingly common in North America (and Britain as well) by 1950, began in the United States in the 1920s. Very short cattle, later to be favored by show judges, had started to appear in various American herds by the first part of the twentieth century. As early as 1927, short-legged Hereford calves could be seen in Texas cattle shows.[3] They had been developed over the years via crossbreeding with so-called duck-legged black cattle found in Texas as early as the 1880s, crossed on Hereford bulls. By 1930 the animals from such constant crossing on Herefords had become almost indistinguishable from purebred Herefords. Some ranchers believed their duck-legged Hereford types fattened more easily than standard Herefords, but this was difficult to prove. While no move had been made to make the style dominant in beef herds by 1930, the stock certainly drew increasing attention in the show ring.[4] Meanwhile, Shorthorn breeders also began to work with short cattle. In 1933 a breeder in Nebraska started to select for shortness, using both female and male Shorthorns.[5] These animals spread out to breeders in Colorado and Kansas and were called "compact" animals.

Accepted styles began to change, and success in the show ring by these short cattle made more American breeders of all beef breeds select for blocky, compact animals. The consistent judge decisions favoring that cattle phenotype thus introduced a new trend in selection, a trend that influenced breeder decisions in Canada as well as the United States.[6] The collective views of judges reflected theories put forward by agricultural colleges across both countries about what constituted quality in a beef animal, thereby further encouraging selection for smaller animals in North America.[7] Believed to be "easy keepers" by the experts, the compact-style cattle were also deemed to be photogenic and, in the words of one historian, "more loveable to the ringside than their more growthy counterparts."[8] Uniformity of judge opinions concerning the style across many subsequent show ring events not only brought about pronounced breeding shifts within the purebred world but also shaped public opinion in the United States and Canada about desirable traits in commercial cattle. Ringside views mattered. Show results for purebred animals were particularly influential on the general herds in the 1940s and 1950s, when purebreds probably exerted their greatest impact on commercial North American cattle, a trend that had begun around 1920.[9]

By the late 1950s, particularly in the United States, it had become apparent that support for short, blocky phenotypes had introduced a serious genetic defect producing not just small cattle but also dwarfism, an autosomal recessive defect that often resulted in early death if a copy for it was inherited from both parents. Animals made especially successful in the show ring through judge decisions, it seemed, tended to have inherited one copy. They in themselves were thus not defective, but they were carriers of the gene and if bred to carriers could produce dwarfs. It also appeared that the defective gene, when present heterozygously (meaning when an animal had one copy), changed the phenotypic appearance of an animal. Show judges claimed that they could visually recognize carriers, yet research suggested that they were right only 50 percent of the time.[10] Phenotypic expression could not be relied on to accurately identify carriers.[11] Numerous studies, however, made it clear that carriers *as a group* were different from noncarriers as a group, by being shorter of leg and by maturing earlier (males particularly). Since these characteristics represented what show judges looked for, it seems clear that selection favored carriers.[12]

Reports of dwarfism in Shorthorns, describing the defect as "stumpy," were evident as early as 1950 in the United States.[13] Dwarfism would not be as serious in Shorthorn herds as other factors, but the breed never recovered its earlier prominence after the dwarfism debacle, and for complicated reasons. The historic strength of Shorthorns had rested on the breed's ability to serve both the beef and dairy industries. An increasing emphasis on beefing qualities and single-purpose breeds made it harder for Shorthorns to compete in the post-dwarfism era. That truth took some time to be evident, probably because of the long-standing position of the breed as the premier improved type of cattle.

In the Angus breed, the dwarfism syndrome became attached particularly to the Sunbeam farms herd of Oklahoma, an outfit operating since 1918. Sunbeam animals became greatly sought after over the 1930s and 1940s by Americans. Canadians, however, did not join in. They were not susceptible, therefore, to dwarfism through those Angus lines. That situation became especially important by the 1960s when all Sunbeam bulls started to get a reputation from commercial bull buyers for producing dwarf calves, whether they did so or not. The appearance of dwarf cattle in any commercial breeding operation was not only a dead loss to the owner, but it also created a tendency to blackball the owner's stock for farmers feeding stock for slaughter.

All connections with Sunbeam animals became anathema, and many herds tracing in any way to those lines were sold off. Sometimes purebred breeders doctored pedigrees to hide the connection. Importation of Angus from Scotland to Canada followed in efforts to counteract dwarfism by attracting buyers, but these tended to be of the blocky short type, by that time completely out of style. US purchasers commenced regularly making trips to Canada where older, taller Canadian lines could be found with no Sunbeam connections, but the buyers avoided the Scottish imports. For all the panic, dwarfism as such seemed to be a minor problem, especially in Canada. One researcher, after spending forty years studying Angus pedigrees, could establish only eight dwarf calves appearing in Canadian herds, and it was unclear, owing to alteration of pedigrees, whether there was any connection to Sunbeam stock. Angus breeders, particularly in Canada, had maintained some relatively tall lines, the type in demand by the 1960s.[14] Many would wonder if dwarfism in the Angus breed could be related to some crossbreeding between Herefords and Angus as early as 1900 or even earlier.[15] In light of that view, it is interesting that at least one study was undertaken in the 1950s to estimate similarities in the dwarfism gene in Herefords, Angus, and their crosses.[16]

American Angus breeders remained more concerned over the dwarfism issue than their counterparts in Canada, partially because of the earlier popularity of the Sunbeam animals. They split, however, over how to handle the dwarfism situation in the 1950s. The issue that caused the problem was whether to identify and label carriers. In 1956 board members of the American Angus Association received a letter from "A Committee of Angus Breeders," asking for the end of research on dwarfism and of collecting pedigrees on carriers. The association continued to do so, however, and in 1958 the research committee recommended certain approaches involving progeny testing. In the end most breeders did not progeny test but instead avoided using lines with known carriers. Dwarfism died relatively fast, with only five registered Angus bulls born after 1964 proven to be dwarf carriers. The last bull known to have sired a dwarf calf was born in 1977.[17] Dwarfism, however, reappeared to a limited degree into the twenty-first century. By 2008 researchers had developed a DNA test for carriers.

By the 1950s the dwarfism problem had become particularly severe in North American Herefords.[18] One 1956 survey estimated that about fifty thousand dwarf-producing Herefords existed at that time in the United States, far more than in the other two breeds. Carriers could also be found in Canada through popular sire lines. In contrast to the Angus situation, in which resistance to association interference had been strong, or the Shorthorn situation, where breeders simply avoided lines known to produce dwarfs, the seriousness of the problem in Herefords seemed to justify drastic measures. Breeders, scientists, and the American Hereford Association attacked the dwarfism problem through pedigree analysis and breeding trials. Since no DNA test existed and carrier status was often difficult to determine, even lines thought to potentially involve carriers were completely destroyed. As a result, owing to the elimination of much of recessive/recessive inheritance in calves, the defect virtually never appeared in Herefords by 1970.[19] Concern with where the defect originated, however, did not abate with strenuous efforts to eliminate it. In 1974, after exhaustive research, L. P. McCann traced the defect back to the bull, St. Louis Lad, born in 1899.[20] How Hereford crosses had worked with the short so-called duck-legged cattle of Texas in promoting dwarfism was not known. Many were, however, interbred with Angus, and Angus breeders began to wonder whether the defect had entered Angus ranks through the same bull, St. Louis Lad.

The various physical manifestations of dwarfs in the breeds had puzzled scientists over the years before the issue became widely known. American geneticist Jay Lush, for example, wondered in 1930 whether the "duck-legged" gene reported in Hereford cattle related to the "bulldog" gene found in Dexter cattle.[21] It had become clear by 1950 that what looked like physically different forms of dwarfism appearing sporadically in various Shorthorn, Angus, and Hereford herds were all manifestations of one genetic defect, and it did not appear to be bulldog dwarfism. Scientists decided that "stumpy" Shorthorns, as well as what was called "snorter" dwarfism in Herefords and Angus, resulted from animals' carrying two copies for the same genetic defect, which they named snorter dwarfism. One study in 1950 concluded: "In the absence of genetic tests . . . the simplest and most tenable [conclusion from various studies] is that both Hereford and Aberdeen Angus breeds carry the same recessive dwarf gene." The study added, "It seemed likely, based on morphological characteristics, that this type of dwarfism is in Shorthorns as well."[22] Understanding that all were aspects of one form of dwarfism, of course, did not do much to eliminate the problem from the herds.

Ultimately, a new North American demand for larger cattle drove the decline in even healthy short-statured compact cattle. The dwarfism debacle also led judges to favor taller and leaner stock in show animals after 1960.[23] Judges' preferences for ever larger sized animals continued unabated until the late 1980s. The framescores of animals between the 1950s and 1990 demonstrate the dramatic shifts in style that judging brought about. (Framescore is a method of estimating relative skeletal size of adult cattle based on hip height. Framescores vary from 1 to 11.) Show cattle of the 1950s often had a framescore of less than 1. By 1990 the framescore of show winners averaged 10 or higher.[24] It was a different world for breeders of the three major breeds serving the beef industry in both the United States and Canada.

Dwarfism and the North American Importation Movement

An importation movement favoring the large continental breeds like Charolais, Simmental, and Limousin, which emerged in the late 1960s, fed into the general demand in North America for greater size. The desire to import, however, carried with it difficulties, most notably the danger of introducing diseases like foot-and-mouth, and rinderpest. It was a problem that both the United States and Canada had confronted since the late nineteenth century, but by the 1960s the organization and quarantine stations for incoming livestock that had been established between 1878 and the early twentieth century had long been discontinued.[25] How to import, guarantee breeding quality, and overcome the threat of introducing disease were all issues that came to a head in 1963 when cattlemen from Western Canada pressured the Canadian parliament to consider putting in place a system for importing Charolais for crossbreeding and for establishing purebred seedstock herds.[26] International animal quarantine agreements within North America, in place since the foot-and-mouth Mexico episode of the 1940s, made the situation particularly difficult. An outbreak of foot-and-mouth in Mexico had led the United States and Canada to agree to cover the staggering cost of eliminating the problem on the condition that all three nations agree to a continuing embargo against future livestock imports from any nation where foot-and-mouth or rinderpest were known to exist. Quarantine for animals moving among these countries after the plague had been eradicated in Mexico would not be required. Stock coming from what were believed to be "clean" countries, especially Britain, would be quarantined off New York at Plum Island. The new demand for breeds of beef cattle from countries where either foot-and-mouth disease or rinderpest existed, namely, those in continental Europe, triggered the need for new attitudes to importation regulations.

The Canadian government quickly saw the situation as providing a unique opportunity to enhance the country's interests by taking the lead in regulating importation. By setting up a quarantine station for incoming European cattle, and with the support of the American government in doing so, Canada could act as the North American agent for new bovine genetics throughout North America. Because the old nineteenth-century cattle stations in Canada had long been closed down, an entirely new quarantine organization had to be put in place to capitalize on the opportunity. In 1965 the Canadian government announced its plans to open a post for cattle from Europe at the old immigration station off the coast of Quebec on Grosse Isle. The new station would adopt the same testing and quarantine procedures as the Plum Island station, and officials invited representatives of the American government to make sure the station met their standards for entry into the United States.[27] By fall 1965 the new cattle station was ready to receive imported stock; by May 1966 the first had arrived. Quarantine was set for six months at the station and a following three months on a local farm, after which the stock could not leave Canada for five years from date of entry. The production of stock generated by the imports would, therefore, be in Canadian hands for a relatively long period of time. The government had ensured that the incoming cattle would benefit Canada first, thereby cementing the country's lead position in the move to new breeding strategies. "It was a brilliant economic and political move," noted historians of the French Limousin breed.[28]

In the first year of the new Canadian import station, one hundred head of Charolais arrived, mostly bulls. The 1966 permits also included the first Simmental, which would enter North America in 1967. From the beginning, in an innovative attempt to assess a bull's productivity, data collection would be central. Owners kept track of birth weights, weaning weights, and yearling weights of the new crossbred progeny, procedures that were still unusual in any form of beef cattle farming in the 1960s. The intention was also to use artificial insemination, a technology long accepted by the dairy industry, where it had led to spectacular results.[29] While both data collection and artificial insemination were pioneering approaches, breeders continued to work within traditional frameworks of the beef industry. Buyers of animals from the new breeds, for example, quickly formed breed associations with the intention of taking on the traditional role that breed associations had always had: promotion over other breeds. Similarly, data collected by owners was aimed primarily at advertising their bulls' worth against the value of bulls belonging to other breeds.

Reaction to Dwarfism by North American Shorthorn, Angus, and Hereford Breeders, 1960–80

Shorthorn, Angus, and Hereford breeders, if their stock was to compete in the new beef world of the United States and Canada, which now favored the imported Charolais, Simmental, and Limousin, had to address the problem of not only eliminating dwarfism from their ranks but also dramatically increasing the framescore of the animals. The reactions to the size problem of Shorthorn, Angus, and Hereford breeders were, not surprisingly, similar in both countries. The outcome of their reactions, however, led to different futures for each breed. The general strategy was twofold: first, to select for taller lines within their breed; and second, to crossbreed, either furtively or openly, with dairy cattle.

American Shorthorn breeders selected for greater framescore within their ranks, then quickly moved to crossbreeding with the Milking Shorthorn, an older dairy breed that had been sidelined when breeding for beef became the dominant factor in Shorthorn selection. It was not difficult for the beef breeders to do so under the purebred system, since Milking Shorthorns were still recognized as pure Shorthorns. Little headway seemed to result from this breeding strategy, and North American Shorthorn breeders began looking to importation from Europe instead. The stumbling block in this breeding strategy was the problem of pedigrees, and the purity designated by pedigrees. In 1972, the American Dick Judy noticed tall Shorthorn-type animals in Ireland that did not have pedigrees. He believed he could sell the animals for use on Shorthorns in the United States even without recording in the Shorthorn herd book. Canadian Shorthorn breeders had also become aware of the Irish animals. Grant Alexander, a Saskatchewan cattleman who was active in the importing business and whose family had been involved with Shorthorns for generations, began buying a year after Judy. He was fully aware of their non-pedigree status.

The pedigreed problem became apparent almost immediately. The American Shorthorn Association refused to register Judy's new non-registered Irish Shorthorns in their herd book. Discouraged, he started to sell off his devalued imports.[30] Alexander and his partners were prepared to use the new stock for breeding regardless of a non-pedigreed status in Canada. By breeding up from the non-pedigreed Irish Shorthorns, they argued, fellow Shorthorn breeders could in the end obtain purebred status by grading up over four generations. When the cattle arrived in Canada, however, breeders pressed for some sort of registration in the Canadian book. The animals were, as a result, admitted into an appendix (grade or crossbred) Shorthorn book.[31] Entry into North American herd books would follow shortly. Irish exporters had by that time addressed the problem of pedigrees for their animals in one way or another. "Many cattle were placed into the herd book if a good bottle of Irish whiskey was involved," Alexander reminisced.[32] Irish breeders often used bulls of unknown background, purchased at local auction marts. Pedigree status had to be manufactured under these conditions.[33] Ancestral background was therefore often invented. In Alexander's words, "I simply shake my head when I see some of the pedigrees that some people will use in their herd, only because the registration paper says they are pure. Total horse feathers in many cases!!"[34]

It is clear in the case of Shorthorn importation patterns that, to trade in "non-pure" stock, importer and exporter had to make cattle fit into a pedigree mold. Exporters invented pedigree status for cattle with unknown ancestry backgrounds, while importers subsequently registered those animals on that basis. The pedigreeing of Irish cattle, along with their entry into North American herd books, resulted in an exploding transatlantic trade.[35] As the international market for Irish cattle mushroomed, Canadians demanded that the cattle be allowed into their closed (purebred) herd book. Alexander and his partners disapproved. "My partners and myself, were totally against this happening," he explained, "as we knew full well that these cattle were appendix at best and more likely truly grades, and I travelled to Vancouver to be able to speak on this motion and try to leave these cattle where they were in the appendix herd book. I was the only opposing vote and it passed."[36] In the case of Shorthorns, the drive for greater size took precedence over the desire for purity of breed.

North American Angus breeders either worked carefully with older, taller lines, imported cattle from Scotland, or started hidden crossbreeding programs with black-and-white Holsteins. As with Shorthorns, it had become apparent by the late 1960s that dairy specialized breeds could play an important role in correcting beef production and size in the cattle. Neither Angus nor Hereford breeders had the advantage that the Shorthorn breeders had in this department, a purebred dairy specialized arm to the breed, and so dairy crossbreeding had to be hidden. Studies on the crossing of Frisian dairy cattle (derivatives, somewhat beefy, of the Dutch Black-and-Whites) and Angus showed promising results as to meat production and size of the progeny. Another advantage was the black color in the makeup of either Frisians or Holsteins (another but more specialized dairy derivative of Dutch Black-and-Whites), and both carried similar desirable characteristics. During the 1970s much international research was done on crossing Friesians on beef cattle for improved meat production, which may have influenced farmers wanting both better production and greater size. A study in New Zealand, for example, pointed out that "the use of Friesian cows, or the grading up of traditional beef breeds to Friesians, offers the possibility of incorporating superior maternal ability into beef herds at a faster rate than may be feasible by selective breeding within traditional beef breeds and requires future study."[37] Even more damning for the purebred Angus was the following statement: "The present results show that the progeny of Friesian cows have a higher return per carcass than those from Angus cows, the straight bred Angus having the least value per animal."[38] How much crossing of Friesians or black-and-white Holsteins (which were far more common than Friesians in North America) was actually done in North America in the 1970s—and manufacturing of pedigrees to hide the practice—is unknown. But remarks made by breeders, privately and in confidence to the author, suggest that some of both were done.

The drive for larger and leaner cattle forced North American Hereford breeders to change breeding aims as well. At first breeders tried to recover by breeding for size within registered lines, but the narrowed genetic field available—due to numerous dwarfism carriers in the herds and restrictive demands for pedigree purity—made this difficult. Some US breeders imported Hereford cattle from Britain; some wanted tall Canadian Herefords. Breeders became increasingly desperate for leaner and taller cattle, in order to compete in both the marketplace and the show ring. By the late 1970s, US Hereford breeders had begun to introduce crossbreeding or breeding up in their programs by using red-and-white Holstein genetics, albeit in an underhanded manner within the registry purity environment. As early as 1956, a comparative study on the productivity of Herefords and Holsteins indicated the benefits of crossbreeding: "At any given weight or age, animals of larger mature size will gain more rapidly on less feed than animals of smaller mature size. Further, carcasses of the larger animals will contain a higher proportion of muscle and a lower proportion of fat. Differences in percent of various wholesale cuts are small."[39] The only evidence of "breed effect," the study concluded, was size of the animal. It seems probable that, since blood typing could not easily distinguish a Holstein/Hereford cross from a pure Holstein, crossbreeding offered breeders a way out of their dilemma. Hereford breeders, like Angus breeders, saw the crossing of Holstein dairy cattle on their breed as a potential answer to their problem of increasing size while maintaining pedigree status or "purity."

The Fortunes of North American Shorthorn, Angus, and Hereford Breeds in Relation to the "Exotic" Breeds, 1980–2000

How successful would breeders of the three original beef breeds in North America be in a new industry dominated by the European continental, or "exotic," breeds? Shorthorn breeders found it difficult to compete. The breed's fate seemed to be tied to vestiges of its dual-purpose history. Single-purpose Angus and Herefords fit better with the increased emphasis on the production of one commodity that so dominated many other aspects of agricultural change in this period. While the Angus and Hereford regained their former positions in the North American beef industry, the Shorthorn, with its reduced market, remained tied to the show ring and the ethos of purebred breeding. As Shorthorn numbers fell in relation to the growth in other breeds, it became difficult to effectively incorporate quantitative genetics, with its reliance on large datasets, in Shorthorn breeding operations, thereby encouraging the dominance of the purebred method alone, with its interconnected base of pedigree keeping, ancestry and individual worth, and the show system. Since marketing via showing was fundamental to purebred breeding, Shorthorn breeders logically remained concerned with show markets. A vicious circle developed, however, when the breed held a relatively weak position in the beef world. More show breeding meant less utility breeding, and less utility breeding meant a smaller commercial market, which in turn drove more interest in show breeding. The show market became so important to this breed that the continuation of genetic defects could be seen almost as a positive good. That situation became particularly evident when a new autosomal recessive defect emerged in the breed as a result of judge decisions in the show ring.

North American Shorthorn history after 2000 showed that breeders were not always prepared to remove recessive genetic defects, even if it was within their power to do so, as evidenced in Shorthorn breeder reactions to a microsatellite test for the defect tibial hemimelia, known as TH and labeled as such in 1999. Defective calves, with shortened to nonexistent hind legs, the brain cavity often open, and unable to live, had begun to appear in the 1990s as a result of inbreeding to certain sire lines desired for show purposes. The defect may have been simply covered up, perhaps because affected cattle emanated out of valuable exhibition animals.[40] Breeders resisted any organized efforts to remove carrier animals from the herds, arguing that markets (in this case for show cattle) should drive pedigree status. "Let the cream rise regardless [of] who breeds it," reasoned one. "That's exactly right," another breeder replied. "And if someone wants to breed carriers, then let them. The buyers will determine if there is a market or not."[41] TH carrier (or THC) cattle sell because they win at shows. The market wants THC cattle; therefore, they should be pedigreed. Attitudes of this nature made it impossible for the American Shorthorn Association to act more aggressively.[42]

By 2000 North American Angus and Herefords, longtime meat specialists from historic times, had reestablished their strong position in the beef cattle market and in the end competed successfully with the imported European breeds. The breeds had recovered by avoiding or eliminating dwarfism from the herds, and also by adopting standards that favored more useful cattle as to size and frame, matching that of the European breeds. The hidden cross-breeding practices had mostly been forgotten or forgiven.

When concepts of purity attached to purebred breeding overrode practical considerations of greater size, however, cracks in the transition became apparent. In 1983, for example, what turned out to be a remarkable Hereford bull was born within an environment demanding lean meat and greater framescore. Named KLC RB3 Perfection, he became a sensation as a show winner and sire of the tall, lean calves so desired by the new beef industry. He amassed a fortune for his owner, Dr. Willard Keith, a wealthy hobbyist breeder. Hereford breeders, jealous of Keith's success, became openly suspicious about the bull's ancestral background. Some argued that Perfection's registered Hereford dam was in fact half-red Holstein. It was well-known that top Hereford breeders were carefully introducing foreign genetics to increase the stature of their cattle, even if the matter was never publicly brought to light. In 1986 the authorities of the American Hereford Association and of the American Polled Hereford Association managed to convince the organizations to deregister both Perfection and all his descendants. The Canadian Hereford Association followed suit. By that time semen sales were huge; each individual descendant of Perfection was believed to be worth $265,000. Non-pedigreeing Perfection and his descendants would cause great hardship. The animals' value would be reduced to virtually nothing.[43]

There were two reactions among Hereford breeders. One was an attempt to form a new registry. Cattlemen ruined by de-registry of Perfection stock tried to form the International Hereford Organization in order to certify Perfection animals and, as one article stated, to "declare the bull once more as purebred."[44] The other reaction proved to be more fruitful. Perfection's owner and those involved in marketing his semen brought nine lawsuits against the Hereford associations. The associations, to avoid payments, capitulated without bringing the issue to court. They agreed to reinstate the pedigree status of the bull and of his progeny that had been conceived before August 1989. Cattle with Perfection background, however, were to be stigmatized: the letter *L* was to go before their registration number. Furthermore, Keith was debarred from the organizations and ordered to breed no more Herefords. In many ways it was a Pyrrhic victory for those determined to demote Perfection, but on the other hand the bull's popularity was enormously diminished by the chain of events. The crisis of that allegiance to purity and pedigrees, and the connection of both to monetary worth, faded into the background quickly, as breeders tried to forget the debacle.

The breakdown of old ways in the American and Canadian beef industries, through the introduction of the "exotic" breeds and the reorientation toward desired animal structure, created an environment that supported change on all levels. Anything seemed possible after the rigid structures imposed by purebred breeding standards and culture came under attack. Importers of European beef breeds, in particular, wanted to establish new structures that supported data collection and, ultimately, the principles of quantitative genetics. Breeders of Shorthorns, Angus, and Herefords quickly followed suit in adhering to standards based on statistics. It would be years, however, before systems in the North American beef industry could in a broad way even come close to those found in the dairy industry by the 1970s. Beef breeders, especially those of the older breeds, regardless of their desire for change, could not simply abandon historic methods used to qualify excellence, in part because of a general lack of clarity as to how beef productivity levels could be measured. Even though a redirection had fundamentally altered all thinking around how beef production should proceed and be judged, change would take time—a fact illuminated by the experience of the international dairy industry with quantitative genetics.

The Viability of Quantitative Genetics in International Dairy Cattle Breeding

In 1950 the only signs that quantitative genetics would penetrate livestock breeding could be found in the international dairy industry. Unlike any other animal industry except poultry, the international dairy industry had international structures in place capable of collecting and corelating data necessary for quantitative genetic analysis. Within a decade it was clear that dairy cattle breeding stood on the cusp of undergoing major shifts, owing to both quantitative genetic emphasis on sire testing and reliance on technology in the form of artificial insemination. Comparatively, the international beef cattle industry seemed to be stuck in the dark ages of purebred breeding, a system that primarily supported the views of purebred breeders, with their adherence to ancestry worth and physical looks rather than productivity.

A primary reason that quantitative genetics could arise relatively smoothly in the dairy industry was that data could be collected on an easily identifiable production question: milk. No similarly straightforward factor could be tied to better productivity in beef animals. The dairy situation also makes it clear that certain critical factors would influence how effective any data collection would be. The road to proper data collection would prove to be long and arduous. An independent body for the collection of data had to exist, for example, coupled with broad agreement on the question of productivity. That would not happen in the dairy industry in any country for years. Understanding that environmental conditions could skew data results was also important, but this remained difficult to appreciate before the advent of artificial insemination. The idea that all data—not just that showing positive results—was essential for proper interpretation would be hard for many breeders across the Western world to accept. Quality could be judged only by taking into account the effects of varying environmental conditions and by assessing the relative percentage of good offspring over bad. The evolution of historic data collecting systems of the dairy industry in North Americas reveals much about the different paths of dairy and beef cattle breeding.

The earliest testing of cows for milk yields in the United States tended to revolve around milking competitions at shows, but it was breeder associations in particular that gave the practice greater acceptability. Almost as soon as they came into existence, American associations required milk tests for animals entered in the herd books.[45] Milk testing continued to be an integral part of American pedigree registration structure and breed promotion, and in fact it played an ever more prominent role in the breeding and marketing of purebred dairy animals. In 1926 the American Ayrshire Association created a herd test known as the Herd Improvement Registry (HIR) and required that all registered cows within a herd be enrolled. However, the stipulation that low records could be canceled or concealed if the animal was dropped off the registry in the herd book distorted results and weakened the usefulness of the test.[46] Within a few years other dairy breed associations adopted the structure, each establishing its own rules for the program. It should be pointed out, though, that at this time the vast majority of dairymen in the United States was not part of any scheme to collect data on milk yields. The purebred breeders represented only a tiny fraction of dairy farmers, so their input was small. They also tended to use the data they collected to promote sales rather than to progeny test bulls.

The keeping of milk records outside the structures directed and run by the American purebred breed associations would initiate what would become a more comprehensive way of assessing the productivity of general milking herds. Organized testing for milk yields by cow testing associations, run by dairymen outside breed organizations, originated in Denmark.[47] In 1906 Helmer Rabild, a Danish immigrant based in Michigan, started the first cow testing association in the United States using the Danish model. By 1929 cow testing associations had sprung up in all forty-eight states and were supervised by state agricultural departments.[48] Ordinary dairymen, whether or not they used purebred cows, were interested in the results. The move of the general dairy industry producers into the process of milk data collection ultimately brought them into the process of breeding, for they would provide the volume of documentation needed to quantify results of breeding bulls. The groundwork was laid for comprehensive data collection to be used to rank the productivity of cows in relation to their sires.

The idea that milk data could be used to identify good bulls had been theorized as early as 1913 by Nils Hansson of Norway. He postulated that, when the production of the daughters of a sire is compared with that of their dams, it might be possible to see how much of their milking ability had been inherited by these daughters from their sire. A bull index works on the assumption that the level of inheritance of a daughter is halfway between that of her sire and her dam, and that by knowing the milk-producing level of dam and daughter, the sire's transmitting ability could be calculated.[49] By the mid-1920s, it had become apparent to many that the milk data records were in fact more useful in identifying good bulls than identifying cows. In the United States, a national sire-proving program, known as bull indexing, was initiated in 1936, in which daughters of each sire were compared with their dams.[50] Milk data might be firmly linked to sire progeny testing, but applying quantitative genetic principles to that data would not be possible until the advent of artificial insemination technology. Data collection at the time did indicate, however, how poorly the American dairy industry was functioning in terms of productivity. In 1936 it was apparent that, of sires recorded, almost half lacked enough daughters with records to appraise their inheritance. Furthermore, of all sires recorded, only one in four showed real evidence of being superior. Dairy-herd improvement associations also argued that only one-third of cows produced enough milk to make them profitable to farmers, while another third provided enough to break even, and the last third were so poor that they cost their owners money. At that time less than 2 percent of the nation's dairy cows were listed in any herd improvement association, and these were probably the best producers.[51] The breed associations still played a powerful, but not necessarily constructive, role in data collection on milk yields and on sire testing via those milk yields. The publishing of good milk yields was a primary way of promoting breeds and herds within breeds, and breed associations pressed their members to collect data with this in mind. But only good results were made public.[52]

The advent of artificial insemination (AI), utilized in a widespread way, would solve a lot of problems relating to impartiality and comprehensiveness of data collection. But the AI industry relied primarily on the existing structures to collect data and generate good information on breeding males. AI, therefore, simply fine-tuned structures already in place and, by allowing for the utilization of quantitative genetic theory, made the whole system more effective. The importance of frozen semen, introduced in the 1950s, cannot be overemphasized. Frozen semen allowed for the use of dairy bulls under enormously different conditions, which meant that nongenetic factors such as environmental influences could be neutralized when evaluating the breeding potential of the animals. Before the advent of frozen cattle semen, bulls were used only locally because the semen could not be moved any substantial distance. Bulls might work well in herds where good management prevailed, but in herds where management was poor the results were often less than satisfactory, thereby masking how much genetics had contributed to the good results.[53] Evidently, the restricted testing of elite bulls had masked their genetic worth.[54] By 1955 some 30 percent of registered American dairy cows were artificially inseminated with frozen semen.[55] By 1965 almost all cattle semen in the US was frozen.[56]

The Viability of Quantitative Genetics in North American Beef Cattle Breeding

This detailed history of data collection methods relating to milk production, the rise of AI, and assessments of sire worth reveals how difficult it was to make such a genetic breeding system work.[57] Collecting data was all very well, but its value was limited as long as it remained tied to breed promotion. How accurate would sire assessments be under differing environmental conditions? Events in the dairy industry made it clear that certain factors had to be in place before quantitative genetics could work, and that it took years for that to happen. The North American beef industry by the end of the 1950s had no comparative historical background as to data collection, agreed-upon standards for production, or an appreciation of how significant environmental variables could be. Dwarfism swept away many accepted beliefs relating to the power of purebred breeding and left the beef cattle industry in the United States and Canada ripe for change, but real change would require a way to identify both what characteristics defined productivity and a structure to collect constructive data. The industry needed to undergo a profound reorientation toward assessing productivity levels to lay a foundation for quantitative genetics. The international dairy industry arguably advanced quantitative genetics as much as quantitative genetics advanced the dairy industry. The two grew together.

Attitudes of the purebred North American beef associations initially stifled any move toward quantitative genetics. They actively opposed the use of AI, for example, and did not allow it for registration purposes until long after the American and Canadian dairy industries had accepted the technology. They believed that AI would decrease their trade in live bulls with commercial breeding farmers, which was their most important market. Furthermore, it was hard for commercial operators to extensively practice AI. Large herds, under minimal management, discouraged the widespread use of AI, and that fact alone hindered the development of quantitative genetic work in beef cattle: the data needed did not exist. The negative attitudes of North American breed associations toward quantitative genetics also slowed the transition. From their beginnings in the 1880s until well into the 1960s, the associations controlled views on how to achieve genetic advancement, and they evaluated breeding worth on the basis of ancestry, show ring success, and subjective visual appraisal.[58] Furthermore, much of the efforts of the purebred breed associations that served Shorthorns, Angus, and Herefords in the United States and Canada were directed at promoting breed interests in competition with the other two. The influence of purebred animals could be felt throughout the industry in both countries. The breed associations, in effect, acted as the ruling class of the North American beef industry. The associations continued to assess productive quality through visual appraisal, via show ring competition. Even academic livestock specialists, at least up to the 1940s, had some sympathy with the idea that it was hard to judge beefing quality in any other way. There was no straightforward counterpart to milk production as a measurable outcome.

Dwarfism, the importation movement, and the demand for a different style of cattle forced the breed associations in both North American countries to revise their outlook. One of the first important concepts to be adopted by the associations was the need to generate data that could be used to reveal levels of productivity, outside the use of the show ring. The first association effort to provide a more objective view of purebred quality (and therefore useable data for eventual testing quality of offspring) was the Red Angus Association, which in 1959 required weaning weights to be provided before pedigree registration was possible. This was a notable first attempt to evaluate potential productivity through data collection. Over the 1960s other beef breed associations developed performance-recording programs, although the Angus association remained the only one that required data reporting. It had largely been the demands of North American beef cattle–feeding farmers in the 1940s and 1950s that led to the earliest efforts at improving performance recording of purebred beef cattle. Cattle-feeding farmers had found the short, blocky cattle emanating from Shorthorn, Angus, and Hereford breeding expensive to feed relative to slaughter values and subsequently rejected them.[59] Their rejection set off a chain of events. The commercial breeding sector was forced to reassess the role of genetics in its operations, namely, the bulls emanating from the purebred industry. At the same time, North American purebred breeders were struggling with dwarfism. Effectively all beef farmers agreed that entirely new structures were needed. A move to better orchestrate improvement programs began in 1965 and resulted in the Beef Improvement Federation, formed in 1967. The breed associations maintained a strong voice in that organization.[60]

Quantitative genetics changed the breeding climate in the North American beef world by calling for selection on the basis of productivity across populations, not individuals as in purebred breeding; emphasizing progeny testing as opposed to the purebred emphasis on ancestry breeding; and pursuing data collection to a far greater extent than under purebred breeding.[61] By the 1970s the purebred associations in the United States and Canada, particularly those supporting the newly imported European breeds, began to adopt more sophisticated performance evaluation systems emanating from quantitative genetics. Evaluation revolved around what was known as EPDs (estimated progeny difference) for a variety of traits. An EPD is a prediction of an animal's likelihood of passing on a trait in relation to breed average for that trait. While the most common EPDs calculated were for birth weight, weaning weight, and yearling weight as gain per day after birth, the number of EPDs expanded over the years in relation to the capacity of computers to handle complicated statistics.

Under breed association structures in the United States and Canada, however, data collection continued to operate solely in competition with other breeds, a phenomenon that the international dairy industry had learned over time to be unworkable. In addition, the limited use of AI, when compounded with the splintering of data collection by breed, made meaningful quantification of results impossible. These factors prevented the beef industry from adopting until well into the twenty-first century one of the most important aspects of quantitative genetics: effective sire indexing. It was only when the North American beef breeds pooled their resources that some effective sire indexing became possible. In the dairy industry, in contrast, the vast numbers of dairy cows belonged to one breed, the Holstein, and the vast majority of them were bred by AI. Therefore, data collection by AI and breed provided adequate numbers to quantify breeding quality of bulls.

The powerful incursion of quantitative genetics into both dairy and beef farming in North America did not spell the complete death knell of purebred breeding or its culture. Pedigreeing continued to be important. Purebred breeding, through pedigreeing, orchestrated how innovative trends could mesh with older ways. In essence, purebred breeding adjusted to the infiltration of quantitative genetics by maintaining power over the regulation of data collection. It was the change of focus to an emphasis on productivity and away from simple breed promotion that would be so important to pedigreeing. Show ring culture with its directive force over breeding did not completely vanish, even though many breeders derided it.[62] "The showring is promotional, but seldom breed-improving," one North American Simmental breeder commented in 1974. "Yes, the showring is a wonderful place to meet and visit with old friends. But how can it measure and select breeding cattle for the future based on one day's parade of only visual analysis all done by one judge for all breeds of cattle?"[63] Despite efforts to downplay the importance of the show ring, Simmental and Charolais breeders in the United States and Canada would use it to promote their animals to farmers interested in crossbreeding. The quantitative genetic approach helped, however, to shape new attitudes of show ring judges. The framescore desired in cattle, for example, changed. By 2000 preferable framescore was set at about 7—or the common size of cattle in 1890.

The North American Beef Cattle Situation and the British Beef Industry, 1940–2000

The impact of North American innovations on the British beef-breeding industry, especially in relation to the Shorthorn, Angus, and Hereford breeds, must be seen within the context of the general British and European cattle world. In these areas, breeding for beef specialization represented only a minor sector within cattle industries generally. Breeding purely for beef purposes never commanded the same attention as did breeding for the dairy, especially in northern European countries like the Netherlands and Switzerland.[64] Britain was somewhat unusual in this context, since breeding for beef had been a significant aspect of the nation's cattle industry since the time of Robert Bakewell in the eighteenth century, but actual production of beef meat in Britain matched prevalent European patterns, especially a heavy reliance on dairy cattle. Beef in Europe historically resulted from male dairy animals and older cows or, increasingly in recent times, from the crossing of a beef-oriented bull on a dairy-oriented cow. By the late nineteenth century, the situation in North America, as to both the breeding of stock for beef purposes and the production of beef meat, presented a sharp contrast. The vast amount of beef meat in Canada and the United States came from using beef bulls on beef cows. The meat of dairy cows, or dairy cows crossed on beef bulls, both of which might be called dairy beef, never accounted in North America for more than a quarter of beef meat production, while in Europe about 75 percent of beef production could be described as dairy beef.[65]

Britain thus supported a viable beef cattle breeding industry, but the primary focus of beef breeding had been to produce bulls for crossing on dairy animals. What makes this story especially complicated is the historic position of the Shorthorn in that world. The breed served both the beef and dairy industries until at least 1940. Shorthorn breeders bred for good beef-producing bulls, but they also concentrated on the milking capacity of cows. Shorthorn bulls supported the production of British dairy beef, but, since Shorthorn cows had been the backbone of the dairy industry in Britain, Shorthorn beef bulls would be crossed on Shorthorn dairy cows to produce dairy beef. Shorthorns, then, had been the primary animal to serve both the beef and dairy industries because the breed, unlike Angus or Hereford, could be bred to excel either for beef or dairy. Although never designed to be truly dual purpose, the breed was malleable enough work with both industries.

That situation had started to change by 1940, with the decline of the dairy Shorthorn and the rise of the British Friesian. Popularity of the Friesian over the Shorthorn grew rapidly, and by the 1950s it supplied 40 percent of milk in Britain.[66] By 1978, 90 percent of Britain's milk came from the British Friesian.[67] The removal of the Shorthorn from the British dairy industry would spell the beginning of the end for the breed's presence in the country's beef industry as well. The rise of the boney Friesian in dairying meant a serious reduction in beefing ability of calves for meat production. Clearly the more powerful the beef characteristics of bulls used on Friesians the better that meat situation would be. While all British breeders of beef bulls adopted selective practices, which reflected the same sort of interest in the short, blocky type common in North America, Shorthorn bulls were increasingly unable to compete effectively with the single-purpose, highly specialized beefing Angus and Herefords in the new dairy world. The Shorthorn's historic usefulness in both the beef and dairy industry played a role in its demise.

British breeders of Angus and Herefords were well positioned to function in this new British dairy beef world. Hereford breeders had historically been solely interested in the generation of bulls, never cows. By the late eighteenth century, Angus cattle had typically been brought to England from Scotland to be fattened for the London market, not as breeding stock. When Angus breeding began in England after the mid-nineteenth century, it too tended to revolve around the production of bulls, although cow breeding was never sidelined as it was among Hereford breeders.[68] The advent of AI in the 1940s expanded the work of beef breeds in the production of dairy beef in Britain. Government support and funding for AI use encouraged that trend. After 1947 AI service was offered for free to British dairy farmers if the bulls were licensed as purebred. From 1950 until the mid-1980s the most important part of all beef AI use in that country would be to breed dairy cows, not beef cows. The avoidance of AI use by British farmers in the breeding of pure beef animals continued to be widespread throughout the period. There were, however, some early signs of change. In 1969, for example, the British Hereford Society allowed the use of AI for breeding pure Herefords, or for upgrading commercial beef cattle to purebred status. The move did not seem to undermine their work in dairy beef. Hereford bulls commanded more than half the British AI market for the breeding of dairy cows, and Hereford-Friesian bull calves were highly valued. These calves brought the highest prices, for example, from cattle-feeding farmers in Britain between 1965 and 1970. Even though Herefords tended to dominate the beef side of British dairy beef production in the years up to the 1980s, the Angus role in the industry was by no means small. Because the small-boned Angus bulls produced small calves, these males were especially popular for use on young dairy cows. In 1969–70, for example, in Britain 60 percent of beef AI to young cows was by Angus bulls.[69]

Changes in the North American beef industry were felt in Britain as early as the 1950s. At first, the North American beef-breeding situation seemed nonthreatening to British breeders, offering new opportunities for expansion of their influence. Potential markets arose. The historic export trade of the three breeds from Britain to North America had long since ended, but dwarfism altered the situation. The defect triggered a new transatlantic market for British breeders, as North Americans began to search for fresh, "clean" genetics in Britain. Scottish Angus cattle, we have seen, were imported to Canada with the thought that they would be attractive to American buyers because the animals had no background to dwarfism. As early as 1950, British Hereford breeders had been surprised at the renewed notice Americans took of their cattle, but it was not until 1956 at the Seventh Annual Hereford Congress held in Tucson, Arizona, that they understood why.[70] Exportation of British Herefords continued throughout the rest of the 1950s. Canadian and American breeders, however, were soon looking for more than an absence of dwarfism. Size had taken on extreme importance. Since breeding trends in Britain had come by 1950 to match those in North America, with blocky, short cattle being desired, most British animals quickly lost favor with North Americans. The animals could do nothing to escalate framescore. Irish Shorthorns, dealt with earlier, were in great demand by Shorthorn breeders in both the United States and Canada simply because the cattle were tall.

A British reorientation toward beef breeding, evident by the mid-1960s, eventually threatened even the Angus-Hereford domination of British dairy beef production. British breeders and producers increasingly wanted larger beef animals, despite the fact that no dwarfism had emerged in their country to encourage such a move.[71] And, as had been the case in North America, an appealing solution to the size problem was importation of the larger continental breeds. The belief that productivity went with larger stock, a theory supported by research emerging in the 1950s in North America, gave credence to the importation plan.[72] All the beef breed societies in Britain vigorously opposed importation of Charolais, Simmentals, and Limousin from the continent. The societies cited disease in continental countries but also feared the complete termination of the new export trade for British breeders of pedigreed stock belonging to domestic breeds. Cattle-feeding farmers in Britain, however, wanted dairy beef calves generated by the continental type, and the British government believed the feeder group carried more important weight in the matter. Also supporting importation was the fact that British importers of the European breeds had undertaken research along American lines on relative productivity, and they were therefore able to offer sires of high-efficiency performance to be crossed on dairy cows.[73] The situation, which promoted the production of calves with predictable feeding potential, naturally appealed to British feeder farmers who fattened beef for the home market.[74]

Breeders in Britain of beef Shorthorn, Angus, and Herefords reacted to the new environment by trying to address both productivity and framescore. They began to run performance tests.[75] Reversing the usual flow, some breeders also searched for greater size in cattle within North American herds. British Hereford breeders in particular chose that path. The British animals of the 1950s, known as "belt buckle cattle" to farmers, would change style over the years with the influx of taller Canadian Polled Hereford genetics.[76] This importation of North American Herefords would, however, become troublesome to British breeders some years later. Purity had always been a particularly important issue for these breeders, and in the 1990s, when they started to question the tactics that North Americans had used to remove dwarfism and increase framescore over the 1960s, the matter took on new significance. British Hereford breeders became concerned with the background of the taller, earlier imported Canadian Herefords. It was noted, for example, that one British Hereford breeder, George Britten, had found the Canadian animals far too small in the 1920s when he visited breeding operations in that country. How could the advanced framescore of the late 1960s in Canadian cattle have been accomplished under purity breeding? What genetics had Canadians used, then, to increase size?[77] Perhaps impurity from that source had infected British herds. A movement devoted to preserving the so-called original Hereford arose in Britain. A "pure" Hereford seemed under these conditions to mean one that resembled British animals as they had been in the 1950s before the new demand for larger animals arose.

At the same time, the Rare Breeds Survival Trust (RBST) in Britain announced the establishment of a new category of endangered breeds, namely, the historic types of British breeds that in themselves were not endangered. The trust named the "original Hereford Type" as its standard. In 1996 DNA testing showed that just 350 British Herefords at the time showed no signs of alien blood—that is, blood found in imported Herefords from Canada and the United States. Contemporary North American Herefords matured faster, looked different from what British breeders defined as traditional Herefords, and seemed to reflect a background of Canadian bulls in particular, which had been widely used in the 1960s for increased size. In a queer twist of fate, it could be said that the Hereford as a breed owed its recognition to the breeding that had been done in countries outside Britain. Before the exportation movement of the late nineteenth century, the breed had been largely restricted to Herefordshire itself. Global circulation around many parts of the world had made the Hereford. As one recent historian put it, "By implicitly disinheriting modern pedigrees, efforts to conserve the traditional Hereford also disinherited the legacy of Britain's imperial history—the reciprocal return of the erstwhile colonial, the Hereford breed."[78] In the end, regardless of any move in Britain to recreate the past, the majority of animals in that country belonging to the traditional British beef breeds had increased framescores and indexes of productivity.

The influx of European bulls to Britain cut into the hegemony of British Hereford and Angus in the dairy beef market but did not end their viable role in it. By 1984 the continental breeds, for example, surpassed British Herefords in AI work with dairy cattle, but not by much: 47 percent versus 44 percent.[79] Both home-bred Herefords and Angus would, however, become increasingly overshadowed in Britain by the continental imported breeds.

Figures for 2016, for example, showed the French breed, Limousin, to be the most important beef breed in the country, representing 27 percent of all beef breeds, with Angus at 17 percent, French Charolais 11 percent, Herefords 8 percent, and Shorthorns 1 percent.[80] While Angus in Britain never attained the level of popularity found in North America, the breed clearly surpassed Herefords and became the most popular of the country's domestic breeds. Its position in the British beef world made it attractive to abattoirs for promotional reasons. An example can be seen in an initiative put forward in 2009 by the Dovecote Park abattoir, in conjunction with the Waitrose supermarket chain and a farm in Oxfordshire. In supplying meat to Waitrose, the Dovecote abattoir planned to control the breeding that went into that meat by dictating which Angus bulls would be crossed on dairy cows. The abattoir stated it used only the best genetic criteria to judge the bulls, which were guaranteed to produce high-quality beef.[81] Obviously the plan was to make the meat attractive to British buyers on the basis of an Angus background and quantitative genetic breeding.

Holsteinization of International Dairy Herds and Specialization in International Beef Breeding, 1960–2000

Changes in the world of beef cattle production encouraged increased specialization in beef and dairy in Western countries. A widely accepted focus on breeding for better production, along with the increased professionalization of breeding through the use of statistical or quantitative genetic principles, both played roles in that shift. Productivity had to be measured, but measurement was designed to pertain only to the contribution of one product to a specific industry.[82] The decline of the Shorthorn, a breed recognized worldwide for centuries as an animal useful for either the beef or dairy industry, serves as an example of that trend. Its ability to work with either industry undermined its capacity to function at newly set high levels for a single product. The fact that it had been bred primarily to serve the beef industry in North America for over seventy years could not hide the reality that it lacked the beef specialization qualities of Angus and Hereford. The new attitudes to beef cattle swept away vestiges of the old ways. The divide between the specialized dairy breeds and beef breeds widened in North America under pressure for ever greater productivity.

The move to more specialization as an adjunct of the innovations in beef production can also be seen in the globalization of the more specialized Holsteins that developed over the late twentieth century. The breed became ever greater milk producers as a result of quantitative genetics in North America, and its success would go on to reorganize much of the dual-purpose breeding for dairy in Europe and lead to the decline of Friesians. Extensive Holsteinization of more dual-purpose Friesians became the order of the day, and the reverberating effects of increased dairy specialization, along with the ongoing production of dairy beef with the use of more specialized beef bulls, could be felt to varying degrees throughout Europe.

Small centers of pure Holsteinization, however, could be found in Europe before the trend became a major movement. Italians, for instance, became aware of the Holstein's superior milking qualities earlier than most Europeans, and long before the new views concerning beef cattle. Italian breeders emphasized Holsteins, rather than Friesians, as early as 1925, when a few breeders in the northern part of Italy became interested in the North American Holstein. Importation started in 1929. While breeding in Italy would be interrupted by World War II, the global move to Holsteins and away from Friesians that followed the beef innovations encouraged a renewed effort in Italy to expand the breeding of Holsteins from that early nucleus. The new widespread demand for Holsteins provided lucrative markets to Italian breeding centers, which were already well established. Italian breeders exported their cattle throughout the Mediterranean area and beyond. Cooperation and development plans were implemented with Turkey, Morocco, Egypt, and Libya, but also in the Sino-Japanese area. Close to 90 percent of Italy's cattle herds would be specialized for dairy, and most of these would be Holsteins.[83] Italian domestic beef meat production resulted from crosses of these dairy animals on imported beef bulls bred at beef-breeding centers. Frozen semen made it possible to use quality beef bulls from countries outside Italy. Importation of beef meat, however, remained more common than domestic production.

A dramatic example of the move to Holsteinization that followed the beef cattle reassessment could be seen in Dutch breeding of the historic Black-and-White, progenitor of the Holstein, over the late twentieth century. Especially interesting is the fact that Dutch breeders had for years selected away from the evolving specialized Holstein type. After 1900 Dutch farmers reduced their focus on breeding of single-purpose dairying and had done so at the same time that Canadians and Americans intensified their selection for milking qualities in dairy cattle. Worried about bovine tuberculosis, Dutch breeders believed a beefier animal was more robust.[84] The rather dual-purpose type that resulted, thought to be healthier, attracted European buyers throughout the 1950s, particularly in Germany and Britain where beefier animals were still preferred for the dairy. The general move to the specialized Holstein in many countries, which coincided with the beef cattle industry changes, reduced the popularity of the modern Dutch type. Of greater significance to the future of the beefier Black-and-White type, however, would be a study under Maria Stolzman, conducted in Poland in the 1970s, on the relative quality of Holstein and/or Black-and-White Friesian breeding bulls from different countries when used on Polish cows.[85] The Netherlands scored poorly, and Britain was last for hybrid effects on Polish cows.[86] The Polish study indicated how much the milking ability of the Dutch Black-and-Whites had declined relative to that of their derivative, the North American Holstein. The result was extensive importation of Holstein genetics and the general Holsteinization of Dutch cattle, a trend that was more or less complete by the late 1990s, when the proportion of Holstein genetics in the Dutch Black-and-Whites approached 100 percent.[87] Beef meat production in the Netherlands reflected the use of imported beef bulls, again made possible by the use of frozen semen, on these dairy cows. Importation of beef meat, however, remained more common.

The move to intense specialization and complete Holsteinization was not inevitable in all European countries. The ultimate position of the Friesian in Britain serves as an example. Holsteinization of the national herd began after the innovations in beef cattle breeding and more particularly after the Polish study. Known as "Americanization," the movement took hold in Britain but was never completed. Many British dairy cows presented a mixture of Friesian and Holstein as a result of the influx. Today the herd book Holstein UK pedigrees Holsteins and British Friesians, doing so on a percentage-of-purity basis. Many if not most animals are not 100 percent pure to either breed. Fifty-one percent of the country's dairy herds are British Friesians under this percentage purity definition, while Holsteins represent 31 percent. The continued substantial genetic presence of the more dual-purpose Friesian in Britain showed that dual-purpose dairy cows could have a place in a specialized world. How or even whether the continued existence of a small but powerful national beef cattle breeding industry is part of this story would be an interesting question to explore. Britain produced improved bulls for the production of dairy beef meat domestically, but these bulls also played a significant role internationally in the production of dairy beef. Beef-breeding centers of comparable size do not exist, for example, in either Italy or the Netherlands, where Holsteinization was more complete.

As a result of these changes in the beef and dairy industries, in both Europe and North America, allegiance to particular breeds altered completely. Intensified specialization for beef and dairy reoriented cattle breeding worldwide.

Yet despite these trends, the classic way to produce beef in North America and Europe did not change, even if the breeds used did. In North America it remained breeding beef animals to beef animals, and in Europe it meant breeding beef animals to dairy animals. Within that framework, the history of the Shorthorn is unique. The breed's demise, seen in conjunction with trends set in motion by the beef cattle breeding transformation, offers a barometer for assessing how and why modern cattle farming has modified what livestock are used. Shifts to more intense specialization of purpose, and the singular emphasis on productivity, which quantitative genetics encouraged, together, relegated the Shorthorn, the original "improved" breed, to the past. These beef cattle innovations represented a real breakthrough of quantitative genetics in the hegemony of purebred breeding. Reorientation in the beef industry, from a science of genetics point of view, showed that the old revered allegiance to purebred breeding in the livestock world was over.

This interconnected story, while it primarily concentrates on beef cattle, suggests that cattle breeding generally is more richly understood if it is seen in terms of changes across separate industries and separate nations as well.

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Notes

1. A particularly notable work on modern beef cattle breeding in the United States is Calvert, "Certified Angus." For specific issues concerning the beef industry, see Derry, "Genetics, Biotechnology, and Breeding." British geographers have written quite extensively about the social construction of attitudes to beef breeding in Britain. See especially the many articles by Lewis Holloway, who writes about livestock breeding in relation to food and consumption, such as Holloway et al., "Making Meat Collectivities."

2. Most work done on quantitative genetics' interface with livestock breeding focuses on dairying. See Theunissen, *Beauty or Statistics*, 14–59; Theunissen, "Breeding without Mendelism"; and Theunissen, "Breeding for Nobility or Production?" See also Derry, *Masterminding Nature*, 94–128.

3. Lush, "'Duck-Legged' Cattle."

4. Lush, "'Duck-Legged' Cattle."

5. Stonaker and Tom, "'Compact' Shorthorns."

6. Voth, "From Big to Small," pt. 2. Voth based this article on the research of Harlan Ritchie. See Willham, "Genetic Improvement of Beef Cattle."

7. See, for example, the address given by C. F. Curtiss, director and professor of agriculture at the State Agricultural College and Experimental Farm, Ames, Iowa, to the superintendent

of Farmer Institutes of Ontario in 1897: C. F. Curtiss, "The Fundamental Points of Practical Excellence in Beef Cattle," Sessional Paper (hereafter cited as SP) 23, Ontario Legislature (1897): 80–85. For comments concerning the commonality of vision in the American and Canadian breeding of Shorthorns, see SP 4, Ontario Legislature (1877): 188.

8. MacEwan, *Highlights of Shorthorn History*, 197.

9. Derry, *Ontario's Cattle Kingdom*, 22; *Directories of the Breeders of Pure Bred Stock of the Dominion of Canada, Dairy Branch*, Live Stock Division (Ottawa: Department of Agriculture, 1901–1920). In Ontario, for example, there were seventeen purebreds per one thousand head of cattle, and in 1921 there were fifty-five per one thousand. See *Census of Canada 1911*, vol. 4, 410, 418; *Census of Canada 1921*, vol. 5, xc, 64. The situation in the United States was similar, and the purebred industries of both countries were closely linked from at least the 1870s.

10. Whitlock, Kaiser, and Maxwell, "Heritable Bovine Fetal Abnormalities," 539; Gregory, Tyler, and Julian, "Bovine Achondroplasia"; Gregory and Carroll, "Evidence for the Same Dwarf Gene," 110; Stringam, "Dwarfism in Beef Cattle," 401; Baker, Blunn, and Oloufa, "Stumpy."

11. Bovard and Hazel, "Growth Patterns in Snorter Dwarf," 194.

12. Whitlock, Kaiser, and Maxwell, "Heritable Bovine Fetal Abnormalities," 539; Marlowe, "Evidence of Selection," 454, 459; Baker, Blunn, and Plum, "'Dwarfism' in Aberdeen-Angus Cattle," 143; Gregory et al., "Phenotypic Expression of Homozygous Dwarfism," 923; Sprague, Magee, and Nelson, "Pedigree Analysis"; Marlowe, "Evidence of Selection," 454, 459.

13. In this case the problem could be traced, through pedigrees, back to the breeding bull, Whitehall Sultan, imported in his dam in 1900 from England by a Canadian, Robert Miller, who acted as agent for E. S. Kelly in Ohio. See MacEwan, *Highlights of Shorthorn History*, 31, 46–47.

14. Pickard, "Dwarfism."

15. Pickard, "Dwarfism," 66.

16. Chambers, Whatley, and Stephens, "Inheritance of Dwarfism"; Burris and Priode, "Crossbred Dwarfs in Beef Cattle."

17. Hermel, "Dwarfism Test Available."

18. Pahnish, Stanley, and Safley, "Inheritance of a Dwarf Anomaly," 200; Johnson, Harshfield, and McCone, "Dwarfism."

19. Johnson, Harshfield, and McCone, "Dwarfism," 539.

20. McCann, *Battle of the Bull*.

21. Stonaker and Tom, "'Compact' Shorthorns," 250.

22. Gregory and Carroll, "Evidence for the Same Dwarf Gene," 110.

23. Academic studies abound in this period over what it meant to be an economic producer of meat. The American Hereford Association, the American Angus Association, and the American International Charolais Association, for example, sponsored type conferences at the University of Wisconsin in 1969 to evaluate performance of beef cattle that varied in frame size within their respective breeds. This shift also led to new US feeder grades, which were adopted in 1979. See also Koch and Alego, "Beef Cattle Industry"; Washburn et al., "Nutrient Utilization."

24. Voth, "From Big to Small," pt. 2, 13; Voth, "From Big to Small," pt. 3, 10–11.

25. For information on the Canadian and American quarantine stations and regulations before 1920, see Derry, *Ontario's Cattle Kingdom*, 57–71.

26. Canada, Parliament, House of Commons Debates, Standing Committee on Ways and Means, Minutes of Proceedings, "Charolais Cattle (Import)," April 9, 1963, 1437, http://api.parliament.uk/historic-hansard/commons/1963/apr/10/charolais-cattle-import.

27. Runnion and Runnion, *Limousin in North America*, 11.

28. Runnion and Runnion, *Limousin in North America*, 10, 7–12.

29. Runnion and Runnion, *Limousin in North America*, 7–12, 17–35.

30. "Topic: Deerpark Leader 16th and D. Seamus 4th," May 9, 2014, http://www.steerplanet.com/bb/the-big-show/deerpark-leader-16th-and-d-seamus-4th/.

31. "Topic: Asterisk Free Shorthorn," May 11, 2011, http://www.steerplanet.com/bb/the-big-show/asterisk-free-shorthorn/?nowap.

32. "Topic: Deerpark Leader 16th and D. Seamus 4th."

33. "Topic: Asterisk Free Shorthorn."

34. "Topic: Shorty Folks," June 10, 2013, http://www.steerplanet.com/bb/the-big-show/shorty-folks/45/.

35. "Topic: Deerpark Leader 13th," May 14, 2007, http://www.steerplanet.com/bb/the-big-show/deerpark-leader-13th/?nowap.

36. "Topic: Asterisk Free Shorthorn."

37. Knight, Everitt, and Jury, "Reciprocal Crossbreeding," 526.

38. Knight, Everitt, and Jury, "Reciprocal Crossbreeding," 527.

39. Kidwell and McCormick, "Influence of Size and Type on Growth."

40. Lapointe, Lachance, and Steffen, "Tibial Hemimelia." The TH situation in Shorthorns soon proved to be more complicated. See Whitlock, Kaiser, and Maxwell, "Heritable Bovine Fetal Abnormalities," 546.

41. "Topic: Potential Genetic Defect in Shorthorn Cattle," http://www.steerplanet.com/bb/the-big-show/potential-genetic-defect-in-shorthorn-cattle/585/ (accessed November 4, 2014).

42. Canadian breeders were generally more receptive to the idea of restrictions regarding TH, but their close working relationship with American breeders and their use of popular American breeding lines precluded any concerted effort to disallow registration of THC animals. It is interesting to note, in contrast, the way British breeders and their association handled the TH issue. The Beef Shorthorn Society of Britain required testing for TH, and after early 2008, it refused to allow entry of THC animals into the herd book. See Beef Shorthorn Society, "Policy Regarding TH," http://www.beefshorthorn.org/index.php/the-breed/beef-shorthorn/policy-regarding-th (accessed October 3, 2015).

43. Howse, "Champion's Demotion."

44. Witt, "Perfection."

45. Even before the founding of a Holstein association in the United States, in 1880 Soloman Hoxie developed the idea of an "advanced registry" with inspection for type and testing for milk-production requirements for the Holstein breed. Canada, Department of Agriculture, *Publications*, 1911–12, 41. Reaman, *History of the Holstein-Friesian Breed*, 320, 324–25, 340, 341, 343. For a comprehensive history of the Friesian-Holstein breed in North America, see Morwick, *Chosen Breed*.

46. Graves, "Superior Germ Plasm," 1010.

47. Orland, "Turbo-Cows," 182; Theunissen, "Breeding without Mendelism," 657; Canada, Department of Agriculture, *Publications*, 1911–12, 41.

48. Arnold, "Fifty Years of DHIA Work," 792; Voelker, "Dairy Herd Improvement Associations," 1269.

49. Graves, "Superior Germ Plasm," 1010.

50. Arnold, "Fifty Years of DHIA Work," 793; Voelker, "Dairy Herd Improvement Associations," 1275.

51. Bressman, "Better Plants and Animals."

52. Graves, "Superior Germ Plasm," 997–99, 1004.

53. Herman, *Improving Cattle by the Millions*, 16, 17.

54. King, "Alan Robertson's Contributions," 158.

55. Morley, "Dairy Cattle Breed Associations," 714.

56. Funk, "Major Advances," 1363.

57. Arnold, "Fifty Years of DHIA Work"; Voelker, "Dairy Herd Improvement Associations"; Morley, "Dairy Cattle Breed Associations." For more on the dairy industry, see McMurry, *Transforming Rural America*; Lampard, *Rise of the Dairy Industry*; Orland, "Turbo-Cows"; Trout, "Fifty Years."

58. For a recent and interesting assessment of cattle breeding in relation to visual appraisal, see Holloway and Morris, "Contested Aesthetics of Farmed Animals."

59. MacEwan, *Highlights of Shorthorn History*, 198–99.

60. For more on the beef industry, see Golden et al., "Milestones in Beef Cattle Genetic Evaluations"; Eller, "Look Back at BIF History"; Bourdon, "Shortcomings of Current Genetic Evaluation Systems." Particularly important are the Proceedings of the Beef Improvement Federation Conferences, http://www.bifconference.com/bif2007/Archives.html.

61. See Derry, *Masterminding Nature*, 40–92; Lerner, *Genetic Basis for Selection*. See Hill, *Quantitative Genetics*; and Walsh, "Quantitative Genetics, Version 3.0." Also Chapman, *General and Quantitative Genetics*; Comstock, *Quantitative Genetics*; Crow, *Basic Concepts in Population*; and Cunningham, *Quantitative Genetic Theory*.

62. See "Charolais Cattle (Import)," House of Common Debates, April 10, 1963, vol. 675, cc1437–48, hansard.millbanksystems.com/commons/1963/apr/10/charolais-cattle-import#column_1437; and "Early Years of Simmental in North America," December 31, 2011, http://simmental-sbl.blogspot.ca/2011/12/about-this-blog.html.

63. Don Vaniman, Exec. Sect. of the American Simmental Association, *Simmental Shield*, August 1974, 119–22.

64. See Orland, "Turbo-Cows"; and Theunissen, "Breeding without Mendelism"; Bidwell and Falconer, *History of Agriculture*, 396; Bateman, "Improvement in American Dairy Farming"; Derry, *Ontario's Cattle Kingdom*, 94–96; McMurry, *Transforming Rural America*, 17–19; Lampard, *Rise of the Dairy Industry*, 170–71, 175; and Atack and Bateman, *To Their Own Soil*, 147. See also SP 5, Ontario Legislature, 1869, 143; *Farmer's Advocate*, February 1, 1900, 64; May 6, 1909, 753.

65. These figures represent generalizations gathered from many sources. See, for example, Ahola, "Beef Production"; "Dairy Cattle a Big Part of US Beef Supply," *Farm and Dairy*, May 13, 2019, http://www.farmanddairy.com/news/dairy-cattle-a-big-part-of-us-beef-supply/552832.html; Heim, "Crossbreeding for Beef"; Gould and Lindquist, "Optimizing Dairy Beef Production"; "Bull Beef Production From Holstein/Friesian Male Calves," *Dairy Site*, http://www.thedairysite.com/articles/2611/bull-beef-production-from-holstein-friesian-male-calves/ (accessed January 8, 2021); email correspondence from Lewis Holloway to author, October 28, 2019.

66. Stanford, *British Friesians*, 28, 35, 50.

67. See Friend, *Cattle of the World*.

68. For more information see Sanders, *History of Aberdeen Angus Cattle*. See also Trow-Smith, *History of British Livestock Husbandry*, 57, 84, 89–116.

69. Grundy, "Hereford Bull," 83, 88.

70. Heath-Agnew, *History of Hereford Cattle*, 200.

71. Email correspondence from David Deakin, breed secretary, Hereford Cattle Society, to author, November 12, 25, 2019.

72. Heath-Agnew, *History of Hereford Cattle*, 231–32.

73. Heath-Agnew, *History of Hereford Cattle*, 231–32. For an interesting study of statistical evaluation and livestock in Britain, see Holloway and Morris, "Contesting Genetic Knowledge-Practices"; Holloway et al., "Biopower, Genetics, and Livestock Breeding."

74. Heath-Agnew, *History of Hereford Cattle*, 231–32.

75. Heath-Agnew, *History of Hereford Cattle*, 233.

76. Deakin correspondence.

77. Heath-Agnew, *History of Hereford Cattle*, 233.

78. See Woods, *Herds Shot around the World*, intro. and chap. 5.

79. Grundy, "Hereford Bull," 86.

80. Condon, "Weekly Genetics Review."

81. Holloway, "Making Meat Collectivities," 1, 4.

82. The situation has been changing to some degree since about 2000. Different countries also look on productivity somewhat differently. Today, efforts are made at understanding "productivity" in such terms as fertility and longevity on a statistical basis against actual levels of production.

83. All of this material on Italy is from Marigliano, "Problem of Innovation," copy in possession of the author.

84. Theunissen, *Beauty or Statistics*, 14–59; Theunissen, "Breeding without Mendelism"; Theunissen, "Breeding for Nobility or Production?"

85. Funk, "Major Advances in Globalization," 1363; Stolzman et al., "Friesian Cattle in Poland," 9.

86. Zarneck et al., "Heterosis for Growth," 1662, 1668.

87. See Theunissen, *Beauty or Statistics*, 14–59; Theunissen, "Breeding without Mendelism"; and Theunissen, "Breeding for Nobility or Production?"

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