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Breeding Without Mendelism: Theory and Practice of Dairy Cattle Breeding in the Netherlands 1900–1950

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Abstract. In the 1940s and 1950s, Dutch scientists became increasingly critical of the practices of commercial dairy cattle breeders. Milk yields had hardly increased for decades, and the scientists believed this to be due to the fact that breeders still judged the hereditary potential of their animals on the basis of outward characteristics. An objective verdict on the qualities of breeding stock could only be obtained by progeny testing, the scientists contended: the best animals were those that produced the most productive offspring.

Some scientists had been making this claim since the beginning of the twentieth century. Why was it that their advice was apparently not heeded by breeders for so long? And what were the methods and beliefs that guided their practices? In this paper I intend to answer these questions by analysing the practical realities of dairy farming and stock breeding in The Netherlands between 1900 and 1950. Breeders continued to employ traditional breeding methods that had proven their effectiveness since the late eighteenth century. Their methods consisted in inbreeding – breeding in 'bloodlines,' as they called it – and selection on the basis of pedigree, conformation and milk recording data. Their aims were 'purity' and 'uniformity' of type. Progeny testing was not practiced due to practical difficulties.

Before World War II, scientists acknowledged that genetic theory was of little practical use to breeders of livestock. Still, hereditary theory was considered to be helpful to assess the value of the breeders' methods. For instance, striving for purity was deemed to be consistent with Mendelian theory. Yet the term purity had different connotations for scientists and practical workers. For the former, it referred to homozygosity; for the latter, it rather buttressed the constancy of a distinct commercial 'brand.'

Until the 1940s, practical breeders and most scientists were agreed that selecting animals purely for production was ill-advised. Cows of the extreme dairy type were believed to be prone to bovine tuberculosis. This conviction was at the basis of the development of 'the modern Friesian,' a rather robust type of dairy cow that was also valued for its aesthetically pleasing conformation and that became a commercial success.

Contrary to the scientists' claims, it was not only for commercial reasons that breeders were reluctant to give up their modern Friesians after World War II, when the introduction of artificial insemination opened up the possibility of breeding more productive types by means of progeny testing. The political economy of breeding did indeed require breeders to protect their breed as a recognisable brand. Yet the moral economy of breeding must also be taken into account: the modern Friesian was also a product of widely shared normative standards of good and responsible farming.

Keywords: bovine tuberculosis, breeding, constitution, dairy cattle, dairy farming, Friesian black and whites, Hagedoorn, Holstein Friesians, Mendelism, progeny testing

Introduction

In the late 1940s and 1950s, Dutch scientists and agricultural engineers repeatedly criticised the practices of dairy cattle breeders.[1] The romantic idea that breeding was an art rather than a science seemed ineradicable, the scientists lamented. Some breeders might even be accused of breeding for fancy rather than for utility. Particularly the top breeders seemed virtually oblivious of the fact that dairying was an economic activity and that the productivity of dairy cattle should come first.

To buttress their claims, the scientists pointed to the dominant role that cattle shows still played in assessing the value of breeding stock, despite the availability of more objective methods for evaluating the animals' qualities. Show judges, herdbook inspectors and breeders alike still judged the hereditary potential of a young bull on the basis of its conformation, i.e. its outward characteristics. Now in pig breeding, for instance, where the objective was the production of pork, judging a boar on the basis of its weight and conformation made sense, for the animal's outward appearance might indeed provide an indication of its economically valuable hereditary qualities. Breeding dairy cows however was a different matter. Correlation studies had shown that most individual details of conformation in dairy cows were unrelated to their milk yield. In the case of bulls, the breeders' preoccupation with their phenotype was even more questionable. For it was not the bulls' looks that mattered, but their daughters' milk yield. An objective verdict on the quality of breeding stock could only be obtained by progeny testing: the best animals, bulls as well as cows, were those that produced the most productive offspring.

[1] In this paper I use the term 'breeders' to refer to commercial breeders of dairy cows; without exception, these breeders were also dairy farmers. The scientists who criticised them where biologists and veterinarians from the Dutch universities and animal husbandry engineers from Wageningen Agricultural College; I shall refer to them collectively as 'scientists' or 'scientific experts.'

What was even worse, the scientists continued, was that many breeders seemed to be on the wrong track altogether in their choice of sires and dams. Despite their claims of being able to 'see' an animal's qualities in its conformation, objective data from the milk recording services showed that milk yields had hardly increased over the last 10–15 years. The bulls and cows themselves, however, as the records of the herd-books showed, were definitely changing: they were becoming smaller, deeper, more short-legged and beefier. True, the Dutch dairy cow was a double purpose breed, producing milk and meat, but the greater part of the profit came from the milk, and the breeders were overemphasizing their animals' disposition for meat production. Considering the many prizes such stocky animals were awarded at shows, it seemed that breeders were unwittingly turning the Dutch dairy cow into a fancy breed unfit for its main economic purpose.

It was high time, the scientists concluded, that fashion and fancy gave way to utility and rationality. Particularly the selection of bulls had to change, since the bull was half the herd, as the saying went. Bulls should be subjected to progeny testing, and only proven bulls should be widely used as sires. Only then would breeding become a rational practice.[2]

Frustrated as they may have been about what they perceived as the conservatism of the breeders, the scientific experts knew that, in the 1950s, the tide was already turning and that a reform of breeding in the sense they envisaged was under way. In the following decades scientists were to acquire a key role in the business of cattle breeding. Progeny testing did indeed become standard practice, and the influence of conformation shows dwindled steadily. Bull shows, once the culminating points of the perpetual competition among the breeders, were eventually even abolished. While traditional breeders began to lose their influence, the involvement of scientists increased. They worked out a system for progeny testing and helped make the plans for its implementation which involved a drastic reorganisation of the plethora of organisations and institutions in the field of dairy farming and stock breeding. They also developed the statistical means to judge and rank bulls according to

[2] Already in 1927 and 1928, dairy adviser C. Zwagerman had published a series of articles that foreshadowed parts of the later critique of breeders' practices. Several critical articles appeared in the 1930s, but the criticism really gathered steam in the 1940s. I will mention only a few characteristic examples: Zwagerman, 1927, 1928, 1934; Hagedoorn, 1928, 1939, 1941a, b; Bosman, 1935; De Jong, 1943, 1947; van der Plank, 1948; van der Plank and Hirschfeld, 1950; Hoekstra, 1957, 1958; de Groot and Bekedam, 1957.

merit, and came up with an index for the exact economic profit to be expected from using a given bull as a sire.[3]

The story of how scientists acquired a leading role in dairy cattle breeding is a fascinating one, but my intention in evoking their views of traditional breeding methods was to put a different set of questions in perspective that I would like to explore in this paper. To begin with, some Dutch scientists had been claiming since the beginning of the twentieth century that only progeny testing provided a rational basis for breeding. Why was it that this seemingly simple and sound advice was apparently not heeded by cattle breeders for so long? And what methods did these breeders use then? As indicated, the economic effectiveness of their practices was increasingly disputed in the 1950s. What were the breeders' views in this matter? Why, for instance, would they prefer animals whose conformation seemed to have an adverse effect on their productivity? Finally, Mendelian genetics had been around for more than half a century before Dutch scientists became seriously involved in practical cattle breeding. This raises the question of what the relation between scientists and breeders had been in the period before World War II. And what was it that conditioned the change in this relationship after the war?

Questions of this kind, that broadly speaking concern the circulation of knowledge between scientific experts and practical workers in agriculture, are receiving increasing attention from historians of plant breeding, as a recent special issue of this journal has underscored.[4] Recent studies have shown that the role of hereditary theory in plant breeding practices in the early twentieth century was much more complex than was suggested by an earlier historiography that described the reception of Mendelism by practical workers in terms of either 'successful application' or 'failed assimilation' of its principles.[5] Historical studies of animal breeding are still scarce.[6] Yet investigations of livestock breeding provide opportunities for instructive comparison, as

[3] General histories of dairy cattle breeding in the Netherlands that describe this development are Strikwerda, 1998, 2007, and Bieleman, 2000.

[4] 'Special Issue on Biology and Agriculture,' *Journal of the History of Biology* 39: 235–424 (2006); see in particular the papers by Bonneuil, 2006 and Wieland, 2006.

[5] See for example Paul and Kimmelman, 1988; Fitzgerald, 1990; Paladino, 1993, 1994; Harwood, 1997; Roll-Hansen, 2000; Bonneuil, 2006; Wieland, 2006.

[6] See for instance Russell, 1986; Cooke, 1997; Wood and Orel, 2001, 2005; Derry, 2003; Orland, 2003. An important recent contribution that focuses on reproductive technologies is the thematic issue of the *Studies in History and Philosophy of Biological and Biomedical Sciences* 38/2, 2007: 'Between the Farm and the Clinic: Agriculture and Reproductive Technology in the Twentieth Century' (Wilmot, 2007a); see in particular Wilmot, 2007b, which addresses the introduction of artificial insemination in the British dairy industry.

I hope my analysis of cattle breeding will demonstrate. One of my conclusions will be that, while breed improvement was high on the breeders' agenda, the implementation of genetic theory was not among their principal concerns. For practical purposes, genetic theory was of little relevance for cattle breeders in the first half of the twentieth century, and as we shall see, even scientific experts in this period agreed with this assessment.[7] In their efforts to improve their stock, breeders were rather concerned, firstly, with the practical possibilities and constraints of dairy farming under Dutch circumstances. Different regions had different soils, for instance, for which different types of cows were required. Secondly, the political economy of breeding required the breeders constantly to perfect and protect their breed as a recognisable 'brand' on the stock breeding market. Finally, the moral economy of breeding must be taken into account: the breeders set great store by attuning their practices to widely shared normative standards with respect to what was considered as responsible farming.

My example here will be the breeding of Friesian black and white dairy cows. In the course of the twentieth century Dutch Friesians became the principal type of dairy cattle worldwide. Some 7500 animals, the foundational stock of the American Holstein–Friesians or Holsteins, were imported in the United States and Canada from The Netherlands in the late nineteenth century as Dutch Friesians.[8] (Their having become known as Holsteins, soon after their arrival, seems to have been due to an inattentive American government official). In America the Friesians were valued for their high milk yield, and they were bred as a pure dairy type, mainly producing milk for consumption. In the Netherlands however, as in most European countries, the 'double purpose' type was preferred, producing meat and milk. After the breeding of Friesians in North America had gathered steam, the U.S. and Canada on the one hand and several western European countries on the other became competitors on the world market for Friesians. In the end, the post-war trend towards specialisation would give the American pure dairy type a decisive edge: from the late 1960s onwards, a worldwide 'Holsteinisation' took place. Ironically, Dutch farmers nowadays also call their black and whites 'Holsteins.'

[7] It should be added, however, that quite different circumstances conditioned poultry and pig breeding practices, for instance; much more work is required to obtain a general understanding of the impact of genetic theory on animal breeding.

[8] For the history of the Dutch black and whites in America, see for instance Prescott and Price, 1930; Mansfield, 1985. In the Netherlands, this type of dairy cow was known as the *Friesch-Hollandsch* variety, after the provinces where they were bred in the largest numbers.

Until the middle of the twentieth century, Dutch breeders of Friesians were among the leading promoters of the European double purpose type. They unabashedly marketed their animals as the world's best dairy cows – a somewhat arbitrary qualification since what was considered 'best' depended on local requirements: even farmers in neighbouring European countries not unusually preferred a slightly different balance between meat and milk production. Still, Dutch dairy cows had an excellent reputation. They had the highest average milk yield in Europe and were valued for their harmonious and uniform conformation as well as for their adaptability to different climates and management regimes. Black and white breeding stock found its way to many countries in Europe, America, Asia, Africa and Australia.[9]

Dutch farmers also did well in terms of the organisation of breeding: participation in herd-book registration and in breeding and milk recording associations was exceptionally high.[10] Developments in other countries were scrutinised in journals issued by the herd-books and in agricultural and dairy industry periodicals. In terms of original scientific research, the Dutch role was less prominent: before World War II Germany had more scientists working on breeding problems, Scandinavian scientists were quicker to get a grip on practical breeding, and the quantitative genetics underlying the reform of progeny testing after the war was mainly worked out by American scientists, Jay Lush prominent among them.[11] Yet all in all, it can safely be said that the Dutch case provides an illustrative example of European breeding practices before the advent of systematic progeny testing.

Type and Tuberculosis

Returning to the criticism leveled at the Dutch breeders by scientists in the 1940s and 1950s, the first issue I shall address is the change in type that the experts worried about. While it seemed obvious to them that smallness and beefiness were undesirable in a dairy breed, most scientists, then and in later years, seemed to have all but forgotten why Friesians had become so small and stocky over the years. Even herd-book officials were puzzled by the loss of withers height: the official Klaas Stapel speculated that smaller cows, while producing less, may

[9] Strikwerda, 1998; Grothe, 1993.

[10] Strikwerda, 1998, p. 192.

[11] In the Netherlands, facilities for scientific breeding experiments with cattle would become available only after WWII; see de Boer and Strikwerda, 1990, p. 11.

have been easier to maintain in the years of crisis before World War II.[12] Yet Wieger de Jong, professor of animal husbandry at Wageningen Agricultural College (the only institution of its kind in the Netherlands) had argued more plausibly as early as 1943 that the decrease in size was a side-effect of breeding for shows. In terms of procreation, the fate of a bull was decided on at an early age. According to De Jong, animals that matured early, i.e. acquired adult proportions rapidly and fattened easily, were preferred by herd-book inspectors and judges at bull shows. As it happened, such qualities were more often found in relatively small bulls than in larger ones, which looked rather gawky in their younger years. Since small bulls won the prizes at shows, De Jong concluded, they had been systematically preferred as sires which in the long run had resulted in a decrease in size of the breed as a whole.[13]

But now the question arises why inspectors and judges should prefer stocky animals in the first place, instead of the tall and lean dairy type that had characterised the Friesian breed in the late nineteenth century. The critics of the 1950s entertained no doubts about the answer to this question: fashion and fancy breeding must have been responsible.[14] Pre-war records, however, show that there was more to the change in type than scientists in the 1950s and after seemed to remember. Some background information is needed here.

Until the late nineteenth century, Friesian black and whites were mainly to be found in the sea clay provinces in the north and west, particularly in Friesland and North- and South-Holland.[15] Yet by the 1890s, black and whites also began to be kept by farmers in some sandy regions in the south and east. The reason for this was an increase in profitability of animal husbandry which had started after the liberalisation of the export markets in many European countries around the middle of the nineteenth century. The trend of focussing on animal husbandry was facilitated by the improving means of transportation, and it was reinforced by the sharp drop of grain prices in the 1880s, when American grains flooded the world market. Towards the end of the century, farmers on the many small mixed farms in the east and south of the Netherlands by and large concentrated their activities on the production of milk, meat (beef and pork) and eggs. Their arable land was increasingly used to produce fodder for their animals. Concentrates also became cheaper and were being fed in growing quantities.

[12] Stapel, 1988, pp. 42, 67.

[13] De Jong, 1943, p. 116, 1947, pp. 8–10.

[14] See note 2.

[15] See for instance Hengeveld, 1865.

Another major stimulus to dairy farming was the establishment of cooperative dairy factories from the mid-1880s onwards. The creameries lifted a major restraint on the growth of dairy farms in that they solved the farmers' problem of finding an outlet for their milk. While the number of dairy cows had been more or less stationary until the 1880s, their number rose from some 900.000 in 1890 to about 1.3 million in 1930.[16]

Meanwhile, partly as a consequence of the grain crisis of the 1880s, the government had given up its nineteenth-century *laissez-faire* attitude with regard to agriculture and began to stimulate and support the improvement of breeding practices. Local, regional and provincial milk-recording and breeding associations were established in quick succession. Engineers from Wageningen Agricultural College were appointed to act as advisers of these associations and to develop educational programs for the farmers. The herd-books expanded their activities from the mere registration of true-bred animals to the improvement of breeding practices. Finally more and more creameries, following the example set by dairy factories in Friesland, provided an incentive by paying the farmers for their milk on the basis of its butterfat content. Milk recording data showed that the percentage of butterfat was, to a considerable degree, determined by heredity; milk yield, in comparison, while also partly heritable, was more sensitive to environmental influences. Thus the milk's butterfat percentage provided an excellent opportunity for selection.[17]

The pages of agricultural newspapers and weeklies such as *Het Friesch Landbouwblad*, *Het Landbouw Nieuwsblad*, *De Veldbode* and *De Veldpost* testify to the growing importance attached to dairy cattle breeding after 1900.[18] Agricultural journalists, scientists and government breeding advisers regularly exchanged views on the aims and methods of breeding in such journals, and more and more reports appeared on conformation shows and on the accomplishments of breeding associations and individual breeders. The interest taken in the subject by

[16] L. Broekema, 1913, pp. 346–379; van Zanden, 1985; Knibbe, 1993.

[17] For the development of cattle breeding organisations in the Netherlands see for instance Löhnis, 1911; Tukker, 1924; van Adrichem Boogaert, 1970. Facts and figures illustrating the involvement of the government can be gleaned from Directie van den Landbouw, 1913.

[18] I will refer mainly to *De Veldbode*, a widely read weekly established in 1903 that continued to appeared during the whole period under investigation and that reported on all important events and dicussions related to cattle breeding. Its full title was *De Veldbode*, *Geïllustreerd Weekblad voor Land-en Tuinbouw*, *Pluimvee-en Konijnenfokkerij en Bijenteelt*.

Figure 1. Friesian black and whites in 1900 (from K.N. Kuperus & Zonen, *Eenige mededeelingen over den uitvoer van Friesch stamboekvee*, Leeuwarden 1912, p. 30).

the dairy farmers themselves can be gleaned from the exchanges in the questions and answers section of weeklies such as *De Veldbode* and *De Veldpost*.

As a consequence of these developments, good breeding stock and particularly good bulls were in high demand in the early twentieth century. The most productive black and whites were traditionally to be found on the specialised dairy farms that exploited the vast natural pastures of the western and northern clay provinces, particularly Friesland and North-Holland, so one might expect the breeders in these regions to have experienced a golden age. They did not do quite as well as expected, however.

In the late nineteenth century, the black and whites in Friesland and North Holland were big, gaunt, leggy, sharp-backed, narrow-chested and ewe-necked animals (Figure 1). 'All milk, skin and bone,' as a British commentator put it.[19] They were milking machines, indeed, and it was precisely for this reason that thousands of Friesians from these provinces were exported as breeding stock in these decades. Animal husbandry experts in the Netherlands however were agreed that Friesians could only be profitably exploited on exceptionally fertile soils.

[19] Stanford, 1956, p. 61.

These highly productive cows were delicate and demanded quality food and careful management. This was not a new insight. In the eighteenth century German buyers, for instance, had learned the hard way that Dutch dairy cattle were an exacting breed. Friesians in the Berlin area were for this reason taken care of by Dutch immigrant farmers.[20] American farmers also knew how to handle their Holsteins: they were fed very rich diets and on many farms they remained stabled all year.[21]

Understandably, when farmers in the south and east of the Netherlands began to import black and whites into their regions around 1900, many experts felt compelled to sound a cautionary note. The mixed farms on the sandy soils in the east and south provided an environment that was 'foreign' to Friesians, they contended. Farmers in these regions could not provide the quality foodstuffs required, and they had neither the means nor the time to provide the care the animals needed. Under such less than optimal circumstances Friesian black and whites were said to become weedy. After a few generations, they were no longer better milk producers than the local breed. Friesians had been bred exclusively for production, wrote herd-book inspector Iman van den Bosch, a respected authority on cattle breeds. This had affected their constitution, and thus they demonstrated the wrong-headedness of the much debated 'Zucht nach Leistung' (selection for production), propagated by the German agriculturist Emil Pott.[22] H.M. Kroon, zootechnical expert of Utrecht Veterinary College, agreed that Friesians ran the risk of becoming so 'overbred' that their functionality was jeopardised. Wageningen engineers fully agreed, and a government report on the improvement of animal breeding similarly warned against the risks of one-sided breeding for production.[23]

[20] Orland, 2003, pp. 173–174. Eighteenth-century sheep breeders were also familiar with the problems involved in maintaining foreign breeds; see Wood and Orel, 2001, pp. 45–46, *passim*.

[21] Thus it was difficult to compare their performance to that of the Friesians in The Netherlands that were fed far less concentrate and stable-fed only during the winter months; see for instance van den Bosch, 1932. This problem would become acute when the Friesians and Holsteins became competitors in the 1970s.

[22] van den Bosch, 1906a. Pott developed his views in reaction to what was then called 'Formalismus,' i.e., selection for phenotypic traits with no demonstrable relation to production; see Pott, 1899; Comberg, 1984, pp. 122, 336–339.

[23] Kroon, 1913, pp. 95–99; Löhnis, 1911, pp. 28, 46. In the decades after 1900, animal husbandry specialists A.A. ter Haar, A. van Leeuwen and E. van Muilwijk constantly warned readers of *De Veldbode* not to be misled by the high milk yields that Friesian farmers were able to obtain on their rich soils. Wageningen engineers concurred with this view; see for instance De Jong and Koenen, 1923; and animal husbandry textbooks contained the same message; see for instance Kok, 1919, p. 76; Dommerhold, 1927, pp. 10, 14–17; C. Broekema, 1913a, p. 16.

The most damaging allegation of all was that Friesians, if not taken proper care of, were highly susceptible to bovine tuberculosis, a disease that was becoming more and more problematic around 1900, and that particularly affected the reputation of the Friesians. A German visitor at a national show remarked that if the conformation of Friesian cattle was not enough to make one suspicious, the constant coughing that could be heard in their stables would not fail to do so.[24] According to veterinarian A. van Leeuwen, German experts even considered Dutch cattle to be the most severely afflicted with tuberculosis world-wide, and Belgian buyers also complained that Friesians were unfit for their soils and often fell victim to the disease.[25]

Before long, Friesian black and whites came to be held in bad repute in many regions of the Netherlands too. Seemingly healthy Friesian breeding stock was claimed to 'degenerate' in other provinces and then to succumb to tuberculosis. Veterinarians compared the fine-skinned and weedy dairy type to the tuberculosis-prone 'habitus phthisicus' in humans, characterised by a weak frame and an almost translucent complexion.[26] There was wide agreement that the delicacy and extreme level of performance of the black and whites from Friesland made them particularly vulnerable.[27]

Acting upon this advice, a considerable number of farmers on the sandy soils preferred dairying with the Dutch red and white cow, the traditional cattle of the regions along the major rivers, the Meuse, Rhine and IJssel, for short called MRIJ-cattle. These red and whites were stockier, more robust and sober, and thus better suited for the circumstances on small mixed farms. Their milk yield was not as high as that of the Friesians, yet they were better meat producers: they could be fattened more easily and the quality of their meat was better. Last but not least, they were claimed to be less susceptible to tuberculosis.[28]

A second alternative was a more robust type of black and whites, to be found in the provinces of Groningen and South-Holland, where thanks to the availability of agricultural waste products fattening had traditionally been more important than in Friesland and North-

[24] Ter Haar, 1913, p. 997.

[25] van Leeuwen, 1905, 1923a.

[26] Abbo-Tilstra, 2002, pp. 27, 146–147, 201.

[27] The susceptibility of Friesians to tuberculosis was pointed out time and again in agricultural journals and handbooks in the early decades of the twentieth century; see for instance Kroon, 1913, p. 97; Bakker et al., 1914, p. 133; Timmermans, 1923, p. 12; van Leeuwen, 1924, 1931; Dommerhold, 1927, p. 10.

[28] See for instance ter Haar, 1919, 1923; Kroon, 1913, p. 107.

Holland, resulting in a preference for heavier animals. Like MRIJ-cattle, cows of this type were believed to be less susceptible to tuberculosis than Friesians. In the 1910s and 1920s, a group of breeders of this variety, all living in the village of Hoornaar in South-Holland, offered serious competition to the Friesian breeders of black and whites. The provincial rivalry sparked by this competition can be gleaned from the articles that one of the type's promoters, agricultural journalist E. van Muilwijk, published in *De Veldbode*. He wrote, for example, that breeders should beware of using the 'effeminate aristocrats' that were bred in Friesland as sires. For within a few generations, tuberculosis-prone, spiky offspring with a miserable constitution would be the result.[29] And animal husbandry adviser Jacq. Timmermans challenged his readers to name a single Friesian bull that had done well in the southern province of Limburg. Imported Hoornaar bulls, on the other hand, had almost without exception improved the local breed in this province, he claimed.[30]

Figure 2 shows the most famous bull of the Hoornaar type: Dirk 4. For years, from the mid-1910s until well into the 1920s, he and his male offspring were considered to represent the ideal type of sire for dairy farmers on the lighter soils. The fact that milk yields were lower than in Friesians was acknowledged but accepted as the price to be paid for a healthy breed. On a more general level herd-book inspector Iman van den Bosch had argued already in 1906 that it was better to aim for reasonable milk yields with a high butterfat percentage than to strive for record yields of blue milk. Foreigners, he wrote, also preferred milky cows with a sound conformation; cows that almost literally produced milk like water were undesirable.[31] He had a point: many English farmers in the 1910s and 1920s described the Friesians as an 'irrigation breed' and as 'mere water carts.'[32] And most German breeders, according to Carl Kronacher, professor of animal breeding and a leading German expert, preferred animals that were more solidly built than the Friesian black and whites.[33]

Nevertheless, the 'Dirk 4' bloodline became less popular in the 1930s, probably, in part, because farmers became dissatisfied with the – by then – even less than mediocre milk yield of this type of cow. The most

[29] van Muilwijk, 1919, 1925. Together with veterinarian A. van Leeuwen, van Muilwijk promoted the Hoornaar type in *De Veldbode* for years.

[30] Timmermans, 1919.

[31] van den Bosch, 1906a, pp. 597–598.

[32] Stanford, 1956, p. 50.

[33] Kronacher expressed his views at a national dairy show in 1928; see Anon., 1928.

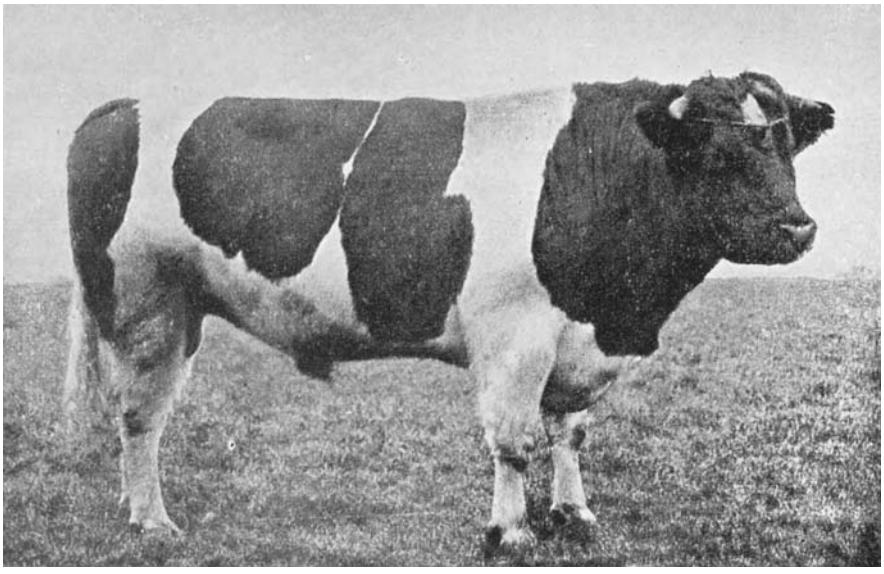

Figure 2. Dirk 4 (from: E. van Muilwijk, *De preferente zwartbonte N.R.S.-stieren*, Den Haag 1937, p. 83)

important reason for its dwindling popularity, however, was that the Friesian breeders of black and whites made a rather spectacular comeback in these years. They had taken the criticism of their type to heart and had been working to improve it since the 1910s. In the 1920s, Friesian farmers also began a vigorous campaign to eradicate tuberculosis among their animals. With the help of the Friesian black and white herd-book, the cooperative creameries and other provincial organisations, the first provincial animal health service in the Netherlands was established in Friesland in 1919. Other provinces would follow suit only after World War II. As a result, the black and whites in Friesland would be the first to be officially declared free from tuberculosis in 1950.[34]

A culmination point of the Friesian breeders' efforts to improve their black and whites was the bull Adema 197 (Figure 3), born in 1934 and bred by the reputed Knol Bros. in the hamlet of Hartwerd. In the eyes of the cognoscenti this animal was the most glorious Friesian bull ever bred until then. Adema 197 was claimed to represent a type that adapted more easily to varying circumstances than the original Friesians. He was broad- and flat-backed, and heavier, deeper and more short-legged than his late nineteenth-century forebears. Yet contrary to

[34] Abbo-Tilstra, 2002, p. 330.

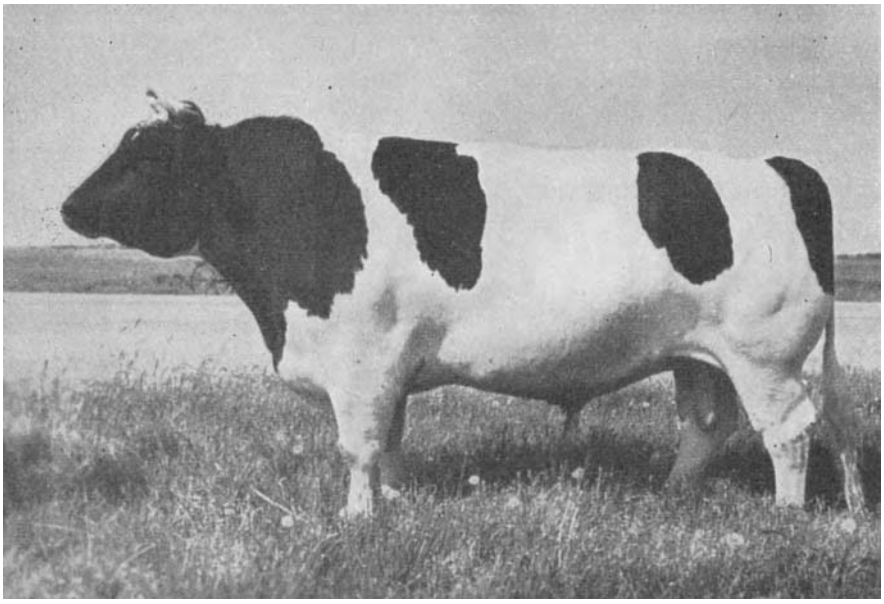

Figure 3. Adema 197 (from: R. Strikwerda, *Een eeuw Fries stamboekvee*, Leeuwarden 1979, p. 310).

the rather crude and coarse Dirk 4 he retained the Friesian dairy type in his more elegant lines, supple skin and fine hair. Moreover, Adema 197 exuded 'nobility,' as the breeders called it, a term borrowed from horse-breeding of which no straightforward definition can be given. It was used to denote the extra phenotypic quality or beauty, to be appreciated only by the connoisseur that distinguished the pick of the breed from animals that were merely phenotypically correct according to the standard of the breed. In the 1950s, the meaning and significance of the term would give rise to extensive discussions in the herd-book journals. Particularly the critical scientists whom I mentioned in the introduction would argue that the breeders' preoccupation with nobility was a clear sign that they were guilty of breeding for fancy. Whether it was a useful notion or not, no conformation expert would deny that Adema 197 was an icon of nobility.

As to Adema 197's production qualities, it turned out that his daughters' milk yield was 'satisfactory,' while the milk had a high butterfat percentage. All in all, he thus represented an almost perfect bull according to pre-war criteria. As a foundational bull for what came to be called the 'modern Friesian,' he was the most influential Friesian sire for several decades. In the 1950s, there were few true-bred

Friesian bulls that did not have Adema 197 in their pedigree at least once.[35]

The modern Friesians, with Adema 197 as their harbinger, restored the breeders in Friesland to the respected position they had had in the late nineteenth century. In the 1950s they experienced the heyday of their fame, nationally and internationally. The Friesian herd-book flourished, the small circle of top breeders enjoyed an enormous prestige, and their animals were much sought after and sold for high prices. The five-yearly jubilee shows organised by the herd-book were events that attracted an international audience.[36] Foreign buyers were particularly impressed by the uniformity of the Friesian black and whites. And they knew full well that the breeders gave priority to quality of conformation. George Hobson, the secretary of the British Friesian Cattle Society even stated categorically that in Holland 'high milk yields [are] not sought.'[37]

Two other factors contributed to the success of the Friesian black and whites. To begin with, bovine tuberculosis was eradicated in all Dutch provinces by the mid-1950s.[38] Secondly, the differences in fertility between the heavier and lighter soils in the Netherlands had almost disappeared by that time as a consequence of the use of artificial fertilisers and improved pasture management techniques.[39] Thus the major obstacles to the spread of the Friesian type had been removed.

Still, the constitution of their animals continued to be among the Friesian breeders' central concerns in the 1950s. It was their job, they argued, to safeguard the health and adaptability of the breed. While it might be argued that productivity came first for run-of-the-mill dairy farmers' cows, a different standard was needed for the breeding stock from which these animals were bred. Trade-offs between milk yield and conformation were necessary in the case of breeding stock; to strive for uniform and harmoniously built animals was no mere luxury or fancy. In the long run, well-bodied cows were economic cows, and the nobility

[35] Strikwerda, 1979, pp. 317–333; 1998, p. 96.

[36] Strikwerda, 1979, pp. 64, 96–97, 253–257, 261.

[37] Stanford, 1956, pp. 186–187. This is not to say that the 'modern Friesian' was accepted uncritically in Britain. The hereditary qualities of a group of 57 bulls exported to Great Britain in 1950 gave rise to heated discussions. Nevertheless, Dutch Friesians remained popular in Britain. See Anon., 1955b; Mingay, 1982, pp. 176–199.

[38] Hofman, 1996.

[39] Accordingly the national herd-book, the NRS, decided in 1954 that it was no longer necessary to judge female cattle from different soils in separate categories at shows, as had been customary until then; see Anema and Jepma, 1960, p. 116.

that distinguished the top of the breed was to be seen as an extra guarantee for the quality of their progeny.[40]

Against this background it will come as no surprise that, in the fifties, breeders and herd-book officials, as well as some of the provincial animal husbandry advisers, qualified the growing scientific criticism of their allegedly excessive preoccupation with the phenotypical qualities of their animals as out of place. In the opinion of these practical workers, the commercial success of their modern Friesians alone may have sufficed to justify their view of the matter. It was precisely for their conformation and uniformity that the Friesians were sought after. And whether they were functionally significant or not, details of conformation that lent nobility to an animal were definitely important financially speaking. An animal's ranking at shows and its score for conformation in the herd-book's point system had direct consequences for its commercial value.[41] For the breeders, beauty was the hallmark of health and adaptability as well as of marketability. And why change a breed that was so obviously successful? 'This can't go on forever,' one of the Knol brothers once remarked, only to add, however, that 'it is what the farmers want.'[42] And in 1956 Kees Rijssenbeek, the animal husbandry director of the ministry of agriculture, remarked that while it was impossible to say whether the modern Friesian represented an advance in terms of efficiency of production, it was an undeniable fact that it sold better than the old type.[43]

A middle position in the rising debate over breeding practices in the 1940s and 1950s was taken up by Wieger de Jong of Wageningen Agricultural College. De Jong had risen from the ranks in both practical and scientific circles. The son of a dairy farmer and a Wageningen graduate, he had worked as a provincial animal husbandry adviser and herd-book inspector before being appointed as a director of the Dutch national cattle herd-book, the NRS which covered all Dutch provinces except Friesland. In 1947 he became chairman of the NRS and, in the same year, Wageningen professor of animal breeding.[44] Thus representing both the Wageningen scientists and the organised breeders in a leading position, De Jong carefully weighed the arguments from both sides against each other.[45]

[40] See for instance Jepma, 1954, 1957, 1962; Anon., 1955a, 1957a, b.

[41] Strikwerda, 1979, p. 255.

[42] Kroon, 1997, p. 82.

[43] Rijssenbeek, 1956.

[44] Dekker and Stapel, 1976, pp. 315–316.

[45] De Jong, 1947, 1957.

Firstly, he pointed to the difficulties inherent in the notion of constitution. Unquestionably, a healthy constitution was important, yet how were constitution and conformation related? Were short legs stronger, did a weedy frame affect longevity, were sturdy-looking animals really healthier? Only comparative studies could decide on such matters, he argued, and these had yet to be undertaken. Nevertheless, De Jong sympathised with breeders who strove for beauty of conformation. Even breeding for fancy should not be rejected out of hand. For many farmers, the joy of breeding and even their happiness in life were bound up with their competitive efforts to create the perfect animal. Conformation shows provided the sporting ground to assess the level of their achievement, and not much would remain of the popularity of breeding without such incentives.

While sympathetic towards the breeders' concerns, De Jong was no less worried about the productivity of the black and whites than his scientific colleagues. Already in 1943 he had shown that there was no correlation between the overall scores for conformation that animals were allotted by herd-book-inspectors and their milk yield. As to the different parts of the body, only the points for udder quality were correlated with productivity.[46] Apparently, the methods and criteria that the breeders and the herd-books used to improve and evaluate their animals were not particularly conducive to the improvement of the productivity of the breed. Thus the question arises what the breeders' methods actually consisted in. For this we must once again go back in time.

Bloodlines and Purity

In the late nineteenth century, a growing number of dairy farmers in the Netherlands considered themselves to be not merely dairymen, but also breeders. (While not all dairy farmers were breeders, all breeders were also dairymen. Cows were too costly to raise and maintain merely for breeding purposes. Their milk constituted an important part of the breeders' income – the greater part by far, for most of them; only a few dozen of them earned serious money with their breeding activities.[47]) In western Europe, Dutch cows had been well-known for their dairy qualities for centuries, yet breeding became particularly attractive in the second half of the nineteenth century, when the fame of the black and whites spread world-wide.

[46] De Jong, 1943.

[47] Minderhoud, 1935, p. 126.

The American cattle traders who in the 1870s and 1880s bought thousands of Friesians provided an incentive for organised breeding in the Netherlands in that they stimulated the establishment of herd-books. An American importer, Holstein pioneer Solomon Hoxie, even acted as an adviser of the Friesian herd-book founders, and he and several other American buyers became herd-book members.[48] There is a pattern here, as Margaret Derry has shown: the establishment of herd-books is indicative of a rising international market.[49] The guarantees on paper provided by herd-books were especially important for American buyers. Whereas a Dutch farmer would never buy a cow that he had not inspected himself, New World geographical distances necessitated American farmers to rely on catalogues and certified pedigrees.

What pedigrees had to prove, was 'purity' (*zuiverheid*, in Dutch). In the case of Arabian horses, for instance, purity was ascribed only to animals all of whose ancestors descended from horses that had been bred, literally, 'in the desert.' In Shorthorn cattle, purity referred to descent from the breeding stock of a very limited number of British breeders.[50] Likewise, a pedigreed Friesian could be trusted to have descended from black and white ancestors bred in the Netherlands. The Dutch national herd-book (the *Nederlandsch Rundvee Stamboek* or NRS) was established in 1874, and it registered animals belonging to what was then called the Dutch lowland breed, mainly comprising the black and white Friesian, the red and white MRIJ and the Groningen whitehead (the *blaarkop*).[51] To enhance the exclusivity of their black and whites, breeders in the province of Friesland established their own herd-book in 1879, the FRS (*Friesch Rundvee Stamboek*). From then on, black and whites from bloodlines in other provinces were no longer accepted for registration in the Friesian herd-book, irrespective of their characteristics or qualities.[52]

The concept of purity was an ambiguous and contested one.[53] For instance, the nineteenth-century notion of constancy of a pure race

[48] Strikwerda, 1979, pp. 81–86; see also van der Wiel and Zijlstra, 2001, pp. 32–35.

[49] Derry, 2003, pp. 156–161, *passim*. Conversely, around 1900, when the German, English and American markets were being closed for live cattle, the herd-books experienced a serious crisis; see Löhnis, 1901.

[50] Derry, 2003, chapter 2.

[51] For a history of the NRS, see Dekker and Stapel, 1976.

[52] Still, although this was later denied by FRS officials, there were a few isolated cases of Friesians born outside Friesland that had, in the early years of the FRS, been registered by the herd-book (Strikwerda, 1979, p. 144). For histories of the FRS, see Zwart, 1960; Strikwerda, 1979.

[53] Derry, 2003, p. 9, *passim*.

('Konstanztheorie'), propagated by the German horse expert Johann Justinus, was based on the conviction that purity resided in an inborn potential of a true race to pass on its defining characteristics consistently and unchangingly through the generations, irrespective of the circumstances under which the animals were kept.[54] Many nineteenth-century practical breeders, however, knew from experience that the purity of their breeds could not be defined in such a strict sense. Friesian breeders are a case in point. They were all too well aware that the purity of their black and whites needed maintenance even under stable environmental circumstances. This was convincingly demonstrated by the irregular occurrence of red and white calves born from black and white parents. In its early years, the Friesian herd-book made no bones about registering such calves and other off-coloured animals. They would soon be relegated to separate registers, however, to please the American buyers for whom a pure Friesian should be black and white.[55]

Meanwhile, Friesian breeders did believe that their black and whites represented a very old race that had been native to Friesland since prehistoric times.[56] Crossing of different breeds, which was still common in other provinces at the time, was supposed to have been rather the exception in Friesland, and a 'pure' core of Friesians was claimed to have been preserved through the ages. Accordingly, the most stringent requirement for a Friesian to be accepted for registration concerned geographical provenance: the animal should descend from ancestors bred by Friesian breeders. In this way, the notion of purity functioned exactly as intended, namely to protect the interests of breeders in Friesland and their buyers.

As we shall see, geneticists would translate purity into Mendelian terms after 1900, yet the purity concept had connotations of exclusivity and quality that Mendelism could not capture. An example is provided by a veritable *cause célèbre* in Dutch cattle breeding, the so called 'coloured spots question' (*vlekjeskwestie*). In the middle decades of the nineteenth century a number of Shorthorn bulls were imported in the Netherlands from the U.K. Some agricultural experts believed that they might improve the beef quality of Dutch cows. The experiment was soon terminated, however, because the milk yields of cross-breds turned

[54] Berge, 1961, pp. 131–134; Comberg, 1984, pp. 106ff; Wood and Orel, 2001, pp. 244–246, 264–266.

[55] Strikwerda, 1979, pp. 31–36, 109–122. See also Dekker and Stapel, 1976, pp. 256–267.

[56] Bakker, 1909, contested this view and argued that the original Friesians had been red and whites, the black and whites having been imported from Denmark after the onslaughts of the rinderpest in the eighteenth century.

out to be disappointingly low. Traces of Shorthorn influence remained visible for some time in the colouration of the experimental herds, but these progressively disappeared when the cross-breds were bred up to the original Dutch type for several generations. The idea took hold, however, among breeders and their customers alike that isolated coloured spots on the lower legs were an indication of lingering Shorthorn influence. For this reason such spots were considered to be highly undesirable flaws. Animals with spots on the phalanges were in the 1920s even excluded from registration by the FRS.[57]

Until far into the twentieth century, scientists and animal husbandry advisers would spill gallons of ink trying to convince the herd-books that excellent animals were, for no good reason, kept out of breeding programmes in this way. In their view there was no evidence that the coloured spots derived from Shorthorns, while, more importantly, a cow's productivity was in no way affected by their presence.[58] It was to no avail, however. In 1912 the well-known breeder A.D. Groneman conceded that the experts might well be right, yet that breeders had different concerns: buyers, especially foreign traders, wanted pure black and whites, and pure animals were not supposed to have spots.[59] The herd-books acted accordingly and did not change their policy. Clearly, purity referred to a breed standard that could not be compromised, irrespective of whether a deviation from the standard was genetically or functionally significant or not. At issue here was not a genotype but a commercial 'brand.'[60]

In order to maintain the desirable qualities of their herds, Dutch breeders employed methods that, as Roger Wood and Vítěslav Orel have argued, had been common practice among experienced breeders since the eighteenth century.[61] Breeders knew that the best strategy to maintain the defining characteristics of their stock was to breed the animals among themselves. In its most strict form, this amounted to inbreeding, which was indeed practised by all experienced breeders of Friesians.[62] Even parent-offspring and sibling matings were not shunned. Adema 197, to give but one example, was the product of a mating between siblings; he had only one grandfather, and his grandmothers

[57] See for instance Strikwerda, 1979, pp. 109–116.

[58] A. van Leeuwen, for instance, campaigned for years on end against the depreciation of animals with spotted legs in *De Veldbode*. See for instance van Leeuwen, 1914.

[59] Groneman, 1912.

[60] Dog and horse breeding provide similar examples; see Derry, 2003, p. 158, *passim*.

[61] Wood and Orel, 2001, chapters 3 and 4. See also Russel, 1986.

[62] See for instance Hoogland, 1921.

were related as aunt and niece.[63] Meanwhile, the risks of inbreeding were well-known. Defective offspring had to be culled carefully and some outbreeding might be unavoidable once in a while. Still, the ideal of uniformity, in the breeders' opinion, could only be reached by close inbreeding. The best breeders created their own 'bloodlines' in this way, and these were considered to buttress the quality of the breed as a whole.[64]

An additional advantage of breeding in bloodlines was that the herds of the top breeders were not only very uniform, but at the same time slightly different between them, as a consequence of minor variations in conformation in each herd that were consolidated through inbreeding. This enabled experienced buyers to tell them apart, and thus helped breeders to enhance the exclusivity of their stock. For instance, buyers knew that breeders in North-Holland produced black and whites of a slightly larger and milkier type than those in Friesland, while farmers in North-Holland liked some of the Friesian bloodlines but not others.[65]

A new method for assessing the quality of dairy cows was introduced in the 1890s, after the example of Danish dairy farmers, namely the systematic recording of milk production. Friesland led the way and would remain the province with the highest participation in milk recording. By carefully weighing a cow's milk yield on a regular basis its yearly production could be estimated, and the figures thus obtained could also be used to assess the hereditary quality of the cows' sires. Milk recording included measuring the milk's butterfat content. After Friesian creameries had, in the late 1890s, set the example, farmers in more and more regions of the Netherlands were paid for their milk on the basis of its butterfat content. Particularly in Friesland selection for butterfat became the breeders' primary focus of selection.[66]

An instrument to raise the interest in breed improvement that had been introduced around 1850 yet that acquired a much more prominent role in the early twentieth century, was the organisation of agricultural exhibitions and conformation shows. The increasing number of regional, provincial and national shows that breeders associations, agricultural organisations and the herd-books organised after 1900 testifies to the growing popularity of purebred breeding as well as to the

[63] Strikwerda, 1979, p. 317.

[64] Some famous bloodlines were described in monographs; see for instance van Muilwijk, 1935.

[65] For the history of cattle breeding in North-Holland see Kroon, 1997; van der Wiel and Zijlstra, 2001.

[66] Strikwerda, 1979, pp. 65–80.

commercial interests behind it. For as already indicated, show prizes earned breeders money: after a successful show, sales of their stock would immediately pick up.

There were several other tools that were employed by breeding organisations and the government to rationalise the farmers' methods to improve their stock. We shall take these in stride in the next section, which analyses the impact of genetic theory on breeding practices.

Breeding and Genetic Theory

For Amsterdam botanist Hugo de Vries, one of the 'rediscovers' of the Mendelian theory of heredity, the improvement of plant breeding and agriculture had been the principal motive for investigating hereditary phenomena, and he considered Mendel's laws to be directly relevant for the breeding of agricultural varieties.[67] While the possible implications of Mendelism for agriculture were thus pointed out from the start, Dutch animal breeding experts were more hesitant in confronting their field with Mendelian genetics. The subject began to receive serious consideration only in the 1910s, when Mendel's rules were explained in several monographs and articles.[68] Even then, the authors took most of their examples from botany. Examples from livestock breeding only involved very simple Mendelian phenomena, mainly relating to coat colour in farm animals.

For example, veterinarian A. van Leeuwen, the stock breeding expert of *De Veldbode*, after having expressed his reservations about the general validity of the theory, inquired among his readership whether anyone had ever bred a black and white cow from red and white parents. Black and whites were known occasionally to produce a red and white calf, but was the reverse also possible? A group of farmers responded that they had never come across such an anomaly; only a single farmer believed that he had. Van Leeuwen concluded that alternative explanations could not be ruled out, yet that this was indeed supporting evidence for interpreting the red colour as resulting from a Mendelian recessive trait.[69] The presence or absence of horns appeared to fall into

[67] On de Vries, see for instance Stamhuis, Meijer and Zevenhuizen, 1999. For the motives underlying his research, see Theunissen, 1994. For his views on agricultural plant breeding, see de Vries, 1907.

[68] See for instance Hagedoorn, 1912; Waardenburg, 1913; Giltay, 1914; Lotsy, 1915; Reimers, 1916.

[69] van Leeuwen, 1912.

the same category, and before long, the more difficult example of coat colour in horses also turned out to be amenable to a Mendelian explanation.

In 1910, geneticist Arend L. Hagedoorn, a pupil of Hugo de Vries and Jacques Loeb, was invited by the Holland Agricultural Society to assist in designing breeding strategies for the improvement of Texel sheep.[70] Breeders had been hybridising the Texel with English races such as the Lincoln and the Wensleydale for several decades. Aiming for a uniform new type, they were struggling to get rid of unwanted fleece, head and nose colours. Hagedoorn helped them by devising breeding schemes along Mendelian lines. Although his efforts were not unsuccessful, the project was discontinued after some time because of the complexity – and consequently the rising costs – of test-mating and culling.[71]

This example illustrates the problems inherent in the application of a Mendelian approach to livestock breeding as opposed to plant breeding. As Wageningen animal husbandry professor J. Reimers pointed out in 1916, experimenting with plants was easier because they could be self-fertilised, and seeds and plants were cheap and could easily be obtained as well as dispensed with in large quantities. Individual animals, on the other hand, especially the larger farm animals, represented a significant economic value and produced far less progeny, and therefore the costs of experiments quickly became prohibitive.[72] Deliberately trying to produce even a single – undesirable – red and white calf, for instance, was not something a breeder of Friesians would readily do for experimental reasons. And he would certainly not be prepared to experiment with several detrimental recessive factors.

Moreover, we have only been discussing qualitative characters so far. The economically most important characters of livestock, such as milk and meat production, are of the quantitative kind. Even scientists who were convinced that such characters could also be explained in Mendelian terms had to admit that in this case the practical application of Mendelian theory was virtually impossible. According to Reimers, a quantitative character such as milk yield might be accounted for by assuming that a group of Mendelian factors with additive effect was responsible for the trait. Yet even if a Mendelian breeding scheme,

[70] Arend Lourens Hagedoorn (1885–1953), animal geneticist and evolutionary theorist, deserves more attention from historians than he has received until now. Basic information on his life and work (in Dutch) can be found in a commemorative issue, published shortly after his death, of the journal of the Dutch Genetics Society, *Erfelijkheid in Praktijk* 15 (November 1954), nr 4/5.

[71] Hagedoorn, 1911; Kroon, 1917, p. 43.

[72] Reimers, 1916, pp. 2, 27; see also Hagedoorn, 1912, pp. 5–6.

based on this assumption, could be devised to improve milk yields, the complexity and costs of such a programme presented great difficulties. Geneticist Hagedoorn remarked that breeders of farm animals, contrary to plant breeders, would learn nothing of practical use from a visit to the Svalöf experiment station in Sweden.[73]

Accordingly, while Hagedoorn would become a well-known expert in animal breeding and genetics, he conducted his experiments with small laboratory animals such as mice. As to the economically important animals, he confined his investigations to animals that were inexpensive, could be kept in relatively large numbers and produced reasonable numbers of offspring, such as chicken and, occasionally, rabbits. Hagedoorn entertained no doubts that the rationality or irrationality of traditional cattle breeding methods could be decided on in Mendelian terms. He was well aware, however, that a Mendelian reform of breeding strategies was an entirely different matter. Little was known about the genetics of quantitative characters such as milk yield and egg production, but there were definitely too many genes involved to be handled by simple crossing procedures. Consequently, traditional breeding methods would be indispensable for a long time to come. In 1927 Hagedoorn stated that the influence of genetic theory on cattle breeding practices had been negligible, and in his well-known *Animal Breeding* of 1939 he even wrote that the influence had rather been the other way round: geneticists had learned a lot from the best breeders. What geneticists had to offer to the breeders of large farm animals was of a different nature: 'The geneticists' main contribution to animal breeding is not an analysis of genes, but an analysis of breeding methods.'[74] This view was widely shared among Dutch animal breeding experts at the time.[75]

What did the assistance that geneticists might give consist in, according to Hagedoorn and his scientific colleagues? To begin with, geneticists and animal husbandry experts concurred with the breeders that inbreeding was a rational strategy. The haphazard crossing of breeds that had been customary among small farmers until the late nineteenth century had resulted in motley collections of animals with unpredictable and widely varying qualities.[76] No improvement was

[73] Reimers, 1916, pp. 27, 37–38, 78; Hagedoorn, 1912, p. 83.

[74] Hagedoorn, 1927b, 1939, p. 19.

[75] C. Broekema, 1913b; van Leeuwen, 1923b; *Compte-rendu* 1923, pp. 53–58; van Muilwijk, 1928; Overbosch and van der Plank, 1931. See Derry, 2003, pp. 12–13, for a similar assessment with respect to the role of classical genetics in horse and dog breeding.

[76] Kroon, 1913, pp. 71, 121; 1917, p. 24.

possible in this way, and the board of the national herd-book had been wise, in 1906, to have formally subdivided the 'Dutch lowland race' into three clearly delineated breeds, the black and white Friesian, the red and white MRIJ and the Groningen whitehead.[77] But even stock improvement within narrowly defined breeds remained something of a lottery as long as bulls of different provenance were used every few years. It was much better, the scientists agreed with the top breeders, to start from a group of excellent animals and to consolidate their qualities in a closely inbred herd. Purity, translated into Mendelian terms, meant homozygosity, and inbreeding increased the degree of homozygosity. Therefore, inbreeding was a rational strategy of breed improvement, provided it was accompanied by scrupulous culling of animals with unwanted recessive traits. Scientists explicitly advised against needless outbreeding with unrelated animals. Animals imported from other regions might not adapt well to local circumstances – as the example of Friesians deteriorating on poor soil discussed above illustrated. Moreover, a bull from an unrelated herd with a long history of its own was bound to be different, genetically speaking, in many characters. Recombination would bring these differences to the surface in the second generation, and thus the achievements of years of careful inbreeding and selecting might be undone.[78]

At the same time, however, scientists also warned breeders not to overestimate the value of pedigrees. Obviously, the productivity of his ancestors should play a role in the choice of a bull. Yet it was of little use to study more than a few generations of an animal's ancestry. From a Mendelian perspective, it was more instructive to look at a bull's brothers and sisters, since they provided more reliable insights into his genetic strengths and weaknesses than remote ancestors whose contributions to his genes was insignificant.[79]

It is difficult to say whether practical breeders took heed of this advice. Yet a cursory survey of herd-book journals and histories of cattle breeding suffices to conclude that where the market for breeding stock was concerned, the preoccupation with pedigrees continued at least as long as inbreeding remained the principal breeding method and as long as a breeder's reputation was inseparably bound up with the reputation of his bloodlines. For instance, until well after World War II articles on individual breeders in herd-book journals invariably included

[77] van den Bosch, 1906b.

[78] Kroon, 1913, p. 102; Hagedoorn, 1912, pp. 57–64, 1927a, pp. 54, 87–95; Lotsy, 1915, pp. 15–17, 33; Reimers, 1916, p. 95; Bakker, 1926.

[79] Reimers, 1916, p. 89; Hagedoorn, 1912, pp. 47–48; van der Plank, 1940.

detailed information on the pedigrees of the foundational animals of their herds. The national herd-book published several illustrated genealogies of the most prestigious bloodlines, and a detailed description of bloodlines constituted the *pièce de résistance* of herd-book histories.[80] Knol Bros. even had the history of their stock-farm and bloodlines privately published.[81] Again, pedigree, like purity, was not merely about genes. Famous ancestors, however remote, continued to lend prestige to their bloodline. In a herd's history resided its quality and distinction. There is an obvious contrast here with the Mendelian interpretation of purity: as soon as a breed becomes pure in Mendelian terms, i.e. homozygous, its history becomes irrelevant. In a sense, Mendelian breeding may be said to aim for the elimination of a herd's history.

Another scientific critique of breeders' practices that could frequently be heard, was that the herd-books were more attuned to the breeders' commercial interests than to cattle improvement. Herd-books, it was argued, might serve as invaluable tools. Much might be learned, for instance, about hereditary diseases, if only the herd-books would register all descendants of pedigreed animals and would also record their genetic peculiarities.[82] It takes no stretch of the imagination, however, to realise that breeders could muster up no enthusiasm for such suggestions. Firstly, they were charged for registration of their animals, so they offered only the best ones for inspection.[83] Secondly, for obvious reasons many breeders rather preferred malformed progeny from their prize-winning animals to disappear without a trace. Herd-book officials feared that the herd-books would lose all their members if complete registration became compulsory, and scientists had to concede that they had a point.[84] Thus, at least in the period before World War II, the herd-books did not develop into the instruments for rational breeding that scientists would have liked them to become.

Finally, scientists were agreed that rational breeding should be based on progeny testing. Conformation and pedigrees were helpful to find a promising young bull, yet ultimately, it was the performance of his daughters as dairy cows that determined the true value of a sire. Therefore, rational breed improvement required the systematic use of tested bulls. From the early decades of the twentieth century onwards

[80] See notes 51, 52, 65.

[81] van Popta, 1965.

[82] Reimers, 1916, pp. 81, 93; Hagedoorn, 1912, p. 48; 1927a, pp. 130–137.

[83] In 1940, for instance, the registration costs of an animal were five guilders; a farm hand at the time earned about fifteen guilders a week (Kroon, 1997, p. 118).

[84] Wibbens, 1923; *Compte-rendu* 1923, pp. 51–53.

geneticist Hagedoorn in particular tried to drive this message home to the readers of agricultural weeklies, and he relentlessly repeated it in his scientific and popular publications. Ideally, he added, several promising young bulls should be tested on a limited number of cows first, and only the best ones should then be widely used as sires.[85]

In this case, there is no evidence that the breeders disagreed in principle. Yet again, meeting this demand for rational breeding in practice was a different matter. The ideal situation as sketched by Hagedoorn was impracticable in every respect until the 1940s.[86] Farms in the Netherlands were small and very few farmers milked more than 10 cows. For instance, in 1920 the 953 organised farmers in the province of Limburg owned a total of 2990 cows. In the Netherlands as a whole, an average number of ten cows per farm would only be reached in the 1950s.[87] Bulls were costly to maintain, and bull-calves increased in value only until their second or third year. Therefore farmers who could afford a bull of their own as a rule bought a young bull-calf, used it for a year or two and then sold it for slaughtering.[88] Thus by the time their daughters began to give milk and their real worth became apparent, most bulls were dead.

Since the late eighteenth century small farmers in many regions of the Netherlands had traditionally shared a bull purchased with municipal support. There were fine animals among them, yet many poor ones too.[89] After 1890, more and more farmers began to organise themselves in breeding associations which enabled them to buy better bulls. Government premiums helped them to keep the good ones for a longer period.[90] While some of these associations managed to improve their stock in this way, others fared less well and were discontinued after a number of years. There were indeed many obstacles to be overcome: farmers had to agree on the type of bull to be purchased; after several years of use, father-daughter inbreeding became unavoidable; a shared bull might spread venereal diseases; older bulls might become dangerous

[85] Hagedoorn, 1912, pp. 47–48, 86, 88; 1927a, p. 63. See also, for instance, van Krimpen, 1905, p. 13; Reimers, 1916, pp. 79, 92–93; Kroon, 1913, p. 99.

[86] The situation in The Netherlands in this respect, to be sketched in the following paragraphs, shows many similarities to that in the U.K. as recently described by Wilmot, 2007b.

[87] Timmermans, 1920; Strikwerda, 1998, p. 67.

[88] See, for instance, van Leeuwen, 1904; Wibbens, 1907; Löhnis, 1911, p. 46

[89] Van der Wiel and Zijlstra, 2001, pp. 57–61.

[90] Löhnis, 1911, p. 3; van Adrichem Boogaert, 1970, pp. 303–305.

or too fat to perform; and the progeny of even an expensive bull could turn out to be disappointing.[91] On the other hand, once a breeding association had acquired a certain reputation, its members might be tempted to buy or rear a bull of their own to get a share in the breeding market.[92]

Farmers might also use an excellent sire owned by a breeder for their cows. Yet if distance and the difficulty of transportation did not preclude such an option, it was the prices that breeders charged for insemination that put many farmers off. Around 1910, prices varied between 25 cents and 20 guilders, and top breeder F.A.F. Groneman found that most small farmers at that time were not prepared to pay the two guilders he charged for an insemination by his service-bull.[93]

Besides such complications, the number of cows inseminated by a bull exploited by a top breeder or a breeding association was still small, and a reliable assessment of his productive qualities was in most cases only possible after his death. Most bulls that, after a thorough investigation of their offspring by herd-book officials, earned the much-coveted title of *preferentschap*, indicating proven hereditary excellence, were no longer around to receive the honours or were at best near the end of their period of service.[94] The ideal situation as envisaged by Hagedoorn, in which a fair number of young bulls was tested before the best of them – by that time having reached the age of at least five or six – seriously began their tour of duty, was beyond the means, financially and practically, of even the most prosperous breeding associations. In 1941, after Hagedoorn had in a lecture once again underlined the importance of systematic progeny testing, NRS president H.W. Kuhn responded that Hagedoorn was apparently ignorant of practical cattle breeding: breeders could not possibly implement such a system, for both practical and economic reasons.[95] And animal husbandry adviser R.G. Anema predicted that current practices would probably not change for a hundred years to come.[96]

Kuhn's was a correct assessment of the pre-war situation, yet as to the future he and Anema soon turned out to have been too pessimistic. Progeny testing would become feasible after the introduction of artificial

[91] Nobel, 1912, pp. 10–11; van der Wiel and Zijlstra, 2001, pp. 99–109, 145–146.

[92] This happened in North-Holland, for instance; see van der Wiel and Zijlstra, 2001, p. 146.

[93] Löhnis, 1911, p. 46; Groneman, 1956, p. 37.

[94] Strikwerda, 1998, p. 114.

[95] Hagedoorn, 1941a; Kuhn, 1941.

[96] Anon., 1941.

insemination in the early 1940s. Interestingly, AI was initially developed to fight venereal diseases causing infertility and spontaneous abortions, but scientists were quick to realize the potential of AI as an enabling technology for progeny testing. AI opened up the possibility to test a young bull on hundreds of cows at the same time. Years were thus taken off the time formerly needed to assess his hereditary qualities. Further, AI enabled the use of proven sires on an unprecedented scale, and consequently far fewer bulls were needed than before. This implied a switch from breeding in bloodlines to breeding in populations: while in the first half of the twentieth century bulls were used in a single or at best a handful of closely inbred local herds, after World War II the best bulls virtually came to exert their influence on the breed as a whole. This in turn required drastic changes in the organisational structure of dairy cattle breeding. In the process, scientists were to take the lead in breeding matters, while the breeders were slowly but surely relegated to the sideline.[97]

This transformation did not take place overnight; it took several decades. As we saw in the previous section, in the 1950s, when the 'modern Friesian' was at the height of its popularity, the breeders, particularly those in Friesland, held on to their breeding methods and their convictions about the ideal Friesian type. This was not merely because of the obvious threat that AI posed to the market for bulls, but also, as indicated, because breeders opposed the exclusive focus on milk yield that in their view was part and parcel of the scientists' pleas for systematic progeny testing. In due course, however, postwar economic pressures forced farmers to scale up, intensify and specialise their farms, and as a consequence the Friesians were slowly but surely turned into a pure dairy type again.[98] This played into the scientists' hands, since the changeover to the specialised dairy type favoured bulls that had been progeny tested for high yields. Eventually, in the 1970s and 1980s, the trend towards specialisation would even lead to the demise of the Friesian black and whites and to their replacement by their American relatives, the Holsteins. In the United States and Canada, the black and whites had been predominantly kept for producing milk for consumption, and they had been selected exclusively for high yields. Even after

[97] On the development of AI in the Netherlands, see Strikwerda, 2007. For the U.K., see Wilmot, 2007b.

[98] On these postwar economic pressures, see, for instance, van der Molen and Douw, 1978, pp. 9–35.

subtraction of the extra yields due to their richer diets, they had left their Dutch forebears far behind in terms of milk production.[99]

The details of these postwar developments are beyond the scope of this paper. Here I have merely mentioned them to indicate the context of the scientists' criticism of breeding practices in the 1950s. Circumstances were changing rapidly in those years, and in their campaign for a new approach to cattle breeding scientists all but ignored the conditions on which breeding methods up till then had been predicated.

Having come full circle now, we can draw some conclusions with respect to the central questions of this paper.

Market and Moral Economy

Before World War II, cattle breeders and scientists in the Netherlands by and large entertained compatible views on the best methods for breeding dairy cattle, even though some of the scientific experts criticised the relative weight practical breeders attached to conformation and pedigrees. Where their opinions diverged, aesthetic and commercial considerations on the breeders' part were often involved: while certain details of conformation, such as coloured spots on the lower legs, might not be demonstrably relevant for milk yield, they did make a difference on the market for breeding stock.

Scientists readily acknowledged the fact that the insights into heredity provided by Mendelian theory were of little practical use to breeders of livestock. Still, hereditary theory was considered to be helpful to assess the value of the breeders' methods. For instance, striving for purity by means of inbreeding and breeding in bloodlines was deemed to be perfectly rational, since it was consistent with Mendelian theory. Yet as we have seen, the terms 'purity' and 'bloodline' had different connotations for scientists and practical workers. For the former, such notions referred to homozygosity of the relevant genetic factors; for the latter, they rather buttressed the constancy of a distinct commercial brand. Consequently, breeders set great store by the history of their bloodlines, while Mendelian geneticists may be said to have aimed at making such histories superfluous.

[99] The results of the implementation of progeny testing and of breeding up the Dutch black and whites to the Holsteins were spectacular. Between the late 1960s and the late 1990s, average milk yield of the cows in milk recording programmes doubled from some 4000 kg to about 8000 kg, while the butterfat percentage rose from almost 4 to nearly 4.5 percent (Strikwerda, 1998, p. 48).

From the early twentieth century onwards, scientists advocated the use of proven sires as indispensable for rational breeding. It might be added that the basic idea of progeny testing was not a new insight. It was hinted at in the well-known biblical phrase that 'the tree is known from its fruit,' and some breeders in antiquity, such as the Roman writer Varro, were definitely aware that the value of breeding stock was to be gauged from its offspring.[100] The methods of eighteenth-century breeders such as Bakewell also reflect this principle. This is not to say, however, that any systematic and controlled tests were developed before the twentieth century. There is no convincing evidence for this, not even in the case of Bakewell and his followers.[101] In the Netherlands, practical realities set severe limits to the implementation of progeny testing before World War II.

Systematic progeny testing became feasible after the introduction of artificial insemination in the 1940s, a technique that was originally developed to fight infertility caused by infections. From the late 1950s onwards, as a consequence of the rapidly increasing use of AI, breeding methods began to change from breeding in bloodlines to breeding in populations. In the process, Dutch breeding experts – mostly Wageningen engineers – began to call themselves population geneticists. They should rather have called themselves quantitative geneticists, however, since nothing was known of the genes involved in milk production, nor was such knowledge needed for their quantitative, statistical analyses of milk production through the generations that constituted the foundation of progeny testing. Neither the principle of progeny testing nor its effective implementation is predicated on a specific theory of heredity.

Before World War II, practical breeders and most scientists were agreed that selecting animals purely for production was ill-advised. Cows of the extreme dairy type were believed to be costly to maintain and prone to diseases, particularly bovine tuberculosis. This conviction was at the basis of the development of what was called the modern Friesian, a type of dairy cow that was more robust than the Friesians of the late nineteenth century. At the same time, the modern Friesians were valued for their uniformity and aesthetically pleasing conformation. Market considerations on the part of the Friesian breeders were important here. Thanks to the modern Friesian they re-established their fame on the national and international market.

It may seem tempting now, as a general conclusion, to explain the differences between scientists and practical workers that we have

[100] Russell, 1986, p. 35.

[101] Russell, 1986, pp. 204–205, 211.

encountered in terms of their different economic orientations. The scientists' case seems rather unproblematic indeed: their aim was to help improve the efficiency and productivity of dairy farming as an economic activity; it was not their principal objective to make breeding more lucrative for the breeders. Can the breeders, for their part, be said to have been driven purely by their own commercial interests, even if these went against the interests of the farmers or the national economy? Geneticist Hagedoorn certainly saw things this way; he didn't flinch from accusing the breeders of deceiving the farmers.[102] Wageningen professor of animal husbandry Wieger de Jong on the other hand did not doubt their sincerity: breeding was a labour of love and creating beautiful animals was the joy of a breeder's life. De Jong's view, in its turn, is open to the objection that it is quite impossible to separate the breeders' aesthetic ideals from their commercial considerations: as Margaret Derry has argued, breeding for perfection and breeding for the market went hand in hand.[103]

Yet even if we accept this, we still have to explain why a certain type of cow, the modern Friesian in particular, was considered to be 'perfect,' not only by the breeders, but also by their buyers. The buyers were farmers too, and would they not have been at least as hard-nosed in pursuing their best interests as the breeders? It seems unlikely that breeders would be able consciously and systematically to 'deceive' them. So why then would they buy animals that according to the scientists were attractive rather than productive? The answer must be that the buyers apparently shared the breeders' conviction that uniformity and beauty of conformation did matter, and that well-built cows were economic cows. To understand why this was so, we have to go beyond the purely commercial, in my view. I want to argue that the modern Friesian should also be seen as a product of a normative view of good farming and breeding that characterised dairying in the first half of the twentieth century. A recent analysis of farming practices in Friesland by agricultural sociologist Jan Douwe van der Ploeg provides the context for this interpretation.[104]

From the later decades of the nineteenth century onwards, according to van der Ploeg, Friesian farmers developed an intensive style of dairying which they themselves designated as 'neat' or 'decent' (*kreas*, in Friesian) farming, as opposed to 'rough' or 'careless' (*rûch*) farming. The latter style had been dominant, for instance, during parts of the

[102] See for instance Hagedoorn, 1941a, b.

[103] Derry, 2003, pp. 156–161.

[104] van der Ploeg, 2000, pp. 57–106.

eighteenth century, when floods and epidemics such as rinderpest were regular occurrences. Under such circumstances, farmers were reluctant to invest in their animals. They preferred an extensive farming style that aimed for quick profits with minimal investments of capital and labor. Food costs were kept as low as possible. The cows were stabled only under severe weather conditions, and particularly the young animals were reared on sparing diets. Resources such as hay and manure were sold when market prices were favourable. Production was maximized by milking as many cows as was feasible and by keeping their dry period as short as possible. There was little or no interest in breed improvement and stock breeding.

In the second half of the nineteenth century, however, when pests were under reasonable control and economic prospects were favourable thanks to the opening of new markets dairy farmers began to invest more in their animals and land and to aim for long-term improvement. Central to this new style of farming was the idea of pursuing a perfect balance of resources within a closed system that produced only milk and meat as commodities. Hay and grains were no longer sold but fed to the animals as winter feed; manure was used only to fertilise the farmers' own fields; and the best calves were kept and reared on good food either to replace the oldest cows or to be sold. In the first half of the twentieth century this style of farming had become synonymous with good farming, according to van der Ploeg. The farmers' own designation of their dairying style as 'neat' or 'decent' also indicates its normative character. Among Wageningen agricultural experts too this intensive style was generally considered as a model for the improvement of dairying practices in the Netherlands.

I would like to suggest that Friesian farmers' breeding practices and their view of the ideal type of cow fit perfectly into this style of *kreas* farming. The increasing demand for breeding stock towards the end of the nineteenth century is in itself an illustration of the rise of a intensive farming style characterised by long-term planning and improvement. The fact that the farmers became more concerned with the quality of their products points in the same direction: selection efforts were aimed at raising the butterfat percentage of the milk. The breeders' reaction to the problem of tuberculosis, that was especially acute in the early decades of the twentieth century, provides a further example. Instead of resorting to *rûch* farming, as had been customary in earlier times, breeders faced the disease by modifying their animals in order to decrease the risk of infection: the weedy Friesians were turned into a sturdier type of cow. In the process, their extraordinary yields were

sacrificed: maintaining a careful balance between constitution and production was believed to be the best option in the long run. Thus the conviction that it was unwise to aim for record yields can be seen as an integral part of the *kreas* style of farming.

To a considerable extent, the same can be said of the high value attached to aesthetically pleasing cows, since many breeders considered beauty and constitution to be closely related: beauty was an indication of the extra quality of constitution that was needed for breeding stock. Thus striving for beauty was not necessarily a tell-tale sign of fancy breeding. The beauty of a breeder's animals indicated his high standards of farming and breeding. From the buyers' perspective, this was also the attraction of buying and owning such animals: if beautiful cows were good cows, beautiful animals contributed to the status of their owners as good farmers. Such animals thus had the extra benefit of lending prestige. This is not to deny that the aesthetic element, as it became an important market asset of the Friesian black and whites, could easily gain momentum on its own, as the example of the overly robust and beefy Dirk 4 line illustrates. After a while, however, the market corrected this breeding trend, as it would also, in the 1960s, correct the trend – the 'fad,' in the eyes of the scientific experts – of the modern Friesian that grew smaller and smaller. Initially however, these types of cows had not been bred just to please the eye but for reasons connected to what was considered as good farming practice by breeders and buyers alike.

From this perspective, it might be argued that the term *dubbeldoelkoe*, which gained currency in the Netherlands in the 1950s as a direct translation of the English term 'double purpose cow,' was a misnomer, at least for the Friesian black and whites. Before 1900, Friesian dairy farmers kept cows for their milk. It was the milk that earned them the bulk of their money; the meat was a by-product, not a second 'purpose.' The breeding of beefier animals after 1900 was never intended to produce more meat. Nor were beefier animals believed to be more profitable in terms of direct returns. On the contrary, it was accepted that such animals might possibly even be less profitable in the short run than the pure dairy-type Friesians. The reason they were preferred was that stock of this type was believed to be more durable and thus more economic in the long run, over the generations. Considerations of this kind were at the heart of *kreas* farming, and thus the modern Friesians were *kreas* animals rather than double purpose animals. More generally, the Friesians were as much a product of the moral as of the political economy of dairy farming.

Finally, it is hardly surprising that scientific experts in the 1950s and 1960s had a hard time convincing the breeders that the increase of milk production should have absolute priority. This advice did not merely conflict with the breeders' market interests, it also went against the grain of the normative culture of *kreas* farming that had been closely bound up with the breeders' economic considerations. The story of how scientists eventually gained the upper hand and succeeded in reforming breeding practices along 'rational' lines has yet to be told.

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