

# World Wide Holstein Breeding

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## **Abstract**

The North American Holstein Breed has literally taken the world by storm over the last 25 years. However, questions exist regarding the breed's suitability for alternative environments. The US is in the process of migrating to a net profit selection goal and will likely place more emphasis on functional traits (other than conformation) than has been practised in the past. Traits most likely to receive attention are somatic cell information, calving ease, and fertility. Milking speed, disposition, early calf mortality, and individual diseases are unlikely to receive major emphasis. Additional research is needed on factors affecting net profit, genetic markers for increased immunological function, and the suitability of crossbreeding as a method to both improve functional traits and avoid inbreeding.

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## **1. Introduction**

The North American Holstein Breed is frequently credited to have begun with imports from Northern Europe in the late 1800's. However, reports of importation as early as the 1850's exist. The US Holstein Association was formed in 1885 and has registered over 19 million animals in the last 113 years. The North American Holstein stayed at home until the early 1970's when large-scale exports began. The early years saw the exportation of live animals that were later banned due to health concerns. Over a 25-year span, US Holstein semen exports grew from less than 400,000 units in 1973 to nearly 8 million units in 1997. Early exports were mainly to EU members countries; particularly Italy, the Netherlands,

Germany and France. In addition, the Netherlands and France pursued a very aggressive embryo import program as a source of breeding stock for their internal genetic development programs. The import of semen and embryos has resulted in the "Holsteinization" of much of Europe.

The impact of the North American Holstein on European Black and White breeding programs can be seen in Table 1 which lists the percentage of top bulls either of USA origin or having a USA sire. The percentages would be even greater if additional generations past the sire were considered. These percentages show the almost total displacement of the European Friesian by the North American Holstein; Black and White breeds with common roots but divergent selection.

Table 1. Percentage of top 100 bulls (INTERBULL, 1998) either of USA origin or sired by a bull of USA origin.

Country	Milk	Fat	Protein
Germany	93	77	76
France	95	87	90
Netherlands	95	83	89

The importance of the Black and White breed as compared to other breeds (“Coloured Breeds”) can be assessed by evaluating the relative number of sires from each breed submitted to INTERBULL. The February 1997 submission shows that 18 of 19 countries submitting data had Holstein information and 66% of the total data submitted were Holstein. Further, 14 of the 19 countries submitting data had Holsteins as their predominate breed. Of the remaining countries, three had Ayrshires as the predominate breed and two had Brown Swiss.

## 2. Competitiveness of the North American Holstein

If shear numbers are an accurate measure of success, it appears the North American Holstein has been tremendously competitive in the major dairy countries of the world. However, at least a portion of the North American Holstein’s success is due to the greater volume of milk produced as opposed to increased concentration of fat and protein. As the industry learns more about profit as compared to gross volume, the equation could shift away from the Holstein. Further, there are questions relating to the competitiveness of Holstein outside of its’ traditional environment.

The North American Holstein has been selected to perform in a high input environment. However, a few major dairy countries are based on a low input environment and there is renewed interest in low input dairying in other countries. Proponents of low input dairying are quick

to point out that the North American Holstein was not developed to perform in those environments and another breed or Holsteins selected under different conditions may be more appropriate for low input dairying. Low input dairying also often involves seasonal calving which requires good reproductive performance, a trait in which the North American Holstein has been faulted.

Dillion *et al.* (1996) compared high and medium merit Holsteins under three levels of nutrient input. High genetic merit animals outproduced medium merit animals under all three levels of input. However, a portion of the higher production was due to either live weight loss or reduced tissue gain in immature animals. Further, the infertile rate was much higher for the high merit line (21 versus 6.2 percent) indicating difficulty in maintaining a seasonal calving program using high merit Holsteins. These results were collaborated by Hurley (1998) who reported greater production but a higher infertility rate for high merit Holsteins as compared to French Normande and Montelliarde Breeds under low input management.

New Zealand, a major low input dairy nation, has recently moved to a breeding index that attempts to measure net profit through accounting for factors over and above gross production levels. The New Zealand Index often ranks Jersey sires above Holstein sires due to penalties for extreme body weight. Because indexes considering traits other than production are highly dependent on the assumptions utilised, additional research on the economic efficiency of the North American Holstein in low input

environments is warranted.

The shift in exports from higher input European countries to lower input Latin and South American countries has also received considerable attention. Stanton *et al.* (1991) evaluated genotype by environment interaction using evaluations from the US, Mexico, Columbia and Puerto Rico. They reported minimal re-ranking of sires but a significant loss in variability for North American sires used in other environments. The expected correlated response from using North American Holsteins in Central/South America ranged from 0.53 to 0.79. While utilising the best North American genetics resulted in greater production in those environments, concern was expressed regarding the ability of the reduced response rate to cover the expense of imported semen.

It appears that the North American Holstein will produce superior gross returns in a wide variety of environments. At this time, a large volume of hard data regarding the net returns from using North American Holsteins in low input environments is lacking.

### 3. Overview of the US Dairy Industry

US Dairy Cattle numbers stood at 7.95 million as of May 1998, a decrease of 0.2% from May 1997. Total production had climbed to 5,507 billion kg, an increase of 2.1% over May 1997 production. The number of permits to produce Grade A milk in the US dropped below 100,000 for the first time in 1998 producing an average herd size of approximately 80 cows. It is daunting to realise that every US producer could attend a sporting event at the Rose Bowl with seats left over! In actuality, the number of grade A permits contains a number of small non-commercial herds resulting in an average herd size closer to 100 head for herds that depend on milk sales as their primary income source.

Milk pricing in the US involves a complex system of Federal, State, and unregulated areas, known as marketing orders. Within each order, milk production is divided into four classes based upon utilisation.

- Class I Fluid milk
- Class II Soft Products including yoghurt, cottage cheese, ice cream, etc.
- Class III Hard Cheeses
- Class IIIa Butter and milk powder

Wholesale market prices of manufactured products are used to set a national base price for use in all Federal Orders. States Orders can utilise a different base price based on wholesale prices in their area. Each Order then develops a blend price that is paid to producers based on the relative utilisation of each class in that Order. One Order may price milk based on components while another may price milk largely on a fluid basis. Orders in the Great Lakes region tend to stress milk components due heavy manufacturing use while Orders in the milk deficient South-eastern US stress fluid production.

In recent years, efforts have been initiated to force milk pricing toward a market-oriented approach. The US government does place a floor under cheese, butter, and milk powder price through open market purchases when the wholesale price falls below a certain level. After several years of no intervention, the government is once again purchasing milk powder. In contrast, the wholesale price of butter is currently at its' highest level in years precluding the need for government intervention. The US government continues to maintain import quotas for dairy products that insulate the industry to an extent from world market prices.

From a national breeding program perspective, the complex patchwork of Marketing Orders does not allow a uniform selection goal. Market stimuli currently favour selection for milk volume in some areas and milk components in other areas. Therefore, the national

selection goal for production traits is a composite that does not totally fit the market in any one region.

#### **4. Selection goals in the US**

Herd numbers decreasing much faster than cow numbers characterises the US dairy industry. Some extreme estimates call for herd numbers to drop to 3,000 in 20 years with average herd size approaching 2,000 cows. While this prediction is unlikely to occur, the trend to larger herds is unmistakable.

Large herds can be characterised by a desire to maximise output while minimising expense. This combination results in a profit oriented approach to dairying in general with sire selection being no exception. Several interesting attributes accompany the desire to maximise net profit. First, the need to continually increase herd size places a premium on near term cash flow to help finance expansion. It is often difficult to convince large herd owners to adopt a multi-generation planning horizon. Decisions that do not cash flow in the near term require additional borrowing for expansion which is not consistent with current trends in the US dairy industry.

A second factor affecting selection decisions in the US is a lower level of individual cow care due to larger herds and more hired labour. This combination results in less concern about human/cow interaction traits such as disposition and milking speed. Cows that do not fit the system do not remain in the herd. While attention to human/cow interaction traits might reduce culling losses, culling due to disposition and/or milking speed problems may be perceived by the owner as due to other problems. Mastitis resulting from the incomplete milkout of a slow milker by hired labor may be perceived as a mastitis problem not a milking speed problem.

A perceived difference between

Europe and the US on the part of the author is attention to animal welfare by the general public. While a small minority of US consumers could be labelled as animal welfare advocates, the majority of US consumers are more interested in a quality product at the lowest possible price. These consumers tend to not “ask too many questions” regarding how the product was produced as long as “excesses” do not hit the news. This affects the industry’s attitude toward functional traits with areas not being addressed unless they are tied to net profit. An example of varying attitudes is calf liveability. In the US, producers do not view the slow progress that would result from selecting for a trait with heritability of 1 or 2 percent as reasonable. In contrast, I have heard the need to reduce early calf mortality referred to as an animal welfare issue in Europe.

The overall US breeding objective can best be defined as net profit with a short term planning horizon. Production traits and non-production traits perceived as being strongly related to profit are emphasised by producers while traits perceived as being unrelated to profit or requiring a long term horizon are ignored.

#### **5. The Net Merit Index**

The USDA released a net profit index known as Net Merit in January 1994. The industry in general was initially slow to adopt USDA Net Merit as selection criteria. Recently, interest in the Net Merit Index has increased significantly with Net Merit being well on the way to becoming the primary selection tool in the US.

The Net Merit Index incorporates milk-fat-protein (MFP) dollar value, productive life and somatic cell information in a 10:4:1 ratio. The production to functional traits ratio is actually greater than 2:1 because productive life is not adjusted for production resulting in a positive environmental correlation between USDA

Productive Life and MFP dollar value.

The production component of Net Merit is MFP dollar value that incorporates a national average milk price. MFP dollar value has a positive weight for carrier and a 2.5:1 relative ratio for protein yield to fat yield. The current formula is 0.048 kg PTA Milk, +1.23 kg PTA, Fat +3.08 kg PTA Protein. This formula is in considerable disagreement with many European breeding objectives that place a negative weight on the carrier fraction. I do not anticipate a negative carrier weight in the US any time soon due to the regional milk pricing structure that places considerable emphasis on volume in some regions.

The induced correlation of Productive Life and MFP dollar value has already been mentioned. Another area to be aware of is the handling of cows intentionally left open for ET purposes. The Productive Life procedure only allows credit for ten months of productive life per lactation. Thereby, cows that do not breed back on a regular interval are penalised. This approach makes sense on the average, but may not fit the management of elite cows that are often intentionally left open for ET purposes. The financial decision to leave a cow open for ET purposes is hopefully not related to genetics for longevity. Since a large number of the most elite cows are intentionally left open, their PTA for Productive Life can be affected which in turn affects the Parent Average of their sons.

The somatic cell component of Net Merit also deserves comment. The relative weight for PTA Somatic Cell Score was developed using economic data for losses due to discarded milk and lower quality premiums. Including only those factors likely underestimates the economic value of lowered somatic cell count. The current perception in the US is that somatic cell information is being under-weighted in the Net Merit Index.

Net Merit is currently the best tool for improving net income available in the US. The current longevity component could be improved by better handling of cows intentionally left open for ET purpose and the relative economic weight for the somatic cell component needs revisited. In addition, consideration should be given to adding more functional traits to the index. Candidates for inclusion include calving ease and fertility.

## **6. Other traits for consideration**

Two functional traits that are not part of the Net Merit Index but have considerable interest from producers are calving ease and fertility. Currently the National Association of Animal Breeders (NAAB) operates a calving ease evaluation for the direct effect only. NAAB plans to have either a maternal grandsire or a pure maternal evaluation available in February 1999. The prevailing sentiment is to provide both the direct and maternal evaluations to producers as opposed to a single calving index. The logic of this approach is the need to prevent difficult calvings in the near term through use of the direct effect alone. Incorporating calving ease in the Net Merit Index would provide proper emphasis on calving difficulty.

An area for additional research is the relative economic value of calving ease. Previous work (Thompson *et al.*, 1983) has shown that calving difficulty is related to a complex of post parturition problems. A recent evaluation of bulls with 90% Reliability for both calving ease and Productive Life demonstrated a strong relationship between the two evaluations. Bulls with calving ease of 6 or below had an average PTA Productive Life of 1.2 months greater than bulls with calving ease evaluations of 14 or above. These observations imply that the relative economic value of calving difficulty could be quite high.

A second area of considerable interest is fertility. Previously cited studies have observed lower reproductive performance in high genetic line Holsteins. This topic is also a great concern to many producers with failure to conceive being the major reason for involuntary culling in the US.

While the US currently lacks a national evaluation for either male or female fertility, the Raleigh NC Dairy Records Processing Center is currently publishing a regional evaluation for male fertility. The Raleigh group has made efforts to include data from other Dairy Records Centers with some success. The NAAB has also requested that the USDA study the feasibility of a national evaluation for both male and female fertility. Additional research on the relative value of fertility is also necessary due a wide range of estimates for the value of an extra day open. Unfortunately, the value of reproduction is probably dependent on a variety of management factors including the use rBST, the presence of seasonal grazing, etc. Based upon current knowledge, both male and female fertility are strong candidates for inclusion in the Net Merit Index.

## **7. Traits with minimal interest**

Functional traits that are unlikely to receive major attention in the US in the near future include calf liveability, milking speed, disposition, and individual diseases. The reason that each trait or group of traits is unlikely to receive major attention varies. US producers have yet to perceive calf mortality as a problem. Producers view a certain level of mortality as a cost of doing business and as long as losses do not exceed a threshold, they are unwilling to place emphasis on liveability. The industry has assigned mortality a secondary position due to the low heritability of and the lack of a genetic trend for calf mortality. However, research work at Iowa State University (Berger, personal communication) has identified a

possible genetic trend in first parity births. Additional work is being conducted to determine if this trend is real or is related to an increase in the level of calving difficulty in the US population (Sattler, personal communication).

US producers also have little interest in milking speed and disposition. Possible reasons have been previously mentioned and are likely related to increasing herd size. I perceive diminished interest in these traits and I do not anticipate their inclusion in the overall breeding objective any time soon. In contrast, I do believe that there is interest in genetic resistance to individual diseases. Unfortunately, the US does not have a national database for health related disorders and several attempts at collecting health data over the long term have been unsuccessful. Without a good data base, traditional (quantitative) approaches to genetic improvement are not feasible.

## **8. Future directions**

Future directions in selection for functional traits in the US can be divided into two areas: near term changes and long term direction. Many of the desirable near term changes have already been addressed including

- more emphasis on somatic cell data,
- inclusion of calving ease in the Net Merit index,
- development of national genetic evaluations for male and female fertility,
- additional research on stillbirth, and
- a new genetic evaluation for maternal (or at least maternal grandsire) calving ease.

Because it is unlikely that all of the changes mentioned in the preceding paragraph will occur, prediction of longer term trends is extremely dangerous. At present, I see a strong need for additional research on what factors affect net profit and the relative importance of production versus functional traits. I believe that the

US industry is currently overly concerned with linear traits such as stature and size that do not have a major impact on profitability. A redirection of this emphasis to important functional traits is warranted. A favourable sign in that direction is increased acceptance of the USDA Net Merit by producers. The inclusion of additional traits in Net Merit should further enhance the value of that selection tool but will require additional research on profitability including the role of size and scale on net profit.

The inability of the US to develop a good database of health-related problems will require a different approach to addressing those problems. I believe that genetic markers hold considerable potential in this area. Work is currently under way to identify health-related markers at several institutions around the world with some promising results reported informally. I anticipate that genetic progress is more likely to occur through selection for increased immunological function as opposed to resistance for a particular disease.

An entirely different approach to addressing many functional problems is through crossbreeding. I am aware of only two North American studies on crossbreeding in dairy cattle; an older study at the University of Illinois (Guernsey X Holstein) and a more recent study in Canada (Ayrshire X Holstein). Both studies reported similar results with crossbred progeny not competitive with the Holstein line for production alone, but crossbred progeny becoming very competitive on a lifetime profit basis. Increases in lifetime profit came through better reproduction and liveability of the crossbred progeny.

An additional area where crossbreeding would be of benefit is avoiding inbreeding. Intense selection has increased the average coefficient of relationship within our pure lines. Both Holsteins and Jerseys have experienced this increase and the rate of increase may be accelerating. Animal Model and BLUP

evaluation techniques are likely to accentuate this problem.

Nagai and McAllister (1982) have documented the conditions under which a two breed rotational system is practical. If two breeds are within 25% of one another and heterosis is 20%, the offspring of a two way rotational cross will always be at least equivalent to the superior parental line. Currently Holsteins and Jerseys are within 25% of one another for production. If heterosis is 20% or greater, the opportunity for a two breed rotational system exists.

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