

# Economical comparison of Ayrshire and Holstein breeds in Finland

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## ABSTRACT

In Finland, the proportions of the two most common dairy breeds, Holstein and Ayrshire, have shifted in recent years. Holstein has clearly become the dominant breed, surpassing Ayrshire, which is now the second most common dairy breed in the country. This development is concerning, as maintaining genetic diversity both within and between breeds is essential for sustainable breeding. Ayrshire is genetically more diverse, which may be an advantage in the long term. Increased inbreeding in Holsteins has led to reduced performance in key traits such as fertility, health, longevity, and environmental sensitivity. These traits are economically important, meaning that even though Holsteins produce more milk, Ayrshire may reach an equal or even higher overall economic performance.

This study investigated differences within herds between Holstein and Ayrshire cattle in five trait categories: yield, fertility, calving, health, and mortality under Finnish production conditions. The dataset was obtained from the ProAgria milk recording system for the years 2021–2024 and included a total of 56,652 Ayrshire and Holstein cows from 296 herds. All herds had an average herd size of at least 50 cows, and both breeds were represented by at least 20 %. For all traits differences were estimated using RStudio (version 2025.05.1+513) as with within-herd differences: the breed difference was first calculated within each herd, and the final average was derived from these herd-level differences.

According to the results, Holsteins produced 600–900 kilograms more energy-corrected milk compared with Ayrshires within different parities. In contrast, Ayrshire performed better in fertility: the interval from first to last insemination (IFL) was on average 1–18 days shorter in different parities, and the number of inseminations required for a pregnancy was lower than in Holsteins. Differences in calving and health traits ranged from –2.6 to +1.0 percentage units in favor of Ayrshire. The difference in hoof health was clear—over 14 percentage units—and mortality also differed substantially between the breeds: more than 11 percentage units more Holstein cows died on-farm compared with Ayrshires. Although some differences were relatively small, disparities in health and mortality may significantly enhance Ayrshire’s overall economic position.

To evaluate the economic performance, economic comparisons were conducted using the SimHerd program (reference). Based on SimHerd simulations, Ayrshire herds achieved an average economic result approximately 90 euros per cow higher than Holstein herds at typical Finnish milk prices, and total costs were about 70,000 euros lower in a 250-cow herd. Ayrshire’s smaller body size and better health notably reduced feeding and health-related costs. The results indicate that Holstein and Ayrshire are economically very similar, but Ayrshire’s strengths translate into cost savings that offset its lower milk yield. Thus, under Finnish production conditions, Ayrshire can be considered at least as economically competitive as Holstein.

## 1. BACKGROUND

The genetic level of a range of important traits has a major impact on the profitability of dairy farming. The economic importance of differences in economic level depends on key economic factors which include milk price, feed costs, animal health and fertility expenses, market conditions and production efficiency. For farmers, the most visible source of profit is the price received for liters of milk delivered to the dairy. In addition to production characteristics, the economic value of a breed consists of factors such as level of fertility, health traits, feed efficiency, and longevity. Many farmers have their own favorite breeds, and in addition to economic considerations, personal preference influences the choice of breed — sometimes even exclusively (Karhula et al. 2024). In Finland, subsidy policy also plays a role. The national Nordic production subsidy in the northern parts of Finland encourages higher milk output independent of content of solids. This may be one of the reasons why Holstein, which produces more liters, has been seen as more favorable choice in recent years (Karhula et al. 2024). Nevertheless, invisible factors such as fertility, health, calving difficulties, and feed savings have an equal impact on the economic performance and profitability of a dairy farm, even if they are not directly reflected in income statements.

The structural development in Finland has led small dairy farms either to stop production or to invest in new, larger, and more efficient barn buildings (Tauriainen & Latukka in Leino et al. 2023, Luke 2025b). The number of farms decreased by over 70% between 2000 and 2022 (Luke, 2025), while herd sizes have grown steadily, with Holstein becoming the dominant breed (Karhula et al. 2024). Despite this, the amount of milk delivered to dairies has remained at the same level (Niemi, 2019). Until 2018, Ayrshire was the most common dairy breed in Finland (Milk Recording, 2021). The percentage of Ayrshire animals in Finnish milk recording has dropped from 60.8% to 39.5% between 2012–2022, while Holsteins have taken over (Milk Recording, 2025). In 2024, there were 49,890 Ayrshire and 91,557 Holstein animals in milk recording (Milk Recording, 2025). The dairy sector has expressed concern about this development for several reasons, for example, due to the reduction in genetic diversity.

Traits under selection vary between countries. In Finland, most animals are of Nordic origin, but the use of foreign genetics outside the Nordic Countries has increased over the years (Paakala 2024).

Intensive breeding towards increased milk yields has, especially in Holstein, led to rising levels of inbreeding and inbreeding depression (Brito et al. 2021, Makanjuola et al. 2020). Across-breed genetic diversity has declined due to the global dominance of a few common dairy breeds, with Holstein in the lead. Within-breed genetic diversity has also decreased, resulting in unfavorable genetic responses in traits related to fertility, health, longevity, and environmental sensitivity in some breeds of European or North American origin. (Brito et al. 2021). However, that has not been the case with Nordic origin animals. For the most sustainable future of Nordic dairy production, it is important to improve genetic diversity. Ayrshire, as a more genetically diverse breed, may have an advantage in this regard compared to Holstein (Brito et al. 2021).

Feed efficiency is an important economic factor, as feed represents the largest single cost on dairy farms (Miglior et al. 2017). Feeding costs are substantial: silage alone may cost up to €0.25 per kilogram of dry matter, in addition to protein and concentrate feeds which cost even more (Korhonen 2024, Storberg 2019). Accordingly, feed efficiency has become an integral component of breeding programs and is already included in the Nordic Total Merit index. Enhancing feed efficiency increases farm profitability by lowering feeding costs without reducing milk yield (Paakala 2024). From an environmental perspective, reduced feed consumption also decreases greenhouse gas emissions (Ahvenjärvi et al. 2022).

Holstein has higher yield than Ayrshire, with average production of 10,964 kg of milk and 863 kg of fat and protein, while Ayrshire's average is 9,421 kg of milk and 781 kg of fat and protein (ProAgria Milk Recording, 2025). However, Ayrshire has higher fat and protein percentages, which evens out the final difference in energy-corrected milk (ECM) yield, 11,604 kg of ECM for Holstein and 10,340 kg of ECM for Ayrshire, compared to differences in kg of milk (ProAgria Milk Recording, 2025). Furthermore, in traits such as fertility, health, and calving ease, Ayrshire performs better than Holstein (Karlsson et al. 2020, Muuttonranta et al. 2019), which may offset the economic difference between the two breeds.

Treating health issues can be costly and result in premature culling. Fertility problems and diseases such as mastitis, ketosis, and milk fever are among the most common health issues of dairy cows (Puerto et al. 2021, Heikkilä et al. 2012, Heringstad et al. 2005, Edvardsson Rasmussen et al. 2024). Fertility is a key component of productivity. Fertility is influenced by genetics but also by environment and management decisions (Pulkka 2021). These walk hand in hand as lower genetic levels in fertility effects to farmers management, that needs to be at a higher level. High production challenges fertility, and fertility problems are usually results from illness, stress, or lack of energy (Pulkka 2021). Fertility treatments are not particularly expensive in themselves; the cost mainly comes from higher insemination expenses and possible medication (Pulkka 2021). However, the real cost of fertility problems may also include longer calving intervals and longer dry periods and in cases where the animal does not conceive, premature culling (Pulkka 2021).

Fertility issues reduce herd profitability by lowering reproductive efficiency (Miglior et al. 2017). Although extending the period between calving and first insemination in first parity cows can sometimes have advantages in fertility, health, and milk production, this is considered an alternative method, and such animals do not suffer from other fertility problems (Edvardsson Rasmussen et al. 2024). Difficulties at birth or during the lactation period also have a major effect on production and, through that, on farm profitability. Losing potential future production, a calf, or in the worst case the whole cow can cost farmers thousands of euros (Miglior et al. 2017., Martiskainen 2025). The losses may result from reduced production, death, premature culling, veterinary treatments, milk loss, added labour, delayed conception, lower milk quality, or increased risk of other diseases (Miglior et al. 2017). It can be difficult to identify all components affecting the total cost of diseases (Heikkilä et al. 2012). Most of the cost comes from production losses and involuntary culling resulting in an increase of replacement rate, in addition to the treatment itself.

In the study of Heikkilä et al. (2012), Ayrshire had a slightly higher probability of mastitis, but Holstein had a higher probability of being culled due to mastitis. Mastitis can occur in early, mid, or late lactation, but it always reduces expected milk production (Puerto et al. 2021). In addition to economic losses, mastitis also affects animal welfare (Heikkilä et al. 2012). The

reduction in production can be around 6–9% and cost from €200 up to €1,000 with milk price of 35 cents, if the cow must be culled due to mastitis depending on the lactation state (Puerto et al. 2021, Heikkilä et al. 2012). Mastitis, milk fever, and ketosis also have low or moderate positive genetic correlations, meaning that one predisposes to another (Heringstad et al. 2005).

Milk fever is often associated with calving and is caused by hypocalcemia, i.e., a drop in calcium levels in the cow's blood (Ibrahim & Kirmani, 2021). It is mostly a disease of older animals (Ibrahim & Kirmani, 2021). At worst, it can cause death (Heringstad et al. 2005). Hypocalcemia can also be subclinical (Couto Serrenho et al. 2021). The economic losses are related to medical care, reduced milk production, and possible culling (Serrenho et al. 2021). It also increases the probability of other metabolic or infectious diseases (Serrenho et al. 2021, Heringstad et al. 2005). Studies show that milk fever predisposes cows to diseases such as retained placenta, uterine prolapse, metritis, mastitis, and ruminal stasis. Milk fever can be prevented through careful monitoring and preventive treatment of older cows, and proper feeding during the dry period.

Dairy cow longevity is a relatively difficult trait to select for because of the strong influence of environmental factors (Hu et al. 2021). However, longevity is important for profitability in dairy production. It usually refers to the time from first calving to culling (Hu et al. 2021). Longevity is affected by things such as fertility, production and health. In Finland, the average parity of dairy cows is 2.68 for Holstein and 2.84 for Ayrshire. Ayrshires average parity is higher than the average reported in other studies e.g., Hu et al. 2021, average less than 2.7 but Holstein is in the same level. For culled cows the averages are 3,41 for Holstein and 3,54 for Ayrshire. When longevity increases, mean herd production also rises because cows produce the most in their later lactations (4–6), and a greater proportion of culling decisions are based on production (Sewalem et al. 2005, Hu et al. 2021).

Dairy cow mortality is a real problem and causes additional costs. In most cases, dairy cows die from various diseases (Hagner et al. 2023). Mastitis, nutritional diseases, and calving-related disorders are among the most common causes of death (Hagner et al. 2023). In the study of Hagner et al. (2023), cows died at a mean age of 5.6 years, which is close to the average age of Finnish dairy cows according to Milk Recording. The type of death was unassisted in 59.9%

of cases and euthanasia in 40.1% in Hagner et al. (2023). A large proportion of cows die within the first 30 days, most within the first 5 days after calving. This makes the economic losses from cow deaths considerable, including the cost of euthanasia, carcass disposal, and loss of milk production. The losses can exceed €5,000 per case when considering these all together (Martiskainen 2025).

Sustainability is becoming an increasingly important part of dairy production. Given the environmental and societal importance of resource use and pollution, new measurements of feed intake and cow methane emissions are needed (Bell 2024). Breeding programs must also become more sustainable, with broad breeding objectives, management of inbreeding, and continuous genetic improvement of included traits (Philipsson et al. 2009). This means cows that are both high-yielding and healthy, with good reproductive performance and the ability to thrive in a wide range of environments (Philipsson et al. 2009). A challenge is the unfavorable genetic correlation between milk production and health and reproduction traits (Philipsson et al. 2009). The Nordic total merit NTM is a balanced breeding goal that aims for healthy, fertile, well producing and long-lasting cows with good conformation (NAV, 2025). This suits well for the sustainability goals of future farming.

In this study, we compare the two most common dairy breeds in Finland to determine which is the more economical under Finnish conditions. The analysis takes breed differences into account by calculation of breed differences for yield, fertility, health, mortality and calvings. Feed efficiency is taken into account with live weights of animals. Our hypothesis is that Ayrshire's better fertility, health, and other traits counterbalance Holstein's higher yield. The economic comparisons were made with Simherd basic program based on the estimated breed differences within herds.

## 2. MATERIALS AND METHODS

### 2.1 *Data*

The data used in the study was collected by Pro Agria milk recording system from 2021 to 2024. The data consisted of 305-days yield, lifetime production ECM, calvings, first treatments, inseminations and claw treatments for animals in these herds. The final data had 56,652 Ayrshire and Holstein animals in 296 herds. 57.2% of animals were Holsteins. The selection of herds was made according to the following criteria:

- The selected herds had been part of milk recording since 2017 and had at least 50 cows
- The herds had at least 20% of either breed, so 20/80 or 80/20 or something in between. Other breeds were allowed in minor proportions
- The proportion of the two main breeds had not changed more than 20% in between 2017 and 2023.
- Animals that had a calving from 2021 onwards were included from the herds.

### 2.2 *Data editing*

The raw data were edited to remove outliers and ensure comparability between breeds. Editing was conducted separately for yield, fertility and calving, and health and hoof treatments.

#### 2.2.1 *Yield and lifetime production data*

From the yield data, outliers were deleted based on kg of milk, kg of fat and kg of protein. Three standard deviations (SD) from the mean were used in kg of milk and in kg of fat and protein two SD's from the mean was used. Animals that did not have full 305-days production were marked as missing. To analyze parity-specific effects, parities were classified as 1–4 separately and  $\geq 5$  as 5+. ECM of 305-days was calculated here separately for each observation using formula

$$ECM = \frac{(Ave\_milk * ((383 * fat\% + 242 * protein\%) + (165.4 * 4.16) + 20.7))}{3140}$$

From the lifetime production dataset, records of animals whose yield data were removed during outlier editing were also excluded. Thus, any cow lacking valid yield observations after data cleaning was removed from the lifetime production data as well. Also, animals that had calvings after 2023 were deleted since we only wanted those animals that had at least one full milking period. After editing, average ECM for culled animals was calculated separately by breed within each herd, and subsequently as with within-herd differences. Later the weighted mean by subsidy areas was compared as AB (A and B areas together) and C (C1-4 together) areas. These were not included in the Simherd calculations.

### 2.2.2 Fertility and calving data

From the fertility data, animals that had natural service or embryo transfer were excluded. The age at first insemination was calculated in months, and outliers that exceeding two standard deviations (SD) from the mean were removed. The insemination interval (IFL) was defined as the number of days between the first and last insemination. The number of inseminations was provided in the raw data and further grouped: 1–4 inseminations were separate categories, and  $\geq 5$  inseminations were combined into one group. Cases with inconsistent insemination records (e.g., two inseminations recorded but an interval over 100 days) were set to be missing (NA).

### 2.2.3 Calving data

From the calving records, the following variables were examined: age at first calving, dystocia, and calf survival. Age at first calving was calculated for animals that calved for the first time between 2021 and 2024, with outliers beyond three SD from the mean removed. Animals with “Not known” recorded for calving difficulty or calf status were excluded. All other categories of calving difficulty were retained.

To analyze parity-specific effects, parities were classified as 1–4 separately and  $\geq 5$  as 5+. “Easy” and “slight assistance” were combined as *easy calving*, while “strong assistance” and “other” (e.g., C-section) were classified as *calving difficulty*. The number of cases in the “other”

category was small, but as they mainly represent extreme cases, combining them was not considered problematic.

For calf survival, only calves marked as “alive”, or “dead” were included. Abortions were excluded. Calves recorded as “alive” formed the survival group, while calves stillborn or dead within seven days after calving were grouped as “dead.” Dystocia and calf survival were calculated for all parities combined, to provide input values for the Simherd calculations.

#### 2.2.4 Treatments and hoof treatments data

The health traits were at first classified as 9 different groups. Treatments were grouped so that fertility treatments were two groups. Group one before calving related fertility issues and two, after calving related fertility issues. Third group was milk fever, fourth ketosis, fifth nutritional disorders, sixth was mastitis and seventh was other udder diseases. Number eight was hoof diseases marked by vets and then all other diseases were number nine. Disease codes outside these were not taken into account. The treatments were also looked at by parities. Any other data editing was not done for this data. The health codes based on Finnish health recording are presented in Table 1.

Table 1. Health codes in health treatments groups.

<b>Traits</b>	<b>Codes</b>
Fertility before calving	10-36
Fertility after calving	40-54, 80-92, 640
Milk Fever	100, 101
Ketosis	140, 650
Nutritional disorders	200-270, 660, 670
Mastitis	300-303, 610-620
Other udder diseases	320-333, 630
Hoof diseases	359-369
Other diseases	400-450, 690-691

Hoof treatments were also looked at from the separate hoof treatments data. In this data all hoof treatments were marked by the hoof trimmers, and in this data they were grouped together at the beginning. Later the six most common ones in Finland were checked as their own. These were sole bruises and -ulcer, double sole, white line separation, corkscrew claw and heel horn erosion.

For Simherd, the average difference was calculated separately for health traits mastitis, milk fever, retained placenta, metritis, ketosis, displaced abomasum, digital dermatitis, foul in the foot and together to sole ulcer and double sole, white line separation and hock lesions. These were calculated with all parities together.

### *2.3 Calculations of average differences*

Average differences between Ayrshire and Holstein were calculated within herds to account for herd-level effects. These within-herd differences were then averaged across herds. The averages were at first calculated by parities, to see the differences within cows life and then with all parities together for the traits mastitis, milk fever, retained placenta, metritis, ketosis, displaced abomasum, digital dermatitis, foul in the foot and together to sole ulcer and double sole, white line separation and hock lesions, replacement rate, cow mortality, dystocia and calf mortality. These calculated differences formed the basis for both descriptive comparisons and for the Simherd simulations.

#### *2.3.1 Differences of yield, fertility and calving traits*

Differences in yield traits were calculated for ECM, milk-, fat- and protein kilos. The average difference of the two breeds was after that calculated from the within-herd differences.

Fertility was measured as interval from first to last inseminations (IFL). Animals were already grouped by parity and for IFL they were also grouped by insemination number from 1-4 separately and all 5 and over as 5+. Differences were calculated first for each herd and then average of difference was calculated after that. In addition to the average difference, the average duration in days was also calculated for each group and both breeds. From fertility data average age at first insemination was also calculated for both breeds.

From calving data, differences for calving difficulties and calf survival were calculated first as within-herd differences and after the average difference was calculated from within-herd differences. Calving difficulties was calculated by comparing the number of difficult calvings to the number of easy calvings. Calf survival was calculated by comparing the number of still born calves to the number of alive born calves. The average of parity was also calculated for both breeds. In calf survival and calving difficulty we considered the proportion of the normal compared to the abnormal and proportions of the abnormal to all the calvings. Status of the calf was also considered with parities 1-5+.

### *2.3.2. Differences of health- and hoof treatments, mortality and survival*

Differences in health treatments were calculated for 9 different health treatments. These were fertility before and after calving, milk fever, mastitis, other udder diseases, ketosis, other nutritional diseases, hoof diseases and other diseases. In this health data, hoof diseases consisted only of treatments registered by vets and other diseases consist of diseases like diseases of the central nervous system and sensory organs, skin diseases and infectious diseases. Differences were calculated for each disease, if there were animals treated for some of the diseases in the herd. Average difference was then calculated for each disease group and parity. Parities were the same as in yield, fertility and calving data.

Hoof treatments data consisted of treatments marked by hoof trimmers. We checked differences in herd for all hoof treatments together and then also six most common in Finland which are sole ulcer, sole bruises, double sole, corkscrew claw, white line separation and heel erosion. Average differences were calculated from within-herd differences.

Mortality was calculated from the culled cow data set. The rate of how many animals were slaughtered or died/killed on farm was checked. The probability to be culled was also looked at and calculated for all animals and each culling method separately. Top 5 culling reasons were also looked at for both breeds. For Ayrshire these were mastitis, poor fertility, -yield and -udder structure and other reason. For Holstein top five were mastitis, poor fertility and -yield, accident and foot disease.

Survival to the next parity for first time calvers were calculated for animals calving first time in years 2021, 2022 and 2023. For 2021 animals, survival was checked until parity 4. For 2022 first time calvers survival was checked until parity 3 and for 2023 first time calvers until parity 2. This was done to see if there were some differences in the survival to next parity.

#### *2.4 Inputs for Simherd*

For the SimHerd analyses the input consisted of the calculated Holstein averages, which the model used to generate baseline or risk values for each trait. These values served as the predicted reference level for the Holstein herd. To estimate Ayrshire performance, breed-specific means were first derived by subtracting the previously calculated breed mean differences from the Holstein averages. The relative ratio was then obtained by dividing the Ayrshire mean by the corresponding Holstein mean. Finally, this ratio was multiplied by the baseline or risk values produced by SimHerd for Holstein, thereby generating the Ayrshire-specific values used in the simulations.

### **3. RESULTS**

#### *3.1 Key figures of data*

The average yields of milk, fat, and protein were 10.619 kg of milk, 440 kg of fat, and 365 kg of protein of milk for Holstein, and 9.489 kg of milk, 411 kg of fat, and 335 kg of protein for Ayrshire, respectively. The average lifetime production expressed as energy-corrected milk (ECM) was 30.326 kg of ECM for Holstein and 28.531 kg of ECM for Ayrshire when considering all animals, including both living and culled cows.

The average parity for all animals, calculated from the edited and sorted dataset, was 2.8 for Ayrshire and 2.7 for Holstein. Table 2 presents the lifetime production means of culled animals as well as the weighted means for culled animals in subsidy areas AB and C. Table 3 shows the lifetime production of culled animals by breed and the corresponding weighted means for the subsidy areas.

Table 2. Key figures from the data.

<b>Trait</b>	<b>Breed</b>	
	Holstein	Ayrshire
Milk, kg	10619	9489
Fat, kg	440	411
Protein, kg	365	335
Cells	173	183
ECM, kg	10570	9738
Lifetime production (ECM), kg all animals	30 326	28 531
Parity	2.7	2.8

Table 3. Lifetime production of culled animals and weighted means of subsidy areas AB and C

<b>Trait</b>	Holstein	Ayrshire
Culled animals, kg ECM	35911	32088
Subsidy area AB, kg ECM	35156	30402
Subsidy area C, kg ECM	36255	32857

### 3.2 Average differences of the traits

The average differences for each studied trait were calculated by parity. Subsequently, overall average differences across all parities were calculated for the traits. These across parity differences were used in the SimHerd simulations. Tables 4–6 present the average differences of all studied traits by parities 1–5+. The averages differences are expressed as Ayrshire mean minus Holstein mean. Negative values therefore indicate lower values for Ayrshire. For yield traits, negative values favor Holstein, whereas for most other traits, negative values favor Ayrshire.

On average, Holstein produced approximately 600–940 kg more ECM, 880–1,210 kg more milk, and about 20–35 kg more fat and protein than Ayrshire. For dystocia, the average differences ranged from –0.42 to 0.37 percentage units, while calf survival differed by 0.30–0.54 percentage units. Ayrshire exhibited slightly shorter intervals between first and last insemination (IFL), with differences ranging from –1.9 to –3.9 days compared with Holstein. Differences in health treatments ranged between –2.6 and 1.0 percentage units across traits. The differences are presented in Table 4.

Table 4. Average difference of yield, dystocia, calf survival, IFL and health traits per parity. The differences are calculated as Ayrshire mean – Holstein mean.

<b>Trait / Parity</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5+</b>
ECM, kg	-604	-933	-889	-940	-803
Milk, kg	-885	-1276	-1209	-1211	-1069
Fat, kg	-18.6	-31.2	-31.4	-33.4	-27.8
Protein, kg	-22.5	-34.6	-30.8	-33.6	-28.7
IFL, days	-1.9	-3.1	-3.8	-1.9	-3.9
Dystocia, %-units	0.4	0.1	-0.3	-0.4	0.2
Calf survival, %-units	0.3	0.54	0.31	0.47	0.32
Fertility before calving, %-units	-1.1	-2.6	-1.5	-1.1	-0.3
Fertility after calving, %-units	0.4	-0.1	0.6	0.4	1.0
Milk Fever, %-units	-0.3	-0.3	-1.0	-1.1	-2.4
Ketosis, %-units	-0.6	-0.2	-0.2	-0.3	-0.4
Nutritional disorders, %-units	-0.9	-0.3	-0.4	-0.8	-0.8
Mastitis, %-units	-0.3	-0.7	-0.3	-1.5	-0.8
Other Udder diseases, %-units	0.8	-0.6	-0.1	-0.2	-0.5
Hoof diseases, %-units	0.7	-0.6	-0.2	-0.9	-0.4
Other diseases, %-units	-2.0	-1.8	-0.9	-0.8	-0.7

Table 5 presents differences in hoof health treatments. When all hoof treatments were considered together, the difference was substantial, amounting to –14.3 percentage units. The six individual hoof diseases presented represent the most common hoof disorders in Finland.

Table 5. Average difference of hoof health traits in all parities. Difference is the mean out of herd differences compared to overall number of animals in herds.

<b>Trait</b>	<b>Difference</b>
Sole bruises, %-units	-5.2
White line separation, %-units	-6.1
Sole ulcer, %-units	-5.1
Heel erosion, %-units	5.0
Corkscrew claw, %-units	6.6
Double sole, %-units	-2,4
ALL, %-units	-14.3

Table 6 presents differences in culling methods and culling rates. A higher proportion of Ayrshire cows were culled by slaughter, whereas approximately 11 percentage units more Holstein cows died on farm relative to all cullings. The overall culling rate was 2.3 percentage units lower for Ayrshire.

The five most common culling reasons for Ayrshire were mastitis, poor fertility, poor yield, poor udder structure, and other reasons. For Holstein, the corresponding reasons were mastitis, poor fertility, accidents, poor yield, and hoof disease. Mastitis, poor fertility, and poor yield were the three most common culling reasons for both breeds. Among these, mastitis was more prevalent in Holstein, whereas poor yield and fertility were more common in Ayrshire. Mastitis and poor fertility ranked as the first and second most frequent culling reasons for both breeds.

Table 6. Average difference of culling methods and culling rate. The culling methods are compared to all number of cullings. The Culling rate is calculated as average from herd differences where culled animals are compared to all number of animals.

<b>Trait</b>	<b>Difference</b>
Sold for Slaughter, %-units	11,1
Died, %-units	-2,4
Killed, %-units	-8,8
Culling rate, %-units	-2,3

### 3.3 Calculations of inputs for Simherd

Inputs for SimHerd were calculated using the average differences across all parities. First, Holstein averages were calculated from the data. The corresponding Ayrshire values were then derived by adding or subtracting the calculated mean differences, depending on whether the difference was favorable or unfavorable. Table 7 presents the calculated breed averages and relative ratios for the traits used in the SimHerd simulations.

These relative ratios were multiplied by SimHerd’s calculated base values (for ECM) or base risks (for diseases). For culling rate and cow mortality, SimHerd applies its own internally calculated base risks, and therefore no relative ratios were used for these traits. However, for the trait “other cullings,” the proportion of accidents was calculated separately, and a relative ratio was applied.

Average live weights were obtained from Finnish milk recording statistics, as sufficient live-weight data were not available in the study dataset.

Table 7. Averages of traits used in Simherd and relative ratios.

<b>Trait</b>	<b>Holstein average</b>	<b>Difference</b>	<b>Ayrshire average</b>	<b>Relative ratio</b>
ECM	10570	834	9737	0.92
ECM 1st, Parity	8807	604	8204	0.93
ECM 2nd, Parity	10791	933	9858	0.91
ECM 3rd, Parity	11176	889	10286	0.92
Culling rate	27	-2	25	0.92
Cow mortality	9	-3	5	0.61
Proportion of accidents in cullings	4	-2	2	0.49
Calf mortality	6	0,3	6	1.05
Dystocia	1	0,1	2	1.06
Mastitis	34	-4	30	0.90
Milk Fever	11	-4	7	0.65
Metritis	2	0,3	2	1.16
Ketosis	3	-0,6	2	0.79
Dissplaced Abomasum	2	-1	1	0.61
Retained placenta	3	0,5	3	1.17
DD	7	-2	4	0.57
Foul on foot	1	1	2	1.83
Hoof diseases	43	-15	28	0.65
Heifer age first ins, months	15	0,1	15	
Live Weight	694	-65	629	

### 3.3.1 Prices for Simherd

The prices used in the SimHerd calculations were obtained from Luke’s statistics or from default values within the SimHerd program. The price of dead animals was slightly higher

than the SimHerd default and was therefore adjusted accordingly (Raatonetti, 2025). Milk prices were based on Luke's statistics, with the lower price representing the average milk price for 2021–2024 and the higher price set five cents above this level.

The price per ECM kilogram was calculated using fat and protein prices, supplemented by the responsibility bonus, which many Finnish dairies currently apply. Treatment prices were based on SimHerd values, which reflect national averages and include both veterinary and farmer labor costs. The average slaughter price in 2024 was €2.75 per kilogram for dairy cows. Because SimHerd applies prices per kilogram of live weight, the slaughter price was halved, assuming a slaughter percentage of 50%. For Ayrshire, a 5% higher live-weight price was applied based on their higher slaughter value, for example due to better classification.

The cost of dead and euthanized animals was based on carcass disposal and veterinary euthanasia costs. All prices used in the simulations are presented in Table 8. The price of milk with different concentrations supplement was calculated by comparing the average concentrations calculated from the data with the average concentration level set by the dairy and then reducing or increasing the concentration supplement in the milk price.

Table 8. Input prices of different traits for Simherd calculations

<b>Trait</b>	<b>€</b>	<b>Unit</b>
Milk fever	211	€
Dystocia	259	€
Retained placenta	110	€
Metritis	110	€
Displaced abomasum	211	€
Ketosis	122	€
Mastitis	114	€
Digital Dermatitis	41	€
Foul in the Foot	41	€
Claw and leg problems	83	€
Genomic test	27	€
Basic price	48/53	cent /l
Responsibility bonus	4	cent /l
Concentration supplement, fat, cent/1 %	5,1	cent /l
Concentration supplement, protein, cent/1 %	6,7	cent /l
Slaughter price	2,75	€/kg of slaughter weight
Died	142	€/animal
Killed	213	€/animal

### 3.4 *The economical comparison*

SimHerd simulations produce average results for herd structure and production for years 6–10 of the simulation period. The results include structural variables such as the number of calvings, distribution of cullings, replacement rate, and average productive life per cow. Additionally, the output tables (Appendices 1 and 2) report key production indicators, including lifetime yield, stillbirth rate, calf mortality, and the number of heifers bought or sold. Variables describing herd dynamics are also included.

In addition to herd characteristics, the simulations provide detailed economic outcomes. Revenues consist primarily of milk sales but also include income from animal sales, such as surplus heifers and slaughter animals. Costs are associated with replacement needs, involuntary culling and mortality, and the management of feeding, health, and fertility.

Economic comparisons were conducted by comparing an average Holstein herd with a corresponding Ayrshire herd through scenario analysis. Holstein mean trait values were calculated from the data while accounting for herd effects. Ayrshire values were derived by subtracting the calculated mean differences from the Holstein means. Relative ratios, calculated as Ayrshire divided by Holstein, were applied in scenario construction. Simulations were based on an average herd size of 250 cows to reduce the influence of stochastic variation that may occur in smaller herds.

All scenarios were simulated using two milk prices. The lower price was €0.48 per milk liter, representing the average milk price for 2021–2024 (Luke, 2025a), while the higher price was €0.53 per milk liter. A responsibility bonus of €0.04 per liter was added in all scenarios. The ECM price was calculated separately for each breed using average fat and protein prices from 2021–2023. The Nordic milk production subsidy and AB-area dairy cow premium were excluded from the base milk price and later incorporated when comparing subsidy areas AB and C2.

For traits not directly available from the data, such as heat detection rate, pregnancy rate for cows and heifers, and days from calving to first insemination, national Finnish averages or SimHerd values between average and high performance were used. Higher-than-average values were applied to better reflect Finnish calving interval levels. The use of sexed and beef semen followed current Finnish averages: sexed semen was applied to 25% of heifers, 9% of first-parity cows, and 5% of older cows in both breeds. Beef semen use was set at 35% for Holstein and 45% for first-parity and older Ayrshire cows to achieve similar numbers of surplus heifers sold. An additional scenario with optimized semen use was also simulated to assess its impact on economic outcomes.

Simulation outputs showed that annual gross margin was approximately €22,000 higher for the Ayrshire herd compared with the Holstein herd at a milk price of €0.48, and €14,000 higher at a milk price of €0.53. This corresponds to an advantage of approximately €50–89 per cow per year for Ayrshire. At the lower milk price, total revenues in the Ayrshire scenario were approximately €47,700 lower than in the Holstein scenario, mainly due to €38,000 lower milk income. Income from cows was higher for Holstein, while calf income was lower due to a higher proportion of crossbred calves in the Ayrshire scenario. Other income components remained stable as milk prices increased, while milk income increased proportionally.

At a milk price of €0.48, total expenses in the Ayrshire scenario were approximately €69,800 lower than in the Holstein scenario. The largest savings were observed in feed costs, with reductions of €51,000 for cows and €10,400 for heifers. Disease treatment costs were reduced by nearly €6,000. Other cost categories, such as breeding and miscellaneous expenses, remained largely unchanged. The reduction in total costs was primarily driven by lower feed and health-related expenses.

Lower expenses resulted in improved gross margin outcomes. The annual gross margin in the Ayrshire scenario was approximately €22,000 higher, corresponding to an increase of €84 per cow-year and €0.028 per kilogram of ECM. Although total revenues were slightly lower, reduced costs led to a superior overall economic outcome. At the higher milk price of €0.53, total costs remained unchanged while milk income increased, reducing the difference between breeds. All economic results are presented in Table 9.

Table 9. The result of important traits and total income and revenues of herd

<b>Trait</b>	<b>Holstein</b>	<b>Ayrshire</b>	<b>Difference</b>
ECM, kg	10764	10043	-720
Replacement rate %	31.8	26.9	-4.9
Mastitis, per 100 cows	34.7	31.7	-3
Milk fever, per 100 cows	12.1	8.5	-3.6
Hoof diseases, per 100 cows	37.7	25.7	-12.1
Sold heifers	10	10	0
Involuntary culled cows	46	34	-12
Feed intake, kg of dry matter	7188	6704	-484
	<b>48 cents</b>		
Total income	1 455 182	1 407 402	-47 781
Total revenues	720 630	650 765	-69 866
Herd gross margin	734 552	756 637	22 085
<b>Cow-specific income</b>	2 941	3 024	84
	<b>53 cents</b>		
Total income	1 587 729	1 531 752	-54 997
Total revenues	720 630	651 146	-69 484
Herd gross margin	867 099	881 606	14 507
<b>Cow-specific income</b>	3472	3524	52

## 4. DISCUSSION

### 4.1 *The average differences of traits*

The calculated average differences between the breeds were generally consistent with results reported in previous studies and national Finnish milk and health recording statistics; however, the magnitude of the differences observed in this study was smaller than those reported at the national level. This likely reflects differences in the study population, as the inclusion criteria excluded the smallest herds by requiring a minimum average herd size of 50 cows, thereby removing farms with potentially more variable management conditions. In addition, the use of within-herd comparisons may have reduced observed breed differences by accounting for herd-level effects such as management, feeding strategy, and housing conditions. Overall, these factors suggest that while the dataset is representative of medium to large Finnish dairy herds, national averages may capture a broader range of production environments, resulting in larger observed differences.

In yield traits, Holstein clearly outperformed Ayrshire, producing on average approximately 830 kg more energy-corrected milk. Differences in fat and protein yields were smaller than expected, as Ayrshire exhibited slightly higher fat and protein concentrations than Holstein, which is reflected in milk pricing per liter. The largest yield differences were observed in parities two to four, while the difference was smaller in first parity and declined again in later parities.

Fertility was assessed using the interval between first and last insemination (IFL), which favored Ayrshire. The difference increased with advancing parity, suggesting a potential decline in fertility in older Holstein cows. Calving performance was evaluated using dystocia and calf survival as indicators. Ayrshire showed slightly higher dystocia rates in the first two parities, whereas in later parities the breed performed more favorably. When all parities were combined, the overall difference in dystocia between the breeds was close to zero. The higher dystocia rate in first-parity Ayrshire cows may be partly explained by a higher genetic body condition score at calving (Bastin et al. 2010). Calf survival was slightly better in Holstein, as calves born to Ayrshire dams had a marginally higher mortality within the first seven days. The sex and breed of the calf were not included in the analysis, although these factors may influence calf survival.

For health traits, average differences were generally small, but most traits favored Ayrshire. Exceptions included post-calving fertility disorders such as metritis, certain udder conditions (e.g. teat injuries), and some hoof diseases, where Ayrshire showed slightly less favorable results. In contrast, Ayrshire performed better in major diseases such as mastitis and milk fever. Overall, the results indicate that Ayrshire is marginally healthier than Holstein, which may translate into lower herd health-related costs. In hoof health, Ayrshire showed a clear advantage, with an overall difference exceeding 10 percentage units in favor of the breed. Among the six most common hoof diseases, only heel erosion and corkscrew claw were more prevalent in Ayrshire. These conditions can largely be prevented through appropriate housing conditions and regular hoof care (Farmit 2010; Härkönen 2016) and are therefore not considered particularly costly to manage despite their higher occurrence in the red breed.

As expected, the overall culling proportion was higher in Holstein, although the magnitude of the difference was notable. Holstein had a higher proportion of cows dying on farm, whereas Ayrshire cows were more often removed through slaughter. This pattern suggests that Ayrshire cows are more frequently culled voluntarily rather than involuntarily. Among the five most common culling reasons for Ayrshire, only mastitis and, in some cases, poor fertility were clearly disease-related; the remaining reasons were more likely associated with farmer evaluation of the animal's performance or conformation. Despite Ayrshire exhibiting better overall health indicators, a lower proportion of Ayrshire cows survived to the next parity compared with Holstein. This apparent inconsistency further supports the interpretation that Ayrshire cows are more often culled based on management decisions rather than health-related constraints.

Differences in body weight between the breeds have implications for feed efficiency. In this study, average live weights from the Finnish milk recording system were used due to insufficient live-weight data in the study dataset. The difference in milk price between the breeds was approximately 1.5–2.0 cents per liter and was smaller than the difference observed in national milk recording data based on fat and protein contents. Slaughter price differences were assumed based on previous studies indicating that Ayrshire generally receives a slightly higher price due to better EUROP classification (Gård & Djurhålsan, 2018). This study also showed that the slaughter weight proportion was marginally higher for Ayrshire. Feed prices were set at €0.30 per kilogram of dry matter, with a one-cent lower price for Ayrshire reflecting lower dry matter intake and, consequently, lower feeding costs. Although these price differences were modest, they may in practice be even larger.

#### *4.2 The economical comparisons*

The average herd size in the simulations was set to 250 cows to improve the reliability of the results and reduce stochastic variation. With the exception of hoof health, where the difference was 13 cases per 100 cows, all trait differences used in the SimHerd simulations were within 0–4 cases per 100 cows. Despite the relatively small biological differences, the economic results were even more favorable for Ayrshire than initially expected. These findings highlight the substantial impact of less visible traits on overall farm profitability. The smaller body size,

better health, and overall functional performance of Ayrshire compensated for its lower milk yield.

Key characteristics influencing the results, such as ECM difference, culling rate, surplus heifers, calving interval, and age at first calving, were close to national Finnish averages, supporting the representativeness of the dataset. Other important parameters, including replacement rate, mastitis, milk fever, hoof diseases, and involuntary culling rates, were also within expected ranges. Ayrshire performed better in most of these traits, particularly in hoof health and involuntary culling. Holstein experienced approximately 12 more involuntary cullings, and the difference in hoof health treatments was also around 12 cases. Although the ECM difference in the SimHerd results was slightly lower than the national average, it was consistent with the average difference calculated from the study data.

A notable finding was the high number of involuntary cullings in both breeds, particularly in Holstein. Involuntary culling results in significant economic losses due to treatment costs, loss of production, and carcass disposal expenses (Martiskainen, 2025). Given the higher milk yield of Holstein cows, the economic loss per involuntary culling may be greater compared with Ayrshire (Martiskainen, 2025). Several factors may contribute to this pattern, including a higher incidence of accidents and potentially lower resilience to disease in Holstein cows (Karhula et al. 2024).

From a sustainability perspective, Ayrshire demonstrated advantages in terms of lower feed intake and reduced methane emissions. Due to its smaller body size, Ayrshire requires less feed for maintenance, resulting in improved feed efficiency (Milk Recording, 2025). As more data on feed efficiency become available, these advantages may become even more pronounced in future analyses.

## 5. CONCLUSIONS AND RECOMMENDATIONS

Overall, these comparisons show that Ayrshire and Holstein are economically similar breeds. Both can achieve comparable profitability, though through different ways. In this study, Ayrshire demonstrated a small advantage, mainly due to lower production costs. Ayrshire's strengths lie particularly in efficiency and cost savings, while Holstein's advantages are driven by higher milk yield. The idea that "a saved euro is worth the same as an earned euro" is well reflected here, as reducing expenses directly enhances overall profitability.

These results indicate that Ayrshire's economic performance was primarily explained by savings in feeding costs, which represent one of the largest expenses in dairy farming. Being smaller in body size, Ayrshires tend to consume less feed, resulting in clear cost benefits. Another significant source of savings arises from Ayrshire's generally better health status, which leads to fewer veterinary treatments and lower healthcare expenses compared with Holsteins. Taken together, these factors demonstrate that cost efficiency and animal well-being play a crucial role in overall profitability. Thus, the value of saved money may, in many cases, exceed that of earned income, since savings do not require additional inputs. It would also be valuable to examine whether similar results would appear when comparing Nordic Holsteins with foreign Holstein populations in future research.

Another relevant topic for further investigation is mortality and the underlying reasons behind it. According to the present study, the number of involuntarily culled cows was remarkably high in both breeds. Holsteins was considerably higher than that of Ayrshires. This difference has a notable economic impact: every cow lost not only reduces future milk production but also increases the cost of raising replacement heifers.

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## APPENDIX

Appendix 1. The overall Simherd calculations results with lower (0,48€) milk price

<b>Change in contribution margin per year</b>	Holstein	Ayrshire	Difference
GM per year	734 552	756 637	22 085
GM per cow-year	2 941	3 024	84
GM per kg ECM	0,273	0,301	0,028
<b>Milk yield, feeding and methane production</b>	Holstein	Ayrshire	Difference
Milk yield per cow-year, kg ECM	10764	10043	-721
Milk yield per cow-year (only milking days)	12003	11232	-771
Bulk tank somatic cell count, delivered	181052	189298	8246
Delivery percentage	99,3	99,3	0
Daily yield during first 24 w.a.c., first parity	29,1	27,1	-2
Daily yield during first 24 w.a.c., older cows	41	38	-3
Daily yield during entire lactation, all cows	33	30,9	-2,1
Daily feed intake in FE (1.1 kg Dry Matter/FE)	20,9	19,6	-1,3
Feed intake in FE per cow-year	7188	6704	-484
Gram methane per kg ECM	17,06	16,9	-0,16
Number of Animal Units (Danish environmental measu)	428	416	-12
Milk yield per Animal Unit, kg ECM	6277	6035	-242
<b>Herd dynamics</b>	Holstein	Ayrshire	Difference
Number of cow-years	250	250	0
Number of calvings	268	259	-9
Replacement rate	31,8	26,9	-4,9
-Number of Involuntary Cullings incl. mortality	46	33	-13
-Number of Voluntary Cullings	34	34	0
Number of productive years per cow	3,1	3,7	0,6
Lifetime production, kg ECM	33891	37380	3489
Stillbirth, %	6,4	6,8	0,4
Calf mortality, after birth, %	1,4	1,5	0,1
Number of alive born bull calves	87	74	-13
Number of alive born crossbred-calves	62	80	18

Number of bought heifers	0	0	0
Number of sold heifers	10	10	0
<b>Reproduction</b>	Holstein	Ayrshire	Difference
Heat observation rate	0,59	0,59	0
Conception rate	0,52	0,53	0,01
Calving interval	406	406	-1
Inseminations per cow-year (# on cows + heifers)	2,2	2,1	-0,1
Age at first calving, months	26	26	0
<b>Disease treatments per 100 cow-years</b>	Holstein	Ayrshire	Difference
Milk fever	12,1	8,5	-3,6
Dystocia	1,5	1,4	-0,1
Retained placenta	3,3	3,7	0,4
Metritis	2,7	3	0,3
Displaced abomasum	1,9	1,1	-0,8
Ketosis	2,7	2	-0,7
Mastitis	34,7	31,7	-3
Digital dermatitis	6,7	3,6	-3,1
Foul in the Foot	1,7	3,1	1,4
Claw and leg problems	37,7	25,7	-12
Dead cows	8,7	7,5	-1,2
<b>Animals in different categories</b>	Holstein	Ayrshire	Difference
First parity cows	78	68	-10
Second parity cows	59	53	-6
Third and older parity cows	113	129	16
Lactating cows	224	224	0
Dry cows	26	26	0
Calves < 6 months	57	50	-7
Calves 6 - 12 months	51	44	-7
Heifers (youngstock > 1 year)	112	97	-15
<b>Revenues</b>	Holstein	Ayrshire	Difference
Milk	1 361 286	1 322 971	-38 315
Cows	45 870	36 561	-9 309
Calves	26 432	27 093	661
Heifers	21 395	20 684	-711
Balance displacement	199	92	-107
Total revenues	1 455 182	1 407 402	-47 780
<b>Expenses</b>	Holstein	Ayrshire	Difference
Feed, cows	546 422	495 408	-51 014
Feed, heifers	79 244	68 807	-10 437

Replacement heifers	0	0	0
Disease treatments	29 340	23 426	-5 914
Breeding	11 544	10 691	-853
Other expenses, cows	41 070	41 136	66
Other expenses, heifers	13 009	11 295	-1 714
Total expenses	720 630	650 765	-69 865

Appendix 2. The overall Simherd calculations results with higher (0,53€) milk price

<b>Change in contribution margin per year</b>	Holstein	Ayrshire	Difference
GM per year	867 099	881 606	14 507
GM per cow-year	3 472	3 524	52
GM per kg EMC	0,323	0,351	0,028
<b>Milk yield, feeding and methane production</b>	Holstein	Ayrshire	Difference
Milk yield per cow-year, kg ECM	10764	10050	-714
Milk yield per cow-year (only milking days)	12003	11241	-762
Bulk tank somatic cell count, delivered	181052	189153	8101
Delivery percentage	99,3	99,3	0
Daily yield during first 24 w.a.c., first parity	29,1	27,1	-2
Daily yield during first 24 w.a.c., older cows	41	38	-3
Daily yield during entire lactation, all cows	33	30,9	-2,1
Daily feed intake in FE (1.1 kg Dry Matter/FE)	20,9	19,6	-1,3
Feed intake in FE per cow-year	7188	6704	-484
Gram methane per kg ECM	17,06	16,9	-0,16
Number of Animal Units (Danish environmental measu)	428	417	-11
Milk yield per Animal Unit, kg ECM	6277	6037	-240
<b>Herd dynamics</b>	Holstein	Ayrshire	Difference
Number of cow-years	250	250	0
Number of calvings	268	260	-8
Replacement rate	31,8	26,9	-4,9
-Number of Involuntary Cullings incl. mortality	46	33	-13
-Number of Voluntary Cullings	34	34	0
Number of productive years per cow	3,1	3,7	0,6
Lifetime production, kg ECM	33891	37398	3507
Stillbirth, %	6,4	6,6	0,2
Calf mortality, after birth, %	1,4	1,5	0,1
Number of alive born bull calves	87	75	-12
Number of alive born crossbred-calves	62	79	17

Number of bought heifers	0	0	0
Number of sold heifers	10	10	0
<b>Reproduction</b>	Holstein	Ayrshire	Difference
Heat observation rate	0,59	0,59	0
Conception rate	0,52	0,53	0,01
Calving interval	406	406	-1
Inseminations per cow-year (# on cows + heifers)	2,2	2,1	-0,1
Age at first calving, months	26	26	0
<b>Disease treatments per 100 cow-years</b>	Holstein	Ayrshire	Difference
Milk fever	12,1	8,5	-3,6
Dystocia	1,5	1,4	-0,1
Retained placenta	3,3	3,7	0,4
Metritis	2,7	3,1	0,4
Displaced abomasum	1,9	1,1	-0,8
Ketosis	2,7	2	-0,7
Mastitis	34,7	31,3	-3,4
Digital dermatitis	6,7	3,5	-3,2
Foul in the Foot	1,7	3,3	1,6
Claw and leg problems	37,7	25,5	-12,2
Dead cows	8,7	7,6	-1,1
<b>Animals in different categories</b>	Holstein	Ayrshire	Difference
First parity cows	78	68	-10
Second parity cows	59	53	-6
Third and older parity cows	113	129	16
Lactating cows	224	224	0
Dry cows	26	26	0
Calves < 6 months	57	50	-7
Calves 6 - 12 months	51	44	-7
Heifers (youngstock > 1 year)	112	97	-15
<b>Revenues</b>	Holstein	Ayrshire	Difference
Milk	1 493 833	1 447 974	-45 859
Cows	45 870	36 561	-9 309
Calves	26 432	27 093	661
Heifers	21 395	20 684	-711
Balance displacement	199	92	-107
Total revenues	1 587 729	1 532 752	-54 977
<b>Expenses</b>	Holstein	Ayrshire	Difference
Feed, cows	546 422	495 667	-50 755
Feed, heifers	79 244	69 010	-10 234
Replacement heifers	0	0	0
Disease treatments	29 340	23 301	-6 039

Breeding	11 544	10 706	-838
Other expenses, cows	41 070	41 139	69
Other expenses, heifers	13 009	11 323	-1 686
Total expenses	720 630	651 146	-69 484