In the old days a dairy farmer would size up a bull, consider the major points of confirmation, and make his or her best guess at the type of offspring the bull would produce.

Today, the farmer is more likely to look over a computer print-out called a Proof Sheet. This sheet tells you how many daughters each bull has had, and information about how well the daughters perform as dairy cows.

More recently, a new technology known as genotyping has been adopted whereby the genetic makeup of a cow or a potential bull is analyzed and determined. This genotyping can be determined by using a single hair from the animal.

With genotyping, tens of thousands of strands of the animal’s genetic map are analyzed and compared to known gene sequences for numerous production and type traits of economic interest. This provides a cheap, quick, reasonably accurate determination of the animal’s genetic strengths and weaknesses. Typically, a Genotype Production and Type Proof will combine both offspring (i.e., daughter) performance records with genotyped information to arrive at Proof Sheets that have high accuracies and repeatabilities for each trait.
Canadian Dairy Network (CDN)
The Canadian Dairy Network (CDN) was created in 1995 and is Canada’s central agency responsible for generating genetic evaluations (or Proof Sheets) on females and males from each of the seven dairy breeds. It does this by collating all known performance and type classification information and available genotyped information, then using complex computer modeling it generates the desired genetic indexes (or Proof Sheets).

CDN maintains a national database of all pedigree and performance data required for its six key genetic evaluation systems that include production, type, longevity, reproductive performance, milking speed, and milk temperament. All publishable data and genetic evaluations are freely available for worldwide access via its website at www.cdn.ca. CDN provides genetic evaluations for nearly 80 different traits in each breed.

In August 2009, CDN added its 7th genetic evaluation system with the launch of its new Genomic Evaluation System. This system allows CDN to simultaneously combine pedigree and performance information with DNA information to estimate each animal’s genetic merit with even greater accuracy.

Animals that have a genetic index (or Proof Sheet) that does not include genotype information will be referred to as simply having a genetic index (or Proof Sheet); however, others who have genotype information included will be regarded as having a Genomic genetic index (or Genomic Proof Sheet).

On the Proof Sheet
Many types of information are recorded on a proof sheet. The key categories of information are:

- production records
- type classification
- descriptive traits
- secondary traits
- lifetime profit index

Production and Type
Canadian breeders use a sophisticated mathematical system to evaluate an animal’s Estimated Transmitting Abilities (ETA)—that is, its ability to pass on certain characteristics to its sons and daughters. The Canada Animal Model (CAM) takes into account information on all ancestors and siblings, not just the sire and dam, and continues to update the information as new results come in.
Some of the information on a proof sheet, such as fertility rating, refers directly to the bull. Most of the information, however, is about the quality of daughters the bull produces.

CAM information includes *production traits* (i.e., milk yield; fat yield; protein yield; fat deviation; protein deviation) and major type traits—how closely the animal conforms to the desired physical type for the breed (i.e., confirmation final score; mammary system; feet and legs; rump; and dairy strength).

Here’s what a proof sheet might say about a top-ranking bull’s production qualities:

<table>
<thead>
<tr>
<th>Trait</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. daus*</td>
<td>72</td>
</tr>
<tr>
<td>no. herds</td>
<td>72</td>
</tr>
<tr>
<td>% repeat</td>
<td>91</td>
</tr>
<tr>
<td>milk rating</td>
<td>20</td>
</tr>
<tr>
<td>fat rating</td>
<td>29</td>
</tr>
<tr>
<td>protein rating</td>
<td>21</td>
</tr>
<tr>
<td>% fat dev.</td>
<td>0.18</td>
</tr>
<tr>
<td>% prot. dev.</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*daus. means daughters

**Descriptive Traits**

*Descriptive traits* provide further information about conformation. They include comparative information on key areas of the animal’s body traits such as set of rear legs, pin setting, body depth, udder texture, angularity, stature, chest width, loin strength, fore and rear udder attachment, and fore and rear teat placement.

**Functional Traits**

*Functional traits* are those that impact the functional aspects of an animal’s performance or daughter performance from a particular sire. These include such traits as milking speed, milking temperament, daughter fertility, daughter calving ability, herd life, somatic cell score, and lactation persistency. Typically, functional traits have moderate to low heritabilities.

**Milking speed** refers to how long it takes to remove all the milk from a cow’s udder. In an intensive production situation, the faster the better.

**Calving ease** refers to how easily the cow gives birth. Some cows may give birth quite easily on their own; others may require the calves to be pulled, and yet others may get into serious difficulty that requires veterinary intervention.
Fertility refers to the ability of the bull’s semen to produce a conception.

Other statistics:
The somatic cell count (SCC) of the milk provides an strong indicator of the level of udder health within the herd. Another useful statistic is the average calving interval (CI) because this is a quick indicator of reproductive efficiency.

Traits and Breed selection
You’ve learned about the popularity of the Holstein and its production compared to other breeds. So you can conclude an important breeding goal is to produce a cow with high milk yield combined with high butterfat and protein yields. Since producers are paid for component yields and not milk yield directly, it is a primary goal of most producers to select and breed for high milk production in combination with high butterfat and protein contents.

Some of the challenges a commercial producer or breeder faces who owns one of the less popular breeds in Canada includes:

1. Lack of a large, diverse group of proven sires to choose from.
2. Less biodiversity within the breed.
4. Fewer marketing opportunities for breeding stock.
5. Fewer opportunities to purchase and introduce better breeding stock into the herd.

Lifetime Profit Index (LPI) Formula
The lifetime profit index (LPI) formula for each breed is applied to bulls and cows in Canada that have official genetic evaluations for production and type traits.

The LPI is a single figure that is used to rank bulls and cows on their overall economic merit relative to one another within a breed. The higher the number, the better the animal.

There are three main components of the LPI Formula. They include: a production component; a durability component; and a health and fertility component. The production component includes weightings on fat and protein yield and deviation traits. The durability component includes weightings on herd life, mammary system, feet and legs, and dairy strength. The health and fertility component includes weightings on somatic cell score, udder depth, milking speed, daughter fertility, and lactation persistency.
The LPI Formula looks as follows:

\[
\text{LPI} = (\text{Production Component} \times \text{Emphasis} \times \text{Factor}) + (\text{Durability Component} \times \text{Emphasis} \times \text{Factor}) + (\text{Health and Fertility Component} \times \text{Emphasis} \times \text{Factor})
\]

No—you don’t have to memorize all that! But maybe you are beginning to see why computers are so helpful in breeding today.

**Computer Dating**

The information we’ve just been looking at is most often used to select a sire or sires for a breeding program, to select bull mothers, to select genetically superior cows within a herd for embryo flushing to improve the herd’s genetic progress or for genetic marketing purposes. All breeders who are serious about marketing their dairy genetics will provide this information to potential clients.

Dairy farmers have ready access to professional genetic services that use specially designed computer programs to match up cows with the best potential sires. The goal in any computer assisted mating (or dating) exercise is to match sires who are strong in those traits where the cow may be weaker, thus resulting in offspring that are genetically improved over their mothers (dams). Usually a list of three sires is recommended in any corrective computer assisted mating program so that the producer is given some choice in what sire to select.

This system saves the producer time and effort, and usually results in a much more effective breeding program that generates offspring that are genetically superior to their parents. As we learned in Module 2, it isn’t easy to consider all the factors involved in genetics.

**When to Breed Dairy Cows**

Because of variations in feeding and management, size rather than age is typically used as a guide to breeding time. This will ensure adequate development for the first calving. Heifers bred too small will have stunted growth, lower long-term production, and more problems with calving difficulty at parturition.

The following are the usual breeding weights:

<table>
<thead>
<tr>
<th>Breed</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jerseys</td>
<td>250 kg</td>
</tr>
<tr>
<td>Guernseys</td>
<td>275 kg</td>
</tr>
<tr>
<td>Ayrshires</td>
<td>300 kg</td>
</tr>
<tr>
<td>Holsteins</td>
<td>350 kg</td>
</tr>
</tbody>
</table>

These weights are typically achieved between 13 to 15 months of age.
Identifying with a Breed
You don’t need purebred livestock to produce good-quality products. Grade animals, if carefully selected, often do the job just as well.

In agriculture today, you do need the best quality animals you can get in order to stay competitive.

Starting with Purebreds
If you are setting out to buy foundation stock, you can get information from the various breed organizations. You’ll want to know characteristics and requirements of the breed, plus information on suppliers.

If you decide to go with purebreds, you must be careful to keep accurate breeding records and register the animals properly as soon as they are born. Otherwise, you will have paid a good price to get good stock, then lost proof of what you have. All cattle are required to be identified as part of the National Animal Health Program. Purebred registration numbers should be included with the identification information recorded for the animal.

Your recorded information about breed, as well as information about the animal’s production, will help you make the best decisions about future sires.

Starting with Unidentified Breeds
If you have a herd of dairy cattle of unknown or mixed breeds, you’ll want to record any information you have about the cows, and then breed to known sires from a recognized breed only.

Most breed organizations have some method of recognizing part-bred animals. The first level is recorded, which applies to an animal that is the offspring of an unidentified female and a registered male. If the daughters of this first union are repeatedly bred to registered males, the percentage of purebred blood increases, so the animal is now called a percentage animal.

No matter how high the percentage of purebred blood, however, there will always be some remnant of the grade animal. Only two purebreds can create a purebred.

Breed Class Average (BCA)
It was previously stated that the average cow produces 36 to 38 litres milk per day. In fact, this amount varies among cows depending upon breed, stage of lactation (days in milk), age, season, feed quality, cow comfort, herd health, reproductive status, and genetics.
In its simplest form, individual cow production for milk, fat, and protein can be compared among different cows within a herd by using an age-old standardized index known as the animal’s breed class average (or BCA). The calculation of a BCA index for milk, fat, or protein adjusts and takes into account the breed, the age, and the month of calving of the cow. By comparing individual cow BCAs to the herd average BCAs as well as to other cows in the herd, the herd owner can get a general idea of which animals may be genetically superior in the herd.

**Other Genetic Indicators**
Since the days of paying attention primarily to BCAs and BCA deviations among cows and in sire proving evaluations, the global dairy industry is much more advanced today in its ability to accurately and rapidly identify superior breeding stock. Genetic indexes tell about specific production and conformation traits.