

Economic Value of Genetic Merit of Dairy Semen¹

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An easy way to rank dairy sires for profitability of their daughters is to compare their predicted transmitting ability (PTA) of an economic index such as USDA's lifetime Net Merit (NM\$). In certain markets, another index such as Cheese Merit, Fluid Merit, or Grazing Merit is more appropriate because the marginal values of improvement of some traits are different. These economic indexes are readily available. However, semen prices are not the same. The number of inseminations needed to produce a conception varies among sires. Considering differences in NM\$, price, and fertility, it is not immediately obvious which sire's semen is the best value. Alternatively, it is useful to determine the amount a dairy farmer can afford to spend on sires that differ in NM\$ or conception rate or both. Attempts to calculate the economic value of semen have been made since at least the 1970s. The basic calculations have since become available (Dechow 2016). This fact sheet reviews these calculations, adds a few other considerations, and offers estimates of the worth of the genetics of dairy semen. A spreadsheet where the user can vary inputs and observe the effect on the economic value of genetic merit of dairy semen is also provided.

Example: There are two sires with PTA for NM\$ that differ by \$100. The NM\$ is a lifetime index, which suggests that the daughter of one sire is \$100 more profitable than the daughter of the other sire during her productive lifetime. USDA has standardized this lifetime at 2.78 lactations, or approximately 3 years (VanRaden 2017). Sires with PTA for NM\$ that differ by \$100. The NM\$ is a lifetime index, which suggests that the daughter of one sire is \$100 more profitable than the daughter of the other sire during her productive lifetime. USDA has standardized this lifetime at just short of 3 years (VanRaden et al., 2025).

The NM\$ value is currently based on USDA's estimates of the marginal economic values of changes in 13 traits

in the next several years. This includes values for protein, fat, beef, feed, and replacement prices. These values make sense, but markets often change. For example, all four indexes assume that 1 pound more fat has a value of \$2.00, but the price of fat is not \$2.00 today. However, today's insemination decision may result in a calf that does not start producing until almost 3 years from today. Therefore, today's market prices are not so relevant. We do not know if, on average, the NM\$ (or another index) over- or underestimates the real differences in profitability or perhaps is right. For this example, we assume that a difference of \$100 in NM\$ results in an actual profit difference of \$100 between the daughters.

It is important to note that not every insemination results in a pregnancy. To start our calculations, we need the conception rate of the female being inseminated as well as the sire conception rate (SCR) of the sire. For example, a sire with an SCR of +2% elevates the conception rate by 2 percentage points. Heifers generally have greater conception rates than cows. Let us assume for now that the SCR is 0 and the female's conception rate is 35%. If conception is achieved, there is still a risk of abortion and subsequent culling. We will assume both risks are 5%. Once a calf is produced, the calf must be alive for the genetic merit of the semen to have value. Stillbirth is already included in the calving ability trait in the NM\$ index, so it is not included again to avoid double counting. Next, we will assume that only female calves benefit from differences in genetic merit. In other words, the differences in NM\$ do not affect the value of male calves. Here we will assume that the probability of a female calf is 48%. Sexed semen would make this probability much greater. Next, the female calf has a risk of being culled in her young stock period before production starts. We will also put this risk at 5%. Now the important factors that determine if an insemination results in a milk producing cow are presented.

Remember that the NM\$ index value applies to a daughter ($1 \times \$100$) but does not include the value that this daughter passes on to her daughters ($0.5 \times \$100 = +\50), granddaughters ($0.25 \times \$100 = +\25), and all later generations (small fractions of \$100). Every generation receives half the genetic merit of the previous generation. The sum of these “gene flow” multipliers is 2, but it also depends on the number of future female offspring of the daughter. We will assume that every female produces one replacement. However, these expected genetic gains are realized in the future, so they need to be adjusted to be put into current prices. For example, the +\$100 NM\$ is not realized until approximately 4 years after the insemination. This discount factor for all future generations is roughly 0.65, so the combined effect of gene flow and discounting is $2 \times 0.65 = 1.3$. In other words, the \$100 NM\$ is worth \$130 in today’s dollars, provided the insemination results in a cow that starts production.

Now we can calculate the value of +\$100 NM\$ difference in the two units of semen using the factors explained above, as $+\$100 \times 35\% \times (1-5\%) \times (1-5\%) \times 48\% \times (1-5\%) \times 1.3 = \18.73 . A dairy farmer could afford to pay up to \$18.73 more per unit of semen that is +\$100 higher in NM\$ and has the same SCR. If this semen is used in heifers with a conception rate of 60%, the value

increases to \$32.10. Genetic differences are more valuable in females with high conception rates because fewer inseminations are needed to achieve a pregnancy. Sexed semen also leads to greater values. Using a 90% chance of a female calf instead of 48%, the value increases to \$35.11 when conception rate is 35%. The value increases much more if the female is an embryo donor.

Differences in SCR cause differences in the overall conception rate and affect the change in and cost of days open. Days open after an insemination that did not result in a conception depend on the service rate (speed of re-breeding) and the conception rate. Low service rates and low conception rates mean more days open and greater economic loss for a missed conception. The average cost of a day open is roughly \$2.50, but it depends greatly on the situation. An insemination late in lactation has a high cost per day open (roughly \$5), so the value of a 1-point greater SCR is worth a lot late in lactation. An early first insemination in a high-producing cow has a low cost per day open (close to \$0). Figure 1 shows the value of semen for SCR of -1%, 0%, and +1% using a cost of \$2.50 per day open and a service rate of 50%. It is clear that differences in SCR at low female conception rates are more important than at high conception rates.

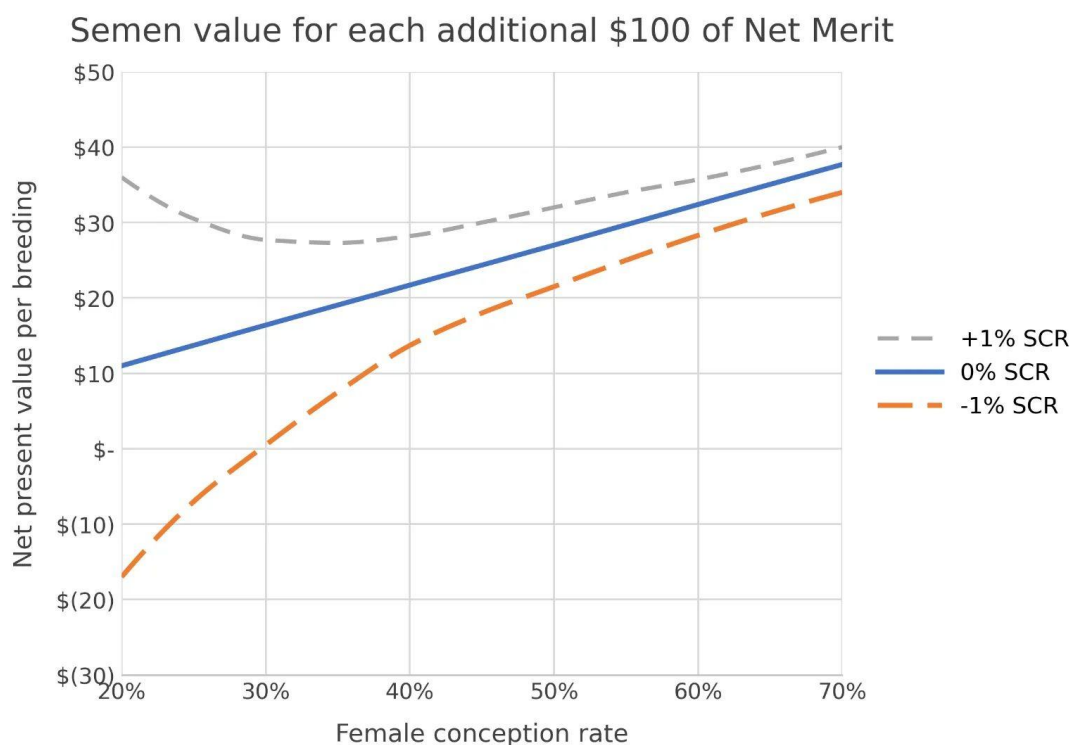


Figure 1. Semen value for each additional \$100 of Net Merit for varying female conception rates and three levels of sire conception rates (SCR). Credit: Credit: Albert De Vries, UF/IFAS

The formulas can also be used to compare two sires directly. For example, sire A has a PTA of NM\$ of \$800 and sire B has a PTA of NM\$ of \$700. The SCR of sires A and B are 0% and +1%, respectively. Semen of sire A costs \$20 per unit and semen of sire B costs \$10 per unit. Therefore, the genetic merit of sire A is greater, but the fertility and cost per unit of semen of sire B are better. We will use all the aforementioned assumptions that led to the \$18.73 net present value calculation. In this example, the net present value of the \$800 NM\$ semen is \$149.80 and the net present value of the \$700 NM\$ semen is \$143.15. As a result, sire A has a genetic value advantage of \$6.65, but also has a \$10 greater cost per unit of semen. Semen from sire B is worth \$3.35 more than semen from sire A and is the better deal for the dairy farmer.

There are three other factors that can affect the value of semen. The first is the reliability of the PTA of NM\$. A lower reliability means more uncertainty about the true genetic merit of the semen. The expected value of +\$100 is independent of the reliability, but a risk-averse dairy farmer would prefer higher reliability to lower reliability. Dairy farmers who are willing to take risks, on the other hand, would prefer the lower reliability. It is difficult to quantify the extent to which attitude towards risk affects the amount a dairy farmer is willing to pay for semen.

A second factor is response to selection. We have assumed that the difference in PTA of +\$100 NM\$ between two bulls results in a true genetic difference of \$100. The response is likely greater on farms where females are well cared for. A greater response to selection increases the value of semen.

Finally, the NM\$ and other USDA indexes are standardized at 2.78 lactations. This corresponds to a

cow cull rate of approximately 33%. On farms with a greater cull rate, the cow has fewer lactations to express her genetic merit, and will have fewer daughters. For example, if the cow had only 1.78 lactations, then the \$100 NM\$ is worth approximately \$64. This estimate is approximate because gene flow and discounting change, and the current NM\$ formula contains heifer conception rate which is independent of the number of lactations. In general, a higher cull rate decreases the value of semen. Other factors could also affect the value and choice of semen, such as the amount of relatedness between the sire and female.

In conclusion, a difference in the genetic merit is probably worth more than many dairy farmers may think. A spreadsheet with the formulas and factors described above is available at [10.5281/zenodo.21327264](https://doi.org/10.5281/zenodo.21327264).

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¹ This document is AN338, one of a series of the UF/IFAS Department of Animal Sciences, Gainesville, FL. Original publication date January 2018. Revised July 2026. Visit the Ask IFAS website at <https://ask.ifas.ufl.edu> for the currently supported version of this publication. © 2026 UF/IFAS. This publication is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)

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