Optimize breeding and replacement decisions using milk recording data

R.H. Fourdraine[1], J.S. Clay[1] and A. De Vries[2]

[1]Dairy Records Management Systems, 313 Chapanoke Road, Suite 100, Raleigh, NC 27603, USA
[2]University of Florida, 2250 Shealy Drive, Gainesville, FL 32611, USA

Abstract

With more breeding options available, decisions regarding which animals to replace and which animals to breed and the type of semen to use has become increasingly complex. US dairy farmers typically consider a couple key individual performance measures in the decision making process. Assessing the future economic returns would provide a better assessment, however requires more data inputs and a more complex method of analysis. This paper will explain how a prediction model developed by the University of Florida in collaboration with Dairy Records Management Systems will reduce the guesswork and simplify the process of making replacement and breeding decisions using cow performance data collected through milk recording.

Keywords: Fourdraine, Clay, De Vries, optimization, breeding, replacements, economic, decision, support, milk, recording.

Introduction

Sorted semen has enabled important changes in how producers manage programs for replacement animals while optimizing overall genetic progress. Increased use of sorted dairy semen can achieve more female calves to replace existing cows or to expand the herd without significantly impacting conception rates. A ready supply of replacement heifers provides more options to replace cows that are low producing, have reproductive problems or are not healthy. Genomic testing accelerates a herd's overall genetic progress when the highest genetic merit cows and heifers are bred with sorted dairy semen. Recently, in addition to conventional and sorted semen, U.S dairy farmers have added another option when making breeding decisions – semen from beef bulls. Typically, the most valuable animals (heifers and higher genetic merit first lactation cows) are bred to sorted dairy semen at first service. Conventional semen usually is used for later services. Because dairy farmers want to take advantage of higher revenues for a dairy/beef calf, there has been an increased use of beef semen in the dairy industry. Utilizing Dairy Records Management Systems (DRMS) breeding data from over 2 million cows, recent results found not only increased use of beef semen but there have been recent changes in the age and timing that dairy cows have been bred to beef semen.

With so many options available including using cows as embryo donors or recipients, how can a producer determine the best breeding option for each animal and thereby improve returns? Utilizing a prediction model developed by the University of Florida in collaboration with DRMS, decision support software was developed that reduces the guesswork while simplifying the process of making replacement and breeding decisions using cow performance data collected through milk recording.

This new decision support software features individual cow genetic information coupled with cow performance data to predict each cow's future performance and economic values for replacement and mating decisions. This information can be used to decide whether a cow should be retained, bred or replaced. In addition, the model assigns an economic value to each of the three potential mating sire choices: sorted dairy semen, conventional dairy semen or beef semen. As inputs related to each cow's stage of lactation, reproductive status or genetic information may change daily, outcomes from the model will change as well, and, replacement and breeding decisions can be made based on the most current data.

U.S. breeding trends

Using data from over 10 million DRMS breeding records, Figure 1 illustrates the type of semen used for Holstein and Jersey breedings during the recent two years. Based on this two-year period, it is clear that there has been an increase in use of both beef semen and dairy sorted semen that has resulted in reduced use of conventional dairy semen. Overall, almost 50% of breedings to Holstein and Jersey cows were to sorted dairy or beef semen.

With easier access to replacement animals and improved fertility, producers have lowered the threshold in terms of how many times they will breed a cow before deciding to stop breeding and to replace her. Therefore, as the number of times a producer will

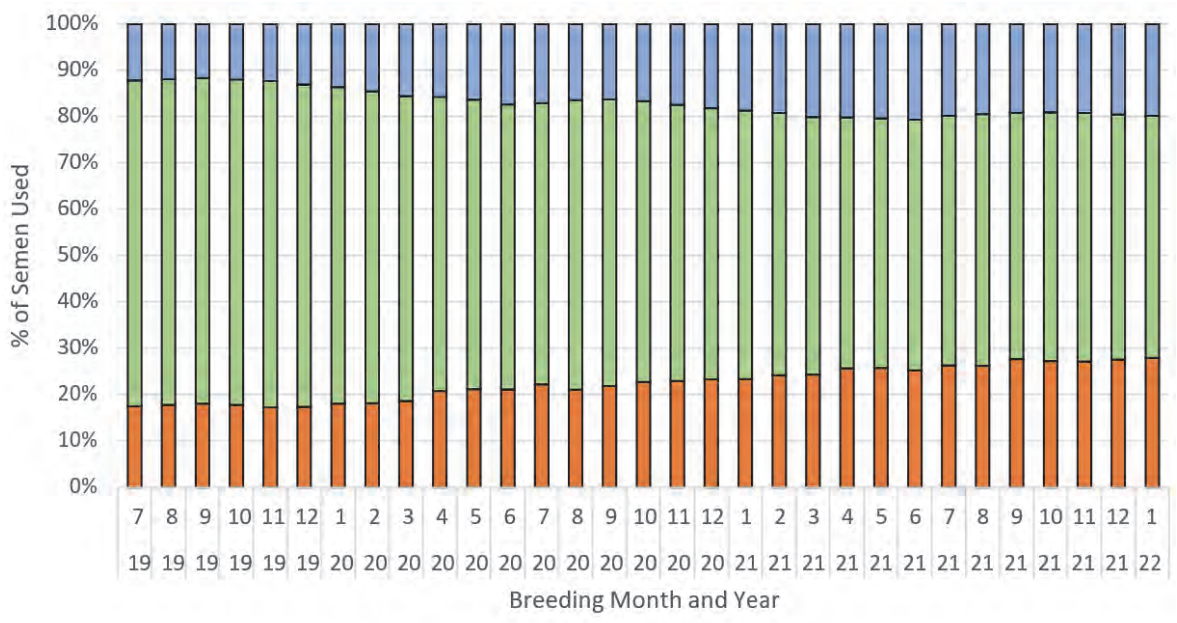

Figure 1. Semen usage trend for Holstein and Jersey cows.

Table 1. Semen distribution for Holstein cows by parity, service number, and type of semen.

	Service #	% Beef	% HO Conv	% HO Sorted	% Jersey
Heifer	1	4.0%	36.0%	58.3%	1.7%
	2	6.7%	40.0%	51.7%	1.6%
	3	25.3%	48.2%	24.6%	1.9%
1st Lact	1	13.1%	59.8%	24.8%	2.3%
	2	19.5%	61.2%	17.0%	2.2%
	3	37.7%	55.3%	6.3%	0.7%
2nd Lact	1	24.8%	60.6%	13.4%	1.1%
	2	29.8%	60.4%	9.0%	0.9%
	3	42.8%	53.7%	2.8%	0.6%
3> Lact	1	36.1%	55.2%	7.8%	0.8%
	2	39.8%	54.4%	5.2%	0.6%
	3	50.2%	47.1%	2.1%	0.7%

breed a cow before considering culling has dropped in the past five years, the decision process to breed with three choices of semen at hand has changed significantly. A fourth option for herds that consider embryo transfers is to use a low genetic merit cow as a recipient. Table 1 shows a comparison based on parity and service number and the type of semen used on Holstein Cows in the DRMS breeding records

Over fifty percent of US Holstein heifers were bred to sorted semen on first or second service. This makes sense because these should be genetically superior animals and because breeding these animals with sorted semen should yield the greatest number of female offspring to use as replacements. Interestingly by the third service, the percent of breedings to beef semen on heifers is twenty-five percent. Additionally, the use of beef semen increases rapidly with lactation number. Thirteen percent of first lactation cows were bred to beef semen on first service. Use of beef semen increases to thirty-six percent for third and greater lactation cows.

Another observed difference relates to semen usage based on herd size. Figure 2 show the distribution of semen usage for herds with a minimum of 1,000 cows. Based on the DRMS data, smaller herds used a substantively lower percentage of beef semen and sorted semen than larger herds. This trend for smaller herds did not change much in the recent two years while the trend in larger herds was to use more beef and sorted dairy semen and less conventional dairy semen.

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Dairy managers face an increasingly complex decision making process pertaining to when a cow should be sold, bred and which sire to breed the cow to. In most cases, decisions are based on a small number of variables that can be easily obtained on an

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individual cow. For example, a replacement decision typically is based on how much did the cow produce in her current or past lactation, did she experience several health problems, is she open and how many times was she bred? The breeding decision concerning which semen type to for a cow will include some of the same variables but in most cases also includes the genetic value of the animal. Although this process can be managed using a report from herd management software and making a personal judgement, it does not take into account some of the more complex factors such as milk price, replacement cost, value of a dairy female versus dairy male or the value of a dairy beef cross calf, to name a few.

To make more informed decisions and allow for a larger number of parameters for individual cows and the herd to be part of the analysis, the University of Florida Animal Sciences department, in collaboration with DRMS, developed a model that will calculate an economic value of each the cow in the herd and also calculates values for breeding a cow to either dairy conventional, dairy sorted or beef semen. The outcomes from the model were then incorporated into a decision support tool showing the relative ranking of the cow in the herd and provides a first choice and second choice breeding recommendation for cows that need to be bred.

Description of the model

Data inputs to the model consist of parameters for the herd and individual cows. Most of the herd parameters such as conception rates, milk production levels by lactation can be obtained from the on farm PCDART herd management software or monthly DRMS test day processing. Financial information must be provided by the producer. Financial information consists of milk price (including milk components), heifer replacement costs, beef price, selling price of a dairy bull calf and dairy x beef calf, and costs per unit of sorted, conventional dairy and beef semen. The model also allows for a feed cost adjustment.

Cow data includes cow lactation number, days in milk, status data (milking or dry), reproductive status (Bred, Pregnant, Open, etc..), the last 2 test day milk, fat, and protein weights, current lactation to date milk, fat and protein weights, and past lactation 305D milk, fat and protein weights. The economic genetic merit (Net Merit Dollars) is also included for each cow.

The model estimates future cash flows following each decision alternative (keep, replace, and breed with sexed dairy, conventional dairy, or beef semen) following optimal replacement and breeding decisions now and into the future. These future cash flows are calculated using dynamic programming and future cow performance estimates based on the milk recording data and prices. Cash flow estimates include cash flows from replacement heifers when the cow is replaced now or in the future. Typically cash flows for six years into the future are needed to capture all changes in cash flows that follow from a replacement or breeding decision. The model automatically determines this length of time.

A novel feature of this model is that future cash flows are calculated for each cow based on her best estimated future performance for milk production, fertility, forced culling, genetic merit etc. This allows for accurate future cash flow estimates. Finally, the model calculates the differences between the net present values of the future cash flow estimates and presents them as four different economic values. For example, the economic value of the cow (Keep Dollar) is the difference between the net present value of the keep (and optimal breeding) decision and the decision to replace the cow now with a heifer. When this economic value is greater for a cow, the more valuable the cow is to keep in the herd. Cows that rank low for this economic keep value should be culled and replaced. Insemination values are calculated as the net present value

of breeding with that type of semen compared to the net present value of the decision to delay breeding until the next opportunity.

Presentation of results

As stated above, the model returns four key economic values, the economic value of the cow (Keep Dollar), plus three economic insemination values for breeding the cow to either Sorted Dairy, Conventional Dairy or Beef semen respectively. The results from the model are merged with other cow data, and the percentile ranking for the cow's Keep Dollar that provides an easily interpreted rank of relative economic worth for each cow within the herd.

The three insemination values are ranked for each cow and the recommendation with the highest economic merit is presented as first choice, while the next highest value is presented as second choice. The dollar difference between first and second choice is provided to determine the economic difference between first and second choice. Picture 1 provides an example output for cows that are due to be bred.

In the example above, Cow 8068 has a Keep Dollar of 1020 which ranks her at 66th percentile (Keep Perc.) within the herd. The first choice recommendation is to breed her with (S)orted dairy semen and second choice would be (C)onventional dairy semen. Breeding 8068 with Sorted semen has a 17 dollar advantage over breeding her with conventional dairy semen. Cow 8075 ranks a much lower 37th percentile so the breeding recommendation is to breed her with (B)eef semen. However, her second choice of (C)onventional semen is close behind with a 1 Dollar difference.

Dairy farmers can use the combination of the cow's Keep percentile and first semen choice recommendation to determine which cows to breed (low Keep percentile cows should be considered for replacement). If semen inventory is limited, ranking cows by first choice and the economic difference between first and second will allow the dairy farmer to select the highest dollar difference values that would be the cows with the strongest recommendation to breed to first choice.

Conclusion

This new decision support tool will help dairy farmers make more informed breeding and culling decisions. The model is customizable using each herd's unique situation, and, new parameters that would impact a cow's economic value can be added. In addition, this new tool is time sensitive and will use the most current data available from the herd management software to ensure changes in production or reproductive status are reflected in a cow's relative economic value in the herd. Current efforts are focused on testing the model with several dairies, and, future enhancements will include breeding

Table 2. Sample Output.

ID	Keep Dollar	Keep Perc.	First choice	Second choice	First over Second
8066	729	43	C	S	2
8068	1020	66	S	C	17
8071	739	44	B	C	4
8072	863	54	S	C	18
8074	875	56	S	C	10
8075	646	37	B	C	1

recommendations for heifers allowing further expansion to a herd level decision tool taking into account number of replacements needed to maintain herd size.