TOOLS FOR MAKING ECONOMIC REPRODUCTIVE DECISIONS

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TAKE HOME MESSAGES

- Critical reproductive decision making on dairy farms can be assisted by the use and application of decision support tools
- A number of recent decision support tools in the area of reproductive management are openly and freely available at the University of Wisconsin-Madison Dairy Management: http://DairyMGT.info -> Tools –> Reproduction
- The tool *Exploring the Time of Pregnancy* finds the theoretical best time for a cow to become pregnant (maximum income over feed cost per year) according to shape and magnitude of cow's lactation curve
- The tool *Premium Beef on Dairy Program* provides an economic assessment of switching inseminations from conventional or sexed sorted dairy semen to beef semen
- The tool *University of Wisconsin-Cornell University-DairyRepro$* is a sophisticated simulation model that calculates the net return of precisely defined reproductive programs and the impact of their changes
- The tool *Economic Value of a Dairy Cow* calculates both the dollar value of a specific cow on the herd and the herd's average net return. This tool can be used to perform cow-specific reproductive management, calculate important reproductive economic values, and assess the overall herd net return associated with herd's reproductive performance

INTRODUCTION

Economic simulation research has proven to be effective for assessing, understanding, and providing dollar value to reproductive management strategies (Cabrera, 2014; De Vries, 2006; Giordano et al., 2011; Giordano et al., 2012; Galvao et al., 2013). Furthermore, economic simulation research translated into farm-specific decision support tools (Cabrera, 2012a; Giordano et al., 2012; Lopes and Cabrera, 2014) can become essential for permanent dairy farm strategic management (Cabrera 2012b). A number of research laboratories and scientists have developed and made available various decision support tools for dairy cattle reproductive management (e.g., University of Florida, University of Pennsylvania, University of Wisconsin-Madison). During the last 5 years, the University of Wisconsin-Madison Dairy Management (http://DairyMGT.info) has been active in producing reproductive management decision support tools (Cabrera, 2012b). This paper explains the rationale, describes their functionality, and presents illustrating case studies of state-of-the-art decision support tools for reproductive management openly and freely available at UW-Madison Dairy Management (http://DairyMGT.info -> Tools -> Reproduction), *DairyMGT.info*.

Exploring the Time of Pregnancy (Milk Curve Fitter)

The time when a pregnancy occurs during a cow's lactation is a large determinant of its economic value. Farmers, consultants, and researchers understand this economic principle. Calculating its real economic value, however, is not straightforward. It depends on the magnitude and shape of the lactation curve, the expected durations of gestation and dry period, and costs and prices. For example, more persistent lactation curves (e.g., first-lactation or rbST-treated cows) may have an opportunity to delay pregnancy.

First, the lactation curve needs to be defined according to farm records. A number of traits could define a particular herd (or individual cow) lactation curve according to pre-defined lactation curve functions (Silvester et al., 2005; Ehrlich, 2011). The principle is to "fit" the herd records to pre-defined lactation function curves by minimizing the differences between the observed and predicted data points. A *DairyMGT.info* tool, the *Milk Curve Fitter,* allows users enter herd records of test-day milk production (days in milk [**DIM**] vs. milk yield), and based on that information, fit lactation curves that best represent herd's productivity. The *Milk Curve Fitter* (Figure 1) provides a graphic representation of the observed and predicted data points together with data-specific fitted parameters. For example in Figure 1, the user entered 12 milk test records (lb/d between 15 and 345 DIM; dots in graph - observed) that were used to fit a lactation function curve based on MilkBot's model (Ehrlich, 2011) represented by the curve in graph (predicted). Parameters of fitted model also are displayed and can be used to explore the time of pregnancy that would produce the maximum income over feed costs.

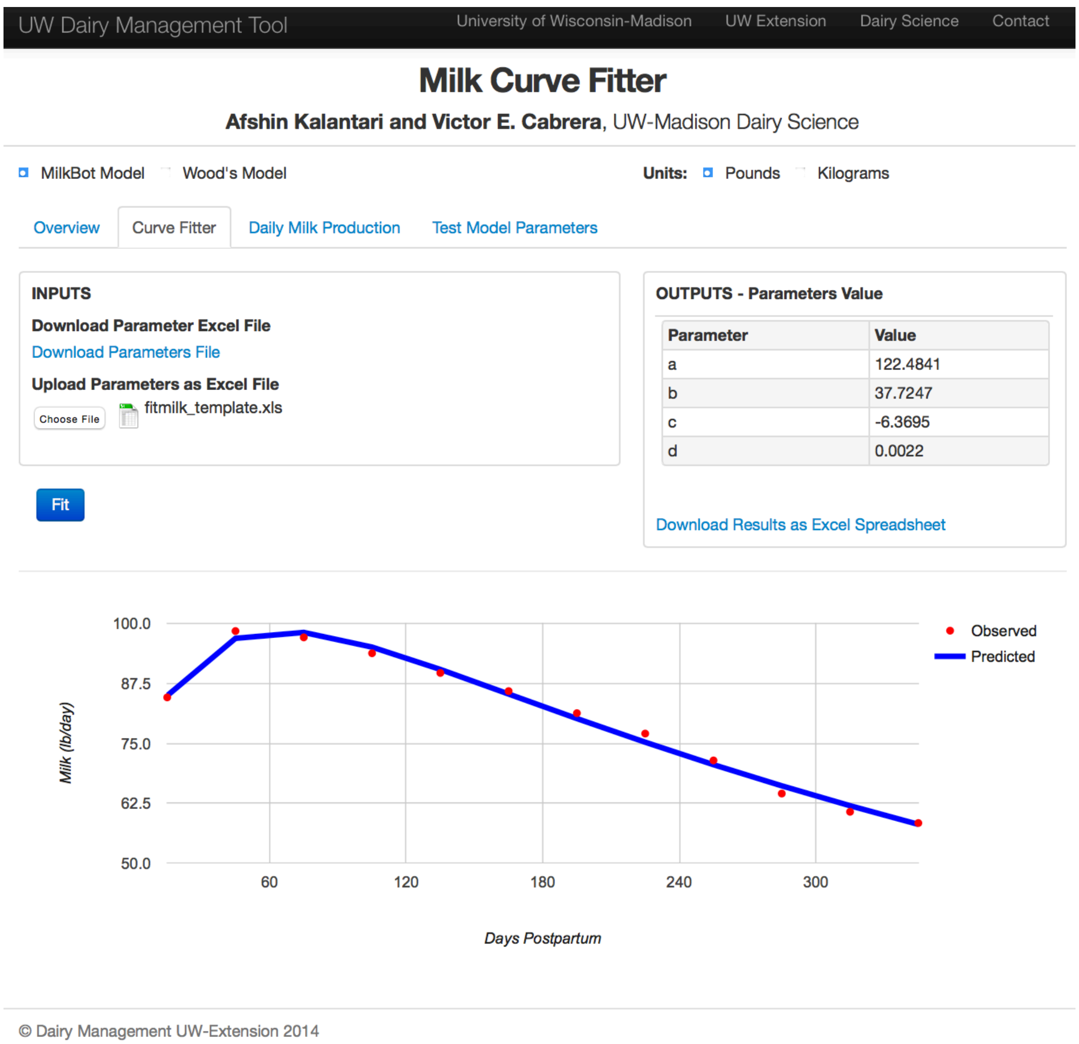


Figure 1. The Milk Curve Fitter decision support tool available at DairyMGT.info -> Tools -> Production displaying a lactation curve fitted with the MilkBot model.

Once herd managers are familiar with herd's lactation curves, they may explore what would be the best time for pregnancy to occur. A *DairyMGT.info* tool, *Exploring Pregnancy Timing Impact on Income Over Feed Cost,* allows users to assess the economic value, expressed as milk income minus feed costs ($/cow per year), expected at different times in pregnancy in relationship with the lactation curve. The tool *Exploring Pregnancy Timing Impact on Income Over Feed Cost* (Figure 2) provides a graphic representation of the lactation curve responding to user pre-defined parameters and its resulting production according to the time of pregnancy, gestation length, and dry period duration. Furthermore, the tool *Exploring Pregnancy Timing Impact on Income Over Feed Cost* also calculates the milk income and the milk income over feed cost (**IOFC**) during lactation, and importantly, the IOFC on a yearly basis. Users can "play" with possible times of pregnancy and find its impact on the IOFC. Moreover, the tool has an optimization engine that calculates the day of pregnancy that results in the maximum IOFC. For example, in Figure 2, the maximum IOFC of $2,109/cow per year would be obtained if the pregnancy is initiated at 32 DIM. Obviously, it is not recommendable to breed cows at 32 DIM, hence the conclusion is, with those lactation curve parameters, the sooner the cows become pregnant, the better. Notice that such conclusion is largely dependent on the shape and magnitude of the lactation curve. Knowing herd- or cow-specific lactation curves and its impact on the IOFC is crucial for strategic reproductive management. Tools presented in this section can help in a first assessment. Nonetheless, decision-makers also must understand that reproductive management in a herd is a much more complex and highly probabilistic process. A full assessment would require a more involved analysis assisted by more sophisticated tools presented later in this paper.

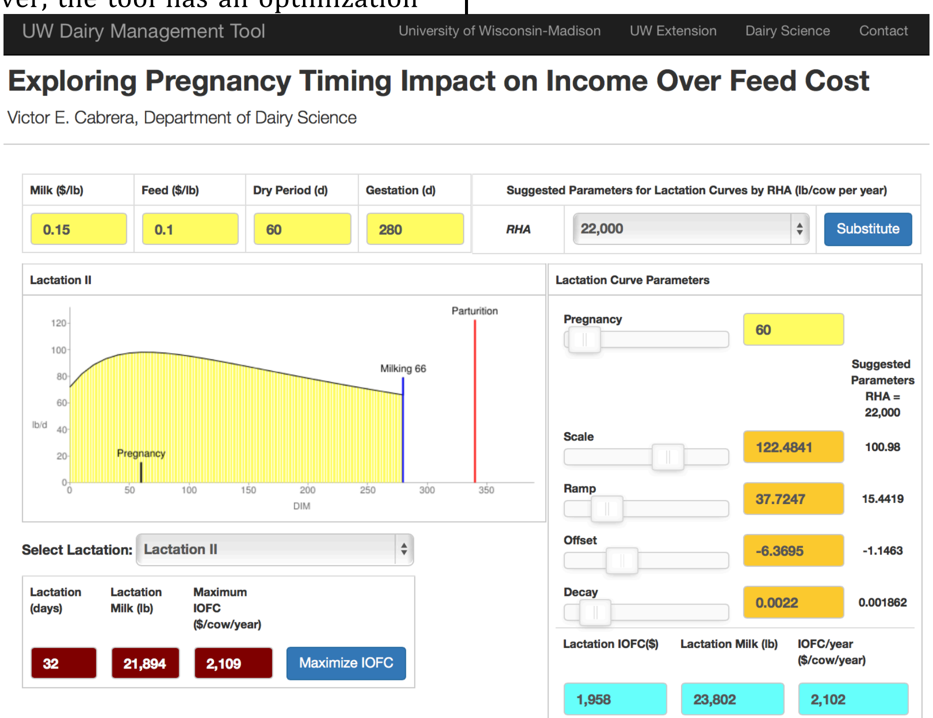


Figure 2. Exploring Pregnancy Time Impact on Income Over Feed Cost (IOFC) decision support tool available at DairyMGT.info -> Tools -> Reproduction displaying the maximum IOFC according to the lactation function parameters of $2,109/cow per year when the pregnancy is initiated at 32 DIM.

Premium Beef on Dairy Program

Dairy farmers may consider an additional source of revenue by producing beef crossbred calves because genetic companies are partnering with livestock companies offering premium alternatives for these crossbred calves when using beef semen. The tool *Premium Beef on Dairy Programs* (Figure 3) analyzes the net income of switching inseminations from conventional or sexed sorted dairy semen to beef semen. This partial budgeting calculation is performed considering the genetic value of animals to be inseminated and the expected premium to be received for crossbred offspring. The tool was conceived as an aid to help producers in their decision-making regarding the use of beef semen. Inputs from the herd such as herd size and herd structure, culling rate, pregnancy risk, number of virgin heifers inseminated with female sex-sorted semen, percentage stillborn, and calf mortality are used to calculate the number of replacements needed to maintain herd size and to determine the number of eligible animals for the beef program. Different prices of semen conventional dairy, sex-sorted dairy, or conventional beef), and different revenues received for the offspring (dairy and beef crossbred) are taken into consideration. Animals are grouped according to parity and then further subdivided according to the number of inseminations to receive. Selection of animals is done by genetic merit or by reproductive performance. The tool then estimates the profitability of selling crossbred calves at a premium price, presenting the dollar net return for the crossbred animals, and the net return for the herd as a whole. Herds using beef semen strategies enhance their genetic gain by generating future replacements from genetically superior heifers and cows. For example, Figure 3 illustrates that the net return to calves will be $57,194 when the bottom 20% of heifers after second service and cows in all services are bred to beef semen. Notice that the estimated number of replacement needed is 316, which is more than supplied when using beef semen (323). This value would decrease to $54,821 ($2,373 less) when conventional semen is used instead of beef semen.

The Dairy Cattle Reproduction Council does not support one product over another.
Any mention herein is only meant as an example, not an endorsement.

UW Dairy Management Tool — University of Wisconsin-Madison | UW Extension | Dairy Science | Contact

DEPARTMENT OF DAIRY SCIENCE, University of Wisconsin-Madison

Premium Beef on Dairy Program

V.E. Cabrera, UW-Madison Dairy Science and **G. Lopes**, Accelerated Genetics

Accelerated Genetics

Overview | Analysis

Number of adult cows	1000	Current heifer conception rate at 1st service, %	55
Current herd turnover ratio, %	30	Current heifer services with sexed semen	0
Current adult herd 21-d pregnancy rate, %	15	Stillbirth + calf mortality, %	5
Female calvings required 9 months from now	316		

Collapse		# Animals Eligible for Service		Conception Rate by Semen Type			Selection and Semen Type	
	Service	Projected	Adjusted	C, %	S, %	B, %	Top	Bottom
							80	20
Heifers	1st	470		60	48	50	S	S
	2nd	211		45	36	45	S	S
	3rd	95		40	32	40	S	B
	>3rd	43		35	28	35	S	B
Lactation 1	1st	29		40	32	35	C	B
	2nd	23		35	28	33	C	B
	3rd	18		30	24	31	C	B
	>3rd	104		25	20	30	C	B
Lactation 2	1st	19		35	28	30	C	B
	2nd	14		33	26	28	C	B
	3rd	11		30	24	27	C	B
	>3rd	51		25	20	26	C	B
Lactation >2	1st	21		33	26	27	C	B
	2nd	16		30	24	26	C	B
	3rd	12		27	22	25	C	B
	>3rd	49		25	20	24	C	B

	C	S	B
Females, % by semen	47	90	0
Semen Cost, $/unit			
Eartag cost, $/unit	0.5	0.5	3

Male and Female Calves by Semen Type

	C	C	S	S	B	B	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	
Calf value, $	50	150	50	150	180	180	
Calves, #	42	37	32	286	30	0	323
Return, $	2,084	5,543	1,590	42,939	5,325	0	57,481
Semen cost, $	0		0		0		0
Eartag cost, $	21	18	16	143	89	0	287
				NET RETURN, $			57,194

Figure 3. Premium Beef on Dairy Program decision support tool available at DairyMGT.info -> Tools -> Reproduction displaying the net return of $57,194 when breeding to beef semen the bottom 20% of heifers after the second service and all bottom 20% cows.

The University of Wisconsin-Cornell University-DairyRepro$

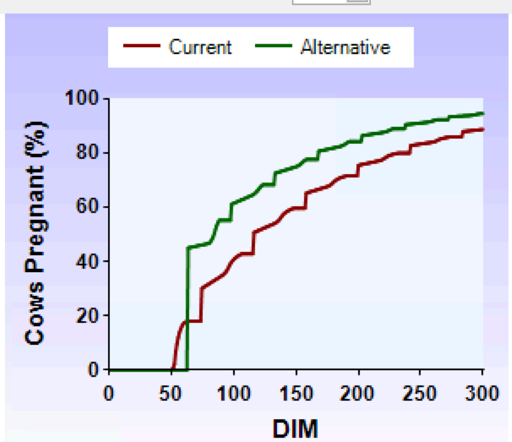
Dairy producers and consultants find relatively easy assess reproductive performance and costs associated with reproductive management. In contrast, they find challenging to fully assess the net economic value of alternative reproductive management strategies. On one hand, it requires estimating the potential impact of reproductive changes (e.g., utilization of heat detection devices) and on the other hand, it requires projecting the impacts on productivity, replacement, newborn, etc. The *University of Wisconsin-Cornell University-DairyRepro$* (*UWCU-DairyRepro$;* Figure 4) calculates and compares the economic value of dairy reproductive programs including timed artificial insemination (**TAI**), heat detection (**HD**), and combinations of TAI and HD programs including the use of activity monitors as an aid for HD in lactating dairy cows. The *UWCU-DairyRepro$* is a complex daily Markov chain model (Giordano et al., 2012) that simulates all cows in a herd and their economics, and computes the net return associated with reproductive performance traits. Input productive traits, economic variables, and reproductive programs are user-defined. The model then runs iterations until finding a solution and calculating economic values. The decision support tool then provides the total net value of the current farm reproductive program and its associated economic, productive, and reproductive herd statistics. The model lets the user compare reproductive and economic performance of current reproductive program with an alternative reproductive program. A distinctive characteristic of the *UWCU-DairyRepro$* decision support tool is its capacity to accommodate very complex reproductive programs mimicking what happens currently in the dairy industry. The model is capable of assessing all costs incurred. For example, a cow that is inseminated after HD in the middle of a TAI protocol will not incur additional costs once she is inseminated before the end of the TAI protocol. The *UWCU-DairyRepro$* is the most sophisticated tool to assess the economics of reproductive efficiency in dairy cattle farm management in today's dairy industry. Figure 4 illustrates that an additional $51.20/cow per year net return could be obtained when tweaking the current reproductive program. The alternative program would have two important changes compared with the current one: (1) first service TAI is Double-Ovsynch with a 45% pregnancy risk without HD; and (2) second and later TAI services have 1 wk shorter interbreeding intervals by starting the resynchronization before the first pregnancy diagnosis. Note the survival pregnancy curves that clearly indicate the improved reproductive efficiency of the alternative program. Also provided in Figure 4 is the breakout of the economics between the current and alternative program. Note that the alternative program is economically superior to the current program even though it incurs additional reproductive costs.

Reproductive Programs

	Current	Alternative
First AI postpartum	Presynch-Ovsynch-14	Double-Ovsynch
Second and sub. AI	Ovsynch	Ovsynch
Resynch before preg check	NO	YES

Programs Description

	Current	Alternative
VWP (d)	50	50
Estrous Cycle Duration (d)	22	22
Maximum DIM for Breeding	300	300
Do-not-Breed Minimum Milk (lb/d)	50	50
DIM first injection for first AI sync program (d)	36	36
Weekday first injection	Tuesday	Monday
Interbreeding interval for TAI services (d)	42	35
Heat bred before first TAI service (%)	60	0
CR heat bred before first TAI service (%)	30	0
CR first TAI service (%)	30	45
Heat bred after first TAI service (%)	60	60
CR heat bred after first TAI service (%)	30	30
CR second and subsequent TAI services (%)	28	28



Contribution to Net Value

Item	Current	Alternative	Diff
Total Net Value ($/cow/y)	2,792.6	2,843.8	51.2
IOFC ($/cow/y)	3,281.5	3,320.0	38.5
Replacement Cost ($/cow/y)	-154.6	-141.2	13.4
Reproductive Cost ($/cow/y)	-375.3	-384.0	-8.7
Calf Value ($/cow/y)	41.0	49.0	8.0

Figure 4. The *University of Wisconsin-Cornell University-DairyRepro$* (*UWCU-DairyRepro$*) decision support tool available at DairyMGT.info -> Tools -> Reproduction displaying an economic advantage of $51.2/cow per year between an alternative reproductive program (Double-Ovsynch + Ovsynch before pregnancy check) and the current reproductive program (Presynch-Ovsynch-14 + Ovsynch).

The Economic Value of a Dairy Cow

Assessing the value of a cow and her associated average herd net return has important economic implications for reproductive management. First, the value of a cow can be used to distinguish reproductive actions according to the particular value of a cow (e.g., best semen used on highest value cows) or to calculate the value of a pregnancy, the cost of a pregnancy loss, and the cost of a day open (De Vries, 2006). Second, the average net return of an average cow or herd's net return can be used to calculate the economic value of improving the overall reproductive performance. The value of a cow is the difference between the future economic value of a cow and its potential replacement (Cabrera, 2012a). The herd net return is the aggregated net return of all possible states a cow according to a reproductive performance level (Cabrera, 2012a). The tool *Economic Value of a Dairy Cow* (Figure 5) calculates simultaneously the value of a specific cow in a herd and the average net return of the herd. Users must define the state of a cow, lactation, months after calving, and months in pregnancy, and potential genetic gain with a replacement to calculate the specific value of a dairy cow. Users must define herd-specific productive and reproductive traits and herd economic variables to calculate the herd's net return.

The economic value of a cow is expressed as $/cow, whereas the average herd net return is expressed as $/cow per year. The value of a cow is presented in the top part of results ($627, upper right corner of Figure 5) and the average net return of an average cow is presented in the bottom part of results ($1,969/cow per year, bottom right corner of Figure 5).

The value of a pregnancy, cost of pregnancy loss, or cost of a day open can be calculated by the difference of two scenarios with the same cow, everything else being held constant. For example, the cost of pregnancy loss of this specific cow would be $213, difference of $627 displayed in Figure 5 and $414 (not shown, decreased value when current month pregnant is changed from 1 to 0, everything else being constant). If the cow, after losing her pregnancy, remains non pregnant for one 1 month, her value would decrease by $135 (not shown is the value of the cow 6 months after calving and non-pregnant =$279, everything else being constant), which is considered to be the cost of an additional month open and can be converted to the cost of a day open by diving it by 30 = $135/30 = $4.50/day open.

The economic value of herd reproductive performance is associated with the economics of an average cow with respect to the 21-day pregnancy rate. For example, the impact of changing the 21-day pregnancy rate from 18% (current value in Figure 5) to 25%, everything else being constant, is $55/cow per year ($2,024/cow per year, not shown, minus $1,969/cow per year), which is the gain solely attributed to the improved reproductive performance.

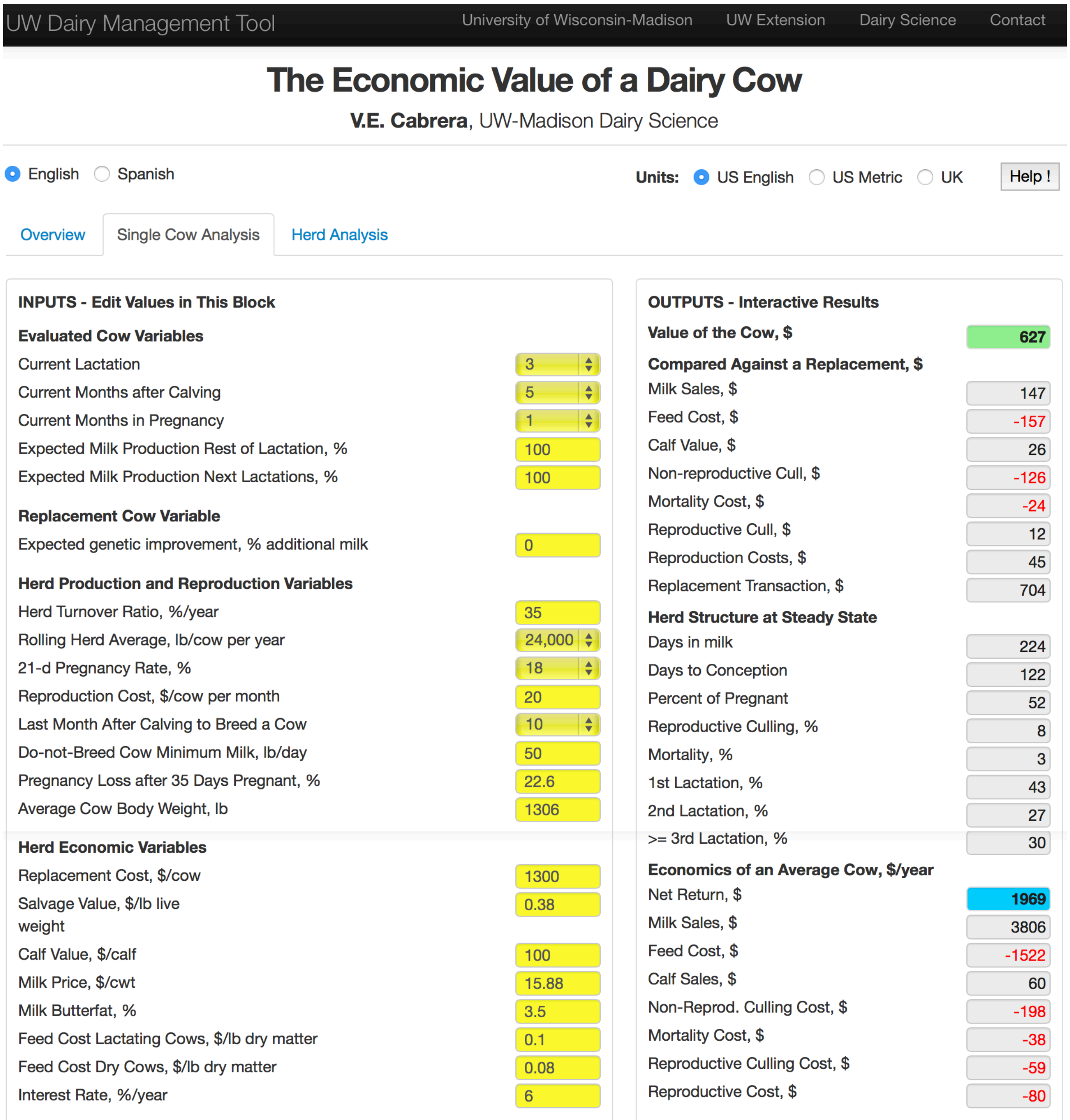


Figure 5. The Economic Value of a Dairy Cow decision support tool available at DairyMGT.info -> Tools -> Reproduction displaying the value of a third lactation, fifth month after calving, and 1 month pregnant cow of $627 and the average cow net return at 18% 21-day pregnancy rate of $1,969/cow per year.

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