UWCU-DairyRepro$: A Reproductive Programs Economic Analysis Tool

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Available at:
University of Wisconsin: DairyMGT.info : Tools : Reproduction
Cornell University: http://www.ansci.cornell.edu/dm/resources.html

The *University of Wisconsin-Cornell University-DairyRepro$(**UWCU-DairyRepro$**)* 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 inspired on Giordano et al., 2012 (J. Dairy Science 95:5442) that simulates all cows in a herd and their economics, and computes the net return associated to reproductive performance parameters. The model was developed as a standalone executable program with Visual Basic.Net 2010 (Microsoft Corp., Seattle, WA). Input productive parameters, economic variables, and reproductive programs are entered as specified in this document. The model then runs iterations until reaching steady state. The number of iterations to reach steady state varies depending on the input parameters and defined reproductive programs but, on average requires about 5,000 iterations. The model then provides the total net value of the reproductive program and its associated economic, productive, and reproductive herd statistics.

Instructions of Use

Calculations are based on user-input information entered in the "HERD DESCRIPTION" and “REPRODUCTION” labeled tabs. Information is selected from provided drop and check selection boxes, entered, or overwritten directly into the input cells. Each highlighted cell, when selected, displays a brief explanation of the information required for that cell.

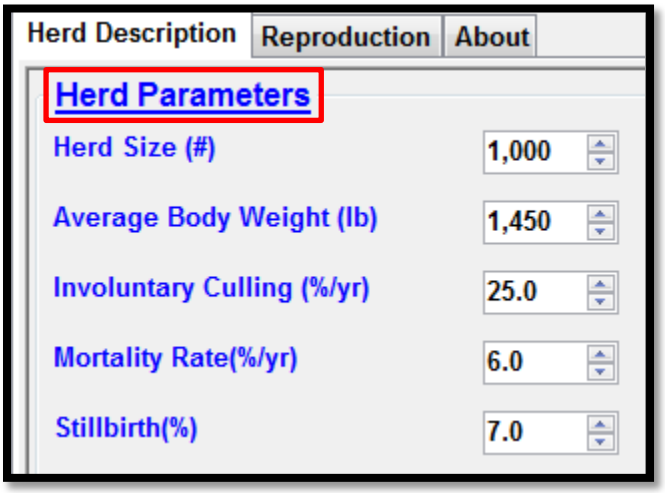
HERD DESCRIPTION tab

Following is a list of the parameters needed for the analysis. Many input cells are self-explanatory. For those variables that need some clarification, additional explanation and a brief discussion is provided.

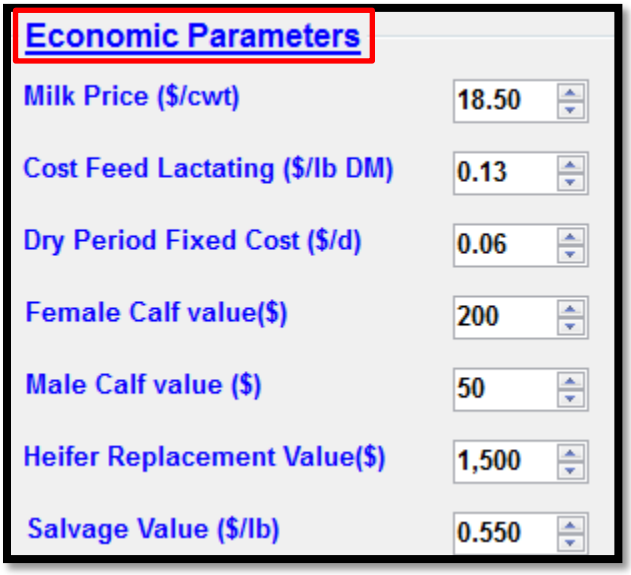
> ***Numbers displayed in the following screenshots (and those appearing by default in the tool when opened) are only for demonstration purposes and should not be interpreted as suggestions or default numbers. The user should enter his/her own parameters.***

The "HERD DESCRIPTION " sheet is divided in 3 sections: 1) Herd Parameters, 2) Economic Parameters, and 3) Lactation Curves.

1) Herd Parameters. This section collects basic current information about the herd being analyzed such as the number of total adult cows and their average body weight, involuntary culling rate, mortality rate, and stillbirth rate. The involuntary culling rate should only include animals leaving the herd (alive) for any other reason but reproductive failure. Culling for reproductive failure is automatically calculated by the tool. Mortality rate refers to the proportion of adult cows dying yearly on the farm. Stillbirth rate should include all those calves born dead or dying within 48 hours postpartum.



2) Economic Parameters. Includes milk price, cost of feed for lactating cows, cost of feed for dry cows, calf values (female and male), heifer replacement value, and cow salvage value. The cost of feed for lactating and dry cows is defined as the cost of one pound of dry matter of feed provided to cows. Consequently, this feed cost is the cost of all ingredients in the diet expressed in a per pound basis. Salvage value is the estimated return obtained when selling a cow for beef (culling).

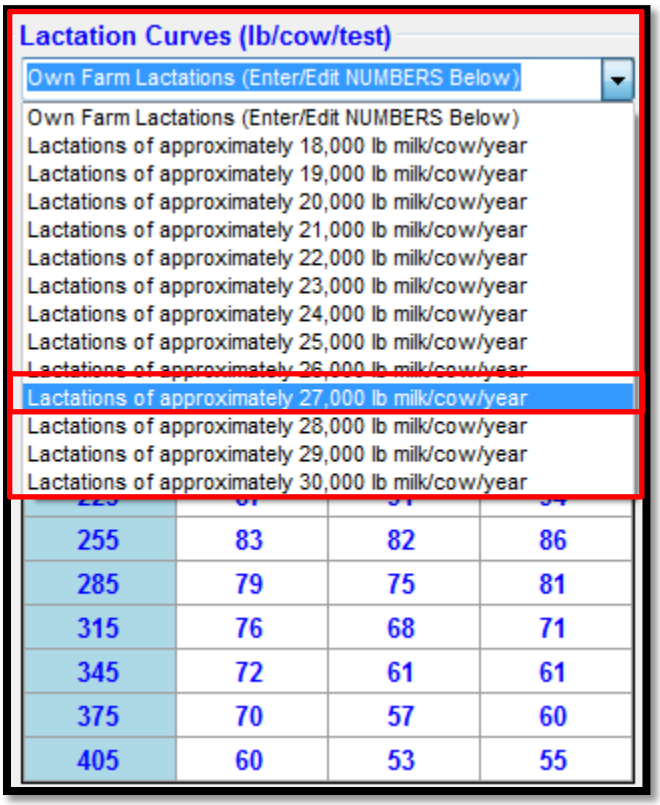


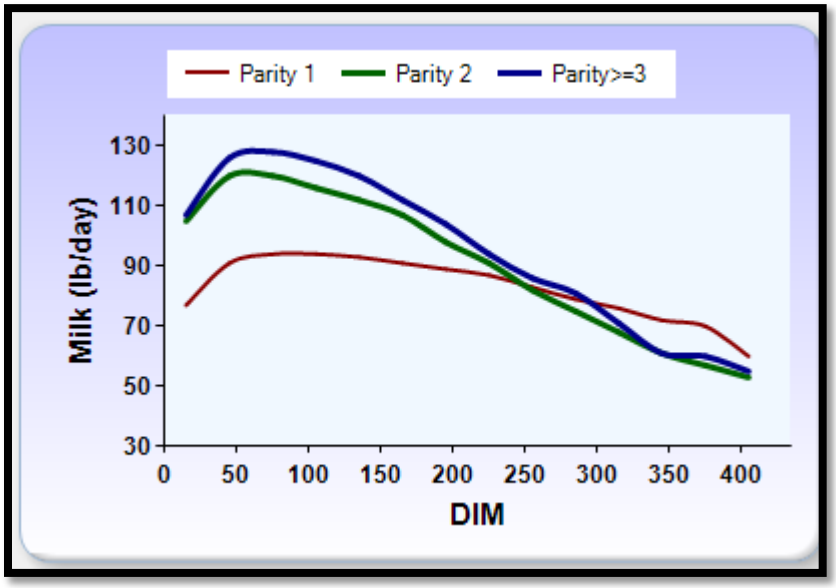
3) Lactation Curves. Users can define their own farm lactation curves (parity 1, 2, and ≥3) by DIM every 30 days which is the equivalent of monthly tests (upper figure; i.e., 15 DIM equal to test number 1). In order to apply user-defined lactation curves, the option "Own Farm Lactations" should be selected in the drop-box menu and data entered in the table accordingly (upper figure). If user selects predefined lactation curves based on RHA from 18,000 to 30,000 lb/cow per year, the model will use pre-defined (AgSource Cooperative Services, Verona, WI) lactation curves and no lactation information is required (center figure). A line graph will display lactation curves for each parity group (bottom figure).

Lactation Curves (lb/cow/test)

Own Farm Lactations (Enter/Edit NUMBERS Below)

DIM	Parity 1	Parity 2	Parity ≥3
15	77	105	107
45	91	120	126
75	94	120	128
105	94	116	125
135	93	112	120
165	91	107	112
195	89	98	104
225	87	91	94
255	83	82	86
285	79	75	81
315	76	68	71
345	72	61	61
375	70	57	60
405	60	53	55





REPRODUCTION tab

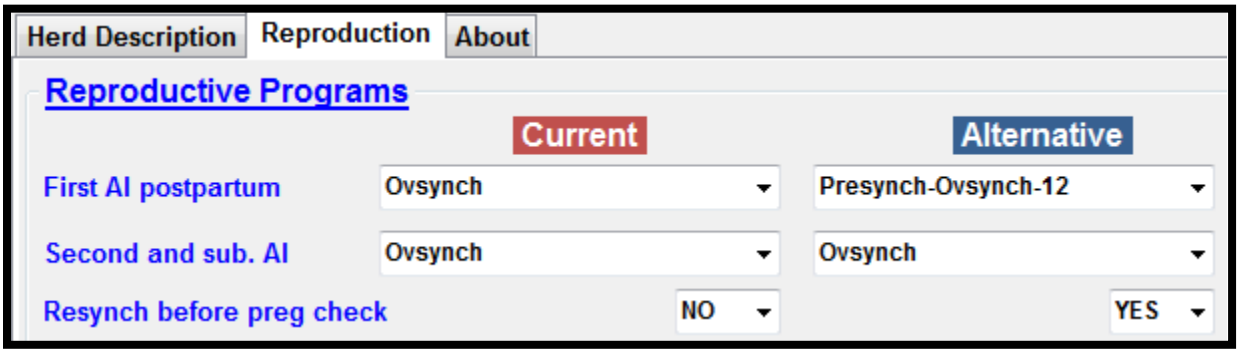
The "REPRODUCTION" tab is divided in 2 major sections:

1) Reproductive Program Selection Pane with subsections
   a) Programs Description
   b) Pregnancy Diagnosis (timing)

2) Cost of Reproductive Program with subsections:
   a) Insemination cost,
   b) Pregnancy check (cost),
   c) Detection of estrus with subsections
      i) Visual observation and ii) activity monitors,
   d) Labor and hormone injections cost for synchronization.

Reproductive Program Selection.

This section defines the ***"Current"*** and "***Alternative***" reproductive programs that ***will be compared in the analysis***. The ***"Current" program is the reproductive management program that is being performed at the farm at the moment or any baseline/default program to which the user wishes to compare to an "Alternative" reproductive management program.*** All input data in this sub-section is managed through drop-box menus from an extensive list of available TAI programs. These need to be defined for first, and then for second and subsequent AI services. Finally, the user needs to indicate if the resynchronization protocol starts before pregnancy diagnosis or after pregnancy diagnosis (e.g., YES should be selected if first GnRH injection of Ovsynch used for resynchronization is given 32 d after a previous AI and pregnancy diagnosis is performed 39 d after AI). All this information is used to assess the costs of injections and labor for different reproductive programs. For programs that use a combination of detection of estrus and TAI the level of detection of estrus (i.e., percentage of cows AI after detection of estrus) is defined in the subsequent subsection. For programs using purely detection of estrus for insemination of cows an option is available in the drop down menu with "Heat Breeding" as the sole strategy for insemination.



Programs Description

This section includes the core inputs parameters for the "***Current"*** and "***Alternative"*** programs. Under most circumstances the differences in reproductive performance and economic value of each program will be dictated by the parameters entered in this subsection.

The voluntary waiting period (**VWP**) is the number of days after calving after which cows are eligible to be inseminated either if detected in estrus or after TAI. "***Maximum DIM for Breeding"*** is the "cut-off" number of days postpartum after which cows are no longer inseminated and coded as "do not breed (DNB)". Cows coded as DNB based on this parameter will remain in the herd until their milk production falls below a threshold milk production when

these cows leave the herd due to reproductive failure. This threshold is defined in line "***Do-not-Breed minimum milk***". The "***DIM first injection for AI sync programs***" defines the DIM for the first injection for the synchronization of ovulation program selected in the Reproductive Program Selection section. "***Week day first injection***" is the day of the week that such first injection is given to cows. Selection of the reproductive program for TAI along with the starting day of the week will determine the specific days of the week that require labor for injections for subsequent calculation of labor cost for injections.

The "***Interbreeding interval for TAI services***" is defined as the time period between one TAI and the next one. "***Heat bred before first service TAI***" and "***CR heat bred before first service TAI***" represents the percentage of cows bred from the end of the VWP until the day of TAI (e.g., cows AI in estrus after the two PGF injections of Presynch and before the TAI of Ovsynch) and their conception rate, respectively. "***CR first service TAI***" is the conception rate for cows that are not detected in estrus and receive a TAI service after completing a synchronization of ovulation protocol. "***Heat bred after first service TAI***", "***CR heat bred after first service TAI***", and "***CR second and subsequent services TAI***" refer to the same parameters than for first AI service but in this case it applies to cows that fail to conceive and receive their second and subsequent AI services either after detection of estrus or TAI.

Programs Description

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)	60	36
Weekday first injection	Monday	Tuesday
Interbreeding interval for TAI services (d)	49	42
Heat bred before first service TAI (%)	60	65
CR heat bred before first service TAI (%)	33	35
CR first service TAI (%)	30	30
Heat bred after first service TAI (%)	60	60
CR heat bred after first service TAI (%)	32	32
CR second and subsequent services TAI (%)	28	30

Because the results of applying an ***"Alternative"*** program at a specific farm may be unknown or difficult to predict Tables 1 and 2 include key reproductive parameters for different TAI programs for first service postpartum and second and subsequent service (Resynch).

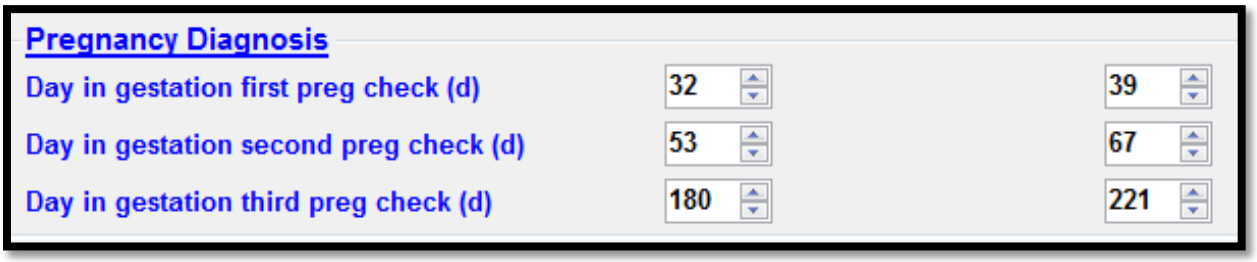
Table 1. Estimated results for different TAI programs in lactating dairy cows for first service postpartum for all parities

		Conception Rate (%)	
Synchronization Program	**VWP (d)**	**Mean**	**Range**
Presynch-Ovsynch-14	70-85	37	(32-42)
Presynch-Ovsynch-12	70-85	42	(37-47)
Presynch-Ovsynch-11	70-85	43	(37-47)
Presynch-Ovsynch-10	70-85	44	(37-47)
Double-Ovsynch	70-85	47	(40-50)
G-6-G	70-85	45	(37-47)
Ovsynch	60-75	33	(30-37)
Cosynch-72	60-75	26	(25-33)
Presynch-Ovsynch-12 w/CIDR	70-85	45	(40-50)
Double-Ovsynch w/ CIDR	70-85	50	(43-53)
Ovsynch w/ CIDR	60-75	36	(40-50)
Cosynch-72 w/ CIDR	60-75	32	(33-40)

Table 2. Estimated results for different TAI programs in lactating dairy cows for second and subsequent (Resynch) service postpartum for all parities

	Interbreeding Interval	**Conception Rate (%)**	
Synchronization Program	**(d)**	**Mean**	**Range**
Ovsynch-Day 25	35	27	(24-30)
Ovsynch-Day 32	42	30	(25-35)
Ovsynch-Day 39	49	28	(25-32)
Double-Ovsynch	49	38	(33-42)
Short-Double-Ovsynch	42	34	(30-38)
HGPG (hCG-7d-Ovsynch)	35	37	(33-41)
GGPG (GnRH-7d-Ovsynch)	35	34	(27-37)
G-6-G	49	35	(32-38)
Cosynch-72-Day 25	35	23	(20-25)
Cosynch-72-Day 32	42	28	(24-32)
Cosynch-72-Day 39	49	25	(23-28)
Ovsynch-Day 32 w/ CIDR	42	33	(28-38)
Double-Ovsynch w/ CIDR	49	41	(36-45)
Short-Double-Ovsynch w/CIDR	42	37	(33-41)
HGPG (hCG-7d-Ovsynch) w/CIDR	35	40	(36-41)
GGPG (GnRH-7d-Ovsynch) w/ CIDR	35	35	(30-40)
G-6-G w/CIDR	49	38	(33-41)
Cosynch-72-Day 32 w/CIDR	42	31	(27-35)

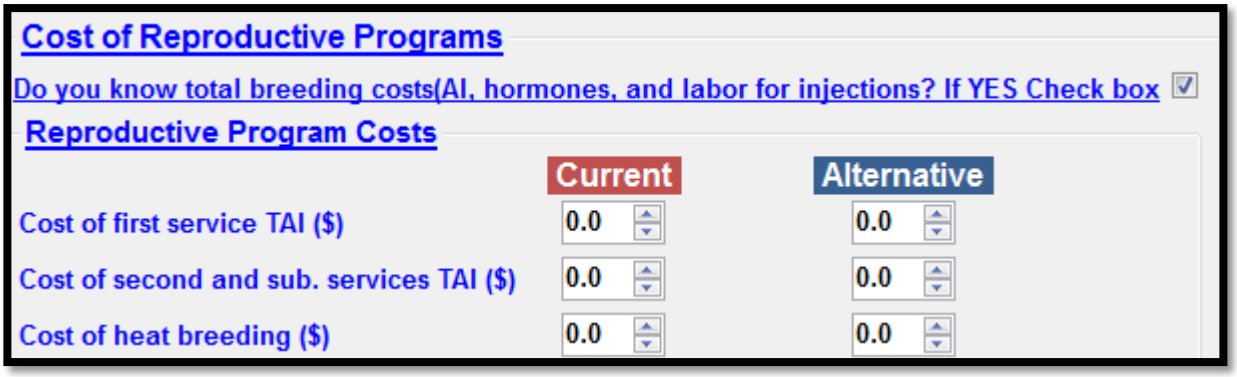
Pregnancy Diagnosis (timing). In this section users should define the days in gestation (or days since last breeding) at which cows are diagnosed for pregnancy for the first, second, and third time in their gestation. Dairy farms that do not perform pregnancy reconfirmation should enter zero for the second and third diagnosis (preg. check).



Cost of Reproductive Program

Attention:* Question: Do you know total breeding costs (AI, hormones, and labor for injections)?** By selecting ***"Yes" in the check box the user will be asked to enter the total breeding costs for a first TAI service, second and subsequent TAI services, and the cost of breedings after detection of estrus as opposed to use the tool as a help to determine, step-by-step, the breeding costs. This option should be checked if user is capable of calculating total cost of breeding a cow for first service TAI, second and subsequent service TAI, and heat breedings on his/her own without the use of the tool or if user is not interested in considering breeding cost in which case should select *"Yes"* and enter zero for all costs. Otherwise, if the option is left unchecked, the model will later require entering specific information to calculate breeding costs (the model has the capability of running with any numbers for these inputs, however, the results may not reflect the reality of the farm if left as defaults or without appropriate numbers).

When user decides to calculate breeding cost without the tool, the calculation is expected to include cost of hormones for synchronization when applicable (i.e., TAI programs), labor to administer hormone injections when applicable, and the cost of AI including semen and labor. However, user can decide which resources used to run a reproductive management program to include in the economic calculations.

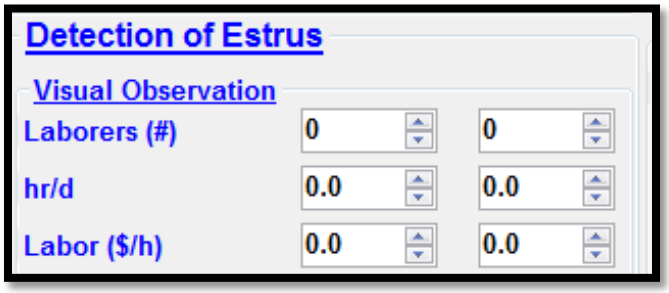


By checking this box, all input cells corresponding to: "Insemination cost", "Preg. Check", "Detection of estrus", "Synchronization", and "Hormones" disappear because they will no longer be necessary.

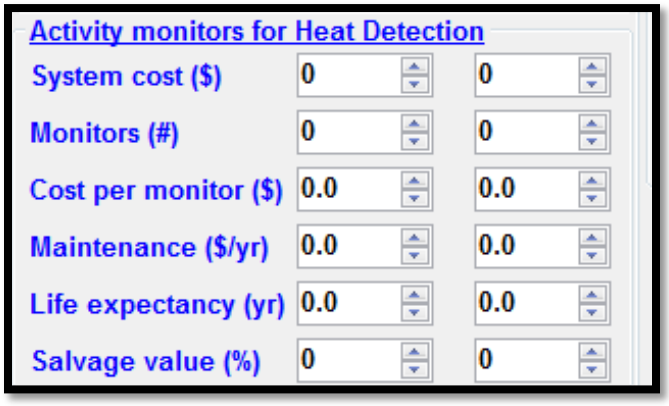
Insemination cost. Users should enter the average cost for a unit of semen and the labor cost to inseminate a cow.

Detection of Estrus

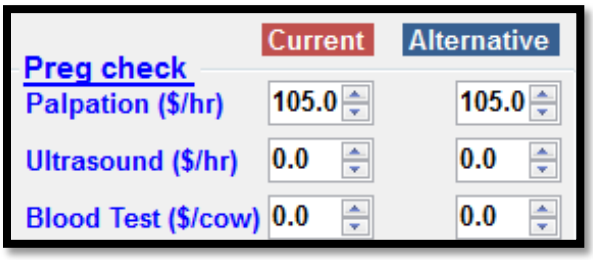
Visual Observation. Users should enter the number of "***Laborers***" involved on daily estrus detection. The tool also requires entering the number of "***hours per day***" required to perform estrus detection and the "***Labor***" cost per hour. It is assumed that estrus detection is performed every day of the week by the same number of personnel and the same number of hours per day.



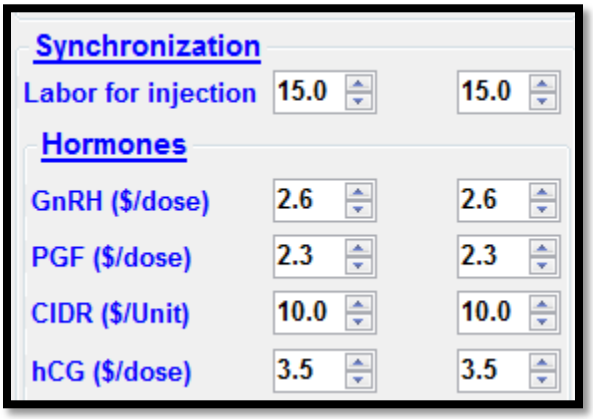
Activity Monitors for Heat Detection. This section is intended to calculate the cost of using "*activity monitors for estrus detection*". Entering the required information will allow to calculate the cost per cow per day of using the system, which can then be accounted for in the calculation of the total PV for the programs under consideration. "***System cost***" refers to the upfront cost of buying any equipment (hardware) and software required for the system to function (not including monitors). Then, "***Monitors***" refers to the number of monitors and the "***Cost per monitor***" should be entered. In those cases in which a "***Maintenance***" fee per year is included with the system it should be entered. Finally, the "***Life expectancy***" in years and the potential "***Salvage value***" of the equipment at the end of its "***Life expectancy***" should be included. The "***Salvage value***" is entered as a percentage of the original value of the system at the time of acquisition. The total daily cost of using the system will be subtracted from the PV of the programs compared.



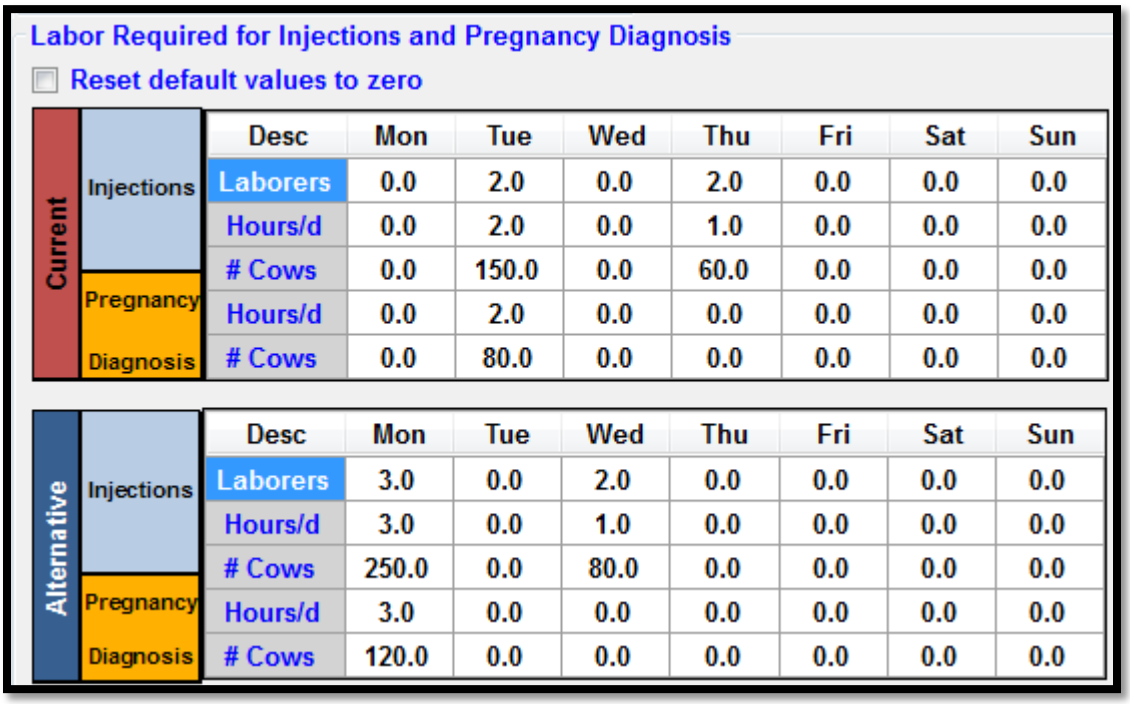
Pregnancy Diagnosis Cost. User should indicate the method of pregnancy diagnosis (palpation, ultrasound, or blood test) by entering a dollar amount in the corresponding cell.



Synchronization and Hormone Cost. User should enter the cost per hour of labor to administer hormone injections as part of the synchronization of estrus and ovulation protocol if one is being used. Then, user should enter the cost per dose of hormone injection or progesterone releasing device (CIDR, Zoetis, Madison, NJ).



Labor Required for Injections and Pregnancy Diagnosis. By filling the tables provided the user can define the labor costs for the "***Current***" and ***"Alternative"*** programs. The approach is to enter current farm information that will allow the model to calculate the per-day and per-cow labor costs according to TAI reproductive programs. Consequently, information for each day should include the farm specific number of laborers, the hours worked, and the number of cows treated. Also, in a specific day, the number of cows diagnosed for pregnancy and the number of hours required are needed.



Labor Required for Injections and Pregnancy Diagnosis

Reset default values to zero

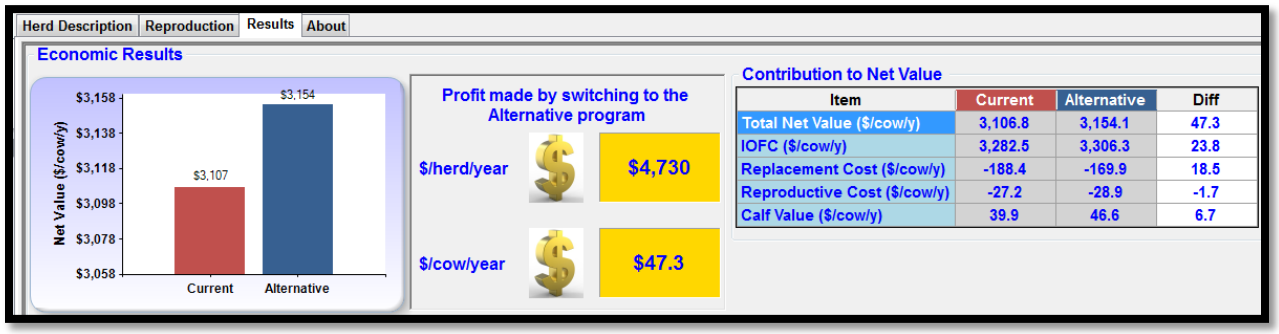
		Desc	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Current	Injections	Laborers	0.0	2.0	0.0	2.0	0.0	0.0	0.0
		Hours/d	0.0	2.0	0.0	1.0	0.0	0.0	0.0
		# Cows	0.0	150.0	0.0	60.0	0.0	0.0	0.0
	Pregnancy	Hours/d	0.0	2.0	0.0	0.0	0.0	0.0	0.0
	Diagnosis	# Cows	0.0	80.0	0.0	0.0	0.0	0.0	0.0

		Desc	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Alternative	Injections	Laborers	3.0	0.0	2.0	0.0	0.0	0.0	0.0
		Hours/d	3.0	0.0	1.0	0.0	0.0	0.0	0.0
		# Cows	250.0	0.0	80.0	0.0	0.0	0.0	0.0
	Pregnancy	Hours/d	3.0	0.0	0.0	0.0	0.0	0.0	0.0
	Diagnosis	# Cows	120.0	0.0	0.0	0.0	0.0	0.0	0.0

Running the Analysis. As a final step the user should hit the button labeled as "***Run***". The analysis will be performed and the results will be displayed in a new results sheet after clicking on the "***Results***" button, which will be activated after the analysis is complete. The time required to run the analysis will vary according to the computer system being used and may take between 2 and 10 minutes depending on the system capabilities. A progress bar on the left bottom corner will indicate the progression of the calculation and the number of iterations run. In most cases the number of iterations run to reach steady state is between 3,000 to 5,000. User may cancel the analysis at any time by clicking on the "***Cancel***" button.

RESULTS tab

Net Value differences between Current and Alternative program. This graph (left side on picture) presents the overall net value (NV; $/cow per yr) per cow per year or economic performance for the reproductive programs defined. The reproductive program with the greatest value would be the most convenient and preferred given the greater potential profitability for the farm. In the example displayed below switching from the current to the alternative program would generate $47.3 extra profit per cow per year or $4,730 per herd per yr. The "***Contribution to Net Value***" table presents a breakdown of the income over feed cost (IOFC), replacement cost, reproductive program cost, and calf value which are calculated for the Current and Alternative programs. The difference between current and Alternative program are also presented in the "***Diff***" column for each one of the items.



Reproductive Programs Summary. This table presents a summary of the most important input reproductive parameters used in the analysis (entered in the Reproduction tab). It is intended to remind users of the most important input values for the programs compared.

Reproductive Programs Summary

Item	Current	Alternative
First AI postpartum	Presynch-Ovsynch-14	Double-Ovsynch
Second and sub. AI	Ovsynch	Ovsynch
VWP (d)	50	50
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	53
Interbreeding interval for TAI services (d)	49	42
Heat bred before first service TAI (%)	60	0
CR heat bred before first service TAI (%)	35	0
CR first service TAI (%)	32	50
Heat bred after first service TAI (%)	50	60
CR heat bred after first service TAI (%)	32	38
CR second and subsequent services TAI (%)	30	34

Cows Leaving the Herd. This table presents a summary of culling and mortality information. The total percentage of cows leaving the herd due to live culling and mortality calculated based on the scenarios simulated is broken down into "***Non-Reproductive Culling***", "***Mortality***" rate, and culling due to "***Reproductive failure***". These values apply to adult cows only. The difference between the Current and Alternative program is also presented in the "***Diff***" column.

Cows Leaving the Herd

Item	Current	Alternative	Diff
Total Culling (%)	40.7	34.6	-6.1
Non-Reproductive Culling (%)	25.9	23.4	-2.5
Mortality (%)	4.1	3.6	-0.5
Reproductive Culling (%)	10.7	7.6	-3.1

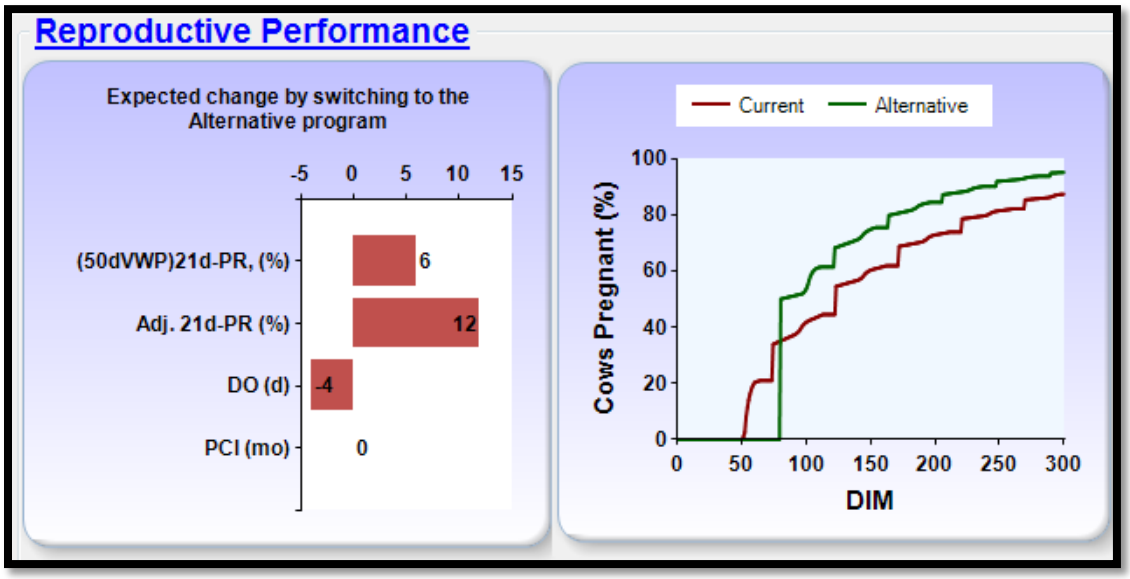
Heifer Supply and Demand. This table presents the number of heifers generated ("***Heifer Supply***") and the number of heifers required to maintain the herd size constant for the Current and Alternative program. "***Heifer Balance***" represents the number of extra heifers available to the herd or the heifer deficit for each program. All calculations are made on a per 100 cow basis so herds with either more or fewer than 100 cows should adjust this number by the total number of cows in the herd. Typically, herds with good reproductive performance will have excess number of heifers whereas herd with poor reproductive performance will have a deficit.

Heifer Supply and Demand

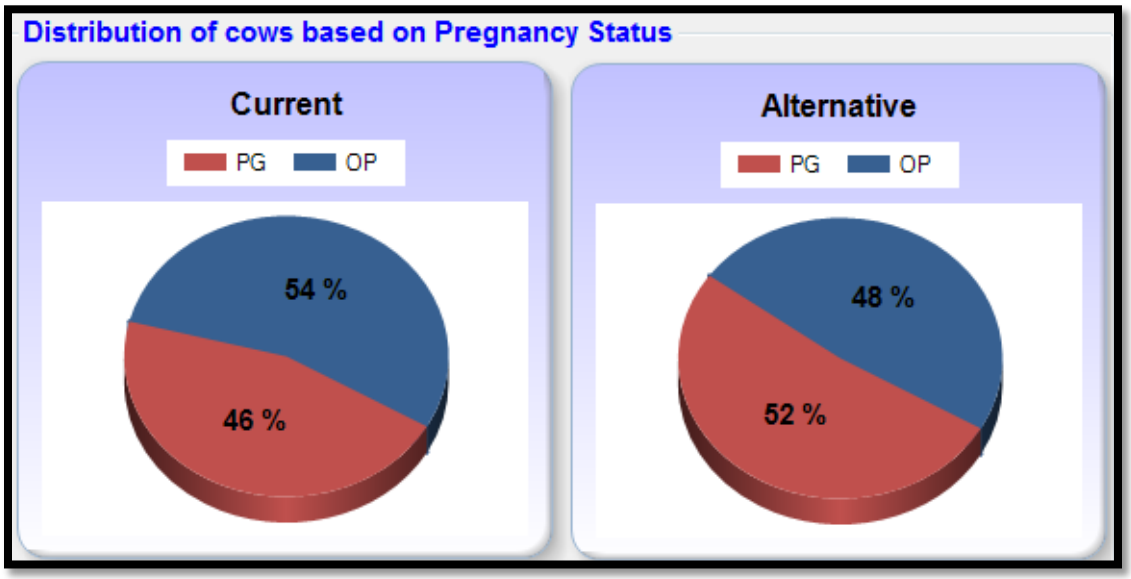
Item	Current	Alternative
Heifer Supply (#/100cow/year)	41.5	42
Heifer Demand (#/100cow/year)	40.7	34.6
Heifer Balance	0.8	7.4

Reproductive Performance. A horizontal bar graph presents the differences for selected reproductive performance parameters [(50d-VWP) 21d-Pregnancy Rate, Adjusted 21d-Pregnancy Rate, Days Open, and Projected Calving Interval]. The "***50d-VWP 21d-PR***" represents a standardized 21d-Pregnancy Rate calculated using the same VWP for both programs regardless of the actual VWP whereas, the "***Adjusted VWP***" represents the 21d-Preganncy Rate adjusted by the actual VWP of each program. All calculations represent the value difference between the ***Current*** and the ***Alternative*** program or what should be expected by switching to the ***Alternative*** program. A bar to the right of the vertical axis (zero value) indicates that by switching to the alternative program a positive difference is expected whereas a bar to the left of the vertical axis indicates a negative change. The respective difference in the parameter between the current and alternative program is displayed next to or within each bar.

Survival curves to pregnancy. Displays "survival" curves to pregnancy for the ***Current*** and ***Alternative*** program. Survival curves represent the percentage of pregnant cows at different days in milk (DIM). Survival curves display graphically the reproductive performance of the defined reproductive programs.

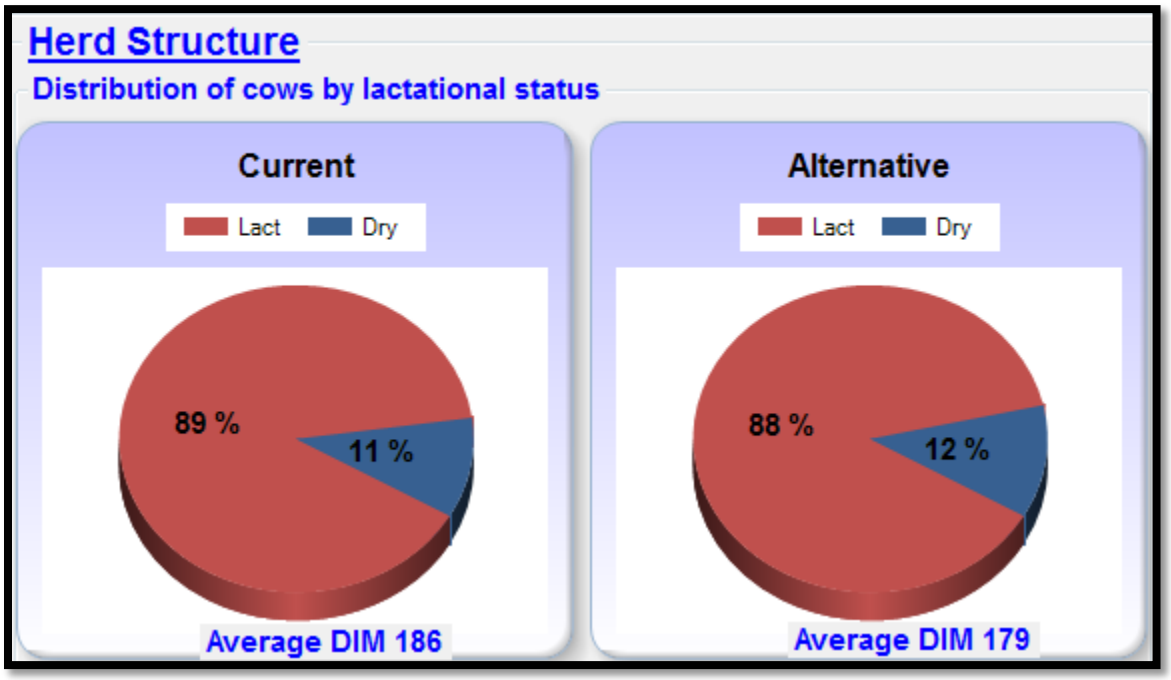


Distribution of cows based on Pregnancy Status. Pie graphs illustrating the percentage of pregnant (PG) and non-pregnant cows (OP) in the herd for the ***Current*** and ***Alternative*** program.

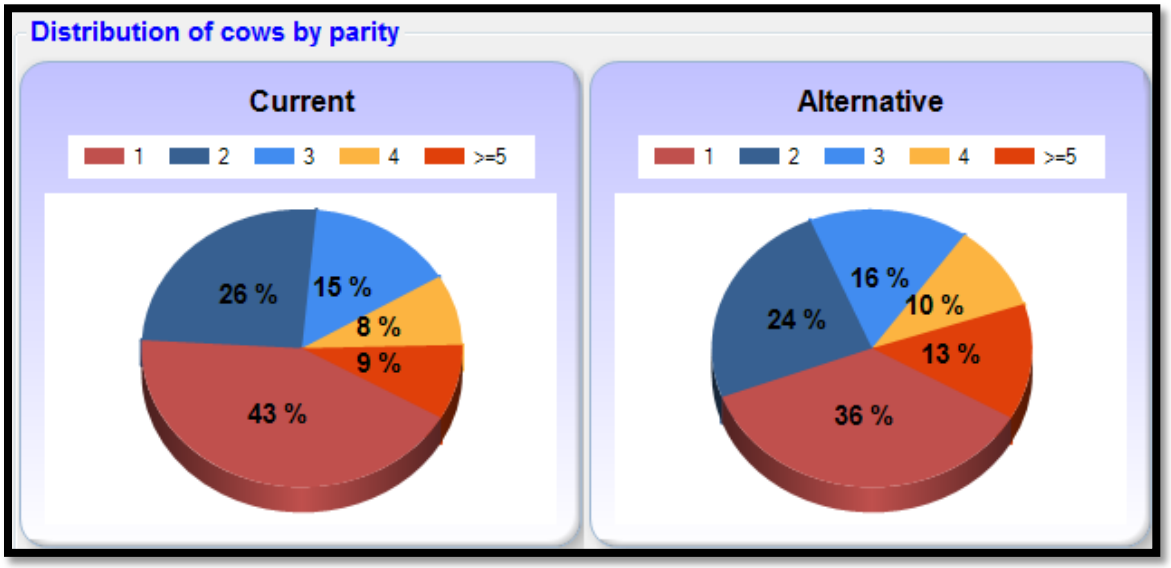


Herd Structure

Distribution of cows by Lactation Status. Pie graphs illustrating the percentage of Lactating (LG) and non-lactating (Dry) in the herd for the ***Current*** and ***Alternative*** program. The average Days in Milk (DIM) for each program are also displayed under each graph.



Distribution of cows by Parity. Pie graphs illustrating the percentage of cows in each parity group (from 1 to ≥ 5) in the herd for the ***Current*** and ***Alternative*** program.



The user can always go back to the "***Herd Description***" and "***Reproduction***" tabs to make changes to specific variables of interest and observe the impact of those changes in the economic performance of the defined reproductive programs.

Note: The results tab contents could be captured using a capture panel buttons. These buttons (Two for each upper and lower panel) capture the visible parts of the screen and store it as a jpg

file on the user's desktop. Please make sure to change the width and height of the form to guarantee a full capture of the screen in jpg files. Notice that the next run will overwrite the contents of the two jpg files and if the user wants to store they need to move the files to another folder.