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Comparing the Economics of Reproductive Management Programs on Dairies

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Studies of the reproductive performance of dairies have shown repeatedly that reproduction is still a major challenge for many dairies. A study across Minnesota DHIA herds in 2000 by Dr. Steven Stewart showed a median estrus detection rate of 35%, median conception rate of 39% and median 21-day pregnancy rate of only 14%. A pregnancy rate of 14% means that if 100 cows are open and eligible to get pregnant, 21 days later only 14 are pregnant. This is unacceptably low if a dairy is trying to return cows back to the herd for a later lactation and to avoid excess culling of open cows.

There are many possible approaches to improving reproduction on a dairy, e.g. improving estrus detection, synchronization programs, improving cow health and conception rates, bull breeding, etc. Given that the status quo on a particular dairy is not acceptable, the challenge may be in deciding which program to recommend. It is not enough that a recommended new program improve the biology of reproduction. The new program must achieve the improvement at a cost that is less than the value of the change. This means that some means is needed to calculate reasonable estimates of the value of a new program's biological improvements and the cost of those improvements. A partial budget could provide such estimates. This paper describes one such partial budget, developed as a spreadsheet in EXCEL.

THE SPREADSHEET MODEL

The model is a complex partial budget that can be used to determine the expected economic difference between two possible breeding programs on a dairy. The model starts from the concept that the biologically derived losses from a reproductive program accrue from two major sources: 1) excess days open due to reproductive inefficiency in cows that finally get pregnant and 2) culling losses from cows that do not get pregnant.

As a starting point example, the model shown compares a full ovsynch program (with a pre-synch program) to a program of daily estrus detection and breeding when cows are observed in estrus. The example assumes a dairy with 100 adult cows. The parameters of the latter program (heat detection program) were set to match the average performance of Minnesota DHIA herds as noted above.

Program expenses

Direct expenditures for reproductive management for each program are entered as inputs into the model (costs for synchronization hormones, breeding costs, labor, veterinary pregnancy examinations, etc.). Other inputs set the values of calves, feed costs, etc. and the discount rate used in the model to adjust for the time value of money in calculations.

Financial inputs

$	3.00	cost per pregnancy check
$	15.00	labor cost per hour
$	2.00	prostaglandin cost per injection
$	2.00	GNRH per injection
$	12.00	cost of a CIDR
$	12.00	cost of an insemination
	8%	discount rate
$	8.50	feed cost/cwt of DMI for milking cows
$	6.50	feed cost/cwt of DMI for dry cows
$	2.00	non-feed marginal cost per dry day per cow

	calf value	% births
live heifer	$ 250	43%
live bull	$ 50	48%
freemartin	$ 30	3%
stillbirths	$ -	6%
average	$ 132	

Program 1

costs	amounts	
$ 9.00	3.0	pregnancy checks per cow
$ 23.40	1.6	labor per cow (hours for whole program)
$ 6.00	3.0	prostaglandin doses per cow
$ 14.00	7.0	GNRH doses per cow
$ -	-	CIDRs per cow
$ 10.00		first cycle setup costs: presynch, single ovsync, whatever
$ -		other costs per cow per lactation
$ 36.00	3.0	inseminations per cow
$ 98		total program costs per cow
$ 9,840		total cost for the herd

Program 2

costs	amounts	
$ 6.00	2.0	pregnancy checks per cow
$ 54.60	3.6	labor per cow (hours for whole program)
$ -	-	prostaglandin doses per cow
$ -	-	GNRH doses per cow
$ -	-	CIDRs per cow
$ -		first cycle setup costs: presynch, single ovsync, whatever
$ -		other costs per cow per lactation
$ 30.00	2.5	inseminations per cow
$ 91		total program costs per cow
$ 9,060		total cost for the herd

As the tables above show for the example, the synchronization program costs an additional 780 dollars per year, or approximately 8 dollars more per cow.

Modeling expected average days open

The model requires inputs that describe the performance of each program in terms of estrus detection (or timed breeding) rates and conception rates. Using these inputs for each breedable cycle past the voluntary waiting period, the model calculates when cows become pregnant and how many cows remain to be bred. The model does not account for abortions.

For the full ovsynch program, the example inputs are:

Breeding program inputs

PROGRAM 1 — full ovsynch with presynch

voluntary wait period (days)	70	19%	long term pregnancy rate		132 days open
days after VWP to first estrus (days)	-				60 days dry
	Synchronized cycles		breeding based on estrus detection		
cycle	estrus detect.	concept. rate	estrus detect.	concept. rate	
1	95%	33%	0%	33%	
2	0%	33%	0%	33%	
3	95%	33%	0%	33%	
4	0%	33%	0%	33%	
5	95%	33%	0%	33%	
later even cycles	0%	33%	0%	33%	
later odd cycles	95%	33%	0%	33%	

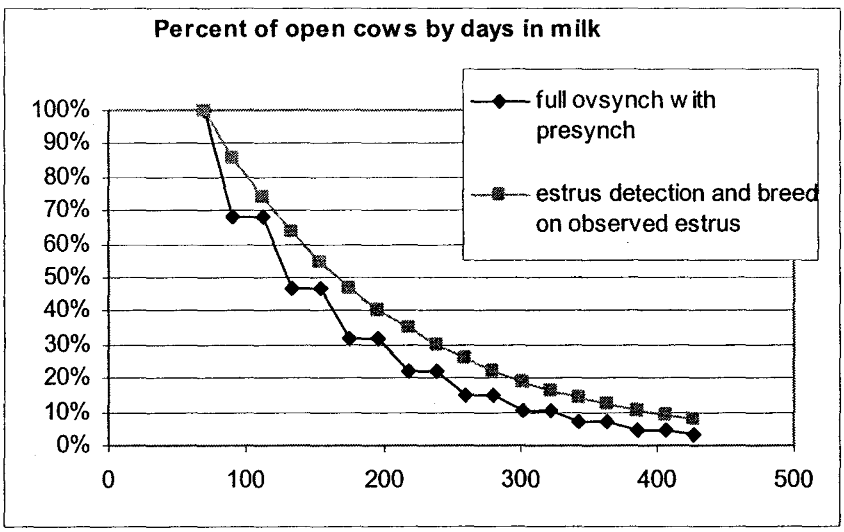
The inputs can be specified cycle by cycle for the first five 21-day cycles, then for ease of input for "odd" versus "even" cycles. "Odd" cycles means cycles 1, 3, 5, 7, etc. after the onset of breeding. Similarly "even" cycles are cycles 2, 4, 6, 8, etc. The presumption is that later cycles in most programs tend to follow a set pattern (all heat detection, all ovsynch, whatever). The reason for distinguishing between odd and even cycles is that many synchronization programs (as the full ovsynch program modeled here) will have different performance characteristics in those alternating cycles. Finally, the inputs allow for a mixture of synchronized breedings and breeding based on estrus detection within the same cycle. Cows eligible to be breed off of synchronization are presumed bred first, with only remaining cows eligible to be seen in estrus (if specified for that cycle).

As the table shows, the full ovsynch program is assumed to correctly set up and breed 95% of the eligible cows. Conception rate on the timed breeding is assumed to be 33%. No cow will be bred on an observed estrus (although 21 day "off cycle" estrus detection could easily be added to the inputs). The expected result will be an average days open of 132 days and a 21-day pregnancy rate of 19%. This assumes that cows will be bred for up to 12 cycles, set as an input elsewhere in the model.

Inputs for the estrus detection program are as follows. The average days open for the program will be 150 days and the average 21-day pregnancy rate will be 14% (the average for Minnesota DHIA dairies). Again, 12 breedable cycles are assumed.

PROGRAM 2	estrus detection and breed on observed estrus			
			150 days open	
voluntary wait period (days)	60	14%	long term pregnancy rate	
days after VWP to first estrus (days)	10		60 days dry	
	Synchronized cycles		breeding based on estrus detection	
cycle	estrus detect.	concept. rate	estrus detect.	concept. rate
1	0%	0%	35%	40%
2	0%	0%	35%	40%
3	0%	0%	35%	40%
4	0%	0%	35%	40%
5	0%	0%	35%	40%
later even cycles	0%	0%	35%	40%
later odd cycles	0%	0%	35%	40%

Graphically, cows transition from open to pregnant in the two programs as follows.



Note that if the dairyman stops breeding open cows (say after 12 cycles {~300 days in milk}, as modeled in this example), there will inevitably be some cows that are still open and will be culled at the end of their lactation. The number of cows that remain open will thus depend on the dairy's policy regarding how long they will breed cows before giving up on getting them pregnant. The cut point for ending breeding is set as an input in the model. This assumption of a single cut point for stopping breeding is a simplification for purposes of modeling. In practice and in reality, dairymen should stop breeding cows based on the cow's individual attributes (age, health, production, etc.).

Lost income over feed costs and extra days dry from extended days open (lactation costs)

Cows with differing days open experience different lactations (milk production and feed consumption) and possibly different dry periods. Accounting for these "lactation costs" is necessary in cows that become pregnant and will remain in the herd. Cows that remain open are assumed to be culled at the same time for both groups and thus to have no difference in lactation costs. Groups of cows that become pregnant will have differing days open depending on the reproductive performance of the particular program used. The impact of differing lactations from extending days open is calculated from an arbitrary baseline of 100 days open. Given the arbitrary baseline, the number calculated for each program is not itself relevant; it is the difference between the two programs that matters. For cows that become pregnant, the calculation of the impact of extended days open on milk income and feed costs (income over feed cost or IOFC) compares the net present value of IOFC for each of the two programs. For each program, the daily milk production and dry matter intakes are modeled (EXCEL model provided by Dr. David Galligan) and thus milk income and the cost of feeding the lactating cow each day are both calculated. This provides daily income over feed costs for each day of lactation. By discounting each day's IOFC to the beginning of the lactation, a net present value of IOFC for the lactation can be determined.

For the model, the lactation costs of added days open is calculated separately for lactations 1, 2 and 3 or greater. This adjusts for the difference in the shape of the lactation curves for animals in these different lactations and for the different proportions of the herd that are in each lactation group.

Conceptually, consider two "herds" of cows with differing days open and thus differing lactation lengths (assume constant dry period for the moment, although the model will account for differing dry periods as well). For the lactation up until the herd that conceives earliest is dried off, both herds follow the same lactation curve, make the same amount of average milk per day, and eat the same amount of feed. The present value of each day's income over feed costs can be discounted back to the start of the lactation and up to that point the two herds' lactations would be the same. The herd that conceived early would then proceed through the dry period, incurring those costs until calving again. Those dry period costs could also be discounted back to the start of the lactation. For the herd that took longer to conceive (longer days open), their average lactation would continue (at a lower level of milk production than the average prior to that point) and they would continue to consume feed. At some point the herd would finally also be dried off. The IOFC of that latter lower phase of lactation, along with the subsequent dry period, could be discounted back to the start of the lactation and incorporated into a final income over feed and dry period costs for the whole lactation. The cost for the extended days of lactation are the difference between the average IOFC of the early bred herd and the IOFC of the tail end lactation production in the herd with delayed conception.

Program 1	full ovsynch with presynch
12	cutoff number of breedable cycles
19%	**average pregnancy rate**
301	days in milk at last breeding opportunity
132	**average days open in pregnant cows**
$ 10,022	lactation costs of day open past day 100 (IOFC, dry days)
$ 825	lost value of calves
10%	**percent of cows culled for reproductive failure**
10	number of cows culled for reproductive failure
$ 9,750	cost of reproductive culls

In comparison, the estrus detection program (with the same cutoff for breeding) results in a 21-day pregnancy rate of 14% and an average days open of 150 days in pregnant cows. Sixteen percent of cows are still not pregnant at the end point and will be culled.

Program 2	estrus detection and breed on observed estrus
12	cutoff number of breedable cycles
14%	**average pregnancy rate**
301	days in milk at last breeding opportunity
150	**average days open in pregnant cows**
$ 15,659	lactation costs of day open past day 100 (IOFC, dry days)
$ 1,288	lost value of calves
16%	**percent of cows culled for reproductive failure**
16	number of cows culled for reproductive failure
$ 15,675	cost of reproductive culls

When these two outcomes are tabulated and the financial differences between them are calculated, the model in complete.

Comparing two reproductive programs

model based on costs of extended days open and forced culling

EXAMPLE DAIRY

$ 17.00	**milk price per cwt**
100	**cows in the herd**
$ 6.19	**average value of a saved day open per cow**
$ 23	**value of a 1% improvement in pregnancy rate per cow**

Advantage of Program 1 over Program 2					
difference in days open and cull expenses discounted for one year					**biological**
	Program 1	**Program 2**	**discounted diff.**	**per cow**	**difference**
lact. costs	$ 10,022	$ 15,659	$ 5,220	$ 52	**18**
calf losses	$ 825	$ 1,288	$ 429	$ 4	**3**
culls	$ 9,750	$ 15,675	$ 5,486	$ 55	**6%**
expenses	$ 9,840	$ 9,060	$ (780)	$ (8)	
totals	**$ 30,437**	**$ 41,683**	**$ 10,355**	**$ 104**	
			return on added expenses	**1328%**	

In this example, the full ovsynch program saves $52 per cow due to lactation costs (IOFC, days dry). The full ovsynch program earns $4 more in calves born per year. It also saves 55 dollars per cow in reduced culling. The full ovsynch program costs $8 more per cow to implement. In total, the full ovsynch program earns about 100 dollars more per cow than the estrus detection program. Return on the extra 8 dollars spent is over 1,000 percent. Given these two choices, and assuming that the dairy can manage the record keeping, scheduling and cow handling needed in a full ovsynch program, the ovsynch program is clearly the better economic option.

The table below gives the cost of a day open broken out by lactation, given the other assumptions in the model. Perhaps counter intuitively, the greatest lactation costs are in first lactation heifers. This runs counter to generally accepted assumptions that extending lactations in heifer is less expensive because the heifer's lactation curve is flatter. The reason that extended lactations in heifers is more expensive is that it postpones arriving at higher milk production in subsequent lactations, in a sense filling what could be a more productive slot with a lower producing heifer. The impact of the value of calves is the same across lactations, since calves born to any lactation are considered of equal value. The cost of culling is greatest if animals are culled in earlier lactations. This culling cost means that the total cost of an extended day open is actually largest in first lactation animals.

Delaying breeding of first lactation animals increases their risk of never conceiving and being culled and overshadows the lactation costs. This does not necessarily argue for a shorter voluntary wait period for first lactation animals. There are other biological and managerial reasons that constrain the lower limits for voluntary wait periods on dairies. For these reasons and for simplicity of management we recommend a consistent voluntary wait period for all lactations in a herd. These results do, however, argue strongly against deliberately prolonging the lactations of first lactation animals.

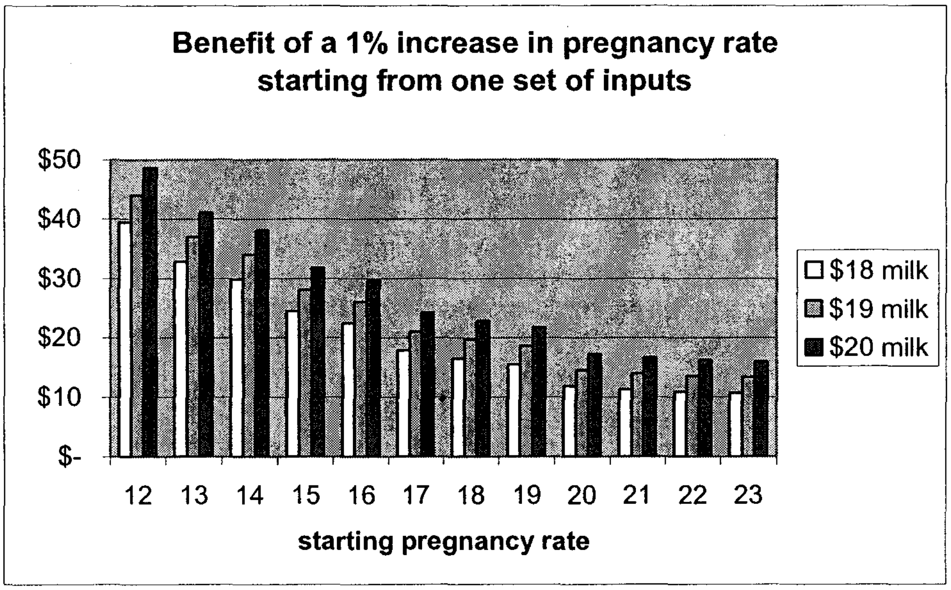
	lactation 1	lactation 2	lactation >=3	all lactations
lact loss / extra day open (NPV of IOFC & dry days)	$ 4.05	$ 2.79	$ 2.13	$ 3.13
loss / extra day open for calves	$ 0.26	$ 0.26	$ 0.26	$ 0.26
loss from excess culling per day open	$ 4.26	$ 3.16	$ 1.93	$ 3.29
loss per day open before discounting	$ 8.56	$ 6.21	$ 4.32	$ 6.68
loss per day open after discounting	$ 7.93	$ 5.75	$ 4.00	$ 6.19

USE IN PRACTICAL TERMS

While the number of inputs may at first seem daunting, for practical application there are not many that change significantly within a given time frame. Spreadsheet shortcuts, particularly in the specification of the reproductive program parameters, also speed model setup. Certainly breeding program performance (estrus detection rates and conception rates) are critical components and require careful consideration. Input costs for items paid out of pocket also matter, as do milk and feed prices. In real terms, it takes only a few minutes to enter the basic data needed to model two options. The greater value comes from altering key inputs to consider "what if" scenarios and to inform the decision about which reproductive program is the best for a herd.

VALUE OF A 1% INCREASE IN THE PREGNANCY RATE

The model can be used to consider what the impact of a 1 percent change in 21-day pregnancy rate might be. Starting with two identical programs based on estrus detection and breeding on detected estrus, the conception rate can be varied between the two programs to achieve different 21-day pregnancy rates. This sensitivity analysis was done comparing the two programs with a one percent difference in 21-day pregnancy rate (12% to 13%, 13% to 14%, 14% to 15%, etc.). The model was run at three milk prices per cwt of milk: $16, $18, and $20. The results are:



As the graph shows, the value of increasing the 21-day pregnancy rate is greater when increasing the 21-day pregnancy rate by 1% starting from a low 21-day pregnancy rate compared to starting at a high 21-day pregnancy rate. Moving from a pregnancy rate of 12% to 13% is worth as much as $40 to $50 per cow under the conditions modeled. Improving by 1% from a 23% rate is worth less only about one third of that value (~$15). Improving pregnancy rates has more value at higher milk prices (and higher heifer costs, lower beef prices, etc.).

Closing:

There are many dairies whose reproductive program performance is inadequate and for whom poor reproduction is an important source of financial losses. Improving reproduction on a dairy will probably cost money, but the investment may be very profitable. Synchronization programs might provide on vehicle to improve performance, if the program can be implemented well under the dairy's practical conditions. The projected financial returns for a change in a dairy's reproductive program can be modeled. Perhaps the use of such modeling can help motivate dairymen to consider altering their reproductive program for the better.