



Introduction

Efficient reproduction is essential to successful dairy farming. Of equal importance with the breeding process is subsequent pregnancy diagnosis (PD), or more specifically, the identification of open cows to return to the breeding pool.

Recent emphasis has been on earlier PD; the sooner open cows are identified, the sooner they are eligible to be re-bred, potentially reducing days open (DO). Traditionally PD was by rectal palpation (RP), generally conducted no sooner than 35 days post breeding. Today, ultrasound (US) is becoming widely available and is used for PD as early as 27 days post breeding. Thus, US gives an 8 day advantage over RP in returning open cows to the breeding pool.

The economic efficiency of these PD strategies is less clear. In general, US is more costly than RP. Pregnancy loss between 27 and 35 days results in an efficiency loss in the identification of open cows. The effectiveness of the subsequent re-breeding plan also impacts overall economic success.

Simulation Modeling

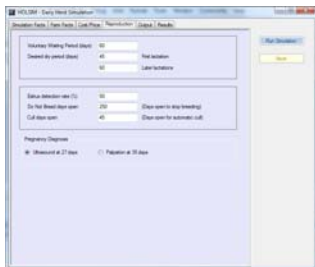
While not new to animal production, simulation models are less common here than in other fields. Physiologic animal models have been used in nutrition, growth, and health; and farm-level models used to evaluate management practices. Object-oriented programming (OOP) is well suited to simulation design. By its nature, it is possible to maintain an intuitive relationship between the computer programming and the reality being modeled.

If you are simulating a dairy farm, intuitively, you create cow objects that have individual and group characteristics. A farmer object may 'observe' a cow object 'in estrus', and 'decide' to 'breed' the cow object. In this case, the cow object has a method for showing heat, and possibly conceiving if bred, and the farmer object has a method for breeding the cow. A barn object may represent environmental factors that can interact with the farmer and cow methods, etc.

Although OOP has been around for years, the development of more universal platforms and increasing computing power have made it a much more powerful tool. It is now feasible to model whole farm systems by modeling individual animal units within the system, and to apply a high level of complexity to all elements of the system and their interactions.

HOLSIM

HOLSIM was developed on the .NET framework as a stand-alone Windows™ application.



Object classes were created representing cows (including animal, lactation, reproduction, and production states), and the farm unit. Additional classes were used to manage simulation functions, including probability distributions, and data accumulation.

Time steps are days. Rather than forecasting events (i.e. deciding at breeding whether the cow will be pregnant at 60 days), this program allows all events to occur in real-time. Thus, conception is determined at breeding, but the cow has a daily opportunity for embryo loss or abortion.

Although computationally more intensive, this is highly intuitive, provides greater flexibility, and possible improvement in the accuracy of interactions in the model. The computational cost is negated by the memory and speed efficiency of the .NET framework.

Simulated Herd

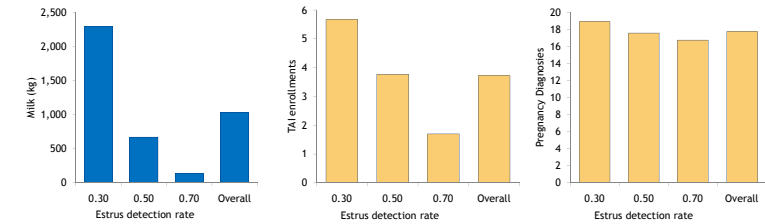
General Herd Characteristics	
Herd size	100 cows
	Seed herd of freshening heifers
	Culls replaced with freshening heifer
RHA	9,980kg/yr (22,000 lbs/yr)
Culling policy	Cull after 7 consecutive days of production
	<40% of herd average for pregnant cows
	<50% of herd average for open cows (excluding first 10 DIM)
Est. days dry	45d after first lactation
	60d after later lactations

Reproduction	
VWP	60 days
DNB DO	Do not breed cows open >250 days
Breeding policy	Breed any observed estrus after VWP, before DNB DO
	Open cows bred by TAI at 75 DIM following a 10d synchronization protocol (SYNC)
Pregnancy diagnosis	RP at 35 days post breeding or US at 27 days post breeding
Re-breeding	Observed estrus (see above)
	Cows open at PD enrolled in 10d SYNC

Stochastic elements	
Gestation length	N-(280, 26)
Days to first estrus	LogN-(19,11)
Estrus detection	Probability of observing an estrus 0.30, 0.50, or 0.70
Probability of conception	0.90 (NOT a pregnancy rate)
Risk of embryo loss before 42d	Exp-(60)
Probability of later abortion	0.03 overall 0.03 / (280-42) daily
Daily production	Cows randomly assigned a herd relative producing ability (PA) N-(100,6), but confined to ±3 SD
	Daily production fit a PA, pregnancy, and parity adjusted Wood's curve

Results

Difference in LSM when PD is by RP at 35d vs. US at 27d was calculated by estrus detection (ED) rate for annual milk yield, and numbers of total breedings, estrus synchronization (TAI) enrollments, pregnancy diagnoses (PD), live calves, and culls. Method of PD had no effect on number of live calves, total breedings, or culls.



Differences in LSM for RP at 35d (LSM_{RP35}) vs. US at 27d (LSM_{US27}). Blue bars are LSM_{RP35} - LSM_{US27}. Orange bars are LSM_{US27} - LSM_{RP35}.

- With low ED, overall milk yield is greater when PD is at 35d rather than 27d.
- More TAI enrollments are made when PD is at 27d, particularly when ED is low.
- Many more PD are required if PD is at 27d.
 - The increased TAI enrollments and PD do not translate to an increase number of live calves.
- Total number of breedings is not dependent on PD method, but is highest when ED is moderate.
 - This suggests that even when utilizing TAI, if ED is low, many breeding opportunities are missed, and if ED is high, cows do not require re-breeding.
- Total milk, and live calves increased with increased ED.
- Total breedings, TAI enrollments, PD, and culls decreased with increased ED.

Conclusions and Future Directions

From these results it is clear that earlier PD does not necessarily provide more efficient reproduction.

This simulation assumed no error in detected estrus, thus, seeing cows in estrus provided the earliest possible identification of open cows. Results under a system without ED (i.e. all TAI) would yield different outcomes.

Seasonality was not considered in this model. The effect of heat stress on milk production, embryo loss, and heat detection are just 3 ways that season might effect outcomes.

The results of PD simulation models could be used to account for risk adjustment in a real options analysis of the value of pregnancy.