An integrated Approach to Improving Dairy Cow Fertility

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OVERALL OBJECTIVE

"To improve reproductive efficiency of lactating dairy cows using an interdisciplinary extension and research team that will identify and remove barriers to reproductive success and link outcomes of basic and applied research with an innovative extension delivery program."

Specific Aim 1

Prediction of Pregnancy Using Machine Learning Algorithms

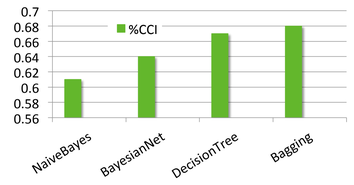
Objectives

1. Find the *machine learning* algorithm that better predicts pregnancy status in dairy cattle.
2. Find breeding optimal decisions through cost/benefit evaluation according to pregnancy values, breeding costs, and days open costs.

Materials and Methods

Data: 129,245 breeding records and 28 explanatory variables for primiparous cows and 195,128 breeding records and 31 explanatory variables for multiparous from 26 dairy farms in the Alta Genetics Advantage Progeny Testing Program (2000 to 2010). Pregnancy values and breeding costs calculated with a daily dynamic programming model (Kalantari and Cabrera, 2012).

Results and Conclusions



Performance of different machine learning algorithms (CCI% = Correctly Classified Instances).

Example of breeding optimal decision

Breeding only a selected group of 59% primiparous cows in 1st service, those that are predicted to have better reproductive performance, will accrue a gain of $4.1/cow.

❖Most important explanatory variables: season of the year, herd's conception rate (last 3 months), cow's days postpartum at breeding, cow's number of past breedings, and cow's calving interval.

❖Cost/benefit evaluations should be carried out on the classification results in order to determine the economic gain by selecting the most optimal subset of cows for breeding.

Specific Aim 2

Determine the impact of specific milk components on reproductive performance of lactating dairy cows.

Experiment 1- Objective: Analyze milk butterfat:protein ratio (FPR) from the first 5 DHIA milk test results to measure health consequences and to predict conception at first post postpartum AI (CR1).

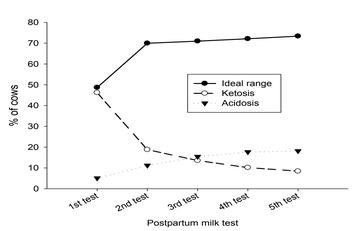
Materials and Methods

❖Dataset consisted of 207,506 1st postpartum services performed in 648 herds (July 2009 to July 2010)

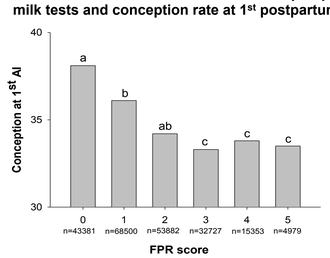
❖ Cows scored based on the number of test that deviated from the ideal FPR range of 1 to 1.4.

Results and Conclusions

Average FPR throughout the 1st 5 postpartum milk tests



Cow level: FPR score based on the 5 initial postpartum milk tests and conception rate at 1st postpartum AI



❖A dramatic amount of cows had a FPR outside the ideal range.

❖Cows deviating from ideal FPR range in 2 out of the 5 initial milk tests still had a good fertility in CR1.

❖FPR had a greater impact when AI was performed in summer months (not shown)

Specific Aim 5

Repro Money

Objective

To improve reproductive efficiency and profitability of the dairy farms by means of farmer-directed team-based program called Repro Money

Pilot Farm Case Study

❖Dairy farm milking 400 cows located near Lodi, Wisconsin

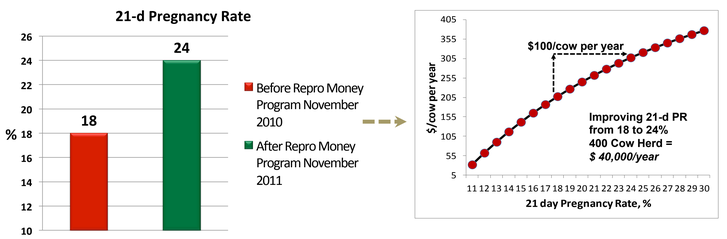
❖ Enrolled in Repro Money Program in November 2010.

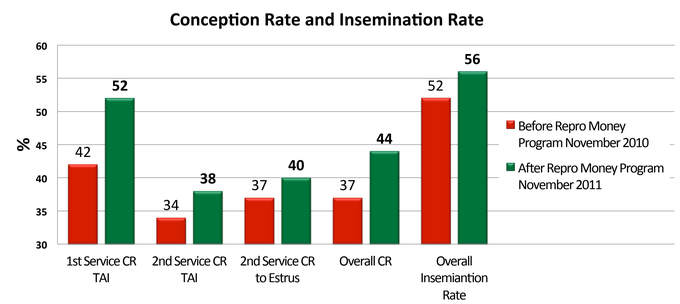
❖ME305 at the beginning of the program was 12,671 kg/cow with 4% butterfat and 3.2% protein.

❖General reproductive program: Double Ovsynch protocol for first service. Cows diagnosed open at pregnancy check are enrolled in an Ovsynch protocol for second and greater services. Cows detected in estrus between synchronizations are inseminated.

❖Team-based main adjustments: a) shifts in synchronization timings; b) increased attention to transition cows, and c) improvement of freestall bedding.

Improved Reproductive Performance and Economic Gains





Conclusions

❖ This case study demonstrates that the Repro Money Program is having an impact in the farm community by changing knowledge, actions, and conditions in dairy farms' reproductive performance. Participating farms are improving their economic performance and profitability.

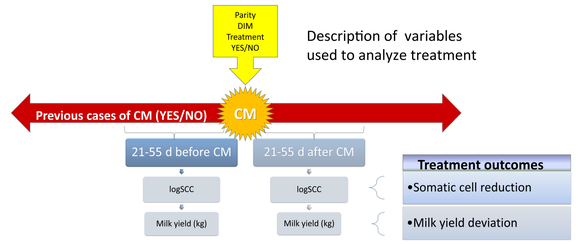
❖ Similar improvements are being documented for other participating farms

Specific Aim 3

Treatment Outcomes for Clinical Mastitis Caused by E. coli in a Wisconsin Dairy Herd

Materials and Methods

Cows (n = 94) enrolled between May 2011 and January 2012 had either a mild or moderate (abnormal milk and/or udder) clinical mastitis (CM) case and single quarter intrammamary infection. Cases were allocated as Treated (IMM ceftiofur) or Control.



Results

	SOMATIC CELL REDUCTION	MILK YIELD DEVIATION
Variables Used In Model	**Interpretation**	**Interpretation**
Treatment	Treatment was not associated (P = 0.54) with SCC reduction.	Milk yield after a CM case was not affected (P = 0.67) by treatment.
Days in milk	For every increase in DIM, SCC was reduced (P = 0.03) 8%.	Milk yield after a case decreased (P < 0.001) 0.06 kg per day in DIM.
Previous milk yield	Every increase in 1 kg of milk yield before a case, a cow was 1.1 times (P = 0.05) more likely to reduce her SCC count.	Every increase in 1 kg of milk yield before a CM case was associated with (P = 0.001) 0.47 kg/d increase in milk production after a CM.

Additional analyses:

❖Continued data collection is currently being used to analyze the integrated impact of clinical mastitis and its association with treatment, DIM, previous milk yield, and other herd and cow specific factors to explain reproductive performance in lactating dairy cattle.

Specific Aim 4

Evaluate the economic impact of different reproductive management strategies on overall farm profitability under a variety of management scenarios.

Objective

Determine the effect of reproductive performance on herd value

Materials and Methods

Develop a daily dynamic programming model (DP) to calculate retention pay off (RPO) → **Develop a daily Markov chain model to simulate herd structure** → **Calculate *Herd Value* by aggregating RPO of all cows in the herd, responding to a *reproductive program***

Results and Conclusions

Herd values ($/cow per year) for 5 reproductive programs (RP) across 5 relative milk yields (MC) (%)

Reproductive Program (RP)	21-d PR (%)	76% (MC1)	88% (MC2)	100% (MC3)	112% (MC4)	124% (MC5)
RP1	**17**	156	374	769	1,224	1,745
RP2	**14**	159	376	729	1,129	1,593
RP3	**16**	161	385	763	1,190	1,683
RP4	**18**	167	395	788	1,234	1,741
RP5	**20**	169	410	806	1,248	1,753

RP1: 100% TAI
RP2 to RP5: Combination of timed AI and estrous detection.
MC1= Lowest milk production;
MC5= Highest milk production

The most extreme herd value difference ($/cow per year) between two RP was $77 for MC3 (RP5 – RP2); $13 for MC1 (RP5 – RP1); and $160 for MC5 (RP5 – RP2).

❖There is a strong positive relationship between 21-d PR and herd value.

❖There is an opportunity to perform individual cow daily reproductive decisions for improved herd value.

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NRI and AFRI Animal Reproduction Project Director's meeting at Penn State, PA, 16 August 2012.