J. Dairy Sci. 96:949–961
http://dx.doi.org/10.3168/jds.2012-5704

Economics of resynchronization strategies including chemical tests to identify nonpregnant cows

J. O. Giordano, P. M. Fricke, and V. E. Cabrera[1]
Department of Dairy Science, University of Wisconsin, Madison 53706

ABSTRACT

Our objectives were to assess (1) the economic value of decreasing the interval between timed artificial insemination (TAI) services when using a pregnancy test that allows earlier identification of nonpregnant cows; and (2) the effect of pregnancy loss and inaccuracy of a chemical test (CT) on the economic value of a pregnancy test for dairy farms. Simulation experiments were performed using a spreadsheet-based decision support tool. In experiment 1, we assessed the effect of changing the interbreeding interval (IBI) for cows receiving TAI on the value of reproductive programs by simulating a 1,000-cow dairy herd using a combination of detection of estrus (30 to 80% of cows detected in estrus) and TAI. The IBI was incremented by 7 d from 28 to 56 d to reflect intervals either observed (35 to 56 d) or potentially observed (28 d) in dairy operations. In experiment 2, we evaluated the effect of accuracy of the CT and additional pregnancy loss due to earlier testing on the value of reproductive programs. The first scenario compared the use of a CT 31 ± 3 d after a previous AI with rectal palpation (RP) 39 ± 3 d after AI. The second scenario used a CT 24 ± 3 d after AI or transrectal ultrasound (TU) 32 d after AI. Parameters evaluated included sensitivity (Se), specificity (Sp), questionable diagnosis (Qd), cost of the CT, and expected pregnancy loss. Sensitivity analysis was performed for all possible combinations of parameter values to determine their relative importance on the value of the CT. In experiment 1, programs with a shorter IBI had greater economic net returns at all levels of detection of estrus, and use of chemical tests available on the market today might be beneficial compared with RP. In experiment 2, the economic value of programs using a CT could be either greater or less than that of RP and TU, depending on the value for each of the parameters related to the CT evaluated. The value of the program using the CT was affected (in order) by (1) Se, (2) Sp, (3) pregnancy loss, (4) proportion of Qd, (5) percentage of cows AI in estrus, and (6) cost of CT. A change of 1% in the Se of the CT was 1.8 times more important than a similar change in Sp or pregnancy loss, and 13.7, 55.0, and 305.8 times more important than similar changes in Qd, cows inseminated in estrus, and cost of CT. We conclude that the major effect of using a CT is the potential of decreasing the IBI. Moreover, inaccuracy of the CT and additional pregnancy loss due to earlier testing resulted in smaller economic differences than when using RP or TU 8 d later.

Key words: simulation, modeling, reproductive program, pregnancy diagnosis

INTRODUCTION

Coupling resynchronization of ovulation programs with practical and cost-effective methods to identify nonpregnant cows as early as possible after a previous AI increases the AI service rate in a dairy herd by decreasing the interval between inseminations. The economic value of any test, however, will depend largely on the accuracy of the test to identify nonpregnant and pregnant cows correctly, as well as the cost of the test (Oltenacu et al., 1990; Galligan et al., 2009; Ferguson and Galligan, 2011). Therefore, diagnostic tests should have high sensitivity and specificity and generate the fewest possible questionable diagnoses.

Besides the traditional methods for nonpregnancy and pregnancy diagnosis in cattle (rectal palpation and transrectal ultrasound), new chemical methods for nonpregnancy diagnosis have been developed and are now commercially available. Assessment of pregnancy status through the detection of placental pregnancy-associated glycoproteins (**PAG**; Sasser et al., 1986; Zoli et al., 1992; Green et al., 2005) released into the maternal bloodstream is a reliable method to determine the pregnancy status of dairy cattle and can be incorporated into already established reproductive management schemes (Silva et al., 2007, 2009; Romano and Larson, 2010). Commercial PAG tests allow for determination of pregnancy in lactating dairy cows with good accuracy as early as 27 to 28 d after AI (Silva et al., 2007, 2009; Romano and Larson, 2010). As a consequence, one of the major advantages of a chemical test (**CT**) is the

Received May 8, 2012.
Accepted November 1, 2012.
[1]Corresponding author: vcabrera@wisc.edu

potential for earlier identification of nonpregnant cows after an insemination, thereby allowing the implementation of aggressive resynchronization protocols that result in a short interbreeding interval (**IBI**).

Performing an early pregnancy test after AI may be highly beneficial because shortening the IBI improves reproductive performance (Giordano et al., 2011). However, like any other diagnostic method, CT may have low accuracy if used too early after AI. Another factor that affects the performance of an early CT is the occurrence of pregnancy loss, which is detrimental to the overall reproductive performance of the herd. Naturally occurring pregnancy losses in lactating dairy cows are more likely during the early stages of pregnancy and tend to decrease as gestation progresses (Vasconcelos et al., 1997; Santos et al., 2004; Giordano et al., 2012b). As a result, the earlier a pregnancy test is performed, the greater the number of pregnancies that will be lost until the next pregnancy reconfirmation or calving. Therefore, a tradeoff exists between the time gained with earlier pregnancy tests and the effect of pregnancy loss, because cows losing their pregnancy should be identified and resubmitted for AI as soon as possible after the loss.

Previous analyses have reported varying degrees of economic difference between the use of a CT, transrectal ultrasound (**TU**), or rectal palpation (**RP**) to detect pregnancy in dairy cattle (Oltenacu et al., 1990; Galligan et al., 2009; Ferguson and Galligan, 2011). These previous studies have relied on cost/benefit and partial budgeting analysis combined with some type of decision-tree framework (Oltenacu et al., 1990; Galligan et al., 2009; Ferguson and Galligan, 2011). Such approaches seem suitable because they can include the sensitivity (and the positive predictive value of the test), the specificity (and the negative predictive value of the test), and the probability of pregnancy loss within a framework to calculate the economic impact of these factors. Nonetheless, to measure the effect of a pregnancy test on the overall reproductive efficiency of a dairy herd, we chose to use a more comprehensive approach that allows for the dynamics of the whole lactating herd to be followed through repetitive breeding cycles and complete lactations. Integrating the pregnancy testing method within the reproductive program, rather than applying it as an isolated event, may better reflect its impact on reproductive dynamics, generating results of greater utility for producers and dairy industry consultants.

The objectives of the present study were to (1) assess the economic value of decreasing the interval between inseminations when using a nonpregnancy test that allows earlier identification of nonpregnant cows; and (2) assess the effects of pregnancy loss and inaccuracy of the CT on its value as a method for earlier nonpregnancy diagnosis in lactating dairy cows. Two simulation experiments were performed using a spreadsheet-based decision support tool (UW-DairyRepro$; Giordano et al., 2011) that simulates the reproductive, productive, and economic dynamics of a dairy herd. Our main hypothesis was that the economic advantage of performing an earlier pregnancy test is the reduction in the interval between 2 successive inseminations. Moreover, we hypothesized that the improved reproductive efficiency due to a shorter IBI would offset any potential additional losses incurred due to inaccuracy of the earlier nonpregnancy diagnosis with a CT as well as the additional cost of performing the test.

MATERIALS AND METHODS

Experiment 1: Model Description

To assess the effect of different IBI on the reproductive dynamics and economics of a dairy operation, a 1,000-cow commercial dairy herd was simulated using the UW-DairyRepro$ decision support tool (Giordano et al., 2011). Briefly, based on multiple herd descriptive and reproductive input parameters, the model simulates the reproductive dynamics of a herd of lactating dairy cows. The model estimates sequentially, as finite Markov chains, the percentage of cows eligible for insemination after the end of the voluntary waiting period (**VWP**), the proportion of cows receiving AI, the percentage of cows that become pregnant, and the percentage of cows that fail to become pregnant after each AI service. The first state in the Markov chain process is represented by the nonpregnant cows, which could move to the next state of being inseminated, becoming pregnant, being culled from the herd, or dying, following transition probabilities determined by the reproductive program under consideration. The model simultaneously calculates a future expected monetary value (based on milk income over feed cost, cost of nonreproductive culling and mortality, cost of reproductive culling, value of newborn calves, and the cost of reproductive programs) for cows becoming pregnant at different DIM between the end of the VWP and a predefined cutoff DIM for insemination, as well as for cows that remain nonpregnant by the end of the breeding period. The expected monetary value (indicates the income generated by cows) calculated for specific DIM for pregnant and nonpregnant cows is then multiplied by the percentage of cows in each reproductive status to estimate the net present value (**NPV**; $/cow per year) of a reproductive program (Giordano et al., 2011). The discount rate entered as input for the calculation of NPV was set at 5.0%.