

What Is the Most Cost-Effective Breeding Program for Dairy Heifers—Timed AI, Estrous Detection, or a Combination of Both?¹

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Introduction

As any other business enterprise, the sustainability of a dairy farm is highly dependent on economics. In order to obtain a profitable return on assets, there is a constant need to maximize outputs and, oftentimes, to minimize inputs. In a conventional dairy farm, most of the cash receipts (about 88%) come from milk sales, and a smaller portion (about 12%) results from animal sales, including those destined for dairy production (Santos et al. 2010). On the other hand, feed cost of lactating dairy cows account for roughly 50% of total cost of production, whereas rearing replacement heifers account for about 23% of the cost of producing milk. Reproduction influences both milk production and number of replacement heifers available on a farm; therefore, reproductive efficiency becomes a key determinant of dairy cow profitability (Britt 1985; Meadows et al. 2005; De Vries 2006; De Vries et al. 2006).

According to a survey conducted by the National Animal Health Monitoring System, approximately 63% of the dairy farms in the United States use AI following detection of spontaneous or induced estrus in dairy heifers (NAHMS 2009). The main advantages of this program are the ease of implementation, relatively low costs, and high pregnancy per AI. However, success of programs for detection of estrus is highly dependent on efficiency and accuracy

of detection, which requires daily observation. Low estrous-detection rates result in low pregnancy rates and a large variation in age at first breeding, at pregnancy, and, consequently, at first calving, all of which are economically undesired (Ettema and Santos 2004). Administration of PGF_{2α} when heifers are moved to the breeding pens is a very common strategy to induce luteolysis and formation of sexually active groups, thereby facilitating detection of estrus by concentrating estrous expression in fewer days, which improves pregnancy rates (Stevenson et al. 2008). Approximately 33% of dairy farms in the United States still use natural service as the main method to breed heifers (NAHMS 2009).

A survey completed in 2007 indicated that fewer than 4% of dairy operations used timed-AI programs as a breeding strategy for dairy heifers (NAHMS 2009). The low utilization of such programs was justified by reduced pregnancy per AI (30%–40%) obtained with standard Ovsynch protocol compared with AI at detected estrus (50%–60%). Another reason was the perception by producers that reproductive management of dairy heifers is not a concern. Nonetheless, novel timed-AI programs for dairy heifers have been developed and resulted in adequate pregnancy per AI (50%–60%; Lima et al. 2011; Lima et al. 2012). With adequate fertility, the major advantage of implementing timed-AI protocols for dairy heifers is to maximize the

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number of pregnant animals immediately after they become eligible for breeding, which is expected to result in younger age at pregnancy and calving, therefore reducing costs with feeding dairy heifers (Ettema and Santos 2004). Nevertheless, these programs require compliance, labor, and costs with hormone administration.

Therefore, the objective of this publication is to present information from recently published work by Ribeiro et al. (2012) that looked at the economics of different reproductive programs for breeding heifers that use timed AI only (TAI), estrus detection only (ED), or a combination of both (TAI+ED).

Economics of Different Reproductive Program for Dairy Heifers

A simulation was performed to calculate pregnancy rates, average time to pregnancy, total costs per AI (including labor, drugs, semen, and equipment required), and total costs per pregnancy for four reproductive programs when the duration of the breeding period was 84 days or approximately four estrous cycles.

Heifers were eligible to be bred starting at 400 days of age (day 0) and were subjected to one of the four breeding protocols:

1. Timed AI only
2. Detection of estrus only
3. Timed AI for first breeding and detection of estrus for the remaining period
4. Timed AI for first AI followed by insemination upon detected estrus or resynchronized insemination after non-pregnant diagnosis

Four estrous detection rates were considered of 50%, 60%, 70%, and 80%. Detection of estrus program included an injection of PGF_{2α} on day 0 in all heifers and a second injection 14 days later for those not inseminated. Pregnancy per AI for those inseminated after estrus was assumed to be 60% for the first breeding and 54% for the remaining inseminations (Norman et al. 2010). For timed AI, nonpregnant heifers were reinseminated every 40 days for up to three AI, and pregnancies per AI were 59%, 55%, and 51% for the first, second, and third breedings, respectively (Lima et al. 2011; Lima et al. 2012). For detection of estrus,

costs with labor were calculated for tail chalking and animal observation was computed. Costs per pregnancy included costs incurred to implement the breeding program and feed costs associated with the interval from beginning of breeding to pregnancy. It was assumed that each extra day to pregnancy after 400 days of age would increase feed costs when heifers consume more DM, at 23–25 months of age. Each extra day cost \$2.00. Nonpregnant heifers at the end of the simulation (day 84) had an additional cost of \$168 for feed.

As expected, results of programs using detection of estrous were highly dependent of estrous detection rates (Table 1). As efficiency of estrous detection increased from 50% to 80%, more heifers were pregnant early and at the end of the breeding period, which reduced age at pregnancy. These improvements in reproduction also affected the cost per AI and the feed cost per pregnancy, which decreased the total cost per pregnancy with higher estrus detection. Incorporation of timed AI for first AI was beneficial to reduce cost per pregnancy compared with estrous detection alone, although the benefits decline at the high estrous detection rate (Table 1). When additional timed AI were incorporated in the breeding program to resynchronize nonpregnant heifers that had not been detected in estrus, it had a further benefit—but only at the low estrous detection efficiency (50%–60%)—not when estrous detection was greater than 60%. Timed AI only was equivalent to a program based on detection of estrus when efficiency was at least 70%. Incorporating detection of estrus after timed AI was superior to timed AI only. Most of the changes in costs per pregnancy are the result of additional feed costs with heifers becoming pregnant later in the breeding period.

Conclusion

In summary, most dairy farms breed heifers using detection of estrus. There is little justification to incorporate timed AI programs when detection of estrus is excellent (above 70%). However, for farms with detection of estrus below 60%, either timed AI for first AI followed by detection of estrus or timed AI alone improves reproductive performance and reduces the cost per pregnancy. The combination of timed AI and estrous detection between timed AIs resulted in the lowest cost per pregnancy among all programs evaluated.

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Table 1. Reproductive efficiency and costs of four breeding programs for dairy heifers according to estrous detection rate.

	Breeding program ¹												
	TAI only	Detection of estrus only				TAI + DE on remaining AI				TAI + DE between TAI			
Estrous detection rate, %	—	50	60	70	80	50	60	70	80	50	60	70	80
Pregnant, %													
Day 20	59.0	45.0	50.4	54.6	57.6	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0
Day 40	81.6	59.9	66.5	71.8	75.9	70.1	72.3	74.5	76.7	81.4	81.4	81.3	81.3
Day 84	91.0	78.6	84.7	89.1	92.2	84.1	87.3	90.1	92.5	91.1	91.2	91.2	91.3
Age at pregnancy, days	418.2	426.6	425.0	423.6	422.4	414.4	415.3	415.9	416.3	416.8	416.5	416.2	415.9
Labor days	12	84	84	84	84	68	68	68	68	68	68	68	68
Labor hours/AI	0.18	0.57	0.49	0.43	0.39	0.37	0.34	0.32	0.30	0.23	0.22	0.21	0.20
Cost/AI, \$	20.8	14.9	13.9	13.3	12.8	18.9	18.3	17.8	17.4	19.1	18.5	17.9	17.4
Number of AI/pregnancy	1.75	1.75	1.74	1.74	1.74	1.74	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Feed cost/pregnancy, \$	53.1	98.9	80.5	67.8	58.9	60.6	55.0	50.2	46.2	49.9	45.3	48.6	48.0
Total cost/pregnancy, \$	89.5	125.0	104.7	90.9	81.1	93.5	86.9	81.4	76.7	83.3	81.7	80.0	78.4

¹ TAI = timed artificial insemination; TAI + DE = timed artificial insemination for first AI followed by detection of estrus for remaining AI; TAI + DE between TAI = timed AI for first AI followed by detection of estrus and resynchronization of nonpregnant heifers for timed AI following nonpregnancy diagnosis. *Source:* Adapted from Ribeiro et al. (2012)