

Accuracy of oestrus detection in cows and its economic impact on Shiraz dairy farms

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Summary

No report has been published on the economical losses associated with errors in oestrus detection in cows under Iranian intensive dairy management. The following study was carried out to determine the accuracy of oestrus detection by farmers using artificial insemination in Shiraz dairy farms. Milk samples were collected from 179 Holstein milking cows at the time of artificial insemination. Milk progesterone concentration was determined using a commercial radio-immunoassay kit. It was assumed that a milk progesterone concentration greater than or equal to 3 ng/ml indicated the presence of active luteal tissue and that all animals in oestrus had a concentration less than 1 ng/ml. Results of the present study showed that error in oestrus detection was higher in dairy herds with more than 85 milking cows compared to that of the smaller size herds (14.4 vs 7.3%; $\chi^2 = 2.59$; $P = 0.1$). Five out of 11 herds (45%) had an oestrus detection error higher than 10 percent while in the remaining six herds the oestrus detection error varied from 0 to 7.1%. Based on the assumptions and calculations made in the present study, the net cost of one day delay in conception for a cow producing 25 litres milk in peak lactation was calculated at 40591.98 Rials (4.51 \$US) when conception is delayed from 85 to 100 days post-calving, increasing to 60120.89 Rials (6.68 \$US) per day if conception occurred at 146 to 175 days post-calving.

Key words: Accuracy, Oestrus detection, Dairy cows, Economics, Iran

Introduction

Successful implementation of artificial insemination in dairy cows generally depends on accurate and efficient detection of oestrus. Accuracy of oestrus detection is one of the main factors influencing the reproductive efficiency of dairy cows. New technologies such as pedometry and radiotelemetric sensors have been employed to decrease errors in oestrus detection however, sufficient visual observation still remains as the most popular and recommended method to detect cows in oestrus (see review by Stevenson, 2000). Using whole milk progesterone assay as an indication of true oestrus, studies have shown that from 0 to 60% of cows had abnormal levels of progesterone at the time of artificial insemination (McCaughy and Cooper, 1980; Reimers *et al.*, 1985; Nebel *et al.*, 1987; White and Sheldon, 2001).

Available literature shows no report regarding the accuracy of oestrus detection in cows in Iranian dairy farms.

Dairy farmers including their Iranian counterparts are now suffering from severe reduction in income due to the high cost of milk production of acceptable quality. In addition, fertility in terms of heat detection, submission rate and pregnancy rate is often regarded as another concern of dairy farmers. The financial implications of delayed conception in dairy cows have been investigated in different countries. One day of delay in conception was calculated to cause \$2.03 (Lineweaver, 1975), \$1.24 (de Vries and Conlin, 2003) loss in the United States and £2.41 loss in the UK (Esslemont *et al.*, 2000) for an average milking cow. Esslemont *et al.* (2000) also reported a loss of £6.52 per day for a high producing cow to become pregnant between 206 and 235 days post-calving. Extrapolation to dairy

industries in other countries by simply converting the reported figures to their currencies is probably a misleading attempt.

Despite remarkable improvements in the Iranian dairy herd management during the last three decades, the possibility of widespread usage of artificial insemination has remained a challenge for the dairy industry. There is a serious need to investigate factors limiting more widespread application of artificial insemination in Iranian dairy herds. To our knowledge, no report has been published on the economical loss associated with errors in oestrus detection in cows under Iranian intensive dairy management. Therefore, the following study was carried out to determine the accuracy of oestrus detection by farmers using artificial insemination in Shiraz dairy farms. Then the results of this study were used as a base to calculate the financial impact of delays in conception in dairy cows.

Materials and Methods

Collection of milk samples

This study was carried out from January to October 2005 in 11 dairy farms located around Shiraz. The target sample size of each herd was 10 percent of the milking cows, or a minimum of 10 cows in the smaller herds. Milk samples were collected from 179 Holstein milking cows at the time of artificial insemination. Only cows were milk sampled that 1) had shown standing oestrus as the most reliable sign of oestrus, 2) were detected in oestrus by visual observation, 3) had come into oestrus without any hormone therapy including oestrus synchronisation treatments, and 4) did not have any signs of clinical mastitis. At the time of insemination a 10 ml sample of milk was collected from at least two quarters of each cow into a sterile tube containing 30 mg sodium azide (Sigma-Aldrich, Germany). Samples were stored at -20°C until assayed for progesterone determination.

Milk progesterone determination

A commercial radio-immunoassay kit (ImmunoTech SA, France) was used to

determine milk progesterone concentration. The sensitivity of the assay was 0.1 ng/ml. The intra-assay and inter-assay coefficients of variations were 5.4 and 9.1 percent, respectively. It was assumed that a milk progesterone concentration greater than or equal to 3 ng/ml indicated the presence of active luteal tissue and that all animals in oestrus had a concentration less than 1 ng/ml (Reimers *et al.*, 1985). Any cow with milk progesterone concentration between 1 to 3 ng/ml was considered suspected as being in oestrus or not. A Chi-square test was used to assess the statistical significance of the difference between the observed and expected proportions of cows with a milk progesterone concentration greater than or equal to 3 ng/ml in large (more than 85 milking cows) and medium sized (less than 85 milking cows) dairy herds. The level of significant was set at less than 0.05.

Calculating the costs of the delay in conception

The method used in the present study to calculate economical losses due to the delay in conception arising from errors in oestrus detection was mainly based on the model developed by Esslemont *et al.* (2000). Calculation of the parameters affecting the costs was based on current costs in Shiraz dairy market and previously published reports in the peer reviewed scientific journals.

Assumptions

a- Assuming a Holstein cow with a milk production of 25.3 litres in peak lactation, erroneously detected in oestrus on day 60 post-partum, is submitted for artificial insemination and then examined for pregnancy diagnosis 40 days after AI (as these may occur under any dairy management system). The cost is calculated for the delay in conception for this cow as well as for a high producing cow with a milk production of 38 litres in peak lactation.
b- It is assumed that the recommended target level of a voluntary waiting period of 60 days is a reasonable reproductive index provided the cow has a history of normal calving without post-partum complications including retained placenta, metritis, milk

fever, endometritis, mastitis and lameness.

c- The cow feeding system is based on the NRC recommended ration for intensive feeding and no pasture available.

d- Lactation extends when calving to conception interval exceeds 85 days. The average extension has been reported to be 0.7 of a day per day (Pasma, 1994). This extension in lactation produces a small amount of extra milk which this, in turn, depends on the amount of milk produced by the cow, its peak milk production and the rate of decrease in milk production. The calculation was made on the assumption of the occurrence of a calving to conception interval of 85 to 100, 101 to 115, 116 to 145 or 146 to 175 days post-calving.

e- It is important to point out that although extension of the calving interval causes an increase in the current milk yield, the annual milk yield declines due to the delay of the next lactation. Delaying conception may increase yields in the current lactation by about 1 litre per day's delay (Esslemont *et al.*, 2000). This brings some income as the benefits of extended lactation which should be considered in the calculation.

f- Milk price was assumed to be 2700 Rials (~9000 Rials = \$1US) per litre. This was based on the current milk price assuming 2.5% milk fat. Concentrates are fed at a rate of 0.33 kg per litre of milk for cows averaging 5400 litres in 305 days (Chadwick, 1999).

g- Market value of one day old calf was assumed to be 2500000 Rials.

h- The cost of veterinary inspection and infertility treatments plus failed artificial inseminations was assumed to be 465000 Rials per affected cow.

i- An unplanned involuntary cull of the cow due to conception failure was not included in our calculations because cows failed to conceive due to the oestrus detection error are successfully treated in most situations by either correcting the oestrus detection or veterinary interventions.

Calculations

Given the above-quoted assumptions, the costs were calculated as follows: when a cow needs more time to get in calf, and when the calving to conception interval (CCI) extends over 85 days, the lactation

extends as well. The extension of the lactation is assumed to alter from 1 day per day in the first 15 day after 85 day post-calving, dropping 0.1 day for every 10 days (Esslemont *et al.*, 2000). An extension of the CCI can raise yields in the current longer lactation but it can decrease annual yield by delaying the next lactation. Therefore, net loss in annual yield per day of delay in conception for a cow with a peak production of 25 litres was calculated at 9.84 litres when conception is delayed from 85-100 days post-calving, increasing to 20.66 litres per day if conception occurred at 146-175 day post-calving. Therefore, one day delay in conception costs the farmer between 26568 to 55782 Rials. Concentrates (at 60000 Rials per tone) are fed for the marginal litre (0.33 kg per litre for a cow averaging 6000 litres) (Chadwick, 1999). So, the cost of concentrate saved ranges between 1948.32 to 4090.68 Rials (Table 2). The current price of a calf is approximately 2500000 Rials. So, the cost of calf per day will be 6849.3 Rials and an extra dry day is calculated as follows:

Initial investment for construction and equipment in a 50 unit dairy farm is assumed to be 125 million Rials. Therefore, equivalent uniform annual cost (EUAC) per head cow for initial investment can be calculated as follows:

$$EUAC = 125,000,000 (A/P, i, n) = 125,000,000 (A/P, 15\%, 30) = 125,000,000 (0.1523) = 19,037,500 \text{ Rials}$$

$$EUAC \text{ per head cow} = 19,037,500 \div 50 = 380,750 \text{ Rials}$$

$$\text{Cost of extra dry day} = 380750 \div 365 = 1034.15 \text{ Rials}$$

Where:

i = minimum attractive rate of return

n = economic life

$$(A/P, i, n) = \left[\frac{(1+i)^n i}{(1+i)^n - 1} \right] = \text{is known as}$$

the equal - payment - series capital - recovery factor

An estimate of 465000 Rials was made to assess the veterinary inspection (50000 Rials), routine infertility treatments (15000 Rials) for incorrect detected oestrus and extra artificial insemination of the cow (400000 Rials for the first failed AI and second AI after infertility treatment). This estimation was based on the current costs

involved. Further, it was assumed that a 200000 Rials straw of semen from registered Holstein bulls is routinely used by the farmer. So, one day delay in conception costs 11625 Rials (100-day calving to conception interval).

Delaying pregnancy itself may increase yields in the current lactation by about 1 litre per day's delay. Therefore, benefit of delay in conception on milk yield in current lactation is: $(1 \times 2200) - (0.33 \times 600) = 2002$ Rials.

Results

On the whole, milk progesterone concentration was greater than or equal to 3 ng/ml in 19 (10.6%) samples. Although there was a tendency towards a higher error in oestrus detection in dairy herds with more than 85 milking cows (14.4%) compared to that of the smaller size herds (7.3%) however the difference was not statistically significant ($\chi^2 = 2.59$; $P = 0.1$). The error in oestrus detection varied from 0 to 32% in dairy herds of different sizes. Five out of 11 herds (45%) had an oestrus detection error higher than 10 percent while in the remaining six herds the oestrus detection error varied from 0 to 7.1%. Milk progesterone concentration was between 1 to 3 ng/ml in 2 samples (2.4%). A composite summary of the results is presented in Table 1.

Based on the assumptions and calculations made in this study (Table 2), the net cost of one day delay in conception for a cow producing 25 litres milk in peak lactation was calculated at 40591.98 Rials when conception is delayed from 85 to 100 days post-calving, increasing to 60120.89 Rials per day if conception occurred at 146

to 175 days post-calving (Table 2). This implies that the farmer has to pay for one day delay in conception due to artificial insemination of a Holstein cow erroneously detected in oestrus under the above-mentioned circumstances. Now, assuming a dairy herd with a 20 percent error in oestrus detection has 50 milking cows that passed 60 days voluntary waiting period. If 40% of the milking cows (20 heads) had become pregnant within the acceptable days post-calving then the remaining 30 cows are empty and need attention to be detected in oestrus. A 20% error in oestrus detection submits 6 cows erroneously detected in oestrus. Therefore, the loss for one day delay in conception of 85 to 100 days calving to conception interval for these 6 cows (assuming two average producing cows and four high producing cows as defined above) would be 243551.88 Rials. Researchers have agreed on a less than 10% error in oestrus detection as the target level. Then, assuming 10% error is an unavoidable oestrus detection problem (Farin and Slenning, 2001) in this dairy herd, the economic loss due to the remaining 10% error comes to 129281.62 Rials per day delay in conception for the 6 cows.

Discussion

Milk progesterone assay and interestrus intervals examination have been used for determining the oestrus detection accuracy. Farin and Slenning (2001) believe that the most effective way to evaluate the accuracy of oestrus detection is to collect and freeze milk samples from each cow at the time of insemination and then assay for progesterone concentration. A low milk progesterone level does not necessarily

Table 1: Milk progesterone concentrations at the time of insemination in dairy herds in Shiraz area

Herds	No.	No. cows sampled	Milk progesterone concentrations (ng/ml)		
			<1*	1-3	≥3**
>85 Milking cows	4	83	69 (83.1%)	2 (2.4%)	12 (14.4%) ^a
<85 Milking cows	7	96	89 (92.7%)	0 (0.0%)	7 (7.3%) ^a
Total	11	179	158 (88.3%)	2 (1.1%)	19 (10.6%)

*Cows in oestrus; **Cows not in oestrus. Similar letters in the column show no significant difference ($\chi^2 = 2.59$; $P = 0.1$)

Table 2: Cost of delay in conception

Yield level	5400 litres per cow/year				9000 litres per cow/year				
	<u>85-100</u>	<u>101-115</u>	<u>116-145</u>	<u>146-175</u>	<u>85-115</u>	<u>116-145</u>	<u>146-175</u>	<u>176-205</u>	<u>206-235</u>
Number of days within delay interval	15	15	30	30	30	30	30	30	30
Number of days by which lactation is extended per one day delay	1.00	1.00	0.70	0.40	1	0.7	0.40	0.10	0.00
Effect of putting off next lactation (lost litres/day)	20.66	20.66	20.66	20.66	34.43	34.43	34.43	34.43	34.43
Yield in last day of extended lactation (litres)	10.82	10.32	9.66	8.60	23.09	21.49	20.00	18.59	17.29
Yield gained from the extended period (litres)	10.82	10.32	6.76	3.44	23.09	15.04	8.00	1.86	0.00
Net loss in annual yield per day of delay in conception (litres)	9.84	10.34	13.96	17.22	11.34	19.39	26.43	32.57	34.43
Value of milk loss (2700 Rials/litres)	26568	27918	37692	46494	30618	52353	71361	87939	92961
Concentrate feeding rate (kg/litre)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Cost of concentrate saved (600000 Rials/tonne)	1948.32	2047.32	2764.08	3409.56	2245.32	3839.22	5233.14	6448.86	6817.14
Loss per day of delay (Rials)	24619.68	25870.68	34927.92	43084.44	28372.68	48513.78	66127.86	81490.14	86143.86
Cost of calf per day (2500000/calf)	6849.3	6849.3	6849.3	6849.3	6849.3	6849.3	6849.3	6849.3	6849.3
Cost of extra dry period (Rials/day)	0.0	310.25	620.49	1034.15	0.0	310.25	620.49	930.74	1034.15
Cost of extra veterinary treatments & AI (20000 Rials/day of delay)	11625	11625	11625	11625	11625	11625	11625	11625	11625
Benefit of delay in conception on milk yield in current lactation (Rials)	2502	2502	2502	2502	2502	2502	2502	2502	2502
Net cost of lost day (Rials)	40591.98	42153.23	51520.71	60120.89	44344.98	64796.33	82720.65	98393.18	103150.31
Cost of delay interval (Rials)	608879.7	632298.45	1545621.3	1803626.7	1330349.4	1943889.9	2481619.5	2951795.4	3094509.3
Cumulative cost (Rials)		1241178.15	2786799.45	4590425.15		3274239.3	5755858.8	8707654.2	11802163.5

mean that the cow was in oestrus however, a high milk progesterone level does mean that the cow has not been in oestrus. Results of the present study showed an overall mean 10.6 error in oestrus detection in the cows inseminated in the dairy herds in Shiraz area. This rate of error, at the first glance and based on the recommended bovine fertility targets (Reimers *et al.*, 1985; Farin and Slenning, 2001), does show a marginally acceptable level of error in oestrus detection in Shiraz area. However, the oestrus detection accuracy was suboptimal (68.75 to 88.24%) in 45% of dairy herds in Shiraz area. Using milk progesterone assay, the accuracy of oestrus detection in dairy cows was variably reported from 40 to 92.3% in different studies (MaCaughey and Cooper, 1980; Reimers *et al.*, 1985; White and Sheldon, 2001).

The overall mean error in oestrus detection in herds with more than 85 milking cows was non-significantly higher than herds with less than 85 milking cows in the present study (14.4 vs 7.3%). Reimers *et al.* (1985), using milk progesterone assay in a large scale study in the USA, observed no significant difference in oestrus detection error as the herd size increased. As herd size increases, less individual attention is allocated for care of cows resulting in increased the possibility of mis-diagnosed oestrus cows (Stevenson, 2000). Accuracy of oestrus detection seems to be herd specific. Factors such as experienced farm personnel (Sprecher *et al.*, 1995) as well as cow genetic background, daily routine activities at the farm and housing type may significantly affect the accuracy of oestrus detection.

The results of the first part of the present study formed the basis for calculating the economical loss resulting from one day delay in conception in an average and high producing Holstein cow kept in Shiraz dairy herds. The financial implications of delays in conception could similarly be investigated under different management systems in other regions of Iran. Esslemont *et al.* (2000) calculated the economical loss resulting from delay in conception at various stages of lactation for two levels of average (5400 litres per cow per 305 days) and high (9000

litres per cow per 305 days) milk producing cows. Their calculation was based on the costs of an unplanned cull, calving disorders and production diseases, veterinary treatments, extra artificial inseminations and the replacement cost. The benefits of delay in conception such as the income for extra milk production and reduced risk of diseases were also included in their calculation. The amount of the extra milk produced depends on the whole yield of the cow over the lactation, its peak, the weekly rate of decline, breed, feeding and lactation number (Schutte, 1996). Further, the season of milk production and milk quality may affect the price of milk produced. Similar studies are needed to evaluate the financial loss associated with other reproductive diseases under different management system in Iran.

In countries with a banking system of high interest and high inflation rates, it seems reasonable to include the loss of currency value after the initial investment and expenses for dairy facilities, in the calculation of the economical loss as well. In addition, the rapid yearly increasing of the milk price, feeds and treatment costs could accumulatively impose a higher economical loss on the farmers.

In conclusion, the present study suggests that suboptimal accuracy in oestrus detection is a major problem in a significant number of dairy herds in Shiraz area. Based on the assumptions and calculations made above, the net cost of one day delay in conception for a cow producing 25 litres milk in peak lactation was calculated at 40591.98 Rials (4.51 US\$) when conception is delayed from 85 to 100 days post calving, increasing to 60120.89 Rials (6.68 US\$) per day if conception occurred at 146 to 175 days post-calving. The economical loss due to delays in conception caused by error in oestrus detection is remarkably high and it is therefore important to train herdsmen and update veterinarians regularly to improve the accuracy of oestrus detection in dairy cows.

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