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Decreasing Fertility in Dairy Cows: Myth or Reality?

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Many studies have reported a decrease in the fertility of dairy cows. This situation is widespread since the studies have originated in regions all over the globe. For example, in the United States, the conception rate at first artificial insemination (AI) has decreased by 0.45% per year over a twenty year period (Butler and Smith, 1989; Beam and Butler, 1999). In England, this decrease has been in the order of 1% per year (Royal et al., 2000a; Royal et al., 2000b).

In the Netherlands, the success rate at first AI went down from 55.5% to 45.5% in 10 years (Jorristma et al., 2000.) In Spain, the same result was obtained by analyzing data from 12,711 lactations over a period of 10 years from 1991 to 2000. The authors observed an increase of 4.6% in the level of ovarian inactivity during the study period. In the U.S.A., Lucy (2001) reported an increase in the number of AIs required for conception, from 1.75 to more than 3 over a period of 20 years. In Ireland, the number of AIs per conception went from 1.54 to 1.75 between 1990 and 2000 (Mee et al., 2004 – abstract 3431), which corresponds to conception rates of 64.9% and 57.1%, respectively. In France between 1988 and 1997, Chevalier and Humblot (personal communication, 1999) reported that out of more than 157,630 first AIs per year, there was a 15% decrease in the non-return rate (NRR). Canada is no exception to this phenomenon. In fact, analysis of insemination data of Canadian Holstein cows between 1995 and 2001 has shown a decrease in the NRR rate at 56 days from above 69% down to 67% (VanDoormal, 2002). In Quebec, fertility as measured by the conception rate at first and second AI (CR1 and CR2) has been continually on the decrease since 1990. CR1 went down from 44% to 39% while CR2 was reduced from 47% to 41%, resulting in a decrease of approximately 5% in 10 years: this corresponds to a minimum increase of 0.48 AI per cow per lactation (Bouchard et Du Tremblay, 2003.)

These reports from various countries have provoked an alarmed response that continues unabated. The goal of this article is to review the various factors associated with decreasing fertility and specially management factors. In addition to the information collected worldwide, the authors will use data from 250,000 dairy cows in Quebec, Ontario and New Brunswick.

A- Indicators of fertility

In the evaluation of reproduction it is important to differentiate between the concepts of reproductive performance, which is defined as the female's ability to produce a live calf, and fertility. Reproductive performance is affected by fertility, embryonic and fetal development, calving and calf survival. Reproductive performance is calculated using various indicators such the number of days open (the interval between calving and successful AI) or the interval between successive calving. These two indicators are influenced by cow fertility as well as by other herd management factors, like heat detection and the length of the voluntary waiting period (interval between calving and time to first AI).

For an adequate evaluation of bovine fertility, we need to refer to certain standards (Esslemont and Kossaibati, 2000). Cow fertility is generally evaluated by the conception rate (CR), defined as the proportion of cows declared pregnant following AI. This indicator is inversely related with the number of AIs per conception.

Artificial insemination centres use indicators calculated from available data. In general, they use the NRR (at day 56 or 60.) This corresponds to the proportion of AI without a second AI within a predetermined period. In the United States, bull fertility is evaluated using the ERCR (Estimated Relative Conception Rate). It may be interpreted as being the NRR at 70 days of the AIs performed using a bull in relation to that of the other bulls used for the same herd. In this case, factors such as the age of the cow, lactation stage and milk production are taken into consideration for the calculation.

B- Factors that influence fertility

Age of the cows

Analysis of fertility data demonstrates unequivocally that decreased fertility is associated with lactation number in cows. A study undertaken by the ASTLQ (Quebec Dairy Herd Health Improvement) between 1993 and 2002 on 60,000 cows/year from 2000 dairy farms (Bouchard and DuTremblay, 2003) shows no change in the conception rate at first AI (CR1) and second AI (CR2) in heifers. However, an important decrease was observed in cows, including primiparous cows (see Table I.) The same trend was demonstrated in AI centres in Canada and the United States (Fricke, 2002; Van Doormaal, 2002).

Data collected from embryo transfers, even though they are performed under different conditions than regular AIs, show the same influence of age on cow fertility. An analysis of data collected from 2809 embryo harvests performed after insemination with semen from six of the most frequently-used bulls shows that:1) the percentage of unfertilized ova in collections performed on primiparous cows is twice that of heifers; and 2) the percentages of unfertilized ova and degenerated embryos of the total embryo/ova collected increases with the age of the cows (Gestion des récoltes, Québec, 2003).

Production and nutrition

All reports have shown an association between an increase in milk production over the years and a decrease in fertility (Lucy, 2001.) The Quebec study of dairy herds shows that in

comparison to cows whose production is less than 7500 kg, CR1 decreases by 7.8% in cows who produce 7500 – 10,000 kg at 305 days and by 15% in cows who produce more than 10,000 kg. It is important to note that in this study, the effect of milk production has been adjusted for disease, lactation number, hormone use and for days in milk. As expected, the decrease in fertility is less important for CR2 (Bouchard and DuTremblay, 2003). Over a period of 10 years in the Quebec dairy herds studied, the average milk production increased from 6800 kg in 1990 to 8800 kg in 2001, while CR1 decreased from 44% to 39%.

Nutrition influences the reproductive endocrinology of the cow. Any deficiencies are difficult to separate from the animal's production level: high-producing cows enter a phase of negative energy balance at the very moment they should normally initiate a phase of reproductive cycling. Negative energy balance adversely affects the normal development of follicles, given the involvement of local and systemic production of growth factors, in particular the insulin growth factor (IGF-1.) When the cow is undernourished or in a phase of negative energy balance, there is a decrease in IGF-1 levels, as well as decreased insulin release and a reduction in the liver's growth hormone receptors (Webb et al., 1999.)

Physiology of dairy cow reproduction

Some researchers have suggested that the endocrinology of the dairy cow has changed over the years due to genetic selection that favours production and physical conformation values to the detriment of reproduction. In cows whose estrus cycles were subject to intense scrutiny 20 years ago, the luteal phase of the first cycle following parturition tended to be shorter than in subsequent cycles (10.6 versus 14.9 days) (Darwash et al., 1997). However, the difference is not as evident today, because the luteal phase lasts approximately 15 days for the first four cycles after parturition (Royal et al., 2000). More recently, a British study demonstrated that shorter intervals between luteal phases correlate positively with higher fertility levels in Friesians (Veerkamp et al., 2000), and that there could be a genetic link (heritability; $h^2 = 0.21$, $p<0.01$) (Darwash et al., 1997.)

Influence of artificial control of the estrus cycle

The increasingly common use of protocols for the hormonal control of estrus has so far produced varying results, ranging from negative effects (Donovan et al., 2003; Morel et al., 1991), to no effect (Xu et al., 1998) to positive effects on dairy cow fertility (McIntosh et al., 1984). However, researchers have noted that fertility in these cases is not affected when inseminations are made upon observed estrus. Fixed-time insemination without prior estrus detection is an approach that has gained in popularity (Bo and Mapletoft, 2004), but it is generally recognized that it can result in decreased conception rates at first AI (Lucy, 2001). In the Quebec study, the use of prostaglandins (with or without a synchronization protocol) before first insemination was associated with a decrease of approximately 3% in conception rates.

Fertility decrease due to disease

Studies have shown that disease, whether or not it is associated with the reproductive system, has a greater impact on fertility than milk production (Eicher and coll., 1996; Gröhn and Rajala-Schultz, 2000; Loeffler and coll., 1999). ASTLQ data analysis has shown that metritis, dystocia, lameness, mastitis, and retained placenta all have a negative effect on CR1,

decreasing it at respective rates of: 8.0%, 6.0%, 4.3%, 2.8% and 2.5% (Bouchard and Tremblay, 2003).

Conclusion

The nutrition and general management of dairy cows have both changed considerably in the past 40 years. Changes have generally been made by trying to adapt the cow to nutrition and management without considering the long-term consequences on the basic reproductive physiology of the animal. Since reproductive parameters have low heritability, the application of new reproductive techniques within the framework of an adapted reproductive health program appears to be an option that deserves further exploration to reverse the current trend of decreasing fertility.

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Abstract

On observe une baisse de fertilité chez la vache laitière dans plusieurs régions du monde. Cette présentation aborde les facteurs associés à la vache, son alimentation, son état de santé et à la gestion du troupeau qui peuvent expliquer cette baisse.

References

1. Beam SW, Butler WR. Effects of energy balance on follicular development and first ovulation in post partum dairy cows. J Reprod Fertil 1999; 54 (Suppl);411-424.
2. Bouchard E, Du Tremblay D. Portrait Québécois de la reproduction. Recueil des conférences du Symposium des Bovins laitiers, Saint-Hyacinthe, 2003, pp. 13-23.
3. Butler WR, Smith RD. Interrelationships between energy balance and postpartum reproductive function in dairy cattle. J Dairy Sci 1989; 72:767-783.
4. Darwash AO, Lamming, GE, Woolliams, JA. Identifying heritable endocrine parameters associated with fertility in post partum dairy cows. Proceedings of the International Workshop on Genetic Improvement of Functional Traits in Cattle; Fertility and Reproduction, GRUB, Germany, November 23-25, 1997; Interbull. 18:40-54.
5. Donovan GA, Bennett FL, Springer FS. Factors associated with first service conception in artificially inseminated nulliparous Holstein heifers. Theriogenology 2003; 60:67-75.
6. Eicher SW, Gröhn YT, Hertl JA. The association between cumulative milk yield, days open, and days to first breeding in New York Holstein cows. Journal of Dairy Science 1996, 79:235-241.
7. Esslemont RJ and Kossaibati MA. The use of databases to manage fertility. Anim Reprod Sci 2000 ;60-61, pp 725-741.
8. Fricke P. Measuring reproductive levels, Dairy, 2002 Jan-Feb; 30-33.
9. Gröhn YT, Rajala-Schultz PJ. Epidemiology of reproductive performance in dairy cows. Animal 9. Reproduction Science 2000; 60-61:605-614.
10. Loeffler SH, de Vries MJ, Schukken YH. The effects of time of disease occurrence, milk yield and body condition score on fertility of dairy cows. Journal of Dairy Science 1999; 82:2589-2604.

11. Lucy MC. Reproductive loss in high-producing dairy cattle: where will it end? J Dairy Sci 2001;84:1277-1293.
12. McIntosh DAD, Lewis JA, Hammond D. Conception rates in dairy cattle treated with cloprostenol and inseminated at observed oestrus. Vet Rec 1984; 115:129-130.
13. Mee J , Ross E and Dillon P. Is Irish dairy herd fertility declining? Proceedings of the 23rd World Buiatrics congress, Quebec, 2004; abstract 3431.
14. Morel JM, Noakes DE, Zintzaras E, Dresser DW. Apparent decline in fertility in heifers after repeated oestrus synchronization with cloprostenol. Vet Rec 1991; 128:404-407.
15. Royal MD, Darwash AO, Flint APF, Webb R, Woolliams JA, Lamming, GE. Declining fertility in dairy cattle: changes in traditional and endocrine parameters of fertility. Anim Sci 2000a; 70:487-501.
16. Royal M, Mann GE, Flint APE. Strategies for reversing the trend towards subfertility in dairy cattle. Vet J 2000b; 160:53-60.
17. Van Doormall B. Effet de l'âge et du mois d'insémination sur la fertilité, 4 pages. www.cdn.ca/articles/fertility-f. 2002.
18. Veerkamp RF, Oldenbroek JK, Van Der Gaast HJ, Van Der Werf JHJ. The genetic correlation between days until start of luteal activity and milk yield, energy balance and live weights. J Dairy Sci 2000; 83, 577-583.
19. Webb R, Garnsworthy PC, Gong JG, Robinson RS, Wathes DC. Consequences for reproductive function of metabolic adaptation to load. British Society of Animal Science, Occasional Publication No 24, 1999; 99-112.
20. Xu ZZ, Burton LJ. Synchronization with PGF2 alpha administered 18 days after a progesterone treatment in lactating dairy cows. Theriogenology 1998; 50:905-915.

Table I. Observed conception rates in heifers and cows of different parities in 1993 and 2002 of 2000 dairy herds in Quebec (ASTLQ, 2003).

	Heifers		Primiparous cows		Pluriparous cows	
	1993	2002	1993	2002	1993	2002
Number of animals	12 656	16 126	14 000	15440	47 442	68 364
CR1*	60	63	49	43	46	39
CR2	50	55	50	45	47	41

*CR1 and CR2 = Conception rates at 1st and 2nd AI