

# Dairy Split Session II

Moderator - Karen Jacobsen

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## Management and Economics of Natural Service Sires on Dairy Herds

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Reproductive efficiency in a dairy herd improves when the percentage of pregnancies resulting from artificial insemination (AI) increases. As described by Bartlett's equation of reproduction, four factors determine the percent of resulting pregnancies from AI.<sup>1</sup> These factors are: cows detected in heat and inseminated, fertility level of the herd, semen fertility level and inseminator efficiency. The percentage of pregnancies resulting from AI is the product of these four factors and not their average. When these factors are multiplied, their product or percent pregnant is less than the lowest factor. The effect of a low factor has a cumulative effect on the percentage of pregnancies and is never averaged out. Examining this equation provides producers with a working concept of dairy cattle reproduction. Of the factors included in the equation of reproduction, the inability to detect estrus efficiently and accurately are the major impediments in attaining an optimal percentage of pregnant cows from AI. Estrus detection efficiency is expressed as the percentage of estruses observed over a given time period.<sup>2</sup> Accuracy of heat detection is the percentage of estruses observed that are true estruses.<sup>2</sup> Collectively, errors in efficiency and accuracy of heat detection results in high semen cost and an increase in the interval from calving to conception, reducing cow production and net returns.

To eliminate inefficient heat detection many dairies use natural service (NS) bulls. The perception is that pregnancy rates improves when NS is used because more cows are detected in true estrus and serviced; that is the intensity and accuracy improves in the herd. A 1984 survey of dairy herds in Florida showed that 50 per cent used AI, 38 per cent used a combination of AI and NS, and the remainder used mostly NS.<sup>3</sup> A Pennsylvania

study involving 329 dairy farms, evaluated the method used in breeding heifers; 11.2 per cent bred their heifers once with AI then used a bull, 8.5 per cent bred their heifers twice with AI then used bulls and 20.7 per cent bred their heifers with bulls only.<sup>4</sup> Estimates from large dairy herds in Florida and Texas indicates that the use of NS is still widespread particularly in dairy herds employing a rotational grazing management. Dairy herds that use NS bulls usually do not raise replacement heifers, the genetic balance of the herd can be maintained by purchasing replacement heifers from breeders who are using AI with semen from proven bulls.

The use of NS can reduce the negative effect that people can have on reproduction by eliminating errors in estrus detection. However, when the equation of reproduction is re-examined using NS, it becomes apparent that the fertility of the bull and his ability to service cows that are in estrus greatly determines the pregnancy outcome. Therefore, in order to adequately exploit the use of NS in dairy herds, proper selection and management of these bulls should be included in the overall herd health program of the dairy. In addition, to prevent the disastrous economic consequences of sub-fertile bulls, periodic evaluation of their reproductive performance must be performed.

### **Economics of Heat Detection (AI vs NS)**

The economics of NS bulls versus AI are usually determined by calculating the cost of semen, equipment, personnel and cost of bull maintenance. The major argument against the use of NS is the predicted difference in milk yield of AI daughters compared to NS daughters.<sup>3</sup> However, a major economic consideration for using

NS bulls is the potential for the improvement in the herds reproductive efficiency by maximizing heat detection and conception rates. Use of NS bulls may result in higher conception rates when compared to AI because errors in heat detection are removed. In general, as heat detection rates improve, net revenues increase as a result of higher milk yields per cow. To illustrate this concept, the projected effect of three different heat detection rates on milk production and economic return is shown in Table 1.<sup>3</sup>

**Table 1.** Estimated long-term (10 yr) effects of heat detections rates (47, 57, & 67%) on milk production & net revenues/cow/yr at a seasonally adjusted conception rate of 30% (From Chenoweth, P.J. and Larsen, R.E., Large Dairy Herd Management, Page 209, 1992).

Heat detection rate	Annual milk production/cow (10 yr avg)	Expected change per +10% HDR	Net revenues/cow/year (10yr avg.)
47	14,914 lb		700.82
57	15,284 lb	+370 lb	740.75
67	15,476 lb	+192 lb	763.72

The model uses a seasonally adjusted conception rate of 30 per cent.<sup>5</sup> This model shows that an increase in heat detection rate from 47 per cent to 57 per cent produces an increase in milk yield of 370 lb of milk per cow per year and \$39.97 per cow per year when modeled over a 10 year period. In addition, the replacement rate of a herd is also reduced as heat detection rates improves Table 2.<sup>3</sup>

**Table 2.** Culling/replacement rate and average months in the herd/cow when conception rate averages 30% and heat detection rate is varied (47, 57, & 67%) (From Chenoweth, P.J. and Larsen, R.E., Large Dairy Herd Management, Page 210, 1992).

	Heat detection rate		
	47%	57%	67%
Replacement rate	.41	.35	.33
Avg. mo in herd/cow	25.06	28.08	29.54

By evaluating the prevailing heat detection and conception rates in a herd, the effective pregnancy rate (heat detection rate x conception rate) of that herd can be determined. The effective pregnancy rate can then be used to determine if the use of NS bulls would im-

prove reproductive efficiency in the herd. Chenoweth and Larsen,<sup>3</sup> have estimated that effective pregnancy rate exert their greatest effect on herd production, profit and replacement rate when it is between 15 and 25 per cent, as shown in Table 3. Conversely, if a dairy herd has an effective pregnancy rate greater than 25 per cent, the use of NS bulls would not result in a significant improvement in net income per cow. Therefore, the expected change in yield per cow based on increased heat detection, through the use of NS bulls or improved heat detection management, can be utilized to calculate the net value of high predicted difference AI semen as compared with the value of higher heat detection rate.<sup>3</sup>

**Table 3.** Effective pregnancy rate (conception rate x heat detection rate) influence on milk/cow/yr, net income/cow/yr, and replacement rate (From Chenoweth, P.J. and Larsen, R.E., Large Dairy Herd Management, Page 212, 1992).

Effective pregnancy rate	Milk/cow	Net \$/cow	Replacement rate
.15	14,826	\$688	.38
.25	16,127	\$828	.27
.25	16,110	\$825	.27
.35	16,482	\$865	.26
.45	16,726	\$896	.25
.63	16,951	\$925	.27

The male effect or biostimulation on female reproduction is well known.<sup>6</sup> Rams introduced early in the breeding season induce and appear to synchronize estrus in ewes. In sheep, this biostimulation effect occurs in ewes that are in transitional cyclicity from the non-breeding to the breeding season and the males are introduced as a novel stimulus. Natural service bulls are often used in dairy herds in cows which already have cycled and have received multiple AI. These are the so called repeat or problem breeders and, in this scenario, biostimulation would probably not play a role. However, in those herds that use natural service only, bulls are introduced to cows in early lactation when the cows are in a transition cyclicity state. In this situation it is possible that some form of biostimulation may occur. An advantage seen for NS over AI suggested a possible male effect.<sup>7</sup> It should be kept in mind that comparison of NS versus AI is difficult to make. Most researchers in this field conclude that a biostimulation effect in cattle in the presence of bulls remains uncertain.

### Selection of Bulls

Regardless of the genotype used for natural service in a dairy herd, bulls must be carefully selected.

The selected bulls should have the capability to detect females in estrus and be able to impregnate them. The ability of the bull to perform this task is dependent on his semen quality, libido, mating ability and social ranking among other bulls and females.<sup>7</sup> Therefore, in common with the recommendations made for beef bulls, selection of bulls for natural service in dairy herds should be subjected to a breeding soundness examination, as recommended by the Society of Theriogenology.<sup>8</sup> Only those bulls that successfully pass their BSE should be used. This examination should be repeated on an annual basis. It is recommended to use bulls that are less than 2 to 2.5 years old.<sup>3</sup> Young bulls should have achieved full puberty and sexual maturity which occur around 14 months of age and should not be under-sized in relation to a mature Holstein cow.

Economic losses that occur from use of NS bulls due to lower milk production in daughters from these bulls are high. The sire-of daughter pathway was the weakest area of genetic improvement in the United States because of extensive use of NS bulls with low genetic merit.<sup>9</sup> Lost revenue is the value of 695 lb of milk in each lactation over each generation. To help reduce these losses from genetically inferior NS bulls, producers should consider using bulls for natural service that are good enough for AI sampling. The genetic merit of young bulls used in AI sampling is as good as that for the average active AI bull. The typical bull in AI sampling would be at percentile 50, just like the typical active AI bull.<sup>9</sup>

### Measuring Efficiency of NS Bull Breeding Programs

Adequate records and their proper analysis and interpretation are fundamental to effective reproductive management. Dairy herd improvement association (DHIA) records are widely used by dairymen throughout the nation, and are frequently analyzed by veterinarians in North America.<sup>10</sup> In dairy herds that use NS bulls in their reproductive program, DHIA records can be used to evaluate the overall herd reproductive performance, which include breeding for both AI and NS bulls. However, these records are not designed to assess the efficiency or performance of NS bulls used in the herd. Therefore, accurate evaluation of the dairy's NS reproductive program is difficult to make. A case in point is the practice by many Dairy Records Processing Centers to enter just a single service in the record for successful bull breedings, regardless of the number of services. This practice gives an inaccurate evaluation of NS bulls reproductive performance. It is important to accurately monitor NS bull performance in order to make correct and prompt decisions to replace sub-fertile bulls.

The reproduction committee of the American As-

sociation of Bovine Practitioners in 1991 recommended reproductive indices for herds using NS bulls.<sup>11</sup> These indices have been summarized by Chenoweth and Larsen<sup>3</sup> and Upham.<sup>12</sup>

#### 1. Percentage Cows Pregnant by the Bull

Calculated as:  $BP/TP \times 100$

Estimates the percentage of pregnancies due to NS bulls (BP) relative to all pregnancies including AI in the herd (TP). This measurement requires that the veterinarian estimates the date of conception in cows that have been bred by a bull so that pregnancies from NS can be distinguish from AI. A high value indicates a low estrous detection and AI technician efficiency for the AI component of the herd.<sup>3</sup>

#### 2. Average Days Open with the Bull

Calculated as : 
$$\frac{\text{sum of days between Turned with Bull date and estimated date of conception for cows confirmed in bull breeding}}{\text{number of cows confirmed to bull breeding}}$$

A performance value recommended is between 40 to 50 days. Elevated values could indicate low cow fertility or low bull fertility.<sup>12</sup>

#### 3. Cow to Bull Ratio

Calculated as: 
$$\frac{\text{cows Turned with Bull and not confirmed pregnant}}{\text{number of bulls with access to cows}}$$

This calculation is used to determined if the low bull fertility is caused by a large cow to bull ratio. The cow to bull ration should vary between 20 to 30.<sup>3,12</sup>

#### 4. Bull Services per Pregnancies

Calculated as: 
$$\frac{\text{average of (conception date - [turned with bull date + 10]) for all cows confirmed pregnant to bull during period}}{21}$$

This calculation excludes open exposed cows until they are diagnosed pregnant. The reciprocal of this figure estimates the conception rate for bull services and can be used for comparison to AI conception rates.<sup>12</sup>

The author is not aware of any current software program that evaluates reproductive performance in bulls. Therefore, the above calculations require that dili-

gent records be kept by the producer and veterinary analysis of these records are conducted on a timely basis. Accurate information on NS breeding efficiency is difficult to obtain because, in many situations, NS bulls are used in cows that have failed to conceive after various AI attempts.<sup>13</sup>

### Management of Bulls

In many situations, NS bulls fail to participate in the health programs designed for the cows. Bulls used for NS should receive the same vaccinations for cows with the exception of Brucellosis.

Venereal diseases such as vibriosis and trichomoniasis are an important consideration when using NS bulls. For vibriosis, vaccination of females affords the best protection with best timing at several weeks prior to breeding. It is recommended that cows are vaccinated at least 3 weeks prior to bull exposure. Some success also has been attained with the vaccination of bulls.<sup>3</sup>

Vaccination for trichomoniasis is also available for females only.

The clinical picture for both of these venereal diseases is similar. The herd picture is one of repeat breedings which contribute to an increase to the interval from calving to conception in the herd. In addition, abortions may occur in the second trimester. In trichomoniasis, pyometra may occur in some cows. Diagnosis is best done with appropriate sampling from both bulls and cows. In cows affected with pyometra as a result of trichomoniasis, culturing is often unrewarding. In the majority of dairy farms bulls are purchased and have an unknown history of vaccination. It may be worthwhile for the veterinarian to design a protocol for the management and care of bulls used for NS that includes a physical examination, BSE, vaccination and deworming program.

Bulls being used for natural service should not be allowed to become overconditioned or to develop foot and leg problems. These undesirable traits negatively affect the breeding soundness of bulls. Rations which are balanced for middle to high producing dairy cows contain higher energy, protein and calcium levels than those required by the bull.<sup>14</sup> The excess in energy intake can predispose the bull to overconditioning and laminitis. Feeding bulls a high level of dietary calcium has been associated with lameness in conjunction with bone lesions in the spine and hip regions.<sup>3</sup> Evaluation of body condition and lameness should be conducted frequently in NS bulls.

During the past years, there has been a concern over the effect of gossypol from diets containing cottonseed products on bull fertility. In many dairy regions of the United States as much as 8 pounds (15 per cent DM

basis) of whole cottonseed is fed in total mixed rations balanced for high producing dairy cattle. A mature Holstein bull with a dry matter intake of 13 kg<sup>14</sup> could consume as much as 13 g of free gossypol per day. Whether or not gossypol intake at this level has a detrimental effect on bull fertility is not definitively known. An increase in sperm cell midpiece abnormality and erythrocyte osmotic fragility in Brahman bulls fed 2.75 kg of cottonseed meal (8.2 g of free gossypol per day) has been reported.<sup>15</sup> In contrast, Hereford bulls ingesting 7.6 to 19.8 g of free gossypol daily from whole cottonseed showed no significant sperm cell abnormalities.<sup>16</sup> In the above study,<sup>16</sup> it was suggested that the mineral content of the drinking water contained sufficient minerals to bind with the free gossypol.

The type of cottonseed product (meal vs whole seed), and gossypol enantiomer (+ or -) may determine the extent of the toxicological effect that will occur and may explain the variable results obtained in research trial.<sup>17</sup> It has been suggested that detoxification of gossypol in the rumen is more efficient with whole seed diets than with cottonseed meal diets.<sup>17</sup> Brahman bulls fed 1.8 g/day of free gossypol from cottonseed meal had similar damage to seminiferous epithelium when compared to bulls fed 16 g/day of free gossypol from whole cottonseed.<sup>18</sup> The spermicidal effect of gossypol may also depend on the predominant + or - gossypol enantiomer present in the cottonseed product. Due to its stereospecific binding properties, the (-) gossypol enantiomer is less bound to plasma proteins and appears better able to cross the blood-testis barrier in vivo and inhibit the biological activity of some proteins.<sup>19</sup> The type of cottonseed used and gossypol enantiomer present, have contributed to the variable results obtained in gossypol related studies.

Recommendations in terms of gossypol intake in the total diet for bulls used for breeding is 200 mg/kg for diets composed of cottonseed meal and 900 mg/kg for diets composed of whole cottonseed.<sup>20</sup> However, the relevance of gossypol studies to commercial cattle operations needs to be carefully considered. The free gossypol content in the cottonseed meal study rations cited above, was obtained from solvent extraction methods, which accounts for less than 2 per cent of the oil extraction method used today. In addition, males in gossypol related studies have not been subjected to a fertility evaluation.

### Conclusion

Despite the tremendous evidence supporting the economical advantage of AI to NS bull, many dairy producers feel that the use of natural service is advantageous to their reproductive management. Considering the prevailing heat detection and pregnancy

rate in a dairy farm, the use of NS becomes a valid option when the effective pregnancy rate (heat detection rate x conception rate) falls below 25 per cent. This option will only be maximized if bulls that are able to impregnate an estrous cow are used. Therefore, bulls should pass a BSE prior to use and should be repeated frequently. With the exception of brucellosis, bulls should undergo the same herd health procedures as the cows. Particular attention should be made to the prevention of vibriosis and trichomoniasis. Reproductive performance monitoring of NS bulls should be conducted on a periodic basis. Attention should be given to the recommended indices for monitoring NS bull performance. Veterinarians should be vigilant of dietary factors that may impair bull fertility.

**A tremendous amount of time is spent by dairy consultants in convincing producers not to use NS bulls in their operations. As is often the case, these producers have made certain financial considerations that are unknown or understood by the consultant in order to arrive at the decision to use a bull. Perhaps our clients would be better served by convincing them to implement a sound management program for NS bulls in their herds.**

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## FUTURE MEETINGS

### American Association of Bovine Practitioners

1997	Montreal	September	18-21
1998	Spokane	September	24-27
1999	Nashville	September	23-26
2000	Rapid City	September	21-24
2001	Vancouver	September	13-16