

MANAGEMENT AND ECONOMICS OF NATURAL SERVICE BULLS IN DAIRY HERDS

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Inability to efficiently and accurately detect estrus in dairy herds is a major constraint to the attainment of maximum reproductive efficiency with artificial insemination (AI). Efficiency of estrus detection is assessed as the percentage of the herd detected in estrus during a stipulated period, whereas, accuracy gauges the percentage of these which represent a true estrus¹. In 4,550 herds monitored by the Raleigh DHIA processing center the mean efficiency of estrus detection was 38%¹. Different surveys show that 5 to 25% of cows presented for insemination are not in estrus^{2,3}. Together, errors in estrus efficiency and accuracy lead to an increase in the interval from calving to conception resulting in reduced milk production, an increase in heifer replacements and consequently a reduction in farm income.

To improve the efficiency of estrus detection, many dairies employ natural service (NS) bulls, based on the perception that NS results in higher pregnancy rates due to improvements in estrus detection efficiency and accuracy. In other words, NS avoids human errors in estrus detection. A 1984 Florida survey showed that 50% of dairies used only AI, 38% used a combination of AI and NS, and the remainder used mostly NS⁴. In a Pennsylvania study of heifer breeding methods on 329 dairy farms, 11.2% bred their heifers once with AI and then used a bull, 8.5% bred their heifers twice with AI then used bulls, 20.7% bred their heifers with bulls only, and 59.6% used only AI⁵. Indications are that use of NS is increasing in areas such as the Midwest, perhaps related to increases in herd size.

With NS, bull infertility could have very serious economic consequences. Thus, for NS to be effective, the selection, management and evaluation of bulls should be important components of the dairy herd health program.

Economics of Heat Detection (AI vs NS)

Economic comparisons of AI vs NS usually estimate components of AI (semen cost, equipment, personnel) vs those of bull breeding (bull cost, maintenance and salvage) and compare these with milk yield of daughters obtained by either method. An advantage in milk yield in daughters from AI programs is usually expected. However, use of NS is considered to be advantageous for herd

reproductive efficiency because of improved estrus detection and conception rates. In general, improved estrus detection rates are associated with reduced calving to conception intervals (Fig. 1), which in turn lead to higher milk yields per cow and increased revenues. To illustrate this concept, estimates are shown of the effects of different estrus detection rates on milk production, replacement rates and costs and net income per cow (Table 1). Here, a model, which employs a seasonally adjusted conception rate of 32%, shows that an increase in estrus detection from 43 to 60% produces an increase in milk yield of 700 lb/cow/year, as well as a reduction in the replacement rate from 38 to 32%^{4,6}. Together, these result in an estimated difference of \$141/cow/year. The following assumptions were made for this model net milk price, \$13 per 100 pounds; ration cost for lactating cows of \$0.08 per pound of DMI; feed cost for dry cows of \$1.00 per cow per day; cost of first calf heifer replacement \$1200 and a salvage price for cull cows of \$0.35 per pound of body weight.

The product of estrus detection and conception rates will give the effective pregnancy rate (EPR). This, in turn, can help determine whether or not the use of NS improves herd reproductive efficiency. As shown in Figure 2, the income effect of EPR diminishes as EPR increases. At EPRs above 25%, the estimated net income per cows begins to decline and the use of NS bulls in dairies that have an EPR above 25% may not be an economic advantage. It should be emphasized that the net revenues obtained from this model depend on the economic assumptions or inputs used. However, irregardless of the inputs used the concept is the same, subsequent changes above an EPR of 25% results in smaller incremental increases in net revenue and level off at 35% (DeLorenzo unpublished information). With this graph expected changes in yield per cow obtainable via either NS or via AI may be estimated. This can be used to compare the net values obtained through either higher predicted progeny differences in milk yield, as with AI, or via improved estrus detection rates, as with NS⁴.

Bull Selection

Bulls for use in NS should be carefully selected for their primary task, which is to get cows pregnant as soon as possible after they become available. The ability of the bull to perform this task is dependent upon his semen quality, libido, mating ability and social ranking among bulls and cows^{7,8}. Therefore, as with beef bulls, it is recommended that NS bulls pass a breeding soundness evaluation, as recommended by the American Society for Theriogenology and that this be repeated, at least, on an annual basis⁹. In hot summer months, some reduction of bull fertility may be expected due to lowered semen quality associated with an increase in abnormal heads, abnormal acrosome, proximal droplets and a corresponding decrease in motility¹⁰. Holstein and British breed bulls consistently show depressed semen quality during the hot summer months in regions between Lat 40° and the equator whereas this effect is less obvious in Bos indicus breed bulls. Bulls newly introduced to hotter regions appear to be more susceptible, as do overfat bulls. The provision of shade or cooling devices is beneficial. There is less evidence for a seasonal effect on bull sex-drive. Breeding activity, a function shared by both males and females, is usually less during the hotter parts of the day in summer, although this is often rectified during cooler periods. As females tend to exhibit less overt estrous activity in hot weather, the inherent bull advantage in estrus detection should compensate, at least in part, for lowered semen quality. Some evaluation of libido and mating ability is recommended, either as part of a formal test or as observations during hand mating. Young bulls (2.5 years or less) are recommended because of the difficulties and dangers of handling older bulls on dairy farms. These young bulls should be fully pubertal (for Holsteins over 14 months of age) and of a size compatible with the cows that they need to service. However, younger bulls

should not be used at low bull to female ratios as their reproductive capacity is not generally as high as that of older bulls.

Economic losses that occur from use of NS bulls due to the loss of potential genetic progress in milk yield are high. In the US, sire-of daughter pathway was shown to be the weakest area of genetic improvement because of extensive use of NS bulls with low genetic merit¹¹. Lost revenue was estimated as 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 of the average active AI bull. The average bull in AI sampling would be at percentile 50, similar to typical active AI bull¹¹. Dairy herds that exclusively use NS usually do not raise replacement heifers. Here genetic improvement of the herd can be achieved by purchasing replacement heifers from breeders who are using AI with semen from proven bulls.

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 America¹². In dairy herds that use NS bulls in their reproductive program, DHIA records can be used to evaluate overall herd reproductive performance, which includes breeding for both AI and NS bulls. However, these records are not designed to access the efficiency or performance of NS bulls used in the herd. Therefore, accurate evaluation of the dairy's NS reproductive program is difficult.

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 Association of Bovine Practitioners in 1991 recommended reproductive indices for herds using NS bulls¹³. These indices have been summarized by Upham¹⁴.

1. Percentage Cows Pregnant by the Bull

Calculated as: $BP/TP \times 100$

This calculation 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.

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 fertility¹⁴.

3. Cow to Bull Ratio

Calculated as: cows Turned with Bull and not confirmed pregnant ÷ number of bulls with access to cows.

This calculation is used to determine if the low bull fertility is caused by a large cow to bull ratio. The cow to bull ratio should vary between 20 to 30^{4,14}.

4. Bull Services per Pregnancies

Calculated as: 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 rates¹³.

The above calculations require that diligent records be kept by the producer and analysis of these records are conducted on a timely basis. In those herds that use NS exclusively and which do not record turned with bull date, the per cent of cows found pregnant after a herd check and percent cows open after 160 days in milk (DIM) can be used to evaluate reproductive performance. In our experience, percent of cows found pregnant after a herd check varies from .50 to .68 during the cooler months of the year in Florida (October - April) and from .15 to .40 during the warmer months (May - September). Cows found open > 160 DIM was derived by considering that a cow that is open > 120 DIM can be considered a problem breeder and that pregnancy diagnosis is performed at about 40 days after conception. This calculation can be used to give an estimate of problem cows, an acceptable level is to have less than 10% of the herd open beyond 160 DIM.

Bull Management

It is apparent that NS bulls on dairies are often not managed as well as the rest of the cow herd. Bulls should be subject to the same vaccinations as cows (except for brucellosis and trichomonosis), as well as the same treatments for parasites. Control of venereal diseases is essential to the success of NS. It is recommended that cows be vaccinated for vibriosis at least 3 weeks prior to breeding and receive a booster at 6 month intervals. Some success has also been reported with bull vaccination⁴. Vaccination is also available for trichomonosis, but in breeding cows only. Older bulls in production should be checked for trichomonosis during the BSE.

Obesity and lameness can negatively impact reproductive performance. Rations which are balanced for middle to high producing dairy cows contain higher energy, protein and calcium levels than those required by the bull¹⁵. The excess in energy intake can predispose the bull to over conditioning 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 regions⁴. The dietary requirements for mature bulls irregardless of genotype, are similar to requirements of a dry dairy cow¹⁵. Major determinants for lameness in bulls include feeding a lactating cow diet, which can contribute to laminitis, and confinement on hard unstable surfaces (e.g. concrete) for long periods of time. To avoid problems related to a lactating cow ration, evaluation of body condition and lameness should

be conducted frequently in NS bulls. Factors which can reduce lameness in bulls include periodic rest, removal from concrete and feeding a dry-cow type ration.

In many dairy regions of the United States as much as 8 pounds (15% of ration dry matter) of whole cottonseed is fed in total mixed rations balanced for high producing dairy cattle. Thus a mature Holstein bull with a dry matter intake of 13 kg 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 midpiece abnormality and a reduction in sperm production in Brahman bulls fed 2.75 kg of cottonseed meal (8.2 g of free gossypol per day) has been reported^{16,17}. In contrast, Hereford bulls ingesting 7.6 to 19.8 g of free gossypol daily from whole cottonseed showed no significant sperm abnormalities¹⁸. The type of cottonseed product (meal vs whole seed) may determine the extent of the toxicological effect that will occur and may explain the variable results obtained in research¹⁹. It has been suggested that decoxification of gossypol in the rumen is more efficient with whole seed diets than with cottonseed meal diets¹⁹.

Based on bull studies, recommendations for maximum daily gossypol intake in the total diet for bulls used for breeding are 200 mg/kg for diets composed of cottonseed meal and 900 mg/kg for diets composed of whole cottonseed²⁰. Even though, these studies have shown that gossypol can have an adverse effect on erythrocyte osmotic fragility and testicular tissue in bulls, their relevance to commercial cattle operations should be carefully considered. The fertility of bulls in these studies was not examined, and overt clinical signs of gossypol toxicity were not reported. Furthermore, the levels of cottonseed products fed were greater than those commercially fed to bulls.

An important aspect of bull management is bull to female ratio (BFR). Although superior bulls can accommodate considerably greater numbers of cows, the standard recommended BFR of 1:25 or 1:30 is generally safe, especially with young bulls. Here, some consideration should be made of the Amale effect@ or Abiostimulation@. The presence of bulls, under certain conditions, may positively impact both calving to conception intervals and puberty in heifers²¹. The mechanism underlying such effects are still unclear and many questions still need to be answered before exploitation of biostimulation becomes standard practice on most dairy farms.

Social effects may strongly influence bull reproductive success. With multi-sire groups, bulls lower in dominance rank may be inhibited by bulls of higher rank. In general, social rank is most influenced by age, or seniority, although body size, presence of horns and breed may also be important. The most serious effects of adverse bull interactions may be avoided by employing homogenous groups of younger bulls. However, as older females may also inhibit inexperienced young bulls, it is wise to monitor breeding activity, at least initially.

Safety is a major concern with bulls on dairy farms, partly because dairies often do not have adequate facilities, or personnel training, for bull handling. Bad temperament in dairy bulls should not be tolerated. Handling facilities should be designed to handle bulls. Other safety considerations should include the preferred use of younger bulls and strict adherence to safety protocols. Accidents occur when people cut corners with such protocols, particularly when they assume that they are safe. As bulls become more agitated (and dangerous) when separated, it is advisable to keep them within groups as much as possible.

Reproductive Management of Cows

In herds that use only NS the advantages of a fresh herd and a voluntary waiting period of 60 days should be considered. Fresh cows can be monitored daily for postpartum complications and sick cows treated promptly without the nuisance of having a bull present. Concerns from practitioners that work in herds that use NS bulls is that the opportunity to observe cows daily for sickness may be lost because of reluctance by herd personnel to enter a pen with a bull. The fresh herd also allows a well balanced postpartum transition diet to be fed that may help reduce metabolic or digestive disorders. In a fresh herd, prostaglandin (PGF2a) can be used to promote multiple cycles and uterine involution during the VWP in an attempt to increase pregnancy rate at first service. To help reduce the interval from calving to first service cows may be treated with PGF2a prior to being exposed to the bull.

Pregnancy diagnosis can be performed in cows 40 to 60 days after being turned with the bull. Cows that are open at pregnancy test can be re-examined 30 to 60 days later. Cows that are found to be cystic can be treated with GnRH use of prostaglandin should be limited to cows with pyometra only. Because of the inaccuracy of breeding dates in many NS herds, it is necessary to accurately estimate gestation length in order to give the cow an appropriate dry period of 60 days. Palpation estimates of gestation length are most accurate when gestation is less than 90 days, so the interval between exams of open cows should be less than or equal to 60 days. The date of the last examination at which the cow was found to be open is important information for estimating gestation after 90 days. To monitor the presence of trichomonosis in a herd, some practitioners have found it beneficial to re-confirm pregnant cows between 90 to 120 days of gestation²². Abortions due to T. foetus occurs during the first trimester of gestation and rarely after 5 months of gestation²³. Pyometra may be present in up to 10 percent of the cows in an outbreak of trichomonosis²³. Trichomonad pyometra is postcoital and not postpartum, but can occur after death of the developing embryo or early fetus²³. Pregnancy in cows should also be reconfirmed prior to dry off similar to the practice used in AI herd.

In most herds that use both NS and AI, cows should be placed with the bull after they are found open at a predetermined day in milk (130 to 150 days) regardless of service number. These cows can then be palpated for pregnancy as previously described for NS breeding. Using service number as the main criterion for putting cows with the bull can delay conception, because some cows late in gestation may have only one or two recorded breedings.

Conclusion

Despite overwhelming evidence supporting the genetic advantage of AI over NS, many dairy producers consider the use of natural service to be advantageous to their reproductive management. Considering the prevailing estrus detection and pregnancy rate in a dairy farm, the use of NS becomes a valid option when the effective pregnancy rate (estrus detection rate x conception rate) falls below 25%. This option will only be maximized if bulls are employed that are able and willing to impregnate estrous cows. Bulls should pass a BSE prior to use and this test should be routinely repeated. With the exception of brucellosis and trichomonosis, bulls should receive the same immunizations as the cows. Particular attention should be made to the prevention of vibriosis and trichomonosis. Reproductive performance monitoring of NS bulls should be conducted on a periodic basis. Veterinarians should be vigilant for dietary and housing factors that may impair bull fertility.

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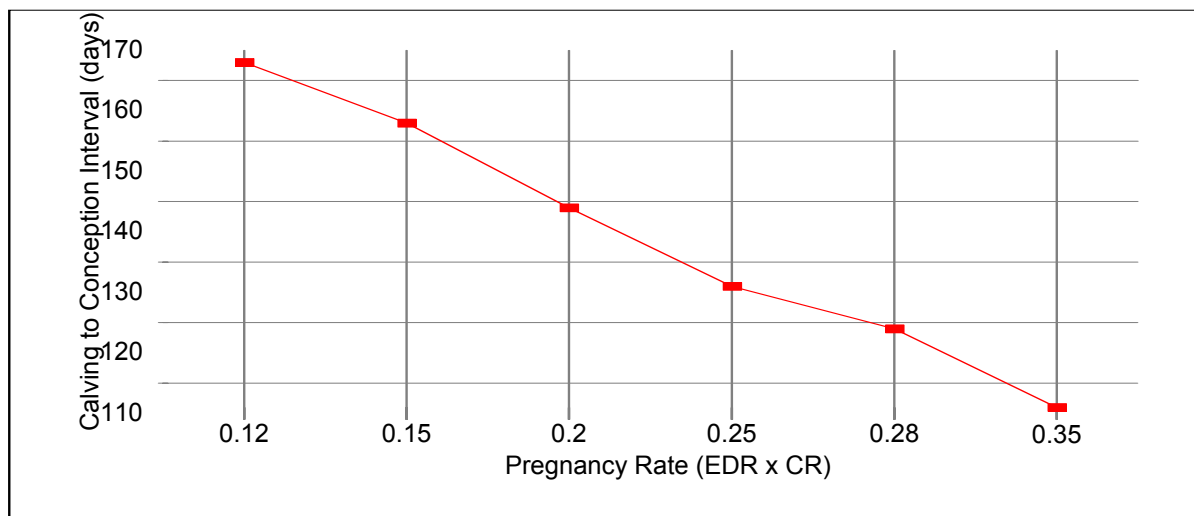


Figure 1. Relationship between calving to conception interval and pregnancy rate. Calculations were based on a voluntary waiting period of 60 days and a range of estrus detection rates (EDR) and conception rates (CR) from .30 to .70 and .40 to .50 respectively. Adapted from Heersche et al (1).

Table 1. Effect of estrus detection rate on net income per cow¹.

EDR	Mean CI ²	Milk/cow/lb/year	Replacement rate	Replacement cost (\$)	Net income \$/cow/year
.34	414	20,607	.44	597	837
.43	406	21,110	.38	514	1070
.51	399	21,455	.34	461	1141
.60	391	21,810	.32	426	1211
.70	384	21,953	.29	393	1265
.80	377	22,116	.28	374	1296
.90	372	22,153	.27	358	1322

¹Calculation is based on a conception rate (CR) of .32 and no seasonality on milk production and CR. The following assumptions were made: net milk price, \$13 per 100 pounds; ration cost for lactating cows of \$0.08 per pound of DMI; feed cost for dry cows of \$1.00 per cow per day; cost of first calf heifer replacement \$1200 and a salvage price for cull cows of \$0.35 per pound of body weight.

² Calving to conception interval in days.

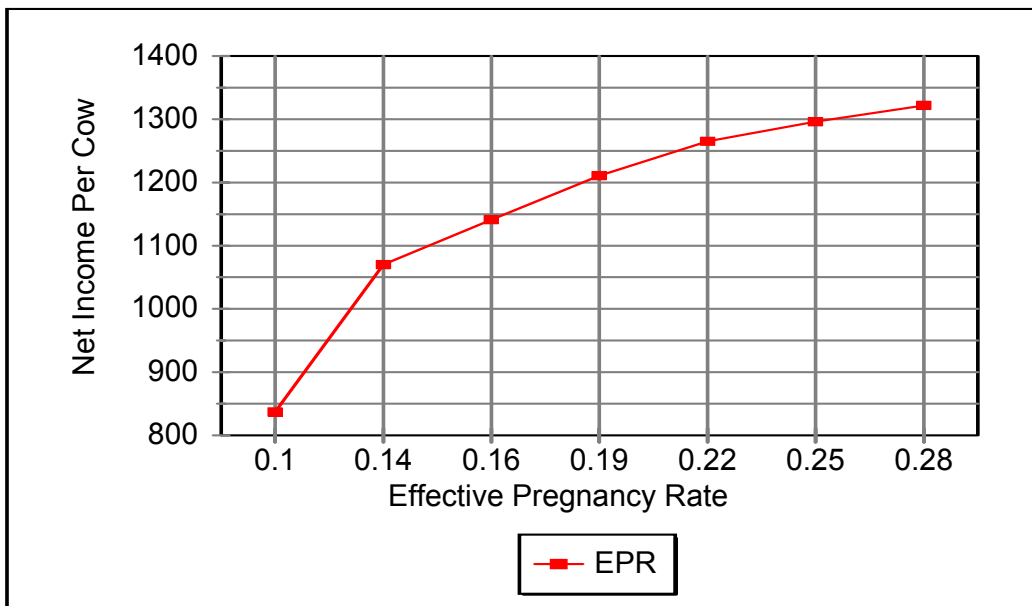


Figure 2. Relationship between effective pregnancy rate (EPR) and net income per cow. The EPR was obtained from the product of EDR x CR shown in table1.