Comparative Study of Artificial Insemination and Natural Service Cost Effectiveness in Dairy Cattle

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Introduction

Despite the well-known advantages of artificial insemination (**AI**), a large number of dairy farmers all over the world still use natural service (**NS**) bulls to breed their cows. The main arguments allegedly justifying their choice are higher AI costs compared to those of keeping herd bulls and additional costs resulting from extended calving intervals because of low heat detection rates when AI is used. On the other hand, daughters of AI sires produce significantly more milk than those of herd bulls and the income from this extra milk may well cover the extra costs. The aim of this study was threefold: (i) to estimate the costs associated with the two service methods, (ii) to examine the factors exerting an influence on them and, (iii) to calculate the amount of milk that AI daughters must produce to cover the extra cost.

Materials and Methods

Data were collected from 120 dairy farms in Central Macedonia, Greece (Valergakis, 2000). Average farm size was 87 cows (Holsteins) and average milk production was 6,440 kg of milk per cow per year. On 56 of the farms, cows were exclusively AI bred, on 27 farms cows were bred only by NS bulls and on 37 farms both breeding methods were used.

A series of different scenarios were simulated based on dairy farmers' practice. Natural service bulls were either home-bred or purchased at a very young age (6 months old) from "breeder farms". Bulls were first used for breeding when they were 18 months old and were kept for 2 years thereafter. Bulls were assumed to breed 80 cows per year and to achieve an optimal 12-month calving interval. Estimated costs included all aspects of raising and keeping them (land, labor, fixed and expendable capital). Artificial insemination costs included labor, equipment, liquid nitrogen, semen (two price levels, 15 or 25 euros per straw) and three ratios of "services per conception" (1.9, 2.2 and 2.5). The difference between AI and NS costs was doubled in order to be attributed to heifers only (the value of bull calves designated to be slaughtered was the same regardless the service method) and spread over 3.5 lactations (average productive life of cows in farms used in this study).

Costs resulting from extended calving intervals (**ECI**) were calculated using the method of French and Nebel (2003). Parameters used included milk price (0.35 or 0.38 euros/kg), feed cost (0.154, 0.176 or 0.198 euros/kg DM), heifer price (1,200, 1,325 or 1,450 euros), cull cow price (1.0 or 0.8 euros/kg of carcass weight), peak milk yield (27.2 or 38.6 kg), number of days in milk when open cows were no longer inseminated (180, 210 or 240 days) and number of days open (100, 115, 130, 145, 160 or 175 days).

The study resulted in 15,552 scenarios in a 2x2x3x2x3x3x2x2x3x6 factorial arrangement of treatments. Analysis of variance was used to estimate the effects of all the above factors on costs associated with AI. The latter was expressed as the additional milk that AI daughters must produce to cover the extra costs of AI and was calculated with the following equation: [(AI costs – NS costs) + ECI costs] / (milk price over feed cost). One kg of feed dry matter was considered to yield 2 kg of milk.

Results and Discussion

The annual costs of keeping natural service bulls were estimated as 1,440 and 1,670 euros for home-bred and purchased bulls, respectively. Corresponding costs per pregnancy were 18.0 and 20.9 euros,

respectively (80 pregnancies per bull per year). Artificial insemination turned out to be more expensive than NS on farms with more than 20-25 and 30-35 cows, when semen was priced at 25 and 15 euros per straw, respectively. These comparisons pertain directly to the costs of the breeding method of choice but do not take into account costs related to ECI.

All factors examined had a significant effect on the amount of milk needed to cover the extra AI costs (Table 1). Number of days open was the most significant factor. Number of days in milk when open cows are no longer inseminated (a management decision) ranked second, closely followed by peak milk yield. Although significant, the other factors had a relatively small effect.

Table 1. Factors affecting the amount of additional milk required by AI daughters to recover the extra cost of using AI and corresponding Wald statistic (F).

Factor	F
Number of days open	94303.8
Number of days in milk when open cows are no longer inseminated	2383.7
Peak milk yield	2037.1
Milk price	1284.1
Cull cow price	1009.1
Semen price	297.2
Heifer price	243.8
Number of services per conception	31.5
Feed cost	6.7
Type of NS bull (home-bred or purchased)*	5.2

$R^2 = 0.969$, $P<0.01$, $*P<0.05$

Semen price, number of services per conception and type of NS bull together sum up the costs associated with the service method of choice (AI or NS). It turned out that the extra cost related with the service method *per se* (AI costs – NS costs) accounted, on average, for only 10.9% of the total breeding-associated cost and ranged from 2.3% to 29.1% (Figure 1), depending on calving interval. Costs associated with extended calving intervals, as a consequence of prolonged days open, constituted the major proportion of the extra costs when using AI.

The average amount of additional milk needed from AI daughters to cover total extra costs of using AI, for various calving intervals, is shown in Figure 2 (NS bulls were assumed to achieve 12-month calving intervals). A difference of more than 1,100 kg of milk per lactation was needed to cover those costs when calving intervals were longer than 14 months; however, about 700 kg were enough when the calving interval was 13.5 months (410 days), which is clearly a feasible target in well-managed farms the world over.

Daughters of AI sires from the farms of this study were producing almost 900 kg more milk per lactation than daughters of NS bulls. This is consistent to DHIA reports from the USA (Smith *et al.,* 2005; Zwald, 2003) showing a difference of more than 1,000 kg of milk per lactation, on farms using AI. This means that even with calving intervals of 13.5-14 months, farms using AI can be more profitable.

In order to avoid bias in favor of AI, the whole simulation was based on the assumption that NS bulls achieve a 12-month calving interval. This is certainly the exception rather than the rule. In this study, the average calving interval in the NS and AI farms was 13 and 13.7 months, respectively (Valergakis, 2000). In such a case, the additional milk needed per lactation in order to cover the extra costs of using AI was only 440 kg. Daughters of AI sires were producing twice as much. Furthermore, reported difference in calving intervals between farms using AI or NS bulls is less than one month (Smith *et al.,* 2005; Zwald, 2003).

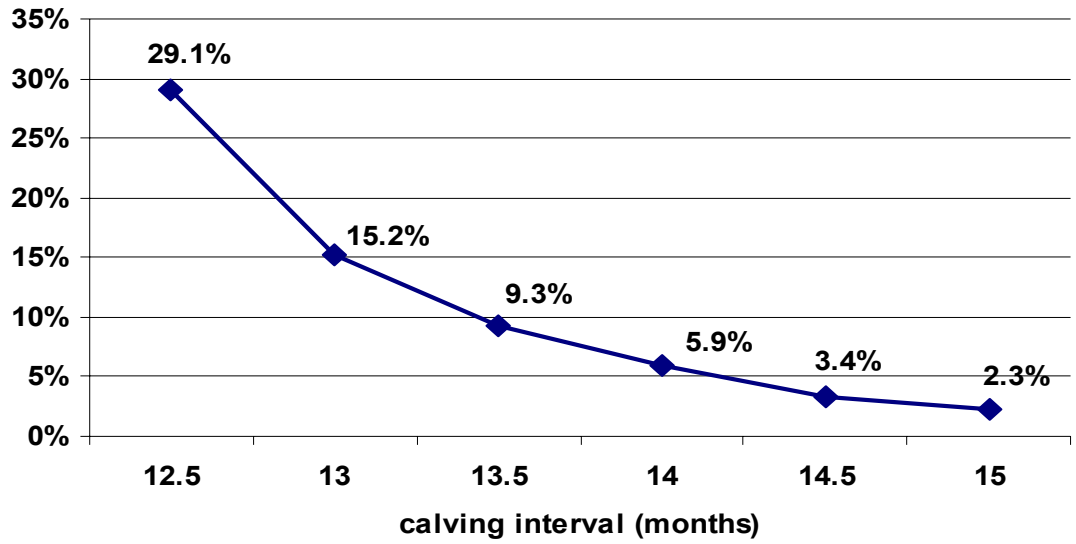

Figure 1. Proportion of total breeding-associated costs accounted for by the service method of choice (AI *vs.* NS), depending on calving interval.

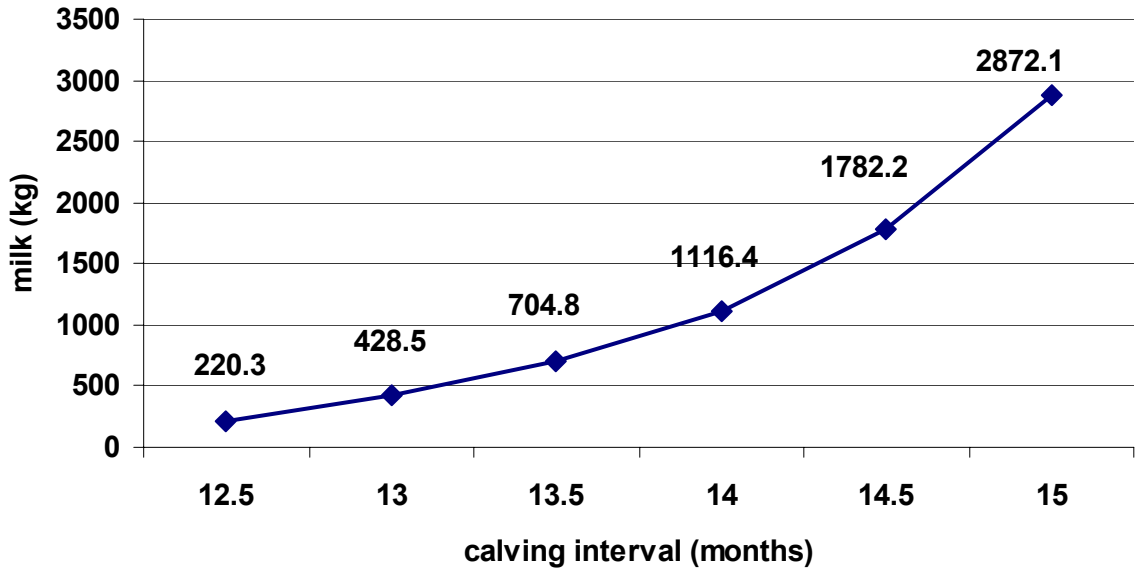

Figure 2. Amount of additional lactation milk yield required by AI daughters to recover the extra cost of using AI, depending on their calving interval (NS calving interval was set to 12 months).

Conclusion

When calving intervals are kept within reasonable limits (13.5-14 months), the superior milk production of AI sires' daughters, not only cover associated extra costs but also generate a profit. This comes as an additional benefit to the well known merits of AI related to health, management and safety issues.

References

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