# Economic Comparisons of Artificial Insemination vs. Natural Mating for Beef Cattle Herds

Artificial insemination (AI) has been commercially available as a viable technology since the 1940s. It is used extensively in the dairy cattle industry and has significantly influenced the genetic makeup of the national dairy herd. Likewise, this technology is also applicable to the beef cattle industry. Currently, only about 6 percent of all U.S. beef cattle producers use AI and/or estrus synchronization in their beef cattle herds. The vast majority of this use is in the purebred segment.

One of the primary deterrents for beef cattle producer adoption of AI is the perceived cost. This publication details the costs of AI versus natural mating and allows producers to evaluate whether adoption of AI will benefit their operations. Refer to Extension Publication 2628 Artificial Insemination Programs for Cattle for information on utilization of AI in a beef cattle herd and Extension Publication 2614 Estrus Synchronization in Cattle for specifics on estrus synchronization protocols.

## Partial Budgeting Examples

In the following example, a producer manages a herd of 100 mature cows and plans to keep 15 heifers as replacements. Cows are synchronized using the 7-day CO-Synch + CIDR® estrus synchronization protocol. This timed AI protocol involves a gonodotropin-releasing hormone (GnRH) injection and progestin-containing device (CIDR®) vaginal insertion on Day 0, a prostaglandin F2α (PGF2α) injection and progestin-containing device removal on Day 7, and then a second GnRH injection on Day 10. All cows are time inseminated after the second GnRH injection. Heifers are synchronized using the CO-Synch + CIDR® estrus synchronization protocol. This timed AI protocol is the same as the 7-day CO-Synch + CIDR® except that the second GnRH injection is administered on Day 9 instead of Day 10 and the timing of AI is earlier than for the cows. **Table 1** explains the per-head costs for estrus synchronization drugs, semen, and AI technician. It also illustrates the expected pregnancy rate with AI (one service), and the number of cattle workings required for estrus synchronization and AI.

**Table 1. Artificial insemination program example description.**

| | Protocol | Drug Cost/Head | Pregnancy Rate | Required Workings | Semen Cost/Straw | Technician Cost/Head |
|---|---|---|---|---|---|---|
| Cows | CO-Synch | $15 | 50% | 3 | $25 | $20 |
| Heifers | MGA-Lutalyse | $15 | 50% | 3 | $25 | $20 |

**Table 2** contains the budget assumptions for this example herd. The overall expected pregnancy rate (AI + cleanup bulls) is 90 percent for cows and 85 percent for heifers. The average weaning weight is assumed to be 575 pounds, with the calves selling for an average of $130/cwt. Five bulls are required for adequate breeding in a natural service situation. Each bull is assumed to cost the producer $2,750 and will be used for three breeding seasons. Therefore, if five bulls are needed for natural service, then an average of 1.67 bulls is being replaced each year (5 bulls/3 years = 1.67 bulls/year). For AI, if four bulls are needed, then an average of 1.33 bulls is being replaced each year (4 bulls/3 years = 1.33 bulls/year). Thus, an additional one-third of a bull is being replaced each year with natural service over AI. Annual bull maintenance costs will average $650, with a salvage value at the end of the 3-year useful period of $1,700/bull.

**Table 2. Budget assumptions for natural service.**

| | |
|---|---|
| Number of cows | 100 |
| Pregnancy rate (cows) | 90% |
| Number of heifers | 15 |
| Pregnancy rate (heifers) | 85% |
| Average weaning weight of calves | 575 lbs |
| Average calf value | $130/cwt |
| Bulls required for natural service | 5 |
| Average purchase price of bulls | $2,750/head |
| Salvage value of bulls | $1,700/head |
| Useful life of bull | 3 years |
| Annual bull maintenance expense | $650/head |

Annual ownership costs attributed to each bull are illustrated in **Table 3**. Purchase costs minus salvage value show that the producer spends $350 per year on ownership costs alone. When coupled with the $650 per-year maintenance costs, plus a "risk of bull loss" factor ($445/year), the producer spends an average of $1,445 per year to own a bull.

**Table 3. Bull ownership/maintenance costs.**

| | $/bull | Total for 5 bulls |
|---|---|---|
| Annual Ownership Cost[a]: **($2,750 - $1,700)/3** | $350 | $1,750 |
| Annual Maintenance Cost | $650 | $3,250 |
| Risk of Bull Loss[b]: **0.2([$2,750 + $1,700)/2]** | $445 | $2,225 |

[a] Annual ownership cost represents the average annual decline in the bull's value. It is calculated as the difference between the bull's original value and his salvage value divided by his useful life.
[b] Risk of bull loss represents potential financial loss due to a bull becoming incapacitated through death, injury, infertility, etc. It is calculated as half of the sum of the bull's average value and his salvage value, with the result multiplied by the probability of such a loss occurring.

**Table 4** compares the costs of using AI versus natural mating. A partial budget compares increased costs of AI to the increased revenue generated from AI-produced calves. Total costs for the AI (including drugs, semen, technician, and labor) are $7,380. This includes the 100 cows and 15 heifers.

On the revenue side, the example assumes that the use of genetically superior AI sires would increase average calf weaning weight by 25 pounds per head. If calves are sold at weaning at a value of $130/cwt for 575-pound calves, the value of the additional weaning weight would increase gross receipts by $3,339.

Because estrus synchronization and AI require enhanced management and increase the number of cows bred early in the breeding season, the expected increase in calving percentage is 5 percent. The value of the additional calves at weaning is $4,298. This results in a total increase in revenue of $7,637 over the use of natural service alone.

Use of AI also reduces for the need for cleanup breeding and lowers bull ownership/maintenance expenditures. Five bulls are required for adequate breeding with natural service alone. With AI, bulls are needed for cleanup breeding purposes only. Based on the expected AI conception rates, only four bulls are required for cleanup breeding (one bull could serve a dual purpose by breeding the six remaining heifers and then being available for use in the cow herd). The reduction in bull numbers with use of AI means one-third less bull to market for salvage value each year. This reduces revenue by $567 annually.

This reduction in costs through the use of AI is estimated to be $1,445 for the scenario herd. Comparing the increased costs of AI with the increased revenue/reduced costs, using AI results in an additional net change in profit of $1,135. So, using these assumptions, there is a profitability advantage for AI over natural service. However, this partial budget does not consider the value of improved genetics of AI-sired heifers retained in the herd. When this is taken into account, AI becomes even more profitable. Results from the Missouri Show-Me-Select Replacement Heifer Program show a $54 per-head increase on average in sale price of AI-bred heifers versus natural service-bred heifers over an 11-year period. There is a notable and consistent market value difference for AI versus natural service pregnancies each sale season in this program.

**Table 4. Artificial Insemination vs. Natural Service: Partial Budget**

| **Increased Costs** | | **Increased Revenue** | |
|---|---|---|---|
| Drug costs | $1,725 | Additional weaning weight | 25 lb/head |
| Semen costs | $2,875 | Value of additional weight | $3,339 |
| Technician fees | $2,300 | Change in calving percentage | +5% |
| Additional labor[a] | $480 | Additional calves | $4,298 |
| **Total Increased Costs** | **$7,380** | **Total Increased Revenue** | **$ 7,637** |
| **Reduced Revenue** | | **Reduced Costs** | |
| Reduced cull bull sales | $567 | Cleanup bulls required | 4 bulls |
| | | Lower bull ownership/maintenance | $1,445 |
| **Total Decrease in Profits** | **$7,947** | **Total Increase in Profits** | **$9,082** |

Net Change in Profits = $1,135

[a] For budgeting labor costs, it is assumed 115 head of cattle can be worked in 5 hours using four hired workers at an $8/hour wage rate, and three workings per head are required for artificial insemination. This is separate from the technician fee.

Note that the increased costs of drugs, semen, technician services, and additional labor greatly exceed the savings from reducing bull requirements. For most beef cattle producers, these items are the most obvious considerations in evaluating the decision of whether or not to implement an AI program. They do not consider the expected revenue increase that may offset the higher costs. This may help to explain some producers' reluctance to try AI in their herds. As this sample budget shows, however, consideration of costs alone provides an incomplete picture of the financial impact of AI adoption.

## Likelihood of Profitability

Whether or not AI is profitable relative to natural service is highly variable (**Table 5**). In the specific case of heat detection-only AI breeding systems in large (300-head) herds using low cow-to-bull ratios (20 cows per bull), AI is economically advantageous to natural service approximately 85 percent of the time. Yet across herd sizes and cow-to-bull ratios, AI is more cost-effective than natural service only about 33 percent of the time.

**Table 5. Percent of situations where artificial insemination is more profitable than natural service.**

| Artificial Insemination Breeding System | Artificial Insemination More Profitable than Natural Service (%) |
|---|---|
| Heart Detection | 33 |
| Heart Detection and Timed AI | 41 |
| Fixed-time AI | 49 |

Source: Adapted from Johnson and Jones, 2008.

The economic advantage or disadvantage of AI to natural service depends on many factors. These factors include genetic value of calves, semen cost, bull purchase price, calf weight advantage when dams are estrus synchronized, conception rate, calf price, cull weight, and calf crop percentage. Regardless of herd size and cow-to-bull ratio, genetic value premiums and semen cost are the driving factors in determining the profitability difference between AI and natural service breeding. Under lower cow-to-bull ratios, AI systems are more cost-effective and bull purchase price is a key influence on the profitability difference. In general, estrus synchronization and AI are economically advantageous compared with natural service when a sufficient genetic value premium can be obtained from AI-sired calves.

It is critical for cow-calf producers to use ranch-specific data when making economic comparisons of AI to natural service. The partial budget examples here provide a guide to making this evaluation. As part of the partial budgeting process, producers may want to consider various scenarios to determine which management and marketing practices to use in an AI program. For more information about beef cattle reproductive management, contact an office of the Mississippi State University Extension Service.

## References

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