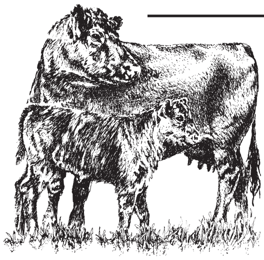

An Economic Comparison of Artificial Insemination with Natural Service in Beef Cattle

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Getting Beef Cows Pregnant

The use of artificial insemination (A.I.) is not new to the beef industry. In 1933, *The Technique of Artificial Insemination* was first published, and by 1936 A.I. was being used on university farms for production and research purposes (Foote 2002). However, only about 13 percent of beef producers currently use A.I. (USDA-APHIS 1998).

When A.I. is used, it’s generally more common in heifers and on seedstock operations. Yet, after over 70 years of availability, why are so few commercial cow/calf producers using A.I.?

According to a USDA survey, producers who do not use A.I. indicated that labor and time were the most common reasons for not using A.I. (39%), followed by difficulty/complication (20%), cost (13%), lack of facilities (7%), and a belief that it does not work (3%).

Regardless of the reason(s) why producers don’t use A.I., researchers have failed to demonstrate the return (or lack of return) on investment with either A.I. or natural service, until recently. Without this information beef producers have been reluctant to choose A.I. over natural service.

A.I. vs. Natural Service

Ultimately, the choice of A.I. vs. natural service comes down to the cost of producing a pregnancy vs. value of the product produced. The major challenge with economically comparing A.I. to natural service involves characterizing “added value” in the product produced.

Costs associated with A.I. or natural service can be predicted with reasonable accuracy, however, the short- and long-term economic value of improved genetics and/or a more concentrated (and possibly earlier) calving season are difficult to accurately determine.

Therefore, the objective of this fact sheet is to convey information from recent research about the costs and benefits associated with A.I. and natural service. However, it should be noted that the authors are not comparing 100 percent A.I. vs. 100 percent natural service.

The use of 100 percent A.I. is unrealistic on western commercial cow/calf operations since it typically requires a 45- to 60-day heat detection period. Instead, cow/calf producers can synchronize and inseminate their cows once before turning out clean-up bulls, as is the case on most operations that use A.I. Therefore, the comparison will be “synchronization/A.I. + natural service” vs. “100 percent natural service.”

Pros and Cons of Synchronization/A.I. and Natural Service

Before discussing research results, the numerous economic advantages and disadvantages associated with synchronization/A.I. and natural service should be mentioned. This is not an exhaustive list and discussion, and not all of these advantages and disadvantages have been documented in the literature. These items should merely be considered as possible or theoretical advantages and disadvantages for the purpose of critically comparing the two breeding options.

Possible ADVANTAGES of Synchronization/A.I.

Genetic Improvement—With the proper use of A.I., it is generally agreed that a producer can achieve more rapid and greater genetic progress via the use of outstanding or genetically proven sires that are cheaper to access via their semen (e.g., $15/straw) vs. natural service (>$10,000/bull). The use of A.I. also allows for the sampling of a bull or breeds with limited investment or risk, and can enable easier implementation of a crossbreeding program.

Increased Weaning Weight—If synchronization/A.I. is used properly, it is possible for more cows to conceive earlier during the breeding season, leading to more calves born earlier and an older calf crop (on average). Older calves at weaning equates to more pounds of weaning weight. In addition, the use of outstanding or genetically proven A.I. sires for growth may increase the genetic potential of a calf crop for weaning, yearling, and carcass weight vs. natural service sires.

Increased Calf Crop Uniformity—More calves born early due to synchronization/A.I. could reduce the number of late born calves, resulting in a calf crop with a more uniform age. Uniformity could also result from the use of closely related sires, or even just one sire. Uniform calf crops typically sell for more at weaning, since buyers generally desire calves of similar age, weight, color, and breed.

Increased Product Quality—It is extremely difficult to place a value (or even a definition) on "higher quality" genetics. However, if a trait such as carcass quality is improved via A.I., the overall demand for the end product may be increased.

Increased Herd Productivity—In addition to a greater weaning weight due to age and genetics of the calf crop, herd production could improve in other ways, including:

1. Improved "quality" of retained replacement heifers,
2. Early identification of reproductive problems (freemartins, non-cycling cows, cystic ovaries, etc.),
3. "Hand-mating" of specific cows with specific bulls through the use of expected progeny differences (EPDs), enabling genetically inferior cows for a trait (e.g., weaning weight) to be mated to an A.I. sire superior for that trait, and
4. Easier compilation of performance data on cows (and their calves), which could help to improve future breeding/culling decisions if they are individually identified when inseminated.

Increased Reproductive Performance—Cows that conceive earlier and calve earlier have a longer period of time to rebreed during the postpartum period and are less likely to be open and culled at weaning time. In addition, older A.I.-sired replacement heifers will have a greater likelihood of staying in the herd longer since they are more likely to conceive early (for the reasons mentioned).

Furthermore, selecting A.I. sires with a high probability to sire low birthweight calves may minimize dystocia (calving difficulty) in first calf heifers and smaller framed cows. It is also easier to reduce the introduction of diseases (e.g., *Trichomoniasis foetus*) into a herd since semen collection and processing is regulated and fewer natural service sires are needed.

Reduced Bull Costs—Synchronization/A.I. can increase certain costs on most operations, as will be discussed below; however, additional costs may be reduced or eliminated compared to natural service. For instance, lower costs will be needed for:

1. Bull purchasing, since fewer bulls are needed for previously-inseminated cows,
2. Bull maintenance, since fewer bulls will incur winter feeding, breeding soundness exam, and facility and labor costs, and
3. Calving season labor, since the calving season should be more concentrated into a shorter time frame with less dystocia.

Possible DISADVANTAGES of Synchronization/A.I.

Increased Management—Without question, the amount of management, coordination, planning, and logistics associated with synchronization/A.I. is substantial and can be overwhelming. More intense management during the breeding season is necessary to coordinate labor, resources, and facilities to work cattle multiple times (typically two to four times within a 10- to 12-day period) compared to natural service. In addition, knowledge of estrous synchronization, drug administration, and A.I. is needed in order to maximize the conception rate to A.I.

Increased Investment—Additional investments are recognized as the largest disadvantage of using synchronization/A.I. compared to natural service. The most costly investments can be additional labor as well as the development and/or maintenance of adequate facilities (sturdy corrals to sort calves off calves, strong alleyways, and easy-to-operate chutes) to efficiently and safely work and inseminate cows.

Additional labor will be required to select, plan, and implement the appropriate estrous synchronization and A.I. protocol. Moreover, additional labor will be required to assist in gathering, sorting, administering synchronization drugs, and inseminating cows.

Other required investments for synchronization/A.I. include semen costs, equipment (syringes, coolers, semen tank, A.I. guns, insemination chutes, thaw box, etc.) and estrous synchronization drugs to synchronize and inseminate cows. Cost estimates for several items are included in Table 1.

Increased Risk—Compared to natural service, more risk can be associated with synchronization/A.I. since many variables affect the probability that a cow will become pregnant to A.I. after the administration of synchronization drugs. Although most synchronization protocols can achieve pregnancy rates to A.I. of 40 to 60

Table 1. Artificial insemination costs.

Item	Cost per unit ($)
Semen	10.00 to 15.00/straw
Prostaglandin	2.50 to 4.00/dose
GnRH	3.00 to 4.00/dose
CIDR	9.00 to 10.00/dose
Supplies	0.50/insemination
Labor[a]	2.88/cow
Fixed Costs[b]	175.00

[a]8.6 hours x 3 working days x 4 workers x $7.00 per hour for 251 cows.

[b]Semen tank, carrying case, pipette gun, thaw box, and liquid nitrogen.

Source: Adapted from Johnson and Jones (2004) and Anderson and Deaton (2003).

percent, it is possible to have extremely poor pregnancy rates to A.I. (<20%, or worse) if extraneous variables are not managed.

Poor A.I. pregnancy rates can be caused by problems with the cowherd (poor body condition scores, non-pubertal heifers, extended post-partum intervals, an elevated rate of anestrous, disease, etc.), labor force (inadequate heat detection, and improper timing, use, or administration of synchronization drugs), and/or technician and management (poor choice of timing to mass inseminate cows, and/or improper handling, thawing, or placement of semen).

Costs of Synchronization/A.I. vs. Natural Service

Unfortunately, the ultimate economic cost/benefit of synchronization/A.I. vs. natural service is not known, and more importantly is difficult to quantify without the use of economic models based on many assumptions. It has been suggested that the true economic difference between synchronization/A.I. and natural service is probably not huge (Johnson 2002). However, on a case-by-case basis substantial differences probably exist.

To begin an economic evaluation, the cost to get a cow pregnant needs to be determined. The costs that are most influential in this comparison include bull purchase price, bull-to-cow ratio, bull maintenance cost, labor availability and cost, facilities, semen cost, and conception rate to synchronization/A.I.

Table 2. Annual bull costs ($) based on purchase price and associated cost per pregnancy.[a,b,c]

Purchase price	$1,500.00	$1,700.00	$2,000.00	$2,300.00	$2,500.00	$3,000.00
Salvage value	896.00	896.00	896.00	896.00	896.00	896.00
Summer pasture	174.00	174.00	174.00	174.00	174.00	174.00
Crop residue	8.50	8.50	8.50	8.50	8.50	8.50
Hay	102.98	102.98	102.98	102.98	102.98	102.98
Protein, mineral	25.00	25.00	25.00	25.00	25.00	25.00
Labor	50.00	50.00	50.00	50.00	50.00	50.00
Veterinary	40.00	40.00	40.00	40.00	40.00	40.00
Repairs	31.00	31.00	31.00	31.00	31.00	31.00
Miscellaneous	7.00	7.00	7.00	7.00	7.00	7.00
Interest	15.35	15.35	15.35	15.35	15.35	15.35
Total variable	453.83	453.83	453.83	453.83	453.83	453.83
Depreciation on equipment	12.39	12.39	12.39	12.39	12.39	12.39
Depreciation on bull	150.85	200.85	275.85	350.85	400.85	525.85
Interest on bull	83.88	90.88	101.38	111.88	118.88	136.38
Death loss	15.00	17.00	20.00	23.00	25.00	30.00
Total fixed	262.12	321.12	409.62	498.12	557.12	704.62
Total cost/year	715.95	774.95	863.45	951.95	1,010.95	1,158.45
Purchase price	**$1,500.00**	**$1,700.00**	**$2,000.00**	**$2,300.00**	**$2,500.00**	**$3,000.00**
Cows exposed per year			**Cost per pregnancy**			
15	50.78	54.96	61.24	67.51	71.70	82.16
20	38.08	41.22	45.93	50.64	53.77	61.62
25	30.47	32.98	36.74	40.51	43.02	49.30
30	25.39	27.48	30.62	33.76	35.85	41.08
35	21.76	23.55	26.24	28.93	30.73	35.21
40	19.04	20.61	22.96	25.32	26.89	30.81
50	15.23	16.49	18.37	20.25	21.51	24.65

[a]Reprinted with permission from Johnson and Jones (2004).

[b]Based on assumptions that each bull was used four seasons, 10% bull death loss, 7% interest rate, and 94% pregnancy rate.

[c]Cost per pregnancy will increase if breeding pastures with carrying capacities less than serving capacities are used. Also, cost per pregnancy will be reduced if highly fertile bulls are identified and exposed to more females compared to more conservative recommendations.

The costs associated with natural service on beef cow/calf operations have been well characterized (Johnson and Jones 2004). Based on the calculations shown in Table 2, natural service costs can range from $15 to $82 per pregnancy, depending on bull purchase price and bull-to-cow ratio.

Costs associated with synchronization/A.I. have also been determined, based on survey data of A.I. use by Nebraska beef operations. A model was developed to determine labor requirements and costs of synchronizing estrus over a range of A.I. pregnancy rates and cowherd sizes. Several assumptions were made, but the additional costs to improve facilities were not accounted for, nor were additional revenues such as increased values of replacement heifers, calf crops, or more predictable calving ease.

Based on these data, synchronization/A.I. cost ranged from $39 to $52 per pregnancy. When costs were broken down by source, bulls were the most costly (approximately 40%), followed by semen (25%), labor (15%), and synchronization protocol (14%).

The proportion of pregnancies to synchronization/A.I. vs. natural service has also been used as an alternate method of evaluating the cost/benefit of synchronization/A.I. vs. natural service (Johnson and Jones 2004). When the cost per pregnant female among several different synchronization/A.I. scenarios and natural service was estimated, natural service was the least cost option ($35 to $58 per pregnant female, depending on cowherd size) followed by several synchronization/A.I. protocols that ranged in cost from $37 to $66 per pregnant female, depending on cowherd size (30, 100, or 300 cows), with the most expensive at $51 to $80 per pregnant female. The A.I.-sired calves were estimated to be 10 days older and weigh 20 pounds more at weaning, which at $1.25/lb is an additional value of $25/weaned A.I.-sired calf vs. natural service. Thus, when cost per hundredweight of calf produced was compared among the same synchronization/A.I. protocols and natural service, three synchronization/A.I. protocols cost less than natural service (ranging from $0.33 to $2.08/cwt of calf less).

From these data, it is apparent that cost per pregnancy and per hundredweight of calf produced can have a substantial range among breeding options. The cost per pregnancy appears to be higher for synchronization/A.I., especially in smaller herds (e.g., 30 cows), unless increased calf weaning weight is accounted for, in which case several synchronization/A.I. protocols can cost less.

Additionally, if the A.I. pregnancy rate can be increased above 50 percent, the increased cost for most synchronization/A.I. protocols can be overcome. It should be noted, however, that these comparisons did not account for any medium- or long-term benefits of using A.I. (such as improved feedlot gain, carcass quality, reproductive performance, or overall "quality" of the cowherd).

Short- vs. Long-term Returns

In addition to comparing breeding costs among synchronization/A.I. and natural service options, other researchers are attempting to evaluate if any short- or long-term differences between synchronization/A.I. and natural service exist by assessing the value of the product produced (the calf).

Anderson and Deaton (2003) at the University of Kentucky designed an experiment to compare the costs and net returns of synchronization/A.I. vs. natural service by dividing a 351-head cowherd into two groups. The first group (referred to as SYNC) consisted of 251 cows that were synchronized, fixed-time inseminated, and after 10 days exposed to a clean-up bull for 50 days. Additional costs for drugs, semen, A.I. technician, and labor for handling cattle totaled $29.88/cow. The second group (referred to as NAT) consisted of 100 cows that were exposed to natural service sires for 60 days.

Calving rate for the SYNC group was 90 percent compared with 81 percent for the NAT group. In addition, more cows from the SYNC group calved in the first 30 days than the NAT group (85% vs. 62%) and calves from the SYNC group were an average of 10 days older than calves from the NAT group. Cows from the SYNC group also showed an increase in percent calf crop weaned and weaning weight, resulting in an increase of 110 pounds of calf weaned per cow exposed.

Calves from both groups were assigned a market value of $80/cwt, which would be low in today's market. With 9 percent more calves and an increase in weaning weight of 72.6 pounds, the increased revenue in the SYNC group was $99.62. Subtracting out the $29.88 for additional synchronization/A.I. costs, the return on investment in the SYNC group was $69.74. However, it should be noted that as weaning weight increases price per hundredweight decreases, which was not accounted for in this calculation.

The long-term effects of synchronization/A.I. are also currently under investigation. Ten years of data from a herd of 45 cows using a 60-day natural service breeding season were collected. The breeding system was then changed to include estrous synchronization and fixed-time insemination followed by 50 days with a clean-up bull.

Thus far, an increase in percentage of cows that calved, percent calf crop weaned, and average weaning weight of steer calves has been observed. These increases in production led to a doubling of net profit per cow bred during the first year alone (Anderson and Deaton 2003).

Additional studies have evaluated when A.I.-sired calves should be marketed in order to receive the greatest return on investment. In comparing 12 different estrous synchronization protocols for synchronization/A.I., investigators found that in all scenarios retaining ownership until harvest provided the greatest return. The increased return ranged from $143 to $214 per head compared to marketing at weaning, and was observed if calves were marketed on either a cash or grid system (Miller et al. 2004).

Another study found that gross income per harvest weight was $131/head higher for A.I.-sired calves than natural service sired calves. However, in that study the additional cost of synchronization and A.I. was not recovered when calves were sold at weaning (Ellis 2005).

Conclusions

Artificial insemination can be a valuable tool for beef producers, however, it is not widely used due to the many challenges associated with its proper implementation. The real and theoretical advantages and disadvantages of synchronization/A.I. and natural service have been identified, yet few of these variables have been characterized economically, particularly the difference in value of the products produced (calves or carcasses) or change in long-term reproductive performance. Such economic characterization is difficult.

Researchers are trying, however, to document the short- and long-term economic differences between synchronization/A.I. and natural service. Evidence indicates that natural service is a lower cost option than synchronization/A.I. protocols (on a "per pregnant cow" basis). Although, when costs are calculated on a "per hundredweight of calf" basis, several synchronization/A.I. protocols are cheaper than natural service. It also appears that if improvements in average calf age and weight are incorporated, synchronization/A.I. can yield a greater return on investment than natural service.

Long-term economic comparisons of synchronization/A.I. vs. natural service are currently underway, and researchers are attempting to characterize differences in performance and costs among the synchronization/A.I. and natural service options. Ultimately, producers should critically evaluate their own operation to determine which type of breeding system to use, taking into account their own production costs, need for genetic improvement, and management capabilities.

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