# The Impact of Production Technologies Used in the Beef Cattle Industry[1]

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## Introduction

Beef cattle producers use technologies to improve animal performance and well-being and to increase the profitability of their enterprises. The use of technologies in the beef industry is a major contributor to the safe, wholesome, and affordable beef supply in the United States. The accumulated use of technology in the beef industry has improved cattle and enterprise efficiency and has decreased the resource inputs of feed and land.

Important technologies that have been adopted include antibiotics, implants, ionophores, parasiticides, genetics, vaccines, physiological modifiers, and nutrition. The adoption rate of technologies is high because of the efficacy and return on investment, but the rate varies between segments of the beef industry (Lawrence and Ibarburu 2008). The improvements in beef cattle production cannot be attributed to a single technology. However, incorporation of multiple technologies in several segments has transformed the U.S. beef industry. This article provides a brief evaluation of the effects that individual technologies have on beef production.

## Antibiotics

Antibiotics are utilized in two distinct methods in the beef cattle industry. Sub-therapeutic use involves low-dose levels generally included in the feed or water. In this application, antibiotics are utilized to increase growth rate and improve feed efficiency (Elam and Preston 2004). The growth-promoting mechanism of sub-therapeutic antibiotics occurs through manipulation of the microorganism in the rumen. The manipulation of the microorganism population and function results in improved digestion, metabolism, and absorption of nutrients. Because of the increase in feed utilization, the animal needs less feed and produces less waste. Use of sub-therapeutic antibiotics elicits a 7% increase in feed efficiency (Table 1; Elam and Preston 2004) and 7% increase in average daily gain (ADG) (Elam and Preston 2004; Lawrence and Ibaruru 2008). The effect of sub-therapeutic antibiotic use in the stocker sector has an estimated cost of production impact of $9.57/animal or 1.22% (Lawrence and Ibaruru 2008). In contrast, antibiotic use in the feedlot sector has a smaller cost of production impact ($5.86, 0.56%; Lawrence and Ibaruru 2008).

Therapeutic use of antibiotics results in healthier cattle. This use of antibiotics combats bacterial diseases and reduces morbidity and mortality. A decrease in the incidence and severity of disease and death improves cattle production efficiency and cattle well-being. The increase in use of antibiotics in the cattle industry is similar to the use in human medicine (Elam and Preston 2004). The use of therapeutic antibiotics is important to modern beef cattle production because of the increased use of high-grain diets, co-mingling of cattle, and scale-size of many modern beef enterprises. Wileman et al. (2009) estimated that metaphlaxis use of antibiotics in feedlot cattle compared to

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non-treated cattle increased ADG by 0.25 lb/d, decreased morbidity from 55% to 29%, and decreased mortality by 50% (3.8% compared to 1.8%).

## Implants

Implants used for growth promotion are one of the earliest and most revolutionary technologies adopted by the beef industry (Elam and Preston 2004). Implants can be utilized in every segment of the beef production industry (cow-calf, stocker, and feedlot) and provide a benefit for all aspects of the beef industry. Implants tend to have the largest impact in the feedlot sector, but their effectiveness in all segments is important. Estrogenic implants function to metabolically enhance nutrient use, which thereby enhance the growth performance of implanted cattle. Androgenic-containing implants have an additive effect with estrogen to enhance muscle growth along with the enhanced growth performance.

The estimated impact of implants in the stocker segment indicates nearly a 13% improvement on stocker ADG (Table 1; Lawrence and Ibaruru 2008). In addition, implants account for a 2.31% effect on the breakeven price in the stocker system that translates to a cost of production effect of $18.19 per head (Lawrence and Ibaruru 2008). Industry standard implant programs in feedlots typically increase ADG by 15–20% (0.55 lb/d) and improve feed efficiency by 8–12% (Lawrence and Ibaruru 2008; Elam and Preston 2004; Wileman et al. 2009). Likewise, implants account for a 6.52% effect on the breakeven price in the stocker system that translates to a cost of production effect of $68.59 cost per head (Lawrence and Ibaruru 2008). Implants also function to attenuate fat deposition in beef carcass and to increase ribeye area and total lean tissue. Increases in carcass yield and lean tissue result in decreased cost of gain, benefitting both the producer and beef processor. Lawrence and Ibaruru (2008) estimated that if implants were removed completely from all segments of the beef industry, it would result in a 7.14% increase in breakeven price and a $71.28 increase in the production cost per animal. Wileman et al. (2009) estimated that not using implants in the feedlot would result in a $77 increase in the cost of production for feedlot steers.

## Ionophores

Ionophores (monensin-Rumensin®, lasalocid-Bovatec®, laidlomycin propionate-Cattlyst®) are used in the feeds of cattle to affect the microbial population in the rumen. Ionophores function by selecting against or negatively affecting the metabolism of certain bacteria in the rumen. By controlling detrimental bacteria in the rumen, fewer waste products are formed, beneficial bacteria are more efficient, and more beneficial organic acids and microbial protein are formed for the cattle to metabolize. Therefore, an increase in the overall energy status of the animal is observed, and the cattle actually become more efficient. Ionophores can be fed to any class of cattle and can be utilized in any segment of the beef cattle industry. Similar to many other feed additives, ionophores are fed in very small amounts and supplied in another feedstuff as carrier for intake. Ionophores are also used to decrease the incidences of coccidiosis, bloat, and acidosis.

The use of ionophores in stocker cattle and replacement heifers increases ADG by 5–15% and improves feed efficiency by 8–12% (Lawrence and Ibaruru 2008; Elam and Preston 2004). The economic effect of ionophores on stocker cattle is less than implants, contributing an impact of 1.46% on the breakeven price and an $11.51 effect on the cost of production. In the feedlot, ionophores improve ADG by 1–6% and improve feed efficiency by 3.5–8% (Lawrence and Ibaruru 2008; Elam and Preston 2004). Similar to the stocker sector, ionophores in the feedlot contribute a smaller but significant effect on breakeven price and production cost per head differential (1.18% and $12.43, respectively) compared to not using ionophore technology. Production practices that combine the use of ionophores and implants likely result in a synergetic effect (Elam and Preston 2004) on growth performance of cattle. Ionophores increase the amount of energy available from the diet, and the application of implants stimulates lean tissue growth that utilizes the increased available energy.

## Parasiticides

Parasites are a diverse group of pest that generally decreases the performance and value of cattle afflicted by them. Internal parasites affect cattle by decreasing feed digestion and increasing energy requirements; these both combine to result in a decrease in feed efficiency, body weight gain, milk production, and conception rate in growing and mature cattle. Additionally, the deleterious effects of a parasite load on cattle can depress the overall health and immune system, which can result in secondary incidents of viral and bacterial disease. A wide spectrum of products can be used to treat and control parasites. There are conflicts in the literature on whether these products have positive effects or non-effects on cattle production. Regardless, Preston and Elam (2004) summarize some general benefits of using parasiticides compared to non-use of parasiticides, including the following:

- Cow body weight and condition score increased (20–30 lbs and 0.2–0.4 units, respectively).
- Cow conception rate increased.
- Calf weaning weight increased (20–40 lbs).
- Heifer growth rate (0.1 lb/d), pubertal status (33% more reach puberty) and conception rate (+31%) at 14 months were improved.

Analysis by Lawrence and Ibaruru (2008) indicated that de-worming had 17.79% positive impact on stocker cattle ADG (Table 1). Likewise, de-worming had a significant effect on breakeven price and production cost per head when utilized. In the feedlot, the positive effect of de-worming continued, having an estimated 5.6% impact on ADG and 3.9% improvement on feed efficiency. De-worming had the second largest economic effect in the feedlot (2nd to implants) on breakeven price and production cost per head.

## Physiologic Modifiers—Beta-Agonist

Beta-agonists, which are also misnamed as "repartitioning agents," act to increase lean muscle yield and decrease fat deposition. Actually, β-agonists act to increase protein synthesis, decrease protein degradation, and block fat cell growth. The β-agonist does not shunt nutrients from fat accretion to muscle accretion, but rather affects the protein and adipocyte enzyme activity. Generally, a β-agonist is fed during the last 4–6 weeks of the finishing period. Utilizing a β-agonist can improve feedlot ADG by 14–25% and increase feed efficiency by 13–25% (Lawrence and Ibaruru 2008; Elam and Preston 2004). An added benefit is that carcass lean gain is also improved by nearly 70% during the β-agonist feeding period (Elam and Preston 2004). Use of β-agonists decreases feedlot breakeven price by 1.24% and decreases feedlot cost per head by $13.02 (Table 1; Lawrence and Ibaruru 2008). Additionally, the utilization of β-agonist is additive to the response of implants and ionophores. However, the overall effect of β-agonist as a proportion of total improvement in production is decreased because they are used for a short period of time (Elam and Preston 2004).

## Vaccines

Vaccines are some of the oldest technologies used in the beef cattle herd. Vaccination against bacterial and viral diseases is prophylactic and must be administered before the animal is exposed to the pathogen. Vaccines are pathogen specific, and many products are compounded so that one retail product can address several pathogens. Vaccines demonstrate effectiveness only when the pathogen is present in the animal's environment, whereas if the pathogen is not encountered, the vaccine has no beneficial effect. Significant vaccines of interest include blackleg, bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), bovine respiratory syncytial virus (BRSV), parainfluenza, costridium perfringes, haemophilus, pasteurella, and leptospira. For some of these vaccinations, it can be difficult to quantify the benefits in normal production. For other vaccinations, the benefit is readily discernible, and the lack of vaccination results in obvious production decreases. Numerous studies have examined the relationship between health status (vaccination titer) and performance in the feedlot. In one study, Fulton et al. (2002) examined the relationship of vaccination program on feedlot performance. Direct relationships between health and performance were evident for total treatment costs, net value, gross margin, ADG, and carcass grade.

## Conclusion

Preston and Elam (2004) estimated that productivity of the US beef herd has increased by over 80% in the last 50 years. Much of the increase in productivity can be attributed to the development and adaption of technologies to improve beef production. Antibiotics, implants, ionophores, β-agonist, parasiticides, and vaccines all make important contributions to the efficiency of beef production. However, other factors such as genetic selection and selection tools, along with advances in nutrition and reproduction management, have also affected productivity of beef operations. In addition, increases in grain and forage crop yields and decreases in relative feed prices have been important to spur the economic momentum of the beef cattle industry.

Elimination of the production technologies would represent a large setback for US beef production. Lawrence and Ibarburu (2008) estimate that eliminating only five technologies (parasite control, implants, sub-therapeutic antibiotics, ionophores, and β-agonists) would increase per-head production costs by $360 over the lifetime of an animal. Likewise, selling price for finished cattle would have to increase by 36% to offset the cost across all of the beef production segments. Modeling by Lawrence and Ibarburu (2008) estimates that eliminating beef technologies would result in a 14% smaller calf crop, 18% decrease in beef production, 180% increase in beef imports, and a 13% increase in retail beef prices. Additionally, if the level of production were expected to be maintained, additional land areas would have to be incorporated for cow herd management and feedstuff production. The increased land area dedicated to beef production and associated feed production would mean more land area put into intensive agricultural production, which could potentially affect the environment.

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Table 1. Effect of utilizing technologies on average daily gain (ADG) and estimated cost of production in the stocker and feedlot segment compared to no use.[1]

| Technology | ADG, %[2] | Breakeven price, % | Cost per head, $ |
|---|---|---|---|
| Cow-calf Sector | | | |
| Implants | 3.07 | 5.80 | 28.03 |
| De-wormer | 4.24 | 34.34 | 165.47 |
| Fly control | 2.56 | 3.05 | 14.71 |
| All technology | -- | 46.78 | 225.55 |
| | | | |
| Stocker Sector | | | |
| Implants | 12.85 | 2.31 | 18.19 |
| Ionophores | 7.74 | 1.46 | 11.51 |
| Sub-therapeutic antibiotics | 6.87 | 1.22 | 9.57 |
| De-wormer | 17.79 | 2.74 | 20.77 |
| Fly control | 8.09 | 0.80 | 6.28 |
| All technology | -- | 10.40 | 80.79 |
| | | | |
| Feedlot Sector | | | |
| Implants | 14.13 | 6.52 | 68.59 |
| Ionophores | 2.90 | 1.18 | 12.43 |
| Antibiotics | 3.37 | 0.56 | 5.86 |
| Beta-agonists | 14.04 | 1.24 | 13.02 |
| De-wormer | 5.59 | 2.11 | 22.16 |
| All technology | -- | 11.99 | 126.09 |

[1] Adapted from Lawrence and Ibarburu (2008).
[2] Weaning weight percent influence for cow-calf sector.