Welcome to the University of Missouri Beef Research and Teaching Farm 3rd Annual Field Day. There are many things in store for the day. You will find we have two good speakers on tap this morning.

Dr. Gene Felton from West Virginia University will present a project completed here at MU. He shipped steers to us to finish and collect individual feed efficiency data using the Grow Safe system here at the BRTF. Dr. John Lawrence from Iowa State University will discuss advantages of technology use in beef production systems. In times of high input costs getting the most bang for the buck is increasingly important. We hope you enjoy these presentations and visit with Dr. Felton and Dr. Lawrence later in the day.

There are also numerous students displaying posters and projects conducted here at the farm. In addition there are numerous vendors present to which we owe a huge Thank You. Please take the time to check out their displays and ask questions regarding products and services.

The applying technology sessions are designed to help you apply practices discussed during the morning session to your business. In addition several equipment demonstrations will be conducted during the afternoon to demonstrate how you may implement wet co-product feeding and storage as well as wet hay harvest in your operation.

This is the third year the Animal Science Graduate Student Association is cooking the meal. I am certain if you get nothing else out of today the lunch will be terrific. Feel free to let them know what you think of it.

Again we hope you enjoy yourself and find many useful tidbits of information you can take home and apply. Feel free as you have questions to grab someone in a BRTF shirt, if we can’t answer the question we will take you to someone who can. Thank you for attending and I hope to see you next year on September 17, 2009 for the 4th annual event.

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Intervet/Schering-Plough
Ridder Farms
Vigortone Ag. Products
Schedule

8:00 AM  **Registration open**  
Coffee & donuts available in Graduate poster & Commercial exhibit area

9:15 AM  **Effects of residual feed intake selection: from conception to slaughter**  
Dr. Gene Felton, West Virginia University

10:15 AM  **Economic impacts of pharmaceutical technologies in modern beef production**  
Dr. John Lawrence, Iowa State University

11:00 AM  **Applying technology posters**, select one to attend  
- Keys to success with fixed-time AI in beef cows  
- Selecting and using growth promoting implants  
- Measuring individual feed intake and calculating residual feed intake (RFI)  
- Sire selection for feed efficiency  
- Use of feed additives for stocker cattle

12:00 PM  **Lunch**  
**Division of Animal Sciences Update**  
Dr. Rod Geisert, Animal Science Division Director

1:00 PM  **Applying technology posters**, repeat of morning sessions, select one to attend

2:00 PM  **Pasture walk**

3:00 PM  **Equipment demonstrations**  
- Hay wrapper  
- Vertical Mixer  
- Wet co-Product storage

4:30 PM  **Demonstrations conclude**
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Effects of Residual Feed Intake Selection: From Conception to Slaughter

Eugene Felton, West Virginia University

Six Angus bulls with known residual feed intakes (RFI) were used to breed two West Virginia University and one private producer’s beef cow herds in the spring of 2005. When all six bulls were compared for RFI, their respective test rankings were as follows from most (-RFI) to least (+RFI) efficient: 111, 127, 117, 112, 26, and 128. Bulls were selected as pairs possessing similar expected progeny differences, growth performance but approximately equal but opposing RFI values within the test groups in which they were determined. Forty-eight steer calves (24 from +RFI sires and 24 from –RFI sires) from these three herds were selected based on similarity in bodyweight and winter growth performance and utilized for a pasture-season experiment beginning March 30, 2007 and subsequent feedlot finishing.

In the pasture experiment, steers were allotted to 1 of 4 treatments, with treatment group being randomly assigned to 1 of 4, one-hectare plots (subdivided into 4 subplots for rotational grazing) and replicated 3 times. Thus, steers were stocked at a rate of 4 hd per hectare with 4 treatments equally represented within each terrain classification. Treatments tested were 4 positive RFI steers per pasture (POS), 4 negative RFI steers per pasture (NEG), 2 positive RFI steers per pasture lead grazing with 2 negative RFI steers follow grazing (+/-), and 2 negative RFI steers per pasture lead grazing with 2 positive RFI steers follow grazing (-/+). Animal weight-gain and pasture forage disappearance/utilization measurements were collected. Data were analyzed as two separate experiments: Experiment 1, POS vs. NEG, Experiment 2, +/- vs. -/+.

Statistically analyzed results from measurements taken from the beginning of the experiment to late June (Period of excess forage) indicate that POS stocked pastures have more forage disappearance than NEG stocked pastures with no difference in animal performance. There was also no difference in pasture disappearance between +/- and -/+ stocked pastures. Although not significant, numerical differences in gain indicate that negative RFI sired steers are better able to utilize material left by forward grazed positive sired steers while no difference was seen in weight gain when positive RFI sired steers followed negative RFI sired steers. Results from late June to early August (Period of limiting forage) have not been fully analyzed but raw means show a 1.3 fold improvement in daily growth of NEG vs. POS steers. Raw means of the -/+ vs. +/- treatment showed similar better use of forage as seen in the earlier period with 1.6 fold greater ADG.

Steers were transported to the University of Missouri South Farm-beef unit in mid October 2007 and worked up on full feed. All steers were treated equally and slaughtered in early February averaging an 832 lb carcass with a SM60 amount of marbling, 0.41 in of backfat, 13.0 sq. in. ribeye and a yield grade of 2.9. POS sired calves outperformed NEG sired calves by 0.57 lb/d over the 72 day finishing period with no difference in slaughter or hot carcass weight or standard carcass measurements. Small numerical, but non-significant differences (0.13 vs. 0.04) existed.
for POS vs. NEG sired calves feedlot determined RFI. When comparing -/+ vs. +/- steers, only RFI differed with +/- steers averaging -0.65 vs. 0.34 for the -/+ steers. Within leader follower treatments, negative RFI sired steers had substantially lower RFI’s compared to the positive sired steers. Negative sired leader steers had an average -0.78 vs. 1.47 for positive followers for feedlot determined RFI. In contrast, positive sired leader steers had an average -0.23 vs. a -1.08 for negative followers for feedlot determined RFI. No other significant pasture treatment effects were detected during the finishing phase. RFI rankings determined from the finishing phase ranked sires from most (-RFI) to least (+RFI) efficient as follows: 111, 127, 112, 117, 26 and 128. Lastly, although not statistically different, feed costs from the time steers entered the feedlot till slaughter averaged 21.63 dollars more per head for positive RFI sired steers than for negative RFI sired steers.

These results may indicate that when forage is plentiful, offspring sired by positive RFI sires are able to have a greater intake of energy than negative RFI sired offspring and therefore compensate for poorer metabolic efficiency yielding similar performance. However, under a limited forage environment, less efficient, positive RFI sired offspring are more likely to have poorer performance and create greater risk for the grass lands producer. The reduction in gain experienced by the positive sired offspring while on limited pasture allowed for them to have compensatory gain while finishing. However, the efficiency of the positive RFI sired steers was still compromised and resulted in them having an overall higher feed costs. These results are based on a limited number of offspring from six different sires, however results indicate that selection for RFI can be made with positive results.
Economic Analysis of Pharmaceutical Technologies in Modern Beef Production
John D. Lawrence and Maro A. Ibarburu, Iowa State University

Executive Summary

Cattle production is the largest single agricultural sector in the U.S. with cash receipts of $49.2 billion in 2005. The industry includes more than 980,000 farms with cattle in all 50 states. Like the rest of agriculture, cattle producers have adopted efficiency and quality improving technology to meet consumer demands for a safe, wholesome, and affordable food supply. Preston and Elam chronicled the 50 year evolution of beef production technologies and estimated a significant savings of resources to produce our current supply of beef. Conversely, if the U.S. used only the current resources for cattle production, the beef industry and supply would be significantly smaller and beef prices to consumers significantly higher.

This research extends the earlier work by using meta analysis to combine information from over 170 research trials evaluating pharmaceutical technologies in the cow-calf, stocker, and feedlot segments of beef production. These results were used to estimate the farm/ranch level economic value of parasite control, growth promotant implants, sub-therapeutic antibiotics, ionophores, and beta agonists for the industry in 2005. These results were used in the Food and Agriculture Policy Research Institute (FAPRI) model of U.S. agriculture to estimate the impact on beef production, price, and trade if these pharmaceutical technologies were removed from the market.

While much of the discussion about technology use is focused on growth and efficiency in the feedlot sector, animal health and well being are also important. This analysis found that parasite control in the cowherd has a significant impact on calf production and cost to the beef system. Growth and efficiency enhancing technologies in the feedlot also have a significant impact on cost of production. These technologies will be particularly important in a bioeconomy era of higher feed costs.

Using 2005 prices and production levels the estimated direct cost savings to producers of the five pharmaceutical technologies evaluated was over $360 head for the lifetime of the animal. Selling prices would have to increase 36% to cover the increase in costs. However, producers and consumers adjust to the changing costs. The FAPRI model of the US beef sector shows a:

- 14% smaller calf crop,
- 18% reduction in US beef production,
- 180% increase in net beef imports, and
- 13% increase in retail beef prices.

Cattle prices do increase, but not as fast as cost of production. Packers and feedlots adjust to maintain operating margins similar to current levels resulting in lower returns to beef cow herds and a smaller feedlot and packing industry. Pork and poultry production expand to fill this void for domestic and export customers.

Some consumers are requesting natural or organically produced beef and research suggests that a portion of these consumers are willing to pay a premium for such products. However, the complete elimination of efficiency enhancing technologies will result in high beef prices to all consumers and the US would import significantly more beef to meet its demand. The small beef industry means fewer cattle operations and less employment in rural communities.
Economic Analysis of Pharmaceutical Technologies in Modern Beef Production  
John D. Lawrence and Maro A. Ibarburu, Iowa State University

Cattle production is the largest single agricultural sector in the U.S. with cash receipts of $49.2 billion\(^1\) in 2005. The industry includes more than 980,000 farms with cattle in all 50 states. These operations vary from small extensively managed range and pasture grazing herds to large intensively managed feedlots. While resources and management may differ, all cattle operations, like much of agriculture, face narrow operating margins from operating in a competitive global market. Also, like the rest of agriculture, cattle producers have adopted efficiency and quality improving technology to meet consumer demands for a safe, wholesome, and affordable food supply.

Preston and Elam chronicled the 50 year evolution of beef production technologies and estimated the benefit of the various technologies. The accumulation of these technologies has resulted in a significant savings of resources by reducing the inputs of pasture, range, and cropland to produce our current supply of beef. Conversely, if the U.S. used only the resources currently in cattle production, the supply of beef would be significantly smaller and beef prices to consumers significantly higher.

The purpose of this paper is to evaluate the impact of pharmaceutical technologies on the beef industry at a point in time, more specifically, 2005. The objectives are two-fold:

1. Estimate the farm or ranch level economic costs and benefits of selected pharmaceutical technologies under current market conditions.
2. Estimate the aggregate impact on U.S. beef production, trade, and consumer prices if these technologies did not exist.

Following a brief literature review is a description of the methodology used to summarize the numerous individual research projects into regional cost of production estimates for cow-calf, stocker, and feedlot enterprises. Then these farm/ranch level impacts are used in the Food and Agriculture Policy Research Institute (FAPRI) model of U.S. agriculture to estimate the impact on beef production, trade, and prices. The final section will summarize the analysis, discuss winners and losers, and identify the key elements that may alter the results.

Introduction

Beef cattle producers regularly use technologies to improve animal health and comfort as well as enhanced performance and profitability. These technologies include parasite control, ionophores, and growth promontants. Their adoption rate is relatively high because of their effectiveness and economic return, but it does differ for cowherds, stockers, and feedlots. National surveys have documented adoption rates by producers and numerous controlled research studies have documented the performance impact and are summarized here.

Nearly 73\% of the cow-calf operations dewormed cattle and 84\% of the cows received some injections in 1996 (Calf Health and Productivity Audit, 1997). Individual trials effects of the dewormers on pregnancy rate ranged from an increase of 2.4\% (Purvis et. al., 1994) to 120\%.

\(^1\) USDA Meat Animals Production, Disposition, and Income 2005 Summary, April 2006  
(Larson et. al., 1992). The dewormers effect on the wean weight ranged from an increase of nearly 0.3% (Stroh et. al., 1999) to over 13% (Stromberg et. al., 1997).

An estimated 14% of all cow-calf operations used some implants in calves prior to weaning. The Calf Health and Productivity Audit (1997) showed the use of implants prior to weaning was more common in the largest operations (55%) compared to the smallest operations (9%). Individual trial effects of the growth promotant implants on wean weight ranged from a slight increase of 0.3% (Simms et. al., 1983) to an increase of 10.7% (Wallace et. al., 1984). A large percentage of cow-calf operations (81%) used some form of fly control. (Calf Health and Productivity Audit, 1997). Individual trials effects of fly control on calves average daily gain (ADG) ranged from an increase of 0.3% (Quisenberry and Strohbehn, 1984) to 21% (Lynch et. al., 1982).

Individual trial effects on stocker cattle ADG differed across trials and technologies. Studies on deworming ranged from a decrease of 9% in (Mertz, Hildreth and Epperson, 2005) to an increase of 191% (Sanson et. al., 2003). Similar studies on growth promotant implants showed ADG ranged from a decrease of 0.6% (Brazle, 1996) to an increase of 45% (Brazle, 1988). Meanwhile the effect of sub-therapeutic antibiotic use in stockers ranged from a decrease of 21% (Brazle and Kuhl, 1989) to an increase of 27% (Brazle and Kuhl, 1989). Finally, effects of ionophores on stocker ADG ranged from a decrease of near 3% in (Corah and Brazle, 1986) to an increase of 24% (Lomas, 1982).

Feedlots are significant users of technologies. Overall 92% of all feedlots use growth promotant implants at placement and the use of implants is more common in the largest operations (99.6%) compared to the smallest operations (89.5%) (Baseline Reference of Feedlot Management Practices, 1999). Individual trials on growth promotant implants reported a range in ADG from a decrease of near 5% (Foutz et. al. 1997) to an increase of near 38.6% (Gerken et. al., 1995) with an average value near 14%. The range in individual trial effects of growth promotant implants on feed to gain (FTG) ranged from an increase of 7.7% (Henricks et. al., 1997) to a decrease of 22.8% (Gerken et. al., 1995) with an average of an 8.8% decrease in FTG.

Eighty-three percent of the feedlots used some antimicrobial in feed or water and the use of antimicrobials is higher for animals placed at 700 lbs or less (Health Management and Biosecurity in U.S. Feedlots, 1999). Individual trial effects of sub-therapeutic antibiotics in ADG ranged from a decrease of 9% (Ramsey et. al., 2000) to an increase of 11% (Zinn Song and Lindsey, 1991). Individual studies of sub-therapeutic antibiotics on FTG ranged from an increase of 19% (Rogers et. al., 1995) to a decrease of 8% (Lee and Laudert, 1984).

Overall, 93% of feedlot operations fed ionophores, and 46% fed coccidiostats (Health Management and Biosecurity in U.S. Feedlots, 1999). A higher percentage of operations in the Central region fed probiotics (34%) compared to operations in other regions (13%). The list of additives is not mutually exclusive since operations may have used more than one additive. (Health Management and Biosecurity in U.S. Feedlots, 1999). The results of ionophore research on ADG in feedlot cattle ranged from a decrease of 20% (Brandt and Pope, 1992) to an increase of 20% (Spires et. al., 1990). Individual trials evaluating effects of ionophores in FTG ranged from an increase of 7% (Brandt and Pope, 1992) to a decrease of 19% (Lomas, 1983).
Parasiticides and avermectins are the most commonly used products with use in over 99% of feedlots (Health Management and Biosecurity in U.S. Feedlots, 1999). Feedlots also regularly use (99%) some method to control fly population (Health Management and Biosecurity in U.S. Feedlots, 1999).

Approximately 98% of feedlot operations vaccinate against respiratory diseases and 86% of operations vaccinate against clostridial diseases as part of the initial processing of incoming cattle. Ninety-two percent of the feedlots implant steers and 96% treat for parasites shortly after placement. (Health Management and Biosecurity in U.S. Feedlots, 1999). MGA® was fed to all of the female cattle on 62% of the large operations and 46% of the small operations that placed female cattle (Health Management and Biosecurity in U.S. Feedlots, 1999).

In summary, pharmaceutical technologies are widely used in all segments of the cattle industry. Some, such as parasite control are used in all segments. A high percentage of feedlots use several technologies. While generally beneficial for animal performance and profitability, the results of the individual research trials do vary. This difference likely reflects the specific nutritional, environmental, and genetic conditions of animals in the study conducted. As a result it is difficult to generalize from any one research trial to the broader industry context and impact. In the following section we discuss a procedure for systematically combining the numerous research results to arrive a representative value and distribution of expected impact from these technologies in the cattle industry.

Methodology

The purpose of the study is to evaluate the value of pharmaceutical technologies by estimating the cost of eliminating their use in each of the beef cattle production segments (cow-calf, stocker and feedlots). The pharmaceutical products analyzed are: parasite control, growth promotant implants, sub-therapeutic antibiotics, ionophores, and beta agonists. Meta-analysis was used to combine numerous individual research studies on these pharmaceutical technologies. It is a set of techniques to integrate empirical studies on the same or similar issues. It is a highly valuable way to review and summarize research literature, and is now widely used in medicine and the social sciences. This analysis reviewed over 170 published articles and incorporated the mean responses, variation (standard deviation), and size of the studies evaluated. Where there was not enough information reported in the literature for a particular technology a similar approach was used to combine the results of the studies to arrive at a mean and the largest standard deviation that would be significant at P<0.05. Given the combined distribution, a Montecarlo simulation of 20,000 events of the expected effect of the technology on production parameters was generated for each product in each production system where information is available. The output of this step is the change in production and/or efficiency resulting from using an individual technology versus not using it. Later the procedure is used to look a combination of technologies that are often used compared to no technologies. Finally, these production and efficiency parameters are put into a farm/ranch level cost of production budget to estimate the cost and benefit of pharmaceutical technologies on a per head basis. In the next section these net return results are used in the FAPRI aggregate model of U.S. agriculture to determine the broader impact on resource use, trade, and food prices of pharmaceutical technologies.
The cattle industry was divided into three production segments: cow-calf, stocker, and feedlot, and into geographical regions where appropriate. Six cow-calf and five stocker regions were identified (Table 1). Feedlot production was treated as one region because the diets and use of technologies are similar across all major feedlot regions. Cost of production budgets for these three segments were developed using selected University Extension budgets for major production states in each region.

<table>
<thead>
<tr>
<th>Region</th>
<th>States in region</th>
<th>University budgets used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow-calf</td>
<td>LA, MS, FL, AL, GA, TN, SC, NC, VA, WV, KY</td>
<td>Louisiana</td>
</tr>
<tr>
<td>North Central</td>
<td>ND, SD, NE, KS</td>
<td>North Dakota</td>
</tr>
<tr>
<td>South Central</td>
<td>OK, TX</td>
<td>Texas</td>
</tr>
<tr>
<td>Central</td>
<td>MN, WI, IA, MO, AR, IL, MI, IN, OH</td>
<td>Missouri</td>
</tr>
<tr>
<td>Northeast</td>
<td>New England States</td>
<td>Pennsylvania</td>
</tr>
<tr>
<td>West</td>
<td>WA, OR, CA, NV, ID, MT, UT, WY, CO, AZ, NM</td>
<td>Colorado</td>
</tr>
<tr>
<td>Stocker</td>
<td>LA, MS, FL, AL, GA, TN, SC, NC, VA, WV, KY</td>
<td>Louisiana</td>
</tr>
<tr>
<td>North Central</td>
<td>ND, SD, NE, KS</td>
<td>Kansas</td>
</tr>
<tr>
<td>South Central</td>
<td>OK, TX</td>
<td>Oklahoma and Texas</td>
</tr>
<tr>
<td>Central</td>
<td>MN, WI, IA, MO, AR, IL, MI, IN, OH</td>
<td>Missouri</td>
</tr>
<tr>
<td>West</td>
<td>WA, OR, CA, NV, ID, MT, UT, WY, CO, AZ, NM</td>
<td>Colorado</td>
</tr>
</tbody>
</table>

For cow-calf operations the literature reports changes in pregnancy rate, weaning weight and calf ADG as a response to the use of pharmaceutical products. For stocker operations the literature reports changes in ADG and there is limited evidence of reduction in death loss as a response to the use of pharmaceutical products. The literature reports the use of pharmaceutical products in feedlots leads to changes in ADG, FTG, average marbling score and average yield grade.

Beginning with the mean and standard deviation summarized from existing literature for the expect impacts of the pharmaceutical technologies of interest 20,000 observations (unless otherwise noted) of effects of each product in production efficiencies were generated using simulations and the rank correlation between variables was included in the random generation of the distribution. These variables are then entered into the regional budgets weighted by the location of the US inventory to generate the expected dollar impact of removing the technologies. Initial cattle and corn prices are average 2005 prices reported by USDA. A sensitivity analysis was run to determine how robust the results are to changes in feed price and feeder cattle price. This procedure results in an average farm/ranch level net return and the risk of returns associated with removing these pharmaceutical technologies.

**Cow-calf segment**

Six regional cow-calf operations budgets were used to evaluate the cost of eliminating pharmaceutical products (Table 1). Representative cull cow prices were developed based on the
average of the monthly Auction Cattle Prices reported for the year 2005 reported by USDA-Agricultural Marketing Service. The prices used were:

- West: Colorado, Washington, Montana, New Mexico, Oregon, and Wyoming
- North Central: Kansas
- South Central: Texas and Oklahoma
- Central: Missouri
- Southeast: Tennessee, Georgia and Alabama auctions
- Northeast: Pennsylvania

The estimated feed cost across the regions ranged from $183/cow/year to $247/cow/year. Annual veterinary and health products cost ranged from $10/cow/year to $25/cow/year. Additional cost for the pharmaceutical technologies were not included in the analysis, nor was this budget item changed when the technologies were removed.

The only changes in production efficiency for cow-calf operations that is consistently reported in the literature is the effect of the technologies on pregnancy rate, average daily gain (ADG) and calf weaning weight. Therefore we have only included changes on pregnancy rate and calf weaning weight in the program. We assumed that the calves are weaned on a fixed date and sold at weaning. The changes in calf ADG affect the weaning weight and therefore the sale weight. It is assumed that feed consumption is the same at higher weaning weights when pharmaceutical technology is used as it is at lower weaning weights. This analysis is based only on the impact of pregnancy rate and sale weight and not any value difference due to a prescribed vaccination or treatment program. A sensitivity analysis determined that the results are robust to changes in feed costs in all cases.

**Results**

Table 2 shows the estimated effects of three different technologies on weaning rate and weaning weight. De-worming is the technology that affects weaning rate the most with an expected value of 23.6%. This is a very large impact and weaning rate includes both pregnancy rate and survival rate of the calf. It also explains why 73% of beef cowherds use de-wormers. The three technologies have similar impact on the weaning weight. All the effects are different than 0 with 99% confidence.

| Table 2. Impact of Pharmaceutical Technologies on Beef Cowherd Weaning Rate and Weight |
|---------------------------------|--------|--------|--------|--------|
|                                 | Wean Rate | Wean Weight |
|                                 | Effect   | St. Error | Effect   | St. Error |
| Growth Promotant Implants       | 2.54%    | 0.0049    | 3.07%    | 0.0023    |
| De-wormers                      | 23.62%   | 0.0600    | 4.24%    | 0.0033    |
| Fly Ccontrol                    | nd       | nd        | 2.56%    | 0.0048    |

The larger the effect of a technology on production efficiency, the larger its effect on cost of production. The expected impact on breakeven selling price of eliminating the de-wormers was 34.3% which represents an added cost of $165.47/head produced (Table 3). The second
most important technology is growth promotant implants with an effect of 5.8% in the breakeven price and $28.03/head increase in costs. In combination these three technologies have a significant impact of cost of production in beef cow operations. Removing these three technologies is expected to increase the breakeven selling price nearly 47% or $225/head and the results are different than 0 with a 99% confidence. In many case producers have a fixed land base and are limited in the number of beef cows the land will support. As weaning rate and weight decrease, there are fewer calves sold to cover the cost of the herd. Producers must still retain replacement heifers but do so from a smaller number of calves. Thus, the cost per calf sold increases dramatically.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Breakeven price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Promotant Implants</td>
<td>5.80%</td>
<td>28.03</td>
</tr>
<tr>
<td>De-wormers</td>
<td>34.34%</td>
<td>165.47</td>
</tr>
<tr>
<td>Flies control</td>
<td>3.05%</td>
<td>14.71</td>
</tr>
<tr>
<td>All technologies</td>
<td>46.78%</td>
<td>225.55</td>
</tr>
</tbody>
</table>

Table 3. Estimated Impact on Breakeven Selling Price and Cost of Production from Removing Pharmaceutical Technologies from the Bee Cowherd

The results are robust to changes in feed cost (Table 4). Feed prices are simulated as 20% higher or lower to evaluate the impact of pharmaceutical technologies under different price scenarios. The efficiency gains of the technologies are more important at higher feed prices.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Breakeven price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>46.78%</td>
<td>225.55</td>
</tr>
<tr>
<td>Feed Price Up</td>
<td>46.90%</td>
<td>247.13</td>
</tr>
<tr>
<td>Feed Price Down</td>
<td>46.63%</td>
<td>203.98</td>
</tr>
</tbody>
</table>

Table 4. Sensitivity of Eliminating All Products on Beef Cowherds when Feed Prices are 10% Higher or Lower:

Stocker Operations

Five regional budgets for stocker operations were used to evaluate the cost of eliminating pharmaceutical technologies. The budgets represent the West, North Central, South Central, Central, and South East regions and were weighted by stocker cattle inventories to represent a national impact. Representative feeder-cattle prices for each weight range were developed based on the average of the monthly Auction Cattle Prices reported for the year 2005 reported by USDA-Agricultural Marketing Service. The prices used were:

- West: Colorado, Washington, Montana, New Mexico, Oregon, and Wyoming
- North Central: Kansas
- South Central: Texas and Oklahoma
- Central: Missouri
- Southeast region: Tennessee, Georgia and Alabama auctions
The estimated feed cost ranged across the regions in 2005 from $0.30/day to $0.45/day. The labor cost ranged from $6/head to $24/head. Veterinary and health products cost was estimated as $10/head. Additional cost for the pharmaceutical technologies were not included in the analysis, nor was this budget item changed when the technologies were removed.

The only change in production efficiency for stocker operations that is consistently reported in the literature is the effect of the technologies on ADG. Therefore, we have only included changes in ADG in the analysis. We assumed that the animals were sold when they reach a desired live weight. The change in ADG affect the days the cattle remain in the operation incurring cost to reach the desired final weight.

Montecarlo simulations were repeated for 20,000 draws from each distribution of the effect of each technology on ADG. The resulting values were used to estimate the breakeven price if each technology is eliminated from the stocker production systems. The change in the expected cost was estimated as the average breakeven price without the technology over the average breakeven price with the technology. A sensitivity analysis was run to determine the impact of 20% higher or lower feed prices and calf prices being 10% higher or lower.

Results

Table 5 shows the estimated effects of the five different technologies on ADG. All the effects are different than 0 with 99% confidence. De-wormers and growth promotant implants are the two technologies that affect ADG the most in stocker operations. Ionophores, subtherapeutic antibiotics, and fly control had similar control to each other, but less than implants and de-wormers.

| Table 5. Effect of Pharmaceutical Technologies on Average Daily Gain in Stocker Cattle |
|-----------------------------------------|---------|----------|
| Effect | Std.Error |           |
| Implants | 12.85% | 0.0062  |
| Ionophores | 7.74% | 0.0094  |
| Subtherapeutic antibiotics | 6.87% | 0.0127  |
| De-wormers | 17.79% | 0.0106  |
| Fly control | 8.09% | 0.0103  |

The higher the effect of a technology on production efficiency, the larger its impact on cost of production. The estimated effect on the breakeven price of eliminating the de-wormers was 2.7% which represents a cost of $20.77/head produced (Table 6). The second most important technologies are growth promotant implants with an effect of 2.3% in the break even price and $18.19/head. Ionophores and subtherapeutic antibiotics have an expected cost of production impact of $11.51/head and $9.57/head, respectively. Fly control has a smaller impact. All the results are robust to changes in feed prices and feeder cattle prices.
Table 6. Estimated Cost of Production Impact of Pharmaceutical Technologies in Stocker Operations

<table>
<thead>
<tr>
<th>Technology</th>
<th>Breakeven price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St. Error</td>
</tr>
<tr>
<td>Implants</td>
<td>2.31%</td>
<td>0.00005</td>
</tr>
<tr>
<td>Ionophores</td>
<td>1.46%</td>
<td>0.00006</td>
</tr>
<tr>
<td>Subtherapeutic antibiotics</td>
<td>1.22%</td>
<td>0.00011</td>
</tr>
<tr>
<td>De-wormers</td>
<td>2.74%</td>
<td>0.00020</td>
</tr>
<tr>
<td>Fly control</td>
<td>0.80%</td>
<td>0.00008</td>
</tr>
<tr>
<td>All technologies</td>
<td>10.40%</td>
<td>0.00037</td>
</tr>
</tbody>
</table>

Some literature indicates that the effects of growth promotant implants, ionophores and subtherapeutic antibiotics are additive. We assumed that the de-wormers and fly-control effects are additive as well. Therefore, the effects of each technology from the Montecarlo simulations were added and the resulting values were used to estimate the breakeven price if these five groups of products are eliminated from the stocker production systems. The estimated impact on the breakeven price of eliminating these five technologies was 10.4% or $80.79/head and was significantly different than 0 with a 99% confidence.

The results are robust to changes in feed prices and calf prices (Table 7). As expected, efficiency and performance enhancing technologies have a larger impact when feed prices are higher. The cost savings decrease at higher calf prices compared to the base price as feed and operating costs are a smaller percent of total costs.

Table 7. Sensitivity Analysis of Feed and Calf Prices when Eliminating All Pharmaceutical Technologies

<table>
<thead>
<tr>
<th></th>
<th>Breakeven price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St. Error</td>
</tr>
<tr>
<td>Baseline</td>
<td>10.40%</td>
<td>0.00037</td>
</tr>
<tr>
<td>Feed Price Up 20%</td>
<td>11.22%</td>
<td>0.00079</td>
</tr>
<tr>
<td>Feed Price Down 20%</td>
<td>9.49%</td>
<td>0.00067</td>
</tr>
<tr>
<td>Calf Price Up 10%</td>
<td>9.69%</td>
<td>0.00069</td>
</tr>
<tr>
<td>Calf Price Down 10%</td>
<td>11.18%</td>
<td>0.00079</td>
</tr>
</tbody>
</table>

Feedlot effects

A single budget was used to represent feedlot production systems to evaluate the cost of eliminating pharmaceutical products. Representative feeder-cattle prices for each sex and weight range were developed based on the average of the monthly Auction Cattle Prices reported for Missouri, Kansas, Nebraska, South Dakota, North Dakota, Texas and Oklahoma for the year 2005 reported by USDA-Agricultural Marketing Service. The monthly average of 2005 fed-cattle price for interior Iowa and South Minnesota (USDA, Agriculture Marketing Service) was used as the fed cattle price. The initial feed cost was estimated as $0.038/lb., representative of prices in 2005. The labor cost was estimated as $27/head. Veterinary and health products cost
was estimated as $10/head. Additional cost for the pharmaceutical technologies were not included in the analysis, nor was this budget item changed when the technologies were removed.

Literature research was done to find the expected value and the distribution of the effect of growth promotant implants on ADG and FTG (expressed as lbs feed/ lbs gained). Research on the impact of pharmaceutical technologies is typically reported separately for steers and heifers. This analysis modeled each technology for both sexes, but combined the results into a single weighted average feedlot effect across both steers and heifers based on the share of steers (63.5%) and heifers (36.5%) slaughtered in 2005 and 2006. A sensitivity analysis was run by moving the feed prices up and down 20% and the feeder cattle price up and down 10%.

Guiroy et. al. (2002) found that for the same empty body fat (28%) at slaughter, the final weight at slaughter is higher for implanted animals than for non-implanted ones, and the increments also depend on the anabolic dose used. We used their results to estimate the increase in final weight needed to reach the same empty body fat, e.g., the same approximate quality and yield grade, with or without implants. The procedure generated 1000 observations for each of the groups of effects on final weight (4 groups in steers and 2 groups in heifers and the estimate the average increase in weight. Perry et. al. (1991) analyzed the effect of trenbolone acetate and estradiol implants on beef steers and the results show little effect on yield when the animals were fed to the same final marbling score. Therefore, no changes in marbling and yield grade distributions are included in this analysis.

Montecarlo simulations were run to get 20,000 draws from each distribution of the effect of pharmaceutical technologies on ADG, FTG and final weight. The rank correlations between ADG and FTG and between ADG and final weight were included in the simulations. Final weight is impacted by implants and beta-agonists, while the remaining technologies effect only days on feed. The resulting values were used to estimate the breakeven selling price if these technologies are eliminated from feedlot production systems. The change in the expected cost per head was estimated as the average breakeven price without technologies over the average breakeven price with technologies. Table 8 summarizes the average impact and the standard error.

Table 8. The Estimated Impact on Average Daily Gain and Feed to Gain from Eliminating Pharmaceutical Technologies from Beef Feedots

<table>
<thead>
<tr>
<th></th>
<th>ADG</th>
<th>FTG</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect</td>
<td>St Error</td>
<td>Effect</td>
</tr>
<tr>
<td>Implants</td>
<td>14.13%</td>
<td>0.0021</td>
<td>-8.79%</td>
</tr>
<tr>
<td>Ionophores</td>
<td>2.90%</td>
<td>0.0030</td>
<td>-3.55%</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>3.37%</td>
<td>0.0037</td>
<td>-2.69%</td>
</tr>
<tr>
<td>Beta-agonists</td>
<td>14.04%</td>
<td>0.0053</td>
<td>-12.59%</td>
</tr>
<tr>
<td>De-wormers</td>
<td>5.59%</td>
<td>0.0159</td>
<td>-3.91%</td>
</tr>
</tbody>
</table>

From the literature reviewed and the simulation procedure outlined we estimated that the growth promotant implants and beta-agonists have the largest increase on ADG and FTG. Implants resulted in an increase of the ADG by 14.1% and decrease the FTG by 8.8%. The rank
correlation is -0.694 between the increase the ADG and the decrease the FTG. Beta-agonists have a similar ADG effect as did implants, but larger FTG impact. De-wormers, subtherapeutic antibiotics, and ionophores had a lesser but still statistically significant impact on costs. De-wormers improved ADG 5.6% and reduced FTG 3.9%. Subtherapeutic antibiotics and ionophores improved ADG approximately 3% and reduced FTG approximately 3%.

The simulations of the individual technologies were used in the budget model to estimate the impact on cost of production. Table 9 reports the percent change in selling price needed to breakeven and the cost per head increase in production cost in the feedlot from eliminating these pharmaceutical technologies. Implants have the largest cost savings effect of the technologies considered with 6.5% and over $68/head higher cost if these technologies were eliminated. De-wormers the second largest cost savings. Ionophores and beta-agonists reduce costs approximately $12-13 per head or about 1.2%. The impact to beta-agonists is smaller than reported in the table above because they are used for a relatively few days at the end of the feeding period. Sub-therapeutic antibiotics have an important, but smaller cost reduction.

Table 9, Percentage and Dollar per Head Change in Cost of Production Resulting from Elimination of Pharmaceutical Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Breakeven price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St. Error</td>
</tr>
<tr>
<td>Growth Promotant Implants</td>
<td>6.52%</td>
<td>0.00063</td>
</tr>
<tr>
<td>Ionophores</td>
<td>1.18%</td>
<td>0.00002</td>
</tr>
<tr>
<td>Sub-therapeutic Antibiotics</td>
<td>0.56%</td>
<td>0.00002</td>
</tr>
<tr>
<td>Beta-Agonists</td>
<td>1.24%</td>
<td>0.00001</td>
</tr>
<tr>
<td>De-wormers</td>
<td>2.11%</td>
<td>0.00002</td>
</tr>
<tr>
<td>All technologies</td>
<td>11.99%</td>
<td>0.00064</td>
</tr>
</tbody>
</table>

The final line of Table 9 reports the effect of simulating these technologies in combination rather than individually. Some literature identifies that the effects of growth promotant implants, ionophores and sub-therapeutic antibiotics are additive. Therefore the effects of each one from the Montecarlo simulations were added and the resulting values were used to estimate the breakeven price if these five groups of products are eliminated from the feedlot production systems. These results reflect a small degree of additive effect. The sum of the individual technologies reduces cost per head an estimated $122.06/head compared to the $126.09/head savings when simulated together.

The results of the combined technologies simulations were evaluated under higher and lower feed and feeder cattle prices (Table 10). As expected the value of the pharmaceutical technologies that improve ADG and FTG have a bigger cost savings at higher feeder prices. Likewise, they are more important at higher feeder cattle prices also.
Table 10. Sensitivity of Cost of Production Results to Changes in Feed and Feeder Cattle Prices

<table>
<thead>
<tr>
<th></th>
<th>Break even price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St. Error</td>
</tr>
<tr>
<td>Baseline</td>
<td>11.99%</td>
<td>0.00064</td>
</tr>
<tr>
<td>Feed Price Up 20%</td>
<td>12.28%</td>
<td>0.00059</td>
</tr>
<tr>
<td>Feed Price Down 20%</td>
<td>11.69%</td>
<td>0.00069</td>
</tr>
<tr>
<td>Calf Price Up 10%</td>
<td>11.75%</td>
<td>0.00066</td>
</tr>
<tr>
<td>Calf Price Down 10%</td>
<td>12.28%</td>
<td>0.00061</td>
</tr>
</tbody>
</table>

Across all segments

The effects of pharmaceutical technologies from each segment were combined and weighted by region and adoption rate. For that purpose the cow-calf effects in the different regions were weighed by the percentage of total calves produced in each area, similar procedure was followed for the stocker operations.

When the adoption rate of each technology was included in the analysis the expected impact on the breakeven price of eliminating the de-wormers on the entire chain was 19% which represents a cost of nearly $190/head produced. The expected value of the predicted effect on the breakeven price of eliminating the growth promontant implants on the entire chain was over 7% which represents a cost of $71.28/head produced. The estimated increase is breakeven selling price of eliminating all the technologies studied from the entire chain was 36.6% which represents a cost of $365.65/head produced.

Table 11. Impact of Estimated Breakeven Selling Price and Cost per Head from Eliminating Pharmaceutical Technologies Throughout the Beef Industry

<table>
<thead>
<tr>
<th>Technology</th>
<th>Breakeven price</th>
<th>Cost per head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St. Error</td>
</tr>
<tr>
<td>Growth Promontant Implants</td>
<td>7.14%</td>
<td>0.00049</td>
</tr>
<tr>
<td>De-wormers</td>
<td>19.02%</td>
<td>0.00071</td>
</tr>
<tr>
<td>All technologies</td>
<td>36.63%</td>
<td>0.00134</td>
</tr>
</tbody>
</table>

While adoption rate is relatively high across the technologies, it is important to account for the existing use of technologies before estimating the cost of eliminating them. The estimated impacts of banning pharmaceutical technologies is significant, but the fully integrated industry impact is less than the sum of the individual segments listed above that do not account for adoption rate.

Market Implications

The combined impacts on cost of production of pharmaceutical technologies were integrated across the three production sectors. The results are additive and if fact show a complementary effect as healthy animals are better able to use other inputs efficiently. The results were weighted by a reported adoption rate for technologies in each segment. For
example, nearly 95% of feedlots use technologies, but only 74% of beef cow herds use de-wormers. As a result, elimination on pharmaceutical technologies would not impact 26% of beef cowherds.

The impact on cost of production and beef production from eliminating pharmaceutical technologies was run as a scenario through the FAPRI model of US agriculture. FAPRI uses comprehensive data and computer modeling systems to analyze the complex economic interrelationships of the food and agriculture industry. FAPRI prepares baseline projections each year for the U.S. agricultural sector and international commodity markets. These multi-year projections provide a starting point for evaluating and comparing scenarios involving macroeconomic, policy, weather, and technology variables. These projections are intended for use by farmers, government agencies, agribusinesses, and others who do medium-range and long-term planning. The analysis compares a ban on pharmaceutical technologies to the current baseline with existing technologies and holds other factors constant. The underlying assumption is that the ban on pharmaceutical technologies, while significant to the beef sector, is not large enough to impact the macro economy or corn and other input markets. It does include the market interactions with pork and poultry markets and beef trade.

A summary of the results are shown in Table 12 and assumes that a ban on pharmaceutical technologies was implemented in 2000. The table represents 2005, five years after the ban was initiated and that most of the adjustment has occurred. It also shows the percent change and the difference from the baseline with technology and scenario without pharmaceutical technologies. The change and difference are based on a three year average in years 4-6 after the ban rather than only one year.

The technology impact on production efficiency described earlier was incorporated into the FAPRI model. The results indicate that the US beef market adjusts to a new equilibrium without pharmaceutical technologies at a smaller industry with higher beef and cattle prices. The model estimated that the number of beef cows is unchanged, but there are 14% fewer calves weaned and carcass weights decline reducing beef production 18% or 4.5 billion pounds annually. There are less total cattle, cattle on feed, and cattle slaughter. Net imports of beef increase dramatically, 180% or nearly 2.2 billion pounds. Consumers eat less of a higher priced product. Domestic per capita beef consumption declines 8.5% while retail prices increase 13%.

Cattle prices increase along with retail prices. Nebraska fed cattle prices increase 20% or more than $17/cwt without the technologies. However, slaughter weight is reduced and FTG increases meaning that feedlots cannot bid as aggressively for feeder cattle. Feeder cattle prices do increase 23% or approximately $26/cwt for Oklahoma City 600-650 pound steers, but not as much they would if feedlots had better efficiency. Cull cow prices increase $13/cwt.

<table>
<thead>
<tr>
<th>Inventory (Million Head)</th>
<th>Values after 5 Years</th>
<th>Average Years 4, 5, 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With Technology</td>
<td>Without Technology</td>
</tr>
<tr>
<td>Beef Cows, Jan 1</td>
<td>32.9</td>
<td>33.0</td>
</tr>
<tr>
<td>Total Calf Crop</td>
<td>37.8</td>
<td>32.5</td>
</tr>
<tr>
<td>Steer and Heifer Slaughter</td>
<td>27.2</td>
<td>22.6</td>
</tr>
<tr>
<td>Cattle and Calves, Jan 1</td>
<td>95.4</td>
<td>83.7</td>
</tr>
<tr>
<td>Cattle on Feed, Jan 1</td>
<td>13.7</td>
<td>11.4</td>
</tr>
</tbody>
</table>

| Beef Supply and Use (Million Lbs)       |                      |                      |                |            |
| Production                              | 24,784               | 20,225               | -18.1%         | -4545.6    |
| Net Imports                             | 2,901                | 5,123                | 180.7%         | 2180.1     |
| Retail consumption (lbs)                | 65.4                 | 59.9                 | -8.5%          | -5.6       |

| Prices and Returns ($/cwt)              |                      |                      |                |            |
| Nebraska 11-13 cwt Steers               | 87.28                | 104.94               | 20.2%          | 17.33      |
| OKC 6-6.5 cwt Steers                    | 120.02               | 147.48               | 22.8%          | 26.52      |
| Utility Cows, Sioux Falls               | 54.36                | 67.72                | 25.3%          | 13.09      |
| Retail Beef ($/Lbs)                     | 4.09                 | 4.63                 | 13.1%          | 0.53       |

| Cow-calf Returns ($/cow)                |                      |                      |                |            |
| Receipts                                | 584.51               | 627.28               | 7.0%           | 40.77      |
| Expenses                                | 446.17               | 491.29               | 10.1%          | 45.94      |
| Net Returns                             | 138.34               | 135.99               | -7.9%          | -5.17      |

Source: Food and Agricultural Policy Research Institute

However, the higher feeder cattle and cull cow prices only partially offset the higher cow herd cost due to the reduced weaning rate. Cow herd returns were very good in 2005 and are projected to decline in the years ahead under either scenario. In the end, cow herd returns are modestly lower, approximately 8% or $5 per head, without the use of pharmaceutical technologies. Thus, the industry reaches new equilibrium with cow-calf returns lower than before the ban on technologies and a smaller industry with fewer cattle on feed, reduced slaughter and more beef imports.

The smaller, higher cost beef industry is beneficial for competing meats. Pork and broiler production is expected to increase 1.4% each in response to restrictions on beef technologies. Exports increase over 6% for pork and broiler meat and per capita consumption increases 0.67% and 0.54%, respectively. In spite of the larger supply, retail prices also increase because of higher retail beef prices. Thus, competing meat industries benefit from restrictions that increase cost of production in the beef sector.

As with other technologies in agriculture, their benefit accrues to consumers in the form of larger supplies at lower prices. Early adopters of technologies typically benefit from lower costs before the larger supplies result in lower prices. In the case of a ban on pharmaceutical technologies the incentives are reversed. Producers want to be the last to quit using the cost.
saving technologies as their ban results in higher prices due to higher costs of production and reduced supplies. While the surviving producers are expected to earn similar returns with or without these technologies, the industry is smaller there will be fewer producers.

Summary

Pharmaceutical technologies are widely used in the US cattle industry and with good cause. They significantly reduce the cost of producing beef by improving the growth and efficiency of cattle production across all segments of the industry. Adoption rates vary across segments, but are quite high with over 95% of feedlot cattle using some or all of the technologies considered. Cowherds do not use implants and ionophores as regularly as do feedlots, but they have high adoption rates for parasite control.

While much of the discussion about technology use is focused on growth and efficiency in the feedlot sector, animal health and well being are also important. This analysis found that parasite control in the cowherd has a significant impact on calf production and cost to the beef system. Growth and efficiency enhancing technologies in the feedlot also have a significant impact on cost of production. These technologies will be particularly important in a bioeconomy era of higher feed costs.

This study incorporated research findings from over 170 trials using meta-analysis to evaluate the impact of individual pharmaceutical technologies on cattle performance and cost of production. Using 2005 prices and production levels the farm/ranch level cost savings of the five pharmaceutical technologies evaluated was more than $360 per head over the lifetime of the animal after accounting for adoption rates. Fed cattle selling prices would have to increase 36% to cover the increase in costs across all segments.

These efficiency and cost differences are incorporated into the FAPRI model of US agriculture. The US beef market finds a new equilibrium at a smaller industry with higher beef and cattle prices. There are less total cattle, cattle on feed, and slaughter and beef production falls 18% or 4.5 billion pounds annually. Net imports of beef increase 180% or nearly 2.2 billion pounds per year. Per capita consumption declines 8.5% while retail prices increase 13%. Pork and poultry will expand to fill this void in domestic and export markets. Cattle prices increase along with retail prices. Nebraska fed cattle prices increase 20%, approximately $17/cwt. Oklahoma City 600-650 pound steer prices increase 23% or more than $26/cwt and cull cow prices increase as well, up $13/cwt.

However, the higher feeder cattle and cull cow prices only partially offset the higher cowherd cost due to the reduced weaning rate. After the adjustment, cowherd returns are approximately 8% or $5 per head lower without the use of pharmaceutical technologies. The beef industry is expected to have the same number of beef cows, but fewer calves are weaned leading to less total cattle, reduced slaughter, and more beef imports.

As with other technologies in agriculture, their benefit accrues to consumers in the form of larger supplies at lower prices. Early adopters of technologies typically benefit from lower costs before the large supplies result in lower prices. In the case of a ban on pharmaceutical
technologies the incentives are reversed. Producers would want to be the last to quit using the cost saving technologies as cost of production rise and supplies decline leading to higher prices. Once the industry has fully adjusted to the ban on technologies, remaining producers are expected to earn similar returns as they did before. However, there will be fewer producers.

Cost of production is a generic measure of resource use. Technologies allow the animal to more efficiently utilize forage and grain resources to produce beef to meet consumer demand. Some consumers are requesting natural or organically produced beef and research suggests that a portion of these consumers are willing to pay a premium for such products. However, if pharmaceutical technologies were banned from use in the US cost of production would rise forcing some producers and resources out of the cattle industry. The feedlot and beef packing sectors would be downsized because there would be fewer calves produced and more beef is imported. The smaller supply of beef will result in higher prices to all consumers, not just those willing to pay a premium for natural and organic production practices.

References: For a full list of the references cited in this paper please see: www.econ.iastate.edu/faculty/lawrence/pharmaeconomics2006.pdf
In an earlier report we evaluated the impact on producer costs and resulting beef supplies and prices expected to occur if existing pharmaceutical technologies were banned from use in beef production. The estimates indicated that users of these technologies would have over a $430/head increase in cost of production over the lifetime of the animal. Adjusted for existing adoption rate indicated that the industry would experience a 36% increase in production costs or approximately $366/head. When incorporated into an economic model of domestic consumption and international trade the higher costs resulted in an 18% reduction in U.S. beef production, a 180% increase in net beef imports, and 13% higher retail beef prices for consumers. That analysis was based on 2005 prices, before increased biofuel production and before corn and other feedstuffs increased dramatically in price.

This brief article summarizes the impact on the producer-cost estimates when feed prices are higher. The original assumptions of production efficiency changes due to pharmaceutical technologies and their subsequent removal are modeled using the same cost of production procedure outlined in the original paper. However, feed input and cattle prices are based on average prices from 2007 to more accurately reflect prices expected in the coming years (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Cow-calf</th>
<th>Percent</th>
<th>Stocker</th>
<th>Percent</th>
<th>Feedlot</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2007</td>
<td>Change</td>
<td>2005</td>
<td>2007</td>
<td>Change</td>
</tr>
<tr>
<td>Feed Cost</td>
<td>224</td>
<td>274</td>
<td>22%</td>
<td>66</td>
<td>81</td>
<td>23%</td>
</tr>
<tr>
<td>Other Costs</td>
<td>259</td>
<td>309</td>
<td>19%</td>
<td>46</td>
<td>48</td>
<td>6%</td>
</tr>
<tr>
<td>Calf Price ($/cwt)</td>
<td>126</td>
<td>117</td>
<td>-7%</td>
<td>675</td>
<td>616</td>
<td>-9%</td>
</tr>
<tr>
<td>Feeder Cattle Cost</td>
<td>786</td>
<td>745</td>
<td>-5%</td>
<td>1095</td>
<td>1176</td>
<td>7%</td>
</tr>
<tr>
<td>Total Cost</td>
<td>483</td>
<td>582</td>
<td>21%</td>
<td>161</td>
<td>277</td>
<td>73%</td>
</tr>
</tbody>
</table>

There were big changes in beef production costs from 2005 to 2007. For example, cow-calf operation feed and non-feed costs increased by 22% and 19%, respectively, at the same time that calf prices decreased 7%, squeezing producers’ profits. Stocker operations benefited from the lower calf prices but their feed costs increased 23% and their non-feed costs increased 6%. The most significant change was on feedlot’s feed costs, which went up 73% during this period. This was compensated by a 5% decrease in the yearling prices, resulting in an only 7% increase in total costs. The feed costs represented 15% of the total costs in 2005 for the feedlot operations while it represented 24% of the total costs in 2007; the feeder cattle purchase value as a share of total costs decreased from 74% to 65% for the same period. It is important to review the effects of pharmaceutical technologies in the costs of production under this new prices scenario.
Cow-calf operations

Table 2 shows that the breakeven price (BEP) for cowherds increased from $125/cwt in 2005 to $151/cwt in 2007 and the cost per head increased from $483 to $582. The analysis only considers effects on weaning rate and weaning weight for the cow-calf operations. Therefore, the cost change due to pharmaceutical technology use comes from the effect on the total pounds of calves to sell after keeping sufficient heifer calves to maintain herd size. Even though the effect of pharmaceutical technologies expressed as the percent increased in the break-even price didn’t change, the effect on the cost per head increased 21% approximately for each technology because of the higher starting breakeven price. The result is that the use of each technology brought about higher returns in 2007 than in 2005 before counting any change in the pharmaceutical product price during that period.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakeven Price, original</td>
<td>1.25</td>
<td>1.51</td>
<td>483</td>
<td>582</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Promotant Implants</td>
<td>1.32</td>
<td>1.59</td>
<td>5.8%</td>
<td>5.8%</td>
<td>511</td>
<td>616</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>De-wormers</td>
<td>1.68</td>
<td>2.03</td>
<td>34.4%</td>
<td>34.6%</td>
<td>649</td>
<td>783</td>
<td>166</td>
<td>201</td>
</tr>
<tr>
<td>Flies control</td>
<td>1.29</td>
<td>1.55</td>
<td>3.1%</td>
<td>3.1%</td>
<td>498</td>
<td>600</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>All technologies</td>
<td>1.84</td>
<td>2.22</td>
<td>46.8%</td>
<td>47.2%</td>
<td>709</td>
<td>857</td>
<td>226</td>
<td>274</td>
</tr>
</tbody>
</table>

Table 2: Impact on breakeven price and cost when pharmaceutical technologies are not used in cow-calf operations

Stocker operations

The stocker operations analysis considers the effects of pharmaceutical technologies on average daily gain, leaving unchanged starting weight and finish weight; therefore, a decrease in average daily gain results in keeping cattle more days on the operation, resulting in higher feeding costs, as well as higher operation and labor costs. The breakeven price went from $105/cwt in 2005 to $99/cwt in 2007 and the cost per head decreased by $41 from 2005 (Table 3) due to 9% lower calf costs that more than compensates the 23% increase in feed costs. The cost savings associated with using pharmaceutical technologies increased from $81/head to $95/head due to higher feed costs. The result is that the use of each technology led to higher returns in 2007 than in 2005 before counting any change in the pharmaceutical product price during that period for the stocker operations as well.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakeven Price, Original</td>
<td>1.05</td>
<td>0.99</td>
<td>786</td>
<td>745</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Promotant Implants</td>
<td>1.07</td>
<td>1.02</td>
<td>2.3%</td>
<td>2.9%</td>
<td>804</td>
<td>766</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Ionophores</td>
<td>1.06</td>
<td>1.01</td>
<td>1.5%</td>
<td>1.8%</td>
<td>798</td>
<td>759</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Antimicrobial therapy</td>
<td>1.06</td>
<td>1.01</td>
<td>1.2%</td>
<td>1.5%</td>
<td>796</td>
<td>756</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>De-wormers</td>
<td>1.08</td>
<td>1.03</td>
<td>2.7%</td>
<td>3.3%</td>
<td>807</td>
<td>769</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Flies control</td>
<td>1.06</td>
<td>1.00</td>
<td>0.8%</td>
<td>1.0%</td>
<td>792</td>
<td>752</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>All technologies</td>
<td>1.16</td>
<td>1.12</td>
<td>10.4%</td>
<td>12.7%</td>
<td>867</td>
<td>840</td>
<td>81</td>
<td>95</td>
</tr>
</tbody>
</table>

Table 3: Impact on breakeven price and cost per head when pharmaceutical technologies are not used in stocker operations
Feedlot operations

Ionophores, antimicrobials, beta-agonists, and dewormers improved the average daily gain and/or feed efficiency for feedlot cattle, while growth promotant implants also allowed the producers to finish cattle to a higher weight without affecting the carcass fat percent. The breakeven price went from $83/cwt in 2005 to $89/cwt in 2007 and the cost per head increased by $81 between 2005 and 2007 (Table 4). Even though feed efficiency and average daily gain improve with the use of growth promotant implants, the cattle are reaching heavier market weight, resulting in a similar feed cost per head. The lower feeder cattle price resulted in lower opportunity cost of cattle in 2007 that compensated for some of the effect of growth promotant implants under higher feed costs. The result was a decrease on the effect of growth promotant implants expressed as the percent increase in the break-even but a similar effect on the cost per head on both periods. Similar results were observed for the use of beta-agonists. The effect on the cost per head finished increased by approximately 50% for ionophores, antimicrobials, and dewormers. The effect of all five technologies on the percent increase in the break-even price increased from 12.0% to 13.2% while the effect of all the five technologies on the cost per head increased from $131/head to $155/head for the same period.

Table 4: Impact on breakeven price and cost per head when pharmaceutical technologies are not used in feedlot operations

<table>
<thead>
<tr>
<th>Technology</th>
<th>Breakeven price ($/pound)</th>
<th>Breakeven price effect</th>
<th>Cost of production ($/head)</th>
<th>Value of Technology ($/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakeven Price, Original</td>
<td>0.83</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Promotant Implants</td>
<td>0.88</td>
<td>0.94</td>
<td>6.5%</td>
<td>6.1%</td>
</tr>
<tr>
<td>Ionophores</td>
<td>0.84</td>
<td>0.90</td>
<td>1.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Antimicrobial therapy</td>
<td>0.83</td>
<td>0.89</td>
<td>0.6%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Beta-Agonists</td>
<td>0.84</td>
<td>0.90</td>
<td>1.2%</td>
<td>1.2%</td>
</tr>
<tr>
<td>De-wormers</td>
<td>0.84</td>
<td>0.91</td>
<td>2.1%</td>
<td>2.9%</td>
</tr>
<tr>
<td>All technologies</td>
<td>0.93</td>
<td>1.01</td>
<td>12.0%</td>
<td>13.2%</td>
</tr>
</tbody>
</table>

Summary

Not surprisingly, pharmaceutical technologies that improve feed efficiency and/or increase pounds of gain have a larger economic impact when feed prices are higher than when they are lower. The value of these technologies for the individual farm increased from approximately $430 per head in 2005 to $524 per head in 2007, a 22% increase. While the market price for calves and feeder cattle going into feedlots has decreased as feed costs have increased, the price decline would have to be larger if stocker operations and feedlots were not allowed to use efficiency improving technologies. Although not updated with 2007 prices, the earlier analysis modeled the impact on total beef production, beef imports, and exports and farm and consumer prices. A ban on pharmaceutical technologies at higher feed prices such as those experienced in 2007 would impact production, trade and prices in the same direction (less production, more beef imports, higher consumer prices), but the size of the impact would be larger.
Keys to Success with Fixed-Time AI in Beef Cows
(CO-Synch + CIDR protocol with AI at 66 hours)

Dan Busch, Mike Smith, and David Patterson

Herd Health
✓ Pre-breeding vaccinations or de-worming should be completed at least 30 days prior to CIDR insertion.

Proper Nutrition
✓ Average BCS should be at least 5.0 (1 to 9 scale) at time of CIDR insertion and should be maintained through breeding season.
✓ Steady to increasing plane of nutrition (keep rations under 16% protein).

Proven Reproductive History
✓ 85 – 90% pregnancy rates in a 60 day breeding season.
✓ Cows should average 45 days post calving at CIDR insertion (minimum of 21 days)
✓ Cows not eligible for AI should be exposed to bulls for natural service

Animal Identification and Record Keeping
✓ Cows and calves should be clearly and individually identified with legible ear tags and/or brands.
✓ Individual calving dates should be recorded for each cow.

Use Proven AI Sires
✓ Only use AI sires proven to perform effectively in a fixed-time AI program.
✓ Use sires that are genetically proven (high accuracy EPDs).

Facilities
✓ Adequate facilities to gather, sort, and process cattle in a reasonable time period.
✓ Use a portable AI barn during the insemination process if available.
✓ Ensure AI technicians are scheduled for AI date and capable to inseminate all cows that are synchronized

Other AI Tips
✓ Use 18 gauge 1 ½” needles for intramuscular estrus synchronization products.
✓ At CIDR insertion, technicians’ hands and CIDR applicator should be thoroughly washed clean of manure using a 2-bucket rinse of Nolvasan or Chlorhexidine solution diluted in clean fresh water.
✓ Restrict all breeding capable bulls from pasture for 10 – 14 days following AI.
✓ Pregnancy diagnosis/check should be performed using ultrasound approximately 70 days after AI.
✓ Stress on cattle should be reduced around the time of AI and maternal recognition.
**HEAT DETECTION**

Select Synch

Select Synch + CIDR®

**FIXED-TIME AI (TAI)**

CO-Synch + CIDR®

CO-Synch + CIDR® & TAI

**HEAT DETECT & TIME AI (TAI)**

Select Synch & TAI

Select Synch + CIDR® & TAI

**COMPARISON OF PROTOCOLS FOR BEEF COWS**

<table>
<thead>
<tr>
<th>HEAT DETECTION</th>
<th>COST</th>
<th>LABOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Synch</td>
<td>Low</td>
<td>Medium/High</td>
</tr>
<tr>
<td>Select Synch + CIDR®</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEAT DETECT &amp; TAI</th>
<th>COST</th>
<th>LABOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Synch (TAI non-responders 72-84 hr after PG)</td>
<td>Low</td>
<td>Medium/High</td>
</tr>
<tr>
<td>Select Synch + CIDR® (TAI non-responders 72-84 hr after PG)</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIXED-TIME AI (TAI)</th>
<th>COST</th>
<th>LABOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO-Synch + CIDR® (TAI 60 to 66 hr after PG with GnRH at TAI)</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

* The times listed for “Fixed-time AI” should be considered as the approximate average time of insemination. This should be based on the number of cows to inseminate, labor, and facilities.

- Cystorelin®, Factrel®, Fertagyl®, OvaCyst®
- Estrumate®, In-Synch®, Lutalyse®, ProstaMate®, estroPLAN®

*Beef Reproduction Task Force*
**HEAT DETECTION**

1 Shot PG

**HEAT DETECT & TIME AI (TAI)**

Select Synch + CIDR® & TAI

Heat detect and AI day 7 to 10 and TAI all non-responders
72 - 84 hr after PG with GnRH at TAI.

**COMPARISON OF PROTOCOLS FOR BEEF HEIFERS**

<table>
<thead>
<tr>
<th>HEAT DETECTION</th>
<th>COST</th>
<th>LABOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shot PG</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>CIDR®-PG</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>MGA®-PG</td>
<td>Low</td>
<td>Low/Medium</td>
</tr>
</tbody>
</table>

**HEAT DETECT & TAI**

Select Synch + CIDR®
(TAI non-responders 72-84 hr after PG)
High Medium

MGA®-PG
(TAI non-responders 72-84 hr after PG)
Medium Medium

**FIXED-TIME AI (TAI)**

CO-Synch + CIDR®
(TAI 54 ± 2 hr after PG with GnRH at TAI)
High Medium

MGA®-PG
(TAI 72 ± 2 hr after PG with GnRH at TAI)
Medium Medium

CIDR® Select
(TAI 72 ± 2 hr after PG with GnRH at TAI)
High Medium/High

• The times listed for “Fixed-time AI” should be considered as the approximate average time of insemination. This should be based on the number of heifers to inseminate, labor, and facilities.

**Beef Reproduction Task Force**
Selecting and Using Growth Promoting Implants for Beef Cattle

Justin Sexten
Extension Beef Specialist – Nutrition
Commercial Agriculture Program

Growth promoting implants improve average daily gain and feed efficiency in all beef production segments. Growth promoting implants offer the second greatest productivity increase for cow-calf and stocker production systems behind de-worming while in feedlot systems implants offer the greatest potential for improvement (Lawrence and Ibarburu, 2006). Less than 15% of beef producers utilize implants in nursing calves or implant calves at weaning and collectively less than 20% of all operations utilize implants in any calves between birth and weaning (NAHMS, 1997). Larger stocker, backgrounding and feedlot operations report greater use of implant technology (Johnson et al., 2008; USDA, 2000). Payback on implant use is conservatively $10 for each dollar invested. Given the potential return on investment and opportunity to increase implant use in cow-calf and stocker/backgrounding programs this paper will focus on selecting and developing implant protocols for cattle prior to entering the feedlot.

To develop implant programs a basic understanding of implant mode of action is required. Growth implants fall into three basic categories, estrogens, androgens, and progestins. Compounds used for each category are illustrated in Table 1.

Growth promoting implants are manufactured using single or combinations of active compounds to develop programs designed for specific uses within the beef cattle industry. Active ingredients are absorbed by the animal from compressed pellets or silicone rubber implants subcutaneously placed in the middle 1/3 of the ear.

Benefits from implant use will only be realized with proper implant administration and product choice. Implant failure results from crushed, broken, lost pellets, or infection at the implant site. Proper implant administration begins with a clean, well restrained ear. Dirty or manure coated ears provide an opportunity to introduce infection to the implant site. To minimize potential infection and implant failure, clean dirty ears with disinfectant solution using a stiff bristled brush prior to implantation. Keep implant needles clean, by placing a sponge in a paint tray containing disinfectant and between animals rest the needle on top of the saturated sponge. For implant guns without retracting needles withdraw needle 1/4 inch after inserting under the skin of the ear to allow for implant insertion without crushing pellets.

When considering implant program development producers should consider cattle age, sex, weight in addition to performance goals (gain and carcass) and future breeding use. Animal

<table>
<thead>
<tr>
<th>Table 1. Growth promoting compounds by category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estrogens</strong></td>
</tr>
<tr>
<td>Estradiol 17β</td>
</tr>
<tr>
<td>Estradiol benzoate&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Zeranol&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Androgens</strong></td>
</tr>
<tr>
<td>Testosterone propionate</td>
</tr>
<tr>
<td>Trenbolone acetate</td>
</tr>
<tr>
<td><strong>Progesterones</strong></td>
</tr>
<tr>
<td>Progesterone</td>
</tr>
</tbody>
</table>

<sup>a</sup> Estradiol benzoate contains 71.4% estradiol 17β
<sup>b</sup> Zeranol contains ~ 31-36% active estrogen

Adapted from (Botts et al., 1997)
Breed, health, and nutrition as well as producer management ability, working facilities, and available labor should also be considered.

Cattle age, sex and weight are the clearly defined considerations relative to implant use. Table 2 illustrates approved implants for growing cattle sorted by weight, sex, active ingredient and dosage. Following label directions for implant use allows producers to begin developing implant programs. Narrowing implant selection requires further consideration of the remaining factors influencing implant choice.

Table 2. Approved beef cattle implants for growing cattle

<table>
<thead>
<tr>
<th>Weight</th>
<th>Sex</th>
<th>Ingredients</th>
<th>Dose (mg)</th>
<th>VetLife Trade name</th>
<th>Fort Dodge Trade name</th>
<th>Intervet Schering-Plough Trade name</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 400 lb</td>
<td>S, H</td>
<td>Zeranol</td>
<td>36</td>
<td></td>
<td>Ralgro</td>
<td></td>
</tr>
<tr>
<td>S, H</td>
<td></td>
<td>Progesterone Estradiol benzoate</td>
<td>100</td>
<td>Component E-C</td>
<td>Synovex C</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>Estradiol</td>
<td>25.7</td>
<td>Compudose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>43.9</td>
<td>Encore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 400 lb</td>
<td>S, H</td>
<td>Zeranol</td>
<td>36</td>
<td></td>
<td>Ralgro</td>
<td></td>
</tr>
<tr>
<td>S, H</td>
<td></td>
<td>Trenbolone acetate Estradiol</td>
<td>40</td>
<td>Component TE-G</td>
<td>Revalor G</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>Estradiol</td>
<td>25.7</td>
<td>Compudose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>43.9</td>
<td>Encore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>Progesterone Estradiol benzoate</td>
<td>200</td>
<td>Component E-S</td>
<td>Synovex S</td>
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</tr>
<tr>
<td>H</td>
<td></td>
<td>Testosterone propionate Estradiol benzoate</td>
<td>200</td>
<td>Component E-H</td>
<td>Synovex H</td>
<td></td>
</tr>
</tbody>
</table>

---

When considering additional implant program factors producers should determine animal endpoint and work backwards. Initially there are two endpoints for cattle in an operation, replacement breeding stock and finishing animals. To date no implant is approved for use in intact males retained for breeding purposes. Currently Component E-C, Ralgro and Synovex C are approved for use in replacement heifer calves when administered no earlier than 30 days of

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*a Adapted from (FDA, 2008), Refer to product label for complete product information

*b VetLife, Division of Ivy Animal Health a Subsidiary of Elanco Animal Health

Fort Dodge Animal Health, Division of Wyeth

Intervet Schering-Plough Animal Health Corporation

*c Available with Tylan (tylosin tartrate)

*d Trade names have been used for clarity, but their use does not constitute an endorsement by the University of Missouri, nor does it imply discrimination against other products.
age for Ralgro and 45 days of age for Component E-C and Synovex C. Implants should only be administered once during the nursing period, research has demonstrated negative reproductive performance in re-implanted heifers (Selk, 1997). Cattle are often processed at ~ two months of age prior to dams being turned out to in breeding groups. This processing period offers producers the opportunity to implant all calves except potential sires and minimize additional cattle handling and operator labor. Potential replacement heifers can be implanted at this time to capture 3% additional weaning weight.

To further evaluate implant program design the implant payout period or effective days should be considered. Implant payout period is variable, two implants approved for use in nursing steers, Compudose and Encore carry label claim for effective dose for 200 and 400 days respectively. Producers retaining ownership within these time periods can utilize these products to minimize cattle handling and labor requirements.

Producers can consider re-implanting steers and cull heifers during the nursing period if gathered and processed at bull removal if calves will be sold at weaning. Alternately, if pre-weaning vaccinations are given and producers plan to retain calves for a short (45 to 60 day) backgrounding period re-implanting at this time may be considered. Unless calves are going to be handled for other purposes the stress and shrink of gathering simply for implanting may not be offset by the improvement in gain due to re-implanting. Consider payout periods of Ralgro (60-80 days), Component E-C (90-110 days) and Synovex C (90-110 days) and labeled cattle weight restrictions in addition to future implant use when considering nursing calf re-implanting.

When evaluating a re-implant program producers should remember programs should increase in potency as the animal grows (Selk et al., 2006). Implant classification by active ingredient level are shown in Table 3. Using these threshold values producers can narrow implant choices for weaned calves headed to backgrounding lots or pasture stocker programs.

Implanted stocker or pasture cattle ADG will be 10-15% greater than non-implanted cattle during the grazing period. In addition, as pasture gain from non-implanted controls improves gain from implanted cattle improves with greater magnitude (Kuhl, 1997). Simply put, as nutrition or environment permits greater ADG, response to growth promoting implants will also improve. Conversely, cattle need to gain at least 0.75 to 1.0 pounds per day to observe a performance due to implant (Kuhl, 1997).

Development of implant programs for stocker and backgrounding operations differ due to nutritional status. Stocker systems will generally gain less while backgrounding systems will target ADG of 2 to 2.5 lbs / day. Managing cattle in confinement with greater ADG may benefit from using additional mild combination implants available for confinement cattle illustrated in Table 4. Unless using a labeled long-lasting or slow release implant, growing and confinement cattle will benefit from re-implanting around 100 days following previous implant. Long-fed

<table>
<thead>
<tr>
<th>Table 3. Implant classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant category</td>
</tr>
<tr>
<td>Mild estrogen</td>
</tr>
<tr>
<td>Strong estrogen</td>
</tr>
<tr>
<td>Mild combination</td>
</tr>
<tr>
<td>Strong combination</td>
</tr>
</tbody>
</table>

(Morgan, 1997)
cattle will benefit from shorter re-implant intervals. Again labor and handling of cattle should be considered relative to implant choice.

Timing of implant is not solely related to pay out length. Fresh weaned, long hauled, and/or health stressed may benefit from delayed implant administration. If cattle are going to be revaccinated or mass medicated shortly following receiving and diet acclimation delayed implanting may be warranted as cattle will not be gaining the required 0.7 to 1.0 lbs / day to express implant benefit.

Most concerns related to implant selection in growing and confinement cattle has been related to reduction in quality grade due to implant. Strong implants administered at less than 70 days prior to harvest may negatively impact quality grade. Producers should consider cattle’s genetic capacity to grade and market premium for choice or better carcasses when developing an implant program focused on maintaining quality grade.

Developing an implant program for beef production systems requires consideration of management, nutrition, genetic, labor and marketing plans within the operation. Given the significant improvement in performance in all aspects of the beef production system producers should continue to adapt available growth promoting implant technologies to their production system or ensure the premiums related to natural cattle production offsets lost productivity.

Literature Cited


Table 4. Approved beef cattle implants for confinement cattle\(^a\)

<table>
<thead>
<tr>
<th>Weight</th>
<th>Sex</th>
<th>Ingredients</th>
<th>Dose (mg)</th>
<th>VetLife Trade name(^b)</th>
<th>Fort Dodge Trade name(^b)</th>
<th>Intervet Schering-Plough Trade name(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedlot</td>
<td>S, H</td>
<td>Zeranol</td>
<td>36</td>
<td></td>
<td></td>
<td>Ralgro</td>
</tr>
<tr>
<td>S, H</td>
<td>Estradiol</td>
<td>25.7</td>
<td>Compudose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S, H</td>
<td>Trenbolone acetate Estradiol benzoate</td>
<td>200 28</td>
<td>Synovex Plus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S, H</td>
<td>Trenbolone acetate Estradiol</td>
<td>200 20</td>
<td>Component TE-200(^c)</td>
<td>Revalor 200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Zeranol</td>
<td>72</td>
<td>Ralgro</td>
<td></td>
<td></td>
<td>Magnum</td>
</tr>
<tr>
<td>S</td>
<td>Trenbolone acetate Estradiol</td>
<td>80 16 120 24 200 40</td>
<td>Component TE-IS(^c) Component TE-S(^c)</td>
<td>Revalor IS Revalor S</td>
<td>Revalor XS</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Trenbolone acetate Estradiol benzoate</td>
<td>100 14</td>
<td>Synovex Choice</td>
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<tr>
<td>S</td>
<td>Progesterone Estradiol benzoate</td>
<td>200 20</td>
<td>Component E-S(^c)</td>
<td>Synovex S</td>
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<tr>
<td>S</td>
<td>Trenbolone acetate Estradiol benzoate</td>
<td>140 20</td>
<td>Component T-S(^c)</td>
<td></td>
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<tr>
<td>H</td>
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<td>80 8 140 14</td>
<td>Component TE-IH(^c) Component TE-H(^c)</td>
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<td>Component E-H(^c)</td>
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<tr>
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<td>200 20</td>
<td>Component T-H(^b)</td>
<td></td>
<td>Finaplix H</td>
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</tbody>
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\(^a\) Adapted from (FDA, 2008). Refer to product label for complete product information
\(^b\) VetLife, Division of Ivy Animal Health a Subsidiary of Elanco Animal Health
Fort Dodge Animal Health, Division of Wyeth
Intervet Schering-Plough Animal Health Corporation
\(^c\) Available with Tylan (tylosin tartrate)
\(^d\) Trade names have been used for clarity, but their use does not constitute an endorsement by the University of Missouri, nor does it imply discrimination against other products.
Measuring Individual Feed Intake in Beef Cattle and Calculating Residual Feed Intake (RFI)

Monty S Kerley, PhD

The University of Missouri BRTF installed the GrowSafe Feed Intake System to measure individual feed intake in beef cattle. The GrowSafe system consists of nodes, or feed bunks, that are supported by electronic weigh bars. The weight of the nodes are scanned and recorded every second. The nodes are also equipped with an RFID antenna that is positioned in the lip of the bunk. Every time a calf comes to the node, the antenna reads the calf’s electronic ear tag. The node weight data and the RFID data are then captured by a computer. The GrowSafe software uses these data to calculate the amount of feed consumed by each calf, the amount of feed the calf consumed each minute it ate, the amount of feed the calf consumed at each eating bout, the number of times the calf visited the feedbunk per day, the time of day that the calf visited the feedbunk, and how long the calf stayed at each eating bout. The amount of data and the different calculations that are made are almost endless.

The data collected to date has been interesting, and it has told us aspects of cattle behavior in the feedlot that we didn’t know. For example, calves eat on a three and five day cycle, but do not appear to eat on a daily or 24 hour cycle. The day to day variation in intake by a calf can be great, with variations in feed consumed from day to day being as great as 10 lbs or more. Calves eat when it is daylight, and do not show much activity when it is dark. Intake is a very sensitive indicator of sickness. The calf will stop eating 24 to 48 hours before we can notice it is sick. If the calves can’t drink, they won’t eat. As we collect more data on intake behavior in cattle, we will undoubtedly learn more about managing cattle at the feedbunk and use eating behavior to tell us how the cattle are doing.

The primary use of individual feed intake data has been to calculate RFI. RFI is a measure of metabolic efficiency. Feed to gain, a typical measure of efficiency, is more accurately a measure of growth efficiency. The attribute of RFI is that it measures efficiency of the animal in a manner not confounded by growth rate. If RFI is used as a measure of efficiency, selection will be for a more efficient animal. If feed to gain is used a measure of efficiency selection will be for a bigger animal, and maybe more efficient. This is the reason that emphasis is being placed on phenotyping cattle for RFI.

Measurement of RFI requires the measurement of the animal’s intake, average daily gain, and average weight during the test. RFI tests are currently recommended to be over a 70 day period. The intake of the calves in a feeding group is regressed upon the calves average daily gain and average body weight as shown below.
Body weight and average daily gain account for approximately 76% of the influence on intake of the animal. This makes sense because the weight of the calf will be the primary factor influencing the amount of maintenance energy the calf expends and the growth rate will be the primary factor determining the amount of energy the calf needs for growth functions. Current research is examining the effect that body composition has on intake. Measures of body composition have been shown to have a small effect on daily intake and it is likely that future equations will include backfat and marbling scores in the calculation.

Currently intake is only regressed upon average body weight and average daily gain in the calculation of RFI. An animal’s RFI value is calculated as the actual intake of the calf minus its expected intake. The actual intake is measured by the GrowSafe Feed Intake System. The expected intake is calculated using the regression equation of intake regressed on average daily gain and average body weight.

For example, we would place 80 bulls on feed in the GrowSafe system. Once they were adapted to the diet, we would measure intake and body weight change over a 70 day period. These data would be used to calculate the intake, average daily gain, and average body weight of each bull. The intake of each bull would be regressed upon the gain and weight of that bull, and the 80 head would be used to calculate a regression equation \[ \text{intake} = \text{intercept} + (\text{ADG} \times \text{coefficient}) + (\text{average weight} \times \text{coefficient}) \]. This regression equation will allow us to compute the expected intake, or average intake for the group of 80 calves, for any ADG and average weight combination. The expected intake of a calf can be calculated by plugging the ADG and average weight of that calf into the regression equation. The RFI is calculated as the actual intake of the calf minus the expected intake of that calf. A negative number indicates a calf that at its ADG and weight required that much less feed than the average of the group, and a positive number means the calf consumed more feed for its ADG and weight than the group average consumed. The example below shows how this would be calculated for data collected in a bull test.
Calculating RFI

Actual intake – Predicted intake at a specified body weight and
daily gain

850 lb bull calf
ADG = 4
Actual intake = 15.3
Predicted intake for the group of bulls = 20.4

RFI = -5.1

This calf consumed 5 lbs less feed than the average calf to perform the same

The bull in the example above would be an efficient calf. He consumed 5 lbs less feed than the average calf in the group. In the groups that we have fed and measured RFI, he would be among the top in efficiency. While this is a great attribute for the calf, the real question is so what does this mean for his offspring. The table below is an example of feed intake by an efficient and inefficient calf. There is a 1.2 fold difference in intake of the calves, but these two calves had the same average daily gain, carcass weight, quality grade and yield grade. The only notable difference was the amount of feed consumed. With 550 lbs of gain by these calves in the feedlot, the efficient calf consumed 605 lbs less feed. At $220 per ton of diet this equals about $66 less feed consumed by the efficient calf. Selecting for efficiency alone has the potential to reduce input costs by $60 or more per head.

<table>
<thead>
<tr>
<th></th>
<th>High FE</th>
<th>Low FE</th>
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<tr>
<td>Feed to gain</td>
<td>4.95</td>
<td>6.05</td>
</tr>
<tr>
<td>Daily feed intake</td>
<td>16.3</td>
<td>19.7</td>
</tr>
<tr>
<td>Residual feed intake</td>
<td>-0.83</td>
<td>0.78</td>
</tr>
</tbody>
</table>

The potential impact that RFI has on profitability is significant. It has been shown to be a moderately heritable trait, and use of efficient bulls has been shown to have positive effects on offspring similar to the example above. Breed associations are beginning the process of assimilating RFI data and are in the process of developing methods to use RFI data in genetic selection programs.
Sire Selection for Feed Efficiency

Bob Weaber, Ph.D. and Dennis Fennewald, M.S.
University of Missouri – Columbia

There are many Economically Relevant Traits (ERT) which impact the profitability of beef production. These include calving ease, fertility, weaning weight, average daily gain, carcass merit, and others. Some of these ERTs are relatively easy to quantify and are high in heritability, such as carcass traits. These ERTs respond well to selection. Other ERTs are more difficult to quantify and are low in heritability, such as fertility. These ERTs can be most easily improved with intelligent crossbreeding. To complicate selection further, some ERTs have a large impact on profit while other ERTs have a smaller impact. Animal breeders have long sought to improve the efficiency of feed utilization and of beef production systems. However, effective selection for improved individual feed efficiency has been elusive. Genetic improvement systems for feed efficiency have suffered from an inadequate supply of individual feed intake measurements. The measurement of individual feed consumption has been limited by both availability of reliable, efficient technology to monitor individual feed intake in typical industry settings and by the cost of such equipment.

The Importance of Feed Efficiency

Feed costs account for approximately 65% of the total beef production costs. Of the metabolizable energy required from conception to consumption of a beef animal, 72% is utilized during the cow-calf segment of production while 28% of calories are utilized in the calf growing and finishing phases of production (Ferrell and Jenkins, 1982). Although feed costs represent a large cost center in beef production, as producers we are fortunate that feed efficiency has a heritability of approximately 40%, which is moderate to high, and should respond to selection with the appropriate tools. Furthermore, it is estimated that feed efficiency can be improved by 10%, which equates to 3-5 lbs/day as fed for a feed lot animal. If a finishing ration costs $0.16/lb ($325/ton), the savings is $0.48-$0.80/day/head or $14.40-$24.00/month/head. For 100 head pen, that is a $1,440-$2,400 savings per month! If all animals in the U.S. fed cattle population of 27 million reduced daily intake by 2 lb per head per day, annual feed cost savings would be approximately $1.31 billion. Indeed, small changes in efficiency of nutrient utilization can have major economic implications.

Selecting for Feed Efficiency

The earliest selection for feed efficiency was associated with selection of faster growing, leaner animals. This was initially achieved by using Continental breeds, which are more efficient compared to British breeds at a weight or time endpoint (i.e. Continental breeds tend to grow faster to a given weight and are heavier at the same age). These leaner biological types are more energetically efficient to a weight endpoint, primarily due to the high water content of muscle.

Because the British breeds are fatter and lighter muscled, many Continental breeds were imported in the early 1970s to improve the growth rate, muscle and efficiency of the US cowherds. The resulting progeny were the optimum blend of British and Continental genetics. In fact, data from the Gelbvieh Alliance (2001), illustrated in the Figure 1 below, show that pens of
calves that are 50-75% British and 25-50% Continental have the best dry matter feed conversions and have the lowest cost of gain compared to other types. This type of pen data is revealing and an important part of feed yard economics.

Pen data provides a general indication of the differences in feed efficiency between breeds, but provides no information indicative of differences among sires within breed for feed efficiency. In addition, a negative consequence of increasing growth rate, which lowers the maintenance costs of faster growing animals during the growing and finishing phases of production, proved to increase the maintenance costs (mature size) of breeding females.

These factors led to three important discussions; 1) how to best use these breeds in breeding systems, 2) how to more accurately select for individual feed efficiency and 3) how to “bend the growth curve” i.e. select for animals that had early, fast growth but were moderate for birth weight and mature size. The latter was partially solved via the simple “Dickerson Index” (Index = Yearling Weight – 3.2 * Birth weight) (Dickerson, 1974). Much later, birth weight, yearling weight and mature size were incorporated into selection indexes of various breed associations along with their appropriate economic weights.
The Power of Crossbreeding

The first discussion of breeding systems included the evaluation of their effectiveness, simplicity and contribution to carcass merit. Time after time, crossbred cows (and thus crossbred calves) proved to be the winner over straight-bred cows and straight-bred calves. Crossbred cows were shown to be 8% more efficient, have 38% greater longevity, raise calves with 8% more weaning weight (Gregory and Cundiff, 1980) and have 23% more lifetime productivity (Kress and Nelson, 1988). Several studies estimated the economic benefits of mating F1 cows to terminal sires yielded $100 over straight-bred cows. Other studies applauded the effectiveness and simplicity of using composite breeds which use both British and Continental breeds. Both of these systems take advantage of individual and maternal heterosis as well as leverage breed complementarity. In either case, the power of crossbreeding is irrefutable. If you are serious about improving efficiency and productivity, this is the place to start.

More Accurate Selection Tools

Initially, the common feed efficiency measure was Feed Conversion Rate (FCR), known as the feed:gain ratio. While simple, selection for improved FCR results in fast gaining animals with a large mature size. Due to this negative association, researchers sought a new method of quantifying feed efficiency.

The search resulted in Net Feed Intake, a term introduced in 1963 by R. M. Koch and colleagues. In the USA we use the term Residual Feed Intake. RFI is defined as the actual feed intake minus the estimated feed intake. The estimated feed intake is determined by the regression of average daily gain (ADG) and metabolic mean body weight (mid-test weight^{0.75}) on dry matter intake across individually fed contemporaries (Archer et al., 1999). By definition of the regression used, RFI is independent of ADG and weight. The use of RFI is a more appropriate selection method as it does not appear to be correlated to other important production traits. Thus, animals with a negative RFI (desirable) can also have high ADG, high marbling, etc. RFI, however, has a strong genetic correlation with feed conversion rate with estimates ranging from 0.66 to 0.86 (Arthur et al., 2001b, Arthur 2001a). RFI also has a strong genetic correlation with feed intake (FI) with estimates ranging from 0.64 (Herd and Bishop, 2000) to 0.79 (Arthur et al., 2001b). Together these correlations suggest that selection for improved (more negative) RFI will in fact decrease FCR and FI.

Tools for Selecting for Feed Efficiency

The tools for selecting for individual feed efficiency are in their infancy. Universities such as the University of Missouri and the University of Illinois as well as a small number of private companies have the equipment to automatically record individual feed intakes. This equipment allows the collection of individual feed intake information over a 70 day test period. It is a somewhat expensive process due to the cost of the equipment and the small number of animals that can eat from each bunk.
Use of Feed Efficiency Tools

The starting point is to have crossbred cows with the appropriate blend of British and Continental genetics which fit our environment and marketing goals. The knowledge gained from research in the 1970’s and 1980’s clearly showed that tremendous efficiency could be easily attained by employing this simple technology. The next step is to continue to place the appropriate emphasis on Economically Relevant Traits, such as calving ease, weaning weight, carcass merit, selection indexes, etc. The final step is selection for differences in efficiency of feed utilization.

Eventually, when enough data has been collected, feed intake and RFI can be appropriately incorporated into the calculation of Expected Progeny Differences and Selection Indexes. Until then, producers can use the ratios of RFI data within contemporary groups to select for more efficient cattle. A balanced selection approach should be implemented and single trait selection for improved RFI should be avoided. Research continues to establish the most appropriate methods to utilized both RFI and FI records in genetic evaluation and selection systems. Efforts to rapidly develop this technology will be fostered the broader adoption of individual feed intake recording systems and accumulation of these records by various researchers and breed associations working in this area. Undoubtedly, producers are seeking methods and genetic resources to improve feed and production efficiency in this time of rapidly escalating feed and other input costs.

Literature Cited

The Use of Feed Additives for Stocker Cattle

Jim Williams
Division of Animal Sciences
University of Missouri

For stockers high quality pasture is the cheapest way to provide nutrients to enhance their growth. However, the quality of the pasture declines in the summer requiring a supplementation program to achieve the gains in order to lower cost of gains. The supplementation programs should also include feed additives to impact the efficiency of growth and improve the health of stocker cattle. For feed additives to be effective in enhancing nutrient utilization, the cattle must be gaining 1.2 to 1.5 lbs per day. This applies as well to the use of implants in cattle. If the cattle are on grazing programs where they are gaining 0.5 to 1.0 lbs per day, feed additives and implants are not going to be effective in promoting growth. All nutrients are being utilized to support maintenance rather than animal growth.

As previously stated by Dr. John Lawrence, feed additives are one of the cost effective ways to improve a producer’s bottom line. Different types of feed additives are available commercially and most of these have been evaluated in many different studies to reveal their beneficial effects in growing cattle on pasture. In general, one can expect a 5 to 15% improvement in daily gain and an 8 to 12 percent improvement in feed efficiency by using feed additives. The response in actual gain from a class of feed additives, like ionophores, used at the proper level is 0.15 to 0.20 lbs per day.

The ionophores are a class of feed additives developed over 30 years ago. At a cost of 1 to 2 cents per head daily, it has been estimated that these feed additives contributed to a cost savings of $250 million annually in feed costs. These polyether compounds exert their effect on improving feed efficiency, growth, and animal health. The mode of action of these compounds is initiated by channeling ions through microbial cell membranes while causing a shift in production of propionate and butyrate and less acetate. They also inhibit proteolytic bacteria causing an increase in post-ruminal flow of dietary amino acids. In practical terms, this increases the amount of protein reaching the small intestine and eventually used for muscle growth. Also, it is recommended that when balancing a ration, the NE_m of the diet increased by 12% because of the ability of ionophores to improve the efficiency of feed utilization. All of these factors translate into calves weighing about 15 additional pounds in a 100 days if the supply of forage is optimal.

There are two different ionophores commonly used in beef cattle diets for cattle on pasture. They are rumensin® and bovatec®. As pointed out in table 1, the optimal dose for rumensin® and bovatec® to increase weight gain is 100 mg and 150 mg per head daily, respectively. The dose depends on the weight of the stockers. With larger cattle, the dose could be increased to twice the optimal level. As far as toxicity, horses should not be allowed to consume any feed containing ionophores. Rumensin® is more toxic to horses and swine than bovatec®.

Evidence indicates that there are inherent differences between ionophores that impact health and performance. Studies confirmed that bovatec® is the superior ionophore for growing
cattle on high forage diets. bovatec® at 200 mg / day enhanced gain and feed efficacy compared to rumensin® at 200 mg / hd / day. Bovatec® may be more effective in controlling coccidiosis because calves reach their targeted supplemental intake with the optimal level of feed additive.

Table 1. Feed additives, dose, and mode of action

<table>
<thead>
<tr>
<th>Feed Additive</th>
<th>Dose, mg/day</th>
<th>Effect</th>
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<tbody>
<tr>
<td>Rumensin®</td>
<td>70-200</td>
<td>Weight gain; control coccidiosis</td>
</tr>
<tr>
<td>Bovatec®</td>
<td>60-300</td>
<td>Weight gain; prevent coccidiosis</td>
</tr>
<tr>
<td>Gain Pro®</td>
<td>10-20</td>
<td>Weight gain</td>
</tr>
<tr>
<td>Aureomycin</td>
<td>350</td>
<td>Weight gain, prevent BRD, reduce liver abscesses</td>
</tr>
<tr>
<td>Bovatec®</td>
<td>60-300</td>
<td>Weight gain</td>
</tr>
<tr>
<td>Aureomycin</td>
<td>350</td>
<td>Treat enteritis(E. coli), bacterial pneumonia</td>
</tr>
<tr>
<td>MGA</td>
<td>0.5</td>
<td>Suppress estrus</td>
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</table>

Rumensin® has been approved for every other day feeding; by feeding every other day, twice the level of rumensin® would be added to the supplement as compared to feeding daily. This practice would save considerable labor costs and time in delivering supplement to cattle. On the other hand, bovatec® has only been approved for daily feeding because animal response is better.

One issue with rumensin® is the animal behavior aspect of cattle developing a taste for the feed additive. Cattle may not clean up the supplement with rumensin® as well as with bovatec®. Therefore, it may require additional time for them to adapt to the supplement with rumensin® suggesting that lower levels of the feed additive may be prudent in adapting cattle to the supplement before increasing to the optimal level. Rumensin® along with salt has been used to limit supplement intake of stockers on pasture. The inclusion of rumensin® reduced the level of salt necessary to limit supplement intake by 25 to 50 %. Before self-fed medicated supplements may be used, Food and Drug Administration regulations must approve to ensure intake is consistent with approved feeding levels.

When using ionophores as a feed additive, it is important to consider the quality of the forage stockers are grazing. When forage quality may be marginal, feeding a high level of ionophore may be detrimental to fiber digestion since it may decrease the number of cellulolytic bacteria in the rumen. Another consideration with poor quality forages marginal in protein is that ionophores may reduce the breakdown of feed protein and create a shortage of rumen nitrogen for fiber digestion. With bovatec® as a feed additive, studies revealed that 200 mg daily gave the greatest improvement in gain when cattle grazed winter annuals (0.24 lb/day gain) as compared warm season (0.12 lb/day gain), cool season grasses (0.18 lb/day gain), and mixed season pasture (0.11 lb/day gain). From these studies, the quality of forage influences the ability of bovatec® enhance daily gain of stocker calves.

Ionophores are effective for the prevention of acute bovine pulmonary emphysema and edema as well as bloat when cattle graze pasture. Rumensin® has been more effective than bovatec® in preventing alfalfa bloat. When comparing rumensin to poloxalene, it was 2/3 effective as poloxalene in preventing alfalfa bloat in cattle. Bovatec® has been shown to be more effective in preventing grain bloat in cattle.
Ionophores have been cleared for use for replacement heifers. Inclusion of bovatec® and rumensin® in heifer diets increases the number of heifers reaching puberty by the start of the breeding season, decreases the age at puberty, decreases the weight at puberty, increases the corpora luteal weight, and increases the amount of progesterone produced. The decrease in age at puberty was independent of improved average daily gain and increased body weight. Bovatec® showed no impairment on reproductive performance, post-calving interval, or conception rate.

Another non-ionophore antibiotic, bambermycin (Gain Pro®), has ruminal effects similar to ionophores in that it changes microbial population and enhances energy utilization on forage-base or grain-base diets. However, the mode of action of Gain Pro is to inhibit the growth of gram positive bacteria through its effect on bacterial cell wall synthesis. As shown in Table 2, field trials at the University of Illinois, Nebraska, Oklahoma State, and Virginia Tech with stockers grazing spring and summer pastures of different forage types, Gain Pro®, rumensin®, and bovatec® were fed at 20, 150, and 200 mg / hd / day, respectively. All cattle were offered 2 lbs of grain supplement medicated with the feed additives, while the control treatment was offered 2 lbs of the grain supplement. The data revealed that Gain Pro® and bovatec® yielded significantly greater ADG than control, and Gain Pro® had greater ADG than bovatec® and rumensin®. The lower gains for the rumensin® may be attributed to cattle not consuming the optimal level of the ionophore, since cattle fed supplements with Rumensin® usually have lower supplemental intake as compared to the other treatments.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>20 mg Gain Pro®</th>
<th>200 mg Bovatec®</th>
<th>150 mg Rumensin®</th>
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<tbody>
<tr>
<td>ADG, lb / day</td>
<td>1.47</td>
<td>1.68</td>
<td>1.59</td>
<td>1.54</td>
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<tr>
<td>Extra Gain vs. C</td>
<td>------</td>
<td>0.09</td>
<td>0.05</td>
<td>0.03</td>
</tr>
</tbody>
</table>

1 Represents studies conducted at 4 Universities with an n = 571 cattle and included fescue, crested wheat grass, bermuda grass, and orchard grass pastures.

Studies have indicated that Gain Pro® was more effective at increasing fiber digesting bacteria in the rumen as compared to rumensin® and bovatec®. Also, it has been shown that Gain Pro® enhances ruminal protozoa populations and appears to influence fiber digestion of cattle grazing forages. Gain Pro® has also been shown to be effective at increasing weight gain of newly weaned calves on a typical receiving diet.

The ideal application of aureomycin is its use in cattle exposed to stresses of disease, shipping, and diet adaptation. Aureomycin, a non-ionophore antibiotic has been approved for enhancing feed efficiency, increasing rate of gain, and reducing liver abscesses in growing cattle. In young calves weaned from milk, feeding 75 mg of aureomycin stimulated appetite and increased rate of gain. Also, it has been approved for the control of anaplasmosis. Although research is limited, studies suggest that aureomycin may improve daily gain by 15%. Evidence from commercial companies revealed that aureomycin treats respiratory infections in cattle. Aureomycin is approved for use with Deccox® to prevent coccidiosis and reduce the incidence of bovine respiratory disease. Also, it has been approved for use with bovatec® for increasing weight gain and feed efficiency and reducing liver abscesses. Studies revealed that the
combination of bovatec® and aureomycin increased weight gain by 0.25 lb daily for stockers on pasture. Also, if pinkeye or foot rot are likely problem, it is recommended to use aureomycin.

As shown in Table 1, melengesterol acetate (MGA) is a synthetic progestogen used to suppress estrus and increase rate of gain in heifers. It is approved for use in grazing heifers that are intended for reproduction. However, MGA should not be fed more than 24 days. Also, lower conception rates may occur if heifers are bred within 1 to 12 days after withdrawal of MGA.

In summary, feed additives offer tremendous economical advantage to enhance the growth and health of stockers on pasture. In using feed additives, like rumensin® or bovatec®, it is important to know the anticipated rate of gain of stockers on pasture. These feed additives work well if cattle are gaining more than 1 per day. Also, make sure that you know the optimal level of the feed additive to achieve the anticipated rate of gain of stockers. Read the label to make sure that you are following the recommended guidelines for the use of the feed additive.
Plan to attend the 2009 Beef Research and Teaching Farm Field Day

September 17, 2009