Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 29

2013

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Recommended Citation

Dikeman, Michael E. (2013) "Commentary: Increasing productivity, meat yield, and beef quality through genetic selection, management, and technology," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.1432

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Abstract

The primary purpose of producing beef cattle is to convert grass, forages, and various byproducts, plus human-edible protein and energy, into highly nutritious and tasty beef. To accomplish this, (1) cattle enterprises must be profitable; (2) carcasses should yield a high percentage of meat; (3) beef should be safe, affordable, attractive, nutritious, and highly palatable; and (4) both production and processing systems must be socially and environmentally responsible. The U.S. population has doubled since 1952, but the number of cows in the U.S. is the lowest since the 1950s. At the same time, a rather dramatic increase in beef production has occurred because of improved genetics, management, and technology. Yet, too many cattle breeders and/or breed associations have failed to realize improvements in meat yield, marbling, and palatability through genetic selection for these traits. Consequently, a significant proportion of cattle are fed to excessive fatness with long feeding periods to attain Choice or Prime marbling. Waste fat production is very costly to the industry. An extensive review, evaluation, and interpretation of research literature, technical bulletins, trade articles, and industry trends demonstrates a path forward through improved genetics, improved management, and optimum use of technology to improve production efficiency, meat yield, and meat quality of cattle.

Keywords

Kansas Agricultural Experiment Station contribution; no. 13-162-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1083; Beef; Productivity; Yield; Quality; Genetics; Technology; Tenderness

Commentary: Increasing Productivity, Meat Yield, and Beef Quality through Genetic Selection, Management, and Technology

M.E. Dikeman

Introduction

The primary purpose of producing beef cattle is to convert grass, forages, and various byproducts, plus human-edible protein and energy, into highly nutritious and tasty beef. To accomplish this, (1) cattle enterprises must be profitable; (2) carcasses should yield a high percentage of meat; (3) beef should be safe, affordable, attractive, nutritious, and highly palatable; and (4) both production and processing systems must be socially and environmentally responsible. The U.S. population has doubled since 1952, but the number of cows in the U.S. is the lowest since the 1950s. At the same time, a rather dramatic increase in beef production has occurred because of improved genetics, management, and technology. Yet, too many cattle breeders and/or breed associations have failed to realize improvements in meat yield, marbling, and palatability through genetic selection for these traits. Consequently, a significant proportion of cattle are fed to excessive fatness with long feeding periods to attain Choice or Prime marbling. Waste fat production is very costly to the industry. An extensive review, evaluation, and interpretation of research literature, technical bulletins, trade articles, and industry trends demonstrates a path forward through improved genetics, improved management, and optimum use of technology to improve production efficiency, meat yield, and meat quality of cattle.

Circumstances

Drought, beef demand, and prices

2011 and 2012 will become historical years in the beef cattle production and processing industries. The effects of severe drought in much of the Midwest likely will be a long-term problem, primarily because of the dramatic decrease in cow numbers, very high feed costs, and the long-lasting negative effects of the drought on grass production. A dramatic reduction in cow numbers and the current high prices of feeder and fed cattle make it more difficult for producers to decide whether to retain more heifers to increase cow numbers. In addition, the drought might not be over in some areas.

Surprisingly, the demand for high-quality beef actually increased during the recent economic recession, which provides potential for significant expansion if more herds were to produce Premium Choice or Prime beef. If producers shrug this off and stick with commodity goals, recovery may only bring the cowherd back from less than 30 million to 31.7 million head by 2017. But if ranchers rebuild with cattle that produce beef for the high-quality markets, there could be close to 34 million beef cows by 2018. That could mean “a 10% increase in overall demand for beef,” which could translate into “a long-term expansion of ≈ 6 million cattle.”[1] When cow-calf producers can

[1] Brown, S. 2012. Premiums for quality beef continue to grow as packers seek cattle. Department of Agricultural and Applied Economics, College of Agriculture, Food and Natural Resources, University of Missouri, Columbia. Retrieved from http://extension.missouri.edu/news/DisplayStory.aspx?N=1368.

sell calves and yearlings for $1,000 to $1,200 without the risk of retained ownership, however, there is little incentive to select for increased marbling.

High prices for feeder cattle and fed cattle have been great for cow-calf producers, but not for feedlots and beef processing companies. A significant proportion of feedlots are running at 62–75% capacity, which is not sustainable. It is conceivable that 1 to 2 beef processing plants could close as a result of dwindling cattle numbers. The retail price of beef reached a record high of $5.09/lb in January of 2012, and this could have both short-term and long-term effects on the demand for beef. High unemployment, the recession, and higher food prices have strained consumers' budgets. A significant proportion of consumers have or will shift away from beef, particularly rib and loin cuts, because of high retail prices, and they are likely to be slow to come back to beef.[2]

Global food issues and resources

On a global basis, more than 900 million people in the world are estimated to be starving or suffering from malnutrition. Even more will be pushed into extreme poverty by high food costs. Yet, livestock production is critical to food security and livelihood of the world's population. Globally, the livestock sector employs 1.3 billion people, either directly or indirectly, and is responsible for up to 50% of global agriculture GDP (Bureau of Food Security, U.S. AID). But to sustainably feed a world population expected to grow to 10–11 billion people by 2100, the resources used to rear livestock — water, fossil fuel and grain — must be used more efficiently. The global land area available for grazing livestock is close to its biological limit for production under the prevailing climatic and soil fertility conditions, putting pastoral systems under pressure. Improving efficiency and reducing waste in livestock production will make important contributions to ensuring the supply and accessibility of livestock sources of food.[3]

Grades, marbling, and genetics

In the late 1970s, the NCA (now NCBA) adopted the goal of "winning the war on fat," but the war has not been won nearly 35 years later. Carcasses with a high yield grade 3 average 24% fat trim, depending on trim level. Major "Premium Choice" beef programs now allow yield grade 4 carcasses (≈ 28% fat trim) to be used to secure an adequate supply of product. Too many beef cattle breeders and/or breeds have failed to make genetic improvements in meat yield and marbling; consequently, a significant proportion of cattle are fed to excessive fatness with long feeding periods to attain Choice or Prime marbling. Genetic improvement in marbling is an important alternative to feeding cattle to excessive fatness. Using two breed associations as examples, the American Simmental Association publishes expected progeny differences (EPDs) for marbling, ribeye area, fat thickness, and tenderness (Warner-Bratzler shear force). For example, two Simmental bulls in two major AI studs have EPDs in the top 1% for marbling, the top 5% for ribeye area and indexes, and the top 10% for tenderness. Some Angus AI sires are available that simultaneously excel in marbling, ribeye area, and fat thickness EPDs. These examples demonstrate that, even though ribeye area and/or meat yield are antagonists to marbling, some cattle defy the antagonisms. In addition, genetic progress can be made in selecting for tenderness because of its moderately high heritability of

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[2] Sands, M. 2012. Dealing with declining inventories amid excess feeding and packing capacity. Presentation at Kansas State University Cattlemen's Day. Kansas State University, Manhattan, KS.

[3] FAO. 2011. World Livestock 2011: Livestock in Food Security. Retrieved from http://www.fao.org/docrep/014/i2373e/i2373e00.htm.

0.40. Although DNA tests can be used for tenderness prediction, they are really most valuable only when the DNA data are incorporated into EPDs. Most breed associations do not yet have that capability. The most recent national Beef Quality Audit shows that cow-calf producers, in particular, and even some seedstock producers, are still producing "commodity" beef rather than focusing on improving carcass and meat quality traits. Cow-calf producers in particular, and even some seedstock breeders, have not focused on producing for a specific quality target such at Lite/Lean, Retail, or White Tablecloth.

Implants and supplements

In terms of production efficiency, implants are one of the most economically viable technologies to increase meat yield and carcass value, but improper use can cause meat quality problems. Implanting five or more times has a negative effect on both marbling and tenderness, and using the more "aggressive" implants within 70 to 80 days of harvest has the same negative effect. Some research shows that delaying implanting until 2 to 3 weeks after cattle are started on feed improves marbling. The industry needs to capitalize on the benefits of implants without causing significant negative effects on marbling and tenderness.

Supplementation of finishing diets with Zilmax for 20 days will significantly improve feed efficiency and increase dressing percentage and meat yield percentage with minimal negative effects on marbling and tenderness when beef is aged for at least 21 days. Shorter aging times will result in decreased tenderness, particularly in the top sirloin of heifers, but feedlots and beef processors have no control over the aging time employed by retailers. Supplementation with Optaflexx (Elanco Animal Health, Greenfield, IN) or other β-agonists is a cost-effective way to increase live weight gain, provide for some increase in meat yield, and have minimal effects on marbling and tenderness if used properly.

Yield Grade Pricing vs. Meat Yield Pricing

Feeding cattle to high yield grade 3 and 4 endpoints is not an efficient method to improve beef cattle productivity. With instrument grading, percentage meat yield can be accurately predicted, but that information usually is not transparent in that it is not communicated to producers, and premiums and discounts are not tied to this information. Instead, the industry continues to use a crude yield grade pricing system and includes "token" premiums of only $1 to $2 per 100 lb carcass weight for yield grade 2 over 3 and yield grade 1 over 2 carcasses. Yet, there can be a difference of up to $16/cwt between a typical yield grade 2 and 3 carcass when carcasses are priced at $180/cwt (which assumes 3 1/2% closely trimmed meat yield difference between these two yield grades). For 850-lb carcasses of the same quality grade, that equates to a $136 difference in total value. It would be a milestone in the beef industry if premiums and discounts were to be paid for *meat yield percentage* differences rather than only token premiums with the yield grade pricing system. The pork industry has utilized percentage of fat-free lean for premiums and discounts for nearly two decades, and the beef industry could do the same thing. Even if only half of the meat yield value difference between yield grades was used for premiums or discounts, it would provide a major catalyst for the industry to reduce waste fat production.

In U.S. Meat Animal Research Center Cycle IV data involving different biological types of cattle in a "calf-fed" program, feeding an additional 30 days beyond a target endpoint of 426 days of age resulted in a net decrease of 2% retail product yield because of increased fat trim and only an 8% increase in percentage Choice from 62 to 70% for all breeds combined. The increase in percentage Choice for Hereford, Angus, and Shorthorn sired cattle was 10% (from 76 to 86%), and the increase in percentage fat trim was 49%, whereas percentage retail product increased 42% over the additional 30 days. If cattle gain 100 lb during an additional 30 days and the percentage of that gain is 75% carcass, the 49% gain of fat would be approximately 37 lb, and the 42% gain of retail product would be 31 lb. In a March 2012 survey of feedlots in Kansas, the cost of gain for more than 60,000 steers and heifers was $114/100 lb (feed, yardage, interest) over the entire feeding period. Assuming that the cost of gain for the extra 30 days for the Cycle IV MARC cattle was 10% higher than for the cumulative cost of gain prior to 426 days, the feed cost for the 100-lb gain would be $125. The 31 lb of meat would be worth about $87 (using a carcass price of $180/cwt and average meat yield percentage of 65%), and the fat would be worth about $17 as choice white grease, for a total of $104. So, the extra days resulted in a loss of $21/head for the whole pen [$125 – ($87 + $17)]. Assuming the percentage Choice was increased by 10% and the Choice-Select spread was $10/cwt, the increase in value of the 10% more Choice carcasses = $85/carcass for eight 850-lb carcasses. The $21/head loss for 100 cattle represent a loss of $2,100, and the increase in value of the extra 10% Choice carcasses is $850, resulting in a net loss of $1,250 for the pen of 100 cattle.

On the other hand, if those 100 cattle gain the same 100 lb live weight in 30 days and have genetics for the same percentage of Choice and increased genetics for muscle (meat) growth without depositing the 37 lb of fat trim, the increase in efficiency would be dramatic. Based on the efficiency of energy utilization for lipid deposition and for protein deposition, cattle could have 1.72 times more muscle deposition with the energy that it takes to deposit excess fat. The calories used to deposit 37 lb of fat could be used to deposit 63 lb (1.72 × 37) of muscle (closely trimmed retail product). Using a 65% meat yield and $180.00/cwt carcass as a base, this equates to $277/cwt of closely trimmed retail product ($180 ÷ 0.65). Adding 63 lb of retail product instead of fat adds $175 value per carcass (61 × $1.77). After subtracting a feed cost of $114/cwt, the net increase in value from shifting 37 lb of fat to 63 lb of retail product would be $61/carcass, or $6,100 for the pen of 100 cattle. Production of "waste fat" is very costly. The beef industry needs to focus on feed efficiency of retail product produced that is of consumer-acceptable quality.

Tenderness

Interest is growing in guaranteeing acceptable tenderness of beef to U.S. beef consumers. The USDA Agriculture Marketing Service has drafted a "Standard Practice for Verifying Tenderness Marketing Claims for Beef Cuts" with marketing claims that can be used by all parties interested in highlighting production and marketing practices for tender beef. Because a significant proportion of beef is marketed by beef processors before near maximum tenderization occurs, retail stores, restaurants, and food service operations will need to further age beef to meet the marketing claims criteria before it is sold to consumers. Therefore, measurements at packaging need to be reinforced by time and temperature monitoring. Marination and mechanical tenderization are considered non-inherent processes and are precluded from use to meet tenderness requirements. Beef can be USDA Certified Tender when WBSF is ≤4.4 kg or slice shear force (SSF) is ≤20.0 kg, or USDA Certified Very Tender when WBSF is ≤3.9 kg or SSF is ≤15.3 kg. This system is anticipated to be used extensively and to decrease the emphasis on marbling to assure consumer acceptability.[4]

Beef is often characterized as the "celebration" meat because of its excellent flavor; however, the most common complaint by consumers when they are not satisfied with beef's palatability is because it is not acceptable in tenderness. Tenderness can be improved both genetically and by proper aging. The recent National Beef Tenderness Survey (2010–2011) shows that tenderness of the longissimus muscle (ribeye, top loin, T-bone, and Porterhouse steaks) scored from 5.9 to 6.3 and the top sirloin scored only 5.6 on a 10-point scale. These results suggest that tenderness of beef needs to improve. Part of the reason for the modest scores by consumers for tenderness was because 35.7% of beef was aged less than 14 days, which was nearly double the time from the 2005–2006 survey. Why can cattle be fed an additional 15–30 days, but the retail and food service industry cannot age beef for the proper amount of time? The retail and food service industries should adopt the policy of the old E. J. Gallo winery advertisement and "sell no beef before its time." The industry should not feel good about earning a modest score for tenderness of only 6 out of 10.

Implications

For beef cattle production to be sustainable and profitable, production must be economically efficient, protect the environment, and be socially responsible. This will require the use of byproducts and a reduction of waste fat production while providing carcasses with high meat yield, sufficient marbling, and guaranteed tenderness that is highly acceptable to consumers. There is great opportunity for the beef cattle industry in the coming years if greater attention is given to improving production efficiency and providing high-quality beef through genetic selection without feeding cattle to excessive levels of fatness.

[4] ASTM Standard F2925-11, "Standard Specification for Tenderness Marketing Claims Associated with Meat Cuts Derived from Beef," ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/F2925-11, www.astm.org.