

Building sustainable beef production: addressing environmental and management challenges in intensive production systems*

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Summary

Intensive beef feedlot and grazing systems that developed in the U.S. over the last century are among the most efficient in the world in terms of production per animal. Whether these systems can be sustained over time is an important question to examine, especially as similar systems are beginning to develop in other countries. In the last 25 yr, intensive beef production systems in the U.S. have faced increasing pressure from environmental regulations related to air and water quality, food safety issues, and attacks from animal rights activists. With continuing concerns about effects of intensive animal production units on surface and groundwater supplies, management of riparian areas, and global apprehension about climate change, environmental regulations on concentrated livestock feeding operations will no doubt increase in the future. Food safety issues continue to be at the forefront of consumer concerns, which have focused greater attention on animal traceability and will likely shift the burden and liability associated with food safety issues to the producer level. Animal rights activism and efforts to combat "factory farming" in addition to consumer perceptions about the health and environmental benefits of less intensive or "organic" production methods will increasingly challenge many of the technological advances (e.g., growth promotion technologies and antimicrobial feed additives) that have been a hallmark of the intensive beef production systems in the U.S. Countries that are currently expanding intensive beef production systems can learn valuable lessons from the experiences of U.S. beef producers, which should assist them in planning the growth and development of their own intensive livestock production systems. Food production will be stretched to the limit by increasing world population in the next several decades, which could have a positive effect on the role of intensive beef production systems in meeting worldwide protein needs. To fulfill this important role of providing food for the world market, intensive beef production systems in the U.S. and elsewhere, must focus on ways to turn the many challenges they face into opportunities for production of safe, wholesome products in environmentally neutral operations using production practices that maintain the highest level of integrity and concern for animal well-being.

Key words: beef production, feedlot, food safety, grazing, nutrient management, sustainability

Introduction

Sustainability is a term that agricultural producers hear and read often. Many of basic concepts of sustainability arose primarily from the plant sciences; however, in recent years, the concept has been applied to various types

of animal production systems. According to Gold (2009), the 1990 Farm Bill passed by the U.S. Congress defined sustainable agriculture as an integrated system of plant and animal production practices that have a site-specific

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application, which over the long term will meet human needs for food and fiber, improve environmental quality and the natural resources on which the agricultural economy is based, use non-renewable resources efficiently, integrate natural biological controls and cycles when possible, and ensure the economic viability of agricultural operations. This legislative definition might be boiled down to a convenient working definition of: sustainable agriculture involves the application of practices that will use natural resources in a way that protects the environment, while ensuring the economic viability of agricultural production systems.

Intensive beef production systems (e.g., feedlots) and large cattle ranching operations in the U.S. generally developed without significant attention to many of the fundamental concepts of sustainable agricultural practices. Thus, a logical question is whether these reasonably mature production systems can be modified to ensure their long-term sustainability. Examining this question in the context of U.S. production systems should prove useful to other countries that might be at an earlier stage in the development of intensive beef production systems. Challenges faced and lessons learned in the U.S. system could smooth the path for development of sustainable beef production systems in these nations.

This paper will briefly examine the development of intensive beef production systems in the U.S. and consider the challenges faced by intensive grazing and feedlot beef production systems in working toward the goal of sustainability. A review focused on the future of feedlot beef production in the U.S. by Galyean (2010) was a significant source for portions of this paper.

1. Development of Intensive Cattle Production Systems in the United States

Cattle have been fed to make them "fatten" for hundreds of years, but the feedlot industry in the U.S. developed largely during the 20th century. With an increase in the feeding of corn to cattle in the late 1800s in

Midwestern states, Chicago, Illinois became a major marketing location for cattle (Ball and Cornett, 1996). Cow-calf production shifted westward, and the rapidly expanding railroad system supported movement of cattle from Western rangelands to the Midwest for finishing. Although large, privately owned ranching operations in the Western U.S. are common, cattle production in this region has always relied on the use of public lands that are currently managed by federal agencies (Forest Service and Bureau of Land Management). In the early 1900s, cattle performance increased as cattle genetics improved, silage was introduced as a major feed resource, and use of grain processing methods like grinding and cracking increased. Rapid expansion of land grant agricultural colleges and associated research led to a greater understanding of the nutritional requirements of livestock, and production systems for cattle grazing and feeding became increasingly science-based. Application of managed grazing systems and new technologies like feed-grade antibiotics and steroidal growth-promoting agents in the 1950s led to even more advances in performance and efficiency.

Demand for beef in the U.S. grew rapidly after World War II, with an increase of approximately two-thirds in the 20 yr between 1945 and 1965 (Ball and Cornett, 1996). Along with increased demand, large-scale cattle feeding operations developed in locations with ready supplies of grains and various byproducts. Sugar mills in Colorado, highly productive, irrigated agricultural areas in Southern California, and the irrigated grain- and cotton-producing areas of the High Plains attracted cattle feeders. For example, cattle feeding operations in the Texas Panhandle grew at the phenomenal rate of 20 to 30% per year from 1961 to 1969 (Ball and Cornett, 1996). Packing plants soon followed the feedlots, moving operations from older facilities in the Midwest to the Great Plains. The Great Plains region is currently the dominant location for cattle feeding, as shown by U.S. cattle on feed numbers by state in Table 1.

Table 1: Cattle on feed by state – January 1, 2009 (Source: USDA National Agricultural Statistical Service; Available: <http://www.cattlerange.com/cof/states-cof.html>). This table is reproduced from Galyean (2010).

Rank	State	Cattle on feed		% Change	% of Total
		2009	2008		
1	Texas	2,800,000	2,980,000	-6.04%	20.22%
2	Nebraska	2,500,000	2,700,000	-7.41%	18.05%
3	Kansas	2,370,000	2,630,000	-9.89%	17.11%
4	Iowa	1,300,000	1,350,000	-3.70%	9.39%
5	Colorado	1,020,000	1,140,000	-10.53%	7.36%
6	California	490,000	560,000	-12.50%	3.54%
7	South Dakota	390,000	400,000	-2.50%	2.82%
8	Arizona	358,000	368,000	-2.72%	2.58%
9	Oklahoma	350,000	355,000	-1.41%	2.53%
10	Minnesota	280,000	325,000	-13.85%	2.02%

Changes in scale of individual cattle feeding operations and in the packing industry have occurred along with geographic compression of the industry. MacDonald and McBride (2009) reviewed changes in the U.S. livestock sector during the last 20 to 30 yr and reported that in all livestock sectors, production units have become larger and more specialized. In the cattle feeding sector, this change in scale is exemplified by changes in capacity of feedlots over the last 4 decades (Figure 1). Assuming that late-2009 cattle-on-feed numbers of approximately 10.5 million are a reasonable estimate of the U.S. one-time feedlot capacity, the 10 largest cattle feeding operations in the U.S. comprise approximately 30% of that capacity (data not shown). In addition to increased feedlot size, ownership of feedlots is shifting to corporations or large privately held companies that own several feedlots rather than individual or partnership owners of single feedlots. Among the top 10 cattle feeding companies in the U.S. in 2009, the 3 largest operations (2 corporations and 1 large privately held company) controlled over 50% of the U.S. capacity (data not shown). The shift to larger operations no doubt reflects economy-of-scale advantages in cattle procurement and marketing, as well as in commodity purchase and risk management opportunities that would be more challenging for smaller, individual feedlots.

In the last decade, the U.S. beef cow herd has decreased from approximately 34 million in 1999 to a 2009 level of approximately 32 million. In that same time frame, yearly commercial beef production has held steady at around 11.3 to 11.8 billion kilograms. Relatively constant beef production coupled with declining cow numbers reflects the increasing mature size of the U.S. beef cow herd. Based on trends in cow slaughter weights, McMurtry (2009) estimated that the body weights of mature cows have increased by approximately 136 kg over the past 30 yr.

As location and capacity of feedlots have changed over the years, feeding and management practices also have undergone significant changes. Use of roughage in feedlot diets has decreased over time because roughage sources are generally considered to be inconsistent in quality, are difficult to handle in large feed mills, and are typically much more expensive per unit of energy than grain. In a survey of consulting nutritionists, Vasconcelos and Galyean (2007) reported that the mode for roughage inclusion in finishing diets was 9 to 10% of DM. As roughage has decreased, extensive processing of grain has become the norm for feedlots, with steam-flaking being the most common grain processing method reported by Vasconcelos and Galyean (2007). In the last decade, an increased supply of distillers byproducts from

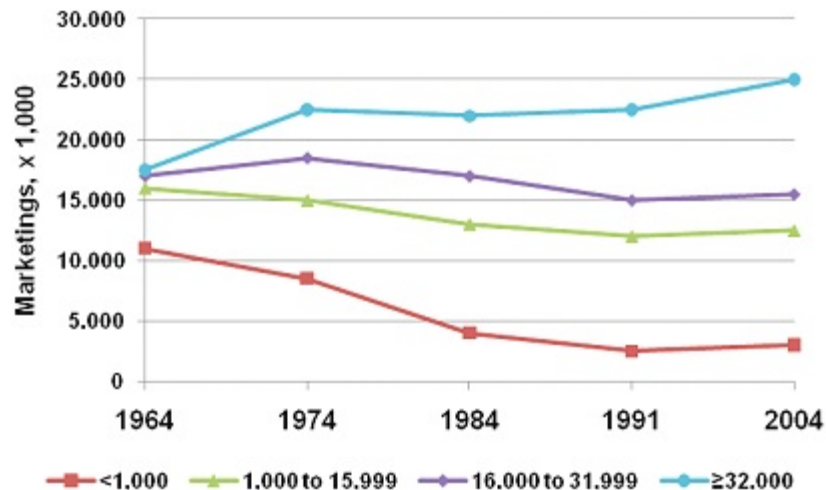


Figure 1: Changes in the capacity of U.S. cattle feedlots over the last 40 yr (adapted from MacDonald and McBride, 2009, as presented by Galyean, 2010).

grain ethanol production has greatly increased the inclusion rate for these ingredients in finishing diets. More than 80% of the clients of the consultants surveyed by Vasconcelos and Galyean (2007) used some type of grain byproduct in the finishing diet.

The feedlot industry responds rapidly to new technologies. Ionophores are fed to virtually all feedlot cattle, and growth-promoting implants based on estrogen and estrogen-trenbolone acetate yield one of the greatest returns on investment of any technologies applied to feedlot cattle. A timed-release growth-promoting implant that eliminates the need to reimplant many cattle was approved in 2007. Two beta agonists were approved by the U.S. Food and Drug Administration for use in feedlot cattle during the last decade, and new antimicrobial drugs requiring a veterinary prescription have continued to be developed for therapeutic use. The cost of developing and gaining approval for these new technologies continues to increase, resulting in greater costs for new products along with lower returns on investment than in the past.

The important question for the future is whether the productivity of the relatively mature intensive beef production systems in the U.S. is sustainable. In other words, in the context of the previously proposed working definition for sustainability, can these systems apply practices that use natural resources in a way that protects the environment, while concurrently ensuring their economic viability? This question will be examined in subsequent sections of this paper in the context of current and future challenges to intensive beef production systems.

2. Sustainability Issues Facing Grazing Beef Production Systems.

2.1. System Advantages and Disadvantages.

Beef production systems centered on utilization of a renewable pasture resource would generally seem to be more sustainable than intensive systems like those used in feedlot beef production. Nonetheless, grazing systems require inputs (e.g., supplemental feeds, fertilizer, etc.) that affect long-term sustainability and that vary depending on the complexity of the grazing system (e.g.,

introduced forages with intensive fertilization and labor requirements vs. native rangelands or minimally managed perennial introduced forages). In addition, in the U.S., grazing systems focused on cow-calf production in which calves are sold at weaning are inevitably linked stocker cattle and feedlot systems, so isolating one component of the overall system to determine its sustainability is often not practical. Stocker systems in the U.S. are generally forage-based (e.g., perennial forages, annual forages, or crop residues). Finishing beef cattle by grazing on forages has sometimes been touted as a more sustainable alternative to grain-based feedlot production systems. Nonetheless, a recent comparison of a corn-based (feedlot) vs. forage-based finishing (Capper and Cady, 2010) suggested that energy use (2.5 X), methane production (2.8 X), and land area required per kilogram of beef produced (>12 X) were considerably increased with the forage-based finishing system. Thus, it seems unlikely that grazing systems for finishing beef cattle are any more sustainable than current feedlot systems, and production from forage-finishing systems is not capable of meeting the current U.S. demand for beef consumption and exports.

Despite the indication that forage-finished beef production systems might not offer advantages in terms of their carbon footprint, the effects that use of high-forage diets in finishing programs has on the composition of beef could be important. Many consumers perceive beef from forage-finishing systems to be a healthier alternative to beef from the feedlot production system. Although many aspects of composition are similar between forage- and feedlot-finished beef, research findings have generally indicated that forage-based finishing programs affect beef fatty acid composition. French et al. (2000) compared the composition of intramuscular fat from the longissimus muscle of steers fed diets varying in the proportion of a barley/beet pulp concentrate and grass (hay, silage, or grazed forage). Steers were fed to achieve similar rates of carcass weight gain and fatness. Decreasing the proportion of dietary

concentrate (increasing grass intake) increased the polyunsaturated fatty acid (PUFA) and conjugated linoleic acid (CLA) concentration in intramuscular fat. Leheska et al. (2008) sampled steaks from grass-fed beef around the U.S. and reported that grass-fed steaks were leaner and had more CLA than steaks from conventional grain-fed beef. Faucitano et al. (2008) compared longissimus muscles from cattle in different production systems that varied in the dietary proportions of grass silage and concentrate. Feeding greater proportions of concentrate increased total fat in the muscle, but CLA concentration was increased by feeding greater proportions of grass silage. Differences in the PUFA and CLA concentrations of beef likely exist as a result of differences among forage and grain sources, between grains and grain byproducts, and numerous other dietary factors. Additional research in this area will be beneficial for producers working to supply forage-fed beef for specialty markets.

2.2 Grazing Management Issues.

Management practices on forage-based beef production systems, particularly those that use public lands in the Western U.S., have been under scrutiny for some time, most notably as it relates to management of riparian areas (DelCurto et al., 2005). The major concern with riparian areas is the tendency for cattle to concentrate there, resulting in overgrazing or damage to the vegetation, as well as the potential for increased invading species, erosion, and contamination of surface waters. Bailey (2004) reviewed various approaches to mitigate potential negative effects of cattle grazing in riparian areas. In addition, DelCurto et al. (2005) summarized research on methods to more effectively manage these areas, including timing of grazing events (early vs. late forage growing season), off-stream water development, supplementation strategies, and effects of cow breed and age. Availability of the grazing resources on public lands is vital to the economic sustainability of Western U.S. grazing systems, so continued research is

needed to effectively address this issue if public land grazing is to continue to be a component of forage-based production systems. Concerns similar to those associated with U.S. public lands are evident in many other parts of the world, particularly issues related to deforestation and the effects of drought-induced overgrazing on damage to land resources.

2.3. Other Sustainability Issues with Grazing Systems.

Provenza (2008) suggested that sustainable animal production systems will become increasingly important as supplies of fossil fuels decrease. He further suggested that forage resources need to be matched more closely with animal needs, animals should be selected that are "adapted anatomically, physiologically, and behaviorally to local environments," animals that are not able to reproduce without extensive human intervention should be culled, and grazing systems need to be created that benefit soils, plants, grazing animals, and people.

With public concerns about greenhouse gas emissions and likely regulations from governmental agencies around the world, evaluation of grazing systems in terms of carbon sequestration will be an important area of research. Whereas many components of U.S. systems for beef production, particularly the feedlot segment, are likely to be net producers of greenhouse gases, the grazing segment has the potential to sequester carbon. For example, grazing lands are estimated to contain 10 to 30% of the earth's soil carbon (Schuman et al., 2002). These authors noted that in the U.S., there are approximately 336 million hectares of grazing lands, with roughly 48% of the total in native rangelands. Although plant species differences in rangeland types (mixed-grass prairie vs. short-grass steppe) affect soil carbon concentrations, grazing on both types of rangelands increased soil carbon compared with non-grazed enclosures (Reeder and Schuman, 2002). Introduced species, establishment of new grasslands, and various

management techniques presumably alter carbon sequestration (Schuman et al., 2002). Thus, producers who can capture carbon through implementation of grazing management systems might generate unique opportunities for financial rewards in concert with positive environmental consequences.

3. Sustainability Issues Facing Feedlot Beef Production Systems

3.1 System Advantages and Disadvantages.

As noted previously, the increased capacity of U.S. feedlots has brought with it advantages in terms of economy of scale. The ability of the large feeding operations to buy and sell in quantity allows them to form business relationships over the complete spectrum of activities and to manage risk at a much higher level than smaller operations. Larger companies also seem more likely to develop marketing arrangements with packing companies and even retail outlets for beef that can help stabilize demand for finished cattle. These financial and risk management advantages might very well be the primary reason for the growth in corporate and large, privately held feedlots. Thus, for the future, consolidation of the feedlot industry will probably continue to increase. Midwestern "farmer feeder" operations will persist for the foreseeable future, particularly in areas with supplies of inexpensive ethanol byproducts, but because of the advantages of scale and risk management noted above, the long-term trend for the U.S. feedlot industry is increasing corporate (both private and publicly traded) ownership.

In addition to financial considerations, the ability to rapidly apply technology to large numbers of animals is another advantage of intensive production systems. Speed of application might decrease somewhat with increased size because of added layers of bureaucracy, as well as costs and logistical concerns of large-scale application, but once a decision is made by a large cattle feeding company to adopt changes, the implications for overall beef production in the U.S. are potentially substantial. Technology use

patterns change with time, but whether the feedlot industry will become more or less technologically focused is difficult to predict. As will be discussed later, it is conceivable that U.S. feedlots might be forced to decrease the use of technologies applied to animals, particularly those related to animal productivity like feed-grade antibiotics, growth-promoting implants, and beta-agonist feed additives. On the other hand, the technologies related to animal identification and product traceability will probably be adopted more rapidly in the future.

Labor issues are a significant problem for both small and large feedlot operations. The U.S. Jobs at all levels in feedlots require long hours and the ability to work on weekends. In addition, with feedlots typically located in rural areas and salaries that are not often sufficient to draw laborers from urban areas, attracting qualified employees is difficult, and turnover is frequently high. Because of labor force issues, greater emphasis will be placed in the future on technological approaches related to feed milling and delivery that save labor. Similarly, technology that decreases labor related to animal health issues (e.g., measures that decrease feedlot morbidity and thereby decrease associated labor) are likely to be applied quickly by the industry.

Another, perhaps more significant change that could occur with greater frequency in the not too distant future is an increased linkage between the feedlot industry and the cow-calf and stocker operators who supply the "raw material" of cattle feeding. In part, these linkages will develop from a purely financial standpoint – cattle feeding companies are not likely to have enough capital to own the large land base necessary for cow-calf and stocker production. In addition, as either voluntary or mandatory requirements for traceability of animal products become a reality, alliances between feedlots and suppliers will be necessary to facilitate tracking of animal movements through the food chain. The potential benefits of alliances extend to implementation of pre-weaning and early post-weaning management strategies that could

improve animal health, as well as the opportunity to apply new tools for genetic selection in cow-calf herds, such as markers for carcass traits, which should ultimately allow feedlots to match output of fed cattle more closely with consumer demands.

3.2. Environmental Issues

Increasing regulatory pressures related to environmental issues have affected all segments of the U.S. livestock industry. Federal and state regulations on air and water quality have highlighted concerns related to N (ground water contamination by nitrates and ammonia in the air) and P (surface water contamination by P in runoff), with current regulations in place that require comprehensive nutrient management plans for concentrated animal feeding operations (Cole, 2003). Implementation of such regulations has stimulated research to identify methods to decrease the environmental impact of intensive cattle feeding operations. Vasconcelos et al. (2007) reviewed possible feeding practices to diminish the negative environmental consequences of cattle feeding. In the context of decreasing environmental consequences, precision feeding was defined by Cole (2003) as an approach that maintains performance while limiting nutrient excretion. One simple means to achieve this goal is through phase feeding, which is characterized by changing nutrient concentrations in the diet to reflect changes in animal nutrient requirements over time. Practical application of phase feeding approaches has not been extensive, although straightforward calculations as well as research findings suggest that the approach should be an effective method to decrease nutrient excretion. Feedlot nutritionists in the U.S. have clearly altered formulation practices in response to environmental concerns and available research. For example, at least in part as a response to concerns about P in the environment, 24 of the 29 feedlot nutritionists surveyed by Vasconcelos and Galyean (2007) did not add supplemental P to finishing diets.

Grain milling byproducts, particularly those resulting from wet (corn sweetener production) and dry (grain ethanol production) corn milling are very common ingredients in the feedlot production systems of the Midwestern U.S. and are increasingly available in the Central and Southern High Plains cattle feeding regions (Vasconcelos and Galyean, 2007). Dry distillers grains plus solubles and dry gluten feed are available to intensive beef and dairy cattle production units throughout the U.S., but in areas close to ethanol plants, the high-moisture forms of these ingredients are most common (e.g., wet distillers grains plus solubles). In addition, wet corn gluten feed has been shipped by rail from the Midwest to the Texas Panhandle feedlots for the past several years. These byproducts are valuable sources of energy and protein for feedlot cattle (Klopstein et al., 2008); however, their use tends to result in excessive concentrations of both N and P in feedlot diets, potentially leading to increased excretion of these nutrients in manure and associated environmental concerns. Moreover, if the digestibility of these byproducts is less because of their greater fiber concentration, feeding them potentially leads to greater manure loads at feedlots, which increases costs for manure handling and requires more land area to spread manure than with conventional grain-based diets. At least for the next several years, renewable fuel mandates of the U.S. federal government will sustain production of grain-based ethanol, which will lead to continued use of ethanol byproducts in cattle feeding. If the ethanol industry moves in a significant way to cellulose-based production, the feedlot industry will be faced with a new challenge of an altered ingredient base. Assuming that grain ethanol production remains steady for the next few years, grain costs might well be greater than historical averages, which will require optimization of the energy yield from the grain portion of feedlot diets. Thus, the use of grain processing methods like steam-flaking is likely to increase.

Issues related to N, P, ammonia, airborne particulates, and odor at local, state, and regional levels will certainly not diminish in the future. In regions like the Great Plains with a limited water resource, water use by the livestock sector and associated cropping systems also will come under increasing scrutiny and regulation. Despite these potential environmental challenges, because of favorable, typically arid and mild, weather conditions for feeding, combined with a manageable environmental situation in terms of N and P and limited pressure from urban encroachment, the Great Plains should continue to be the heartland of cattle feeding in the U.S.

Concerns about nutrient excretion are now being matched by concerns related to the role of intensive livestock production operations as contributors to greenhouse gases. The United Nations FAO publication "Livestock's Long Shadow: Environmental Issues and Options" (Steinfeld et al., 2006) stimulated considerable debate regarding the role of livestock production in global climate change. Intensive dairy and beef cattle production systems currently used in the U.S. are clearly among the most efficient animal production systems ever developed. Initial evaluation of the carbon footprint of currently used intensive production systems suggests that they might have advantages relative to less intensive systems used in the past. For example, assessment of the U.S. dairy industry by Capper et al. (2009) showed that the carbon footprint of dairy production (per billion kilograms of milk produced) in 2007 was 37% of 1944 values. Similarly, Capper (2010) evaluated changes in the U.S. beef industry from 1977 to 2007 and concluded that the carbon footprint decreased by 14% over the 20-yr time frame. A significant component of the decreased carbon footprint of intensive systems is the greater production per animal, which has resulted in fewer animals involved in the system and thereby decreased carbon output.

Global concerns about climate change will likely lead to increased environmental regulations for intensive beef production systems in the coming years. In advance of the United Nations Climate Change Conference in Copenhagen, the U.S. Environmental Protection Agency announced on December 7, 2009 that greenhouse gases are a danger to public health and require regulation. At present, livestock producers are exempt from reporting greenhouse gas emissions (except for certain large manure management facilities). Nonetheless, as long as mitigation of greenhouse gases is the approach of choice to deal with climate change, livestock production, particularly intensive production systems, will be under pressure from an environmental perspective.

3.3. Societal Pressures and Consumer Perceptions

During the past 25 yr, the intensive livestock production sector in the U.S. has faced many external pressures. Animal rights activists portray intensive livestock production as "factory farming," which has negatively affected how the industry is perceived by the general public. Many of these activist groups openly oppose meat consumption and advocate a vegetarian lifestyle. Too often, the industry has not helped itself in dealing with this issue. Highly publicized animal abuse cases have reinforced the claims made by activists and have negatively affected the industry. Thus, it is vitally important for everyone involved in intensive animal production systems to evaluate animal housing and management practices and for the industry to police itself more diligently than in the past. Animal abuse will not be tolerated by the public, and it should never be considered acceptable under any circumstance in the industry. These situations accomplish nothing other than contribute to a belief by the general public that the U.S. livestock industry is focused solely on making money, further increasing the backlash against "factory farming." All segments of the livestock industry in the U.S. and elsewhere must be

proactive and ensure that animal welfare and humane treatment of livestock are top priority issues for producers.

Food safety concerns, especially contamination of ground beef products with *E. coli* O157 and *Salmonella*, as well as bovine spongiform encephalopathy, have had major effect on the beef industry in the U.S. Product recalls and food poisoning outbreaks negatively affect livestock markets and the red meat industry in general. The meat packing industry has taken the greatest responsibility for devising approaches to decrease the potential for foodborne pathogens. Because packing plants are "gathering points" for cattle from a large number of feedlots, this approach makes good sense and has worked well. Packing plants have made great strides in decreasing the risk of pathogen contamination, and research-backed pre-slaughter interventions that can be used in feedlots (e.g., probiotics and vaccines to decrease the prevalence of *E. coli* O157) also are available. Although some feeding operations use pre-slaughter approaches to decrease pathogen loads, alternative measures that have even greater efficacy need to be developed. Food safety concerns will continue to increase pressure for traceability of animal products from birth to slaughter; however, traceability brings the potential for liability, and it is likely that U.S. feedlots will need to do all they can in the future to act responsibly in dealing with food safety concerns.

Antimicrobial resistance is another highly charged issue that faces the livestock industry. It is abundantly clear that microbes develop antibiotic resistance, but the role that antibiotic use in livestock feeding plays in altering the prevalence of antibiotic-resistant organisms in humans continues to be a hotly debated topic. The U.S. Food and Drug Administration (FDA) has recognized the need for antibiotics in a therapeutic context, but the agency desires to limit the use of antimicrobials for growth promotion and improved feed efficiency (Sharfstein, 2009). The agency (FDA, 2010) released a draft guidance statement on June

28, 2010 to describe the current situation and to provide 2 principles to reflect its current thinking on the topic of antimicrobial resistance. The principles were: (1) "The use of medically important antimicrobial drugs in food-producing animals should be limited to those uses that are considered necessary for assuring animal health;" and (2) "The use of medically important antimicrobial drugs in food-producing animals should be limited to those uses that include veterinary oversight or consultation." Thus, it seems clear that additional regulation is likely, and the pressure will probably increase dramatically in coming years to remove all antibiotics from animal feed. For feedlot cattle, the FDA has noted that ionophores are not used in human medicine (Sharfstein, 2009), which, at least in the short run, might spare this important class of compounds from a ban on feed-grade antibiotics. Although ionophores can still be used for veterinary purposes, they were banned for growth promotion by the European Union in 2006, so it is possible that the similar restrictions could occur in the U.S.

The U.S. feedlot industry has made strong efforts to address many of the issues noted

above. Nonetheless, such outside pressures have probably contributed to the overall decrease in beef consumption in the U.S. since the 1980s (Figure 2). Increased consumer interest in and demand for "organic" beef production is presumably related to many of these societal pressures and consumer concerns, particularly those related to animal welfare, the environmental impact of intensive livestock systems, and food safety concerns. As noted previously, forage-finishing systems can alter the fatty acid concentration of beef products, and as such are viewed by some consumers as "healthier" than beef from conventional grain-finishing systems. Regardless of the reasons for decreased demand, the continuing drop in per capita beef consumption is clearly a negative trend for the U.S. beef industry – one that will likely to drive down the overall size of the industry. Because the marketplace of today and for the foreseeable future is a global one, increasing world-wide beef demand could offset lower internal U.S. demand as long as import-export policies allow for movement of U.S. beef products.

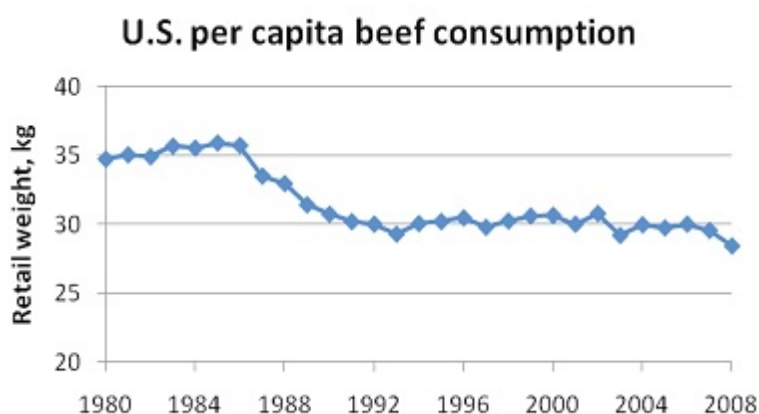


Figure 2: Average annual per capita beef consumption (retail weight) – 1980 to 2008 (Source: National Cattlemen's Beef Association – www.beef.org, as presented by Galyean, 2010).

Conclusions and Recommendations

The Role of Research: The relatively swift changes that have often characterized the U.S. feedlot industry, particularly in terms of applying technology, have generally been driven by quick adoption of academic research. Increasing pressure on publically funded agricultural colleges to support research activities by extramural funding suggests that the likelihood of any significant increase in applied academic research programs that will service the intensive beef production systems, whether grazing or feedlot, is small. As universities focus on adding more “bench scientists” with increasingly fundamental research programs, it is likely that more applied research will be conducted by feedlot operations partnering with the pharmaceutical and feed ingredient industries. Basic research programs in academic settings can continue to generate vital new information for the intensive beef production industry, but to accomplish this, the industry must take a proactive role in working with universities to provide input on real-world problems that need to be addressed. Achieving this type of cooperative effort will be difficult, and the burden for creating this union will be on the beef production sector.

Long-Term Expectations. From an economic standpoint, cattle feeding operations in the U.S. are a high-risk, low-return business. In the 10 yr from 1999 to 2008, a recent university report (ISU, 2009) indicated an average estimated return of -\$7.20 and -\$6.85 over the 10-yr period for calves and yearlings, respectively. Returns were negative in 6 and 7 of the 10 yr for calves and yearlings, respectively, with a range per animal from \$-110 to \$150 for calves and -\$108 to \$154 for yearlings. With this type of historical balance sheet, the probability of increased financial returns from intensive beef production systems is not great. As a result of the considerable financial risk and lack of financial rewards associated with cattle feeding, even greater industry consolidation and corporate ownership of feeding operations is likely to be the norm for the U.S. industry in years to come. Larger companies can manage risk associated with all

aspects of their operations, balancing gains in one area against losses in another. Bigger operations that have comprehensive risk management, procurement, and marketing arrangements in place also will be more likely to secure the financial backing need to stay in business than smaller operations with more limited resources.

Challenges faced by the U.S. feedlot industry such as increasing regulations, a diminishing labor pool, and various outside societal pressures and consumer concerns, could lead to an expansion of beef cattle production in other countries. Argentina and Brazil, for example, seem ready to welcome expansion of intensive beef production systems. With a larger labor pool than the U.S., coupled with a history of strong forage-based beef production systems and existing beef export programs, these nations are poised to become the next frontier in intensive beef production. Developers of intensive cattle production operations in these countries should benefit from a critical evaluation of the experiences of the industry in the U.S.

Although growth in the world population will increase demand for food, whether intensive beef production systems, particularly feedlots, will be considered a sustainable contributor to meeting increased food demand is open to debate. Cattle can play an important role in providing high-quality protein for a hungry world, but as noted previously, ruminant livestock production is often cited as a major contributor to climate change through deforestation to expand grazing and enteric production of greenhouse gases. Nonetheless, as already pointed out, intensive, highly managed systems of beef production lend themselves to the use of fewer animals, which potentially decreases the environmental footprint of the industry. If beef producers in the U.S. and around the world can capitalize on the efficiency associated with intensive production systems and convince an often skeptical public that environmental, animal welfare, and food safety issues can be dealt with in an acceptable manner, intensive beef production systems could have a long-term, potentially sustainable future.

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