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U.S. Beef Industry: A Sustainable Success Story, Challenges and Priorities

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Introduction

The National Research Council Committee on Twenty-First Century Systems Agriculture has defined agricultural sustainability in terms of four goals that can be summarized as:

1. Meeting the human need for food and biofuels
2. Enhancing environmental quality
3. Sustaining the economic viability of agriculture and
4. Improving the quality of life for those involved in farming and their surrounding communities [1].

Based upon this definition, modern beef production in the U.S. is a resounding success story. Approximately eighty-five percent of U.S. grazing land is unsuitable for crop production. Utilizing this land for grazing livestock could more than double the landmass that is available to produce food for human consumption. Between the years of 1977 and 2007, technical advances in genetics, production, and processing reduced the number of animals required to produce 1 billion kg of beef by thirty-percent and the amount of feed required by nineteen-percent thus reducing the land, water and carbon footprints associated with these endeavors [2]. Currently, domestic beef feedlot production generates $40 billion in farm gate receipts annually [3]. Satellite industries affiliated with the beef production supply chain contribute an additional economic impact of five to ten dollars per every dollar of cattle sales. Often these industries form the critical economic foundation for under-represented communities. Additionally, the U.S. exports approximately one million metric tons of beef valued at $4 billion annually [3].

Potential Long-Term Challenges Facing the US Beef Industry

The industry faces multiple challenges that threaten the sustainability of the current production chain. Historically, beef production in the U.S. has evolved into a specialized supply chain that utilizes high-energy input to achieve the acceptable carcass merit rewarded by current grid marketing systems. In this paradigm, calves are generally produced in pasture-based production systems. Stocker cattle are then shipped to feedlots concentrated in regions that allow cattle to be finished on grain-based diets that drive intramuscular fat (IMF) deposition. Unfortunately, IMF accretion occurs predominantly at a time when significant quantities of unwanted visceral and subcutaneous fat stores have already accumulated on the carcass [4]. Thus, modern harvest weights represent a balance between achieving desired quality grades and tolerating diminishing feed efficiency. In this system, an estimated 55 to 75% of the total cost of beef production is related to feed and it is this aspect that makes the beef supply chain vulnerable [5].

The world population is projected to exceed 9 billion by the year 2050 with demand for agricultural products growing 1.5% annually [6]. This competing demand for use of grain for human consumption or animal feed unfortunately comes at a time when U.S. bio-fuel policy strongly encourages the use of corn as a source for energy, as exemplified by regulations such as the Renewable Fuel Standard and the Energy Independence and Security Act of 2007. Additionally, mounting evidence indicates climate change will occur in coming decades, which would almost certainly impact animal production. The current economic loss due to seasonal depressions in weight gain and feed efficiency has been estimated at $300M in beef herds and $900M in dairy herds in the U.S. annually [7]. Importantly, even greater future losses should be expected if warm season temperatures rise as climate models predict [8].

Additionally, pressure from animal activists in the U.S. has increased the importance of animal welfare issues and terms such as "factory farming" resonate with some consumers given the importance of feedlots and industrial-scale packing facilities to the current supply chain. Furthermore, while beef consumption is expected to increase worldwide in the coming years, it is important to note that heightened animal welfare concerns in foreign markets can place further pressures upon producers. For instance, European consumers have consistently demonstrated a willingness to pay more for products that they perceive as humanely produced while public policy such as the Amsterdam treaty (1997) mandates the monitoring of animal welfare [9]. Despite the great success of the last half-century, such looming challenges clearly indicate the beef industry has to keep evolving strategies to improve efficiency, safeguard the welfare of cattle, and to protect the environment. Several excellent recent reviews treat many of these issues in greater detail [10-12].

In response to these crises, the United Nation's Food and Agriculture Organization projects that seventy-percent of the world's additional food needs will have to be satisfied by improving existing production methods and by developing new technologies [6]. To address these pressures, it is inevitable that changes will have to occur in the current production system. One potential long-term solution entails an increased reliance upon pasture-based production systems and modification of the ideal beef type to favor leaner carcasses that take less time to reach market. This would dictate a trend toward smaller-framed, earlier maturing animals. It is likely that market weights in such a system will also tend to decrease in order to improve efficiency by limiting fat cover on the carcass while avoiding effects of connective tissue remodeling on tenderness. Well-marbled cuts might become a luxury as the need for improved production efficiency is at odds with current meat quality goals forcing a shift in the way beef is consumed. Meat scientists will need to devise new strategies to improve product quality post-harvest while preserving food safety. Likewise, there will be an even greater burden placed upon large animal medicine to not only preserve the health and well-being of changing herds but to

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preserve the integrity of the production chain as well.

Several regions of the U.S. offer grazing conditions which could lessen the impact of these anticipated shifts in beef production and thus may factor prominently in potential changes in the food delivery chain. For instance, as forage utilization increases in the southeastern United States, more cattle will be harvest-ready eliminating or reducing the need for transportation to the Midwest or the High Plains for finishing. This increased availability of finished cattle could drive expansion of harvest capacity and the associated infrastructure for the beef packing industry. Such changes will create increased job opportunities in the region and increase food system efficiencies by reducing transportation needs for the harvest and distribution of beef to growing population centers throughout the eastern United States.

Research Priorities Needed to Enhance Sustainable Beef Production

There needs to be a high priority placed on large animal research in order to drive necessary innovations and create new technologies. Recent USDA Farm Bills have identified pasture-based beef systems as a high-priority research and extension area. However, continuous reductions in state and federal funding have critically eroded the research capabilities within the Land Grant system needed to address this federal priority [13]. In order to address the global challenges that threaten the sustainability of U.S. beef production, it is crucial that this funding trend be reversed and increased support provided for several synergistic research priorities. First there needs to be a major emphasis on reducing inputs both to ease pressure caused by competition for the cropland used to produce grain for human consumption and bio-fuel production but also to reduce the breakeven point for producers. Improving feed efficiency could improve long-term profitability for beef producers by as much as thirty-three percent [14]. However, to accomplish this, the molecular basis for feed efficiency needs to be established both in soft tissues of the carcass and in regions of the brain known to regulate satiety, metabolic rate and modulation of the somatotropic axis. This should yield targets for new technologies that improve efficiency or provide new selectable markers. In this regard, residual feed intake (RFI) has been established as a heritable proxy for feed efficiency that is largely independent of growth rate and frame size. Understanding the basis for the considerable variation in RFI found within a herd could lead to rapid improvement in feed efficiency. Beef industries in Canada and Australia have already incorporated RFI in breeding programs while the U.S. has lagged behind. Likewise there needs to be better understanding of the physiological basis for heat tolerance. An increased emphasis on adipose tissue development is also necessary to improve both feed efficiency and meat quality. There will be a greater need to selectively alter fat deposition on the carcass in a depot-specific manner that favors IMF and limits fat accretion in undesirable depots. Pharmaceutical and biological research will be critically important to develop novel products and strategies to overcome shifting patterns in viral mutations and antimicrobial and parasite resistance to currently available products. Finally, forage-based research needs to be prioritized to overcome difficulties in providing a consistent supply of product due to seasonality of regional forages that currently limit the adoption of year-round pasture-based beef production systems in many regions of the U.S. For instance, there is a great need for applied research aimed at developing forage options that provide energy and protein nutritive values sufficient to sustain rapid, efficient growth throughout warm and cool seasons.

Conclusion

The U.S. beef industry has a history of combining the dedication to stewardship inherent in the psyche of cattlemen with science-based technologies and improvements in management to continually enhance the sustainability of beef production ultimately helping lift the human condition. While the challenges facing the industry in coming years loom large, there is no reason to doubt that these challenges can be overcome provided key funding and support for large animal research is prioritized by industry and granting agencies alike. Scientists, livestock producers and support personnel within the food industry have a tremendous obligation and an exciting opportunity to address these issues. The clock is ticking. We only have thirty-seven years to double the global food supply to feed a world population estimated to exceed 9 billion people.

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