

SUSTAINABLE SOLUTIONS FOR _____
— *Beef Production Systems*

Version 16.1 • December 2015



ANIMAL SCIENCE
TEXAS A&M UNIVERSITY

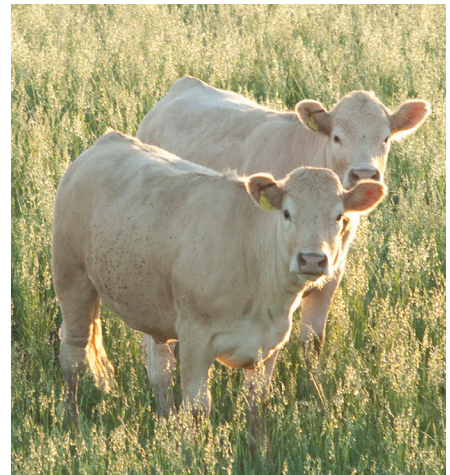
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■ INTRODUCTION

Cattle and calves are the number one cash agricultural commodity in Texas (\$10.5 B, 2012); this is approximately five-fold greater than the 2nd most valuable commodity (poultry and poultry products, \$2.3 B) or the single most valuable crop (cotton, \$2.2 B). In fact, crops grown for feed (primarily for cattle) are themselves the second largest crop commodity (\$2.1 B); thus the agricultural economy of Texas is dominated by the livestock sector, and the livestock sector is dominated by beef production systems. Beef production remains a significant driver of economies in Texas, with over 240,000 declared agricultural operations on over 130 million acres of land. However, due to drought, land conversion, fragmentation, and increasing capitalization requirements for entry, the total number of beef cows in Texas has declined by 34% in the past 15 years.

There are 729,000 beef cattle operations in the United States; while still numerous, the total number of operations has declined almost 20% in 20 years. The number of beef cows in the United States has declined at an even greater rate. The reductions in the Texas and national cow herds have created shortages throughout the supply chain and a resulting contraction in feeding and processing capacity, even as retail prices have increased and impacted consumers both in the United States and around the world.

Ironically, this contraction has occurred even as indicators for the future of the global animal protein sector suggest an unprecedented period of growth in demand. Estimates for global population growth, coupled with the movement of significant numbers of persons from poverty into the middle class, are expected to lead to an increase in demand for proteins of animal origin, including beef, of 70 to 100%. At the same time, the developed world has an increasingly skewed perspective on modern agricultural systems, and scrutiny of food production systems has increased exponentially. An increasing population, both in Texas and around the world, creates additional competition for land, water, labor, and capital.

- *How will the beef industry capture the possibilities associated with this dramatic growth in demand and consumption in the face of increasing barriers?*
- *Who will produce beef in the future?*
- *Can continuous improvement be obtained through innovation to sustain growth in protein production sufficient to meet the demands of a growing population?*
- *Can these production increases be achieved in parallel with wise stewardship of resources?*



The Texas A&M System has long served as a resource for the beef value chain, from producers to the consuming public. Fundamental discovery, development and validation of best management practices, and the dissemination of information to current and future producers, leaders, scientists, and consumers remain essential outcomes of our programs. In the face of the challenges and questions inherent in global protein production systems, Texas A&M AgriLife and affiliated members of the Texas A&M University System remain committed to the development of solutions.

The Vision: Texas A&M AgriLife will be viewed as the thought leader, innovator, and provider of *Sustainable Solutions* for beef production at local, regional, national, and global scales. This stature will be achieved through:

- Incremental and radical innovation in prescriptive production systems;
- Development and delivery of solutions based upon these innovations;
- Growth of capacity to address future challenges and create continuous improvements in beef systems.

The primary purpose of this document is to crystalize the overarching challenges and opportunities for global beef production systems, and to clarify how the core competencies of Teaching, Research and Extension can serve as strategic platforms from which to provide solutions for our state, nation and world. Our success in living into this vision is predicated upon our ability to generate and deliver innovative solutions to the critical challenges and opportunities that exist in our world and training those who will develop the solutions of tomorrow. To effectively deploy strategies, objectives must exist. To develop sustainable solutions, challenges must be defined.

■ THE CHALLENGE

How might the beef complex increase protein production to satisfy global demand in systems that are:

- Resource efficient
- Economically viable
- Socially and ethically acceptable
- Resilient to shocks

This challenge addresses the fundamental purpose of the beef value chain (the production of high quality protein) in the context of identified demand growth drivers. Constraints to solution development shape the direction of thought and incorporate critical issues impacting production locally and globally. Resource efficiency includes typical views of efficiency, such as reducing input usage per unit of output, but necessarily incorporates environmental concerns such as emissions to air, water and soil, which result from resource consumption. Economic viability encompasses firm-level decision making, sector-level economies, and the balance between industry viability, profitability and affordability of the food supply for consumers. Social and ethical considerations encompass the considerations of public health, societal concern, and the responsibility of stewardship in biological systems.

■ KEY STRATEGIES

Aligning this challenge with the vision and mission of our organization leads naturally to the development of objectives within and among each challenge area. Strategies, the mechanisms by which goals can be accomplished, are the intrinsic functions of the land grant systems perspective:

- Research: Fundamental discovery, application and technology development
- Extension: Solution delivery, issue identification
- Teaching: Creation of future capacity

Considering these functions as strategies to address the challenge creates a more integrated approach to solution development and delivery, rather than outlining separate efforts for each part. This maintains the system perspective that we seek, while capitalizing on the unique land grant structure as a competitive advantage toward fulfilling the vision of being the leading solution provider. These *are* strategies, the means by which the challenge can be met, the goals achieved.

■ STRATEGIC OBJECTIVES

Strategic objectives are formulated from the foundational constraints on potential solutions designed to address the Key Challenge. These objectives are rooted in the most commonly held concepts and definitions for sustainability, and reinforce the vision of providing “Sustainable Solutions” in protein production. Within each strategic objective, a set of “stretch” goals applicable to the key challenge are established, and frame natural metrics of progress and success. Metrics of academic inputs and outputs, such as ‘external funding’, ‘publication rate’, ‘student credit hours’, etc. may be used as measures of the efficiency with which the strategies are being executed, but only in the context of the larger objectives. Achievement toward goals can readily be communicated in terms of potential impact, direct impact, or capacity building. This perspective may enhance our views on evaluation of success in achieving the vision and foster strategic communication efforts.

Within each strategic objective, tactics describe discrete efforts by which progress will be made toward goals. It is important to note that within each set of tactics, the last item is open – this is to demonstrate that the development of tactics is ongoing, and that innovation in solution development is not static. It is emphatically our intent to encourage the addition of additional items within each objective. It should also be recognized that execution of individual tactics may contribute to progress toward more than one goal. This is also an intended feature as we strive to create more integrated solutions through this framing effort. This approach in the listing of tactics affirms the evolving nature of our efforts and is intended to foster continuous improvement and innovation as we make progress toward goals. While we anticipate frequent updating of strategic objectives, we expect the evolution of tactics to be even more rapid, resulting in updates to this document on a frequent basis.

Strategic Objective 1: Enhance protein production while improving resource stewardship.

GOAL	TACTICS
1.1. Define valid metrics for resource stewardship and sustainability for beef production systems	1.1.1. Engage with key stakeholders to effectively and defensibly define metrics for sustainability in beef production systems 1.1.2. Benchmark model systems against these metrics 1.1.3. Create prescriptive management systems that drive positive change in systemic sustainability without compromising productivity gains 1.1.4. Develop balanced scorecard tools to facilitate sustainability assessment 1.1.5.
1.2. Reduce carbon/GHG emissions per unit of protein produced by 15%	1.2.1. Benchmark carbon/GHG emissions per unit of protein under current production systems through various approaches, including Life Cycle Analyses and other footprinting methods 1.2.2. Identify combinations of existing technologies that simultaneously reduce carbon/GHG losses while enhancing protein production 1.2.3. Develop prescriptive production systems to optimize technology application and indicate opportunities for disruptive innovation 1.2.4. Develop methods to accurately predict emissions and sequestration based on production environment 1.2.5.
1.3. Increase protein production per unit of net blue water losses by 20%	1.3.1. Benchmark current total, blue, and green water utilization per unit of protein production 1.3.2. Identify critical pathways for directly improving water use efficiency 1.3.2.1. Feed production systems 1.3.2.2. Animal production systems 1.3.2.3. Post harvest and processing systems 1.3.3. Reduce water losses due to nutrient discharge 1.3.4. Reclaim grey or black water created through production systems 1.3.5. Develop process-based models and BMP to mitigate dust emissions without increasing blue water consumption 1.3.6.
1.4. Increase protein production per unit of land area by 30%	1.4.1. Reduce energy requirements required per unit of beef produced 1.4.2. Increase harvest efficiency of produced forages 1.4.3. Create innovative intensification strategies that reduce land requirement 1.4.4. Develop adapted forages that extend grazing seasons and yield that are resilient to local climate variance 1.4.5.
1.5. Increase conversion of “human consumable” protein, energy into beef protein above 0.7:1 (beef protein: human consumable protein)	1.5.1. Benchmark current conversions for beef in conventional and alternate systems 1.5.2. Benchmark alternate protein sources on same basis (pork, poultry) 1.5.3. Expand coproduct, other inaccessible protein sources to provide protein in beef cattle diets 1.5.4. Provide prescriptive production technologies to enhance protein yield 1.5.5.
1.6. Prepare current and future leaders to innovate	1.6.1. Develop educational programs focused on scientific sustainability measures 1.6.2. Revise/develop capstone course curricula to encompass systems evaluation and resource sustainability metrics 1.6.3.

Strategic Objective 2: Enhance the economic viability of beef production systems.

GOAL	TACTICS
<p>2.1. Increase risk adjusted returns to beef production systems 15%</p>	<p>2.1.1. Develop technologies that enhance productivity and/or reduce risk in production systems 2.1.2. Quantify cost: benefit ratios using biological assessment to allow for adaptive management in dynamic price environments 2.1.3. Create benchmark return rates among sectors and enterprises 2.1.4.</p>
<p>2.2. Increase relative value of beef by 10%</p>	<p>2.2.1. Develop protein value index for beef and competing proteins 2.2.2. Create innovative product offerings through production and processing technologies 2.2.3. Identify flavor chemistries and attributes to specifically drive value creation 2.2.4. Enhance quality attributes and value drivers for specific markets 2.2.5. Minimize waste, refusal and spoilage using innovative processing and packaging 2.2.6.</p>
<p>2.3. Reduce unit cost of protein by 10%</p>	<p>2.3.1. Identify productivity enhancement to reduce marginal costs 2.3.2. Create innovative prescriptive production systems that allow dynamic optimization 2.3.3. Increase net production rate per supporting population 2.3.4. Prescribe combinations of technologies, genotypes, and strategies that streamline production flow and product array 2.3.5. Define role of microbial metagenomics in nutrition and health responses 2.3.6.</p>
<p>2.4. Capitalize on variance in supply chain through portfolio analysis</p>	<p>2.4.1. Define system value for particular phenotypes and product characteristics 2.4.2. Evaluate demand drivers among various markets and define demand elasticity for market sectors 2.4.3. Create innovative production paths to achieve high net value product array 2.4.4.</p>
<p>2.5. Prepare current and future leaders to innovate</p>	<p>2.5.1. Develop educational programs focused on scientific sustainability measures 2.5.2. Revise/develop capstone course curricula to encompass systems evaluation and economic sustainability metrics 2.5.3.</p>

Strategic Objective 3: Enhance the social responsibility and acceptability of beef production.

GOAL	TACTICS
3.1. Improve the well-being of animals in beef production systems	3.1.1. Define objective and valid metrics for animal well being 3.1.1.1. Individual scale 3.1.1.2. Group/population scale 3.1.2. Develop early detection systems capable of reducing response time and increasing accuracy of therapeutic delivery 3.1.3. Create comparisons to alternate populations to create context for metrics (e.g., sick days per employee) 3.1.4. Create comparisons relative to protein yield as an indicator of incidence scaled on food yield 3.1.5.
3.2. Reduce morbidity and mortality rates by 25% each	3.2.1. Create innovative methods for clinical evaluation, diagnosis 3.2.2. Develop information systems and analytic tools that are anticipatory of escalating risk 3.2.3. Devise prophylaxis strategies that can be prescriptively deployed 3.2.4.
3.3. Reduce total antimicrobial usage per unit of protein produced	3.3.1. Utilize information and analytics systems to reduce need for therapeutic intervention 3.3.2. Capitalize upon individual, group descriptors to optimize therapeutic response 3.3.3.
3.4. Evaluate and reduce antimicrobial resistance in food production systems	3.4.1. Identify novel therapeutic agents 3.4.2. Identify strategies that reduce or reverse acquisition of resistance 3.4.3. Develop technologies and decision support that allow for optimal deployment of antimicrobials to mitigate increases in off-farm resistance 3.4.4.
3.5. Ensure microbiological safety of beef products	3.5.1. Develop novel post-harvest intervention strategies to reduce pathogen load 3.5.2. Develop pre-harvest strategies that reduce pathogen load 3.5.3. Create and validate BMP and systems to enhance quality control 3.5.4.
3.6. Assess and enhance health impacts of beef consumption	3.6.1. Develop protein value index for beef and competing proteins 3.6.2. Capitalize on fatty acid profiles of beef cuts to amend human diets 3.6.3.
3.7. Prepare current and future leaders to innovate	3.7.1. Develop “issues forums” to disseminate current scientific assessment of issues of social concern 3.7.2. Revise/develop issue-based course curricula to address systems evaluation and social context 3.7.3.

Strategic Objective 4: Enhance the resilience of beef production systems

GOAL	TACTICS
<p>4.1. Reduce impact of climate variance on protein yield</p>	<p>4.1.1. Develop strategies that reduce negative impacts of drought on productivity 4.1.2. Develop strategies, practices, and decision support tools for proactive mitigation and recovery from drought events 4.1.3. Identify technologies and strategies that mitigate heat stress in extensive production systems 4.1.4.</p>
<p>4.2. Quantify genetic variants, components that confer resilience</p>	<p>4.2.1. Identify genetic basis for resilience to abiotic stressors (heat tolerance, fluctuating feed availability) 4.2.2. Identify genetic basis for resilience to biotic stressors (disease, parasites) 4.2.3. Capitalize on discoveries with applications to enhance resilience 4.2.4.</p>
<p>4.3. Create decision support systems that allow optimization of system flow</p>	<p>4.3.1. Integrate data streams and biological information to create Prescriptive Production systems 4.3.2. Identify innovative data capture and diagnostic tools to permit system control and evaluation 4.3.3. Capitalize on existing and emerging modeling capacity to facilitate dynamic/adaptive management systems 4.3.4.</p>
<p>4.4. Improve resilience to current systems through knowledge transfer</p>	<p>4.4.1. Deploy tools and applications that increase uptake of current BMP 4.4.2. Foster evolution of decision support systems based on knowledge development 4.4.3. Create impact ratios that describe the production response to shocks 4.4.4.</p>
<p>4.5. Prepare current and future leaders to innovate</p>	<p>4.5.1. Develop innovation centers for development and demonstration of adaptive management/prescriptive production practices 4.5.2. Revise/develop capstone course curricula to encompass systems evaluation and adaptive management 4.5.3.</p>

■ ESSENTIAL ELEMENTS OF APPROACH

A vital feature of this approach is the systems orientation to innovation in solution development, creation of knowledge and information products, dissemination and application, and training. It is anticipated that successes toward a particular goal or within a strategic objective can and will be translated among other elements to yield highly integrated outcomes and impacts. Most importantly, both continuing efforts and new starts can be held up against the key challenge and the strategic objective areas to determine priority. Goals and tactics are purposefully void of disciplinary titles, to facilitate and encourage systems thinking and cross functional development. The orientation is toward solution development, and the systems perspective should lead to natural gap analysis and thus the addition of new goals and innovation events. Advances in disciplinary research will be both foundational for application development and a product of solution development efforts. This orientation also aims at directly addressing stakeholder needs, and creating a vehicle for strategic communication in many directions while maintaining context.

Ultimately, to achieve the vision, progress and innovation will be the pivotal elements of success. As further challenges are identified, asking “How might we...” will enable our progress toward feeding the world’s growing population sustainability.

■ SUMMARY

Expanding populations – and expansion of the global middle class – will dramatically increase the demand for dietary protein over the next 35 years. While beef production systems have some inherent capacities well suited to addressing these needs, these systems are currently challenged by escalation in capital requirements and input costs, and are exposed to exogenous influences ranging from weather to public opinion. Texas A&M AgriLife and the Texas A&M University System aims to be the thought leader, innovator, and provider of Sustainable Solutions for Beef Production Systems at local, regional, national, and global scales.

To achieve this vision, we will develop solutions framed upon key elements of sustainability of systems: economic viability, environmental and resource use efficiency, social acceptance, and resilience to market, weather, and systemic shocks. We will rely on the core functions of the land grant system – Teaching, Research, and Extension – as the proven strategies for advancing agricultural systems to meet human needs. Strategic objectives, built upon the framework of sustainability, are used to foster establishment of stretch goals; targets that, if achieved, will positively impact dimensions of sustainable protein production. The strategic objectives are:

- Enhance protein production while improving resource stewardship.
- Enhance the economic viability of beef production systems.
- Enhance the social acceptability of beef production systems.
- Enhance the resilience of beef production systems.

Tactics and approaches to achievement of individual goals are described that are believed to be high leverage efforts. A conscious awareness that innovative approaches are desired, and may not have yet been envisioned, is expressly incorporated to encourage ongoing establishment of new efforts toward goal accomplishment.

Progress toward stated goals will yield knowledge products that can be applied to facilitate continuous improvement in the sustainability of beef production systems. Discovery, validation, application and training efforts have impact across the value chain, and result in enhancement for value-chain participants, critical and defensible information for policy-makers, and increased societal understanding of elements of sustainability.