The Australasian beef industries—
Challenges and opportunities in the
21st century

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Implications

Accelerating global demand for beef offers great opportunity to the predominantly beef-exporting nations of Australia and New Zealand. However, Australasian industries face serious challenges in their ability to capitalize on this opportunity sustainably, including, but not limited to,

- The need to mitigate the environmental impact by reducing greenhouse gas emissions (mostly enteric methane) and threats to the stability and biodiversity of pastoral ecosystems.
- The increasing risk of incursions of devastating exotic diseases, such as foot-and-mouth disease, and the consequent loss of preferential access to export markets.
- Increasing public awareness and concern about management, transport, and slaughter practices that, if not addressed proactively, could negatively affect domestic and export markets.

Effective responses to these challenges, and therefore to industry sustainability, will require a combination of innovations in research and development, public and private investment in industry infrastructure, and development of well-informed public policy and trade diplomacy initiatives.

Key words: animal welfare, environmental sustainability, exotic disease, genetic improvement, smart farming technology

Introduction

Within the broader geopolitical region of Australasia, only Australia and New Zealand have significant beef industries. These industries share many of the challenges and drivers that are influencing other beef industries around the world, as discussed in other papers in this issue of Animal Frontiers. However, in Australia and, to a lesser extent, New Zealand, the internal diversity of the beef industries is a distinctive feature, influenced by wide climatic and biogeographic variation, and consequent variation in management systems, cattle genotypes, impact of endemic diseases, supply chain infrastructure, and market opportunity. The Australasian industries also are distinctive in their freedom from most potentially devastating exotic diseases that plague many other beef-producing countries, their substantial dependence on export markets, and their relative lack of public subsidy and tariff protection.

This paper discusses some of the most serious challenges to the economic, environmental, and social sustainability of the beef industries in Australia and New Zealand and comments on opportunities to overcome these challenges, especially those with a regional flavor that are amenable to innovative solutions.

Background

A Brief History of the Australian and New Zealand Beef Industries

Cattle were first introduced to Australia and New Zealand at or soon after European settlement in 1788 and 1814, respectively. Growth in numbers was initially slow but accelerated in the latter half of the 19th century in response to the Australian gold rushes and the advent of refrigerated transport. By 1900, the Australian beef herd numbered 8.6 million animals (Australian Bureau of Statistics, 2005) and extended to most regions of Australia, including very large pastoral holdings in central and northern Australia. Growth of the beef breeds during this period was slower in New Zealand and was outstripped by that of meat sheep numbers.

During the first half of the 20th century, productivity in northern Australia was limited by the inability of British breed cattle to adapt to extreme heat, seasonal variations in feed quality and availability, and, in the wet tropics, tick infestation. This changed in the 1950s with the introduction of heat-tolerant, tick-resistant Bos indicus breeds, especially the American Brahman (Figure 1). In the 1960s, large-framed European breeds such as Limousin, Charolais, and Simmental were introduced to Australia and New Zealand and were crossed with British breed stock to produce larger, later finishing animals. Soon after, with the admission of the United Kingdom to the (now) European Union, most beef exported from Australasia was diverted to emerging markets in the United States and East Asia (Australian Bureau of Statistics, 2005).

This led to rapid growth in the Australian industry, with cattle numbers peaking at about 30 million in 1976. Since then, cattle numbers in Australia and New Zealand have fluctuated with climatic conditions and world beef prices; in 2010, the Australian beef herd numbered 24.3 million animals, excluding dairy cattle used for meat.
Industry Structures in Australia and New Zealand

The beef production industry extends over almost one-half the land mass of Australia, across all climatic zones. During the period from 2001–2002 to 2008–2009, it included an average of 40,200 beef cattle farms, excluding major feedlots (Australian Bureau of Agricultural and Resource Economics, 2010). Of these, almost 10,500 were located in northern Australia (Queensland, the Northern Territory, and northern Western Australia) and about 29,700 were located in southern Australia. The scale of operation and market share is strongly influenced by climatic region, with many more large, extensive operations accounting for a much larger market share in the northern than in the southern regions (Table 1).

The Australian beef production industry also includes almost 700 accredited feedlots, which in 2009–2010, accounted for 2.4 million cattle slaughtered (33%; Australian Bureau of Agricultural and Resource Economics, 2010). These operations are located mostly in areas close in proximity to cattle and grain, such as southeast Queensland, the northern tablelands, and Riverina of New South Wales. The number of feedlots and cattle finished on grain has fluctuated widely in recent decades because of major variations in grain costs and cattle prices.

The New Zealand beef industry is principally characterized by its interrelationships with both the sheep and dairy industries. Most beef is produced on mixed-livestock farms (sheep, beef, and sometimes deer), and often the beef enterprise has multiple purposes, including pasture improvement for other livestock classes as well as generating income in its own right. Hence, beef cows and, to a lesser extent, finishing cattle often are a low-priority stock class in the farming system, with implications for animal performance and supply chain management.

The New Zealand dairy industry (4.4 million cows; DairyNZ, 2011) is considerably larger than its beef breeding industry (1.14 million cows; Beef+Lamb NZ, 2010). It contributes to beef supply both as a source of surplus calves for beef finishing and also as a direct source of beef from cull dairy cows. This creates significant diversity in terms of production systems (surplus dairy calf, prime beef, bull beef, and cull cow beef) and genetic background (dairy and beef × dairy breeds), as well as influencing which markets are targeted (e.g., lean beef for the North American hamburger market versus prime table beef markets). The dairy industry also causes significant seasonal peaks in the flow and type of cattle slaughtered, with implications for supply chain infrastructure.

Most beef production in New Zealand occurs on hill country because both dairy and, to a lesser extent, the sheep industry compete with beef for more productive land. Unlike Australia, New Zealand does not have a large grain resource and most beef is finished on pasture. This limits the ability of the industry to buffer seasonal variations in forage availability and therefore beef supply patterns.

Value of the Australian and New Zealand Industries

In 2009, Australia was the eighth largest producer of beef and veal in the world, and after Brazil, was the second largest beef exporter, accounting for 2.1% of the global cattle inventory, 3.5% of global production, and 19% of global trade. In that year, Australia produced 2.12 million tonnes of beef, valued at AU$7 billion, of which 1.37 million tonnes (65%), val-
Increasing Demand for Animal Protein

The relationship between national affluence and demand for animal-source foods is well established (FAO, 2009; Figure 2). The growing prosperity of many developing nations, coupled with regionally varying rates of population growth, is driving accelerating demand for meat in East and Southeast Asia and Latin America (FAO, 2009). In Asia, much of this growth has been in poultry and pork consumption. However, long-term projections of increased opportunity for beef exporters seem reasonable, particularly if the industry can cater to a likely increase in demand of Asian consumers for beef with higher quality and safety attributes (Dalton and Keogh, 2007), such as those assured by the Meat Standards Australia program (http://www.mla.com.au/Marketing-red-meat/Guaranteeing-eating-quality/Meat-Standards-Australia).

In addition to their general focus on increasing quality and safety, Australian exporters have sought to exploit niche markets in Asia and elsewhere. A striking example has been major growth in Japanese imports of extremely marbled Wagyu beef after the introduction of this traditional Japanese breed to Australia in 1991. Nevertheless, more than one-half of Australian beef exported to Japan and Korea is grass fed, and recent growth in the north Asian fast food industries has strengthened demand for manufacturing beef (MLA, 2011).

Taking Advantage of the Clean, Green Image of Australasian Pastoral Industries

The pastoral industries of Australia and New Zealand have benefited directly from trade advantages because of their relative freedom from infectious animal diseases that have either the potential to cause devastating economic loss, such as foot-and-mouth disease (FMD), or the potential to pose frightening zoonotic consequences, such as bovine spongiform encephalopathy (BSE). These industries also have sought to take advantage of the fact that, in both countries, the majority of cattle are raised and finished on pasture under “natural” conditions. New Zealand, in particular, seeks to differentiate products, including beef, by highlighting the environmental attributes of New Zealand.

These real and perceived advantages may continue to offer trading advantages into the future. However, as discussed below, the disease-free status of the Australasian industries could be challenged at any time. In addition, the present disease-related trade advantages will be lost if competitors such as Brazil and Argentina can successfully eradicate FMD and if the global risk of BSE continues to wane.

Opportunity for Sustainable Growth of the Beef Industry in Australia and New Zealand

A recent report based on scientific analysis and views of industry leaders has suggested there may be scope to more than double production from Australia’s northern beef cattle herd, building on a record of productivity growth over several decades (Cribb et al., 2009). However, as noted by these authors, such development will depend heavily on increased access to reliable supplies to fresh water. This will be essential to overcome seasonal feed shortages through development of irrigated pastures and fodder cropping, possibly based on mosaic irrigation systems. Other significant barriers include lack of transport and processing infrastructure, especially in far north Queensland, the Northern Territory, and northern Western Australia.

In New Zealand, beef production has declined by approximately 10% since 1990, largely because of changing land use with the growth of the dairy industry and a decreased role for less profitable beef breed-

Table 1. Distribution of Australian beef cattle farms by region and number of cattle

<table>
<thead>
<tr>
<th>Farm size (head of cattle)</th>
<th>Northern Australia</th>
<th>Southern Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of farms</td>
<td>Share of sales value, %</td>
</tr>
<tr>
<td>&lt;200</td>
<td>3,914</td>
<td>4</td>
</tr>
<tr>
<td>200–800</td>
<td>3,272</td>
<td>12</td>
</tr>
<tr>
<td>800–1,600</td>
<td>1,462</td>
<td>13</td>
</tr>
<tr>
<td>1,600–5,400</td>
<td>1,397</td>
<td>30</td>
</tr>
<tr>
<td>&gt;5,400</td>
<td>404</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>10,449</td>
<td>100</td>
</tr>
</tbody>
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Adapted from Australian Bureau of Agricultural and Resource Economics (2010).
ing in mixed farming systems. Opportunities for growth will depend on increased availability of dairy calves and cull cows, and possibly on innovations to improve the value of co-products and lower-value portions of the carcass.

**Major Challenges**

**Environmental Impact**

The introduction of grazing ruminants to Australia and New Zealand after European settlement has had a dramatic and often negative effect on the rural landscapes of both countries. The introduction of cattle and sheep was generally associated with land clearing to reduce competition between trees and pasture for water and nutrients and to allow greater stocking densities (Ash and McIvor, 1998). Combined with overgrazing, this has especially negative impacts on fragile tropical rangelands and savannas, which came under increasing pressure after the introduction of *B. indicus* cattle after the 1950s. For example, an estimated 2.1 million hectares of Brigalow woodland was cleared in Queensland between the 1960s and mid-1990s, leaving only 14% of the original stocks (Lindenmeyer, 2007). However, recent legislation (e.g., State of Queensland, 2009) has curtailed land clearing for cattle production and the prospect of the involvement of Australian agriculture in the carbon economy may further offset the drivers for land clearance. Similar policies in New Zealand will probably reduce the land available for beef production in the future. In addition, growth in the carbon economy may drive changes in the use of marginal land from beef production to forestry.

The introduction of improved, non-native pasture species has had a substantial, positive influence on Australasian beef productivity. This has been largely uncontroversial in temperate regions, where improved pastures have been productive and environmentally stable for many decades. However, the introduction of productive pasture species in the tropics and subtropics, such as buffelgrass (*Cenchrus ciliaris*) and leucaena (*Leucaena leucocephala*), has raised environmental concerns because of their aggressive growth habits and negative effects on native flora biodiversity (Friedel et al., 2007). This has led to the establishment of buffelgrass as a pasture species being prohibited in Western Australia and the Northern Territory, notwithstanding its undoubted value for cattle feeding.

The erratic climate and poor soils of Australia contribute to periodic overgrazing, loss of pasture ground cover, and consequent soil erosion, especially in the northern regions. Assessment tools based on ground cover and other factors, such as the ABCD Land Condition guide (Figure 3), have been introduced to assist graziers in managing the land. Of particular environmental concern is the runoff of sediments from adjacent grazing lands into the Great Barrier Reef lagoon, threatening this world heritage site and tourist magnet (Great Barrier Reef Marine Park Authority, 2009).

Since 1950, average temperatures in Australia have increased by 0.9°C, and most of the continent has experienced major declines in rainfall. These climatic trends are predicted to continue (CSIRO, 2007). Such changes will affect the balance between tropical (C4) and temperate (C3) grasses and the seasonal growth patterns of pastures across the continent (FAO, 2008). Although increased atmospheric CO₂ concentration may increase plant growth and water use efficiency, it will also decrease the nutritional quality of both tropical and temperate forages.

**Figure 2.** Per capita gross domestic product (GDP) and meat consumption by country, 2005 (source: FAO, 2009). PPP = purchasing power parity in constant 2005 international US dollars.
The Australian beef cattle industry is estimated to account for about 7% of total greenhouse gas (GHG) emissions in Australia, or about 40 Mt CO₂-equivalents (eq.) per year, almost entirely derived from enteric emissions of methane (~39 Mt). However, because of the extensive nature of the grazing lands in Australia, it is estimated that improved land condition caused by reduced stocking rates could sequester more than 120 Mt CO₂-eq. per year (Gifford and McIvor, 2009). The potential carbon sequestration from increased tree cover in the grazing lands is also significant, but both options imply reduced cattle numbers in the rangelands (Eady et al., 2009). Proposed legislation in Australia would reward producers with carbon credits for abatement of emissions via recognized mitigation and sequestration management practices.

In New Zealand, with an economy more heavily reliant on ruminant livestock production, enteric methane is estimated to account for 32% of total GHG emissions (Ministry for the Environment, 2011). Options for assessment and mitigation of these highly dispersed emission sources are discussed below.

In the long term, water availability and use may be a more important environmental issue for the Australian beef industry than will its carbon footprint. Recently, life cycle analysis was used to estimate that water use for beef production in southern Australia was 27 to 540 L/kg of carcass weight, depending on the production system, reference year, and use of source or discharge flow characteristics (Peters et al., 2010). These values are orders of magnitude less than some much-publicized American estimates owing to differences in the treatment of rainfall and the fact that almost all Australian cattle feed is produced in dryland systems.

Preservation of Disease-Free Status

Australia and New Zealand are essentially free of 20 of the 33 notifiable infectious diseases of cattle listed by the World Organization for Animal Health (OIE). Among these, FMD poses the greatest potential threat, with the estimated cost of an Australian outbreak amounting to as much as AU$13 billion and with the greatest predicted impact on the beef cattle industry, especially in Queensland (Productivity Commission, 2002).

A recent comprehensive review of the Australian quarantine and biosecurity systems identified numerous risks and challenges to preserving the disease-free status of the country (Beale et al., 2008). Risk categories include incursion of truly exotic diseases, such as FMD; reemergence of endemic diseases, such as bovine tuberculosis; emergence of previously unknown diseases, such as BSE in Europe; and human-induced risks, either inadvertent (e.g., laboratory escapes) or deliberate (bioterrorism). Major challenges of concern are the increasing globalization of trade, including that of animal genetic material; the human spread into new habitats; increasing tourism and the movement of cargo across national boundaries; climate change; a looming shortage of appropriately trained animal health professionals; and physical constraints to quarantine barriers (e.g., at airports).

The export and domestic markets of the Australasian beef industries also are at risk from food-borne pathogens that can enter the food chain at various points, most notably Salmonella spp., Escherichia coli (especially E. coli O157:H7), Campylobacter jejuni, and Listeria monocytogenes. The increased scale, intensification, and complexity of both on-farm operations and the postfarm processing and distribution chain have contributed to the increased risk of food-borne disease despite the introduction of control systems such as the Hazard Analysis Critical Control Points System and major advances in pathogen diagnosis and traceability. Interestingly, recent evidence suggests that the relatively low incidence of E. coli O157-associated disease in Australia may be related to the prevalence of less virulent genotypes of E. coli O157 in Australian cattle compared with those in several other countries (Whitworth et al., 2008).

Static or Shrinking Resources

Limited availability of land suitable for beef production in Australia and New Zealand means that improvement of the feed base, especially in
northern Australia, and the efficiency of animal production systems will be essential to future increases in industry productivity (see below).

The availability and cost of input resources, such as nonrenewable energy sources and fertilizer, also will increasingly challenge the Australasian industries. For example, predictions that global supplies of accessible rock phosphate will peak in the foreseeable future (Figure 4) are of concern because of the widespread, often severe phosphorus deficiency of most soils in Australia and New Zealand. This is driving research and development into new technologies for recycling phosphorus from human and livestock wastewater, and for increasing the efficiency of phosphorus utilization through plant breeding, precision agricultural practices to optimize fertilizer application, and the use of microbial inoculants to enhance the availability of soil phosphorus ( Cordell et al., 2009). The latter approaches to increasing efficiency will be less applicable to the extensive pastoral industries, where an affordable supply of phosphate fertilizer combined with direct supplementation of cattle with phosphorus will continue to be necessary.

Animal Welfare Concerns

The power of public reaction to animal welfare issues was dramatically demonstrated by the recent Australian government suspension of live cattle export from Australia to Indonesia, triggered by a public affairs television program showing distressing images of cruel and inhuman slaughters in some Indonesian abattoirs. This disruption of trade worth $350 million per year occurred despite significant, evidence-based improvements in welfare standards for the transport of cattle by land and sea and efforts by Meat and Livestock Australia to improve practices in Indonesian abattoirs.

Industry awareness of changing public attitudes is driving research into more humane alternatives to a number of traditional husbandry practices. For example, the development of gene markers to identify bulls likely to sire horned offspring should significantly reduce reliance on physical dehorning, especially of older B. indicus cattle in northern Australia. Nonsurgical approaches such as immunocastration are being investigated as alternatives to the surgical castration of young bulls and flank spaying of heifers. Recent concerns about withholding food from surplus dairy calves during transport has sparked the Australian Primary Industries Standing Committee to commission a review of these practices, with potential to affect the segment of the beef and veal industries that relies on this by-product of the dairy industries in Australia and New Zealand.

Other Challenges

The Australasian industries are challenged by numerous other external and internal factors. Some, such as the shortage of skilled labor, are at least partially amenable to research and development solutions, as discussed below in the section on smart farming. Social policy to facilitate reengagement of indigenous Australians with the pastoral beef industry also could help address the labor shortage in central and northern Australia. Other factors, such as the lack of transport, processing, and shipping infrastructure in northern Australia, will require significant public and private investment and risk mitigation strategies. Still others, such as the impact of currency exchange rates on export market demand and terms of trade, are largely outside the control of the Australian and New Zealand governments beyond ongoing international trade diplomacy efforts.

Research and Development Opportunities

Improving the Feed Base

The Australasian beef industries rely heavily on pasture, which varies widely in availability and quality, especially in northern Australia. Intensive management of improved pastures offers the opportunity to manipulate forage quality, with positive effects on the intake and growth performance of cattle. However, this is limited mostly to the climatically favored parts of southern Australia and New Zealand. Options to improve performance on extensive, largely native pastures in northern Australia may depend more on exploitation of selective grazing behavior, decreased grazing pressure, and encouragement of legumes in the sward than on introduction of new, “improved” forage varieties. For example, inclusion of leucaena in tropical pastures has been critical to the ability of many producers to achieve annual body weight gains of up to 300 kg in cattle on pasture ( R. A. Hunter, unpublished observations).

Proposed expansion of irrigated cropping systems in the wetter tropical and subtropical regions of Australia should generate new opportunity feeds ( Cribb et al., 2009). Collocation of intensive beef finishing enterprises also could take advantage of new and existing (e.g., sugarcane, banana) residues and co-products in northern Australia. For example, in most years, sugar mills in north Queensland produce more than one million tonnes of molasses, of which only about 15 to 20% is used for stock feed. Research has demonstrated that feedlot diets containing up to 65% molasses as a primary energy source can support body weight gains of 1.5 kg/d in Brahman steers, with no negative effects on cattle health or product quality ( R. A. Hunter, unpublished observations).

Genetic Improvement of Cattle Performance and Health

Genomic selection, now widely used in the European and North American dairy industries, offers great promise for increasing the rate of genetic improvement of beef cattle, especially for complex, hard-to-measure traits such as feed efficiency, environmental adaptability, reproductive performance, and disease resistance. In addition to expanding the complexity and range of traits that could be included in breeding indices, molecular breeding should greatly accelerate genetic progress through the opportunity to identify superior animals at birth, or even at the embryonic stage.
The cost of genotyping, although still prohibitive to widespread industry adoption, is rapidly declining. Of greater concern is the availability of phenotypic data of sufficient quantity and quality across multiple traits to validate reliable molecular genetic selection tools. The difficulty and expense of assembling these data is exacerbated by the likely need to create breed-specific tools because of the substantial genetic variation among the major beef cattle breeds. In the meantime, marker-assisted selection tools for individual traits such as meat tenderness and polledness are already available. Others, such as those for age at puberty and postpartum anestrus interval, are in advanced stages of development and validation.

Reproductive technologies for delivery of superior germplasm, such as artificial insemination and embryo transfer, are not practicable for use in the extensive beef sector. Australian researchers are investigating the alternative possibility of modifying the genetic profile of bull semen by direct injection of testis germ cells from desirable donor bulls into the testes of recipient bulls. An example application would be the use of Brahman bulls with a portion of *Bos taurus* (e.g., Angus) sperm to achieve a partially crossbred calf crop under tropical conditions in which poorly adapted taurine bulls could not survive, let alone work (Figure 5).

**Improved Systems for Detection of and Response to Exotic Disease Incursions**

The development of molecular diagnostic tools based on polymerase chain reaction technology has greatly increased the speed, sensitivity, and accuracy of diagnosis of infectious diseases in livestock, including the exotic viral diseases most feared by the Australasian industries. Tests for most of these pathogens, such as the multiple strains of bluetongue virus, have been developed locally at the Australian Animal Health Laboratory and other Australasian laboratories. A major exception is the need to develop diagnostics for FMD in Southeast Asian laboratories because of a ban on introduction of the live virus into Australia and New Zealand. Ongoing research seeks to further improve the laboratory techniques and develop kits that are sufficiently accurate and specific for rapid, early diagnosis in the field.

The challenge of disease surveillance across the vast, sparsely populated landscape of Australia, especially at the northern border, demands increased public investment and improved integration of federal and state or territory resources. An emerging research focus is the development of techniques for the targeted surveillance and predictive modeling of risk factors that forecast disease emergence. For example, Australian scientists are using atmospheric dispersion models to develop a spatially and temporally explicit risk analysis for the movement of insect vectors known to carry bluetongue virus into northern Australia (Eagles et al., 2011). The capacity for disease surveillance and response also will be enhanced by the development of increasingly sophisticated National Livestock Identification System ear tags that can identify disease through changes in animal behavior and track animal movement.

Improved diagnostic tools and surveillance systems for detection of exotic diseases must be complemented by robust rapid-response strategies involving isolation of infected animals and targeted vaccination of potentially vulnerable populations. These strategies require the establishment of reliable and sophisticated communication networks among producers, veterinarians, diagnostic laboratories and public health authorities. An ongoing research priority is to develop improved vaccines that are safe, stable, effective, affordable, and capable of differentiating infected from vaccinated animals.

**Minimizing Environmental Impacts**

Current research to minimize the environmental impacts of the beef industry, particularly in northern Australia, has several major goals. First is the development of grazing and pasture management systems that are resilient to climatic extremes, that enhance cattle productivity, and that...
minimize land degradation and threats to biodiversity. For example, a 10-year grazing trial in the tropical savannas of north Queensland has clearly demonstrated the financial benefits as well as the multiple environmental benefits of good pasture management through long-term use of stocking rates more moderate than those used by many producers (O’Reagain et al., 2008).

Another major research goal is to reduce the contribution of enteric methane emissions by beef cattle to Australia and New Zealand’s total GHG inventories. Current work is focused on both assessment and mitigation of methane emissions. Recent research has shown that emissions from tropical forages are actually 30% less than previously thought (P. Kennedy, CSIRO Livestock Industries, St Lucia, Australia, and E. Charmley, unpublished data).

Australia and New Zealand have significant research programs on manipulation of rumen fermentation (e.g., Attwood and McSweeney, 2008), vaccination against ruminal methanogens (Wright et al., 2004), and genetic selection for low emissions in cattle (Hegarty et al., 2007) and sheep.

Although these strategies could have a major long-term impact, in the short term, real gains are being made in reducing the intensity of methane emissions, especially in extensive systems. Currently, Australian rangeland systems are associated with emission intensities of between 30 and 40 kg of CO₂-eq./kg of salable product. However readily adoptable changes in management practices, such as increased weaning and growth rates, are reducing the intensity of emissions, sometimes by up to 50% (Hunter and Niethe, 2009). Over the last 20 years, progress has already been made. Implementation of the Carbon Farming Initiative, currently going through the Australian parliment, should accelerate these gains.

Smart Farming Systems for Remote Management of Pastures and Animals

The isolation, scale, and employment challenges of the Australasian pastoral industries make remote management technologies an attractive proposition. Limitations in information technology and remote power generation are being overcome. In addition, necessary access of Australian properties to high-speed broadband will be achieved by a combination of fiber-optic connectivity via the National Broadband Network (http://www.dbcede.gov.au/broadband) and other solutions, such as CSIRO’s Ngara technology (http://www.csiro.au/science/Broadband-to-the-bush.html).

Existing technologies include the National Livestock Identification System, which relies on a low-frequency, passive radio-frequency identification ear tag with a unique identification number linked to a national database. This mandatory system enables trace-back and tracking of animals between farms, sale yards, and abattoirs. Development of a “smart tag” that carries all information about the animal will further improve this system for cattle monitoring and allow for the integration of various technologies on the farm.

Other technologies include satellite imagery to enable almost real-time monitoring of pasture growth and conditions on individual farms (Figure 6; e.g., Pastures from Space, http://www.pasturesfromspace.csiro.au/index.asp); devices for remote control, operation, and monitoring of watering points to enable automated drafting of cattle; and use of unmanned aerial vehicles for pasture assessment, weed control, and even mustering. We anticipate that the integration of data from these sources with remotely sensed data on animal behavior, atmospheric variables, and soil conditions will inform a wide range of management decisions, including cattle movement and grazing pressure, nutritional supplementation, veterinary interventions, breeding strategy, and marketing.

Whereas animal monitoring can be used to inform management decisions, remote animal control devices can be used for implementation (Figure 6). This technology relates the GPS position of the animal to spatially fixed coordinates on the ground (the control barrier) and modifies the behavior of the animal as it approaches the invisible barrier by eliciting an audio or electrical cue from a neck-mounted device. Current research is focused on reducing the size and optimizing the power supply and usage of these devices.

Conclusions

The projected continuation of increasing global demand for animal protein offers great opportunities for beef-exporting nations such as Australia and New Zealand during the next few decades. However,
the ability of the Australasian beef industries to take advantage of these opportunities while remaining environmentally and socially sustainable will face some formidable challenges and uncertainties.

Among these, the potential impact of climate change on the already dry and erratic climate of much of pastoral Australia looms large. If, as cautiously predicted, northern Australia maintains or increases its present average rainfall without becoming too much hotter, there may be significant opportunity to expand beef production in the tropics and subtropics. However, this will require widespread adoption of sustainable grazing management practices and, where appropriate, selective introduction of technologies such as mosaic irrigation to support the production of forage and grain crops for intensive feeding of growing and finishing cattle.

Other major challenges include the urgent need for the industry to address heightened public visibility and concerns about management, transport, and slaughter practices. In this regard, the Australian live export industry is especially vulnerable. Some of these welfare issues can be addressed by research and development, but the long-term solution also will require trade diplomacy to encourage beef-importing nations such as Indonesia to switch from live import to boxed beef. This, in turn, will require substantial investment in the transport and processing infrastructure in northern Australia.

Finally, prospects for growth in New Zealand beef and veal production will depend heavily on the future growth and structure of the dairy industry, by-products of which are the major source of cattle slaughtered for meat.

**Literature Cited**


Robert A. Hunter gained an honors degree in agricultural science (1970) and a PhD (1980), both from the University of Queensland. His professional career was spent with CSIRO serving at the Beef Unit (Townsville), at the Minerals Unit (Perth), and for 26 years at the Tropical Cattle Research Centre (Rockhampton). He was a deputy director of the Cooperative Research Centre for the Cattle and Beef Industries, and from 1993 to 1996 and then 2001 until his retirement in 2007 was office-in-charge of the CSIRO Laboratories in Rockhampton. Hunter’s major areas of scientific expertise are in the fields of rumen nutrition and the metabolic regulation of growth in beef cattle.

Jason A. Archer has qualifications from the University of Adelaide (B Ag Sc, Hons, 1992; PhD, 1996) and the University of New England (Grad Cert Management, 2000). After completing his PhD, he was employed as a research scientist in NSW Agriculture, based at Trangie, New South Wales, where he worked on beef cattle genetics. He was project leader for Feed Efficiency within the Australian CRC for Beef Quality from 2000 to 2002. In 2002, he joined AgResearch Ltd., New Zealand, where he worked on genetics, nutrition, and management of deer and beef cattle and was team leader of Farm Systems. Archer has recently been appointed as portfolio leader of Meat & Fibre Paddock to Consumer, with responsibility for overseeing the AgResearch portfolio of work relating to on-farm and off-farm research and development for the sheep, beef, and deer sectors in New Zealand.