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AGRICULTURAL SCHOLARSHIPS

Ecosystem Services for Pastoral Business

Timothy D. Smith

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Nuffield Canada Agricultural Scholarships

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3. Achieve personal development through travel and study
4. Deliver long-term benefits to Canadian farmers and growers, and to the industry as a whole

Applications are due annually by June 30th.

SCHOLAR PROFILE

Tim Smith was awarded a Nuffield Canada scholarship in 2016, sponsored by Glacier Farm Media, to research the valuation of ecological goods and services provided by cattle ranching and the public support for ranchers under social license for sustainability. He believes there is much to be learned in studying how other cultures recognize and value the pastoral benefit ranchers provide to society. His interest is in how public support develops to maintain and improve sustainable habitats in soil, air and water ecosystems on agricultural land and how that support is transferred at the farm gate to the stewards of the land. Tim believes that good stewardship of the land will be increasingly important to the fiscal health of Canadian cattle country. His Nuffield travels have taken him to Ireland, France, Germany, Poland, Czech Republic, the U.S., Kenya, South Africa and Australia. His research is timely in the sense that consumers not only want affordable food, but also food that is raised in a humane, ecologically sound and sustainable manner.

Tim and his wife, Tammy, own and operate Ribstone Crossing, a century cattle ranch located in east central Alberta that his grandfather established in 1915. After pursuing and obtaining a Bachelor of Science at the University of Alberta and subsequently pursuing his dream of following his ranch heritage, Tim rebuilt and grew from a small portion of a divided farm to a successful, thriving 800 head cow/calf operation. He and his family also own a custom forage harvest business, harvesting several thousands of acres of cropland each year.

Tim enjoys serving the agricultural industry through his involvement in the Alberta Beef Producers (ABP) where he sits on the board of directors, chairs the cow/calf council, and also serves as an ABP delegate nationally to the Canadian Cattlemen's Association. Tim is always eager to host visitors, both international and domestic, at his family ranch, and tour them around the beautiful Nose Hills country where his prized possession, his Angus cattle herd, roam the native prairie grasslands.

ACKNOWLEDGEMENTS

I would like to sincerely thank Glacier Farm Media for sponsoring my research and for their generous support of the Nuffield Canada program. The incredible opportunity to learn and travel with some of the world's best agricultural minds, develop life-long, long-distance friendships and deepen my understanding of global perspectives and world agricultural challenges is only made possible through generous financial sponsorship. To Nuffield Canada and the scholarship committee board members, I extend my humble gratitude for believing in me and bestowing upon me this great honour and privilege we call Nuffield. I am forever grateful for the chance to broaden my horizons and dig deeper into the questions rattling through my brain. I would especially like to applaud Nuffield Canada Executive Director Shannon McArton for her continual encouragement and deadline reminders, without which this report may never have come to fruition. I'd be remiss not to extend my deepest appreciation to Sarah Megens for her effort in reviewing and editing this report and to the members of the Reports Committee Cheryl Hazenburg, Steven Wolfgram, Brent Wright and ED Theresa Whelan for their contributions and support to see this report "cross the finish line".

Many thanks to Nuffield Australia for organizing a top-notch Global Focus Program (GFP) to Africa in spring 2016. The quality and intensity of this rigorous tour will never be forgotten and was certainly a highlight in every way. Thanks to all the people who willingly gave of their time, knowledge and expertise throughout the tour and throughout my study year—David Stanley, Sarah Flowers, Wayne Dredge, Rob Small, Michael Horscht, the late Gilfrid Powys, Sam Archer, Sue Ogilvie, Natalie Williams, Geoff Park, Anna Roberts, Michael & Anna Coughlin, Kilter Rural, Howard Smith and Jodie Dean.

Sincere thanks to my fellow Nuffielders worldwide who opened their homes to me during my travels, namely, William Harrington, Lachie Green, Angus Duddy, Fred Appleton, Adam Coffey and Dennis Holder. The networking, camaraderie and hospitality while away from home was a shining light and truly appreciated. It was also my pleasure and privilege to host several Nuffield travellers at our Alberta ranch, and I treasure the fond memories of each of you.

No words can adequately express my heartfelt gratitude for the support of my tireless cheerleading team at home. My daughter, Katelyn, has been my technological whiz and consultant and has spent countless hours picking up the slack on the ranch while, at the same time, working towards a nursing degree. My son, Jaydon, along with finishing his agricultural management studies at Olds College, managed to cope with the daily grind of work on the farm as well as managed our harvest crew team while I was away on my travels. His work ethic and vision know no bounds. To Riley, our diamond in the rough, who fed cattle and helped his mom while I was away on my Global Focus Program, your contributions did not go unnoticed. Lastly, to my biggest fan of almost 30 years, Tammy, I couldn't have done it without you. Your positive encouragement at every turn, your organizational and navigational skills and your exceptional abilities as a farm wife and manager in my absence made this experience an enjoyable, peaceful reality. You welcomed strangers into your home with grace and hospitality that was second to none. Thanks Smith team! You are truly amazing and deeply appreciated!

SPONSORSHIP

Many thanks to my key sponsor, Glacier Farm Media. Thank you for your continuing interest and support of Nuffield Canada; for recognizing and investing in global travel as an integral part of learning and for assisting me with the financial means to undertake my research project; as well as for the media exposure I received through Glacier Farm Media publications.

The Foothills Forage and Grazing Association is highly recognized in the industry as leaders of soil health, and for educating the producers. Thank you to Foothills Forage and Grazing Association for your generous support of my Nuffield research. I look forward to working with you in the future to promote the cattle industry.

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EXECUTIVE SUMMARY

My objective in writing this report is to increase awareness of cultural valuations of ecosystem services and how ranchers can leverage environmental benefits on their land. One major challenge looming for cattle producers is the competing alternatives for land use predominantly because of lower comparative valuation of monetary return per acre of pasture. To address this challenge, ranchers require payments for the provision of ecosystem services from society to balance between dollars' worth of production and the investments farmers contribute to enhancing ecological goods and services on their land. My report on the interface between cattle production and nature will clarify how nature underpins all economic benefits with ecological services it provides through improving soil health, water and air quality, and pollination potential for all major food crops.

It is important to point out that ideas in this report and the information covered were gleaned from global travels. Ecosystem service provision, which is not commonly understood, can sometimes be difficult to recognize. Inspiration to apply and amplify environment enhancing practices at my Alberta ranch are made more confidently because of my Nuffield journey. This report is prepared with my view as a cattleman with the purpose of providing an information resource for cattle producers as well as those seeking to better understand the nature of ecosystem service supports.

I toured several countries in search of where nature's ability to contribute might be compromised and how cultural valuation of nature's services are shaping life on Earth. In this report I demonstrate how developed countries are best suited to meet the expected increase in demand for meat protein. Less developed countries will increasingly strain their ecosystem services if cultural and social values are waylaid to hunger concerns. Control of food waste and the cost of food needs to be valued enough to thwart ecological degradation.

Varying levels of cultural valuation, biodiversity, and economic stability are covered in this report and I will show how scientific knowledge and technology may influence behavior changes. Others travelling my same steps will uncover more nuggets of wisdom of ecosystem service provision and valuation as awareness grows.

I have found that some cultures show greater support to producers for providing different tiers of ecosystem services. The social respect of valuation in those cultures can challenge the public coffers and hold back changes in favour of including more primary producers. This was a global theme—that producers must educate each other and work together on best management practices. The greater the number of primary producers and employees involved, the greater the cultural and social integration with environmental benefits.

DISCLAIMER

This report has been prepared in good faith but is not intended to be a scientific study or an academic paper. It is a collection of my current thoughts and findings on discussions, research and visits undertaken during my Nuffield Canada Agricultural Scholarship. It illustrates my thought process and my quest for knowledge. It is not a manual with step-by-step instructions to implement procedures.

Neither Nuffield Canada nor my sponsor, nor any other sponsoring body guarantees or warrants the accuracy, reliability, completeness or currency of the information in this publication nor its usefulness in achieving any purpose. Readers are responsible for assessing the relevance and accuracy of the content of this publication.

Scholar Contact Details
Timothy Smith
Box 72
Coronation, AB
T0C 1C0

Phone: 1-403-575-2246
Fax: 1-403-575-2246
Email: tntsmith_40@hotmail.com

In submitting this report, the Scholar has agreed to Nuffield Canada publishing this material in its edited form.

NUFFIELD CANADA Contact Details
Email: exec.director@nuffield.ca

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1.0 INTRODUCTION

There is consensus that the population of the world is increasing exponentially and will surpass 9.7 billion people by 2050. The demand for food will increase; however, the demand will be tempered by environmental constraints. Sustainable food production is like a three-legged stool. The three legs of sustainable production that control which way the stool leans are environment, economics, and social factors.

This report attempts to address issues of competing land usage within a sustainable beef production model. Consideration for economic and social factors while relying on good stewardship places huge valuation constraints on ranches. With cultivation of marginal soils competing with ecological goods and services provision within agricultural systems, I see a social shift in favour of a preference for land conservation and preservation developing that will compete with agricultural access to natural capital. Access to natural capital – in this case, land - has allowed cattle ranchers to increase production capacity. While the marginal lands and riparian areas are the target of choice for conservation groups, there is no doubt that cattle industry capacity is being eroded in favour of increased land conservation and biodiversity.

Cattle producers can remedy these tensions through research, market developments and by adopting innovative means to enhance profitability *and* provide ecosystem services that extend far beyond simply supplying high-quality beef products to global food supply. Ecosystem services are often interdependent and bundled, affecting multiple outcomes. The challenges of increasing the food supply to meet growing demand can be met in many ways through the functioning of bundled ecosystem service provision. The financial returns of bundled ecosystem services drive the industry forward by meeting the growing demand for sustainably raised grass-fed beef, for where there is money to be made, there is the desire to pursue greater returns on labour and investment.

Ecosystem service investment can take many forms. The aim of my Nuffield journey was to travel globally to discover how other countries are shaping and implementing ecosystem service investment. I chose to travel to Ireland, France, Belgium, USA, Czech Republic, Germany, Austria, Kenya, South Africa, Australia and New Zealand. I met and conversed with scholars, politicians and cattle industry stakeholders abroad to gain an understanding of the various supports available at the farm and ranch level. I wanted to gain an appreciation of how other countries value the cattle industry.

Of particular interest was how strong the social license for ranching was worldwide, particularly in beef exporting countries like Ireland and Australia. I suspected that the European Union was no longer supporting grain over-production that had dramatically suppressed world grain prices in the 1980s. I needed to know where and how their support had shifted to greater stability and societal influence of decisions at the farm level. I focused my studies on identifying how other cultures recognize and value the benefits of pasture-based cattle ranching and the use of ecosystem service programs. With a better understanding of how public interest influences

management decisions at the ranch level, the beef producers of the world will find their way to a more sustainable future.

2.0 Linking Ecosystem Services to Social License

Increasing demand from competing interests on our finite land base places pressure on the land's capacity to provide ecological services. A growing global population and the coinciding increase in consumption continue to deplete our natural resources. This has resulted in greater pressures exerted on environmental attributes which in turn, affect our sustainability more broadly. The environmental goods and services offered by naturalized landscapes promote biodiversity and strengthen our resilience. Resilience means having a buffering capacity to absorb shocks and maintain adequate functioning of environmental systems. For sustainability, we need to balance environmental, economic and social factors that promote ecosystem resilience. This section explores the relationship between ecosystem service provision and social license as it relates to Canadian ranchers in the international marketplace.

2.1 Defining Ecosystem Services

Ecosystem services (ES) is defined as the benefits humans receive from nature that support our health and well-being. They fall into four categories, as shown in Figure 1 below, in the widely quoted Millennium Ecosystem Assessment of the United Nations in 2005.[1]

[1] Goddard, T., & Raven, K. Ecosystem Services and Agriculture, 2017.

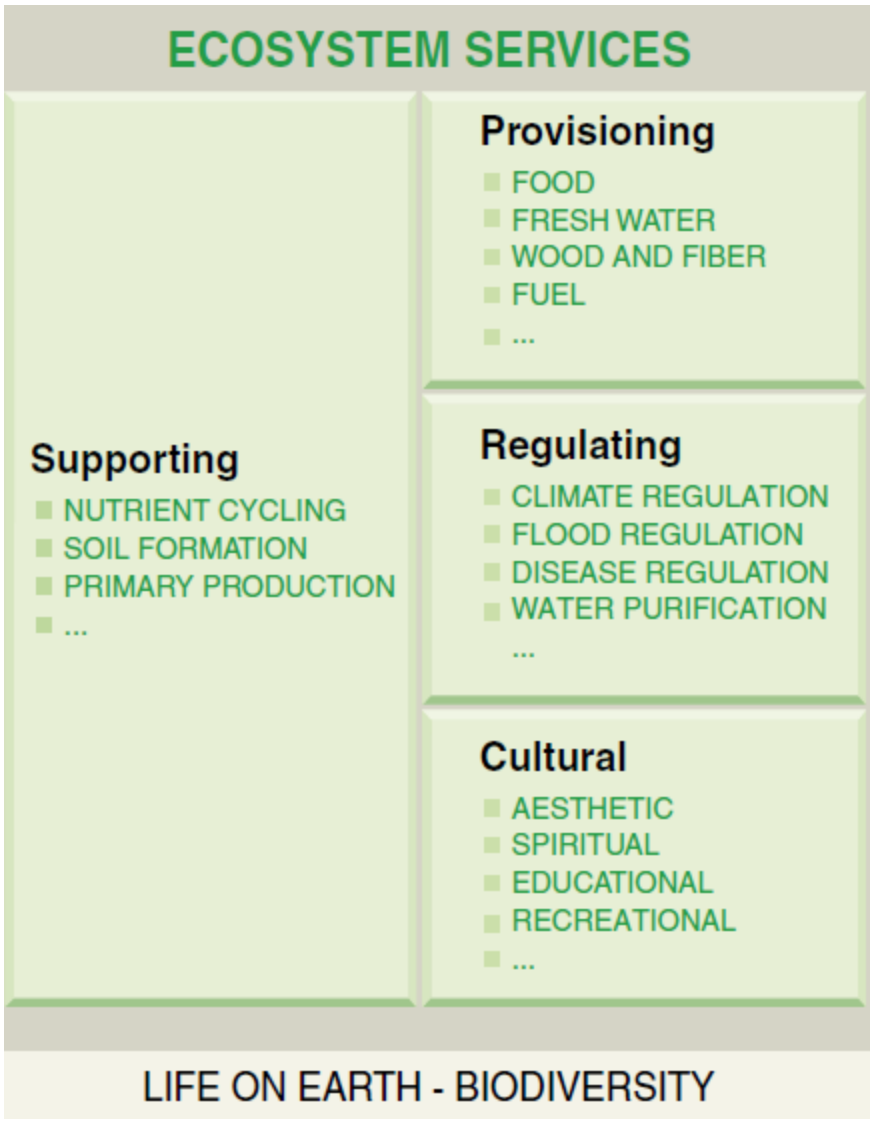


Figure 1 Ecosystem Services From: Ecosystems and Human Well-being: Synthesis (p vi), by Millennium Ecosystem Assessment, 2005, Island Press

Often multiple ecosystem services (ES) can be bundled together and add value to one another but other times, ES are in direct competition for limited resources. Scarcity of resources has allowed market-based approaches to develop.[2] Market-based approaches allow businesses, government and the public to analyze land-use trade-offs and evaluate the land's environmental goods and services potential. This market-based approach also affords policy makers the opportunity to monetize the benefits of ES and balance economic development goals with goals related to protecting and improving the environment.

[2] Anderson, T. When Traditional Regulation Fails: Using Market-Based Instruments to Improve Environmental Management. Silvacom, 2016.

Alberta Innovates and the Ecosystem Services and Biodiversity Network offered the best explanation of capitalizing environmental services that I would like to cover in this report. The report, titled *Creating Ecosystems Services and Biodiversity Markets in Alberta* offers seven reasons for businesses to incorporate ecosystem services:

- Enhance social license, which can open new markets;
- Reduce the risk of changes in the flow of ecosystem services they rely on;
- Improve landscape management to gain approvals from regulators;
- Develop new sources of revenue;
- Understand the monetary value of everything nature produces;
- Ensure sustainable development; and
- Leave a healthy planet for future generations. [3]

These seven reasons apply to all businesses in principle, but for this report, I am concerned only with those that deal with pastoral lands. Nonetheless, these reasons can be applied even more forcefully to the biodiverse rangelands and pastures used by cattlemen for provision of their livelihood.

2.2 Understanding Social License

The ability to operate a cattle ranch like mine relies on a social license of public trust. Social licence must allow producers to collect funds necessary for the maintenance and/or establishment of ES. To strengthen sustainability in the beef industry for cow/calf producers, social, economic and environmental supports need to be built into our operations.

[3] Alberta Innovates. Creating Ecosystem Service and Biodiversity Markets in Alberta. Ecosystem Service and Biodiversity Network, 2016.

Figure 2 Feeding cattle on my ranch in central Alberta. Source: Tim Smith

It is fundamental that producers are engaged in the development of sustainability programs destined to strengthen our industry. Producers have their finger on the pulse of the industry and understand how scarce resources can be managed for maximum benefit. From soil to sward, the strength of our cattle industry lies within its producers.

Figure 3 Nuffield CSC in Cavan, Ireland

2.2.1 Enhancing Social License Through Ecosystem Service Provision

During the 2016 Contemporary Scholars Conference presenter Ed Kee, who at that time was serving as the Delaware Secretary of Agriculture, told us that agricultural land per capita will be halved in the next 20 to 30 years, and that every 20 years, the number of people depending on one farmer for food doubles. Certainly, the eyes of social license will be increasingly piercing.

The role of agriculture is changing, and it is not just about food production anymore. Competing interests for access to agricultural land for energy, biodiversity and carbon sequestration are just the tip of the iceberg. As ranchers, our social license to operate will be more sustainable and flexible if we minimize the regulations that force us into partnerships with others.

It is incredibly important that cattle and sheep operations maintain a strong sense of social support. Their acceptance is challenged by special interest groups, namely environmental and animal rights activists, and other competing industries. I will discuss the benefits of animal welfare and environmental stewardship later, however, there are still competing agriculture industries vying to be the protein source of choice for the consumer.

3.0 Challenges and Opportunities

3.1 Shifting Consumer Preferences

The global middle-class (those that have been the main consumers of beef) will increasingly be from non-Western cultures. The rising global middle-class may not view the beef industry in the same positive light.[4] The social license of the ranching industry faces numerous challenges, particularly those promoted by individuals and groups who advocate against meat consumption in favour of plant-based diets. These groups offer arguments against animal agriculture that I argue are occasionally misleading, arriving at pre-ordained conclusions designed to tell consumers what is good for them. This is despite the fact that investigation into the health claims of plant-based "meat" suggests that the highly processed nature of these products and the amount of saturated fats and sodium they contain probably leave them less healthy than good quality lean ground beef.[5]

The plant-based meat movement has gained a lot of traction in the past few years. In response to the rise in popularity of plant-based proteins, the federal government announced $150 million in funds to support the Protein Industries Supercluster (PIC). The PIC is a publicly funded, not-for-profit innovation super cluster mandated to help position Canada as the global leader in

[4] Nagel, S. Canadian Beef Industry Conference. 2018.
[5] Bharti, B. "Vegan Beyond Meat burgers are just ultra-processed patties that can be bad for our health." National Post. August 7, 2019.

plant-based food production through investing in research and industry development. The program is built upon the premise that plant-based foods offer Canada an opportunity to be a global leader in environmental sustainability, a position that is celebrated on their website.

As a rancher, it's disheartening to encounter the increasing politicization of dietary preferences. As a cattle rancher, it feels like certain groups of activists are attempting to enter into a psychological weaponization of "shameful" habits by assigning a moral value to food preferences.

We often hear of how harmful animal agriculture is to the environment, and that consuming too much meat contributes to poor health. Advertisers seek to increase corporate profits by influencing consumer decision-making in their favour through emotionally compelling messaging. In this case, promotional campaigns for plant-based meat are attempting to align their processed, less nutritive choice with positive thoughts, feelings, and emotions about health and the environment to make more money for their companies. Rather than selling nourishment value, they promote the products with a message of "doing the right thing." With that mindset, they market to change eating preferences to positions where we feel we are judged or punished by society. They are marketing so that consumers feel poorly for choosing real meat and are proud for choosing their products instead.

The goals of the companies driving the plant-based meat "revolution" – referring here to plant-based proteins manufactured to mimic the appearance, texture and flavour of animal protein - are ambitious. David Lee, CFO for Impossible Foods, has been quoted to say, "we are bringing technology to an industry starved for innovation…we want to replace livestock." Their marketing efforts are trained on capturing the hearts and minds of consumers by arguing that they offer a morally superior product based on a series of assumptions that may not be true.

Despite the provocative advertising campaigns, I believe that the enthusiasm for fake meat will eventually yield to healthier choices by consumers. There is nothing like real meat, and it is important to acknowledge that moderate consumption of animal protein in modern diets continues to offer nutritional benefits. A study published in the European Journal of Epidemiology concluded that "more frequent childhood meat-eating was associated with better cognition through to old age."[6]

The well-respected work of Dr. Sangita Sharma, from the University of Alberta, Department of Medicine researcher of Indigenous and Global Health, has enlightened my knowledge that the problems associated with under–consumption of red meat protein are not restricted to developing countries.[7] Her studies indicate that the majority of inner-city youth in Alberta and often indigenous youth populations are not meeting daily recommended consumption levels of

[6] Heys, M., Jiang, C., Schooling, M. et al. *"Is childhood meat eating associated with better later adulthood cognition in a developing population?"* European Journal of Epidemiology, 25(7): 507–16. July 2010.

[7] Sharma, Sangita PhD*., "The Nutritional Benefits of Red Meat: Why do we need to eat more Beef?"* University of Alberta, Department of Medicine. 2017.

meats or alternatives. She believes that these populations would benefit with improved health if they consumed an additional 85g/day of beef. Beef contains essential nutrients including protein, iron, zinc, selenium, and vitamins B3 and B12, which are necessary for proper body function. These are readily available in red meats and should be eaten according to the Canada Food Guide recommendations. According to Dr. Sharma, underconsumption of red meat protein has resulted in undernourished youth. Some of the impacts of insufficient red meat protein are:

1. Iron deficiency: tiredness, suboptimal growth and development, lower school attainment, dizziness, and pregnancy complications with poor fetal development;
2. Zinc deficiency: weight loss, poor wound healing, stunted growth, poor immunity, inadequate reproductive development; and
3. Vitamin B12 deficiency: lack of energy and muscle weakness, trouble with concentration and memory, loss of appetite, weight loss, nerve damage, numbness, depression.[8]

Dr. Sharma also referred to Canada's Food Guide and stated that beef is the most cost-effective source of the dietary needs that it contains. This is a compelling argument that the provisional ES is benefiting humans with health by providing nutritious food from nature. According to the World Health Organization, over 30% of the world's population has anemia.[9] It is the only nutritional deficiency that is prevalent in both developing and industrialized countries and affecting so many people that it is now widely recognized as a public health epidemic.[10]

In terms of the environment, it could be argued that compared to sustainably raised beef, plant-based meat substitutes in supermarkets compromise biodiversity in ecosystems through the proliferation of intensive monoculture cropping systems. Production of beef using non-saleable grains and biodiverse pasture (on land that is not suited to annual cropping) is arguably a better ecosystem service choice for society and should be recognized as such.

While the environmental impacts of plant-based protein are as yet unclear, the financial costs to the consumer are more obvious. The retail price for Beyond Beef products is up to four times the price of traditional ground beef according to The Market Insider. "Consumers that want it don't seem to be fazed by the price." This can only be explained by emotion, not reason.

The environmental concerns of consumers present an opportunity for Canadian cattle ranchers. Consumers are the most powerful stakeholders in the food chain because consumers bear the cost of production models that support sustainable farming practices. Governments of developed nations make decisions that appear to be supportive of grain and livestock production at lower levels than recent production practices have allowed. The social pressures to protect our waters are suggesting less inorganic fertilizer use. This alone will temper grain yields as some of the higher yields we have obtained were reached with the use of fertilizer at

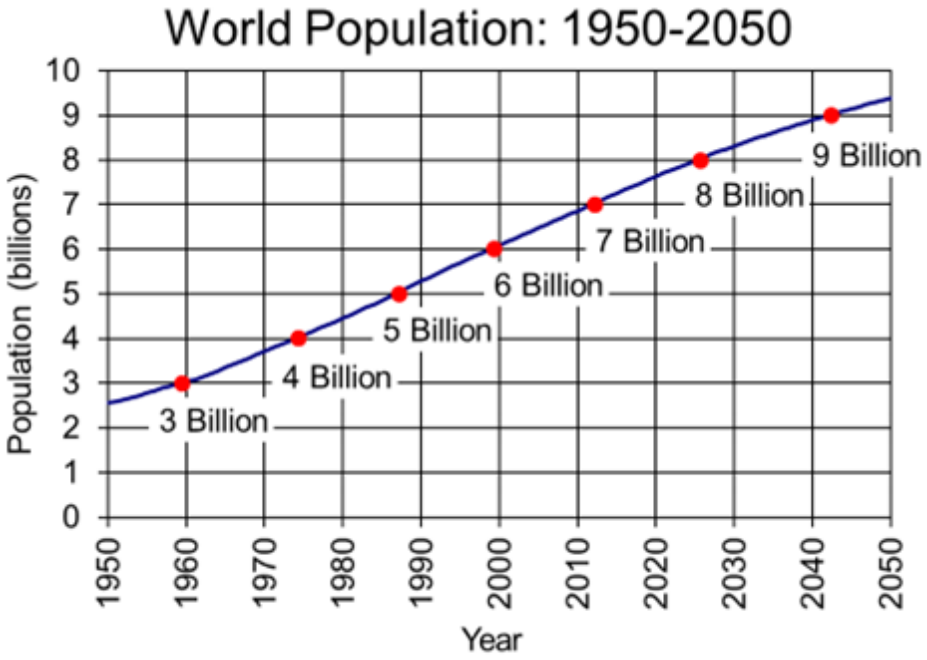
[8] Ibid
[9] Ibid
[10] Ibid

unsustainably high rates. Soil health improvement stands out as an area where production yields will grow slowly and sustainably.

We are witnessing steady improvements in energy efficiency, greenhouse gas reduction, nutrient cycling, and feed efficiency of livestock. Philanthropic and environmental interest groups have, in the past, been some of the greatest supporters for alternative land use policies. Politicians and regulators have a strong will to support biodiversity and bundled ecosystem services that offer benefits to society and promote human wellbeing. This is occurring at many levels and demonstrates the opportunity for ranching businesses to incorporate ecosystem services into their management plans. Secure social license, reduced risks, and regulation-approved landscape management with new sources of revenue should provide sustainable beef producers a healthy and profitable future.

3.2 A Growing World Population

At the 2016 Contemporary Scholars Conference in Ireland we were introduced to the concept of an expected population growth on earth. Expectations were that by 2050, there would be twice as many people in Africa and four times as many people in Asia as there are now. It was stated that there are about 158 births per minute, and of them, 154 are in developing countries. Earth currently has 800 million people who are chronically hungry, and 1.4 billion who are overweight. One-third of the 1.4 billion overweight persons are obese. Furthermore, nearly a third of food produced on earth is wasted (as a direct food source). Developing regions spend up to 75% of household income on food. Currently, China has about 1.5 ha/capita and this is expected to diminish to 0.5 ha/capita by 2050. Every 20 years, the number of people depending on one farmer doubles. There were also hopeful messages that healthier living and less waste was the increasing trend. One example was that consumption of soda (pop) has decreased by 25% in the United States over the past two years.



Source: U.S. Census Bureau. International Data Base. December 2013 Update.

While consumers are making their own choices, there is a larger, much more powerful push brewing in the information I have read from the UN. China's meat consumption has doubled over the past decade. This has had great health benefits for China.

As China has historically been a lower-income country, its consumption of beef (and animal products) would be in the 25–50 g/day range for much of the population. The UN's FAO is proposing that the 2050 international target for animal product consumption be 90 g/person/day. This is effectively doubling the current consumption in the least affluent countries of the world. China has already found that mortality from all causes and especially stroke, was lowest in areas where consumption is highest. That is where more people are reaching the beneficial level of 90 g/day of animal protein than ever before. The demand for beef in China is growing exponentially with the explosive growth in middle income families, driving in for better health and taste reasons.[11]

3.3 Sustainability and the International Beef Market

The Chinese demand for meat is outpacing current domestic production volumes, making it the world's largest importer of beef and veal by volume. It's a trend that is expected to continue in

[11] McMichael et al. Food, livestock production, energy, climate change and health. 2007.

the medium-term. This huge and growing market presents a trade opportunity for beef exporting countries such as Canada. Fortunately, the Canadian beef industry is internationally competitive however there is much we can learn from competing export markets such as Australia. In my discussions with Howard Smith, the Cattle Council of Australia President, I learned that the Australian livestock export trade was one economically significant alternative to domestic processing.

The Australian live export market creates opportunities for diversification and opens competition for Australian cattle producers at home and abroad. It was encouraging to read in Beef Central (January 17, 2018), where James Nason told of the first live cattle shipment from Northern Australia that left for China with 1600 steers aboard. The Queensland beef producers that I visited will surely be encouraged with sea shipments, like this, of livestock from Townsville to Shanghai now being an option. The Australian port of Townsville is massive, and capable of handling a million cattle per year.

This significant export opportunity to China was made possible because specific biosecurity, animal welfare and health protocols were established and met. These conditions also include provisions for harvesting within a maximum time to processing, and stock free of hormonal growth promotants. The presence of an Australian government-accredited veterinarian on board for voyage is another factor that likely contributed to securing the deal.

Figure 4 The Live Export Vessel the Ocean Ute at the Port of Townsville

Biosecurity, animal welfare and health protocols similar to those implemented in the Australian live-export market are primary examples of what Canadian beef producers need in order to

remain internationally competitive. According to a report published by BUSH AGRI Business, 75% of Australian beef producers, who comprise about half the beef herd and land base, are operating in unsustainable economic conditions.[12] The Australians are very aggressive at marketing their beef as they are an export-driven market that will continue to compete with Canada.

In response to this, an over-arching international export criterion has been developed at the Global Roundtable for Sustainable Beef with the Canadian Roundtable for Sustainable Beef furthering Canadian-pertinent criteria developed from our Canadian beef industry stakeholders. As I discuss below, the membership of the Canadian Roundtable for Sustainable Beef includes ranchers, processors, retailers, and conservation interest groups who highlight the importance of environmental performance while recognizing economic viability and social license for Canadian cattle ranching.

4.0 Cattle Ranching and the Environment

4.1 Climate Change and Greenhouse Gas Emissions

According to climatologists, methane, nitrous oxide and carbon dioxide are greenhouse gases when released into the atmosphere. While not at the top of the daily list of priorities, cattle producers realize that loss of these gas emissions are diminishing return on their investment in nutrients, energy and organic matter. Ranchers are aware that these greenhouse gas losses undermine efficiency and economic viability. These production losses occurred as ranches mobilized natural resources, namely, land, water and soil nutrients with the goal of healthy cattle production. Wastage gases are viewed as detrimental to environmental sustainability even if sustainability of the food production has not been targeted for improvement and may be relatively very acceptable when properly scrutinized through the lens of peer comparisons on other food choices.

A 2015 Chatham House report has labelled “livestock responsible for over 14.5% of GHG emissions globally” and suggests the developed world should contribute to GHG reductions by eating less meat.[13] However, it is my belief that even if consumption levels dropped to the recommended levels of the FAO at 90 g/day from the current 250 g/day consumed in western diets, that livestock (particularly cattle) numbers DO NOT need to decrease in the developed world at the expense of environmental degradation elsewhere to meet the growing health requirements of the developing world for meat protein. The developed world is far more prepared to deal with methods for decreasing cattle emissions than the developing world. While I’m sure the authors of the report have the best of intentions, they have neglected much in their assumptions of sustainability. For example, the prairie grasslands in North America

[12] Holmes, P.& McLean, I. Australian Beef Report: Identifying the Barriers to Profitable Beef Production. 2017.
[13] Wellesley, L., Happer, C., & Froggatt, A. Changing Climate, Changing Diets: Pathways to Lower Meat Consumption. Chatham House: London. 2015

evolved for thousands of years providing nutritious diets for 70 million buffalo. Ruminants evolved with the grasslands and the rumen microorganisms. The fact that people allow cattle to continue with this grassland management hardly equates to an anthropogenic methane belch being any different than that of their close cousins, the prairie buffalo, which persisted for thousands of years sustainably.

Modern agriculture impacts the environment in many ways and a broadening awareness of agriculture's contribution to climate change through GHG emissions (primarily methane and CO2) has prompted greater scrutiny and with it, more ambitious GHG reduction proposals. Many strategies to reduce greenhouse gas (GHG) emissions include significant focus on reducing consumption of animal products in high-income countries to the level of low-income consumption levels[14] which, as noted above, continues to grow. For cattle producers, the hyperfocus on emissions attributed to agriculture has fostered alarmism and prompted calls for often unrealistic curbs on animal farming while neglecting meaningful opportunities for agriculture in general and ranchers in particular to reduce emissions and actually contribute to carbon sequestration and climate mitigation.

There are many aspects of both reducing GHG emissions and beef consumption that need to be considered, and I believe we should take a multifaceted approach that goes beyond simply reducing consumption. Industry driven opportunities for reducing GHG emissions per unit of cattle production include:

1. Sequestering carbon (avoiding deforestation), restoration and increase of organic carbon and soil organic matter.
2. Reducing methane emissions from enteric fermentation (efficiency and diet).
3. Reducing methane emissions with better manure and biogas management.
4. Reducing nitrous oxide emissions with better use of nitrogenous fertilizer.

[14]McMichael et al. Food, livestock production, energy, climate change and health. 2007

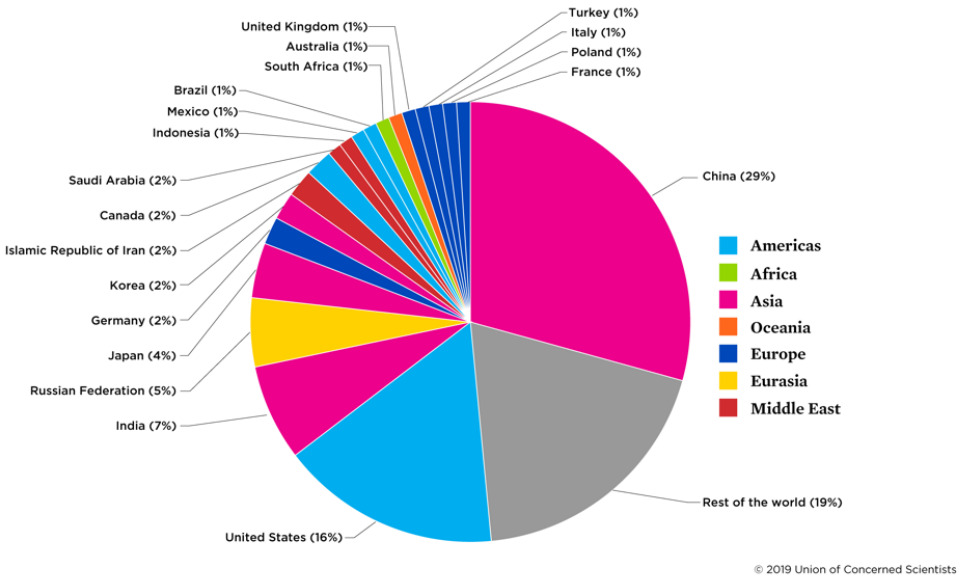


Figure 5 Greenhouse gas emitters by country

The world livestock sector, which for my report concerns only beef cattle, faces the difficult challenge of having to reduce its GHG emissions while responding to a significant demand for livestock products (projected to be +70% between 2005 and 2050) that is driven by a growing world population (9.6 billion by 2050) and rising levels of affluence and urbanization.[15] Demand for meat is expected to grow by 58% from 2010 levels.[16] However, avoiding higher emission intensities in systems characterized by low productivity through low digestibility, less efficient herd management and lower reproductive performance will become increasingly challenging, particularly in cultures that use animal draught power and manure as fuel.

[15] Food and Agriculture Organization. A Global Assessment of Emissions and Mitigation Opportunities, 2013.
[16] Ibid

Figure 6 Silage storage for biogas plant in Czech Republic

For the cattleman, emissions are a loss of energy, nutrients and soil organic matter. Their loss undermines efficiency and economic viability. Loss of methane is a loss or waste of the feed energy, and this damages production. This production loss came after mobilizing natural resources such as land, water and soil nutrients. These wastages can be viewed as detrimental to portions of environmental sustainability. The following practices can help reduce methane emissions:

1. efficient use of manures;
2. the use of dietary lipids to improve energy efficiency of feeds and reduce enteric emissions;
3. sowing of legumes;
4. semen sexing; and
5. use of growth promotants.[17]

[17] Food and Agriculture Organization. A Global Assessment of Emissions and Mitigation Opportunities, 2013.

Figure 7 Silage generating biogas in Czech Republic

Many strategies to improve mitigation practices are likely to be profitable in the midterm, but public policies should ensure that cattle producers can finance initial investment and possible risks. Less affluent countries are particularly vulnerable due to lack of credit and risk-adverse strategies. Microfinance for small scale farms to support adopting new technology would be useful for less affluent countries. Where large public mitigation benefits are received, subsidies for new technologies and practices can be used to lower excessive short to midterm costs. To be effective and fair, mitigation actions also need to be global.

Figure 8 Biogas electricity generator in the Czech Republic

4.2 Soil Health

Agricultural soils provide ecosystem services that are maintained by prudent soil health management best practices. Soils are home to more than one-quarter of all living species on earth.[18] For obvious reasons of size and abundance, we have not yet seen or studied much of what is under our feet.

Healthy soils have that pleasant humus smell about them. Some of the most memorable moments of my global focus tour were stopping at different fields throughout Europe, Africa, and Miami, USA. It was quite a sight to see my fellow scholars always digging into the soil and raising a handful to their nostrils while they evaluated quality by the humus smell. The stronger the decaying organic matter smell of humus, the greater the attraction. We were all of the opinion that greater humus levels were most likely a great determinant of profitability. An interview with soil biologists has noted that "focusing on soil health has led to a microbial gold rush of information to manage."[19]

[18] Cork, S. The Nature and Value of Australia's Ecosystem Services: A Framework for Sustainable Environmental Solutions, 2012.
[19] Rance, L. Farmer's Focus Must Shift from Yields to Soil Health. Glacier Farm Media, 2017.

Soils are home to a vast number of living species and "hold more carbon than the atmosphere and all vegetation combined."[20] Soil organic matter is 58% carbon. At the Alltech conference I attended in Lexington, Kentucky, Pearce Lyons stated that "a 1% increase in soil organic matter holds 20,000 gallons (of carbon) per acre."[21] Also, we were thankful to hear of the rich supply of antibiotics that have been discovered in soil. I was told there were 25 new antibiotics isolated in the soil of researchers' back yards and so many more to come that will surely be used to control pathogenic disease in the future.

Indeed, keeping soil alive and healthy on our ranches is the foundation we must strive for. Living soils in a good state of health will have great diversity of microbes along with air and moisture. According to Peter Rutherford's book, *Let's Talk on the Dirty Secrets of Healthy Soil*, "healthy soils are impacting human health".[22] Rutherford states that "We need the 95% of soil microbes that are beneficial to aid us in immune function" and "these 95% keep the 5% harmful ones in a controlled balance." "Food grown in higher humus organic matter soils seem to create a more alkaline forming response in our bodies and that healthy people tend to be more alkaline." Also, "mycobacterium vaccine (from soil) has been shown to boost the levels of serotonin in humans. Microbes like these in soil can make us feel healthy." "Humus improves nutritional value of food as mineral storage in plants improves with humus." Perhaps there are particular microbes behind every important mineral. "Humus acts as a carbon filter tying up heavy metals and chemical residues." Humites made from decaying humus containing humic and futuric acids which are useful for making otherwise unabsorbable nutrients absorbable, aiding in cellular detoxification processes.

4.2.1 The Benefits of Grazing on Soil Health

According to well-known grazing management guru Allan Savory, grazing animals and grasslands are interdependent. Throughout his research, Savory frequently observed that soil and land quality deteriorated when grazing animals were absent.[23] To qualify this statement and his regenerative agriculture grazing movement, cattle can have negative effects on soil health if rest periods between grazing are insufficient. It is highly promoted that mob grazing or high-density grazing, over short periods of time, while leaving one-third of the above ground biomass intact and following grazing with long periods of rest is known to be the most economical and environmentally friendly. This mimics the natural development under which grasslands worldwide were formed. Throughout history, dense herds (in Canada, buffalo) grouped tightly for safety from predators, grazed heavily and moved on frequently with varied length return

[20] Cork, S. The Nature and Value of Australia's Ecosystem Services: A Framework for Sustainable Environmental Solutions, 2012.
[21] Lyons, P. Alltech One Conference. Kentucky, 2016.
[22] Rutherford, P. Let's Talk on the Dirty Secrets of Healthy Soil. Healthy Soil Impacting Human Health, 2018.
[23] Savory, A. Savory Global, 2016.

times. This practice also promotes good biodiversity of pasture land and increased stock weight sums.[24]

One more production practice I found interesting can be read about in the second chapter of Soils for Life where the authors discuss a biodynamic soil preparation that involved developing an innovative and cost-effective way to address nutrient deficiencies and improve soil fertility. This particular example involved highly concentrated and cured rumen organisms providing an inoculant of species naturally occurring in ruminant intestines introduced to the soil through an aerated water system. This inoculation increased rumen organisms and resulted in greater utilization of feed intake conversion to protein in the animal rather than being lost to excretion in urine or manure.[25] This case study offered an interesting concept but was not quantified with scientific analysis, providing anecdotal success that was not backed with cost/benefit analysis. My thoughts are possibly an improvement in relative feed conversion but with limitations on intestinal receptor sites being maximized. There would still be by-pass protein excreted, and without cost/benefit analysis, it is difficult to support adoption.

There are important benefits of time controlled planned grazing through some form of rotational or cell grazing that applies stock density to match carrying capacity over shorter times while controlling grazing period to utilize all forage species. Determining pasture rest and recovery by adhering to plant growth recommendations provided by local forage or range specialists should provide positive environmental outcomes as environmental services. The benefits of cattle to soil health development are the results of manure application, trampling of the biomass litter, and release of root material that decays when top growth is removed. “There are 5 billion acres of grassland globally. Grass has four times as much organic matter below ground as above ground, and one hectare of healthy functioning perennial pasture fixes more carbon in the soil than a hectare of rainforest.”[26]

The following is a list of some of the benefits proper grazing provides:

- Increased organic matter and soil organic carbon;
- Promotion of aggregate formation;
- Retention of soil moisture (which further reduces production risks);
- Improvement of water infiltration and ground water recharge;
- Provision of nitrogen, phosphorous and trace elements in available forms;
- Promotion of soil microbial activity to aid nutrient cycling;
- Reduction of soil acidity;
- Increased yields with groundcover quality and quantity of encouraged preferred species;
- Minimization of weeds and undesirable grazing plants;

[24] Soils for Life. Innovation for Regenerative Landscape Management: Case Studies of Regenerative Landscape Management in Practice. Outcomes Australia. Manuka, 2012.
[25] Ibid
[26] Lovell, T. Soil Carbon—Putting Carbon Back Where It Belongs—In the Earth. 2011 https://www.youtube.com/watch?v=wgmssrVInP0

- Increased long term grazing capacity;
- Provision of feed supply indicators early to help adjust stocking rates;
- Prevention of soil erosion; and
- Capture of sediments in riparian area management.[27]

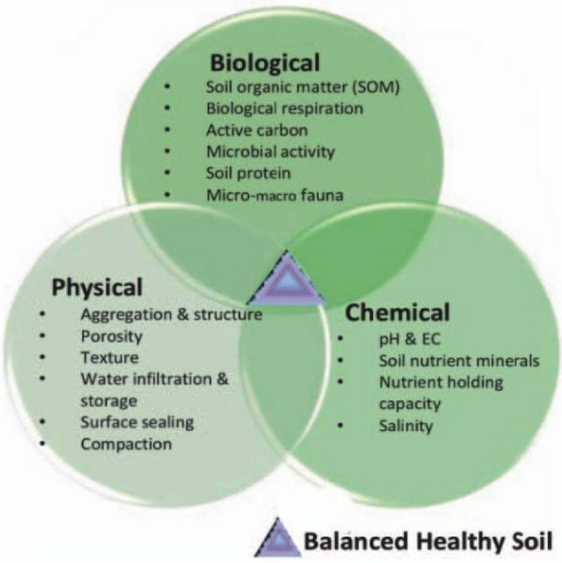


Figure 9 The three components to healthy soil

4.2.2 Beneficial Burns

One must not overlook the ecosystems that benefit from a prescribed burn. In the driest areas of Florida ranch country, both the Archibald research station and the large cattle ranch that I toured, supported and practiced regular burns as a means to bolster productivity, soil carbon, and wildlife. The burns were also required to maintain wildlife that depended on them for survival.

Plant communities in many areas have developed based on a response to burning. Birdlife, like quail, require reasonably open land and benefit greatly from burned land regrowth. I believe that fire in a controlled setting is a tool that has the ability to manage different ecosystems, but I fear that public opinion on its use stifles it.

[27] Ibid

Figure 10 Beneficial burn in Australia

5.0 Agricultural Approaches to Address Climate Change

5.1 International Policy Directives

Recognition of the environmental and health implications of food production underlies the integrated approaches of new nutrition science based ag policy. The European Union's Common Agricultural Policy (CAP) includes, where possible, policy directions about food, nutrition, environment and health. "Key findings suggest the need for communication and agreement of clear, high level nutrition guidelines, clarity on the EU mandate to address nutrition related health concerns via CAP policy… stronger civil engagement… and addressing worldwide views on agricultural trade versus public health."[28]

The Food and Agriculture Organization (FAO) has outlined the factors needed to improve decision making; these include political will, better policies, making more informed choices about livestock policies in support of sustainable food production, economic growth and poverty alleviation.[29] The factors identified by the FAO will need to target the less developed countries because that is where demand for meat will increase most rapidly. The Global Agenda of Action from the FAO supports sustainable livestock sector development through catalyzing and guiding stakeholder action toward improved practice and more efficient use of natural resources.

[28] Food Policy 59 (2016): 12-23.
[29] Food and Agriculture Organization. A Global Assessment of Emissions and Mitigation Opportunities, 2013.

Meanwhile, the report by the Energy Environment and Resource Department at Chatham House referenced earlier in the report is more narrowly focused on the reduction of meat consumption. They proposed doing this through the following manners:

1. Capitalizing on public procurement policies to promote plant-based diets in schools, hospitals and long-term care homes;
2. Advocating that the relative price of meat be raised as the most effective means of changing consumption habits;
3. Using any opportunities to lobby elected representatives to remove any direct or indirect subsidies to the livestock sector while subsidizing plant-based alternatives, or intervening to increase the price of meat through means such as a carbon tax;
4. Offering policies and funding to support research and development that pulls promising technologies to market such as lab grown meat. [30]

According to the FAO's Global Agenda for Sustainable Livestock's Theory of Action draft for Restoring Value to Grasslands "developed countries of the United Nations have committed to provide $100 billion/year by 2020 mainly by the Green Climate Fund Channel of support and many countries are developing NAMA's relating to livestock and grassland management."[31] In the United States, for example, American consumption of beef has fallen 40% since 1976 and has now reached 54 pounds of beef/person/year. These are consumption levels comparable to 100 years ago. There are 10 million fewer cattle slaughtered from a herd that is almost 40 million head smaller. Each carcass yields 23% more meat than in 1976. There have been tremendous gains in both feed and water use efficiency in the last 40 years.[32]

On January 30, 2018, the Alberta government announced $81 million in joint funding with the federal government spread over four years through the Climate Leadership Plan with the aim to improving sustainability by addressing climate change and reducing costs to increase competitiveness.[33] Alberta ranchers are optimistic that climate leadership will recognize what the World Wildlife Fund already has: The Great Northern Plains have had 53 million acres of grassland plowed down since 2009. Between 2009 and in 2015, 3.2 billion metric tonnes of CO2 emissions were released.[34] Cultivation of grassland results in the loss of anywhere between 30 to 50% of the sequestered carbon. Done well, pastoral beef production offers an alternative land stewardship model that supports climate resilience.

[30] Wellesley, L., Happer, C., & Froggatt, A. A Changing Climate, Changing Diets: Pathways to Lower Meat Consumption. Chatham House: London. 2015.
[31] Wilkes. Global Agenda for Sustainable Livestock. Food and Agriculture Organization. 2014.
[32] Kunzig, R. The Carnivore's Dilemma. National Geographic. 2014.
[33] Carlier, O. Minister of Agriculture. Government of Alberta. 2018.
[34] World Wildlife Fund, 2016.

5.2 Farm Level Approaches: Herd Management

The Australian government supports funding of eligible producer practices under the Australian Government Emissions Reduction Fund's Beef Herd Management Methodology. I was fortunate to see an impressive leucaena grazing plantation funded by credits from lowering the intensity of livestock emissions as a result of grazing on this high producing legume tree. Reducing methane emissions from grazing stock has the greatest potential because the largest source of cattle emissions is from enteric digestion of higher fiber feeds. I would expect that mitigation strategies applied to cow/calf herds will be multifaceted and will include incentivising genetic improvement of feed efficient livestock and livestock with increased fertility and number of calves weaned. These are the strategies that can be influenced by genomic sequencing. Hybrid vigour can also be selected more reliably with DNA analysis to determine the best heifers for survival and efficacy. The selection process will enable producers to select stock genetically suited to their individual ranch environments.

Figure 11 Leucaena in Australia

Additional climate change mitigation strategies for cow/calf herds include:

1. Extending grain finishing to decrease GHG emissions intensity –lower enteric methane production, shorter time to market, and less methane from manure;
2. Feeding oilseed by-products which can reduce GHG emissions by 8%;
3. Feeding earlier-cut (less mature) forages which improves nutrient value and can decrease GHG intensity; and
4. Planting grass on cropland to form a carbon sink for sequestration. [35]

[35] Beauchemin et al. Mitigation of Greenhouse Gas Emissions from Beef Production in Western Canada—Evaluation using Farm-Based Life Cycle Assessment. Animal Feed Science and Technology. 2011 p. 663-677.

Perhaps there are ways of encouraging methane oxidation in soil. Soil that is biologically active can oxidize all methane produced by stocking (up to one livestock unit/ha.)[36] There may be ways to select and utilize methanotrophic bacteria in ever increasing activity to reduce emissions. Their activity is, however, reduced by nitrogen fertilizers, herbicides, pesticides, acidification and excessive soil disturbance. Improvement, selection and cultivating of these bacteria would be working with natural systems. We have all heard the saying that 'nature finds a way'. All systems on earth can be held in check by natural forces, some just need a little tweaking to work the way we would like them to.

6.0 Policies and Programs to Enhance Environmental Services

6.1 International Biodiversity Preservation and Conservation Programs

To further my understanding of how other countries approach the relationship between animal agriculture and environmental conservation and biodiversity preservation, I had several discussions with the beef director for the World Wildlife Fund (WWF) of Washington, D.C., Tim Hardman. He expressed genuine concern about maintaining grasslands within the Northern Great Plains of North America as a shared interest between the public, environmental stakeholder groups and cattle ranchers, and recognized that well managed cattle herds, much like the herds of buffalo that roamed the plains generations ago, share wildlife habitats and can even provide environmental benefit.[37] Acknowledging this approach keeps the cattle industry and wildlife conservation groups working together to mutual benefit.

Figure 12 My Nuffield GFP group at the US Department of Agriculture building in Washington DC

[36] Jones, C. "Ruminants and Methane." Re-generational International. October 13, 2015.
[37] Hardman, T. Personal Communication, 2016.

We see this in Canada, too. As I've discussed, environmental services are dependent upon provision of some goods from natural resources, and those provisions are more secure with the support of strong and meaningful programs and policies. Canadian cattle ranchers understand that investing in responsible environmental stewardship makes good sense because it can have a positive impact on the bottom line. Cattle producers can find support from environmental stakeholder groups by making on-farm investments in biodiversity preservation and conservation. Many environmental services are supported financially by organizations such as Ducks Unlimited Canada, Nature Conservancy Canada and ALUS Canada (discussed below) who, like WWF, also see value in preserving our wildlife habitat lands for the public interest.[38] These groups also develop strategic philanthropy and business engagement strategies for climate change and promote the adoption of science-based greenhouse gas (GHG) emission reduction.

The relationship between ranchers and conservation groups is not always easy. This could be seen no clearer than on my Global Focus Program (GFP) visit to Kenya where I met Gilfrid Powys, a well-seasoned senior citizen maintaining ranch practices and adapting to change more than most ranchers. One of his greatest challenges was conservation legislation that forbade killing wildlife, and in particular, carnivorous predators. As a result, his sizeable cattle ranch of 400 - 500 head of mature cows needed to be confined to corrals and guarded every night or they stood less than a 10% chance of survival. This rancher witnessed great changes in his time—from the days when a well-targeted rifle would control predators, to now, where the carnivorous predators have the upper hand. Kenya has reaped great rewards from ecotourism and safaris where the ecosystem services promoting wildlife habitat and safari hunting expeditions have brought new streams of tourism revenue to the country. The Powys ranch has capitalized on this as well. More recently, Gilfrid's daughter, an accomplished botanist, developed a successful tourism lodge by repurposing living quarters on the ranch that were built for science conventions as tourist accommodations.

Much of the international land conservation initiatives are driven by international organizations. Nature Conservancy, a global ENGO, has a presence throughout all the countries that I travelled on my GFP. Gilfrid's ranch bordered an enormous cattle ranch that had recently been purchased by Nature Conservancy. That neighbouring ranch will likely never see cattle again. An ancient stone wall erected for miles along the perimeter separated the two ranches but proved inadequate when marauding elephants smashed through the wall to get to his cattle watering hole, causing much destruction and the loss of Gilfrid's life.

[38] Scott, T. Personal communication. 2017.

Figure 13 Burhan Cattle in Kenya at Gilfred Powys' ranch

Wildlife preservation efforts, while well-intended, present unintended—and often undesirable--consequences for producers such as damage to crops and harm to livestock. An emerging concern of ranchers is the need for predatory kill compensation for livestock loss. From the literature I have reviewed, I am shocked that the number of predator kills in Alberta is escalating.[39] Fortunately, compensation payments have also increased. For example, $100,000 was paid out for primarily wolf and grizzly bear kills in 2000. By 2015, $800,000 of compensation was paid out. The levy on hunting licenses has funded 52% of the compensation program with the rest being paid by the federal government funneled through the province. This program is run by the Alberta Conservation Association.

Figure 14 Wild Zebra at Gilfrid's Ranch

[39] Derworiz, C. Predatory Compensation Program for Ranchers Helps Conservation Efforts: Study. CBC, 2018.

6.2 The European Union Common Agriculture Policy

The two objectives of the Common Agriculture Policy (CAP) in Europe are:

1. Complete beneficial effects on the environment with a reduction in agriculture production based on income forgone and loss incurred.
2. Contribute to agricultural diversification and rural development.

Since the 1970's, the CAP throughout the EU was subsidizing production. On our Global Focus Tour, we visited with Michael Horsch in Eastern Germany, where he manufactures and sells Horsch line of farm equipment to producers. Horsch explained that the CAP subsidies of the past have caused overproduction. European overproduction that Horsch referred to reminded me of listening to the news on CBC in the 1980s when grain markets around the world suffered a tremendous loss in value and farm grain receipts in Canada plummeted leaving many farmers unable to pay their expenses. This, as Horsch explained, was a result of subsidies rewarding production volumes of commodity grains in Europe. Subsidized reward of commodity production resulted in excessive fertilizer use, ultimately causing nitrogen and phosphate leaching into ground and surface waters. Things have changed since then, as Horsch explained. Now, corner to corner, all-inclusive planting, with no buffers around riparian areas, and excessive fertilizer use are now discouraged. Presently, CAP reform has resulted in direct payments per hectare with the ability to increase subsidies with the green payment by respecting three environmental requirements which are:

1. Maintenance of permanent grasslands,
2. Maintenance of ecological focus areas, and
3. Maintenance of crop diversification.

This green payment is 30% of the first portion of direct payment but can be lost if protocol is not followed.

One conversation that I had with an Austrian farmer was that his Austrian regulatory burden felt crippling to farming. He believed in a simpler model and envied ours. Of course, there is push back from agribusiness characterized by intensifying conflict with conservationist interests resulting in decreased production subsidies that previously encouraged fertilizer use.

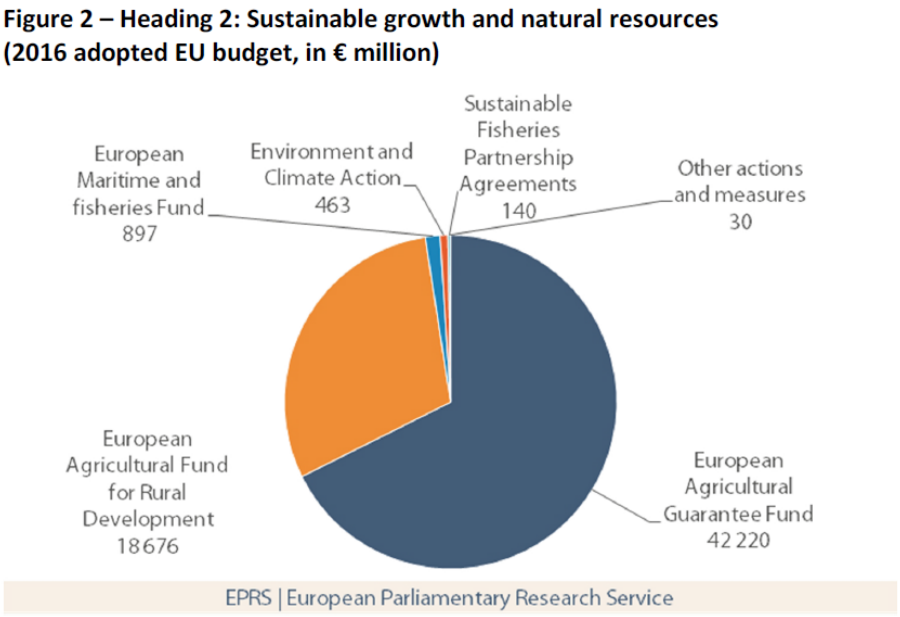


Figure 15 Breakdown of the CAP

Conservation interests are gaining in strength in Europe. The Living Land Coalition launched by WWF, Birdlife Europe and the European Environment Bureau are calling for further agricultural policy reform.[40] This recent development represents the largest combined influence in history. To date, 22% of total CAP budget is dedicated to measures encouraging biodiversity. With many large conservationist influencers uniting, measures to enhance biodiversity will likely represent an even higher percentage of the CAP budget in the future.

6.2.1 CAP and Farm Profitability

With the CAP effort to decrease synthetic fertilizer use, I believe Horsch's comment to our group that, "The world grain supply will likely never be as high as recent past levels because high fertilizer use is not allowed now under CAP regulation to decrease fertilizer runoff." Lower grain volumes will result in higher grain prices and I believe we have seen this in North America since 2014. Higher grain prices and lower grain volumes will reflect in lower profitability of cattle feeding generally, until higher cattle prices at a time of low supply result in driving production cycles ahead to increase numbers.

Aiden Connelly, chief innovations officer for Alltech spoke at our Contemporary Scholars Conference in Ireland, 2016. Connelly spoke of the CAP of Europe today being in a poor position to leverage food policy. He reported that two-thirds of all farms in Europe will need a new

[40] World Wildlife Fund, 2016.

owner in the next decade, and that social and environmental support are selling a detrimental food policy. He told me that before subsidies, Irish beef farms were losing 103 Euros per acre. I was later told that Ireland relies heavily on meat export.

I trusted Connelly's comments more once I attended the Alltech "One" Conference in Lexington, Kentucky. Here I was better able to appreciate Connelly's comments in the view of Alltech, where accomplishments in nutrition and nutrigenomics were breaking new ground. For example, the Alltech product organic "Sel-plex" (selenium) had shown proven results of replacing vast antibiotic usage. Alltech studies had shown different nutrients effects on a variety of gene expression traits. Their studies had identified gene markers for nutritional deficiency likelihood and subclinical disease states. With the knowledge that Alltech had, it is no wonder the newest push for reform in CAP is for nutrient value of food subsidy. According to Connelly, animals need to increase selenium in their diets for us to eat quality food with enough nutrients.

6.2.2 Collaborative Approaches: Involving Youth and Community

The EU CAP program is making a strong effort for funding youth investment and rural development programs. These programs include sustainable measures going significantly beyond the greening requirements that are under direct payments with special funding for High Environmental Value Farming (organic would classify). The budget of each Rural Development Program reserves 30% or more for voluntary measures that are deemed beneficial for the local environment and climate change. This is cost shared funding by the EU with member states (countries). Effectiveness of Agri-Environmental programs are influenced by farmer training and cultural activity. Collaborative schemes involving several farms gain more farmer trust. Environment and people working together as a unit and it is their community who can offer the balance.[41] The Burrenbeo Trust, a landscape charity in West Ireland offers cultural ES support with 10-week primary school education programs to introduce high nature value farming to the students. Through the BurrenLife program, in the same Trust, experts in high nature value farming work with animal farm management plans where they monitor farms with scoring systems that incentivize farmers toward goals that deliver higher payments due to their increased ES value.

The involvement of the community and youth are often the backbone of the many varied success stories I came across or heard about in my study travels. Organized groups around watersheds, regional landscapes and wildlife often were the catalyst for changes at the ranch level. The support they provide and the credibility they are warranted help build social license for ranchers and that helps to ensure the continuation of the programming.

The Canadian situation is similar. In the beef sector, our producers have rallied around riparian area protection, and many have worked with Ducks Unlimited. Elsewhere, it has been

[41] Williams, E. La Canada. Newsletter of the European Forum on Nature Conservation and Pastoralism. 2017.

established in southern Alberta that judicial orders under the Species at Risk Act have far superior results when handled by groups like Multisar (discussed in more detail below), which partners with landowners to conserve grassland species-at-risk in Alberta. Often, we find that the presence of an at-risk species on a ranch is a direct result of positive management practices with the mutual benefit of preserving that species. By working together to clarify the beneficial management practices, we can help species at risk survive.

6.3 Improved Landscape Management in Canada

Regulators and policy makers with keen environmental conservation policies are eager to see the environment upheld or maintained, and there are always competing influences vying for natural capital. Competing interests for natural capital can be found within agricultural production on land suitable for crop production, often even on marginal lands. Pastoral grazing, the focus of this report, occurs on land not suitable for crop production as this land is often the most affordable and most suitable, given there are fewer competing interests within agriculture.

Occasionally, when annual cropping returns are good due to commodity price increases, this gives economically perverse incentives to farm marginal soils. Often, large parcels of land have been cultivated on the Canadian Prairies, only for short-term gain at the expense of lost soil organic matter (carbon), poorer water infiltration and holding capacity, and nearly permanent loss of great biodiversity.[42] This is worsened by the fact that when grain prices are high, cow/calf production returns are often low. Poorer quality feed grains are used most often to finish calves raised on our prairie grasses to desired carcass weights where packers can optimize returns. As cattle feeders are margin operators, if profits are low, they bid the calf prices lower, effectively putting the burden of losses directly onto the cow/calf producers that are living off the returns their grasslands provide. This further creates an environment where marginal lands are exposed to greater returns from grain production than can be obtained by grazing and as a result, we often see grasslands ploughed under.

6.3.1 Land Use Framework in Alberta, Canada

In 2008, the Alberta government brought forward the Land Use Framework (LUF) and began policy development to manage population growth, while accommodating social, environmental and economic outcomes. The LUF left gaps in policy areas relevant to farmers such as agricultural land fragmentation and coordination of surface and sub-surface use. This was addressed in 2009 with the Alberta Land Stewardship Act (ALSA) which provided a suite of conservation and stewardship tools including:[43]

- transfer of development credits to redirect development to more suitable areas;

[42] Sparrow, H. Soil at Risk: Canada's Eroding Future. 1984.
[43] Alberta Innovates. Creating Ecosystem Services and Biodiversity Markets in Alberta, 2016

- conservation offsets to counterbalance the effects of activities through use of particular environmental management practices;
- tractable credits separate from land interests;
- exchange formation with credit related and market facilitation factions.

The ALSA also enables tools that provide for the direct protection of agricultural lands for environmental, natural, scenic, or aesthetic value.[44]

6.3.2 Alternative Land Use Services

The face of production is changing and environmental services are a feature of production worthy of marketing like any other. Ranchers recognize the value of doing the right thing, but not necessarily in the context of a public good or service. Programs are emerging in Canada, such as the Alternative Land Use Services (ALUS) program, that recognize ranchers for their contributions to sustainability through environmental improvements on their properties.[45] These new programs encourage rancher participation by offering financial incentives for farm-level activities that promote conservation and biodiversity.

The aims of these programs include:

- improving the land for the farmers and their families, but also for their greater community;
- allowing producers greater management choices for their marginal lands;
- creating bundled ES such as cleaner air, cleaner water and greater biodiversity;
- keeping livestock from accessing sensitive areas including creeks, lakeshores, dugouts, sloughs, steep banks and treed areas, using fencing.[46]

6.3.3 Multisar: Partnering with Landowners to Conserve Grassland

The Multisar program of Southern Alberta is a collaboration between agencies and landowners (including cattle ranchers) that seeks to protect vulnerable species-at-risk through voluntary stewardship programs covering over 473,400 acres. By offering free assessments and working with landowners to establish and implement Beneficial Management Practices (BMPs), Multisar recognizes the valuable role that ranchers play in maintenance of our native grasslands and the species that live there. Proponents and participants of the program witness not only the protection of species-at-risk, but also net positive gains for agricultural producers.

[44] Ibid

[45] Blair, J. Stewardship Program Putting our Money Where our Mouth is. Alberta Farm Express, 2017.

[46] Blair, J. New Acre Program Produces New Kind of Commodity. Alberta Farmer, 2017, p.6.

The Canadian cattle industry protects large tracts of native grassland from greater threats of fragmentation and loss. The Canadian Cattlemen's Association (CCA), through funding received from the Species at Risk Partnership on Agricultural Lands (SARPAL) program from Environment and Climate Change Canada made these programs possible and they are expanding. The beef industry leadership of CCA has brought these partnerships together, and they are functioning well. Multisar has a program focus on multispecies conservation at the landscape level that promotes stewardship through voluntary participation of landholders, and is a collaborative effort with them and the Alberta Conservation Association, Alberta Environment and Parks, the Prairie Conservation Forum, CCA, Alberta Beef Producers, Canadian Roundtable for Sustainable Beef, and Cows and Fish. My research has led me to believe that this well-rounded approach using habitat conservation strategies, developed collaboratively through detailed plans with the landholders, is the most effective tool. It needs follow-up evaluation and opportunity for adjustment, but it also allows for education, outreach and awareness programs along with research and monitoring. Some of the Beneficial Management Practices (BMP) embedded in the program are:

1. Salt, mineral and water sites away from edge of riparian area to create more favourable breeding conditions for Northern Leopard frogs and Great Plains toads;
2. Resting lands after grazing;
3. Unit grazing in vulnerable periods;
4. Patchy grazing is often good; and
5. Leaving 25–50% carry over to protect the plants and soil for good forage production the following year.

Some BMPs need to be site-specific and based on the unique land characteristics and priority species of area. For example, burrowing owls need heavier grazing in their habitat lands than do Bairds sparrows.[47] Working with Multisar and like-minded groups like Cows and Fish, can give ranchers confidence in their decision to invest and participate in collaborative environmental stewardship initiatives.

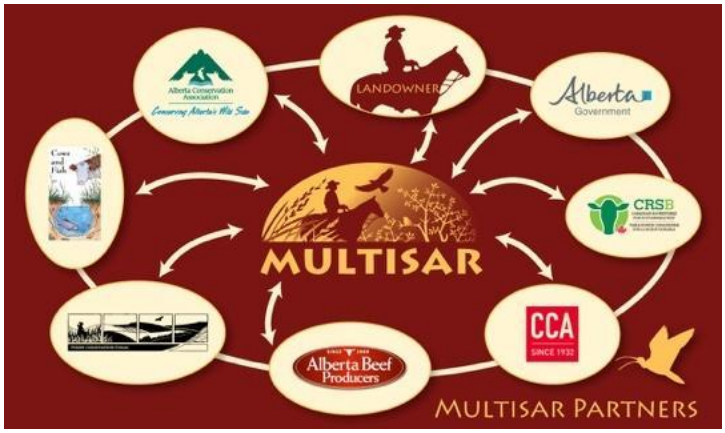


Figure 16 Multisar program (http://multisar.ca/who-we-are/)

[47] www.multisar.ca 2017.

7.0 Market-Based Sustainability Initiatives

There have been many payments schemes for ecosystem services in Canada and abroad although the political will to fund these programs is not consistent across time or geographies. Support seems to have waxed and waned in our homeland over the last 20 years. What has changed at the government-funded level appears to have been a shift of program delivery from federal to provincial governments. This makes good sense as activities at regional levels would be much better monitored, more responsive to local contexts, as the provincial government agencies are better able to keep their finger on the pulse. Programming has become much more focused, requiring Environmental Farm Plans as well as developed work plans. Currently, with less Best Management Practices funding overall, there is desire to only fund BMPs with the greatest environmental benefits or returns. The following section outlines various market-based sustainability initiatives I encountered in my study travels, and includes programs such as conservation easements and carbon offset schemes.

7.1 Land Conservation and Biodiversity Protection

7.1.1 Bush Tender Auctions in Australia

To obtain greater ecological goods and services in agriculture, the reverse auction process, like the Bush Tender Auctions in Australia, operates in five steps:

1. Target environmental objective and the BMPs to follow are clearly defined by the provider;
2. Producers with a clear understanding of processes to follow to implement BMPs, propose a payment (tender or bid) for the amount of money they would need to receive to implement it;
3. Proposals by all producers are analyzed and classified using benefit indicators that express the benefits received in relation to the price required;
4. Landholder with best proposals enter into contract with funder;
5. Landholder implements the BMPs agreed to and collects the agreed fee from the funder.

These auctions can reduce cost to government for implementing environmental programs. This system has worked well, providing it is competitive with enough landholders so that holdouts and collusion become less likely.[48] Appendix A outlines some of the lessons we can draw from the Australian conservation auction policy experience.

[48] Hays, F. Ecological Goods and Services Review. Alberta Beef Producers. 2012.

7.1.2 Tax Incentivized Ecosystem Services

Property tax incentives have been used in Manitoba to upgrade environmental management. For example, riparian tax credit programs have been used to promote good riparian management practices such as elimination of tillage in riparian area buffer zones, limitation of grazing and watering by livestock, and maintenance and establishment to control erosion. These benefits have been used by Manitoba farmers and livestock producers who made 5-year commitments to protect a riparian buffer zone on agricultural land. Direct tax credit benefits based on performing tasks for desired outcomes have been used, over time, to benefit rural economies and safeguard water quality.[49] In structures like this, overall property tax amounts due were decreased which may have other consequences. Organizations like Ducks Unlimited Canada have also been involved in municipal tax credit projects that resulted in significant levels of satisfaction among participants.[50]

7.1.3 Transfer of Development Credits

Transferring the development rights of a property is utilized by the government for control of land use planning. With developers willing to buy agricultural land, a development credit of value can be paid to landowners to restrict development in perpetuity and direct development into zoned areas where development would be permitted. “While transfer of development credits appear to be an effective method of preserving farmland, open space and natural resources, the reality is that they have been primarily effective within urban setting.”[51]

7.1.4 Conservation Easements

I foresee that conservation easement use will likely be one of the most influential tools that the ranching community in Canada may have. Our Global Focus Tour through Florida toured a ranch that had successfully navigated the murky waters of succession through the use of a conservation easement. Conservation easements are voluntary agreements between landowner and a qualified organization (as determined by government policy) to promote, conserve and enhance environmental, natural, scenic, and aesthetic value. Qualified organizations can be government, government agencies, local government bodies or registered organizations that meet criteria. The ranch in Florida that I toured was challenged in maintaining its ranching land base. Sibling shareholders had different personal goals with their equity and developers were knocking with sizable purses to buy land to supply housing for the urban encroachment of the heavily populated coastal area moving inland.

[49] Boaitey, R. & Goddard, E. Optimal Livestock Management for Improved Environmental Outcomes: How Effective are Carbon Offset Markets? 2016.
[50] Ibid
[51] Hays, F. Ecological Goods and Services Review. Alberta Beef Producers. 2012.

The state of Florida had the solution for that family ranch. They purchased a conservation easement from the family which allowed the ranch unchanged management operations on the land base. The government paid half of the cash value of the ranch real estate to stop urban encroachment into the pristine ranch land. Management was to continue as is by the family, with restrictions on changes like plowing up perennial pastures. Since the ranch was apparently located in a bear wildlife corridor, the interest of the government was to maintain an agricultural land base while preserving this bear wildlife corridor. Nature Conservancy was to monitor the conservation easement on behalf of the State of Florida. The deal allowed the establishment of a water reservoir which helped recharge aquifers in the area. That reservoir resulted in annual payments to the ranch manager and was not conditional to the conservation easement in any way but offered several thousand dollars of income based on water holding capacity. The siblings were bought out of their inheritance by the state funds and the ranch owner/operator was very appreciative and recommended this process.

Figure 17 My GFP Group standing in front of a conservation easement in Florida

Here in Alberta, there has been a significant purchase by Nature Conservancy Canada known as the Waldron Conservation Easement. In 2014, Nature Conservancy Canada (NCC) paid $15 million for a conservation easement on the Waldron Grazing Association lands. With these funds shareholders at the Waldron Grazing Reserve used their combined purchasing powers to buy an $11.5 million iconic ranch adjoining it. That newly purchased ranch was included in another conservation easement for $5.4 million with $2.3 million having been donated by the provincial and federal funding. This combined conservation easement is the largest purchase of development rights I have ever heard of. It includes 14,000 hectares of Alberta grassland, preservation of wildlife corridors, habitat land and water recharge areas. The shareholders of the Waldron have been able to grow capacity and preserve ranch livelihood that otherwise may have been diminished by development. Nature Conservancy Canada has conservation easements on 234,654 acres of ecologically significant land and watershed. With the amount of land lost daily to development, conservation easements offer hope to those ranches most vulnerable to development pressure.

Conservation easements can also be used to leverage support for policy-based land conservation efforts. Government policy to support agricultural land reserve areas such as the British Columbia Agricultural Land Reserve demonstrate success in protecting an agricultural land base in a populated area from encroaching development interest.

Conservation easements may also qualify for tax benefits as a portion of payment. For example, in the Ecological Gifts Program, private and corporate landowners who donate property through the program receive tax benefits such as a tax receipt for the full value of their ecological gift that can be applied against 100% of their net annual income. Corporate donors deduct the amount directly, while individuals use it to calculate a non-refundable tax credit. Unused portions of the receipt may be carried forward up to 10 years, and there is no taxable gain. Requirements of the Ecological Gifts Program require certification by the Ministry of Environment and Climate Change that the land is acceptable as ecologically sensitive. Approval of the recipient organization and fair market value is also required.

7.2 Carbon Pricing and Carbon Markets

7.2.1 Greenhouse Gas Offsets—Carbon Credits

"Putting a price on carbon is the most effective way to reduce GHG emissions."[52] There is great hope within the cattle industry that the negative effects of the carbon tax directly to beef producers as well as additional revenue generated by the tax may be distributed in support for incentivizing other ecosystem services contributions by the cattle sector. There are plans to develop Alberta Protocols for wetland management and native grass and rangeland management for tradeable GHG offsets. Conversion to perennial forages and pasture management protocols could also be indirectly credited to wildlife feed sources.[53] Alberta introduced a mandatory emissions trading scheme requiring large emitters of GHG to reduce by 12% every year. Those unable to do so can purchase 'Alberta made' carbon offset credits, which under legislation can only be derived from agriculture or farming. This has created a market for farmers to trade carbon offsets, generated through biological means such as tillage practices, beef cattle growth and conversion efficiencies that lessen the amount of carbon dioxide and methane production.

Very few livestock-based carbon credit schemes are operational in different countries. Appendix B outlines some of the livestock related carbon offset schemes operating around the world. The list includes:

1. Improved feeding practices such as replacement of forages with concentrates in diets, and addition of oils;
2. Use of dietary additives, growth implants, ionophores;

[52]65 Government of Alberta, 2018.
[53] Hays, F. *"Ecological Goods and Services Review."* Alberta Beef Producers. 2012.

3. Animal breeding—selecting for feed efficiency cattle (there is 15–25% less methane produced by low residual feed intake cattle versus high). This would lead to potential long-term changes in the herd; and
4. Management practices—keeping cattle on alfalfa and managing manure.

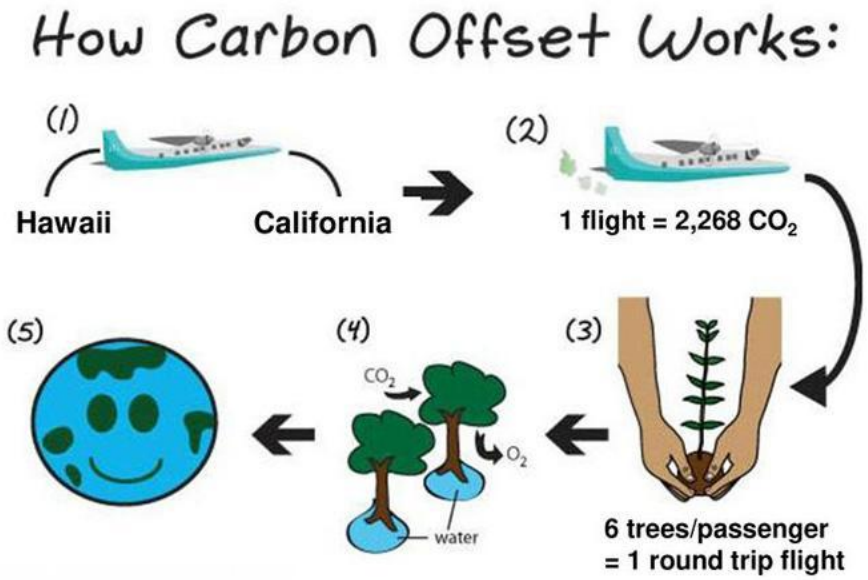


Figure 18 How carbon offsets work

7.2.2 Voluntary Carbon Offset Schemes

Beef cattle producers have the opportunity to claim offset credits for the adoption of new practices and methods of reducing GHG emissions. This can be done by selection of feed efficient cattle using the low residual feed intake (RFI) carbon offset protocol. This protocol would allow cattle owners to earn additional revenue from engaging in practices that reduce GHG emissions. The effectiveness of measures such as offset markets in reducing production-based emissions in cattle using important tools like genomics, and its ability to change the feed intake of cattle need consideration. The main advantage for breeding-related practices such as genomic selection for feed efficient cattle is the potential to introduce long term changes into the herd compared to shorter term use of additives which do not change underlying genetic composition permanently.

Large emitting firms in Alberta have the choice between adopting new technology or purchasing offset credits produced under eligible criteria or they are required to contribute payment into the Climate Change and Emissions Management Fund (CCEMF). For every tonne of carbon produced by big emitters in excess of their reduction targets, the $/tonne equivalent of the payment rate required by the government becomes the limit maximum that these industry businesses would consider paying for offset credits such as those the cattle industry could provide. This amount was at $20/tonne in 2016, but I anticipate this will rise equivalently to

match the carbon tax rate increases in our province. The New Democrat Party government was continually making every indication that this amount will slowly go up to $50/tonne in 2020. At rates that could approach $50/tonne there should be steady incentivization to purchase producer offset credits.

Government can underwrite the cost of genomic bulls as a form of indirect subsidy in return for limits on cow herd size that might increase natural tendency to utilize pasture but cause greater overall GHG emission. Given the price of carbon and the level of emissions on-farm, revenue from the scheme is currently inadequate to compensate producers from foregone revenue of raising a larger herd from increase stocking rate ability.[54] Paying a premium on calves to producers involved in this scheme may be required to further incentivize this.[55] Increasing the $/tonne of carbon could easily generate more value here too, but may be too large to be borne by large emitter funding without deep analysis.

Conversion of marginal croplands to well-managed perennial rangeland would increase carbon storage by 20-40 tonnes/ha. The carbon gain in cropland conversion to grassland would be achieved over many years and as such would be a difficult program to develop to work for large emitters, needing yearly results. This is also under consideration to qualify in the Alberta Offset Market. Our Alberta government does not issue offset credits. For compliance, a third party must verify that real offsets are measurable and submit their verified offsets.

7.3 Private Investment in Ecosystem Services

Impact investing in ecosystem service provision is most effective when cost/benefit analysis is holistically viewed. Development gains can provide revenue and a larger taxation base with employment and gross domestic product increase, but there are always trade-off losses such as wildlife habitat, carbon sequestration, disease regulation and biodiversity.

As a result of my research, I have come to believe that finance, including all banking and the function of credit creation and allocation have a distinct public purpose to serve and support society. I am convinced that those of us talented enough to use investor money to move forward in on-farm ecological service provision can be financially rewarded. The Savory Institute is a prime example. Led by an industry guru on regenerative, economically viable and socially sound management of the world's grasslands, the Savory Institute has trained countless managers on holistic management practices for rangeland. Having identified good managers, the Savory Institute has partnered with impact investor capital funds to create a limited liability company named Grasslands.

Grasslands LLC identifies attractive real estate investments, raises investor capital to purchase the assets, and then engages in long term management contracts on the acquired properties. Total land under management is at present 81,000 ha and growing. This may well be the future

[54] Hays, F. Ecological Goods and Services Review. Alberta Beef Producers. 2012
[55] Ibid

of ranching. I have attended the Alberta Beef Industry Conference and AgTech Conference and heard presentations on managers managing and owners owning. Impact investor money competes and drives good managers into business. My research led me to discussions with Sue Ogilvy at the Australian National University in Canberra, ACT, Australia.

Figure 19 Ms Sue Ogilvy

In her research, Ogilvy discusses the monetary value of various ecological services. She stated, "we need to identify and study leading practices of ecological capital management by farmers that achieve economic performance with enhanced or maintained ecological land bases."[56] Sue believes early adopters that value ecological balance sheets for agriculture sustainability will likely be impact investors seeking to generate improved environmental performance. There are leaders in every industry. If we strive to be leaders, we can do this on our own farms and ranches, we just need to be conscious of new developments and technology to stay in a position of strength.

Impact investors that are in tune to finding quality managers will surely compete in this field of investment to strengthen resilience of our industry and contribute to strong environment, social and values that improve resilience and sustainability in agri-business. Complacency, whether by cycle of demographics and aging or by not being motivated to do our best, will be the millstone that drowns those of us who do not drive forward with passion in this industry. With the recent good rates of return in agricultural investment compared with stock markets, I believe these impact investment dollars will be seeking our ranch lands as safe investments. Perhaps some of us can work with these investors to leverage our own success stories.

[56] Ogilvy, S. Developing the Ecological Balance Sheet for Agricultural Sustainability. Sustainability Accounting, Management and Policy Journal. 2015 p. 110-137.

7.3.1 Evidence Informed Decision-Making

There are industry professionals that are available to help guide farm managers identify the cost/benefit of different conservation practices to determine which actions are more appropriate to help the business reach production, environmental and personal goals. I met up with Anna Roberts and Geoff Park in Melbourne, Australia on my research tour. Roberts is an agricultural scientist with 30 plus years' experience in research and extension and policy reform. Park is an ecologist with 25 years of community-based natural resource management. They have teamed up with David Pannel, a professor of environment and brought forward an Investment Framework for Environmental Resources (INFFER).

Figure 20 The INFER Framework

INFFER is a tool to help organizations achieve cost effective and realistic environmental outcomes. Their company Natural Decisions, helps managers make better decisions on environmental investments. The team at Natural Decisions works to understand problems, assess costs and benefits and often find themselves myth-busting because while everyone thinks what they are doing the right thing, that is often not the case. By taking an interdisciplinary approach the team is able to prescribe how to maintain environmental benefits from investments. Early efforts have found that while ES provision is great in theory, the concept is still immature and often difficult to operationalize. Their observations are that while not often well-defined, landowners generally have a duty of care and that governments shouldn't pay for notions landholders will do anyway. They believe funded ES need to go above and beyond normal landholder action. They have worked with contentious situations like Australian ranchers who desire to completely clear brigalow scrub to maximize grass production and minimize cost of re-clearing.

It was encouraging to find Natural Decisions at work in Brazeau County, Alberta, where they are providing multiple cost and scenario comparisons for conservation initiatives by applying the INFFER model of analysis to the objectives and activities of the programs. Natural Decisions was brought into Alberta to assist the Land Stewardship Centre with funding provided by the Agricultural Watershed Enhancement Fund. INFFER will be able to compare the environmental and social outcomes and cost effectiveness of potential conservation initiatives enabling the selection of approaches best suited to addressing important issues in the area and how the goals of the county can be attained. While not the only tool, Natural Decisions is capable of

discovering response thresholds for ecological services or the ecological threshold tipping point from which rapid change is costly to reverse.

Human wants exceed resources available to satisfy them all. These resource constraints often mean that deciding to do one thing means deciding not to do another. The Alberta Beef Producers have membership in all the watersheds in Alberta and keep abreast of developments with the intention of being involved in regional planning and how it influences the provision of ES and the use of agriculture land and governance. Services provision needs to be enhanced by the choices society makes regarding land use and management.

8.0 Examining Threats to Sustainable Agriculture

Despite all the positive programs and policies described above that support enhanced ecological services on the farm and contribute to sustainable and profitable farming, the agricultural industry and cattle ranching continue to face challenges to their social license to operate. In this section I describe some of the pressures we face from the public perceptions of farming and competing interests on our land.

8.1 Science-Skepticism Within Agriculture

I attended the BeefTech Conference in Edmonton in December 2017. The keynote speaker, Robert Saik (PAg, CAC) runs a private international agricultural consulting firm with over 250 staff, many of whom are scientists and agricultural experts who engage directly with farm clients. Saik gave compelling talk on the presence of a genuine non-science movement within agriculture. Saik spoke of support for the choice of consumers to spend where they wish, but argued that advertising bombards them with messages designed to confuse and create fear. He clarified that all plants need nutrition, and that plant nutrients, like nitrogen, can certainly come from animal manure, nitrogen-fixing plants or urea-based fertilizer, but that a return to pre-1960's agriculture, which today would be called organic in nature, would require 3 billion fewer people on the planet.

Scientific innovation has allowed increases in food production to feed the growing global population. Saik informed us that the biggest threat that may prevent agriculture from eradicating hunger on the planet are the science-skeptics who prefer a romantic vision of agriculture similar to the kind of farming before the Green Revolution. He advocates that genetically modified organic food production could be the future of agriculture if not targeted by a very strong anti-GMO movement. Saik believes that a serious increase in organic food production would require GMO technology as a significant part of the solution. Solutions that allow plants to biologically fix their own nutrients, reduce pesticides, reduce tillage and increase water efficiency are being withheld due to political lobbying fears.[57] Saik uses examples such as Golden Rice sitting on the shelf in Kenya. This rice, bio-fortified with vitamin A, has been

[57] Saik, R. The Agriculture Manifesto: 10 Key Drivers That Will Shape Agriculture in the Next Decade. 2014.

withheld, while millions of children have gone blind or died painful deaths due to vitamin A deficiency.

Figure 21 BeefTech Conference in Edmonton, 2017

As beef ranchers, we also face these threats every day – especially in terms of growth hormones and feed additives. The active ingredients in hormone implants used by the North America beef industry are essentially naturally occurring hormones that increase feed efficiency, and any residues must be gone by harvest but many consumers still find that unpalatable. According to Saik there are more naturally occurring hormones in French fries than a hamburger.[58]

A recent article in National Geographic entitled, "The Carnivore's Dilemma," explored whether America's appetite for meat is bad for the planet. It concluded that after great analysis and simulation to various levels of production, "the problem of global warming is overwhelmingly one of replacing fossil fuels with clean energy sources."[59] Also, you can reduce your own carbon footprint by eating less beef, but if that's your goal, avoiding grass fattened beef where much more methane is produced than in a feedlot would be more important to you as a consumer.

As Saik argues, "We have got to intensify. We've got to produce more with less. Feedlots are better than grass fed, no question."[60] For anyone who expects more grain would be available to human consumption should feedlots not exist, they must realize "ethanol consumes 36% of

[58] Ibid.
[59] Kunzig, R. The Carnivore's Dilemma. National Geographic. 2014.
[60] Ibid

available grain in the U.S., while cattle finishing only about 10%." [61] As a cattle rancher, I also know that lower quality grains offer little to no return for human consumption, yet can add value when fed to livestock.

According to Stina Nagel, Stakeholder Engagement Advisor for the Canadian Cattlemen's Association, who presented at the 2018 Beef Industry Conference in London, Ontario, "the Canadian Centre for Food Integrity did research that showed that 29% of Canadian consumers believe Canadian farmers are good stewards of the environment.[62] With this perception backing the beef industry, it is understandable that transparency values have superseded physical values of traded commodities.[63] This sentiment reminds us that true sustainable developments need to be supportive of land management at a local level, respective of property rights and economic incentives valuing realized environmental services.

8.1.2 Growth Implants and a Safe Food Supply

The use of growth implants in animal agriculture is recognized as safe and regulated under Canada's Food and Drug Act.[64] This Act, designed to protect Canadian consumers, requires that hormone implants must:

1. Be effective and do what they are supposed to do;
2. Result in food products that are safe to eat on a regular basis; and
3. Be safe for animals.

The Canadian Food Inspection Agency (CFIA) randomly samples final beef products to ensure hormone levels are within normal range. The level of synthetic hormone residues that can be left in beef prior to entering the market is zero. "Manufacturing standards and protocols for use of these products are regulated by the government and Veterinary Drugs Directorates, and only products with proven safety for people, cattle and the environment are approved for use."[65] Health Canada requires that animals given growth supplements follow strict withdrawal times prior to marketing.

On my Global Focus Tour's Washington D.C. stop, we listened to a Delaware senator talk about international food safety. He encouraged me to have faith in a return to sensibility in international trade discussions. He stated that "one must understand that Codex protects global consumers — that, and the work done by influential Americans like Harry Wallace and Hugh Hammond Bennet. The rest is politics."[66] His inference of politics was in response to our conversation on the European Union banning North American beef that may have been raised

[61] Ibid
[62] Nagel, Stina, Canadian Beef Industry Conference, 2018.
[63] Ibid.
[64] Alberta Beef Producers. Worried about hormones in cattle? You don't need to be. 2017.
[65] Ibid
[66] Steineger, C. Delaware Senator. Personal Communication. 2016.

with growth implants. I support the freedom of individuals to pay more to access no-added-hormone production lines, but restrictions on product-flow across national borders is simply a denial of our science and technology.

Codex Alimentarius Commission (CAC) is a joint FAO and World Health Organization (WHO) food standards program responsible for the protection of public health and fair practices in the food trade with global reference points for consumers. Clearly, politics play an enormous role in counter-science with favour for few. "The implants direct growth towards muscle and away from fat which boosts growth rate and means less feed is needed for the animal to gain weight. The result is fewer resources used to produce beef, with a smaller impact on the environment."[67] Implant use serves as an environmental benefit by providing more efficient use of input resources, like feed. Their application helps keep beef affordable, and the industry competitive and profitable. Hormone-free beef is available, but its environmental footprint is larger and any advertising that it is somehow better for your health is misleading to consumers. A return to pre-implant beef production in Canada while maintaining production rates would cause 11% more feed usage, 4% more water usage, 7% more fuel usage and increase beef prices 8% or more.[68]

8.2 Loss of Farmland

On our Global Focus Florida tour, we were told that the USA loses 3000 acres per day of productive farmland to development.[69] The global estimated loss of environmental services from land use drainage during 1997–2011 is $14–15 trillion.[70] Clearly, there are political choices being made that do not support long term sustainability of cattle grazing. The environmental footprint of beef is willingly made larger in the European Union. I am increasingly under the impression that climate mitigation and control of GHG emissions in the beef industry are not the priority when weighed against cultural measuring sticks in Europe. The environmental priorities in Europe are set by the CAP.

[67] Alberta Beef Producers. Worried about hormones in cattle? You don't need to be. 2017.
[68] Ibid
[69] Florida Sugarcane Farmers. Personal Communication. 2016.
[70] Constanza, R. et al. Changes in the Global Value of Ecosystem Services. Global Environmental Change. 2014 p. 152-158.

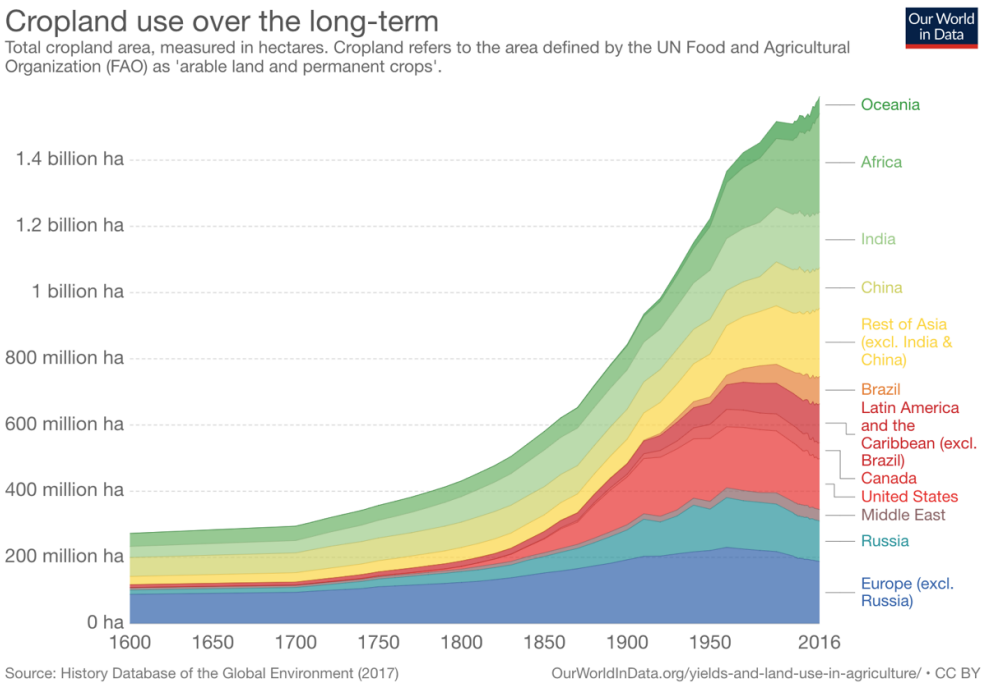


Figure 22 Cropping land use[71]

8.2.1 Energy vs. Food

My Global Focus tour through eastern Germany and the Czech Republic took me through hundreds of thousands of acres with no cattle present. This was explained to be the result of fragmented land ownership with a large percentage of the population owning small parcels of land as a direct result of the collapse of the Communist regime. Because of this, 90% of land is rented by those farming it. The division of property made it too difficult to maintain herd numbers in any volume of scale to be economical. However, I did travel through good agricultural soils and see solar panel farms blanketing hundreds of acres of prime land.

Energy is one of the main competitors for agricultural land, especially in the developed world. Wind power generation sites and oil and gas development leases compete with agricultural food producing land, but in Canada, we also have ethanol production from our grain lands replacing food with fuel for our gas tanks. One interesting site I visited in Florida had a special megawatt solar power system installed on it. I questioned why the farm had that and was told that the land leased annually for its installation paid remarkably well when compared to agriculture. That site was an arm of Nature Conservancy known as Nature Vest. I was told they are particularly active in Colorado (prime cattle country) power production.

[71] https://ourworldindata.org/exports/cropland-use-over-the-long-term_v6_850x600.svg

Figure 23 Oil well in a field in Alberta

9.0 Conclusion

As a result of my Nuffield travels and studies, I believe that competing land usage on the Canadian Great Northern Plains is diminishing the provision of ecological services that pastoral cattle ranching offers. Improving water quality, nutrient cycling, protecting biodiversity and mitigating climate change are key ecological goods that pasture systems provide. Interest groups, philanthropists, organizations, community efforts and governments are eager to lead us to greater sustainability and encourage ecosystem production and restoration. As ranchers, we struggle with many competing interests over natural capital resources. In addition, the ability to operate a cattle ranch relies on a social license effectively provided by public trust. How pastoral beef operations can effectively use their limited natural resources for the betterment of sustainability of their operations as well as provide and promote ecosystem service and social license is often dependent on location, networking and capital.

Environmental stewardship appears in a variety of manners and at different levels. Wealth and knowledge can enable rapid adoption of best management practices that offer opportunities for some management to acquire land properties at discounted values and literally turn those investments into assets of greater value for economic production and ecological service provision. There are partners for producers who are less able to absorb natural capital improvement costs that must be leveraged to maintain the middle-class ranching operation's equity position. Producer adoption of management practices and extension services offered to industry speak volumes to other producers and society. This will certainly support pastoral meat production because of the benefits received. Notable benefits such as improved soil quality, water filtration and infiltration, air purification, aesthetics, recreation, climate mitigation and biodiversity all add value for society. This natural capital will increasingly be valued in society, but partnerships and alliances must be developed with stakeholders to facilitate the process.

When it comes to addressing levels of atmospheric GHG, the issue is more about reframing existing knowledge where many of the management strategies associated with the reduction and removal of GHGs from the atmosphere also protect the environment and offer a return on investment through improved production efficiencies. The Canadian feedlot model, for example, is more efficient to reduce methane than grazing and feeding poor quality roughage. However, food production will be needed and is more sustainable from biodiverse grazing lands.

Research is showing steady improvements leading to the efficient use of energy, greenhouse gas reduction, nutrient cycling, and feed efficiency of livestock. With marginal soils competing within agricultural production systems and other ES production, I see a social shift towards conservation and preservation developing that will certainly compete with cultivation for rare natural capital. The strength of our cattle industry lies with producers. We strive to reduce GHG emissions per unit of cattle production because emissions are a loss of energy, nutrients and soil organic matter which undermines efficiency and economic viability. Keeping soil alive and healthy on our ranches is the foundation we must strive for, and it is my belief that grazing cattle can play an important role in benefiting soil health.

Soil health supported by holistic regenerative grazing practices is our key to sustainability, but genomics and technology will also play large roles. Financing and investment are drivers in our industry particularly when interest rates are low and stock market returns are not attractive. Energy is competing for land use, and so is riparian area and habitat land.

Marginal land is gradually being taken out of agricultural production as set aside land. The ever-increasing population of the world will be mostly in the developing nations, and they will need more meats to increase their dietary protein to maintain or improve human health. The developing world will increasingly be under pressure to produce more beef/meat and must be encouraged to do so in a responsible, globally accepted manner as their growing middle-class population mushrooms. Developed nations have the responsibility to set standards for sustainability initiatives and will be much better equipped with resources necessary to produce beef than counterparts in the developing nations. Developed nations will be held to higher social licensing costs and pressures, capping production. In the developed world, we must educate consumers that over- and under-consumption of beef has consequences on human health and environments.

There will be government policies developed regionally to facilitate sustainability, and farmers working together toward education and awareness is a successful model. Conservation easements have proved useful for some ranches and associations to sustain and grow their business. Often, producers working with conservation groups in controlled model settings can result in greater sustainability of our ranches and ranching lifestyle.

10.0 Recommendations

I hope some of my results will help in developing proactive policy by aligning regulations and incentives to environmental outcomes. The following are my recommendations and considerations to inform policy that promotes enhanced ecological service provision in Canadian agriculture and beef production in particular:

1. Food security, climate change initiatives and competing land uses need to balance with ecosystem preservation.

2. Tools, such as INFFER, for assessing environmental externalities can be effective for investor cost/benefit analysis and for regional planning.

3. Support for high yielding farming while safeguarding or restoring natural habitat is very important. The more diverse a plant population is, the greater synergy there can be particularly in feeding soil and increasing biomass with biodiversity.

4. I believe in advocating for proactive policy by aligning regulations and incentives to environmental outcomes. Only capital that is scarce is considered valuable. It is fundamental that producers are engaged in the development of sustainability programs destined to strengthen our industry to ensure that such policies are practical at the farm/ranch level. Additionally, paying farmers for stewardship that produces environmental benefits isn't a new idea, but it's one that's been slow to catch on in Canada and should be pursued.

5. We must preserve natural capital before tipping points of expensive conservation recovery are reached by natural resource usage.

There are many benefits realized from the agricultural land base, including energy, food, water, air, and disease resistance. Robust biodiversity is best for the health of all plants and animals. Adding up and including on a balance sheet, the natural capital on farm can help add value, benchmark and boost returns of valuation.

11.0 Glossary

ABP: Alberta Beef Producers—the Alberta provincial beef organization that represents producers and voices their concerns.

ALSA: Alberta Land Stewardship Act—Alberta legislation used for regional land-use planning that concomitantly respects landowner property rights.

ALUS: Alternative Land Use Services—a private, land conservation project that pays landholders to maintain or enhance their natural assets.

CAC: Codex Alimentarius Commission—international acceptable food standards body

CAP: Common Agricultural Policy—a European agricultural subsidy program

CRSB**:** Canadian Roundtable for Sustainable Beef—a Canadian framework initiative that seeks to highlight where the beef industry is doing well and identify areas for improvement.

ES: Ecosystem Service—the benefits humans receive from nature that support our health and well-being

FAO: Food and Agriculture Organization—a United Nations agency that aims to defeat world hunger.

GHG: Greenhouse gases—gases such as methane, nitrous oxide and carbon dioxide that contribute to the greenhouse effect by absorbing infrared radiation.

GFP: Global Focus Program—a multi-country travel program for Nuffield scholars.

LEAP: Livestock Environmental Assessment Performance—an assessment program to develop guidelines and improve environmental performance of the livestock sector.

LUF: Land Use Framework—a new approach for managing Alberta's land and natural resources to achieve long term economic, environmental and social goals.

MBI: Market Based Instrument—instruments of policy that uses markets, price, and economics to get after polluters.

Sward: the grassy surface of land

USDA: United States Department of Agriculture

WWF: World Wildlife Fund—an international organization that works toward wildlife and endangered species preservation and environmental conservation.

12.0 References

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13.0 Appendix

APPENDIX A: Lessons from the Australian Conservation Auction Policy Experience

Table 1 Lessons from the Australian Conservation Auction Policy Experience.

Opportunities

- Flexible for landowners
- Easy to adapt to local circumstances
- Effective use of public expenditures
- Promising in areas of resource conflict
- Promising where there are substantial variations in compliance costs and where there are a relatively high number of bidders
- Effective when actions and outcomes are homogeneous
- More attractive to landowners than regulation
- Provide a means to value for public goods in land use decisions
- Bidders reveal the true cost of compliance

Issues

- Time consuming to design and implement
- Environmental Improvements are difficult to evaluate
- More complex than traditional regulatory approaches
- Market failure potential due to inadequate information
- Potential of market dominance by a few players
- Administrative intensity (e.g., contract development, monitoring and assessment of outcomes requirements, public consultation)
- Inappropriate design can exacerbate environmental issues
- Must ensure that the process is transparent and fair; build trust in the process

Taken from: Ecological Goods and Services Review for Alberta Beef Producers by Fred Hays, 2012.

APPENDIX B: Examples of Livestock Related Carbon Offset Schemes in Different Countries

Table 2 Examples of Livestock Related Carbon Offset Schemes in Different Countries

Country	Location	Name of Program	Eligible Activities
Canada	Alberta	Alberta Offset System	Beef Cattle: Eligible activities include: i. Reducing age at harvest ii. Reducing days on feed iii. Selection for low RFI Dairy Cattle: Eligible activities include: i. Increased milk production ii. Retaining fewer replacement heifers iii. Increased feed efficiency iv. Manure management changes
Australia	Nationwide	The Carbon Farming Initiative	Projects that avoid emissions of: i. Methane from the digestive tract of livestock ii. Methane or nitrous oxide from the decomposition of livestock urine or dung
United States	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont	The Regional Greenhouse Gas Initiative (RGGI)	Dairy cows Manure management (Anaerobic digester)
United States	California	Livestock Projects Compliance Offset Protocol	Installation of a Biogas Control System (BCS) for Manure Management on Dairy Cattle and Swine farms.

Taken from: Optimal Livestock Management for Improved Environmental Outcomes: How Effective are Carbon Offset Markets? By Albert Boaitey & Ellen Goddard, 2016.

APPENDIX C: Selected Approaches to Reducing Methane Emissions from Cattle Production

Table 3 Selected Approaches to Reducing Methane Emissions from Cattle Production

Approach		Estimated reductions in methane emissions	Reference
Improved feeding practices	Replacement of forages with concentrates in diets	Methane emissions/kg 2.8 (corn) vs. 4.03% (barley) of GE.	Beauchemin and McGinn (2005)
		Reductions in CH4 as % of GEI F/C ratio (0.65:0.35)=6.00% F/C ratio (0.10:0.90)=4.44%	Lovett et al. (2003)
	Addition of oil to diet	Increase in diet coconut oil from as a proportion of dietary dry matter reduces CH4 by up to 250g/day. Sunflower oil (21% reduction in GE loss CH4).	Jordem et al. (2006) McGinn (2004)
	Addition of distiller's grain	2% reduction in CH4 emission with the inclusion of corn distiller's grain	Hunerberg et al (2014)
Use of dietary additives	Growth implants	9% reduction from the methane emissions from higher milk yields in dairy cows.	Johnson et al. (1991)
	Additives:	Ionophores (9% reduction in GE loss CH4)	McGinn (2004)
Animal breeding	Selecting for feed efficiency cattle (residual feed intake (RFI))	Reductions of 13.38g for a 1kg/day reduction in RFI 15–25% less methane produced by low RFI cattle vs. high RFI cattle.	Hegarty et al. (2007) Basarab et al. (2013)
Management practices	Grazing practices	Keeping cattle on alfalfa reduces emissions by 0.53-1.08t CO2e/t	Stewart et al. (2009)
		Installation of AD systems on US dairy farms can result	Gloy (2011)

		in the reduction of 220MT/unit	

Taken from: Optimal Livestock Management for Improved Environmental Outcomes: How Effective are Carbon Offset Markets? by Albert Boaitey & Ellen Goddard, 2016

APPENDIX D: Tradable Permits – Carbon Offsets: Alberta's Approved Protocols

Table 4 Tradable Permits. Carbon Offsets: Alberta's Approved Protocols

Acid Gas Injection	Landfill Bioreactor
Afforestation/Agro-Forestry	Landfill Gas
Beef Feeding (Edible Oils)*	Modal Freight Shift
Beef Feeding (Reducing Days-On-Feed)*	Pork Operations*
Beef Lifecycle (Reducing Slaughter Age)*	Road Rehabilitation
Biofuel	Run-of-the-River Electricity System
Biogas/Anaerobic digestion	Solar Electricity Systems
Biomass Combustion	Tillage (Reduced/No Till)*
Compost (Non-Ag materials)	Waste Heat Recovery (Multiple Entity)
Energy Efficiency (Pork, Dairy, Poultry)*	Waste Heat Recovery (Single Entity)
Enhanced Oil Recovery	Wind Powered Electricity System
Enhanced Oil Recovery (Streamlined)	

Those indicated by * have an agriculture modification role or operational production at farmer level.
Taken from: Ecological Goods and Services Review for Alberta Beef Producers by Fred Hays, 2012

APPENDIX E: Additional Carbon Offset Protocols for Alberta

Table 5 Additional Carbon Offset Protocols for Alberta

Additional Carbon Offset Protocols in draft	Carbon Offset Protocols under consideration
Solar thermal Low impact, water-powered electrical energy generation Green building projects (residential) Intermodal switching Waste non-incineration	Wetlands management*** Native grass/rangeland management*** Conversion to perennial forages** Pasture management** Nitrogen use efficiency (cropping)* Reducing summer fallow* Residue management* Beef (residual feed intake genetic markers)* Pulse crops* Lagoons*

*agriculture modification **agriculture/field management ***wildlife

Taken from: Ecological Goods and Services Review for Alberta Beef Producers by Fred Hays, 2012.

APPENDIX F: Colorado Conservation Stewardship Program Funding Scheme

Table 6 Colorado Conservation Stewardship Program Funding Scheme

- Improved forage quality $49/ac
- Forage and biomass planting over-seeding legumes $17.52/ac
- Prescribed grazing intensive pasturing $2.68/ac
- Native perennial conversion from dryland cropland $64.39/ac
- Upland wildlife habitat management establishment of seasonal wildlife forage cover on cropland $46.92/ac and on non-cropland $15.77/ac
- Intensive cover cropping to increase soil health and increase soil organic matter $12.23/ac
- Enhanced field borders to reduce wind, or water, or to increase carbon storage $680.28/ac
- Increasing riparian forage buffer width to enhance wildlife habitat or to reduce sediment loading $1775.73/ac
- Including nature grasses or legumes in forage base $54.18/ac
- Grazing management to improve quantity/quality of plant structure for wildlife $2.91/ac
- Grazing management to improve movement butterfly habitat $8.71/ac
- Range planting for soil organic matter $41.17/ac
- Range planting for wildlife $97.34/ac
- Brush management juniper clearing single pass $8.40/ac, cover crop $8.32/ac
- Silvo pasture establishment $23-66/ac

Taken from: http://www.nrcs.usda.gov/wps/portal/nrcs/main/co/programs/financial/csp/

Appendix G: CAP—An Austrian Example

In the summer of 2017, I employed Martin Leitner from Austria. He provided me with a list of payments that were available to him in Austria. He explained that 50% of the funding comes directly from the EU with the other half being channeled, with 40% of the remaining 50% provided by the Austrian national government and 60% from regional provincial funding for activities that are, by nature, for localized concern. Leitner's farm was reportedly average in his area at about 124 ha in size and yielding production of, for example, 2.02 tonnes/ac of triticale grain or 17t/ac of corn silage. The following is a list of what was available for this Austrian farmer, and the payment for ES that his government provided:

1. Seeding of cover crops on at least 10% of cultivated land - $145/ac;
2. Seeding of cultivated land within a 50-day seeding window allotted time - $73/ac;
3. No manure application between November 11 and April 1 on cropland and grasslands - $91/ac;
4. Hay land breakup to cropland or vice versa within 4-week window - $55/ac;
5. Leaving grassland riparian buffer zone at least 3 metres wide—can be hayed once per year - $400/ac;
6. No fertilizer on cropland except manure - $37/ac;
7. Meadowland haying (no silage because does not shed enough seed) can cut twice just not before certain stage of maturity - $73/ac;
8. Alpine pasture 60 days/year per fenced pasture based on historic stocking density - $37/ac (This encourages use of distant steep pastures so that livestock density can be spread out and encouraged to continue despite limitations of cost; helps maintain the historic cattle pastures).;
9. Daily cattle checking for 60-day period of pasturing on alpine pastures - $32–280/Livestock Unit depending on distance;
10. Steep slope haying (often with small equipment that had been historically walked behind - $335/ac;
11. Keeping cattle on pasture April 1st to November 15th (as opposed to stall feeding)—120 days - $80/Livestock Unit
12. Organic farmer meadow hay or cropland - $200/ac; and
13. Crop rotation involving 7-year plan for crop diversification - $42-50/ac.
14. There were also payments for diversification into older nearly extinct cattle breeds.

This list, while not exhaustive, shows the great extent to which European farmers are micro-managed into audited compliance for large portions of their income.

Appendix H: HISTORICAL INFLUENCERS OF ECOSYSTEM SERVICES

At the request of the Delaware Senator on my Global Focus Tour, I reviewed some background information on two great Americans that were very influential in provision of ES throughout the United States and beyond. Firstly, Harry Wallace was known as the greatest social capitalist of the 20th century.[72] His company was the first to genetically engineer hybrid corn strains to produce greater yields. His Pioneer Hybrid corn seed company's fame worldwide is a testament to his overwhelming success. His ability as an orator led him to success as farmers advocate, secretary of agriculture, and on to vice-presidency of the United States. His philanthropy and support for agriculture research were indeed admirable. The legacy of his seed company is production to feed the world.

Figure 24 Henry A. Wallace

Secondly, Hugh Hammond Bennett used science and research to increase conservation movements at a vulnerable time in U.S. history. The homesteading movement had encouraged plowing of the land as a condition of acquiring a homestead. Some of that land should never have been plowed. Bennett was a talented orator talking in simple terms with sun-baked skin and calloused hands. He talked the language of farmers and was able to restore many acres of sun scorched, wind-blown land by techniques he developed as director of soil erosion research stations. He pulled biologists, engineers, economists and technicians together with science and practicality to help farmers and conservation technicians to develop farmer approved plans. Bennett delayed his planned presentation on May 12, 1934 to Washington D.C. until a nation-wide, Montana to Texas, dust storm hit D.C. as he was presenting. This was greatly influential in the unanimous passing of the Soil Conservation Act. Bennett was the founder of the National Resource Conservation Service. He was the inspiration that resulted in more than

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3,000 soil conservation districts across the U.S. He advocated conservation of natural resources that all should agree on. He maintained trust with farmers while tapping into research. He knew that economic, social, public health, national defense and all cultures should focus on conservation plans. The results of his efforts now have brought ranchers to the next tier where they are assisting science and are partners in conservation stewardship programs. Conservation stewardship programs in Colorado make acreage payments similar to some of those in Austria under the CAP of Europe. (See Appendix G.)

The commonality of these two men is that both of these great influencers realized the potential was so much more than their own backyards, and they were great advocates of agriculture. It makes me think they would have made great Nuffield alumni.

Figure 25 Hugh Hammond Bennett

15. Tables and Figures

FIGURES

TABLES