The Future of Grain Research: Maximizing Productivity Growth through Partnerships

Final Report

Nuffield Study Tour

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2012 Canadian Nuffield Scholar

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Foreword

When I applied for the Canadian Nuffield Scholarship, I hoped the experience would broaden my perspective on agriculture around the world. My Nuffield experience far exceeded my expectations and provided me with the opportunity to not only learn, but to develop friends and acquaintances around the world that continue to shape and influence me every day.

My travels took me to Australia, New Zealand, the Netherlands, the United Kingdom, Western Canada, the United States (Washington DC and California), Mexico and Brazil. I logged countless miles in the air and acquired over 25 boarding passes in the process. In every country, I met people that exuded absolute passion and enthusiasm for agriculture and their businesses.

My interest in farm oriented research as a study topic developed over the past 12 years I have been involved with farm organizations in Canada. Through these experiences I have seen many partnerships that have worked well. However, there have been times when I have felt that partnerships developed to further research could have accomplished more. Through my role as Manager of Research and Market Development with Grain Farmers of Ontario, I have had the privilege of helping farmers set research priorities and develop research projects that help advance the interests of farmers. In most cases, projects involve collaboration between farmers, government funding agencies, and private industry. Farmers have expressed an interest in looking at options for new ways to organize and improve the return on their investments.

Through my role as a farmer, growing corn, soybeans and wheat near Kincardine, Ontario, I have seen the results of research first hand. My crop yields are increasing and my ability to manage weeds and pests have improved through better genetics and new agronomic techniques. However, there is always room for improvement and I hope to play a role in bringing results to farmers, including my own operation.

This report is a summary of some of the things I've learned about research systems, partnerships and efforts to help grow the agricultural industry. The ultimate results will be seen when we take action and implement.

Acknowledgements

I would first like to thank Nuffield Canada for making this experience possible. I feel privileged to have been selected as a Nuffield Scholar. The people involved in Nuffield Canada are inspiring leaders and it is an honour to be associated with the organization.

I would like to acknowledge Grain Farmers of Ontario for their support. My intent is to repay this generous contribution by applying the results of my work to improve the Ontario grain industry. I would also like to thank Glacier FarmMedia for their generous support to my scholarship.

To my travelling companions Bryan, Ryan, Rhys, Dave, Damien, Natalie and Ray and our many hosts during our February-March 2012 Global Focus Program. It was an amazing seven weeks of travel together and the memories will last forever. I would also like to thank Nuffield Australia for opening their doors to Canadian participation in the Global Focus Program. A special thanks to Jim Geltch, who is instrumental in making the entire Nuffield program work smoothly. Jim went out of his way to help with many arrangements and connections.

I would like to thank the individuals that opened their doors to me while I was travelling to answer my many questions, provide suggestions on who to speak with next and give advice on how to improve our research programs in Canada.

One memorable moment that will stay with me was during a presentation by Lance Eydenbry during the 2012 Contemporary Scholars' Conference in London, UK. He suggested we all look in the mirror and ask ourselves these questions:

> Am I passionate about what I do?
> Do I share that passion with others?
> What evidence do I have that others are aware of my passion and positively influenced by it?

Finally, I would like to thank my family – my wife Carie and my children Clayton and Hazel for their support and encouragement in taking on this endeavour. Carie, I am forever grateful for your ability to 'hold down the fort' while I was away.

Executive Summary

As agricultural systems advance, the appropriate use of science and technology can mean the difference between farming success and farming failure. Canadian farmers need access to new and cutting edge production tools to remain competitive in the global marketplace. Through research, these tools are developed, refined, investigated, and turned into products, knowledge, and services for farmers. This includes aspects related to genetic development of new hybrids and crop varieties, new agronomic production methods, new planting and harvesting techniques, as well as the areas of weed, insect and disease management.

The overall goal of this study project is to explore research partnerships and develop strategic recommendations to optimize return on investment in research by farmers. Organizations that represent farmers in Ontario and Canada (such as the Grain Farmers of Ontario) have a long history of supporting research at Universities and Government Research facilities. Often, this support is a result of private-public partnerships among various government funding agencies, farm organizations, and private industry.

The pace of change in the grain sector is rapid, especially with the increased development of new genetics, traits and products by private sector companies. This report provides a perspective on how Australia and the United Kingdom organize and fund research of interest to farmers. These countries were chosen because their production systems share many similarities with Canada, yet their approaches to research are quite different. Canadian farmers and farm organizations can benefit from examining ways that private (for profit) and public (not for profit) entities form partnerships along with farmers to better meet growing demand for increased productivity.

As Canadian farmers, adapting and updating our production methods by learning from others provides the opportunity to be globally competitive. As a result of stronger research linkages within Canada and with other countries, we will accomplish:

- Higher productivity gains in our grain crops for Canadian farmers and industry,
- More efficient use of resources through coordinated research efforts between farm organizations, public research institutions and private companies.

Key Results and Recommendations

1. Research has led to our ability to feed the world and will be even more important in the future – reinvestment is critical
    - By 2050, global cereal demand will increase from 2.1 to 3.0 billion tonnes.
    - Through effective research investment and advances by farmers, we can meet and exceed this growing demand for food. A reasonable probability exists that global grain production will increase faster than global demand.
    - As a defence against globally depressed grain prices resulting from surpluses, research into new uses for grain is needed in addition to research to increase productivity.
2. Canadian farmers have the opportunity to lead in creating a vision, developing partnerships and ensuring research results accrue to investors (including farmers)
    - Farmers benefit from both 'public good' type research that isn't easily monetized AND research that leads directly to new products and services.
    - As a result, farmers are a logical bridge between the public (government) and private (industry) and can play a key role in building new partnerships
    - New methods of providing return on investment to stakeholders should be seriously considered for Canada, such as an end point royalty system for wheat. Regional differences within Canada need to be evaluated to ensure the outcome will work for all areas. Regional implementation should be considered if a national system is not feasible.
    - Large multidisciplinary projects such as the 20:20 Wheat project in the United Kingdom provide the opportunity to assemble and coordinate significant resources around a common goal.
    - Research efforts should be connected to implementation on farm or industry, where the returns are generated. Even basic, early stage research should show how it links into a pathway to application on farm.
3. International research linkages provide a significant opportunity for Canada and should be expanded
    - Global research opportunities exist and will help leverage investment and expand reach and impact of research resulting in greater overall benefit.
    - Organizations such as CIMMYT and initiatives such as the Global Wheat Initiative are examples that provide opportunity for Canada to expand international research collaboration.

Chapter 1: The Great Grain Challenge – Past, Present and Future

INTRODUCTION

Demand for agricultural commodities has grown dramatically over the past 50 years. Major drivers of increased demand include a growing human population, increased per capita consumption, and the development of expanded uses for commodities, including biofuels and livestock feed markets. Corresponding to increased demand has been an increase in commodity production by farmers around the world. This increase in production is a result of farmers applying the results of research on their farms to increase crop yield, quality and efficiency. This chapter will explore the past, present and future of grain production and demand and highlight some key aspects of research that have led us to today's level of productivity.

In recent years, a lot of attention has been placed on a potential threat to global food security due to demand for agricultural goods outstripping supply. Depending on the source of information, the factors leading to this concern include both supply and demand factors. Demand factors include human population growth, increased demand for meat and livestock products, and increased demand for grains for biofuel and bioproduct production. Supply factors include loss of prime farmland due to urban expansion and declining productivity gains in major grain crops and potential negative effects of climate change.

GLOBAL GRAIN PRODUCTION AND DEMAND

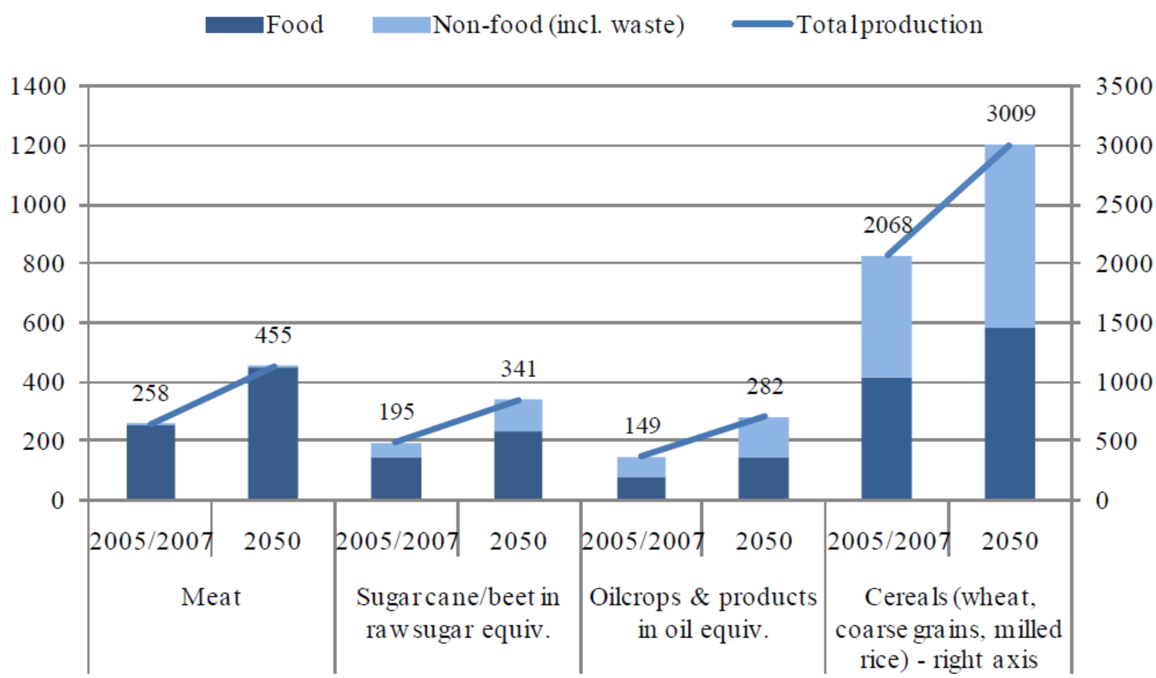
A comprehensive investigation into the past, present and future global supply and demand for food was recently published for the Food and Agriculture Organization of the United Nations (Alexandratos, N. and J. Bruinsma. 2012). The report provided a detailed look into past drivers of demand and corresponding supplies of food and provided projections for the next 40 years, to 2050.

Some key finding from that report that are critical to understanding global grain supply and demand factors are:

- Global population increased to 6.9 billion in 2010, up from 2.5 billion in 1950 and 3.7 billion in 1970. Current UN projections indicate that world population could increase by more than two billion people from today's levels, reaching 9.15 billion by 2050.
- Incomes will grow even faster. To meet increased demand, FAO projects that global agricultural production in 2050 will need to be 60 percent higher than in 2005/07.

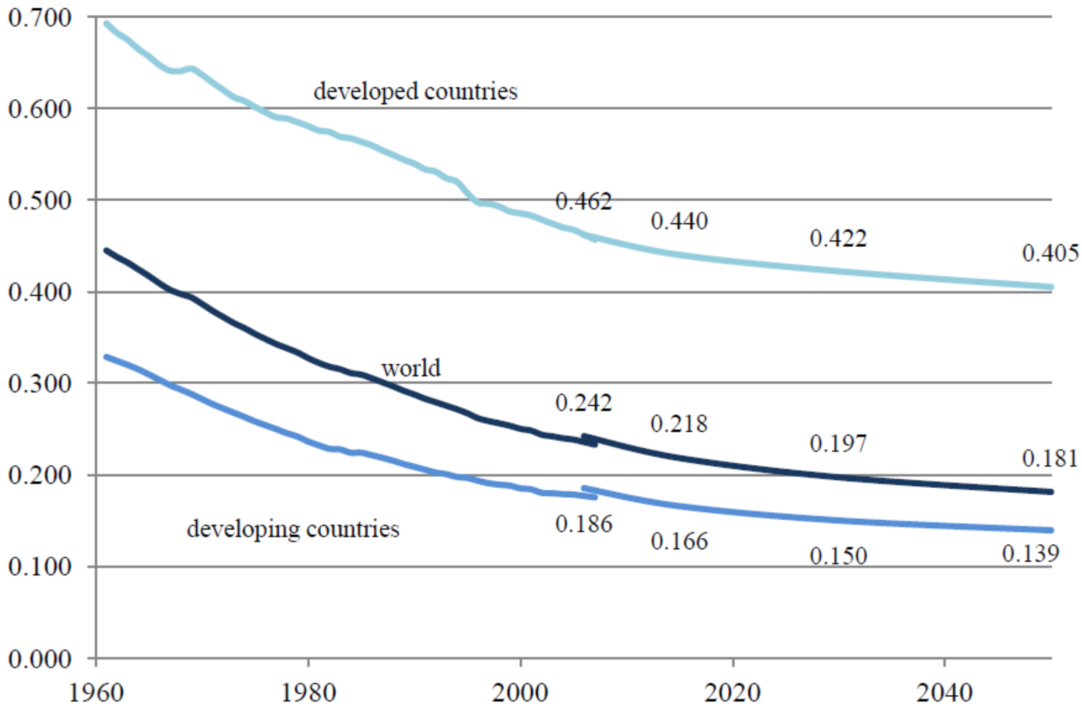
- Global GDP is projected to grow 2.5-fold by 2050 with per capita income growing 1.8-fold, resulting in a world that is richer and characterized by less pronounced income gaps between developed and developing countries.
- Annual demand growth for grains is expected to be 1.1 percent per annum. This is a smaller increase than the agriculture sector has achieved over the past half century, but still raises concerns about how it can be achieved sustainably.
- By 2050, global cereal demand will increase from 2.1 to 3.0 billion tonnes (Figure 1).
- In aggregate, most of the increase in production (greater than 85 percent) over the next 40 years is expected to derive from improved yields.

Figure 1: World Production and Use, Major Products (million tonnes) (Alexandratos, N. and J. Bruinsma. 2012.)



By their nature, accurate predictions of global demand and supply are difficult to accomplish. However, it is clear that global demand for food products will increase and that most of the increase in supply will need to be accomplished through increase in yield. This is most easily demonstrated in Figure 2, where arable land per capita will decrease from 0.242 ha (0.605 ac) to 0.181 ha (0.453 ac) by 2050. Yield increases will largely be accomplished through research into increasing genetic yield potential, improving agronomic techniques and minimizing losses and waste.

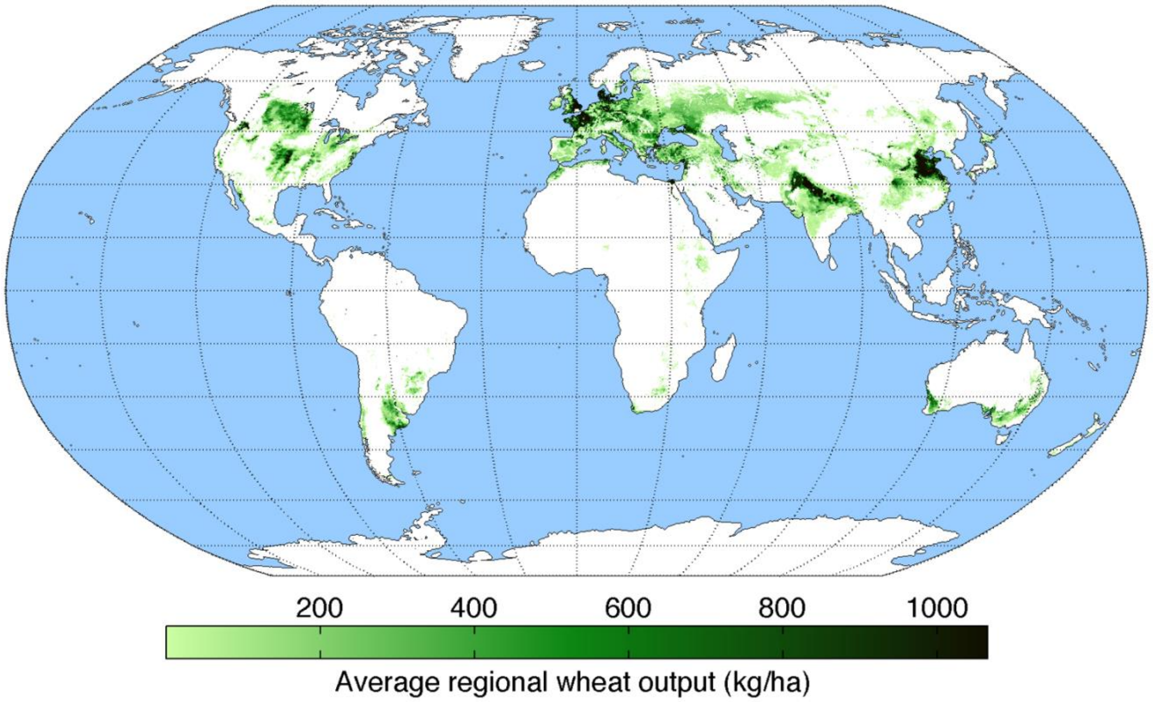
Figure 2: Arable land per cap (ha in use per person) (Alexandratos, N. and J. Bruinsma. 2012.)



GLOBAL WHEAT PRODUCTION

Wheat is truly a global crop, with production on all continents and production of over 700 million tonnes in 2013 on over 219 million hectares (547 million acres). It is the most important protein source and provides around 20% of global calories for human consumption (wheatinitiative.com). Average global wheat yield was 3.25 T/ha (47 bu/ac) in 2013, but varies widely around the world as shown in Figure 3 (USDA, Foreign Agricultural Service, Production, Supply, and Distribution). While overall yield continues to increase, concern has been raised that the global rate of increase is slowing.

Figure 3: Map of wheat production across the world (Monfreda, et al., 2008)



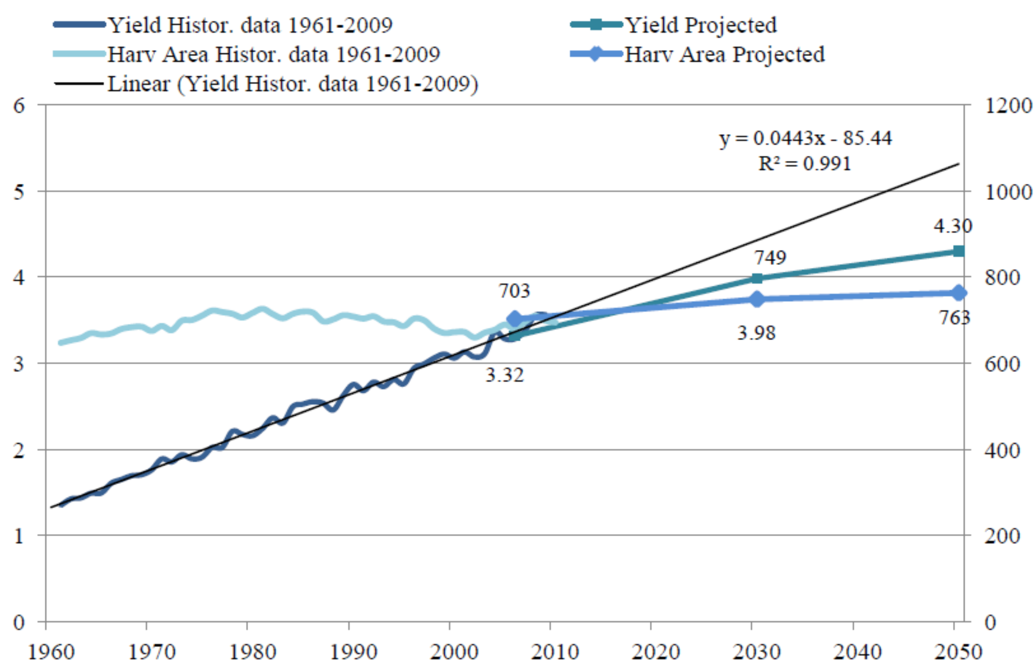
The Global Wheat Initiative was formed in 2011 by research and funding organizations from several countries to develop a global strategy to increase wheat yield around the world. Some of their background work has quantified the mean global yield of wheat by decade. Their work has showed that yield increase on a percentage basis has slowed in recent decades. As shown in Table 1, mean wheat yield increase from 1971 – 1981 was 3.9%. From 2001-2010, mean wheat yields increased 1.1%. The Global Wheat Initiative has set a target of 1.7% per year to 2050, to keep up with increasing global demand, which is greater than our recent decadal gains. Figure 4 shows the global average wheat yield trend and production trend and projects out to 2050, given expected yield gains.

Table 1: Evolution of global wheat yield over 10-year periods since 1960 and projected needs for 2050

Period	Mean area harvested /yr (Mha)	Mean production/ yr (Mt)	Mean production increase/yr	Mean Yield t/ha (bu/ac)	Mean Yield Increase/yr
1971-1980	225	388	3.9%	1.7 (24.9)	3.2%
1981-1990	229	509	3.1%	2.2 (32.3)	2.9%
1991-2000	220	571	1.2%	2.6 (38.2)	1.7%
2001-2010	216	622	0.9%	2.9 (42.6)	1.1%
2050 (target)	220	1045	1.7%	4.75 (69.8)	1.6%

Source: www.wheatinitiative.org/sites/default/files/WheatInitiative_VisionDocument.pdf Accessed Feb 26, 2014

Figure 4: World cereals, average yield and harvested area (Alexandratos, N. and J. Bruinsma. 2012.)



CANADIAN GRAIN PRODUCTION

Relative to global production, Canada is a small producer of grains with about 4% of global production. However, a significant proportion of our crops are exported around the world, and Canada is consistently in the top 5 grain exporting nations (USDA, 2013). Wheat, canola, and barley, followed by grain corn and soybeans are the highest tonnage annual crops grown in Canada. Table 2 provides a snapshot of Canadian grain production in recent years.

Table 2: Field and special crops in Canada (Stats Canada, 2014)

	2010	**2011**	**2012**	**2013**
Field crops	Area ('000 hectares)			
All wheat	8,552	8,726	9,630	10,626
Canola	7,117	7,685	8,912	8,068
Tame hay	7,260	6,985	6,761	6,808
Barley	2,799	2,666	2,997	2,866
Soybeans	1,513	1,559	1,680	1,829
Corn for grain	1,247	1,292	1,434	1,493
Dry peas	1,467	986	1,509	1,329
Oats	1,210	1,313	1,165	1,282
Lentils	1,394	1,035	1,018	968
Flaxseed	370	299	397	419
Mustard seed	190	133	136	148
Rye	132	124	140	109
Canary seed	160	111	136	85
Sunflower seed	55	14	41	28

ONTARIO GRAIN PRODUCTION

One of the unique aspects of Canadian agriculture is its diversity. Canadian agriculture varies significantly across the country, driven by a variable climate and geography. Agriculture in Ontario is very diverse with significant production of field crops, livestock, and fruits and vegetables. Table 3 shows the area and production of field crops in Ontario in 2013. The top three annual field crops in terms of area are soybeans, grain corn and winter wheat. These three crops are widely grown throughout Ontario and are usually grown in a three crop rotation by the same farmers. Crop choice and rotations are driven by several factors, including the desire to spread workload, manage market risk through diversification, maintain long term soil health and crop yields. As a result, it is desirable to have several crop choices that are economically viable.

Table 3: Area and Production of Field Crops in Ontario, Canada (2013) (OMAF, 2013)

Crops	Seeded Area (ac)	Seeded Area (ha)	Yield (bu/acre)	Yield (T/ha)	Production (Million T)
Grain Corn	2,225,000	900,400	160.5	10.10	9,007.3
Fodder Corn	260,000	105,200	n/a	46.50	4,889.7
Hay	2,000,000	809,400	n/a	5.60	4,399.8
Soybeans	2,500,000	1,011,700	45.3	3.00	3,078.1
Winter Wheat	1,060,000	429,000	80.1	5.40	2,277.9
Barley	115,000	46,500	58.9	3.20	134.6
Spring Wheat	80,000	32,400	52.2	3.50	113.6
Mixed Grain	95,000	38,400	66.3	3.00	96.2
Oats	70,000	28,300	68.4	2.60	58.0
Dry White Beans	45,000	18,200	22.2 (cwt/ac)	2.50 (cwt/ha)	45.5
Canola	55,000	22,300	35.5	2.00	44.2
Coloured Beans	45,000	18,200	18.4	2.10	37.7
Fall Rye	45,000	18,200	38.2	2.40	29.1

Crop economics drive acreage decisions by farmers. In Ontario, it is relatively straightforward to calculate potential costs and returns for each crop. However, volatility in year to year yield and prices limit the ability to predict margins to a precise level. Yield trends and acreage trends can provide insight into the competitiveness of individual crops. Area, yield and total production trends for corn, soybean and winter wheat are shown in Figure 5, Figure 6, and Figure 7 .

Average provincial yield for corn, soybean and winter wheat have increased significantly during the 32 year period from 1981 to 2013. However, year to year variation exists which demonstrates the impact of year to year weather variability. A number of factors contribute to average yield changes, with genetics and agronomy considered to be the major factors. Development of improved genetics with greater yield potential, layered with improved agronomic techniques, including fertilizer, planting technology, pest management, have contributed to the increase.

IS ONTARIO GRAIN YIELD INCREASING?

Yield trends can provide insight into whether overall crop productivity is changing over time. It is desirable from a farmer's perspective to continually increase yield. One way to look at whether yield gains are increasing is to look at the number of years above or below a linear trend line. By definition, a linear (straight line) trend line drawn through average yield points on a graph results in half of yield points above the line and half below. More points above the trend line in more recent years are an indication that the increase in yield gain is speeding up. Correspondingly, more points below the trend line in recent years are an indication that the increase in yield gain is slowing down.

Looking at the corn chart in Figure 5, during the recent 10 year period from 2004 to 2013, 7 years had yield above the trend line. Similarly, the soybean chart in Figure 6 shows that 7 years of the past 10 had soybean yield above the trend line.

When we look at winter wheat in Ontario, a different pattern emerges. The winter wheat trend in Figure 7 shows only 3 of the last 10 years have exceeded the 30 year trend line, with 7 falling below. This shows that in the past 10 years in Ontario, winter wheat yields are not going up at an increasing pace and appear to be levelling off.

Figure 5: Ontario Corn Production, Yield and Area (1981-2013) (OMAF, 2012)

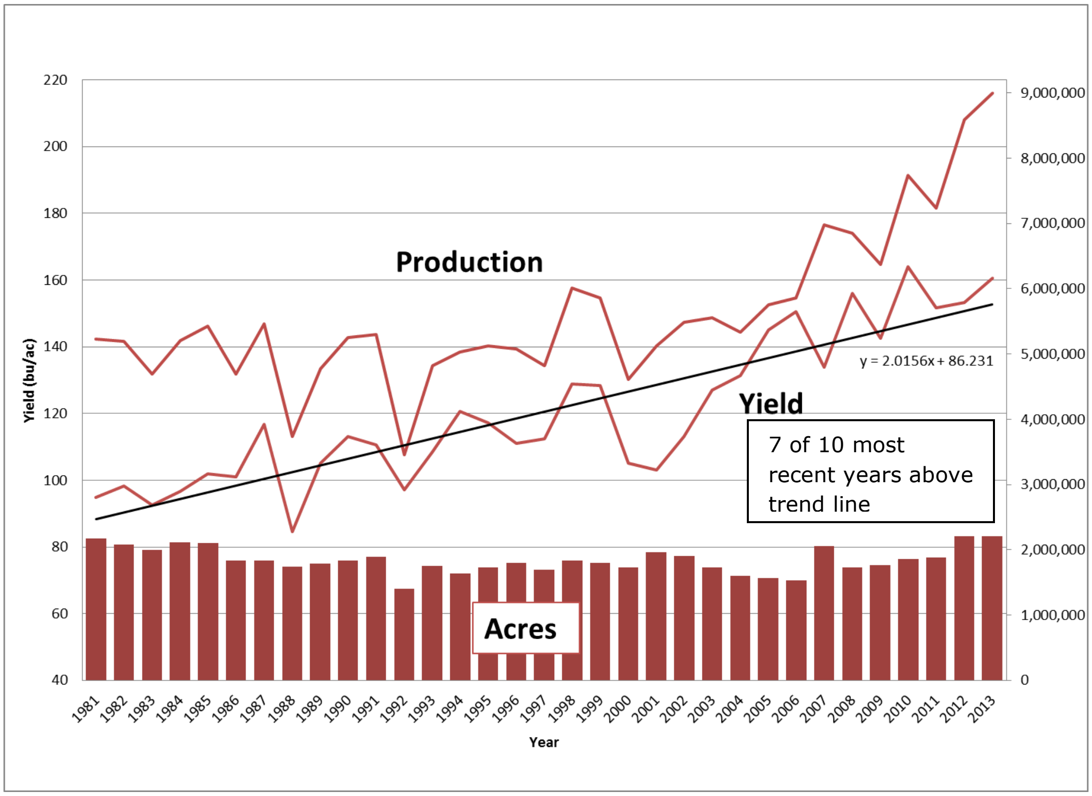


Figure 6: Ontario Soybean Production, Yield and Area (1981-2013) (OMAF, 2012)

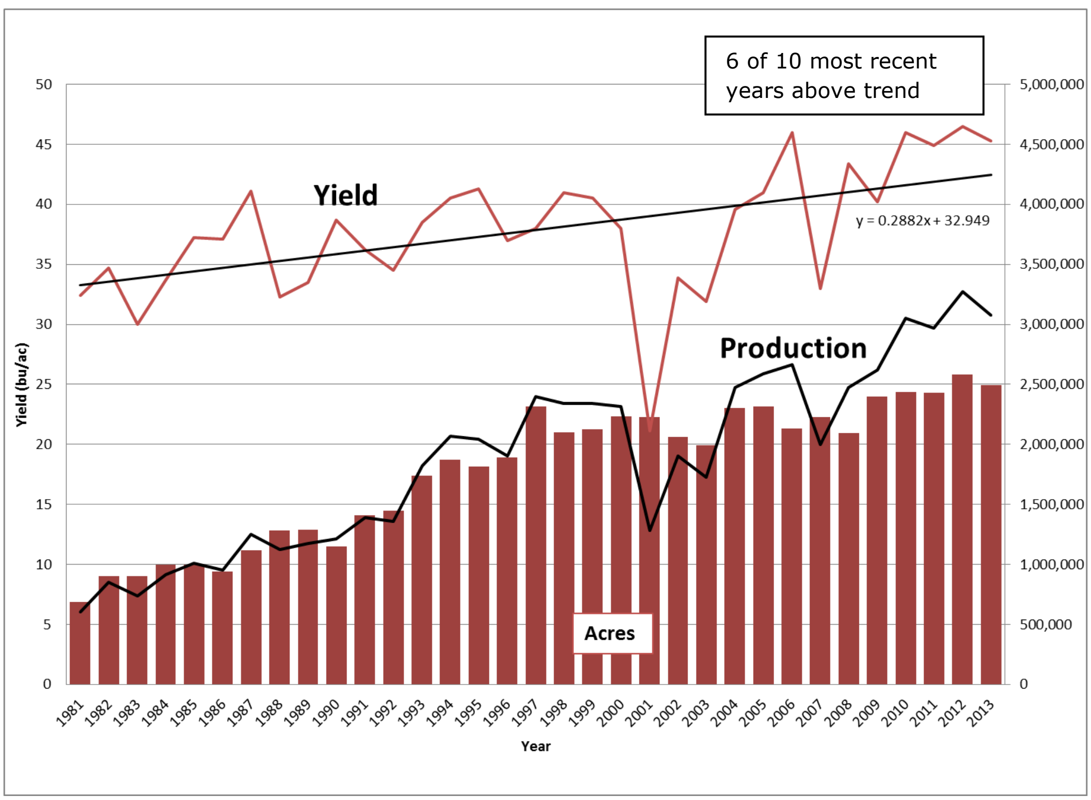
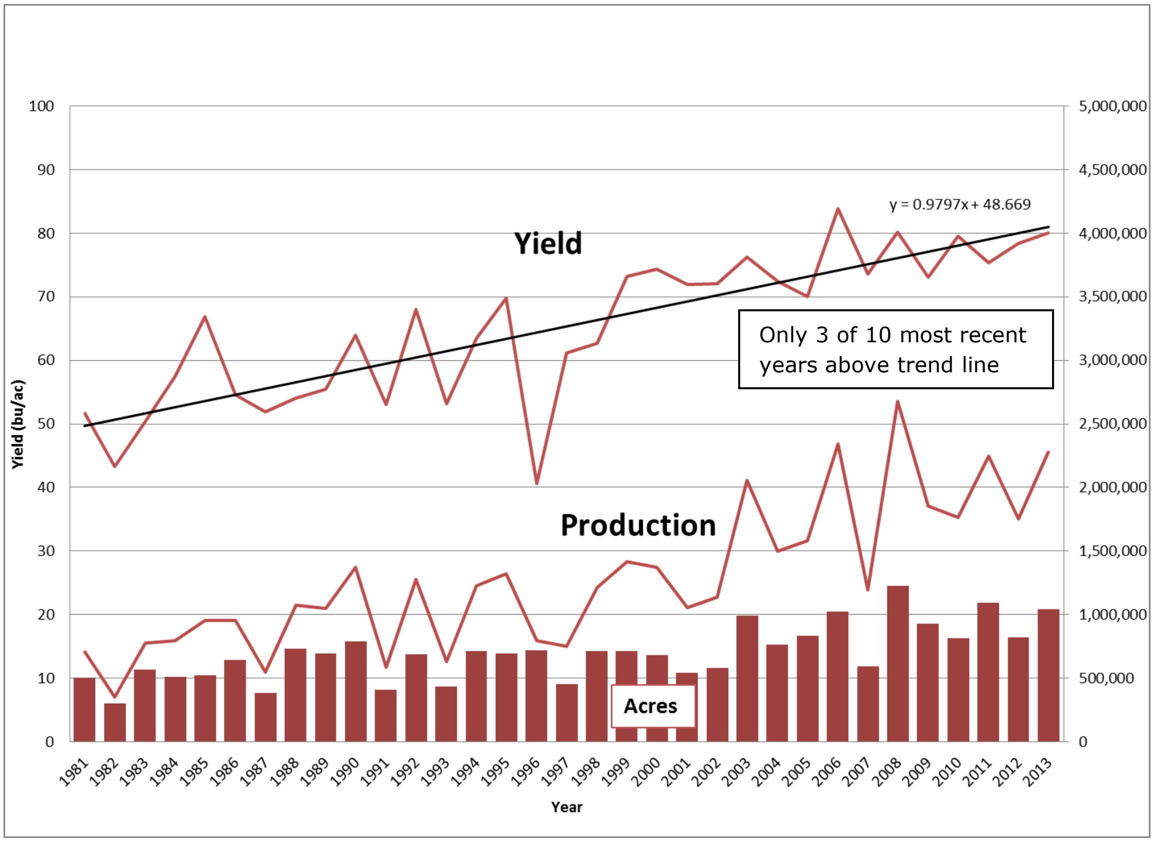


Figure 7: Ontario Winter Wheat Production, Yield and Area (1981-2013) (OMAF, 2012)



The reasons for a slowing increase in winter wheat yield compared to corn and soybean yields could be attributed to several possible factors, including management, weather and genetics. Since the same farmers generally grow all three crops in Ontario, it is unlikely that adoption of management technology or lack of education is a contributing factor. Likewise, the advances in agronomic technology have not changed in a more dramatic way for corn or soybeans compared to winter wheat. It is suspected that the major driver is a change (or lack of) in the genetic potential of the crop.

Development of genetics and investment in breeding research in Ontario (and around the world) is very different for corn and soybeans compared to wheat. Since the introduction of genetically modified (GM) corn and soybeans in 1996, farmers have gradually increased adoption to the point where at least 80% of corn acres and 70% of soybean acres in Ontario are grown from seed with patented GM traits. This adoption has provided the seed industry and trait developers the opportunity to sell higher levels of certified seed and return more dollars back into their research programs. Farmers are purchasing seed with more genetic potential and yields are increasing on the farm.

There are no patented technologies on wheat seed sold in Ontario, and there are higher levels of farm saved seed compared to corn and soybeans. As a result gross seed sales of winter wheat seed is lower than corn and soybeans, which provides less incentive for the private sector to invest in new wheat genetics. Perhaps this lower level of investment is showing up in lower rates of genetic gain and less overall productivity gains. In order to keep winter wheat as a viable crop in Ontario, yield gains need to keep pace with other crops in the rotation. To accomplish this, new ways of funding wheat research and new types of partnerships are required.

The intensity of research investment has been studied by Gray (2013). The results of his work show that wheat research investment in Canada is lagging behind investment in other crops and countries. Gray (2013) estimates that less than 0.5% of gross wheat crop value is invested in research in Canada, compared to 2.0% in Australia.

The following chapters investigate partnerships and research funding models for consideration in Canada.

Chapter 2: Importance of Research Partnerships

INTRODUCTION

Research has played a huge role in past changes to agricultural productivity around the world. It has impacted every agricultural product grown today and has led to the ability for the world to continue to produce enough food for a continually growing population at reasonable prices. Research often results in incremental changes and sometimes results in major breakthroughs that have massive impacts.

Perhaps the most significant example of crop research success is in the research program that led to new wheat varieties in the 1950s and 1960s that helped Mexico and India to rapidly increase wheat yields and become self-sufficient in wheat production. The research effort was led by Dr. Norman Borlaug at CIMMYT in Mexico and is known as the Green Revolution. Dr. Norman Borlaug was known as the father of the green revolution and was awarded the Nobel Peace Prize for his efforts in 1971.

Often research accomplishments are much smaller in direct immediate impact but nonetheless have a significant impact over time. Results from research become a new standard to build from and the impact is often felt over a number of years. An example of this type of result is research that incrementally increases yield potential of a crop. Each year, progress may be small, but because the changes are cumulative and permanent, the impact becomes larger over time.

CIMMYT – International Research Success

The author had the opportunity to visit the CIMMYT (The International Wheat and Maize Improvement Center) research station in Obregon, Mexico. The Obregon station is located in the Yaqui Valley and is one of the most important agricultural research stations on the globe. This is where the Green Revolution started under the leadership of the late Dr. Norman Borlaug. It was here that new wheat varieties were developed that helped Mexico, Pakistan and India become self-sufficient in wheat production by the mid-1960s and is said to have saved a billion people from starvation.

Today, CIMMYT runs and organizes an international wheat and corn breeding program and shares their genetics freely to any interested breeders from around the world. They have 450 acres of plots at the Yaqui Valley station and coordinate plots and research at many other stations around the world. Dr. Norman Borlaug was awarded the Nobel Peace Prize in 1970 for his accomplishments.

RETURN ON INVESTMENT TO AGRICULTURAL RESEARCH

Several studies have examined the returns to investment in agricultural research. Dr. Richard Gray of the University of Saskatchewan has been involved in this area of study and has published several reports on the effectiveness of research in delivering results (Gray, et al. 2008; Galushko and Gray, 2008). Dr. Julian Alston of the University of California, Davis has studied and published extensively on the return on investment in research to farmers and the greater economy. In a book titled *Persistence Pays: U.S. Agricultural Productivity Growth and The Benefits from Public R&D Spending*, Alston and colleagues provide a detailed account of agricultural research spending and return on investment.

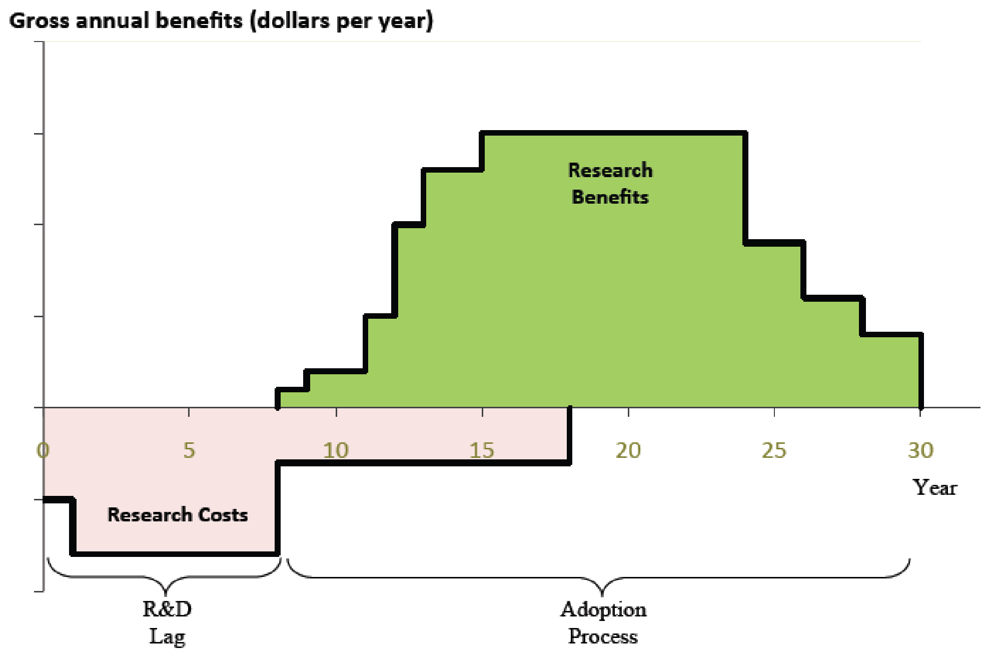
Results from studies have shown benefit to cost ratios of investments in Canadian agricultural research ranges from 20:1 to 63:1 (Gray and Malla, 2007; Darku and Malla, 2010). A large study of research investment in the United States showed an average benefit to cost ratio of investment in research of 32:1 for national research and 21:0 for within state research (Alston 2010). A study of the soybean breeding research program at the University of Guelph showed that between 1980 and 1998, net value generated by soybean breeding at the University of Guelph was $711 million with a benefit to cost ratio of 48.6:1 (Vyas and Zhang, 2002).

Return on investment in the magnitude of 20:1 to 63:1 is absolutely huge, compared to the returns realized on many other types of investments. To put this into context, a 20:1 benefit cost ratio means that for a $1 million investment, $20 million in benefits are gained.

Despite the potential gains from agricultural research, there appears to be a scarcity of funds and that more investment will lead to greater productivity growth in agricultural crops. This was mentioned by farmers and researchers in many countries as they believe that more results can be achieved through more investment and research intensity. However, it is likely near impossible to define an optimal level of research investment due to the fact that by its nature, research outcomes are uncertain. Alston et al. (2012) argues that investment into farm productivity enhancing research and innovation is lacking and that we are missing opportunities to increase our productivity.

Perhaps the scarcity of funds for agricultural research is a consequence of two main factors: the time lag in realizing return on investment, and the ability for investors to capture the returns on their investment. Alston (2011) illustrates the challenge and impact of time lag in promoting research investment. Figure 8 shows that most of the costs of research are incurred before any returns are gained. As a result of this time lag between investment and returns, investors may avoid investing and choose to direct funds to areas that provide a faster return on investment. Another consequence of a long time lag is that it becomes more difficult to attribute a specific investment to its eventual outcome. The ability for investors to capture the return on investment in research is critical to attract investment for any stakeholder.

Figure 8: Stylized Representation of Research Benefits and Costs (Alston, 2011)



PRIMARY MOTIVATORS OF RESEARCH INVESTMENT

There are three primary sources of funds for agricultural research around the world: farmers and farm organizations, government, and private sector companies. Each group has specific outcomes required to stimulate investment in research. Farm groups want to see productivity enhancements on the farm that lead to more profitable production. Government wants to see economic development and results that provide public good, such as food safety and healthier food (beyond political motivations). Private sector companies are generally looking for return on investment to shareholders and a strong, growing customer base.

Farm organizations that are funded through grower license fees (also called a check off or levy) make investments based on potential economic benefits to farmers. For example, farm organizations have justified funding wheat breeding programs based on the potential for their farmers to grow higher yielding, more valuable varieties.

In the public sector, investment is ideally driven by the desire for economic development and public benefits. For example, federal and provincial governments have invested in research programs to develop more competitive farmers and food and feed processing sectors to create jobs and wealth. Non–economic public benefits, such as healthier and safer food, are also drivers of government investment.

In the private sector, investment is driven by projected return on investment. For example, there is significant private sector investment in corn breeding in North America, including Ontario. This is largely driven by the high margin associated with corn seed sales and the size of the market, as corn is a hybrid crop and farmers must purchase new seed every year. There is comparatively less investment in wheat genetics because there are lower margins and a smaller market due to significant levels of farmer saved seed and seed logistics.

Each of the three main sources of funding for research – private, public, and producers - may align on their funding of certain types of research, but each group has different drivers for their decision making and expectation. These drivers must be considered when designing research partnerships to ensure each investor remains engaged and committed to the partnership.

FARMER INVESTMENT IN RESEARCH

Farmers have the option to invest in research in several ways. They can conduct research on their own farm, contribute a levy or check off to their farm organization that invests in research or they can support research indirectly through the purchase of products.

When it comes to developing new wheat genetics and varieties, it is practically impossible for an individual farmer to develop and grow their own variety of wheat and realize a sufficient return on investment. It is more likely that farmer support for this type of research comes from seed purchases or a levy that is collected from all farmers by their representative farm organization and invested in research on their behalf.

Levy systems are common in many countries. Organizations that collect a levy are usually governed by farmers that make decisions to invest farmer funds in research that is deemed to have the greatest return on investment for their members.

Chapter 3: Research Partnerships in Australia and the United Kingdom

INTRODUCTION

One of the primary reasons for the author's travel and study was to go beyond our Canadian borders and look at research and partnerships that work to deliver results to farmers. It was realized early on in this study that in order to provide effective recommendations, the scope would need to be focussed from the broad discipline of agricultural research to a more defined scope that will lead to action. After consideration of several areas, the decision was made to focus on wheat breeding research and variety development. There were several reasons to choose this focus area:

1. Wheat productivity gains have not matched gains seen in other crops, such as corn and soybeans.
2. Breeding and development of genetics is a key factor in increasing productivity.
3. Wheat is grown throughout the world and different research support systems are in place around the world.
4. While wheat is grown across Canada, significant regional differences exist that need to be recognized in new research models.

Regional Differences in Canada

Early on in this study, the stark contrast between Ontario and Western (Prairie) Canadian wheat production and research systems became evident. The classes of wheat grown are different, with primarily hard red spring wheat grown on the prairies and soft red winter wheat grown in Ontario. The prairies have a shorter, drier growing season while Ontario has a longer season with more moisture. Markets and marketing systems are different, with the majority of Prairie wheat exported and a significant proportion of Ontario wheat milled closer to home. Current varieties in the Prairies have mostly been developed by Agriculture and Agri-Food Canada or the University of Saskatchewan. Many Ontario varieties originate from private companies and public efforts. Significant support is provided by farmers and the public sector toward the development, evaluation and commercialization of wheat varieties. However, the system is not fully coordinated and concern has been expressed that more resources and organization is required to meet the future needs of the industry.

For the remainder of this report, the investigation into research partnerships will be primarily focussed on research related to wheat genetics and variety development. However, it is expected that the types of partnerships investigated can apply to other agricultural commodities and systems.

Profiles of the Australian and United Kingdom research systems related to development of wheat genetics are included in this report. Both of these countries are significant wheat producers, but have different research structures and ways of supporting research compared to Canada. Australia has a unique system for collection of funds for wheat research and has dramatically changed their research structure over the past decade. The United Kingdom has a production system with similarities to Eastern Canada but with different research funding systems and independent research institutions.

THE AUSTRALIAN RESEARCH AND INNOVATION SYSTEM

While in Australia in Oct-Nov 2012, the author had the opportunity to meet with farm organizations, companies, research institutions and many farmers that are involved in agriculture and research in Australia. Through meetings and a review of literature, a perspective was gained on many of the efforts Australians have made to increase the level of farm productivity by structuring their research and development programs.

On an overall national level, Australia and Canada share a lot of similarities related to economic drivers, demographics and the importance of agriculture to their economies. Both countries have a large land area and relatively low populations that are concentrated in a small number of urban centres. Canada's population was 35.2 million in 2013, with over 50% living in Ontario and Quebec (Stats Canada, 2013; World Population Review, 2013). Australia's population was 23.4 million in 2013 with over half living in the top 5 cities (World Population Review, 2013).

Both countries have a seen a strong resource boom in recent years, driven by increased global demand for energy and minerals. Their economies are both strongly influenced by the United States and have seen their currencies become stronger relative to the US dollar, which impacts export competitiveness. Agriculture is important in both Australia and Canada and grain crops are major drivers of productivity and trade. Both countries are known for relatively harsh environments; Canada for long, cold winters and relatively short growing seasons, and Australia for its hot, dry climate. Due to vast geography, variable, harsh climates and large land masses, each country has a great diversity in agricultural production and output.

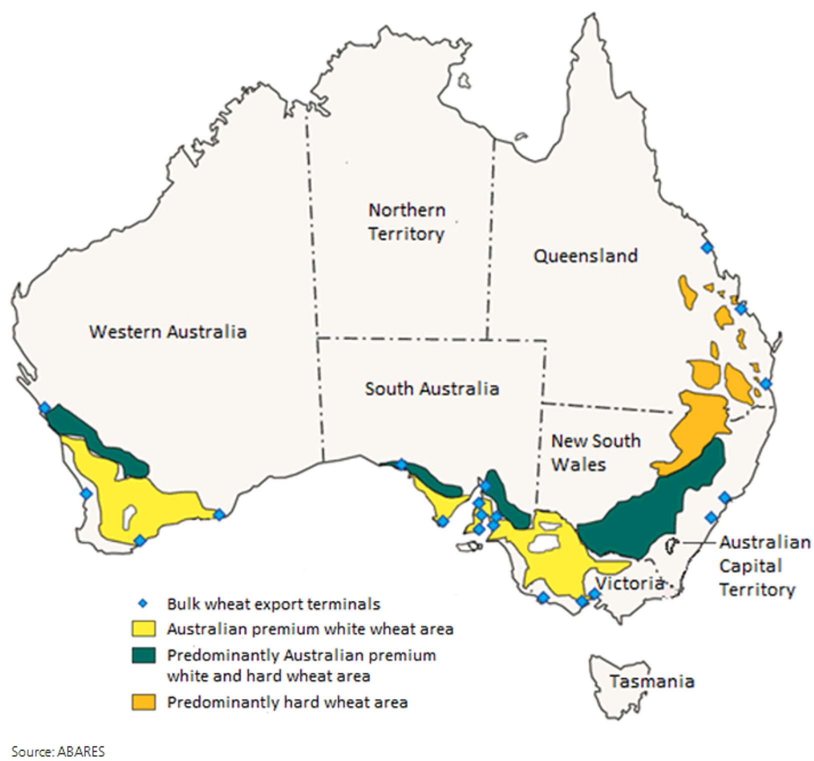
GRAIN PRODUCTION IN AUSTRALIA

The Australian grain industry produces about 35 million tonnes of grain each year on an area of about 20 million hectares (45 million acres). Wheat is the largest acre and tonnage crop grown in Australia, with 21.8 million tonnes produced on 13.8 million hectares (34.5 million acres) in 2010 as shown in Table 4. Wheat is grown across a relatively large geographic area of Australia as shown in Figure 9. Western Australia is the leading wheat producing state, followed by New South Wales (Grain Growers Association, 2010). Approximately 50% of Australian wheat is exported, and grains and oilseed represents close to 30% of Australia's total agricultural exports, making them the largest category of food exports (GRDC, 2012).

Table 4: Australian Crop Production (2009-10) (PWC, 2010)

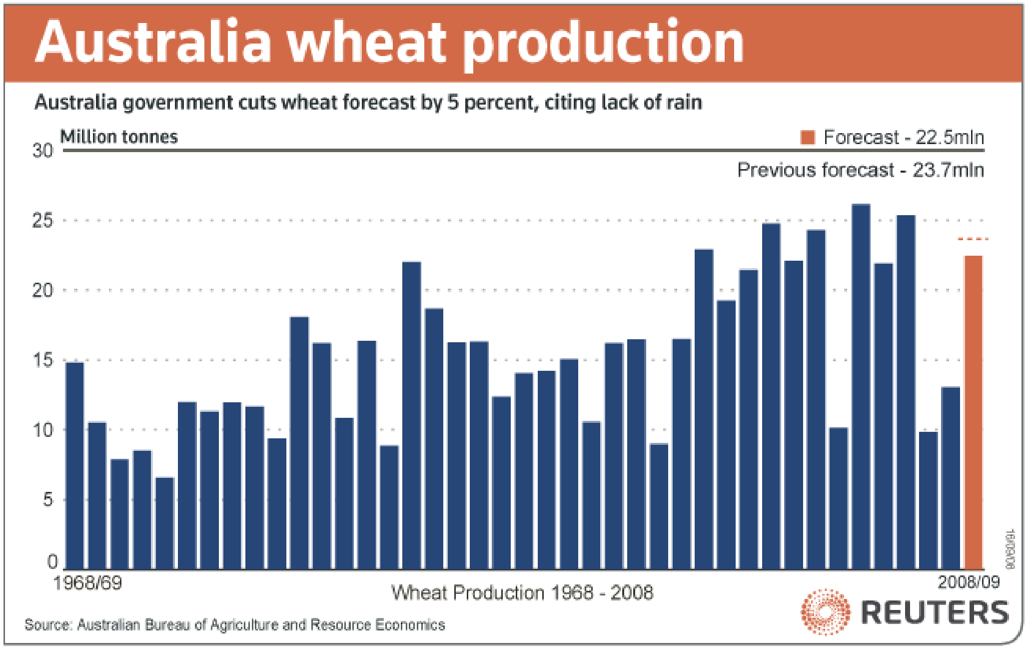
Crop	Area (million ha)	Production (000 T)	Yield (T/ha)
Wheat	13.8 (34.7 million acres)	21834	1.57 (23.1 bu/ac)
Barley	4.2	7865	1.86
Canola	1.7	1920	1.12
Sorghum	.498	1508	3.02
Oats	.850	1162	1.37
Rice	.019	65	3.42
Pulses	1.406	1666	1.19

Figure 9: Wheat Growing Regions of Australia (PWC,2010)



The Australian grain industry has built its success in a relatively harsh climate. The Australian climate is known to have large year to year variability in rain fall and temperature and this shows up clearly in the size of the wheat crop in Figure 10.

Figure 10: Australian Wheat Production from 1968 to 2009



Reuters graphic/Catherine Trevethan

Despite the challenging climate, the Australian grain industry has grown significantly over the past 30 years. A study of the Total Factor Productivity (TFP) shows that grains industry productivity growth over the past 30 years has averaged 1.9% per year (Grains Industry, 2011). Total Factor Productivity is a measure that combines several factors including yield, output and efficiency of resource use. However, the study found that Total Factor Productivity growth slowed in recent years, actually becoming negative from the period from 1993-2007. They found that contributions of research and development to productivity growth were significant, with one third attributed to better genetics and two thirds attributed to improved farm management and agronomy.

Australian grain research systems have evolved over the past thirty years and the current system is very different from the Canadian system. Overall, the Australian system has been designed to incorporate and coordinate contributions from government, farmers, and the private sector into a system that delivers results to the industry.

AUSTRALIAN RESEARCH AND DEVELOPMENT CORPORATIONS

Australia has 15 national Research and Development Corporations (RDCs), that cover most agricultural, fisheries and forestry commodities produced in Australia (Table 5). The RDCs are a co-funding partnership between the Australian Government and the agriculture, forestry and fisheries industries. They are tasked with commissioning and managing research and promoting adoption on behalf of their sector. They are unique in that they are co-funded by the Australian government and industry and must address the needs and priorities of both segments. The RDCs are a major source of research funding across Australia, investing $441 million in R&D in 2008-09. This amount includes $244 million of industry investment and $207 million in Government matching contributions (Council of Rural Research and Development Corporations Chairs (2010).

A study was conducted that evaluated the return on investment to the contributions of both government and industry to the RDCs. The report showed that over a 25 year timeframe, for every $1.00 invested there was an average return of $11.00, in 2007 dollars (Council of Rural Research and Development Corporations Chairs (2010)). This is a significant return, considering it covers all sectors of agriculture, and isn't based on key examples of success.

Table 5: List of Research and Development Corporations in Australia (Council of Rural Research and Development Corporations Chairs (2010))

Name	Acronym
Statutory Bodies	
Cotton Research and Development Corporation	CRDC
Grains Research and Development Corporation	GRDC
Fisheries Research and Development Corporation	FRDC
Rural Industries Research and Development Corporation	RIRDC
Sugar Research and Development Corporation	SRDC
Grape and Wine Research and Development Corporation	GWRDC
Industry owned companies	
Dairy Australia	DA
Australian Wool Innovation	AWI
Meat and Livestock Australia	MLA
Australian Egg Corporation Limited	AECL
Horticulture Australia Limited	HAL
Australian Pork Limited	APL
LiveCorp	LiveCorp
Australian Meat Processors Corporation	AMPC
Forests and Wood Products Australia	

The Grains Research and Development Corporation is the largest of the 15 RDCs. It was created in 1990 and is a unique partnership between farmers and the Australian government that is responsible for coordinating and funding research and extension activities for Australian grain farmers. GRDC is primarily funded by a grower levy (check off) and Australian Government contributions. The levy is based on the net farm gate value of the annual production of 25 crops: wheat; coarse grains—barley, oats, sorghum, maize, triticale, millets/panicums, cereal rye and canary seed; pulses—lupins, field peas, chickpeas, faba beans, vetch, peanuts, mung beans, navy beans, pigeon peas, cowpeas and lentils; and oilseeds—canola, sunflower, soybean, safflower and linseed. However, since wheat is close to 60% of the total grain production in Australia, it comprises by far the largest single crop contribution to the GRDC budget.

GRDC Mission and Scope

GRDC's Mission is to 'Create value by driving the discovery, development and delivery of world-class innovation in the Australian grains industry'. However, the goal of GRDC is perhaps best summed up in a quote by Keith Perett, 2011 Chair of the GRDC Board: *'We want the GRDC levy to be the best investment a grower can make to improve their business'* (Ground Cover 2012).

GRDC has a broad scope related to grain research, but their primary function is to invest funds in Research and Development and related activities (including extension and communication). They identify four key strategies (GRDC 2011):

- The coordination of a national grains R&D agenda and portfolio
- Delivering results according to Australian Government priorities
- Growing and leveraging total grains R&D investment, and
- Ensuring that grains R&D is market driven.

GRDC Budget and Funding

GRDC is a large organization with an annual budget of over $160 million AUD in 2010-2011. Growers pay a levy of 0.99% of the farm gate value of grain produced, which amounts to approximately $100 million per year. The Australian federal government matches the levy funds up to a maximum of 0.5% of crop value, with an adjustment based on the market value of various grains. In 2010-2011, the Australian government contribution was $53.4 million. Income from other sources (interest, royalties) brought the total budget to $175.5 million AUD. The vast majority of expenses were related to Research and Development Projects, which amounted to $140.7 million or about 80% of their annual budget in 2010-2011.

GRDC Structure

GRDC is responsible for planning, overseeing and investing in research that will benefit the Australian grains industry. Investment from GRDC is intended to increase the productivity, sustainability and profitability of grain farmers throughout Australia.

The structure of GRDC is set up to be accountable to both farmers and the government. GRDC is a stand-alone entity that is governed by a board of directors. The eight member board of directors is officially appointed by the federal government based on recommendations from an independent selection committee, which is formed in consultation with growers. The board of directors has the responsibility to oversee corporate governance, sets strategic direction and the performance of the Managing Director (CEO).

GRDC has a series of advisory panels that are responsible for ensuring that research investments are directed to efforts that address the needs of its stakeholders. There are three regional panels that represent the main grain growing regions plus a national panel that aims to address and coordinate national research priorities. GRDC's staff structure is aligned among three operational business groups: Research programs; Regional grower services; and Commercial. A fourth, Corporate Services, provides support to enable the overall function of the organization.

GRDC has six strategic themes that are followed when planning, investing and communicating (GRDC 2011):

1. Growers meeting market requirements
2. Improving crop yield
3. Protecting your crop
4. Profitable farming systems
5. Maintaining the farm resource base
6. Building skills and capacity

While GRDC investments are targeted toward the six themes, they also break out their budget into four areas or lines of business (GRDC 2011):

1. Practices ($60.2 million)
2. Varieties ($57.7 million)
3. New Products ($14.9 million)
4. Communication and Capacity Building ($6.8 million)

It was interesting to find that almost 40-50% of their research investments go toward new varieties. At 45 million acres of grain production, this amounts to about a rough average of $1.28 per acre (CDN) invested into genetics research. This is in addition to investment into genetics and variety development by companies involved variety development and marketing.

John Harvey, Managing Director of the GRDC provided great insight into what makes an organization like GRDC successful. He was insightful in his views on achieving public good through research. John Harvey made two memorable statements that can apply anywhere in the world:

'Until research results in farmers actually changing a practise or doing something different, its value is zero.', and

'The best way for the government to help farmers implement practices that have an aspect of public good (such as environmental protection) is to find ways to make it improve their business.'

These statements may seem obvious, but are considerations that the Canadian system can pay more attention to when looking at research strategy and investment. **Focusing on IMPLEMENTABLE RESULTS and ACHIEVING PUBLIC BENEFITS THROUGH STRONGER FARM BUSINESSES will lead to successful results for both government and farmers.**

GRDC Investment in Genetics

Through GRDC, farmers are investing significant amounts of money into the development of new genetics and varieties of wheat. GRDC's investments in genetics span the entire research spectrum from early stage trait development through to applied variety development. Part of their investment originates from an End Point Royalty (EPR) on varieties that GRDC has all or partial ownership, but a significant amount of their investment in genetics comes from the grower levy and government matching funds.

PRE-BREEDING VS BREEDING

Pre-breeding is a term often used in Australia to describe genetic research. It is a term not often used in Canada and it is a helpful way to articulate to pathway from basic discovery research through to finished varieties. A definition of Pre-breeding is provided by Grains Industry (2011):

'Pre-breeding is R&D intended to contribute to genetic improvement for a trait or trait of economic value. It is often undertaken outside a commercial breeding program, but with the intent of providing improved germplasm, screening technology or breeding methods. Pre-breeding may include gene discovery, trait identification, developing markers, phenotypic screens, and information generation.'

To determine priorities for pre-breeding research, GRDC organizes and facilitates a meeting annually between commercial crop breeders and researchers working on pre-breeding research. The goal is to discuss key priorities for pre-breeding research that will be of importance to the commercial industry and to avoid overlap. Screening tools that are used in breeding programs are generally the responsibility of commercial companies. However, there are cases where GRDC would subsidize the provision of breeding tools, such as rust screening and pre-harvest alpha-amylase screening in wheat. Support is provided when there is a key industry need for the result and the test is moving from research to commercial use.

Providing a definition of pre-breeding has allowed the Australian industry, farmers and government to improve the organization and efficiency of genetics research. GRDC plays an important role in facilitating the knowledge exchange between researchers working on pre-breeding activities at research institutions such as Universities, and breeding of new varieties that typically occurs within seed companies. The connection between pre-breeders and breeders has improved because if the pre-breeding activities are not relevant, there is no funding from GRDC.

WHEAT VARIETY DEVELOPMENT IN AUSTRALIA

During the 1990s, the wheat genetics research and variety development system in Australia underwent significant change. Preceding the change, there were several (at least 7) public wheat breeding programs at Universities and State research institutes that were involved in all aspects, including pre-breeding and variety development.

A number of factors came together to provide the impetus for change:

- State governments strapped for cash were looking for ways to divest their support of wheat breeding
- GRDC was looking for a way to focus on pre-breeding, rather than variety development
- Private companies complained that public programs were competing with them, using government dollars
- Australia signed on to UPOV 91 and enacted Plant Breeders Rights in 1994, which enabled a framework for collection of royalties from farmers.

To address these factors, several new commercial companies were formed to focus on breeding of wheat varieties in the early 2000s. GRDC and state governments took equity positions, essentially turning their germplasm resources into an equity stake in the new companies. Over the past 10 years, these wheat breeding companies in Australia have continued to evolve and emerge.

As shown in Table 6, there are now several companies in Australia with a commercial interest in developing and marketing new wheat varieties. It is interesting to note that three of the companies include GRDC as shareholders and several include the major multinational seed companies as well as State government organizations. Even though these companies operate as commercial enterprises; their shareholders include farmers, government, and private industry, and must provide returns that satisfy each of their needs.

Table 6: Wheat Breeding Companies in Australia (adapted from Jefferies, 2012)

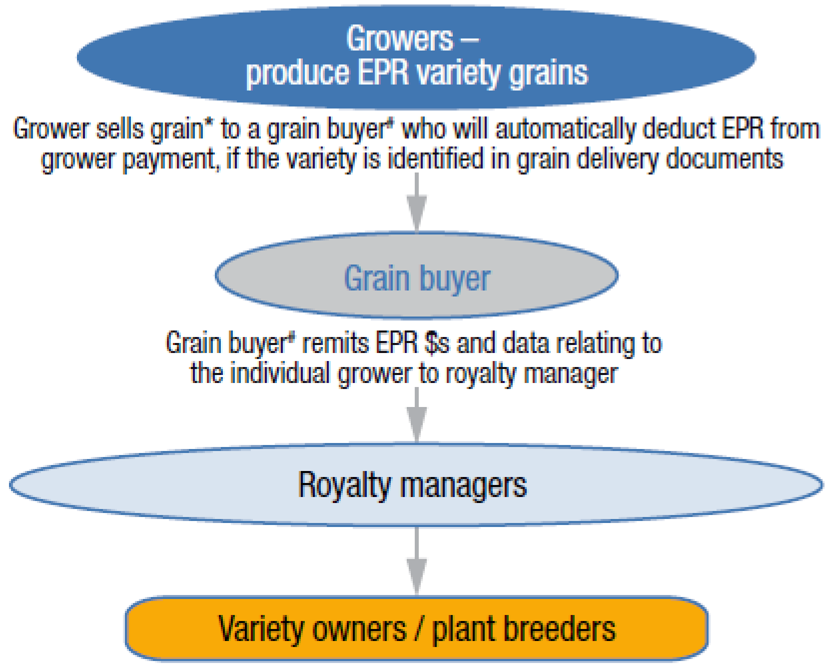
Company	Shareholders	Year Established in wheat breeding	Estimated market share
AGT	GRDC, Limagrain, Adelaide University, SA State Government	2002	18%
Intergrain	WA State Government, GRDC, Monsanto	2007	12%
Longreach PB	Advanta, Syngenta	2002	5%
HRZ	Dow, CSIRO, GRDC, NZ Crop and Food, Landmark	2003	2%
Grainsearch	Grower owned	2002	1%
Bayer	Bayer	2010	0%
Seedmark	SeedCo	2008	0%

END POINT ROYALTIES

Around the same time as changes to the structure of breeding efforts were occurring, an End Point Royalty (EPR) system was set up in Australia to allow collection of a royalty on delivered grain to be provided to the variety owner. This process took about 2-3 years to implement.

In simple terms, an End Point Royalty (EPR) is an amount of money paid by a farmer to a seed company at first point of sale of harvested grain, as payment for the use of the genetics contained in the variety. The payment is based on a set level per tonne of grain and each variety can have a different level, requiring the farmer to declare the variety grown. The EPR system is designed to provide value capture by plant breeding companies to recover their return on investment in variety development. The first EPR variety was released into the Australian market in 1996. Since then, the number of varieties under the EPR system has increased dramatically to the point where there are now over 180 EPR varieties in the Australian market, across a wide range of crops, with wheat being the most prevalent. End point royalty rates for wheat in 2012 ranged from $1.00 to $3.00 per tonne of harvested grain (Variety Central 2012). Most EPRs are collected through deduction from the farmer's payment by the grain buyer as outlined in Figure 11.

Figure 11: End Point Royalty (EPR) Auto Deduct Collection System (GRDC 2011)



In contrast to the Canadian system, sale of certified seed is not a significant source of revenue for Australian seed companies, as they rely on the collection of EPRs as their primary source of revenue. Certified seed prices are often set low to encourage farmers to grow the new variety (Jefferies, 2012, personal communication).

Advantages of an EPR system

- Since EPR returns are linked to production level, plant breeding organizations have an incentive to develop the most productive and highest value varieties.
- Farmers are allowed freedom to save seed and replant on their own farms, AND plant breeding companies have a mechanism to collect returns from the marketplace.
- Farmers and plant breeding companies share production risks. In a lower yielding year, farmers pay less EPR since it is calculated on tonnage of grain, not amount of seed used.

Disadvantages of an EPR system

- Collection methods must be robust to ensure collection of all EPRs and avoid misdeclared varieties.
- Reductions in use of certified seed can be disruptive to established commercial enterprises, especially during the transition phase when EPRs are introduced.

- Implementation requires significant communication, system changes and implement is difficult. For example, in Ontario, EPRs do not match with already established commercial corn and soybean seed industry structure, which has certified seed as a cornerstone..

AUSTRALIAN GRAIN TECHNOLOGIES (AGT)

The author was fortunate to have the opportunity to spend a day with Steve Jefferies, the CEO of Australian Grain Technologies PTY LTD (AGT), a wheat breeding company formed in 2002 and currently the wheat variety market share leader in Australia. AGT was first established with three shareholders: Grains Research and Development Corporation (GRDC), the South Australian Government and the University of Adelaide. AGT was created in 2002 with 5-year transitional funding from GRDC. At the end of 5 years, Limagrain bought into the company, bringing operating resources and a global network and resources. Limagrain is the fourth largest seed company in the world, with research and commercial business across the globe.

AGT has a vibrant research and development program, located on the Roseworthy Campus of the University of Adelaide. They have approximately 50 staff, and manage several regionally based wheat breeding operations, developing and supplying new varieties adapted to Western Australia, New South Wales, and South Australia. These wheat breeding programs work both independently and jointly to meet the needs of western, northern, and southern Australian growers.

AGT is an example of a plant breeding company that is operating successfully within the End Point Royalty system. Steve is a passionate supporter of the EPR system and shared some simple math to explain the basis of his support. In Australia, an EPR of $3/tonne on 20 MT of wheat production has a potential EPR revenue of $60,000,000 per year. If one were to look at certified seed sales as an alternative, the revenue stream is significantly lower. The level of certified wheat seed use in Australia is very low at approximately 10,000 tonnes (Jefferies, 2012 personal communication). Based on an example $60 per tonne seed royalty, total revenue would be $600,000, only a 10th of the potential EPR revenue.   Based on this explanation, it is easy to understand why there is support from the seed industry for EPRs in Australia.

RURAL INDUSTRIES RESEARCH AND DEVELOPMENT CORPORATION (RIRDC)

While the Rural Industries Research and Development Corporation (RIRDC) doesn't concern itself with wheat related research, it is included in this report to provide perspective on how applied research programs can meet the needs of new and emerging crops and agricultural products. This type of structure could be considered in Canada for new emerging crops that currently have little commercial production and therefore have unstructured and minimal industry representation, despite economic opportunity and growth potential.

Rural Industries Research and Development Corporation (RIRDC) is one of Australia's agricultural research and development corporations (RDC's) that serve to support research related to new and emerging agricultural products, termed rural industries. Like GRDC, RIRDC shares similar government oversight of their operations and programs.

RIRDC sees themselves as seed funding to support new, emerging, and small agricultural industries. The RIRDC was formed in 1989 and has recently launched a new 5 year corporate plan and they have 3 primary goals:

1. Promote leadership and innovation in the rural sector
2. Increase profit and productivity in rural industries
3. Enhance sustainability across the rural sector

These are very broad goals, and a detailed corporate plan provides full details on specific targets within each goal.

RIRDC focuses on 3 core areas:

1. New emerging crops and animal industries
2. Established crops and animal sectors that are small but growing
3. National rural issues that provide public good such as climate change and the environment

RIRDC Budget and Scale

RIRDC has an annual budget of about $25m AUD, primarily from government. About 10% comes from growers through and industry levy (check off). About 75% of revenue is invested into research projects, which combined with communication and project management is their primary suite of activities.

RIRDC Activities

RIRDC establishes research priorities and issues requests for proposals in a 2 stage process – a letter of intent stage, followed by full proposal review. Proposals are reviewed by staff and an industry committee. They have implemented a life cycle approach to selection and funding of research projects, which has helped to organize a portfolio that is very diverse and complex. They use four phases to describe the life cycle and use this system to characterize where products fit (see Table 7)

Table 7: RIRDC Industry Life Cycle Approach to Investment (RRIDC, 2012)

	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**
Title	Proposed (new)	Precommercial (developing)	Commercial (maturing)	Large commercial (established)
Percent RIRDC funding	100	75	50	50
Number of crops (approx.) RIRDC involved	10	30	5	2
Examples of products	Cocoa, dates, stevia	Hazelnuts, coffee, green tea	Tea tree oil, wildflowers, ducks	Chicken meat, olives, kangaroo

Research proposals are usually submitted by researchers, but require industry collaboration. Project length of 1-3 years is typical, which provides enough time to determine whether the crop has potential for growth. The Australian olive industry was provided as an example of a success story that has been developed through support from RRIDC. They recently started a levy and it will be managed by RIRDC.

RIRDC seems to be an effective way to support new industries with funding that do not have check off programs. It also provides a mechanism to manage small organizations that have a check off, but do not have the critical mass to stand alone. This model could provide some insight into new commodities in Canada, such as biomass crops, new grains, new vegetable crops, and new and minor livestock industries.

UNITED KINGDOM RESEARCH AND INNOVATION SYSTEM

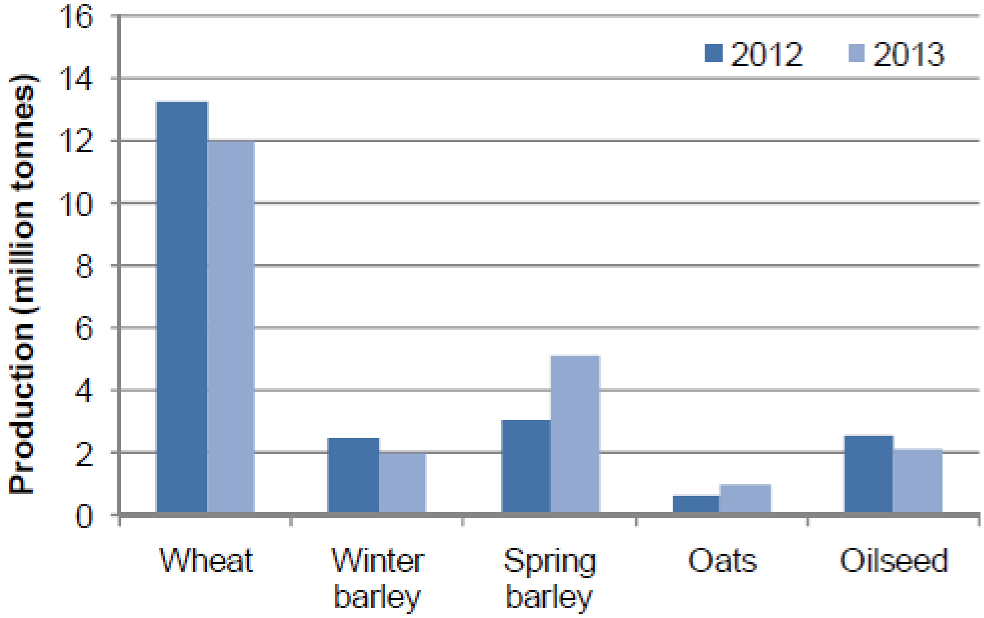
While in the United Kingdom in March 2012 and July 2012, the author had the opportunity to meet with farm organizations, government, private sector companies, research institutions and farmers that are involved in agriculture and research in the United Kingdom. Through meetings and a review of literature, a perspective was gained on many of the efforts the British have made to increase the level of farm productivity by structuring their research and development programs.

The UK is different from Canada in many ways: it has a relatively small land area, and a larger population (63,134,171 according to Word Population Review, 2013). Population density is much higher in the UK than Canada, and in 2010, there were 255 people living in every square kilometre of land which ranks it twelfth in the world. Canada as a whole has a population density of just 3.41 people per square kilometer overall. However, like Canada, agriculture is an important part of their rural economy and grain production is a significant part of their landscape.

GRAIN PRODUCTION IN THE UNITED KINGDOM

The United Kingdom has a long history of grain production and research. According to DEFRA (2013), the total utilized agricultural area in the UK is 17.3 million hectares (39.6 million acres). About a third of the total agricultural area is crop land, totalling 6.3 million hectares (15.8 million acres). Wheat is the dominant crop and since 1984, the wheat area has fluctuated between approximately 1.6 and 2.1 million hectares (4.0 and 5.3 million acres) (DEFRA (2013).

Figure 12: Crop production in the UK: 2012 and 2013 DEFRA (2013)



Wheat is grown throughout most parts of the UK, with the greatest concentration of production in the eastern part of the country (Figure 13). Farmers in the United Kingdom produce some of the highest yielding wheat in the world. In 2013 wheat harvest for the UK was 11.9 million tonnes, with yields averaging 7.4 tonnes per hectare (about 108 bushels per acre). Despite the high absolute grain yield per acre, UK farmers have not experienced significant increases in average yields on farm over the past 20 years (Figure 14). Farmers, government, and industry have recognized the need for wheat yield to increase if UK farmers are to remain competitive and have responded by launching several new initiatives and research partnerships. It is with this in mind, the author set out to understand the current state of research and innovation in the United Kingdom.

Figure 13: UK Wheat Growing Regions (Spectrum Commodities, 2012)

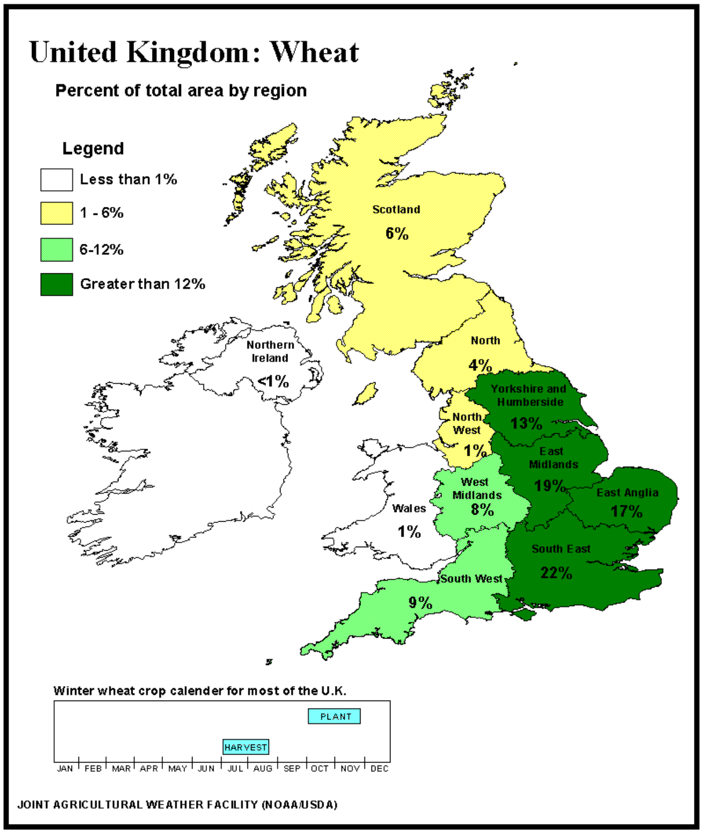
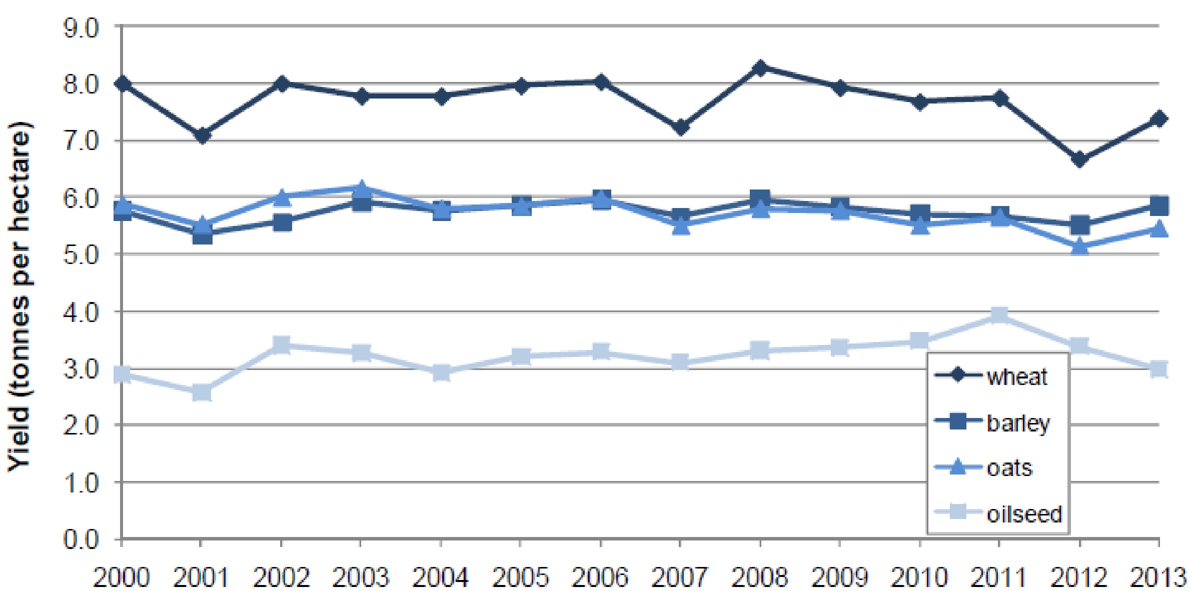


Figure 14: UK Crop Yields between 2000 and 2013 (DEFRA 2013)



UNITED KINGDOM RESEARCH AND DEVELOPMENT STRUCTURE

The United Kingdom has a long history of research and development aimed at improving productivity of grains. A recent report by Galushko, V. and Gray, R. (2012), provides a detailed description of the many changes that have occurred in the UK wheat research system. One of the most significant changes was the privatization of wheat breeding programs. In 1987, Cambridge's Plant Breeding Institute (PBI) was sold to Unilever marking an end to public wheat breeding in the UK. The Plant Breeding Institute (PBI) held a dominant position in the history of the UK wheat research industry for many years prior to its privatization. Today, most wheat breeding programs in the UK are led by private companies, including Limagrain, KWS, RAGT, and Syngenta (Galushko, V. and Gray, R. (2012)). However, there is a significant amount of research conducted through the levy organization, Home Grown Cereals Authority (HGCA) and independent research institutions such as Rothamsted Research and NIAB-TAG. The author had the opportunity to meet with representatives from each of these organizations to learn more about their current research strategy, targets and collaboration.

HOME GROWN CEREALS AUTHORITY (HGCA)

The Home Grown Cereals Authority (HGCA) is the cereals and oilseeds division of the Agriculture and Horticulture Development Board (AHDB), a statutory levy board, funded by farmers, processors and others in the supply chain and managed independently of both commercial industry and of Government. Its stated purpose is to make the agriculture and horticulture industries more competitive and sustainable through factual, evidence-based advice, information and activity.

HGCA Mission, Scope and Structure

HGCA is considered a value chain organization that is responsible for addressing the needs of farmers and the downstream processing industries. Its mission statement is 'To deliver a world-class arable industry through independence, innovation and investment' (hgca.com). The HGCA Board is made up of grower and processor representatives, an independent member and a Chair. The Board is responsible for setting HGCA strategy and ensuring levy money is invested for the benefit of the UK cereals and oilseeds sector. Each year the Board produces a business plan which is put out to the industry for consultation.

HGCA has a research and knowledge transfer strategy that sets out how HGCA will address research challenges. The strategy identified four priority areas that guide their efforts, with environmental issues considered across all themes:

1. Increasing yield
2. Optimising inputs
3. Increasing crop value
4. Preparing the industry

HGCA has made investments in the following areas, which comprises about 50% of their total annual budget:

- Soil management
- Weed control
- Pest management
- Crop nutrition
- Varieties and breeding
- Greenhouse gasses and environment
- Grain quality
- Animal feed quality

HGCA plays a significant role in communication of research to growers and industry. For example, over 500 project reports based on these research areas are available on their website. They take a more active role in building a strong UK grain industry through the following focus areas: Consumer Marketing, Business Development and Improvement, Exports, and Market Intelligence

HGCA Budget and Funding

HGCA is funded by growers, dealers and processors in the cereals and oilseeds supply chain through a levy (check off) collected on every tonne of cereals or oilseeds sold or processed in the UK. HGCA income typically averages around £11m a year (about $20 million Canadian).

The cereals levy has two components: a grower levy and a buyer levy. When cereals are bought from a farmer, the buyer deducts the grower levy from the farmer's payment and submits it to HGCA along with the buyer levy.

The following amounts are collected per tonne:

- Cereal grower 46p ($0.85 CDN)
- Cereal buyer (dealer) 3.8p ($0.07 CDN)
- Cereal processor - animal feed 4.6p ($0.09 CDN)
- Cereal processor - non feed human and industrial 9.5p ($0.19 CDN)
- Oilseeds grower 75p ($1.39 CDN)

Contributions from growers make up the largest share of the HGCA budget. About 66% of the total £11 million in revenue comes from cereal grower levies and 17% from oilseed grower levies. The remaining 17% originates from the dealer and processor levies. At an average of 7.5 tonnes per hectare, the typical levy rate for wheat is about $6.37 per hectare or $2.55 per acre in Canadian dollars. This is significantly lower than the Australian system, which collects 0.99% of crop value. If wheat in the UK averaged $225 CDN per tonne at 7.5 tonnes per hectare, the HGCA levy equals about 0.37% of crop value.

RESEARCH INSTITUTIONS IN THE UNITED KINGDOM

There are several independent research institutions operating in the United Kingdom that provide significant agricultural research capacity. The Biological Sciences Research Council (BBSRC) is a large UK government funding institution that provides significant resources to research institutes and universities in the UK. Rothamsted Research is a major recipient of BBSRC funds and has a mandates to conduct research aimed toward the improvement of plant agriculture.

As a national science funding organization, BBSRC has a mandate to invest in research that aims to further scientific knowledge, to promote economic growth, wealth, and job creation, and to improve quality of life in the UK and beyond (BBSRC 2013). The BBSRC vision includes priorities that are directly aimed at agriculture, including:

- Feeding 9 billion people sustainably by 2050

- Developing renewable 'low carbon' sources of energy, transport fuels and chemicals to reduce dependence on fossil fuels
- Staying healthier for longer as lifespans increase and society ages

ROTHAMSTED RESEARCH

Rothamsted Research is the largest agricultural research centre in the UK and is considered to be the oldest agricultural research station in the world, operating for almost 170 years. Their mission is 'to deliver the knowledge and new practices to increase crop productivity and quality and to develop environmentally sustainable solutions for food and energy production'.

Over its history, Rothamsted Research has built itself into a centre of excellence for science in support of sustainable land management and its environmental impacts. The author had the opportunity to learn more about Rothamsted Research through a visit to the Harpenden facility.

Rothamsted Research provides significant scientific expertise and capacity to achieving their primary goal, which is to increase crop productivity and quality. While a lot of their research focus is on early stage development, such as plant metabolism and genome modelling, they conduct it within a context that shows a clear pathway to market and application.

Rothamsted Research operates within a five year Science Strategy (currently operating from 2012-2107) that provides the context and justification for all research activities at the centre. Their current strategy includes four strategy themes, each with significant multidiscipline research efforts and detailed plans (Rothamsted Research 2012):

1. 20:20 Wheat – Increasing wheat potential to yield 20 tonnes per hectare in 20 year
2. Cropping Carbon - Optimising carbon capture by grasslands and perennial energy crops, such as Willow, to help underpin the UK's transition to a low carbon economy
3. Designing seeds - Harnessing our expertise in seed biology and biochemistry to deliver improved health and nutrition through seeds

4. Delivering sustainable systems - Designing, modelling and assessing sustainable agricultural systems that increase productivity while minimising environmental

20:20 Wheat Initiative

The Rothamsted strategic theme that is most relevant to the grains industry is the 20:20 Wheat Initiative. This program has set an enormously high goal for the UK wheat industry: to more than double their wheat yield within the next 20 years, to 20 tonnes per hectare, which is about 294 bushels per acre!

Scientists at Rothamsted Research involved in the 20:20 Wheat Initiative are quick to point out that the research program extends beyond their research institution and is a truly global research initiative.

The 20:20 Wheat theme is organized into four main programs:

1. Maximizing yield potential
2. Protecting yield potential
3. Determining soil resource interactions
4. Using systems approaches to crop improvement

The head of the 20:20 Wheat program, Professor Martin Parry, explained to the author that to achieve the desired outcome, the research program requires a long term strategy, and a range of disciplines and integrated approaches. His view is that Rothamsted Research can play a role in building strategic links and scientific collaboration with key players internationally. Not only will the benefits help farmers in the UK, but the results can be applied around the world. He also noted that the scientists are motivated by involvement in large programs like this because it provides clear overall targets and an opportunity to see exactly where their efforts will make a difference. Faced with a clear target, growers, scientists and industry stakeholders are working together to achieve the goal.

NIAB-TAG

Like several other research institutes in the UK, NIAB-TAG has a long history. NIAB (National Institute of Agricultural Botany) was created in 1919 when Britain faced a food crisis at the end World War I, and is headquartered in Cambridge, among some of the oldest and well regarded educational and research institutes in the world. It has played a role in supporting development of crop varieties and bringing new technology to farmers through research programs. The organization has evolved over time and in 2009 NIAB and The Arable Group Limited (TAG) joined forces to create a national, independent crop research and information centre, NIAB-TAG.

NIAB-TAG's mission statement is 'to provide independent science-based research and information to support, develop and promote agriculture and horticulture; helping the industry to fulfil its potential in supplying food and renewable resources, while respecting the natural environment.' This is best summarized in their tag line: 'Plant Science into Practise', which can be found posted throughout the research institution.

NIAB-TAG is a major centre for research in plant science, crop evaluation and agronomy and has three main focus areas:

1. Genetics and breeding: Supplementing commercial plant breeding by linking applied research to upstream genetic research
2. Varieties and Seeds: Variety evaluation, seed certification, seed testing and verification services
3. Crops and Agronomy: Crop and field research and delivery of information directly to farmers through a network of crop advisors.

NIAB Innovation Farm

One of the new initiatives undertaken by NIAB-TAG is the creation of an 'Innovation Farm' at their Cambridge research centre. The Innovation Farm is a networking and demonstration facility aimed at highlighting progress in crop genetic improvement, and showcasing new plant traits and crops that could increase in production in the UK. The Innovation Farm is designed for visitors and several events and workshops are designed around the farm. The Innovation Farm is doing an effective job of showing how scientific research provides practical value to farmers and the greater population. The farm puts specific emphasis on four key areas that crop genetic improvement has addressed global challenges:

Figure 15: Key Focus Areas for the NIAB Innovation Farm

1. Food Security – Securing food supplies to keep pace with a growing population
2. Climate Change – Predicting and responding to the threat from pests, diseases and extreme weather
3. Sustainable Resources – Producing more food using less land and few resources
4. Health and Nutrition – Improving and maintaining the nutrition and health properties of our crops.

Discussion and Conclusions

Evaluation of research programs and partnerships across countries is a more qualitative than quantitative process. It is challenging to directly compare systems across countries because there are so many variables and each country has a unique history and industry structure. For the purpose of this investigation, the value of travel was in the discovery of the systems and not necessarily a numerical analysis of their success or failure.

One of the goals of this project was to look at research systems outside of Canada. The research programs studied had many attractive elements, especially in the ability of End Point Royalties in Australia to return value to farmers and seed developers. However, a word of caution is advised. The design of research systems in Canada will benefit from using elements from other countries but must be designed and tailored specifically to our industry structure and business environment. For example, rapid introduction of a system of End Point Royalties in Canada may cause unintended disruption to aspects of the Canadian system that currently function well, such as the certified seed trade. Careful analysis of all aspects of major changes is an absolute necessity before implementation.

The involvement of government in research programs is strong and welcomed in Australia and the United Kingdom. Australia and the UK both have systems with significant government oversight but their research organizations operate outside of the government. While this shields them somewhat from political factors, it must be recognized that any government funding or oversight will have a degree of political influence. This could be an advantage or disadvantage, depending on the circumstances.

During travel and study, there was an attempt to speak with farmers to understand their likes and dislikes with regard to their research systems. Among farmers, levels of satisfaction with research systems are difficult to assess and would require a full study to draw firm conclusions. However, the impression gained during this investigation is that Australian farmers are very pleased overall with their research system. This was interesting to note since farmers in Australia are contributing significantly larger amounts toward research than most countries, including Canada. They must be seeing value in return for their investment.

Travelling to several countries with comparable agricultural sectors was instrumental in the author's discovery of different research systems. As a result of this investigation, three primary conclusions have been drawn:

1. Research has led to our ability to feed the world and will be even more important in the future – reinvestment is critical
2. Canadian farmers have the opportunity to lead in creating a vision, developing partnerships and ensuring research results accrue to investors

3. International research linkages provide a significant opportunity for Canada and should be expanded

It is the author’s hope that the perspective and descriptions in this report will be of help to Canadian farmers, government and industry in evaluating and designing research programs and systems that will ensure a prosperous future for Canadian agriculture.

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