APPENDICIES

Environmental Scan

This environmental scan identifies emerging trends, issues, and opportunities in Alberta agri-industry and then relates these to overall agri-industrial R&D requirements.

1. INDUSTRY TRENDS

Agriculture is Alberta's largest renewable resource-based industry and it is still the defining characteristic of much of rural Alberta. The number of commercial farmers in Alberta (i.e. sales > $100,000/year), however, has now declined to about 17,000. (Census 2001) In addition, there are about 10,000 lifestyle/retired farmers, and another 20,000 or so acreages. Over time, farms will become increasingly bimodal and increasingly diverse:

The total number of Census farms (2001) is 53,652; down from about 59,000 in 1996. Forty-four percent of all farm operators are over 50 years old. (1966) The sector has average annual gross sales of about 8 billion dollars plus or minus about $2 billion, depending upon external factors (1994-1998), while generating an average value-added of about $2.8 billion/annum. (Figure 1) This represents about 20 percent of Canada's total agricultural output.

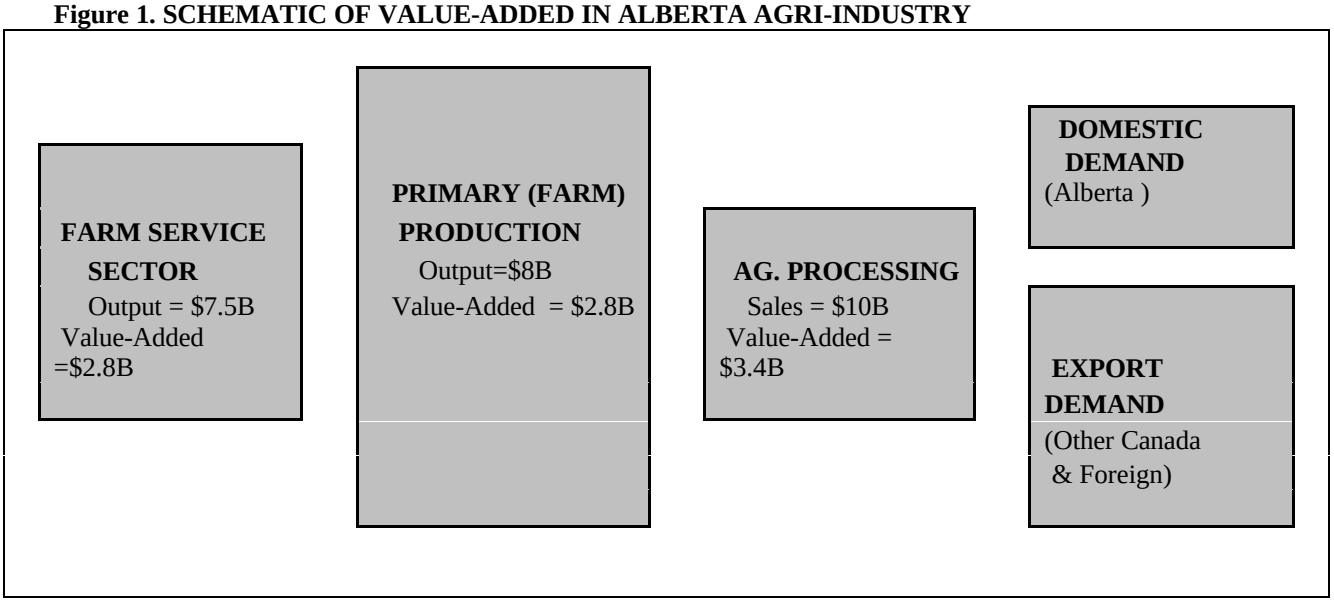
At the same time, there has been a parallel consolidation of the farm supply industry: fertilizer, pesticides, farm machinery, and so on. These technologically-determined backward linkages are indirect spin-offs which ripple throughout the local economy to generate additional output, value-added, employment, and incomes. For every commercial farmer, there are about 1.5 farm supply personnel. Annual farm supply sales (and value-added) are similar to primary agricultural production levels. (Figure 1) This activity is increasingly concentrated in a few larger rural service centers.

Growth during the last decade has been most pronounced in the agri-processing sector. With about $10 billion in shipments, this is Alberta's largest manufacturing sector and represents about 13 percent of all Canadian food and beverage shipments. This sector employs about 22,000 people and generates an additional $3.4 billion or so in value-added. (Figure 1 and Table 1) Agri-processing has a relatively large meat and poultry component (33%), followed by beverage products (11%), dairy and vegetable products (each at 9%), and flour products (8%). In terms of value-added, about 46% of the meat and poultry processing and 58% of the vegetable processing is located in the irrigated south. The ratio of agri-processing receipts to farm receipts is now approximately:

Irrigated Area	2.66
Other Alberta	1.05
All Alberta	1.25

Agri-processing outside of the irrigated south is still limited. Comparable ratios in Oregon and Washington State are 1.7 and 2.1 respectively. Unlike backward linkages which are generally technologically-determined, the relative size of these forward linkages is largely determined by the prevailing socio-economic milieu.

Figure 1. SCHEMATIC OF VALUE-ADDED IN ALBERTA AGRI-INDUSTRY



Total value-added in Alberta Agri-Industry = approx. $2.8B + $2.8B +$3.4B = $9 Billion.

Value-added = rents, wages & salaries, and a return to capital (interest & "profit") in Alberta..

In total, the rural population has gravitated to larger urban centers and a few larger rural service centers. Small rural communities and more remote rural populations (exclusive of the Edmonton-Calgary-Lethbridge corridor) are generally contracting. During 1996-2001, however, the total rural population grew about 2.8 percent. (Census 2001). A gradual strengthening of micropolitan (vs. metropolitan) regions should increasingly blur the traditional urban-rural dichotomy.

2. CHANGE AGENTS

There are six over-arching trends which will likely continue to drive changes to the structure, conduct, and performance of agri-industry in Alberta (and Alberta's psyche) during the next decade or so:

- The globalization of our culture, commerce, and communications is, increasingly, all-pervasive. This accelerates growth, change, as well as adjustments to change.
- Continued but dispersed urbanization/suburbanization. Computer networks will increasingly support distributed economic and technical systems, e.g. vertical integration. Cities generally provide goods and services with a higher and frequently appreciating value-added. At the same time, there has been a decline in the relative real value of rural raw materials; products which continue to gradually decrease in real value and consequently squeeze relatively low value-added margins even more. Urban/suburban/acreage growth and more intensive agri-industry is gradually displacing lower-valued activities and putting additional pressure on the eco-system (esp. the Edmonton-Calgary corridor).
- A growing consumer demand for natural, wholesome, safe, high-quality food products. This is largely being driven by: a) a growing recognition that healthier diets/foods will affect future health costs; and b) an increasingly affluent but aging population, particularly in Western Europe and North America.
- Growing concerns about the sustainability of our ecosystem as reflected by the need for: a) more holistic resource management and adaptation to environmental change; and b) the

greening of markets (e.g. by incorporating external costs into the marketplace) to reduce the ecological footprint of both production and consumption.

- Increased risk and uncertainty, especially due to physical phenomena (such as droughts and floods), political instability (e.g. terrorism), complex and highly calibrated technologies (which either work superbly or not at all) and increasing slow/ineffective institutional response times.
- Accelerated developments in science and technology to try to successfully balance growth with environmental sustainability and quality-of-life objectives. This is a paradigm shift from just improving existing technologies to further reduce unit costs to developing entirely new technologies. North America and Europe, in particular, now increasingly want environmentally benign growth which also enhances their quality of life (e.g. biopharmaceuticals) rather than just further augmenting total consumption levels.

Each of these six over-arching trends has a multitude of socio-economic, institutional, environmental, and political (governance) sub-themes

3. THE COMPETITIVE ENVIRONMENT

Freer trade and freer markets have, unfortunately, not yet translated into a level playing field. Dozens of variables affect our competitive position in each and every market niche and competitors are constantly tweaking these variables. Traditional siting factors (e.g. proximity to markets) will continue to decline in importance while technology, social capital, and market infrastructure will continue to increase in importance. In the bulk agri-commodity market where real prices have been gradually declining, competitors employ a multitude of transparent and non-transparent subsidies to try to brake this long-term trend. Comparable Producer Subsidy Equivalents highlight these very different support levels between countries and indicate Canada now has a relatively low level of protection (i.e. crops 10%; poultry and dairy 25%).

At the same time, increasingly large multinational corporations have a growing impact on private R&D investment patterns in the province. Pfizer (one of the world's largest drug companies), for example, now has annual revenues in excess of US$48 billion and a research budget of more than US$7 billion. To put this in perspective, the entire R&D/TT budget for agri-food research in Alberta is now about Cd$134 (FY 2000/01) million/annum while Alberta GDP is about Cd$150 billion/annum, and total GOA spending is about Cd$ 20 billion/annum.

Perhaps most seriously, Alberta's competitors are generally already far ahead of Alberta in changing their R&D systems to reflect the demands of the new global marketplace and related change-agents (see above). Efforts to boost biotechnology in Finland, for example, have already spawned some 180 research groups, 14 biotech graduate schools and several science parks and bio-centres dedicated to biotechnology. As a consequence, it already has some 120 small and medium-sized biotech enterprises employing 4,000 people and producing total sales of some Cd$1 billion/annum. International pharmaceutical companies approximately double these totals. With about 5 M people (Alberta = 3M), Finland is about ½ the size of Alberta.

A key element of this new systems approach to agri-R&D are strong, world-class research-based universities and related institutions. These institutions not only generate new technologies but they also attract investment and a critical mass of outstanding people. This synergy, in turn, enhances public knowledge, quality-of-life, and the widespread adoption of best management practices. Prerequisite R&D is an acknowledged engine of sustainable socio-economic growth. Similar concerted R&D system development is also well underway in Australia, New Zealand, Denmark, Netherlands, U. K., U.S.A., and in Canada, Ontario, Quebec, and Saskatchewan.

In short, like Finland, we know that we can't compete with the brute force of money like larger countries. We have to be strategic and compete on the basis of world-beating social software –highly trained, highly motivated people who know where they are going and how they are going to get there. This is the central role of a well-funded ,comprehensive, and very strategic R&D system.

4. THE CHALLENGE

There are two overriding and inter-related longer-term challenges: 1) can Alberta agri-industry establish and/or maintain a competitive advantage in select agriculture-based sectors in the national and international marketplace? This relative efficiency will determine its future growth potential. And: 2) can Alberta agri-industry aggressively and successfully adapt to the ever-changing environmental and social agenda?

The central problem in the agricultural sector is how to capture more value-added in the rural sector on a sustainable long-term basis. Increasingly, the agricultural production (growth) paradigm of the last century is perceived as being neither economically sustainable nor environmentally sustainable.

Increasingly intense international competition for bulk commodities (e.g Mexico, Brazil, China and India), accompanied by the continued contraction of traditional importers (USSR, China, etc.) is also almost a certainty.

Growing urban-driven social-environmental concerns in Alberta (and elsewhere in N. America and Europe) will also almost certainly make future broad-based agricultural growth even more difficult:

- Growing restrictions on confined feeding operations (CFO's) and growing NIMBY (Not in My Back Yard) and special interest political success.
- Growing concerns about food safety. E.g. emerging on-farm HACCP –Hazard Analysis and Critical Control Point; a new 2002 USA country-of-origin beef labeling provision.
- Continued public anxiety about Genetically Modified Organisms (GMO's), particularly in Europe.
- Growing urban concerns about animal welfare: growing opposition to confined feeding and long-distance livestock transport, vegetarianism, opposition to domestic animal hunting farms, etc..

- An increasing focus on the need for whole-farm nutrient management. E.g. eventually switching from using N-criteria to using more restrictive P-criteria for sustainable manure management.
- A gradual requirement for formal on-farm environmental plans and improved environmental management. This will affect the disposal of toxic wastes, operator licensing (e.g. spraying), professional sign-off requirements (e.g. CFO plans), and so on.
- Increasing pressure on and competition for traditional agricultural resources, especially land contiguous to urban areas and provincial water resources. E.g. acreage and ranchette growth in the Barrhead-Claresholm corridor and growing water conflicts (re: Highwood, Bow, Red Deer, etc. and 2002 provincial Water Strategy.)
- Revised GDP accounting (to account for resource depletion), the Kyoto Agreement, carbon credits, and so on.

These and related pressures on the agricultural sector will generally increase total (public+private) costs of production and, thus, potentially make them less competitive in the international marketplace.

5. OPPORTUNITIES

Alberta already has a very strong human and physical and resource base which, when combined with a highly entrepreneurial culture, creates a dynamic outward-looking "can-do" people. Compared to many of its potential competitors (esp. in Europe), a relatively large land base (660,000km^2), a low population density (4.5/km^2), access to ample fresh water, and the limited use of pesticides all provide Alberta with some additional advantages in agri-industry. The financial resources of the province, as well as existing social and physical infrastructure, are also uniquely available to mobilize this potential.

Thus, although the challenges are daunting, many of them have the potential of being translated into very real opportunities for Alberta agri-industry:[1]

- Fully prepared gate-to-plate foods with complete quality (health & nutrition) and portion control. This would represent a large extension of the (existing) conventional food processing sector. It also probably implies vertical (or distributed) system integration and gate-to-plate tracking.
- Development of unique identity-preserved commodities. This includes: a) organic foods; b) ethnic foods; and c) distinctive high-end products and other niche markets, e.g. Alberta Beef specialties.
- Development of functional foods and nutraceuticals. These would produce bio-enzymes, steroids, vitamins, antioxidants, etc.. As designer foods these could replace many vitamin supplements, medicines, etc..
- Natural health products –traditional medicines, dietary supplements, and extracts from biological sources. This includes additives to cosmetics.
- New environmentally-friendly cost-reducing production technologies. E.g. bio-pesticides (re: integrated pest management), cereal nitrogen-fixation, more drought-resistant plants, and more large-scale nitrogen-fixing legume production- –fababeans, chickpeas, etc. similar to that of Saskatchewan. This also includes more whole farm system development which is ecologically sustainable, i.e. resource re-cycling.
- Increased emphasis on sustainable agriculture which is more complimentary to urban development: nurseries, golf courses (18 hole greenbelts), and turf farms, pick-your-own fruits and

[1] Virtually all of these have already been identified and detailed elsewhere. See especially: S. J. Campbell et. al. (1999), and Serecon-Toma/Bouma-Campbell (2001).

vegetables, Christmas trees, hayrides, crop mazes, ranchette-leasing, rural bed and breakfast, nature trails, horse/quad/ski trails, fishing holes, and so on. This embraces multiple-use resource management.

- Increased custodial responsibility by the rural community for environmental amenities. These include presently "free" environmental goods such as wetlands, woodlots, species management, landscape heritages, etc.. This builds on the WTO "green box" multifunctionality concept.
- Development of bio-fuels, including ethanol (extracted from wheat) and bio-diesel (extracted from a new oil mustard), bio-lubricants, and bio-plastics.
- Production of bio-mass for industrial uses and carbon credits. This includes cereal straw (for strawboard), aspen (chemical feedstocks), and hemp (oil and fibre).

The "importance" of each of these, as reflected in agricultural R&D priorities in the province, largely depends upon the accounting perspective employed.

6. RESEARCH & DEVELOPMENT SYSTEM

6.1 Rationale

Publically-funded research is mandated by three limitations inherent to a typical mixed market-driven economy: a) inter-generational equity; b) externalities; and c) structural imbalances. *Inter-generational equity* addresses the issue of valuing future costs and benefits such that sustainable development is assured, e.g. nature's thresholds and very long—term values. *Externalities* refer to costs and benefits which are external to the financial calculus of a market economy, e.g. third party pollution or exhausting a fishery –sometimes called the "tragedy of the commons". *Structural imbalances* simply acknowledge that a mixed market economy does not always grant everyone equal access to knowledge and management. This is the underlying rationale for providing public support to primary agriculture and infant industry. A market economy can generate efficient growth (i.e. making the economic pie as large as possible) but it cannot, without public input and public R&D, guarantee sustainable development.

6.2 Research Priorities

In conjunction with short-term profitability, it is imperative that enhanced publically-funded agri-industrial R&D continue to also give due consideration to inter-generational equity, externalities, and structural imbalances in its screening and monitoring activities. More specifically:

- Value-added. It is the value-added (and not the $ value of shipments) which basically determines the potential economic benefit to Albertans. These wages, salaries, resource rents, and profits (i.e. GDP) are what accrue to Albertans. See Table 1 for some comparative estimates.
- Social/environmental criteria. These "externalities" must also be internalized to accurately measure the social costs and benefits of any particular R&D or investment initiative. This includes all anticipated environmental and quality-of-life impacts. It has repeatedly been shown that, given a market-driven price

structure, there is often a tradeoff between efficiency and environmental sustainability.

- The incidence of value-added, particularly with respect to how it impacts on the vitality of farm & rural communities ($ capture by primary agriculture and backward linkages). Only looking at the potential of agri-processing can obscure the parallel contribution to value-added (i.e. GDP) made by primary producers (i.e. farmers), as well as the accompanying agri-service sector. (Figure 1)
- Total social net present value. This is the cumulative absolute dollar value-added over time. This measures scale.

This helps put the vast number of agri-industrial opportunities (above) and their underlying R&D requirements into better perspective:

1. Conventional food processing still represents about 75% of the agricultural processing sector. But recent growth-rates in conventional food processing are unlikely to be sustainable. Two new world-class slaughter plants and two new world class potato processing plants during the last decade generated an investment bubble. Relatively low value-added characteristics, in conjunction with related social/environmental considerations, will probably discourage any future developments of this frequency and/or magnitude. Strategy: Further upstream processing and identity-preserved tracking.
2. Pharmaceutical/medical/related products made from agriculture food and fibre show tremendous potential and could generate very large world-wide consumer benefits. But this would largely be an urban development phenomena (in Alberta) with the potential for only a relatively small trickle-down effect in the farm/rural community.
3. In terms of being "green" as well as having the potential to provide a big impetus to both urban and rural communities, the greatest unleashed agri-industrial opportunities in Alberta probably involves the following:
    i. New environmentally-friendly crops and cost-reducing production technologies
    ii. Urban agriculture
    iii. Joint-product environmental amenity "production"
    iv. Production of bio-fuels, bio-lubricants, and bio-mass.

6.3 R&D Funding Requirements

Gross Domestic Product (GDP), or value-added, measures growth. Value-added consists of the wages, salaries, resource rents, and profits which accrue to Albertans. High quality science and scientists generate knowledge and management capability; the principal engine for growth and sustainable development.

More advanced societies invest more in science and technology than less developed jurisdictions. Highly-developed Finland, for example, spends 3.3% of its GDP on R&D. Even Ontario and Quebec spend 2% and 2.4%, respectively. Total R&D as a percent of GDP in Alberta is a relatively low 0.9 percent. Using the USA as a benchmark, and totally ignoring growth requirements, the increase in R&D funding suggested for Alberta

agri-industry would amount to between 13 and 44 percent; or between $15 and $50 million. This is just annual catch-up funding.

The projections in Table 1 indicate a parallel need for an annual increase in R&D funding of about 9 percent (or $22 M) per annum. The implied total R&D funding level required in 2010 is about $355 million per annum. This would be bracketed by the R&D funding patterns projected for Finland (higher) and Ontario (lower). (Table 2 and Figure 2)

Private-sector agri-industry R&D funding in Alberta is a relatively low 22 percent. In Ontario about 1/3rd of all agri-industry R&D comes from industry while in the USA and Finland it has now climbed to about 56 percent and 68 percent, respectively.

6.4 Public R&D Data Management

With a growing need for more accountability and more "due diligence", hard empirical data becomes even more important. Baseline data is badly needed which is consistent with the newly-established Strategic Research Networks. For effectively tracking/monitoring R&D outputs, outcomes, and impacts over time, the existing database) is particularly inadequate –especially as it relates to agriculture's impacts on the eco-system. This might be strengthened by the predicted worldwide use in five to ten years of billions of inexpensive biosensors to monitor the environment, human activities, and industrial processes. (Facing the Future, May 2002)

Table 1. PROJECTED GROWTH OF THE ALBERTA AGRI-PROCESSING INDUSTRY

Sector	1996 Value of Manufactured Shipments $million	2010 High Growth Projection $Shipments	Source of Value-Added Growth (%)	% Value-Added per $ of Sales*
Plants & Plant Products:				
Oilseeds & Oilseed Products	506	1,378	3%	0.17
Cereals & Cereal Products	228	875	6%	0.5
Potato & Potato Products	178	843	7%	0.62
Vegetables excl. potato	55	227	1%	0.45
Special Crops	93	191	1%	0.3
Sub-Total $ Shipments	**1,060**	**3,514**		
%/yr. Growth		**8.95%**		
Sub-Total $ Value-Added*	**363**	**1,354**	**18%**	
%/yr. V.A. GROWTH		**9.85%**		
VALUE-ADDED/SHIPMENTS	**34%**	**39%**		
Livestock & Animal Products:				
Beef including Forage	2000	5,000	12%	0.23
Dairy & Dairy Products	648	1,300	5%	0.46

Poultry & Poultry Products	321	1,100	4%	0.32
Pork & Pork Products	451	1,674	5%	0.25
Processed Meats	580	2,500	10%	0.3
Alternate Livestock	25	181	1%	0.35
Sub-Total $ Shipments	**4,025**	**11,755**		
%/yr. Growth		**7.96%**		
Sub-Total $ Value-Added*	**1,156**	**3,332**	**39%**	
%/yr. V.A. GROWTH		**7.86%**		
VALUE-ADDED/SHIPMENTS	**29%**	**28%**		
Niche Processed Products:				
New Uses	100	1,800	18%	0.6
Beverages	584	1,940	14%	0.59
Specialty Foods	190	762	6%	0.6
Malt	104	358	1%	0.3
Feed Products	340	607	1%	0.23
Pet Food	58	102	0%	0.3
Animal By-Products	175	551	2%	0.3
Sub-Total $ Shipments	**1,551**	**6,120**		
%/yr. Growth		**10.30%**		
Sub-Total $ Value-Added*	**697**	**3,107**	**43%**	
%/yr. V.A. GROWTH		**11.26%**		
VALUE-ADDED/SHIPMENTS	**45%**	**51%**		
TOTAL $ SHIPMENTS****	**6,636**	**21,389**		
TOTAL %/yr. Growth**		**8.72%**		
TOTAL $ VALUE-ADDED*	**2,216**	**7,792**	**100%**	
TOTAL %/yr. V.A. GROWTH		**9%**		
VALUE-ADDED/SHIPMENTS	**33%** ***	**36%**		

*Approximate. Based on Canada-wide data, 1996.

** Actual average annual rate of growth during 1997-2001 = 7.6% per year.

***Identical to the average for all of Canada.

**** Basis of $20 B "value-added" policy objective.

Source: Basic data in: S. J. Campbell Investments **et. al**., **Growth Strategies & Research Investment in Agricullture & Food in Alberta**, July 1999.

Table 2. R&D OPERATING & CAPITAL REQUIREMENTS ($M)

Source	Annual Investment Requirement ($M)	Av.Increase per Year ($M)
Baseline 2001/02	134	
Baseline 2001/02 Adjusted	150	

2010 Requirement:		
Increase of 9% per year (Table 1)	355	22
2% of GDP (Ontario)*	276	14
3% of GDP (Finland)*	414	28

* Based on GDP estimates derived from Figure 1.