

**Research and Development
Strategic Directions
for
Alberta's Agriculture and
Food Sector**

Draft 7.3 - for input

**Alberta Agricultural Research
Institute**

**Research And Development
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Alberta's Agriculture And Food Sector**

EXECUTIVE SUMMARY

Introduction

Research and Development represents a critical set of tools to assist the further development and sustainability of the agriculture and food industry. The **vision from AG Summit 2000**, which represents the future vision of the industry, is **“to create a collaborative environment which supports continued growth of a healthy, productive and sustainable agri-food industry in Alberta.”** World market opportunities have been interpreted to indicate that Alberta's agriculture and food sector could grow substantially from its current \$6.5 Billion production sector to \$10 Billion and from its current value-added sector of \$ 7.3 Billion to \$ 20 Billion by 2010.

Research and Development Mission to Support Agriculture and Food Sector

The research and development system must focus on priority areas of importance to Alberta and support the continuing competitiveness of the industry. Key strengths required include:

- C leadership, collaboration, coordination,
- C internationally recognized excellence in science,
- C enabling technologies, such as genomics, proteomics, bioinformatics, ICT, and
- C effective, adequate and strategic funding.

The research and development system must be effectively coupled to a strong innovation system in order for commercialization and utilization, of knowledge and technology from research, to take place.

Strategic Directions for Alberta's Agriculture and Food Sector

The Strategic Directions recommended for further development and sustainability of the Alberta industry include:

- C A highly attractive research and development environment;
- C New value-added technology platforms in applications;
- C Increased focus on the relationship between food and human health;

- C Building innovation and sustainability into primary agricultural production for improving competitiveness; and
- C Protecting and improving environmental resources.

Strategic Investment Priorities

A shift in relative investment into various areas and an increase in total investment are proposed to take place through collaboration amongst the research performers and funders if Alberta is to have the new knowledge and technology it needs for industry growth and sustainability. Relatively increased emphasis is recommended for Life Science technologies, value added technologies and environmental sustainability research. An absolute increase in investment by all funders and performers, from \$100 million now to \$300 million by 2007, is required in all strategic areas.

Toward Implementation

In order to achieve the desired results a provincial implementation plan will be developed. Some important topics for consideration are:

- C A more integrated innovation system is needed,
- C Increased collaboration through centres and networks is required,
- C AARI will champion and facilitate change,
- C New research themes are required to meet the needs and opportunities of future markets and of sustainability, and
- C New governance approaches should be explored to effectively manage collaboration centres and networks.

Research and Development Strategic Directions for Alberta's Agriculture and Food Sector

Draft 7.3 - Revised - July 26, 2000

(Prepared by AARI Strategic Task Force; with input from AARI Board and Ag Summit)

Vision for Alberta's Agriculture and Food Sector

To create a collaborative environment which supports continued growth of a healthy, productive and sustainable agri-food industry in Alberta (Ag Summit 2000 vision, June 2000). The future includes:

- , A globally competitive agriculture and food sector which is sustainable in economic, health and environmental terms;
- , An industry which provides integrated approaches to related health and environment issues;
- , A \$30 billion sector by 2010 - including \$10 billion in primary production and \$20 billion in value added.

Research & Development Mission for Alberta's Agriculture and Food Sector

- , Focus the research and development (R&D) system in strategic directions to deliver new products, technologies and knowledge to help achieve the Alberta agriculture and food sector vision through:
 - leadership, collaboration and coordination;
 - internationally recognized excellence in science;
 - enabling technologies such as genomics, proteomics, bioinformatics, ICT; and
 - effective, adequate and strategic funding.
- , Ensure the research and development system is effectively coupled to a strong innovation system, which results in commercialization and use of knowledge and technology in Alberta. Help Alberta producers and processors meet global market needs through commercialization and use of science and technologies which are next generation, integrated and innovative.

Strategic Directions for Alberta's Agriculture and Food Sector

The strategic directions provide the focus for key research and development needed to further diversify the Alberta economy by delivering new knowledge and technologies to the innovation system, which will enable producers and processors within the food, fibre and life sciences value chains to **capture expected national and international market opportunities**.

1. A **highly attractive research and development environment** for sustained world-class research excellence in selected areas, complemented by an equally responsive and seamless development and innovation system leading to increased technology commercialization and use in Alberta. New collaborations and research approaches will be a key feature to improve efficiency of, and enhance the current R&D system and to attract and retain leading-edge people and projects.
2. **Value added technology** platforms and applications developed through research for use by Alberta's producers and processors to capture commercial opportunities in food, feed and industrial uses. Alberta must increase the ratio of value-added production to primary production, from 1:1 to greater than 2:1. This is the next economic wave for the sector.
3. **Agri-health initiative** to produce new discoveries and enhanced agriculture and food products to improve human and animal health and wellness, increase food safety, prevent disease and enhance overall quality of life, through new products like nutraceuticals and functional foods and new and enhanced technology like proteomics, extraction and process control. This offers a direct integrated sector approach for vast benefits.
4. **Build on** Alberta's competitive and resource **strengths in primary agricultural production and science**, by delivering leading- edge knowledge (such as **information on soil and rumen microflora**) and technology to develop innovative practices and sustainable production systems and to capture value added and diversification opportunities for primary production.
5. Maintain or improve **quality of our environmental resources**, through stewardship and use of best practices within an expanding sector by developing leading-edge, integrated solutions across sectors. This may include ethical, legal, policy and socio-economic research to help avoid adverse effects on the environment and respect the needs of future generations.

Strategic Investment Priorities - Alberta's Agriculture and Food Sector

Life Sciences are the next economic wave. The agriculture and food sector, depending heavily on biotechnology, has the greatest potential to expand and effectively compete for the national and international market opportunities. Therefore, the Alberta agriculture and food sector vision signals a change in direction and size, and consequently different knowledge and technology needs to meet a more specialized and diverse future sector. The investment in R&D has to adjust to ensure the knowledge and technology will be developed and delivered for the future Alberta agriculture and food sector. Investments by the private and public sectors need to be made now as a lead-lag relationship exists in research and commercialization processes. A challenge is to develop a portfolio of R&D investments that reflects the strategic directions identified as the key focus areas to achieve the agriculture and food sector vision.

The investment strategy expected to address the change in focus and approach is reflected in Table 1 (also see figs. 1A & 1B at end), which presents the R & D investment portfolio by technology area. The current amount of \$102 million annually invested by all funding agencies is seen to be too low relative to our competitors such as Ontario, USA, Australia. The **recommended amount is \$300 million annually by 2007** from all sources, with a direct link to the strategic directions. The public sector will need to be the catalyst.

Table 1: R & D Investment Portfolio - By Research Focus Area

Research Focus Area	Current Portfolio	Recommended Portfolio by 2007	Recommended Funding Ratio- Public : Private	Link to Strategic Direction	Comments
Basic Platform Technologies (eg. Biotech, proteomics)	15% \$15 M	30%	5:1	1,2	high risk, public role is key
Value Added Technologies (eg. processing, fibre, nutraceuticals, new uses)	15% \$15 M ----- \$7 B industry	30% ----- \$20 B industry	2:1	1,2,3	mid risk, shared with industrial partners
Primary Production and Enhancement Technologies (eg. Crop & livestock innovations)	65% \$65 M ----- \$6.5 B industry	30% ----- \$10 B industry	1:1	1,4	low-mid risk, shared with industry and commodity partners
Environmental Sustainability/ Socio-economic Research (eg. water, soil, air, ethics, trade, policy)	5% \$5 M	10%	5:1	1,5	emerging issues, multi-sector, long term, indirect benefits, mainly public role
Total - Alberta agriculture & food sector	\$102 M all sources	\$300 M all sources			

The strategy is also expected to address the required investment allocations in the technology development and commercialization continuum. Table 2 (also see fig 2 at end) provides the current levels of investment by R&D and commercialization stages in Alberta. It is expected that more emphasis will be placed on the development of technology and products which will effectively be commercialized.

Table 2: Agriculture & Food Technology Development and Commercialization Continuum in Alberta

R&D & C Stage	Operating 198/99 \$ Millions	Percent of Total Investment
Basic Research	16.3	14
Applied Research	51.2	45
Technology Development	20.9	19
Technology & Knowledge Transfer	17.2	15
Commercialization & Utilization	4.1	4
Unallocated	2.9	3
Total	112.6*	100

* This value is greater than \$102 in Campbell 1999 report because additional investment in commercialization has been identified.

The **basic life sciences** leading to new discoveries (for example: the understanding of evolution, biodiversity or capabilities of soil and rumen microflora) and new platform technologies (such as **genomics, proteomics, bioinformatics**) will benefit agriculture and food, and also other Alberta sectors such as health, forestry and the environment to maximize returns and benefits to the province. Joint platform and technology discoveries can be accomplished more quickly with a collaborative and integrated approach. This can be accomplished by specific research themes and integration of research organizations in mutual projects and collaborative ventures.

Specific **applied technology** areas such as: extended shelf-life, logistics and materials handling, advanced materials, data mining and precision farming, e-commerce, trace back systems, value chain management, fractionation and designer foods have the potential to provide market opportunities in many new product and technology collaborations. Markets will include domestic and export interests in foods, food for health, ingredient and industrial materials.

Current investments in crops, livestock, sustainable practices and niche products **research areas for primary production** are essential and critical to meet the vision. To maintain and enhance the production capacity in a sustainable manner, these investments will also need to increase in this vision.

Environmental stewardship and socio-economic considerations are important components of sustainable development of the industry. The industry's ability to wisely handle consumer related issues and manage natural resources and wastes are important to the maintenance of a globally competitive and environmentally responsible industry. Major emphasis is on maintaining or improving the quality of air, water and soil, and issues related to ethics, trade and marketing policies.

Alberta's Agriculture and Food R&D and Technology Development System

Alberta has a capable, collaborative and responsive agriculture and food research and development (R&D) system which has to date served the agriculture and food sector well. This system has evolved over time and has been now evaluated as requiring changes to improve efficiency and massive enhancement and expansions to meet the R&D needs of the future and to provide world class state of the art R&D support to the expanding industry in Alberta. The current **R & D system faces new challenges** and will need new approaches in adjusting to meet the 21st century's needs and opportunities.

The Alberta agri-food research and development system has some strengths to help the sector moderately meet the global markets. New and aggressive investment will be required for meeting the industry's vision. This investment will help to improve and enhance R&D and technology development infrastructure such as facilities, equipment and collaboration "backbones"- information, communications and shared databases and new specific skill sets which are not in the province, including new applications and other technologies (eg. fractionation). The investments strategies should lead to increased funds with industry partners. Commercialization and innovation system partners will also be needed. Past investments indicate tremendous returns to Alberta from all levels of the value chain. Strengthening the provincial innovation system will increase commercialization opportunities and returns to the province. Removing intellectual property barriers to new discoveries will stimulate the international industry interest in and attraction to the strong science base in Alberta.

The integrated innovation system ensures that science, knowledge and technology lead to either commercial products or industry use for competitive advantage or other benefits. Provincial and federal economic development departments, along with regional economic development agencies are the main facilitators of the innovation system, with a focus on business skills, access to capital and related commercialization topics. They work closely with many R&D system partners, industry and entrepreneurs.

As noted, the total investment in Alberta from all sources was about \$102 million in 1998/99. The source of funds was 78% from public sector and 22% from private sector. Agriculture and food R&D in Alberta is funded primarily by:

- Alberta Government Departments and agencies,
- Federal Government Departments and agencies, and

- Industry - a wide variety of companies and agricultural sector organizations.
 Agriculture and food R&D in Alberta is carried out at a variety of facilities, which are mostly public sector:

- Agriculture and Agri-Food Canada, (44%)
- Universities of Alberta, Calgary, and Lethbridge, and some Colleges, (24%)
- Alberta Agriculture, Food & Rural Development, and Alberta Research Council, (24%)
- Industry (11%).

(**Note:** The numbers above in brackets indicate the percent of research funding performed. Public sector facilities conduct 89% of the research funding invested annually.)

Alberta has nationally and internationally recognized R&D expertise in many areas (Table 3), however, R&D competencies need to be up graded to develop world class science base in the emerging disciplines of **Environmental and Life sciences**. This is a fundamental requirement for developing and supporting an environmentally sustainable agriculture and food industry.

Table 3: R&D Organizations and Areas of Expertise in Alberta

Organization	Areas of Expertise
Agriculture and Agri-Food Canada-AAFC Research Centres, Lethbridge and Lacombe	<p>Animal Sciences: beef production, cattle genetics, feed biotechnology and nutrition, livestock parasitology/insects/pests, animal behaviour</p> <p>Crop Sciences: agronomy, crop breeding and pathology (cereals, canola, potatoes, peas, forages)</p> <p>Microbiology: molecular genetics and biology</p> <p>Renewable Resources Management: soil/air/water quality, soil conservation, manure management</p>
Alberta Agriculture, Food and Rural Development-AAFRD	<p>Livestock: production practices</p> <p>Agronomy: crop breeding and pathology (cereals, canola), minor/special/horticultural crops development</p> <p>Value-added processing and product development</p> <p>Renewable Resources Management: irrigation management, soil/air/water quality, soil conservation, manure management</p>

Alberta Research Council-ARC	<p>Animal Sciences: animal health care products including vaccines, biotechnology and impact of pollutants on livestock (toxicology)</p> <p>Crop Sciences: integrated weed and pest management, biocontrol, speciality and transgenic crops development, native plant development</p> <p>Renewable Resources Management: greenhouse gas mitigation, air emissions, waste and landscape management, aquaculture and water management</p> <p>Bioinformatics: data mining and system development and management</p>
University of Alberta	<p>Animal Sciences: dairy, beef, swine and poultry production, cattle genetics, feed biotechnology and nutrition, livestock parasitology/insects/pests, animal behaviour</p> <p>Crop Sciences: agronomy, crop breeding and pathology (cereals, canola, forages and vegetables)</p> <p>Food Science: Functional and health food product development</p> <p>Microbiology: molecular genetics and biology (biotechnology)</p> <p>Renewable Resources Management: soil/air/water quality, soil conservation, waste management</p> <p>Rural Economy: resource and production economics and marketing</p>
University of Calgary	Plant biotechnology, vaccine development and health linkages with agriculture production and food safety
University of Lethbridge/AAFC	Proteomics, beef production
Olds College (OCCI)	Horticulture, composting and agri-equipment development

The best expertise will likely need to lead specific research theme areas to enable Alberta to cluster expertise and labs, marshal scarce resources and achieve new breakthroughs within shorter time frames.

Rationale for New R&D Investment Strategy

The agriculture and food industry is a science based business. Research and technology is essential for a modern industry and offers the potential to increase industry efficiency, improve productivity, diversify output and enhance environmental quality. The best R&D and technology development & commercialization capability and expertise will certainly be **needed to effectively compete in national and international markets.**

Life Sciences is the wave of the future. The agriculture and food sector, which together with health depends heavily on biotechnology, has the greatest potential to effectively compete in the global market. World class facilities and expertise in ag-biotechnology is required to capture market opportunities in the expanding sector of genetically modified products including functional foods, nutraceuticals and other industrial ingredients and materials.

State of the art R&D capabilities and world class expertise are also required to develop and maintain a globally competitive and environmentally responsible industry. It is also important to carefully respond to consumer demands and market needs through competent management (based on scientific findings and facts) of our natural resources and industry wastes **to maintain an environmentally sustainable industry.**

Toward Implementation - Turning Strategy into Action

Agriculture and Food R&D is performed by a number of research agencies and centres geographically distributed across Alberta. This contrasts with other jurisdictions in Canada and elsewhere. Development of the Alberta implementation plan needs to consider whether the distributed system can be more efficient through collaboration or whether a more centralized, cluster approach is needed. A few approaches and models are proposed to achieve the desired outcomes of the strategy.

Collaboration and Networks

To achieve the industry vision, Alberta R&D system partners need to jointly embrace the new sector vision and coordinate their R&D efforts and their roles. The sector vision and strategies need to be aligned with the overall provincial vision and R&D strategy, especially the Life Sciences Strategy.

To meet the investment priorities, will mean effectively agreeing on roles and responsibilities, coordinating allocation of resources and leveraging resources with R&D partners. Alberta has a long established and networked research delivery approach involving many public and private sector collaborators. Although the sector has its roots in primary agriculture, the sector is now realizing many new and vital linkages to other Alberta sectors, including value added products and other directly related sectors of information systems, telecommunications and health.

Alberta R&D agencies will need to coordinate and align their research goals to meet this aggressive agenda. Criteria to consider in priority setting include: risk/ return of the research investment; infrastructure, research investment levels and timing; current investment mix; science and technology personnel, and collaboration approaches to minimize duplication. Research investments will be performed by different players in the Alberta system aligned with the strategic directions for R & D.

Currently, AARI provides R&D funds to several R&D performers for research projects in identified priority areas. These projects are of various sizes and durations. Although most projects involve several researchers, there is room for improving and enhancing collaboration among the grants recipients. Several collaboration agreements are in place with AAFRD, AAFC, ARC, universities, Olds College and industry.

Collaboration with national and international partners will be also be needed, for example, the emerging Agriculture and Agri-Food Canada Life Sciences (Biotechnology) Strategy. Further, the benefits of alliances, cooperation and coordination are not limited by jurisdictional and institutional boundaries, but by our willingness to work together for mutual benefit.

New Governance Approaches Will Be Needed

Collaboration and creating new networks which have formal structures will be needed. Several options are possible - centres of excellence or “research clusters”, a stronger innovation system, and employing specific research themes under joint management.

Centres of excellence with specific expertise are flexible structures which bind researchers and labs together through specific research themes. A centre of excellence approach needs long term dedicated public funds under a public-private board. However it is possible to start several new centres building on specific Alberta research strengths. A network hub is needed and it is very useful to consider industry associations as a partner for priority setting and partial funding.

AARI will need to define major areas and develop portfolios for R&D investment, with advice from industry and research performers. AARI may then encourage funding for agreed major multidisciplinary goal specific/oriented projects such as Centres of Excellence. Some possible examples, which have emerged from the Ag Summit process, are:

- < Functional Food Alberta Centre of Excellence (a model)
- < new- Precision Agriculture Alberta Centre of Excellence
- < new - Agriculture Fibre Alberta Centre of Excellence
- < new - Industrial Crops Alberta Centre of Excellence
- < new - Minor/Niche Crops Development Alberta Centre of Excellence
- < new - Livestock Diversification Alberta Centre of Excellence
- < new - Integrated Pest Management Alberta Centre of Excellence
- < new - Agriculture Processing Technology Development Centre of Excellence.

A much stronger research and innovation system is needed. Some successful models developed and employed by Kansas, Austin and others to start new industries and sustainable industry partnerships are well recognized and known. This “systems” approach includes agreements with university partners, creation of incubators for new spinoff companies, development of venture capital corporations and industry partners for commercialization. This approach moves the R&D system into a strong public-private partnership in an integrated and sustainable manner.

AARI will “Champion” Implementing the Sector R&D Strategy

AARI will champion developing the provincial implementation plan for the agriculture and food sector R&D strategy to achieve the vision. AARI will provide on-going leadership on strategic priorities for Alberta through consultation processes. A name change should also be considered to fully reflect the changing sector, from AARI to perhaps the Agriculture and Food Research Institute (AFRI).

Alberta needs a “champion” for the sector to achieve the vision and implement the strategic directions. The champion will strive to help others understand and endorse the vision and the research and development strategic directions in Alberta and identify their role to help achieve the strategy and the vision. Fostering new approaches, building collaborative linkages and seeking opportunities for additional **resources for people, infrastructure and operating** will be important roles.

AARI has led the sector for over 20 years through coordination, research administration, grant and matching grant programs, and industry conferences. Its operating authority derives from an Act under which it now reports to the Alberta Science and Technology Research Authority (ASRA). AARI has managed several thousand research projects, many of which have resulted in break through intellectual property and commercial benefits to the industry (for example, canola research for USA market acceptance, shelf-life extension, “hirudin” production, water quality, nutraceuticals). Other research and technology programs have addressed risk management, loss prevention and use of research results by industry.

Another approach can be employing specific research programs under AARI co-management direction to achieve strategic goals. It would be a minor mandate adjustment to the current system and may not create as many impacts as the above models. Further, funding may not be as easily leveraged from industry partners. The charts over indicate examples of each system.

Potential Topics for Future Research and Development

As noted earlier to achieve the vision will require both new approaches for maximizing the utilization of the current R&D resources and more resources to improve and enhance our R&D capability and competence. The future will have new characteristics, including: distributed intelligence and knowledge, complex technologies, continuous innovation, global economic forces, infrastructure renewal, life-long learning and scientific breakthroughs. To meet these dynamic changing events, Alberta will need priorities and specific research themes.

Ag Summit workshop and other professional discussions have proposed several critical and new areas requiring R&D support. Most of these suggestion are categorized in the following themes or focus areas:

- < **Basic Life Sciences Platform Technologies:** These includes enabling technologies such as genomics, proteomics, natural and organic genetic banks - crop and animal - for global markets; and bioinformatics, data mining and ICT applications in agriculture and food sector including agri-equipment technology interface with ICT.
- < **Value-added Technologies:** Assisting to develop industrial and new uses of agriculture products including functional foods, agri-health platforms and new industrial ingredients and materials.
- < **Primary Production and Enhancement Technologies:** To build on Alberta's competitive and resource strengths in primary agricultural production and science, by delivering leading-edge knowledge (such as **information on soil and rumen microflora**) and technology to develop innovative practices and sustainable production systems and to capture value added and diversification opportunities for primary production.
- < **Environmental Sustainability/Socio-Economic Research:** This focus area covers communications, ethics, legal, policy and environmental issues.

These research investment areas need comments. Further, lead researchers and agencies and supporting agencies need identification to crystalize the delivery strategy, be it centres, new innovation systems or specific research themes. Developing a limited but strategic number of new initiatives will help build on the current R & D system in Alberta.

Measures of Progress

It is important to understand the potential outcomes and to measure the progress after implementing this R&D investment strategy. The measures of progress may include:

Next Steps

A stakeholders meeting has been scheduled for August 3, 2000.

Please send your comments to:

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Thank you for your advice.

Figure 1A

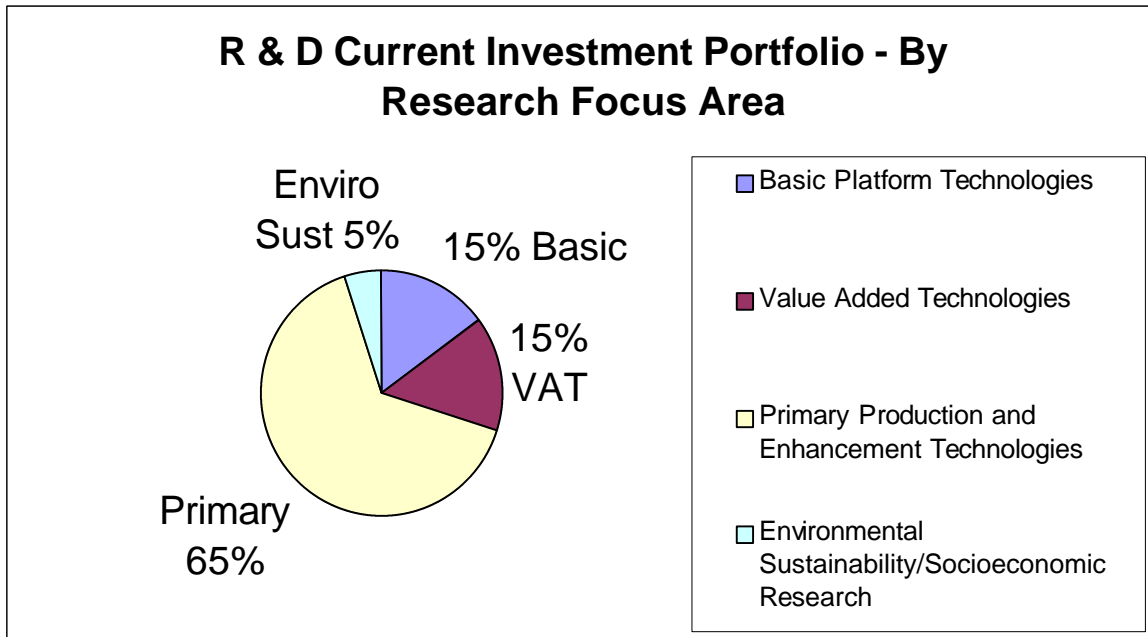


Figure 1B

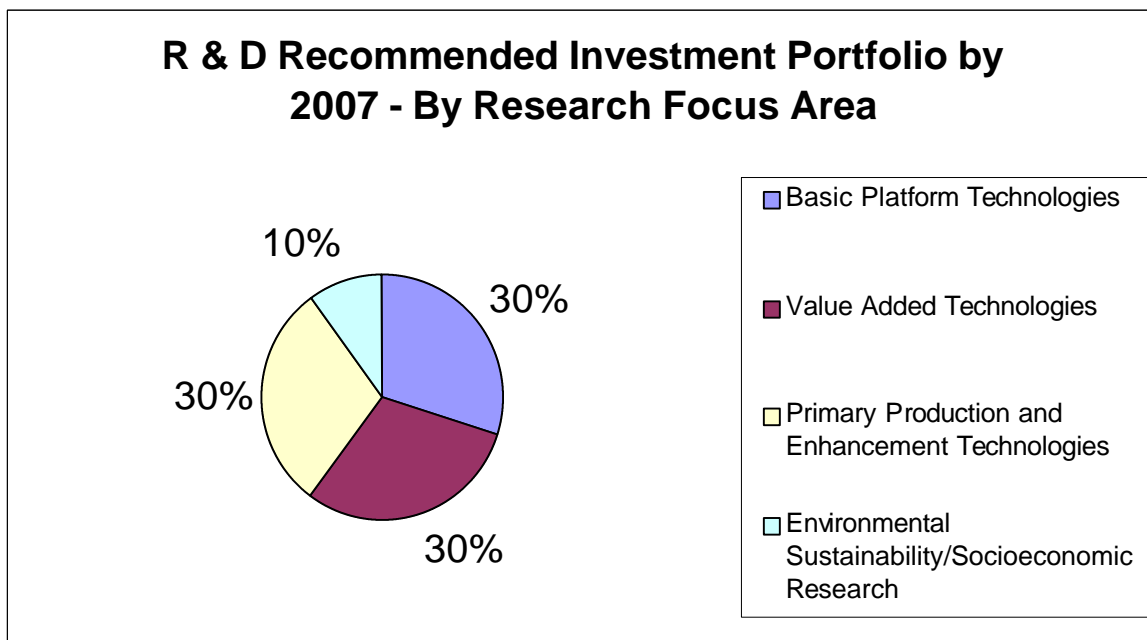


Figure 2: Distribution of 1998/99 Alberta Investment in Agriculture and Food R& D and Commercialization by Technology Continuum, from all sources (Campbell, July 2000)

