Bioproducts Development Survey:

Analysis of the Summary Results

by

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prepared for

Agriculture and Agri-Food Canada

September 2006

BIOPRODUCTS DEVELOPMENT SURVEY : ANALYSIS OF THE SUMMARY RESULTS

September 2006

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Strategic Research
Agriculture and Agri-Food Canada

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Electronic versions of Research and Analysis Directorate publications are available on the Internet at www.agr.gc.ca/pol/index_e.php

Publication 10170E
ISBN 0-662-44024-2
Catalogue A38-1/2-2003E-PDF
Project 06-052-r

Aussi disponible en français sous le titre :

Enquête sur le développement des bioproduits: Analyse des résultats sommaires

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Foreword

Recent advances in information and communication technology (ICT), biochemistry and engineering are creating a new range of environmentally-friendly replacement products which can be made from agricultural and other renewable feedstock. Referred to as bioproducts, these products are biologically-based commercial or industrial products other than food, feed and medicines made with biological or renewable agricultural (plant or animal), marine or forestry materials.

In an effort to better define the size and structure of the bioproducts industry in Canada, Agriculture and Agri-Food Canada (AAFC) commissioned Statistics to conduct the Bioproduct Development Survey in 2004. This report analyses summary tables generated by Statistics Canada representing the responses to the survey questions provided for the year 2003 and provides a basis and benchmarks for future research into size, structure and activity of the Canadian bioproduct industry. It helps us better understand the drivers behind developing bioproducts, the challenges facing the industry and the gaps in knowledge that may require future research to enable the Canadian bioproducts industry to grow.

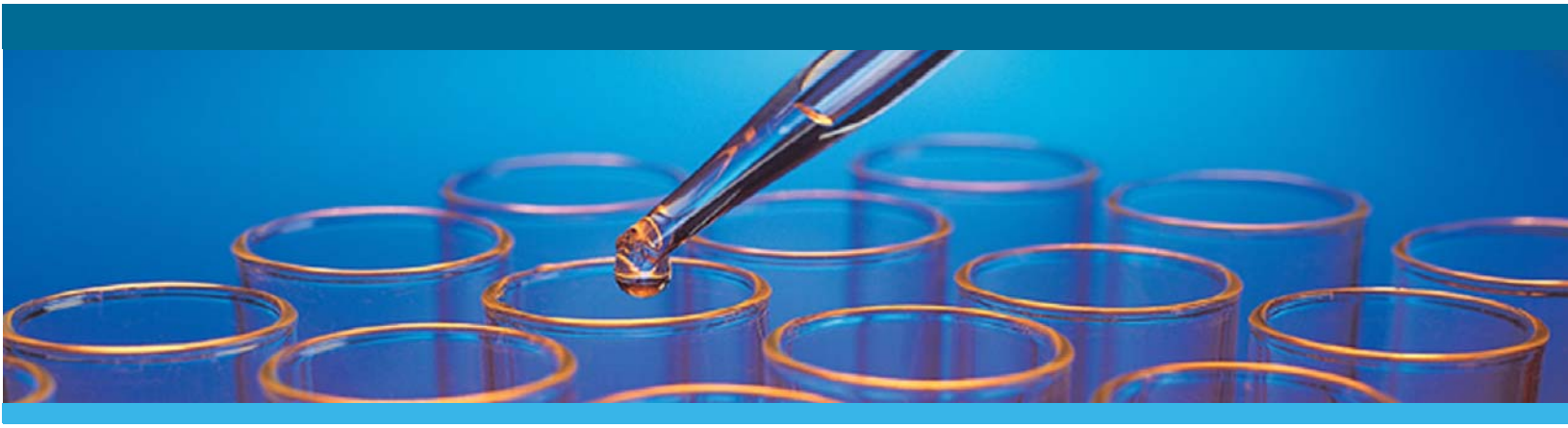
Overall, there were 232 bioproduct firms in Canada in 2003. Firms were predominantly situated in Quebec, Ontario, BC and Alberta with 82% of firms residing in these four provinces. While each region exhibited varying degrees of strengths and weaknesses, Quebec and Alberta were leaders on many dimensions (i.e. R&D, revenues, financing) while Atlantic Canada and Manitoba lagged behind the rest in several areas. Bioproduct development in Atlantic Canada appears to be behind the rest of the country with relatively low levels of research and development and limited success in accessing funding. Quebec, with the most firms in Canada, seemed to be highly successful in creating an environment where new firms could enter the sector and access knowledge and partnerships with universities and private firms as well as both public and private funding.

Firms were also organized according to firm size. In 2003, there were 154 small (< 50 employees), 40 medium-sized (5-149 employees) and 38 (> 149 employees) bioproduct firms. Small firms were in the process of developing/producing 574 bioproducts while medium and large firms had 222 and 252 bioproducts, respectively. Although small firms had the largest number of products, large firms averaged the largest number of products per firm (6.6), average total revenue per firm ($244,654) and average R&D per firm ($2,906).

Bioproducts development is taking place in many different industries including bio-fuels, bio-chemicals, bio-energy, bio-plastics and bio-fibres. In 2003, most bioproducts were developed/produced in the field of bio-chemicals. Bio-chemicals accounted for 432 (41%) bioproducts with bio-fuels ranking second with 201 (19%) bioproducts. To develop these bioproducts, firms look to numerous sources of biomass to convert into new products. Biomass sources include agricultural, forestry, marine, animal manure and organic wastes. Agricultural biomass is the most popular type of feedstock preferred by firms with 93 firms reporting the use of agricultural biomass in their operations. Forestry biomass ranked second with 77 firms using forestry products and byproducts as their preferred biomass.

As an emerging sector, bioproduct firms tend to be young with 65% of firms being involved in bioproduct development and production for less than 10 years. These firms have entered the sector in different ways (i.e. start-ups, spin-offs, corporations extending their core activities) and usually maintain bioproduct development as only a portion of total firm activity. In 2003, nearly all firms became involved with bioproducts as either the result of internal R&D (66% of firms) or began as a spin-off from either universities or other firms (32%). Some firms devote all of their resources to bioproducts while other firms see bioproduct development as a complementary activity to already established operations. Overall, bioproduct activity accounted for less than one-third of total employees and one-quarter of total firm revenues.

This report examines additional characteristics related to bioproduct firms such as intellectual property (IP) rights, collaborative arrangements and provides in-depth coverage of regional/provincial and size aspects. Because the analysis is based solely on tables provided by Statistics Canada, it has not allowed this report to go beyond surface level analysis but provides a basis and benchmarks for further research into the size and structure of the Canadian bioproduct industry.



Executive summary

Bioproducts are non-food products developed from biomass originating from agricultural, food, forestry, marine and industrial and municipal sources. This report analyses the results of the first Canadian survey of bioproducts firms commissioned by Agriculture and Agri-Food Canada and conducted by Statistics Canada in 2004. This analysis is performed using summary tables of the responses to the survey questions provided by Statistics Canada. The summary tables were organized on two dimensions, by region/province and by firm size. Some of the key results of the analysis are presented by region and firm size in Summary Tables 1 and 2 respectively.

For most of Canada's 232 bioproducts firms, bioproducts are just one part of the business activities, accounting for less than one third of employees and slightly more than one quarter of total firm revenue. Most firms (66 percent) entered the bioproducts business as a result of internal research and development. Only eighteen percent started as spin-offs, usually from universities (64 percent of spin-offs) or other firms (32 percent). The major benefits from bioproducts were new product/market opportunities, but environmental benefits and benefits related to product performance and production costs were also significant. Reducing energy was a low rated benefit from bioproducts except for large firms and firms in Atlantic Canada and B.C.

Capital was the most commonly cited factor limiting the expansion of bioproduct activities. Although financing was a challenge, only 47 percent of Canadian bioproducts firms took advantage of the Scientific Experimentation and Research Development Tax Credit program. Cost and timeliness of regulatory approval was the second most cited barrier to expansion and it ranked among the top three barriers in all firm sizes and all provinces except Manitoba and Alberta. A related issue, lack of product standards or certification, was relatively highly rated across Canada and for both small and large firms. Problems related to intellectual property, negative public perception or acceptance and human resources were generally not seen as major inhibitors to bioproducts expansion.

The importance of knowledge to the bioproducts sector was revealed in firm strategies. Acquiring industry knowledge was rated as the top knowledge management strategy across all firm sizes and five of the seven regions. Firms used a combination of internal and external knowledge management strategies, accessing external knowledge from industry and research institutions while at the same time promoting employee development. Quebec firms were more focused on intellectual property (IP) management and were the most successful at acquiring IP.

Summary Table 1 highlights some of the provincial differences. While each region exhibited strengths, Quebec and Alberta were leaders on many dimensions while Atlantic Canada and Manitoba lagged behind the rest on several measures. Bioproduct development in Atlantic Canada appears to be behind the rest of the country with relatively low levels of research and development and limited success in accessing funding. Quebec, with the most firms in Canada, seemed to be highly successful in creating an environment where new firms could enter the sector and access knowledge and partnerships with universities and private firms as well as both public and private funding. Although Ontario had the highest overall revenue from bioproducts, it lagged on several dimensions: attracting companies into bioproducts, developing new products, securing IP, raising money and using government programs, relationships with other firms and expenditures on both general and bioproducts R&D. With the lowest percentage of firms entering the sector in the last five years and the highest percentage of public companies, Manitoba gives the impression of an older sector more focused on production than on generating new products and firms. Although Manitoba led Canada in average bioproducts R&D expenditure/firm, it was the least active region in terms of numbers of firms, total employment in the sector and reported IP assignments. Saskatchewan had many new entrants but with most firms starved for cash and having to lever their relatively small expenditures on R&D by being the most active collaborators with universities and other firms. Alberta bioproducts firms appear to be very well funded, active in product development and committed to bioproducts. R&D expenditures were the highest in Canada and bioproducts R&D was among the highest and they had the highest average number of products under development (5.4/firm) with almost two thirds on the market. Bioproducts employees per firm, revenue per firm and bioproduct revenue per firm were the highest in Canada, with most bioproduct revenue coming from exports. In terms of characteristics like product development, employment and revenue, B.C. was in the middle of the pack. Still, financing was a challenge, with much of 2003 funding coming from government sources.

For Canada's 154 small bioproducts firms, bioproducts were a large proportion of their business, with a significant percentage of their employees and R&D targeted at bioproducts. They were more heavily involved in the development of early stage products, more likely to have IP and also more likely to export, with over 61 percent of bioproducts revenue from exports. Capital was the major barrier to expansion but surprisingly small firms that sought capital were more successful that their larger counterparts.

Of the 40 medium sized bioproducts firms in Canada in 2003, 37 percent were public and 44 percent were subsidiaries of multi-national corporations. Of their average of 98 employees, 69 were devoted to bioproducts and 70 percent of those were either scientists or technicians. They spent $1.5 million/year on R&D, but only 34 percent went into bioproducts. They had an average of 5.5 products/firm, with 74 percent of those on the market. They were the least likely to have bioproducts IP (15 percent) and the least likely to be involved in collaborations (15 percent). Unlike small or large firms, medium sized firms secured the majority of their revenue from bioproducts.

In general, large firms were involved in bioproducts as a minor sideline or supplement to their main businesses, often using by-products of their other businesses. Only 19 percent of employees were involved in bioproducts and 18 percent of their revenue came from bioproducts. They were more active in using forestry products and in developing bio-fuels. They are more likely to be public (60 percent) and foreign owned (40 percent) than smaller firms. They appeared to have significant difficulty raising money. Research and development expenditures were lower as a percentage of revenue than for smaller firms. Large firms spent almost $3 million on total R&D but only 21 percent was used for bioproduct development.

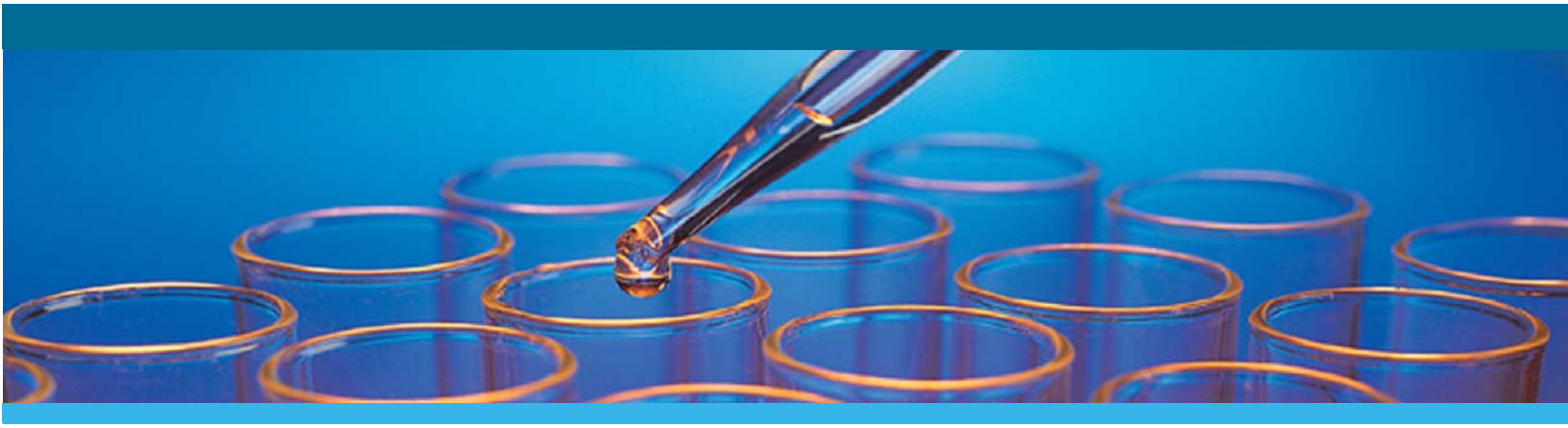
Summary Table 1: Key Bioproduct Firm Indicators by Region (2003) Note: F indicates unreliable data

Category	Canada	Atlantic	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.
Number of Firms	232	15	72	53	9	18	27	38
Firm Characteristics								
% < 5 years in BP	34.6%	21.2%	42.7%	30.0%	29.0%	39.4%	39.6%	24.5%
% Public companies	29.3%	18.9%	20.9%	24.5%	65.1%	F	43.9%	45.0%
Avg. # of employees/ BP emp.	105/34	262/15	83/35	77/39	108 / 32	157 / 12	96 / 40	100/39
% BP employees	32.5%	5.8%	41.7%	50.7%	29.5%	7.7%	41.6%	39.4%
Entry into bioproducts								
% from internal R&D	65.9%	49.6%	73.2%	65.9%	34.4%	84.8%	42.8%	72.5%
Biomass Use:								
Top 3 Biomass Sources :% primary/ % by-prod.	Ag/F/Other 46/47	F/Ag/ Food 61/22	Ag/F/ Marine 46/47	Ag/F/ Other 43/52	Ag mainly 50/45	Ag/ Manure/F 47/53	Ag/F/Other 58 / 43	F/Ag/Food 37/51
Revenue ($ 000):								
Average total/firm	$ 51,560	$ 26,966	$ 32,504	$ 52,666	$ 43,385	$ 85,775	$ 105,492	$ 43,243
Average % from BP	26.4%	F	33.5%	31.2%	32.5%	6.5%	21.9%	38.6%
% BP rev. from export	47.5%	F	30.8%	48.5%	59.0%	78.4%	80.6%	27.1%
R & D ($ 000):								
Average R&D/firm	$ 1,033	$ 288	$ 1,327	$ 674	$ 1, 589	$ 562	$ 1,922	$ 736
Average BP R&D/firm	$ 403	$ 33	$ 572	$ 309	$ 640	$ 206	$ 526	$ 310
Avg. # of BPs under development/firm	4.5	3.0	5.1	3.2	F	4.9	5.4	4.5
% on market	60.3%	71.8%	54.1%	70.4%	F	54.2%	65.6%	59.1%
Financing								
- % seeking financing	53.6%$	39.2%	61.4%	53.2%	34.8%	49.9%	47.9%	55.0%
- Avg. raised/firm seeking ($000)	2,218	$ 407	$ 2,864	$ 700	$ 2,351	$ 176	$ 7,133	$ 1,221
IP - % firms with IP	30.5%	28.5%	43.0%	23.0%	32.9%	F	27.9%	30.2%
Collaborations								
- % with collaborations	35.7%	39.1%	41.4%	24.1%	34.4%	57.9%	37.1%	28.8%
- Main collaborations	Non-bioP	Non-bioP	Academic	Non-bioP	F	BioP/ Academic	Non/bioP	Academic
Strategies								
- Top knowledge dev.	Acquire Ind. Know.	Acquire Ind. Know.	Pub. Know /IP Audit	Acquire Ind. Know.	Staff Educ.	Acquire Ind. Know. Trials	Acquire Ind. Know.	Acquire Ind. Know.
- Top business strategy	New R&D	New R&D	New R&D	Trials/New R&D	Trials		New R&D	Trials/R&D
Benefits – Top two identified (PM = Product/Market)	↑ Sales/ New PM	Env. Impact/ New PM	↑ New PM/ Sales	New PM/ Env. Impact	↑ Sales/ New PM	New PM/ Env. Impact	↑ New PM/ Sales	↓ Env. Impact/ Prod'n cost
Barriers – Top two identified	Capital/Reg. approval	Reg. approval/ Capital	Reg. approval/ Capital	Capital/Reg. approval	Transpor-tation/ Price of Mat'l	Capital/Price of Mat'l	Capital/Price of Mat'l	Capital/Reg. approval

Summary Table 2: Key Bioproduct Firm Indicators by Firm Size (2003)

Category	Firm Size		
	Small	Medium	Large
Number of Firms	154	40	38
Firm Characteristics			
% less than 5 years in bioproducts	42.6%	17.4%	17.8%
% Public companies	19.8%	37.1%	60.1%
# of employees/ # BP employees	14 / 11	98 / 69	476 / 89
% Scientific R&D or Technicians	77.7%	70.4%	18.8%
Entry into bioproducts			
% as a result of internal R&D	72.0%	47.1%	60.4%
Biomass Use:			
Top Three Biomass Sources[a]	Ag/F/Other	Ag/F/Marine	F/Ind/Ag
Source:% primary/ % by-product	48%/46%	44%/48%	40%/53%
Revenue ($ 000):			
Average total/firm	$ 6,026	$ 43,429	$ 244,654
Average % revenue from BP	45%	63%	18%
% BP revenue from exports	62%	53%	41%
Research and Development ($000):			
Average R&D/firm	$ 444	$ 1,517	$ 2,906
Average bioproduct R&D/firm	$ 321	$ 512	$ 618
Average # of BP under development/ firm (% on market)	3.7 49.5%	5.5 72.3%	6.6 74.5%
Financing			
- % seeking financing	60.4%	45.0%	31.6%
- Avg. raised/firm seeking ($000)	$2,468	$2,539	$1,441
Intellectual Property			
- % of firms with IP rights	35.8%	15.0%	24.9%
Collaborations			
- % with collaborations	42.8%	15.0%	28.9%
- Main collaborations	Non-BP	BP	Academic
Strategies			
- Top knowledge development	Acquire Ind. Know.	Acquire Ind. Know.	Acquire Ind. Know.
- Top business strategy	New R&D	Trials	New R&D
Benefits – Top two identified	↑ New PM/ Sales	↑ Improve Value performance/ Sales	↓ Env. Impact/ Prod'n costs
Barriers – Top two identified	Capital/regulatory approval	Price of material/regulatory approval	Price of material/ transportation

a. Ag: Agriculture, F: Forestry, Ind – Industrial Organic Waste



Introduction

Canada, like many other countries, has been actively developing bioproducts and promoting the companies behind them. To better understand the Canadian bioproducts sector, Agriculture and Agri-Food Canada (AAFC) commissioned Statistics Canada to undertake the first national bioproducts survey in the world. The survey was based partially on the Biotechnology Use and Development Surveys administered by Statistics Canada every two years. The Bioproducts Development Survey was administered in 2004 with firms required to answer questions and report results based on their 2003 data.

This report is the first examination of the results of the survey. The data for this report was provided by AAFC from tables supplied by Statistics Canada. Data was provided in the form of tables summarizing responses to the survey questions by province and by firm size; small, medium or large[1]. The analysis which follows is based on those two methods of classifying the data. Unless noted, all data in this report was derived from the results of the Bioproducts Development Survey. The data captured in the survey and reported in this paper is 2003 firm data, unless otherwise noted. The limitations on the analysis are discussed in the following section.

The report is organized into key sections as follows. The first section discusses the limitations imposed by the data used in the study. This is followed by an overview of the analysis and summary of the key results of the study, which is designed to act as a stand-alone document. The overview reports common themes found in the results and some of the most significant differences between provinces and firm sizes. Next, the main body of the report begins with an examination of the structure of the Canadian bioproducts sector and the firms in the sector. The second section examines the products being developed and the use of biomass by firms in the sector. Succeeding sections examine bioproducts revenue and the factors that play a role in revenue and expenditures, intellectual property, contracts and collaborations, human resources. These are followed by an analysis of benefits from and barriers to bioproducts development and commercialization. The next section considers an analysis of the business strategies used by bioproducts firms. The final section includes concluding remarks examining the differences between provinces, suggestions for improvements to the survey instrument and recommendations for further analysis.

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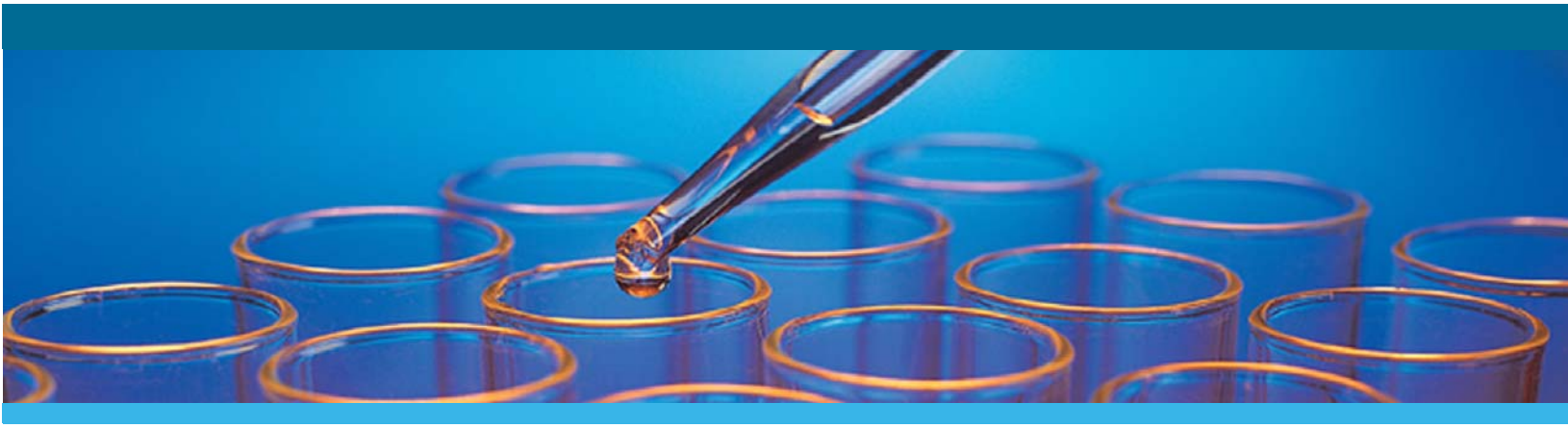
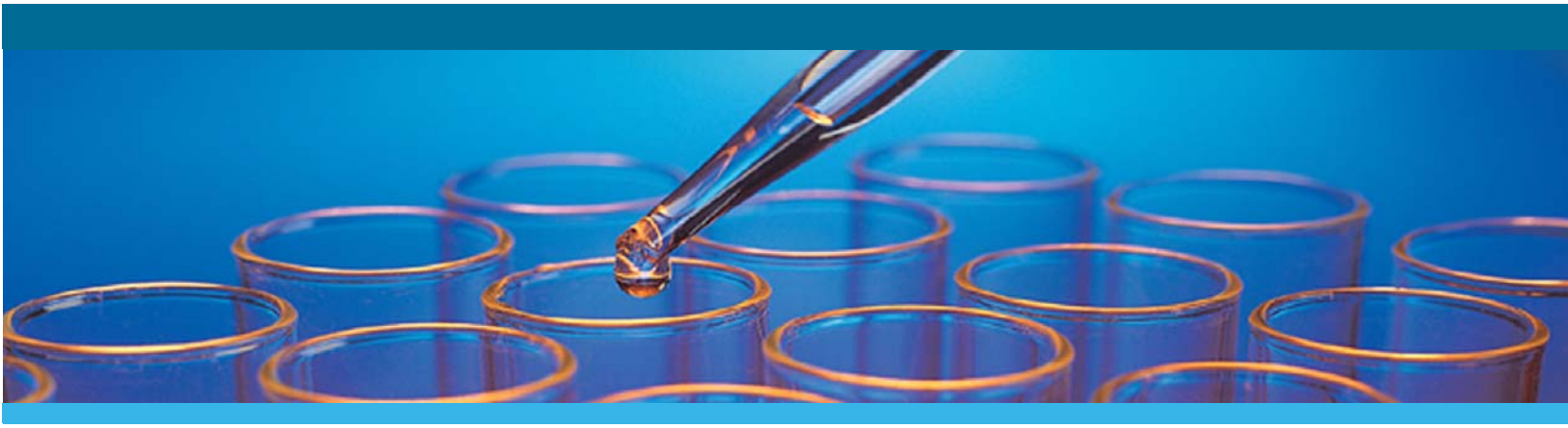
1. *Statistics Canada noted that the data provided is preliminary and may be subject to revision in the future.*



Limitations

This report is intended to provide an initial analysis of the bioproducts sector using data tables provided by Statistics Canada. All tables and figures in this report are derived from the Bioproducts Development Survey and contain responses based on 2003 activity and the summary tables provided by Statistics Canada. The authors had no access to the original survey data. In cases where data was deemed by Statistics Canada to be unreliable, the data in question was replaced with an F. If data was deemed to possibly compromise the confidentiality of a firm the data was withheld and replaced with an x.

The data analyzed in this report was organized and reported on two dimensions. The first is regional, with data provided for the Atlantic provinces as a single region and for each of the remaining six provinces individually. The second categorization is by firm size, measured by the number of employees. Firms are classified as small (less than 50 employees), medium (50-149 employees) and large (more than 149 employees). For this initial analysis, data was not provided on any other dimension and so the analysis necessarily is performed on these two dimensions. The presentation of the data also prohibited analyzing on the two dimensions simultaneously. It is therefore not possible to analyze the number of firms of each size in an individual region. The authors had no access to the underlying survey results and could not perform any additional analysis beyond the two dimensions provided. It is the intention of AAFC to perform a more in-depth analysis in the future, but that is beyond the scope of the data provided. This analysis reveals that the survey has provided a rich data set for a more in-depth analysis of the bio-products sector.



Overview of the Bioproducts Development Survey Results

The survey studied bioproducts use and development in Canada. For the purposes of the survey bioproducts were defined as those products which were derived from biomass, specifically biomass from agricultural crops, forestry, marine & aquaculture, food processing, animal manure, industrial and municipal organic waste. In 2003, the bioproducts sector in Canada exhibited striking regional differences on some dimensions but similarities on others. Some of the key characteristics of Canadian bioproduct firms are identified by region in Summary Table 1, and by firm size in Summary Table 2.

Common Themes in the Canadian Bioproducts Sector, 2003

Bioproducts are just one part of firm business activities and the proportion decreases with firm size - The first observation is that, in general, bioproducts was just one part of the business activities of most of the 232 Canadian firms involved in bioproducts in 2003. Canadian bioproducts firms had less than one third of their employees involved in bioproducts and derived just over one quarter of their revenue from bioproducts activities. Almost half of firms secured their inputs from by-products and most of the rest as primary products purchased as inputs.

Bioproduct firms generally entered the business as a result of internal R&D - Almost two thirds of firms (66 percent) entered the bioproducts business primarily as a result of internal research and development. Only 18 percent entered as spin-offs, primarily from universities (64 percent of spin-offs) or other firms (32 percent). The benefits firms received from involvement in bioproducts varied significantly. The most common dealt with new product/market opportunities, however firms also secured environmental benefits and other benefits related to product performance and production costs. Except for Atlantic Canada and B.C., reducing energy was a low-rated benefit from bioproducts. However, the recent increase in energy costs will almost certainly increase both the interest in the development of bio-energy products and focus of companies toward bioproducts as a means of reducing energy costs. This benefit was relatively important only for large firms. Thus, there are many reasons for firms to enter the bioproducts business and there is no obvious single motivation which can be used to promote the bioproducts business in general.

Barriers to expansion include capital, particularly for small firms, regulation and access to personnel - The factors limiting the expansion of bioproduct activities are relatively consistent across Canada, with capital as the most commonly cited barrier and difficulties related to regulatory approval second. A closer look at data by size reveals that the dominance of capital is related to the number of small firms in the survey. Access to capital is the major barrier for small firms, who make up 66 percent of the population, but is less important for large ones. However, cost and timeliness of regulatory approval was among the top three barriers in all firm sizes and all provinces except Manitoba and Alberta. Although not among the top barriers mentioned, the related issue of lack of product standards or certification was relatively high-rated across Canada and for both small and large firms. It was not seen as a barrier by medium sized firms.

One interesting finding regarding financing was that survey respondents generally did not make good use of the Scientific Experimentation and Research Development Tax Credit program. Across Canada the average participation was only 47 percent with smaller firms slightly more likely to participate than larger firms.

Also of interest are the factors that were not cited as barriers – problems related to intellectual property, negative public perception or acceptance and human resources were not seen as major inhibitors, except for Alberta and B.C. firms who rated human resources as a moderate barrier.

The final area of similarity across firms and provinces related to firm strategies. Acquiring industry knowledge was rated as the top knowledge management strategy across all firm sizes and six of the seven regions. Firms used a combination of internal and external knowledge management strategies, accessing external knowledge from industry and research institutions while at the same time promoting employee development.

Provincial Differences

A glance at Summary Table 1 shows that the differences between provinces are significant in most sector indicators. Some areas of the country, particularly Quebec, Alberta and British Columbia seem to be more successful in developing active, successful and growing bioproducts sectors, while others have had more difficulty. The differences highlighted here are discussed in more detail in the main body of the report.

Atlantic Canada

It appears likely that many of the bioproducts firms in Atlantic Canada are large forestry and food companies which include bioproducts as one small part of their overall business. Atlantic firms lead Canada in the number of firms using both forestry and food processing by-products. Interestingly, 60 percent of Atlantic firms produce bioproducts as primary products and almost half of firms use them internally. Both of these are significantly higher than the proportions for firms in other provinces. Few companies have entered the bioproducts business recently; only 21 percent in the last five years.

Since bioproducts is of lesser business importance Atlantic firms trail behind those of other regions on almost every dimension of bioproduct business development. Although the fifteen firms in the region are the largest in terms of employment, they have the lowest average total revenue of any region in Canada and the lowest percentage of bioproduct employees per firm. Both general research and development and bioproduct research and development expenditures lag significantly behind those of other regions. Average bioproduct R&D of $33,000 per firm is

inadequate to maintain a significant bioproduct development presence. The fact that the firms are in other businesses could explain the low percentage seeking financing, but those who sought financing raised an average of only $407,000 per firm. Relatively few are public companies (19 percent), eliminating one potential capital source for most firms.

Quebec

Based on the data in this survey, Quebec is the leading province in new bioproduct development. The province has attracted many young firms to the bioproducts business, with 43 percent of firms having entered in the last five years. The province was also home to 45 percent of Canadian bioproduct spin-off companies, including the most new university and company spinoffs. Quebec firms had the second highest proportion of staff dedicated to bioproduct activities, the highest average number of products under development (5.1) and the highest percentage of firms with IP (43 percent). The latter reflects the very high emphasis that Quebec firms place on intellectual property (IP) and the significant investments in bioproduct R&D. Quebec was the only province where IP audits were viewed as one of the top knowledge management strategies. Quebec firms appear to be heavily involved in early stage development, and they had the lowest percentage of products on the market.

Numerous studies have shown the importance of intellectual property in securing funding in the field of biotechnology. In the bioproducts industry the importance placed on IP may be one explanation for the success of Quebec firms in securing financing and the fact that they raised the second most funding per firm seeking financing. Firm revenues were lower on average in than most provinces, as was the percentage of bioproduct exports, likely reflecting the younger age of the companies.

Accessing outside skills was important for Quebec firms, who had high levels of both collaborations and contracts with private laboratories and universities. Of all bioproduct contracts in Canada, 38 percent involved Quebec firms.

Ontario

Ontario firms were heavily involved in the use of agricultural crop biomass, with over half of their inputs coming as by-products. Bioproducts were important to the province; firms in Ontario saw $871 million in bioproducts revenue, the highest in Canada. However, with the exception of products on the market, bioproduct employees and average revenue/firm, Ontario firms lagged behind Quebec on many indicators of bioproduct activity. Ontario had difficulty attracting new companies into the field and the companies in the business were not as active in developing products (3.2/firm), securing IP (23 percent) or raising money, securing less than 25 percent of the amount raised by Quebec firms. Ontario firms spent considerably less on general R&D and bioproducts R&D than other organizations and they had the lowest percentage of firms contracting out activities and involved in collaborations in Canada. The proportion of Ontario firms pursuing government funding was significantly below the national average. Overall, Ontario firms were less active than firms in most provinces in both internal and collaborative bioproduct development. The focus of Ontario firms was much more on producing products for sale to outside organizations, with only 19 percent of firms producing for internal use.

Manitoba

Looking at Manitoba, one gets the impression of an older sector more focused on production than on generating new products and firms. The province had the lowest percentage of firms entering the sector in the last five years and the highest percentage of public companies. It was the least active region in the bioproducts sector in terms of numbers of firms, total employment in the sector and reported IP assignments. There were relatively few products in the research and development stage but Manitoba firms appear to have the highest percentage of products/firm in production or on the market in Canada. All the firms in Manitoba used agricultural biomass. However, firms in the province are in the mid-range of both total and bioproduct revenue. It is somewhat paradoxical that they are were the top end of R&D expenditure per firm and led Canada in average bioproducts R&D expenditure per firm. Although Manitoba had relatively few firms in the sector, those which were present appeared to be committed to bioproduct development.

Saskatchewan

New firms were entering the Saskatchewan bioproducts sector at a fair rate. Approximately 40 percent entered within the last five years and the province's 3 spin-offs come from other companies. Internal R&D spurred entrance into the sector for 85 percent of companies in the region. Saskatchewan firms were actively using agricultural biomass, and made the greatest effort of all regions to use animal manure. Saskatchewan firms were slightly above average in terms of products under development or production but they raised the least capital to fund that development. Spending on both general and bioproduct R&D was below all regions except Atlantic Canada. The firms were the most active in collaborating with other organizations and second most active in contracting. Although average revenue/firm was second in Canada, bioproducts revenue was lowest and their spending on general R&D and bioproducts R&D was the second lowest in Canada. They seemed to lever their R&D effort by collaborating heavily with organizations of every type resulting in relatively high numbers of products under development, albeit at the earlier stages than in most provinces. Continued sector development in Saskatchewan will be constrained by the lack of capital.

Alberta

Alberta bioproducts companies appear to have been well funded, active in product development and committed to bioproducts. They had the highest average number of products under development (5.4/firm) with almost two thirds on the market. Biomass inputs came from several sources (notably agriculture, forestry and other sources) and most of the biomass was transported from distances of more than 50 km. Bioproducts employees per firm, revenue per firm and bioproduct revenue per firm were the highest in Canada, with most bioproduct revenue coming from exports. R&D expenditures were the highest in Canada and bioproducts R&D was among the highest. Alberta firms could afford to spend more since, on average, firms seeking funding raised over $7 million each in 2003, two and a half times the funding of the next closest province (Quebec). Interestingly, low levels of IP did not seem to hamper attempts to raise money. Most of the money raised came from private placements and IPO's rather than from government sources. There is nothing in the data to indicate that Alberta will slow down and the recent surge in energy prices will only enhance the province's role in the sector.

British Columbia

B.C. is very active in the bioproducts field, with a mix of young and older companies. Of no surprise is the fact that B.C. biomass came predominantly from the forestry products, with 64 percent either by-products or recycled product. In many respects it was in the middle of the pack in terms of characteristics like product development, employment and revenue. However, in some areas the province appeared to be somewhat behind. Financing was a challenge, with much of 2003 funding coming from government sources but the rest coming from a mixture of private sources. B.C. firms were second only to Quebec firms for total funding secured through the SR&ED tax program. Both general and bioproduct R&D expenditures were below the Canadian average but the number of products under development was typical. B.C. firms are less active in collaborating with other organizations.

Firm Size Differences

The companies involved in bioproducts in Canada were also analyzed by firm size with firms classified by the number of employees: Small (1-49 employees), Medium (50-149 employees and Large (more than 149 employees). A summary of key results by firm size is presented in Summary Table 2.

Small firms

Canada's 154 small bioproducts firms made up two thirds of the firms in Canada but with just over 14 employees each they employed only 9 percent of the workers employed by the 232 firms and just 22 percent of bioproducts employees. However, 77 percent of their bioproducts employees were scientists and technicians. They tended to be private (80 percent) and Canadian owned (92 percent). They were more involved in the development of early stage products and in the development of all products except bio-fuels. Rather than using their own by-products they usually had to secure raw materials from a distance and use foreign sources more than other categories.

Total revenue per firm was roughly $6 million per year, of which 45 percent came from bioproducts. These small firms were active exporters with over 61 percent of bioproducts revenue from exports. Although total R&D expenditure of $444,369 was lower for small firms, bioproduct R&D expenditure was only half the level of large firms. These companies spent 72 percent of their R&D dollars on bioproducts. Small firms were much more likely to have rights to IP than larger firms but only 35 percent of them had such rights.

Most entered the sector as result of internal R&D. The vast majority (86 percent) of the bioproduct spin-off companies were small firms. Small firms supplemented their internal development capabilities by working with other firms and research institutions to take advantage of industry knowledge. Collaborations were utilized by 43 percent of firms. As in other industries, money is a major barrier to expansion; 60 percent of firms sought capital and $1.36 million was raised on average. Of the 154 firms 30 secured funding from government grants, 24 from venture capitalists and 24 from angel investors, while another 25 obtained funding from private placements and initial public offerings. Bank loans, government loans and matching funding programs were far less important.

Medium Firms

There were only 40 medium sized bioproducts firms in Canada in 2003. Of these firms 37 percent were public and 44 percent were subsidiaries of multi-national corporations. The firms averaged 98 employees with 69 devoted to bioproducts (70 percent of which were either scientists or technicians). With their larger resources they have more products under development (5.5/firm) and had 72% of those products already on the market. They spent $1.5 million on R&D but only 34 percent was allocated to bioproducts. They were the least likely to be involved securing rights to bioproducts IP (15 percent) and the least likely to be involved in collaborations (15 percent).

Medium sized firms were the most active users of agricultural crop biomass (54 percent) but many used forestry biomass (30 percent). They were more likely to sell directly to consumers (78 percent) and to other firms (71 percent) with only 22 percent using the products internally. These firms had significant business activity in bioproducts. On average their revenue was seven times that of small firms at over $43 million per firm, and 63 percent came from bio-products. Their main strategies focused on increasing revenue, particularly through entering foreign markets. They perceived significant benefits from bioproducts in terms of both improved value and performance and in increased sales.

Only 45 percent of medium-sized firms looked for money, and they raised less than small firms from matching funds (15), collaborations (6) and grants (5) and banks (5). They also received nearly as many credits under the Scientific Research & Experimental Development tax program as large firms, averaging $2.3 million per firm. The firms used their funding primarily for R&D and proof of concept studies.

Large Firms

In general large firms were involved in bioproducts as a minor sideline or supplement to their main business and their responses to survey questions repeatedly reflected that fact. Being larger they are more likely to be public (60 percent) and foreign owned (40 percent) than smaller firms. Forestry companies figure prominently among large firms with 70 percent securing forestry biomass compared to 30 percent and 25 percent for medium and small firms. They dominated small and medium firms in the development in bio-fuels. Over half of large firms used by-products in their processes and they sourced much of their biomass on site or nearby. Revenue was significantly higher than in other classes ($245 M/firm). Only 18 percent of their revenue came from bioproducts with 41 percent of that from exports. Although large firms had relatively more revenue, 31 percent still sought financing; however, they appeared to have substantial difficulty raising money, securing far less than smaller firms. Few obtained more than half of their target. The average of $485,000 secured/firm was less than half that of medium firms, and barely over one third of the average amount typically raised by small firms which sought financing. Money came primarily from matching funds (8), banks (3) and grants (3). Most sought funding to increase production capabilities (91 percent) or to further production development through R&D and proof of concept studies (76 percent).

The firms averaged 476 employees per firm with 19 percent devoted to bioproducts. They have significantly more production/management employees but only twice the scientific and technical employees per firm that small firms have. Research and development expenditures were lower as a percentage of revenue than for smaller firms. Large firms spent almost $3 million on R&D but only 21 percent of that was used for bioproducts.

Policy Implications

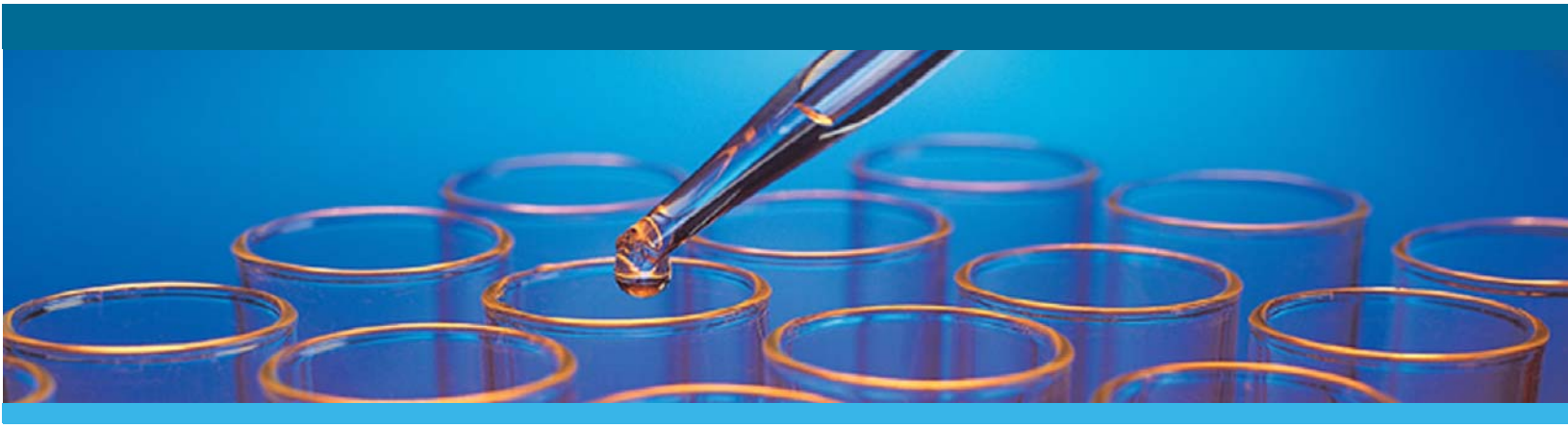
The different strategies and challenges of firms from different size and regions generally necessitates distinct policies to promote bioproducts among Canadian companies. However, the common themes point out some reasonable starting points at the national level.

One pressing issue identified was the time and cost associated with the bioproduct approval process. This was a challenge to firms across regional and size categories. It is worthwhile investigating why this issue was raised so regularly and what can be done to improve the situation. One aspect of any review should deal with product standards and certification since this could be one factor in the regulatory approval process.

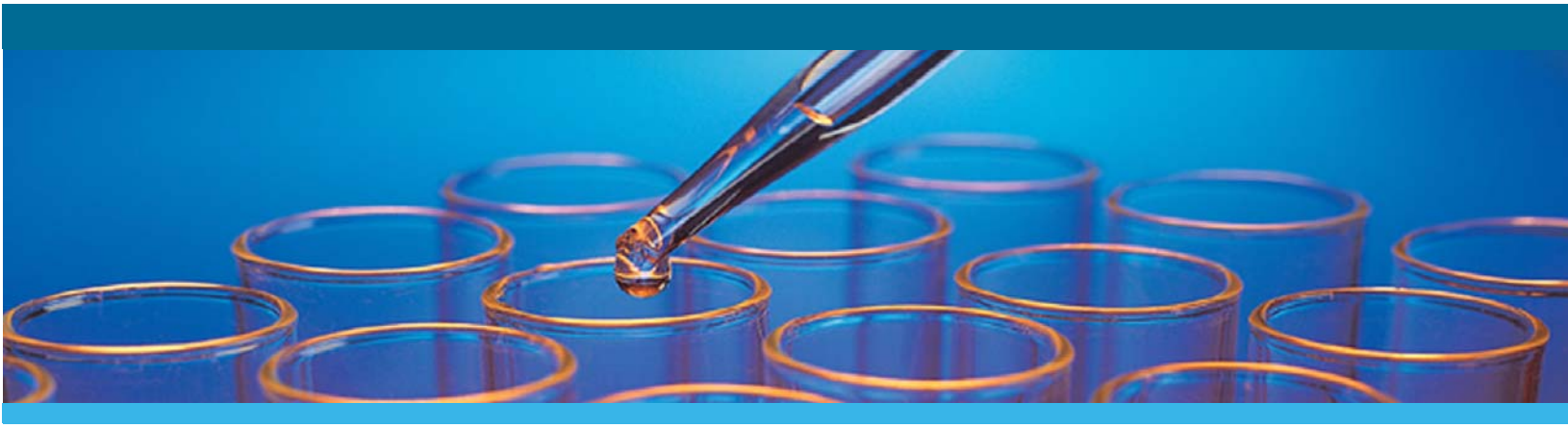
Addressing the lack of capital is a different matter since it involves small firms in a new technology area. While individual programs may be targeted at the bioproducts sector, programs aimed at promoting new technologies in general may help to create an environment conducive to the creation of new companies in a variety of technology sectors. Capital supplies are impinging on the ability of firms to attract highly qualified personnel. Although firms did not identify human resources as a major barrier, when asked about difficulties in filling positions, the impact of capital restrictions on small firms became apparent - lack of capital was cited as the main reason for not filling positions across Canada.

A related issue is the relatively low uptake and variability of government support programs. Just under half of firms used the Scientific Research and Experimental Development tax credit programs and roughly one third accessed both federal and provincial support programs. Frequency was inversely related to firm size, with smaller firms taking greater advantage of the programs across a broader range of activities. The differences by region were huge with Quebec the leading user of programs and Alberta firms least likely to access support. One obvious conclusion is that different approaches are required depending on whether the target is promotion of bioproducts development in large firms or increasing the number and success of small bioproducts firms focused on developing new bioproducts. Large firms incorporate bioproducts into their existing businesses for environmental, cost and market reasons; therefore, such a move must make sense on those terms. Support programs that promote such developments would have an impact. Small firms build a major portion of their business on bioproducts and commit a significant percentage of their scientific development resources to those products. They tend to require and use assistance in every area from technology development to loan guarantees and training since a lack of both financial and personnel resources are significant factors limiting their development.

From a provincial perspective, further analysis would allow for better understand of the differences and would be an essential input to the policy creation process. The obvious starting points would be a regional analysis cross-tabulating firms by location, product line and size to better understand the composition of the regional sector and the challenges facing the region.



Detailed Analysis of the Bioproduct Development Survey Summary Tables, 2003

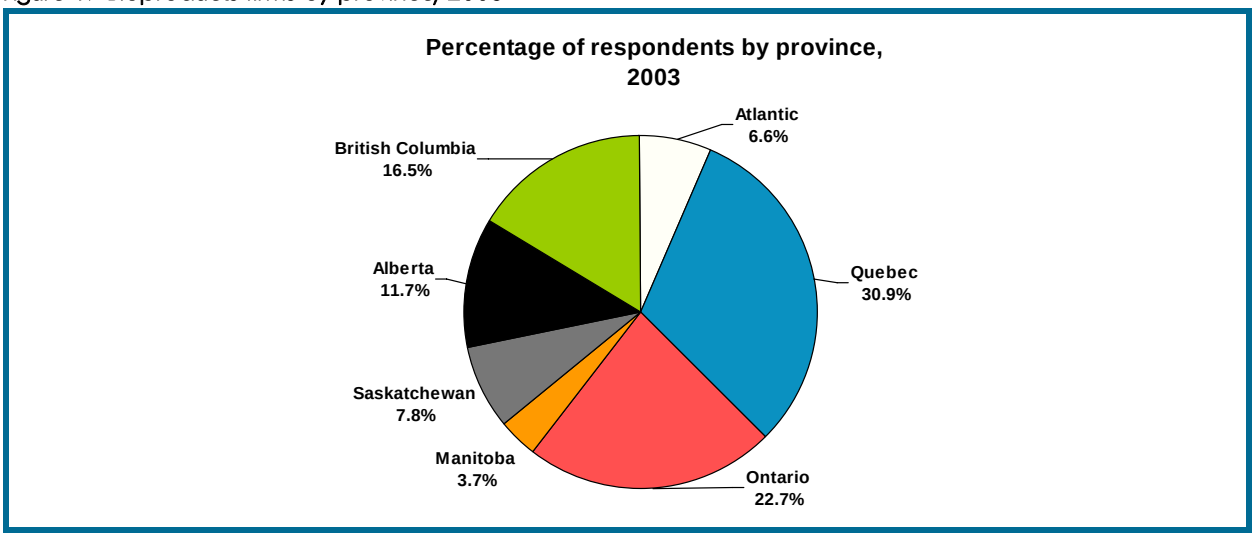


Chapter 1

Canadian Bioproducts Businesses

Two hundred and thirty-two firms across Canada participated in the production or development of bioproducts during 2003. Quebec, Ontario, and British Columbia are home to most of these companies; 31 percent, 23 percent, and 16 percent respectively of all firms were located in these provinces (Figure 1). Revenue for these firms in 2003 totaled just under $ 12 billion. However, bioproducts revenue was just over $ 3 billion and 47 percent of the bioproducts revenue was from exports of bioproducts.

Figure 1: Bioproducts firms by province, 2003



The bioproducts sector is dominated by small firms, at least in terms of numbers. Approximately 66 percent are small in size with less than 50 employees. Of the remaining firms 17.2 percent were medium sized with 50 – 149 employees, and 16.4 percent were large firms with more than 149 employees.

Many of the firms surveyed have been in the business of bioproducts for a relatively short period of time. Sixty-five percent have been involved in bioproduct-related activities for 10 years or less. Quebec, Alberta and Saskatchewan appear to have created environments conducive to the creation of new bioproducts firms. Forty-two percent of Quebec firms are five years old or less, and about thirty-nine percent of firms in Alberta and Saskatchewan are in that category (Table 1). In all other regions in Canada less than thirty-five percent of firms are five years old or less.

The proportion of firms under 10 years of age was markedly higher for small firms (75 percent) and lower for large firms (36 percent). Nearly half of large firms reported involvement in the sector for over 20 years.

Table 1: Number of years of involvement in bioproducts, 2003

Region	Number of firms	10 years or less	5 Years or less
	#	%	%
Canada	232	65.1	34.5
Atlantic	15	60.0	20.0
Quebec	72	77.8	43.1
Ontario	53	58.5	30.2
Manitoba	9	33.3	33.3
Saskatchewan	18	61.1	34.5
Alberta	27	74.1	40.7
British Columbia	38	55.3	23.7

Entry into the Bioproducts Sector

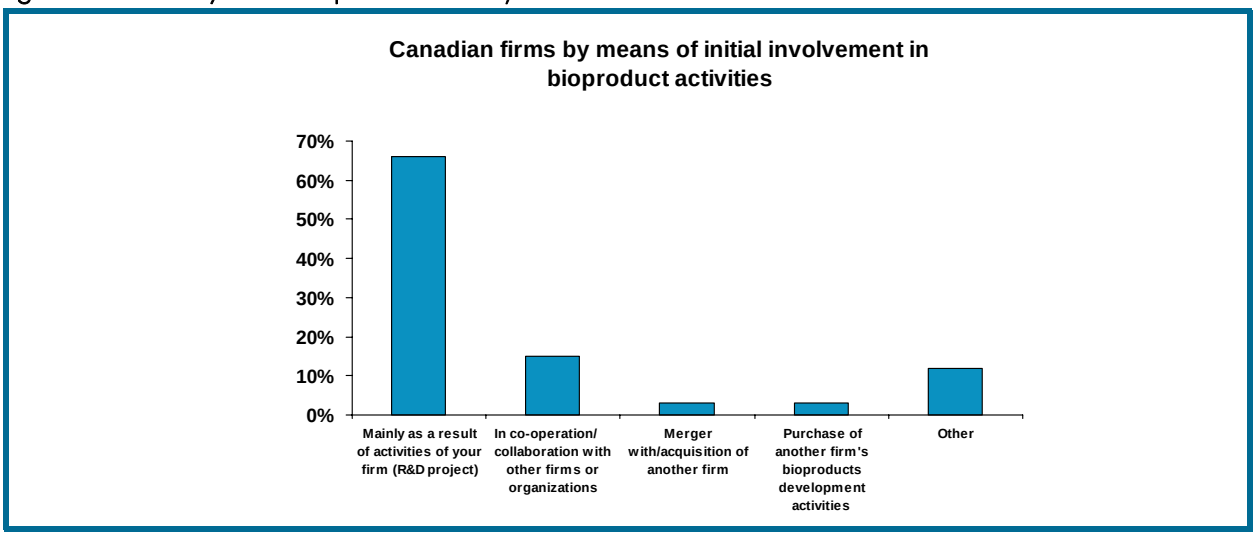
Approximately 19 percent of Canadian bioproducts firms originated as spin-offs (Table 2). Not surprisingly, most are small (86 percent), a few are medium (14 percent) in size and none were large. The vast majority originated from either universities (64 percent) or other firms (32 percent). Quebec had the largest share of spin-off companies, with 20 of the 44 Canadian bioproducts spin-offs. Eight of those companies have been spun out of another firm rather than out of universities, representing 57 percent of all Canadian spin-offs from companies. The results regarding company spin-offs display significant regional differences. Alberta and Ontario spinoffs are almost exclusively from universities, while Saskatchewan and British Columbia's small number of spin-offs came solely from other firms. Government agencies did not figure prominently in bioproduct company spin-offs.

Although spin-offs are an important means of creating new bioproducts firms, most companies entered the bioproducts field as the result of internal company research and development, as illustrated in Figure 2. Other entry methods were far less frequent.

Table 2: Number of firms by origin of spin-off, 2003

Region	Total number of spin-offs	Percentage of all Canadian spin-offs	University	Another firm	Government agency/ laboratories	Other
	#	%	#	#	#	#
Canada	44		28	14	F	F
Atlantic	F		0	0	0	F
Quebec	20	45.5	11	8	F	0
Ontario	10	22.7	9	1	0	0
Manitoba	0		0	0	0	0
Saskatchewan	3	6.8	0	3	0	0
Alberta	7	15.9	7	0	0	0
British Columbia	F		0	F	0	0

Figure 2: Initial entry to the bioproducts sector, 2003



Ownership

Ownership among Canadian bioproducts firms varies with location (Table 3) and company size (Table 4). Bioproducts firms in Manitoba, Alberta and B.C. are much more likely to be public companies than those in other provinces. Only Manitoba has a relatively high proportion of foreign owned companies compared to the other regions.

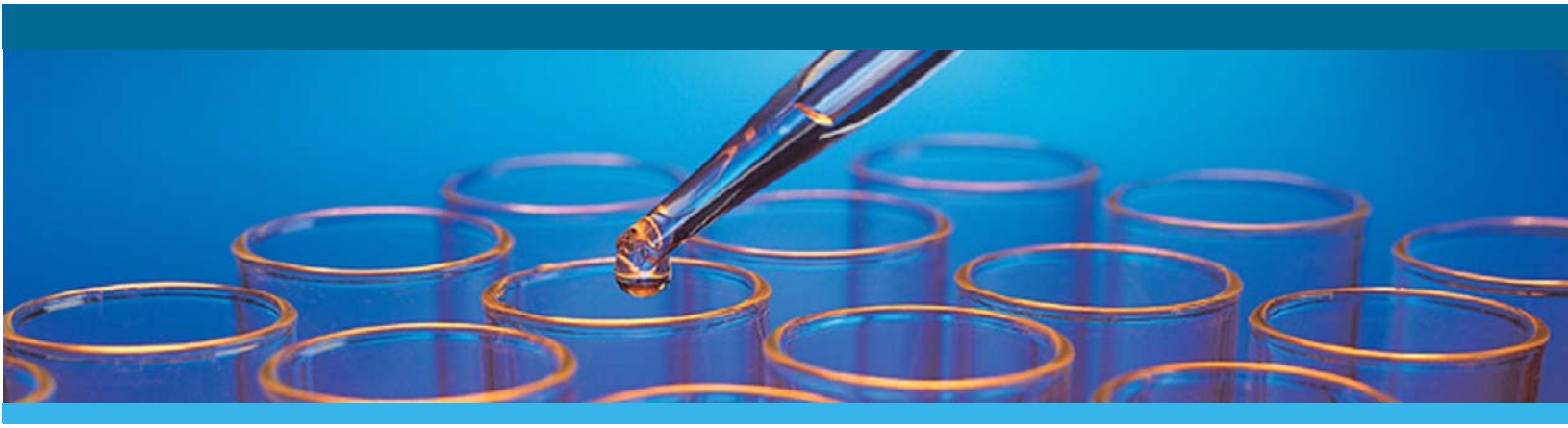
Table 3: Ownership of Canadian bioproducts firms, by region, 2003

Region	Total number of firms	Percentage of firms which are public	Percentage of firms which are subsidiaries of MNC's	% of firms with majority Canadian stock ownership	% of firms with majority U.S. stock ownership	% of firms with majority other stock ownership
	#	%	%	%	%	%
Canada	232	29.3	18.1	83.6	9.1	6.5
Atlantic	15	18.9	-	93.3	-	0.0
Quebec	72	20.9	9.7	87.5	6.9	2.8
Ontario	53	25.6	24.5	83.0	7.5	9.4
Manitoba	9	65.1	33.3	66.7	33.3	0.0
Saskatchewan	18	-	-	88.9	-	0.0
Alberta	27	43.9	29.6	70.4	11.1	18.5
British Columbia	38	45.0	21.1	84.2	7.9	7.9

Large firms are far more likely to be public companies, and more likely to be foreign owned. Although only 18 percent of firms are subsidiaries of multi-national corporations (MNC's), this increases to 44 percent for medium sized firms. Canadian ownership is highest among small and medium sized firms with non-U.S. firms owning the majority of non-Canadian bioproducts companies. However, among large companies U.S. ownership is quite high at 28 percent.

Table 4: Ownership of Canadian bioproduct firms, by firm size, 2003

Firm size (# of employees)	Total number of firms	% of firms which are public	% of firms which are subsidiaries of MNCs	% of firms with majority Canadian stock ownership	% of firms with majority U.S. stock ownership	% of firms with majority other stock ownership
	#	%	%	%	%	%
Small (< 50)	154	19.8	8.0	91.9	3.9	5.2
Medium (50-149)	40	37.1	44.0	74.1	10.5	13.8
Large (>149)	38	60.1	31.5	60.3	28.1	6.8



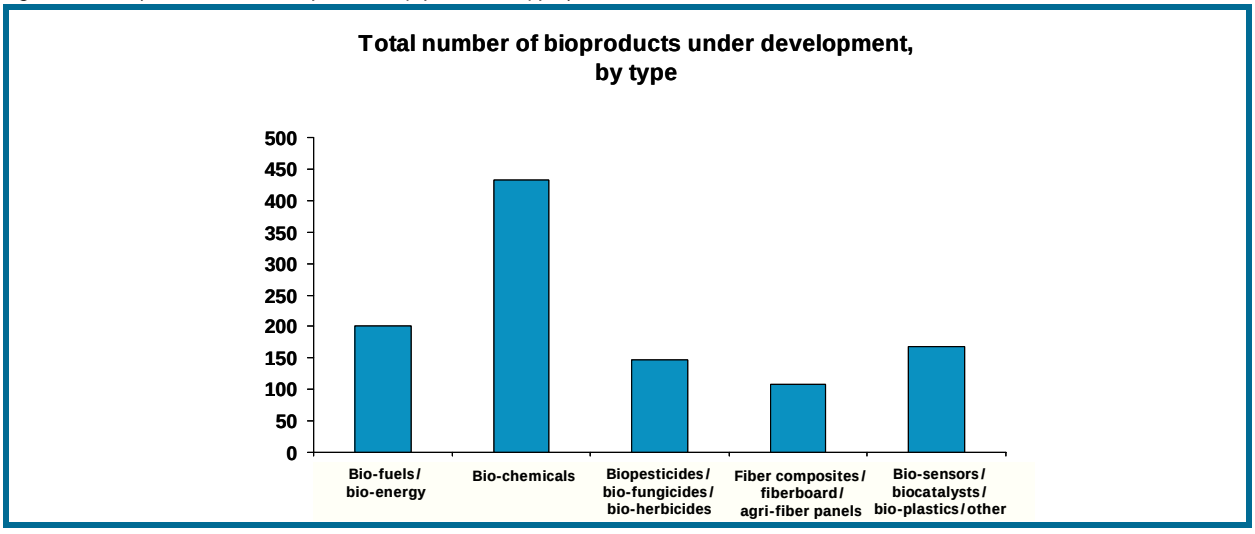
Chapter 2

Bioproduct Development and Biomass Use

Bioproduct Development

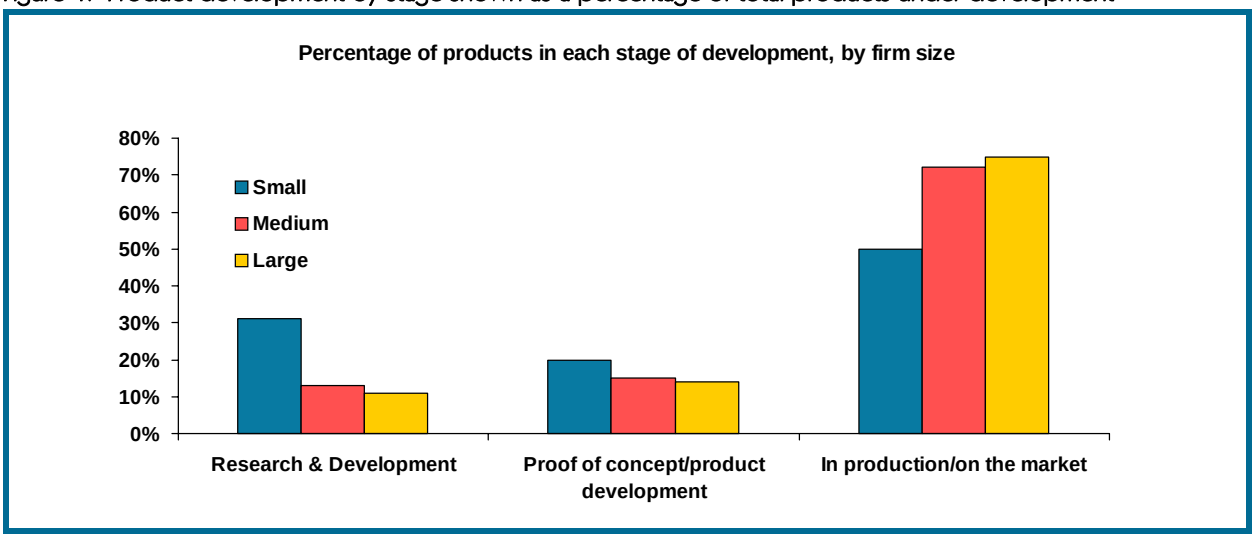
Canadian firms are actively developing and producing a variety of bioproducts. In 2003, the firms had a total of 1,048 products under development or in production, an average of 4.5 products/firm. Of these, 60 percent were already on the market, 18 percent were mid-developent, and 22 percent were in early stages. The largest category of products was bio-chemicals, which made up 41 percent of all bioproducts (Figure 3).

Figure 3: Bioproduct development by product type, 2003



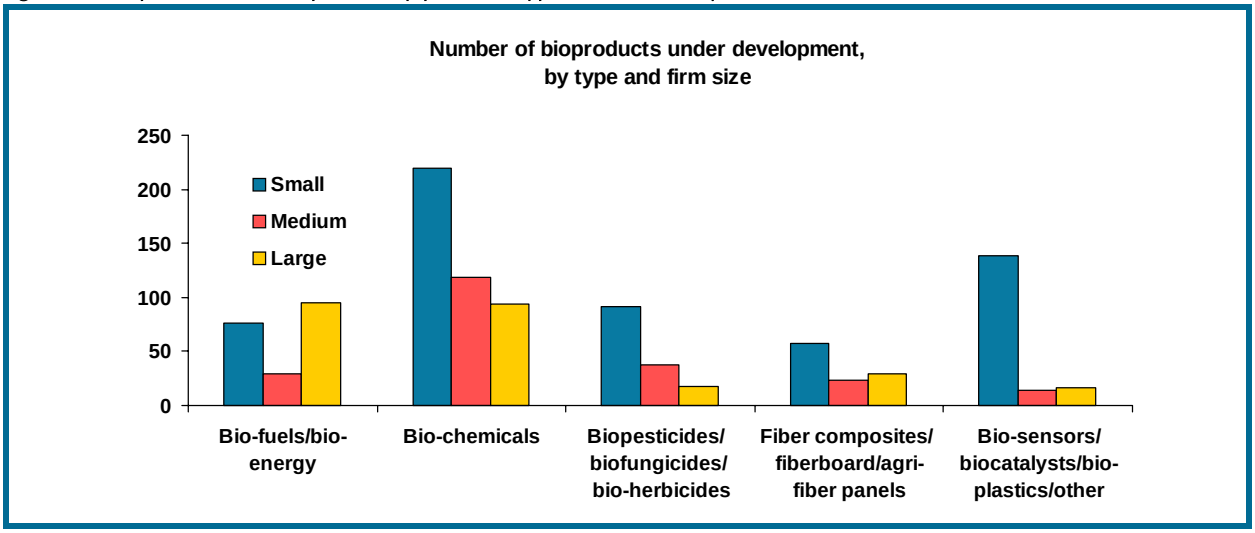
As one would expect, small companies were more focused on the early stages of research and development than the larger firms (Figure 4). In any technology development process there are typically more products in the early stages of development and much of the research and development and proof of concept work is done in small firms. As products are developed, many are trimmed as they are found to be infeasible or to have no technological or commercial advantages over existing products. Medium sized and large companies have the resources to produce and market a limited number of commercial products so they dominate the last stage of development. It is interesting to note that in the bioproducts sector more products are on the market than in development.

Figure 4: Product development by stage shown as a percentage of total products under development



With one exception, product development patterns were fairly consistent across all product types with small firms having the largest number of products under development. The exception is in bio-fuels/bio-energy products where the largest number of products is under development in large companies and 43 percent of large firms were engaged in the production of biofuels/bioenergy. This was more than double the number of large firms producing any other single product type (Figure 5). This result reflects the nature of the chemical and energy businesses, which are dominated by large companies with significant resources.

Figure 5: Bioproduct development by product type and firm size, 2003



Biomass Use

Firms were asked to indicate the type of biomass product used in 2003. Table 5 provides a break-down of responses to this question on a regional basis. (Note that responses to this question are not mutually exclusive, so the percents in any given column can sum to more than 100 percent.) Agricultural crop and forestry biomass were the most common forms of biomass used in Canada. They were used by 93 and 77 firms, respectively, more than twice the number of firms using any other single type of biomass.

Agricultural crop biomass was favoured by firms in most provinces, including Manitoba, Saskatchewan, Ontario, Alberta, and Quebec. Firms in British Columbia and the Atlantic regions made significantly more use of forestry biomass, while Quebec firms made fairly extensive use of both forestry and marine biomass. Firms in the Atlantic region made use of food processing products and by-products, in addition to agricultural crop and forestry biomass.

Table 5: Percent of firms reporting use of different biomass types, by region, 2003

Region	Agricultural crop biomass	Forestry biomass	Marine & aqua-culture materials/ products	Food processing products and by-products	Animal manure	Industrial organic waste	Municipal organic waste	Other
				-percent-				
Canada	40.3	33.2	14.2	15.2	8.7	10.6	6.6	15.5
Atlantic	40.7	59.0	21.1	40.7	-	29.5	-	0.0
Quebec	35.2	28.3	26.8	14.6	8.5	13.9	7.9	14.5
Ontario	51.5	24.4	2.0	8.7	4.4	5.7	5.7	24.2
Manitoba	100.0	-	0.0	0.0	0.0	0.0	0.0	0.0
Saskatchewan	44.7	27.7	0.0	-	28.8	0.0	0.0	21.2
Alberta	37.1	31.0	-	16.6	4.6	0.0	0.0	22.2
British Columbia	23.9	53.8	21.1	21.4	10.1	14.7	13.6	7.3

Agricultural crop biomass was the dominant form used in both small and medium sized firms (see Table 6). Large firms most often used forestry biomass in their production; however, very little use was made of marine products, food processing products, animal manure, or municipal organic waste.

Table 6: Percent of firms by type of biomass used, by firm size, 2003

Firm size	Agricultural crop biomass	Forestry biomass	Marine & aqua-culture materials/ products	Food processing products and by-products	Animal manure	Industrial organic waste	Municipal organic waste	Other
				-percent-				
Small	41.8	24.6	15.3	16.7	11.3	6.4	9.1	21.4
Medium	53.5	30.3	15.8	15.6	F	10.2	F	F
Large	20.2	71.0	8.3	8.8	3.5	28.3	0.0	F

Table 7 shows the percentage of firms using biomass inputs of different origins. This breakdown is based on whether firms secure their main biomass input as primary products (e.g. soybean, corn, hemp, etc.), by-products (e.g. straw, fat, etc.) or recycled products (e.g. cooking oil, industrial sludge, etc.). Within Canada, most firms used either primary (108 firms) or by-product (109 firms) based biomass inputs. Moreover, this pattern of biomass input type also appears to hold across the different regions, albeit in different proportions. Regardless of firm size, most used either primary or by-product based biomass inputs (see Table 8).

Table 7: Percent of firms by principal biomass input, by region, 2003

Region	Primary product	By-product	Recycled product	Foreign Source
		-percent-		
Canada	46.4	47.1	6.3	15.6
Atlantic	61.4	21.6	18.9	-
Quebec	46.2	47.1	6.2	18.2
Ontario	42.8	51.6	4.9	13.0
Manitoba	50.4	45.4	0.0	0.0
Saskatchewan	46.8	53.3	0.0	-
Alberta	57.5	43.0	0.0	33.2
British Columbia	36.8	51.4	12.3	10.6

Most biomass inputs were sourced domestically. At a national level, over 80 percent of firms reported sourcing their biomass inputs domestically. Except for Alberta, where one third of firms sourced their inputs internationally, this pattern holds on a regional level. Firm size does not appear to affect whether a firm sources their biomass domestically with medium sized firms being one subtle exception with 90 percent source domestically.

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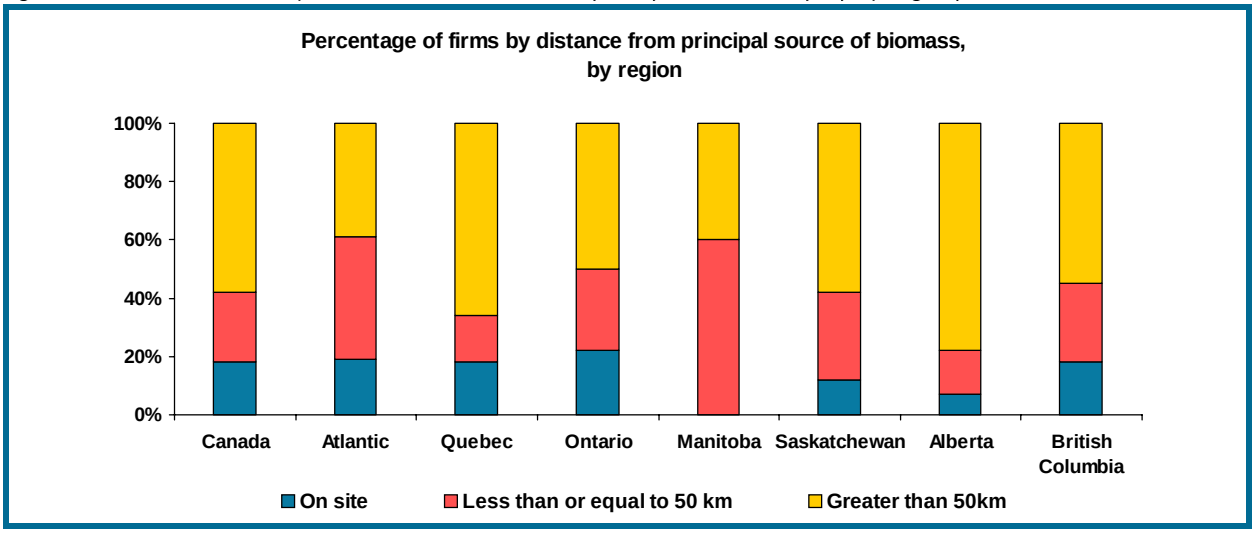
Table 8: Percent of firms by principal biomass input, by firm size, 2003

Firm size	Primary product	By-product	Recycled product	Foreign Source
	-percent-			
Small (less than 50 employeees)	48.0	45.7	5.5	17.7
Medium (50 - 149 employees)	44.0	48.0	8.0	10.6
Large (more than 149 employees)	39.9	52.5	7.6	12.4

Only 18 percent of all Canadian firms had their biomass on site, and nearly 60 percent of firms were farther than 50 km from their primary source (see Figure 6). With the exception of the Atlantic region and Manitoba, more than half of the firms indicated that they traveled 50 kilometres or more to source their biomass inputs. This suggests that an active market with substantial search and transport costs exists in the sourcing of biomass inputs. As will be seen later, the cost of transporting biomass inputs is viewed by some firms as a barrier to bioproduct development/production.

Figure 6: Percent of firms by distance from location of principal biomass input, by region, 2003



Off-site sourcing was important for small and medium sized firms which predominately sourced biomass inputs from locations greater than 50 kilometres from the firm (Figure 7). As firm size increases, the share of biomass input sourced on-site increases, a finding consistent with the increasing level of by-product used with increasing firm size. This would suggest that smaller firms were focused more on processing biomass not produced by the firm, while large firms used biomass processing as a means to develop a revenue generating output based on some other production process. Alternatively, larger firms may be adjacent to sources of their biomass inputs, thus taking advantage of agglomeration economies.

Figure 7: Percent of firms by distance from location of principal biomass input, by firm size, 2003

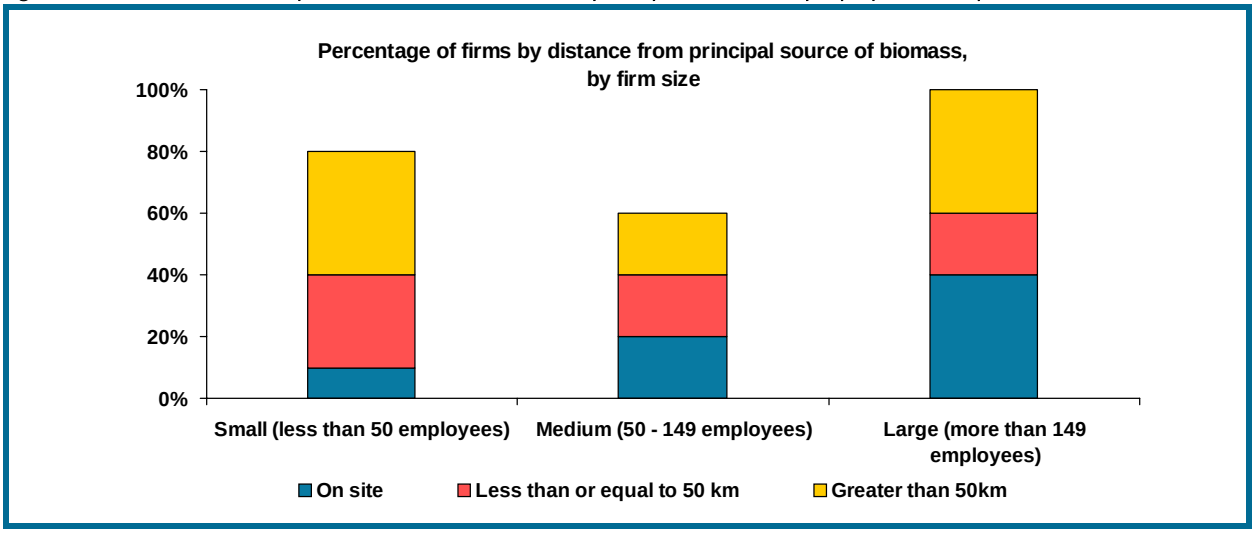


Table 9 summarizes firm's responses regarding where their bioproducts were sold or used. Within Canada as a whole, most firms (65 percent) indicated they sold their bioproducts directly to consumers or distributors, followed by 47 percent who reported sale to another firm for use as an intermediate input, and 33 percent who indicated their bioproduct is used internally. Note that the responses to this question are not mutually exclusive, and the percentages in Table 6.1 could sum to more than 100 across a row.

Except for the Atlantic region and Manitoba, firms sell primarily to consumers or distributors, followed by sales to other firms and lastly, for own use. In Atlantic Canada, 51 percent of the firms reported sales to a consumer or distributor, or production of the bioproduct for own use, while 31 percent reported sales of bioproduct as an intermediate input to another firm. In Manitoba, sales of the bioproduct as an intermediate input to another firm was reported by 65 percent of firms, while 45 percent report sales to a consumer of distributed and 34 percent reported production for own use.

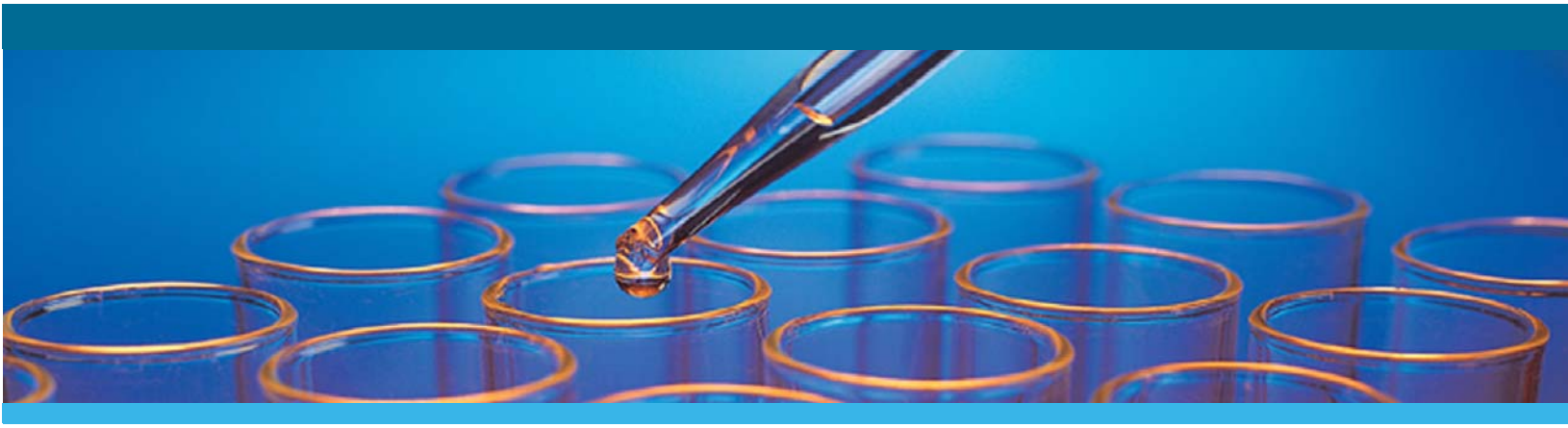
Table 9: Percent of firms by end user of bioproducts, by region, 2003

Region	Sold directly to consumers or distributors	Sold to other firms to be used as input(s)	Produced for internal use
		-percent-	
Canada	64.6	47.4	32.7
Atlantic	50.7	31.2	51.7
Quebec	62.6	51.3	37.2
Ontario	68.3	41.0	19.0
Manitoba	45.4	65.1	34.4
Saskatchewan	77.3	39.0	23.2
Alberta	69.2	53.2	47.2
British Columbia	63.8	51.0	29.4

Also note that the size of firm appears to affect the end use of the bioproduct (see Table 10). A large number of small and medium sized firms reported selling direct to consumer or distributor, but fewer of these firms reported selling their bioproducts as an input to some other firm, and even fewer still reported using their bioproduct for internal use. In contrast, 67 percent of large sized firms used their bioproducts for internal use; slightly over half of the large firms sold directly to consumer or distributor and fewer still reported selling bioproducts as an input to another firm.

Table 10: Percent of firms by end user of bioproducts, by firm size, 2003

Firm size	Sold directly to consumers or distributors	Sold to other firms to be used as inputs	Produced for internal use
		-percent-	
Small (less than 50 employeees)a	63.9	43.0	26.9
Medium (50 - 149 employees)	78.2	70.9	22.0
Large (more than 149 employees)	52.8	40.4	67.2



Chapter 3

Bioproduct Revenue and Expenses

Bioproduct Revenue

Nearly $12 billion in revenue was generated by Canadian bioproducts firms in 2003 (Table 11). However, just over one quarter (26 percent) of their revenue was derived from bioproduct activities; Canadian bioproduct firms were not only active in the bioproducts area. We note that with the exception of Saskatchewan and Alberta, firms in most provinces obtained more than 30 percent of their revenues from bioproduct activities. The largest total provincial revenue figures came from Alberta, Ontario, and Quebec; Ontario had the highest provincial revenue from bioproducts at $871 million. Firms from British Columbia generated the largest share of their revenues through bioproduct activities compared with other regions, at 39 percent. Saskatchewan companies received the lowest proportion of their revenues from bioproducts (6.5 percent), over 75 percent of which was generated through bioproduct exports. Alberta firms showed a similar dependence on exports, which accounted for 81 percent of their total bioproduct revenues.

Table 11: Revenue for bioproducts firms, by region, 2003

Region	Total revenue	Revenues from bioproducts		Revenues from bioproducts exported		Bioproduct revenue from exports
	($000)	($000)	%	($000)	%	%
Canada	$11,961,964	$3,160,887	26.4	$1,502,307	12.6	47.5
Atlantic	$404,497	F	-	-	-	-
Quebec	$2,340,260	$785,066	33.5	$241,860	10.3	30.8
Ontario	$2,791,291	$871,035	31.2	$422,581	15.1	48.5
Manitoba	$390,462	$126,978	32.5	$74,945	19.2	59.0
Saskatchewan	$1,543,943	$100,394	6.5	$78,710	5.1	78.4
Alberta	$2,848,275	$624,399	21.9	$502,979	17.7	80.6
British Columbia	$1,643,237	$633,621	38.6	$171,723	10.5	27.1

Average revenue per firm displayed significant provincial differences (Table 12). Firms in Alberta and Saskatchewan had significantly higher average revenue than firms in other provinces but Alberta firms derived the highest average revenue from bioproducts, while Saskatchewan firms derived the lowest. Revenues for Quebec firms seemed reflective of their age. Average revenues were low relative to those of firms in other provinces and bioproduct revenues made up a relatively large share, with a smaller percentage exported. British Columbia firms displayed a similar pattern.

Table 12: Average revenue/firm, by region 2003

Region	Total revenue per firm	Revenues from bioproducts per firm		Revenues from bioproducts exported, per firm		Share of bioproduct revenue from exports, per firm
	($000)	($000)	% of total revenue	($000)	% of total revenue	% of bioproduct revenue
Canada	$51,560	$13,625	26.4%	$6,475	12.6%	47.5%
Atlantic	$26,966	F	-	-	-	-
Quebec	$32,504	$10,904	33.5%	$3,359	10.3%	30.8%
Ontario	$52,666	$16,435	31.2%	$7,973	15.1%	48.5%
Manitoba	$43,385	$14,109	32.5%	$8,327	19.2%	59.0%
Saskatchewan	$85,775	$5,577	6.5%	$4,373	5.1%	78.4%
Alberta	$105,492	$23,126	21.9%	$18,629	17.7%	80.6%
British Columbia	$43,243	$16,674	38.6%	$4,519	10.5%	27.1%

Bioproduct revenues, as a percentage of total revenue also varied widely depending on firm size. Medium sized firms derived the largest portion of total revenue and exports from bioproducts (Table 13). Large firms appeared to incorporate bioproducts into their companies as one line of business, but not the major focus. Only 18 percent of total revenue and seven percent of export revenue were derived from bioproducts.

Table 13: Bioproduct firm revenue, by firm size, 2003

Firm size	Total revenue ($000)		Revenues from bioproducts ($000)			Revenues from bioproducts exported ($000)		
	Total	Average/ firm	Total	Average/ firm	% of total revenues	Total	Averrage/ firm	% of bioprod-uct revenue
Small	$927,961	$6,026	$418,796	$2,719	45%	$258,656	$1,680	61.8%
Medium	$1,737,167	$43,429	$1,100,449	$27,511	63%	$578,081	$14,452	52.5%
Large	$9,296,837	$244,654	$1,641,642	$43,201	18%	$665,570	$17,515	40.5%

Bioproduct Research and Development Expenditures

As shown in Table 14, Canadian firms spent an average of just over $1 million on R&D for the year, 39 percent of which was devoted to their bioproduct programs. Firms in Alberta, Manitoba, and Quebec spent more than the average on both total R&D and bioproduct R&D. Quebec firms typically spent nearly twice as much as Ontario firms on both total and bioproduct research and development. Although their R&D spending was lower, Ontario firms did utilize 46 percent of their R&D spending to fund bioproduct development, which was the highest of any region. Quebec firms were a close second with 43 percent of their total R&D budgets geared towards bioproduct uses. On average Atlantic firms invested only $288, 251 for all R&D activities on average, and only 12 percent of this was used for bioproduct programs.

Table 14: Bioproduct firm research and development expenditures, by region, 2003

Region	Average total R&D per firm	Average Bioproduct R&D per firm	R&D Total Revenue	Average Bioproduct/ Average Total R&D	Bioproduct R&D/ Bioproduct revenue
	$	$	%	%	%
Canada	$1,032,509	$403,006	2.0	39.0	3.0
Atlantic	$288,251	$33,019	1.1	11.5	-
Quebec	$1,326,609	$571,543	4.1	43.1	5.2
Ontario	$673,718	$309,468	1.3	45.9	1.9
Manitoba	$1,589,441	$640,525	3.7	40.3	4.5
Saskatchewan	$562,151	$205,875	0.7	36.6	3.7
Alberta	$1,911,127	$526,447	1.8	27.5	2.3
British Columbia	$736,090	$309,599	1.7	42.1	1.9

As a percentage of total R&D, small firms were the most intensely focused on bioproduct development, with seventy-two percent of R&D expenditures aimed at bioproducts (Table 15). Large firms focused roughly a fifth of their R&D budgets on bioproducts R&D, spending only marginally more than medium sized firms and almost double what small firms spent.

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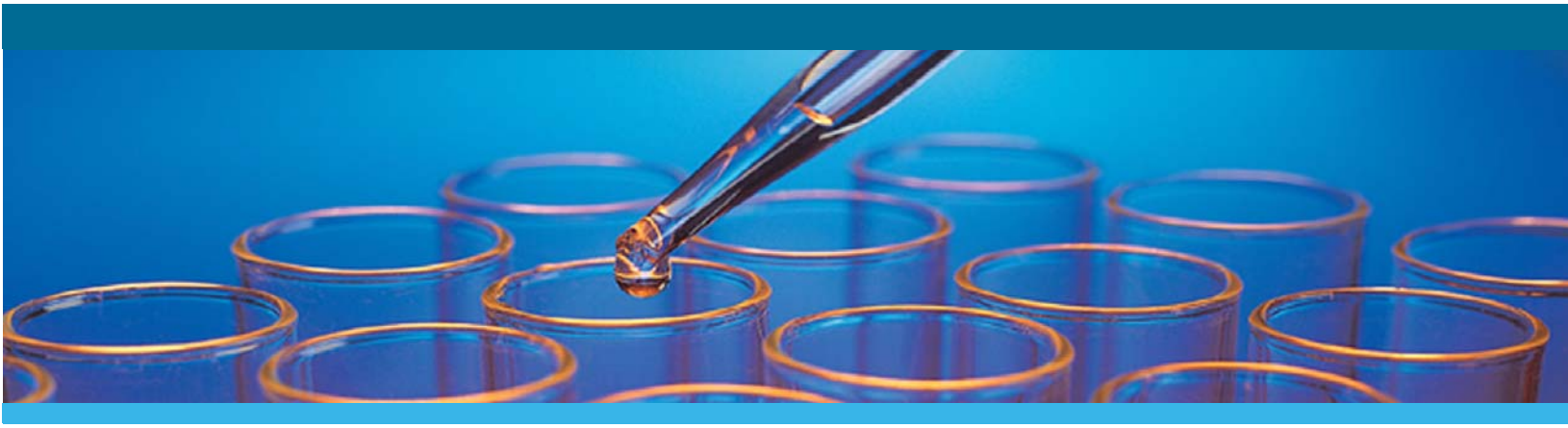
Table 15: Average research and development expenditures, by firm size, 2003

Firm size	Average total R&D	Average bioproduct R&D	Average bioproduct/ averarage total R&D
Smalll	$444,369	$321,395	72%
Medium	1,516,962	$512,147	34%
Large	$2,906,076	$618,863	21%



Chapter 4

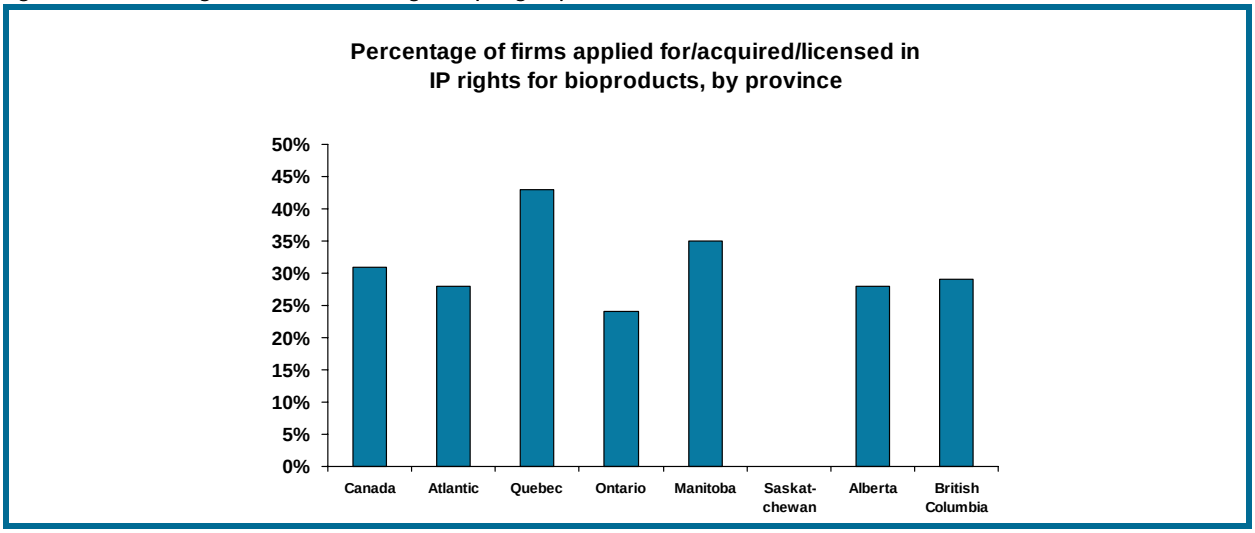
Intellectual Property

Thirty percent of all Canadian firms either possessed or had applied for some form of IP rights during 2003 (Figure 8). Most obtained their IP through either a patent assignment or a licensing agreement, with the former being most common regardless of province or size (Tables 16 and 17). Tables 16 and 17 indicate only the number of firms with each type of IP source, but not the number of arrangements. For example, a firm could have numerous licensing agreements with Canadian and foreign firms but there would only be a single entry under licensing agreements and one entry each under Canadian and foreign sources.

Firms in Quebec took a much more aggressive attitude toward acquiring and protecting IP. Quebec bioproducts firms were the most likely to have acquired or pursued IP protection for their technology (43 percent of firms); this is compared with 30 percent of B.C. firms and just 23 percent of Ontario firms. Consistent with this finding, two of the three most important knowledge development strategies (discussed later) used by Quebec firms pertained to IP; specifically, conducting IP audits to ensure protection of technology at all development stages, and developing firm policies for knowledge and IP protection. Firms in all other provinces rated the acquisition/use of knowledge from industry sources as the most important. In fact, conducting an IP audit, which was most important to Quebec firms, was the least important factor in knowledge development to Canadian companies overall.

With the exceptions of Ontario and Quebec, the percentage of firms which possessed/pursued IP rights during the year was fairly stable across the country, ranging from 28 percent to 32 percent of firms. (Note: There is no data for Saskatchewan).

Figure 8: Percentage of firms with IP rights by region, 2003



Ontario firms were the most likely to have obtained foreign IP. Nearly 58 percent of Ontario firms with IP had acquired it from sources outside of Canada. Quebec firms, in contrast, were least likely to have obtained their IP from foreign firms or institutions. Firms in Alberta, B.C., and the Atlantic regions acquired 67 percent, 63 percent and 50 percent of their IP from domestic sources. (Note: Manitoba and Saskatchewan data are insufficient to make conclusions.)

Table 16: Intellectual property arrangements, by region, 2003.

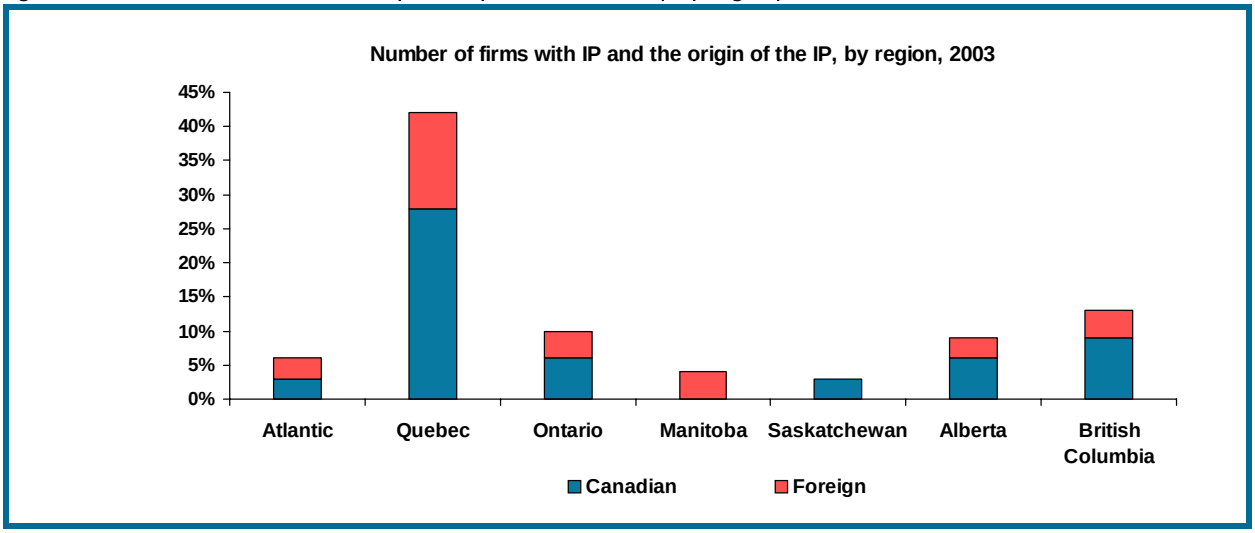
(The number of firms which acquired IP in 2003 and the source of the IP)

Region	Number of firms	Type of IP			Source of IP	
		Licensing agreement	Patent assignment	Other	Canadian	Foreign
			-number-			
Canada	232	38	50	24	52	35
Atlantic	15	4	F	0	3	3
Quebec	72	16	19	16	28	14
Ontario	53	7	10	3	5	7
Manitoba	9	0	3	F	F	1
Saskatchewan	18	F	F	0	0	F
Alberta	27	4	6	F	6	3
British Columbia	38	4	9	F	9	5

Table 17: Intellectual property arrangements, by firm size, 2003.
(The number of firms which acquired IP in 2003 and the source of the IP)

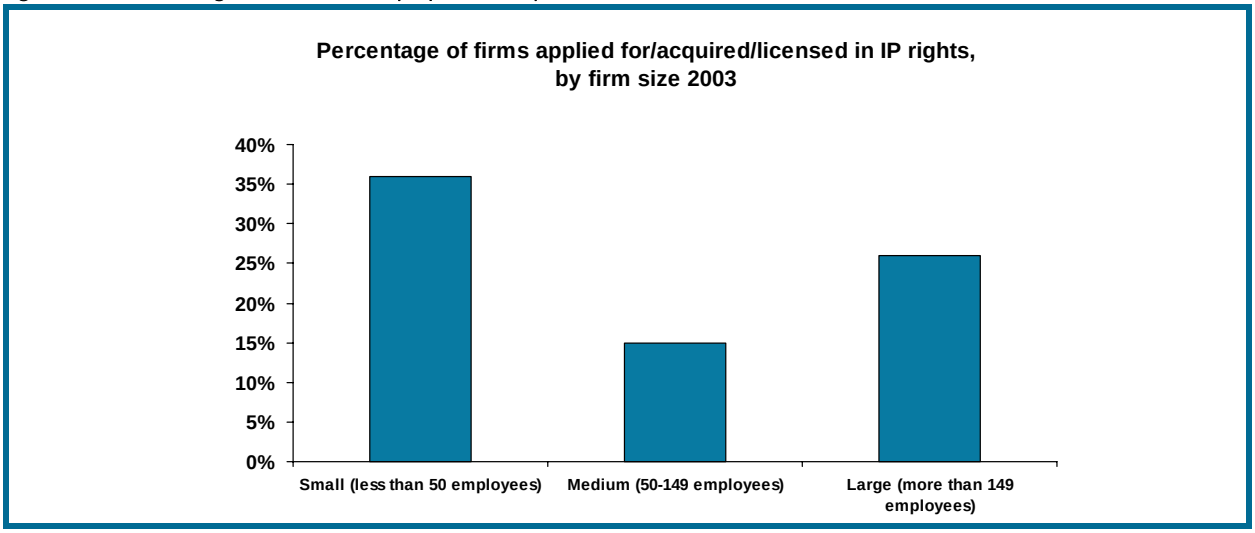
Firm size	Number of firms	Type of IP: Licensing agreement	Type of IP: Patent assignment	Source of IP: Other	Source of IP: Canadian	Source of IP: Foreign
			-number-			
Small (less than 50 employees)	154	31	37	16	40	27
Medium (50-149 employees)	40	3	4	3	5	6
Large (more than 149 employees)	38	3	8	5	8	3

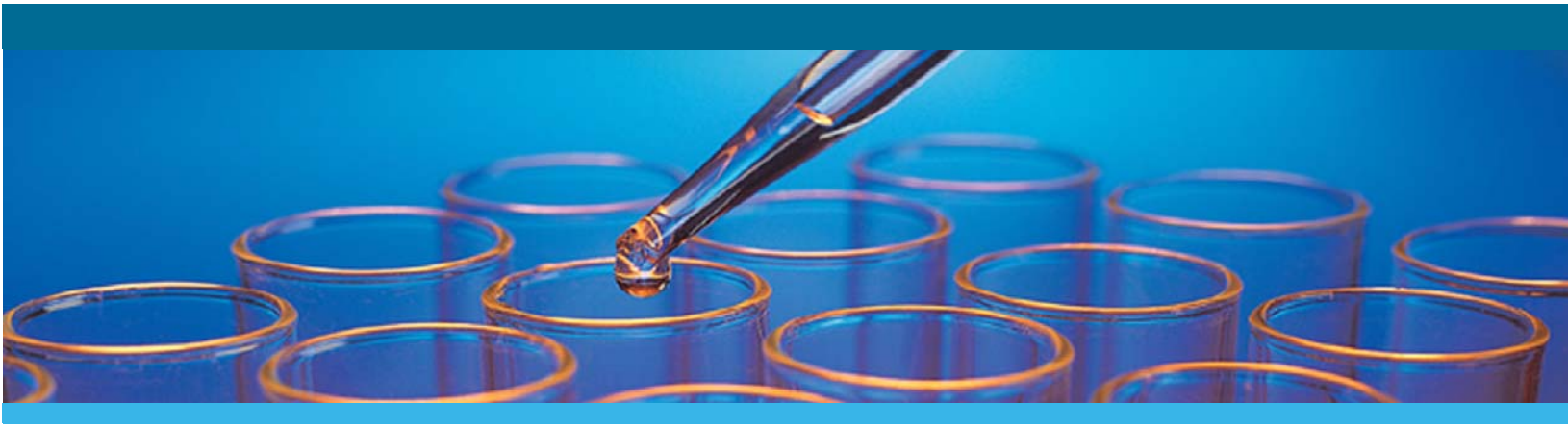
Figure 9: Number of firms which acquired by source of the IP, by region, 2003



Small firms were also most likely to have acquired/pursued IP protection, with 36 percent having done so. This is also consistent with other areas of the survey, which indicate that the small firms may be more involved in the early development of new technologies. It may also have been related to their search for capital as IP is often an important factor in obtaining financing. Medium and large sized firms had relatively lower rates, at 15 percent and 25 percent respectively. The proportion of firms which obtained IP from domestic sources varied from 50 percent for medium sized firms to 59 percent for small firms and 73 percent for large firms. As will be discussed later, restrictions on IP rights were not considered one of the major impediments to the development of bioproducts. Despite this, the inability to obtain IP protection for technology was the most common reason for lenders limiting or refusing capital to firms (see financing section for details).

Figure 10: Percentage of firms with IP, by firm size, 2003





Chapter 5

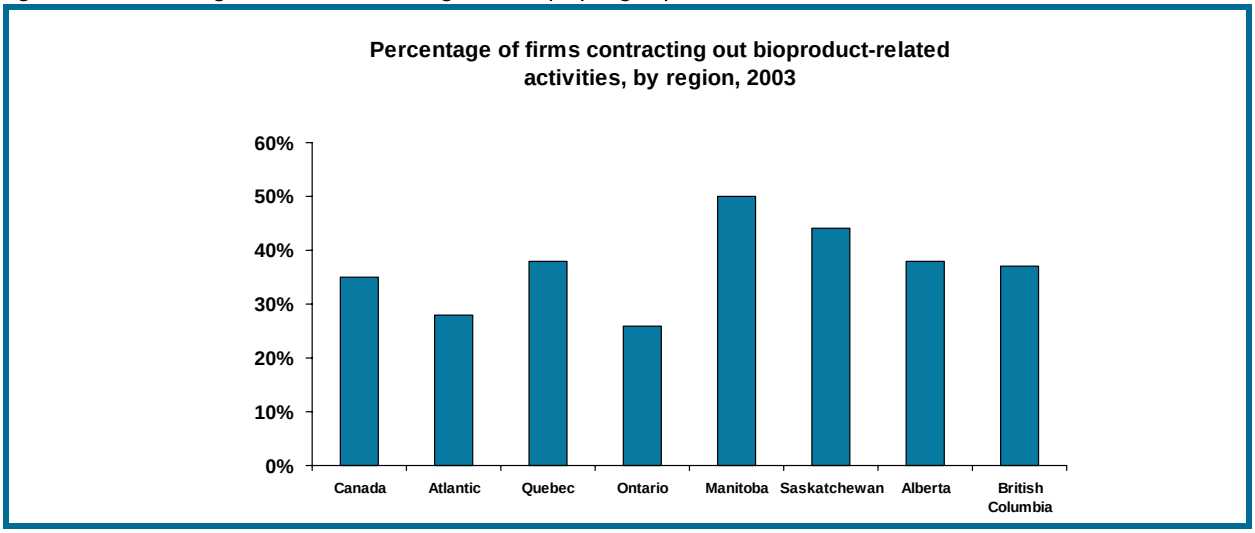
Contracts and Collaborations

Canadian firms relied heavily on outside organizations for research and development activities, to reduce costs and risk exposure and to access new markets. They accessed skills and capabilities in other organizations in one of two ways, through contracts and through collaborations. Contracts are straight-forward exchanges of services for money. They are the simplest to negotiate and execute but may not always provide the best long-term access to required capabilities. Consequently, many firms have undertaken to create more extensive and permanent relationships with other companies through collaborations.

Contracts

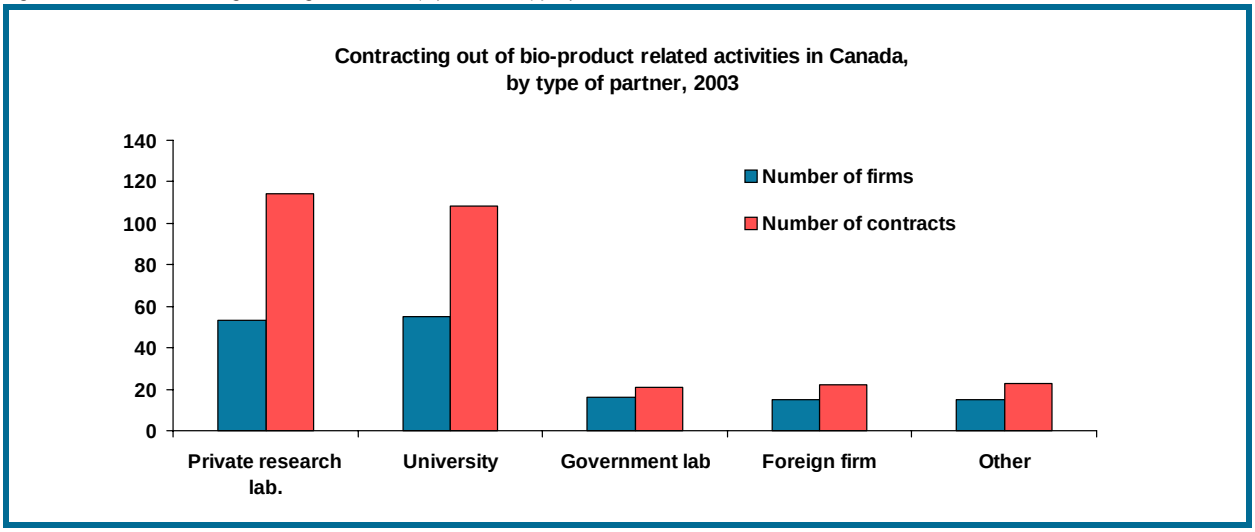
Contracts were a significant part of operations for many firms. Canadian companies had nearly $117 million in total bioproduct-related contracting in 2003. On average, 36 percent of all Canadian firms had contracted out some part of their bioproduct activity during the year (Figure 11). Firms engaged in contracting activities had 1.9 contracts on average. The percentage of firms contracting was fairly stable across firm sizes, but varied to some extent by province. Manitoba had the highest proportion of firms contracting out, at 48 percent. The lowest proportion was in Ontario (only 24 percent). Alberta firms were the most involved in contracting out bioproducts activities. The $76 million of contracts provided by Alberta companies represented 66 percent of the total value of contract expenditures by Canadian bioproducts firms.

Figure 11: Percentage of firms contracting activities, by region, 2003



Most bioproduct-related contracts were with private research labs and universities. Contracts with these institutions comprised 40 percent and 37 percent, respectively, of all contracts (Figure 12). Around 7 percent of contracts were with each of the remaining categories of institutions (government labs, foreign firms, other).

Figure 12: Contracting arrangements by partner type, 2003



Although Alberta had the highest expenditure on contracts, Quebec firms were the most active, particularly involving contracts with private or government labs. In general, private labs and universities comprised most of the partners in all provinces. Government labs were a more common partner for Quebec firms. (It is difficult to comment on the number of contracts with foreign firms, since we are missing values for both Atlantic and Ontario.)

Table 18: Total number of contracts, by partner type and region, 2003

Region	Private lab	University	Government lab	Foreign firm	Other
			-number-		
Canada	114	108	21	23	23
Atlantic	0	F	0	F	4
Quebec	50	39	12	7	9
Ontario	10	17	3	F	0
Manitoba	15	5	0	7	0
Saskatchewan	9	4	3	0	8
Alberta	14	16	0	0	3
British Columbia	16	25	3	3	0

Analysis of contracts by partner by firm size reveals the extent to which small firms rely on contracts. Small firms tended to have more contracts with private labs than with universities, and large firms had more contracts with universities than with private research labs. Results on a contracts-per-firm basis are consistent with the above observations. Small firms clearly had the most contracts per firm with private labs, government labs, and foreign firms. Large firms, however, had by far the most contracts per firm with universities, with more than double the number for small companies.

Table 19: Percentage of contracting firms, by firm size, 2003

	Number of Contracting Firms/Total Firms				
Firm size	Private research lab.	University	Government lab.	Foreign firm	Other
			-percent-		
Smalll	22.1	25.6	5.6	4.7	6.4
Medium	23.3	18.5	7.8	11.2	7.3
Large	24.0	21.1	12.8	8.4	7.5

Collaborations

Thirty-five percent of bioproducts firms in Canada were involved in collaborations with other organizations in 2003 (Figure 13). Firms in Ontario were least likely to be involved while Saskatchewan firms were the most likely, at 58 percent, followed by Quebec firms at 41 percent. Fifty-one percent of firms reporting collaborations cited the access to external scientific expertise as the primary reason for collaborations (Table 20). Collaborations for that purpose made up 63 percent of all Canadian collaborations. This appeared relatively common across all sizes and regions. Cost reduction related to R&D activities was the second motivating factor.

Figure 13: Percentage of firms involved in collaborations, by region, 2003

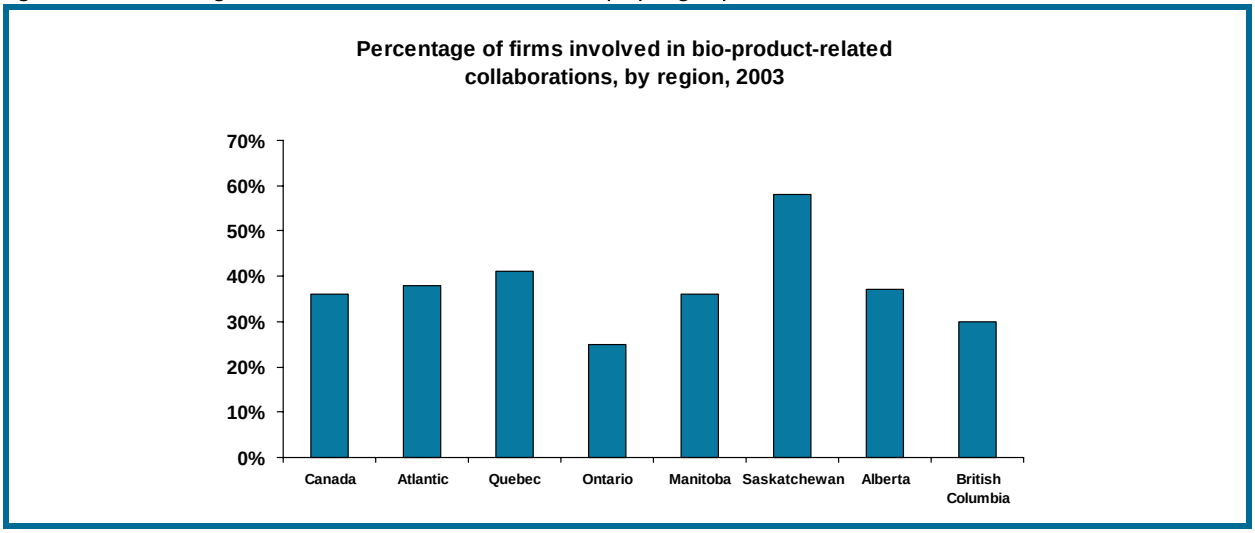
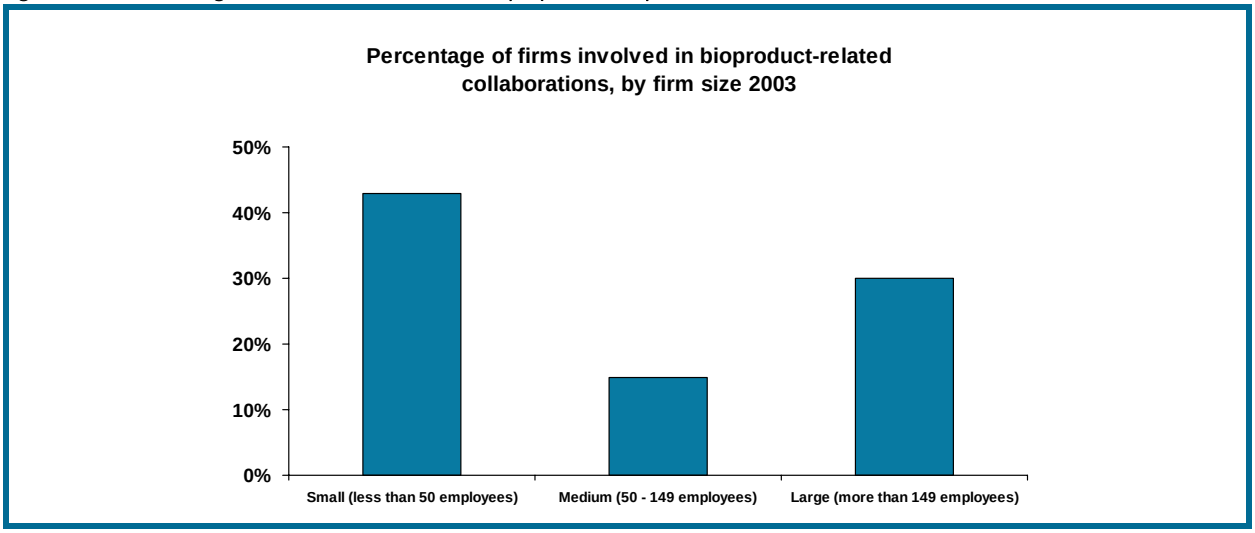


Figure 14: Percentage of firms in collaborations, by firm size, 2003



Small firms again displayed their need to extend their capabilities and were more likely than larger firms to be involved in collaborative arrangements (Figure 14). Their motivations were primarily to access external skills not available inside the organization (Table 21). Small firms were more likely to work with private sector organizations; labs, bio-products and non-bio-products firms, than larger firms. Large firms, on the other hand, collaborated much more closely with academic institutions, for both access to expertise and reducing the cost of R&D.

Table 20: Motivations for collaborations, by region, 2003

Region	Total number of firms	Bioproducts firms	Non-bioproducts firm	Academic institution	Government lab. or agency	Other	Total arrangements
			-number-				
Canada							
Knowledge not available internally; access outside scientific expertise	65	30	84	71	30	20	235
Cost reduction related to R&D activities	34	32	5	20	9	6	72
Reduce risk exposure	17	3	8	F	3	17	32
Other	11	12	19	0	0	0	31
Atlantic							
Knowledge not available internally; access outside scientific expertise	6	F	14	8	F	0	28
Cost reduction related to R&D activities	F	0	0	F	F	0	F
Reduce risk exposure	0	0	0	0	0	0	0
Other	1	0	6	0	0	0	6
Quebec							
Knowledge not available internally; access outside scien tific expertise	21	16	13	17	10	9	64
Cost reduction related to R&D activities	18	9	3	6	6	F	27
Reduce risk exposure	7	3	F	F	F	F	9
Other	4	8	0	0	0	0	8
Ontario							
Knowledge not available internally; access outside scien tific expertise	12	F	32	19	6	11	70
Cost reduction related to R&D activities	3	F	0	F	0	F	20
Reduce risk exposure	F	0	0	0	0	F	F
Other	3	1	6	0	0	0	8

Table 20: Motivations for collaborations, by region, 2003

Region	Total number of firms	Bioproducts firms	Non-bioproducts firm	Academic institution	Government lab. or agency	Other	Total arrangements
Manitoba							
Knowledge not available internally; access outside scientific expertise	3	F	F	F	F	0	9
Cost reduction related to R&D activities	3	F	0	F	0	0	3
Reduce risk exposure	F	0	F	0	0	0	F
Other	0	0	0	0	0	0	0
Saskatchewan							
Knowledge not available internally; access outside scientific expertise	9	6	4	6	4	0	20
Cost reduction related to R&D activities	1	1	0	0	0	0	1
Reduce risk exposure	F	0	F	0	0	0	F
Other	0	0	0	0	0	0	0
Alberta							
Knowledge not available internally; access outside scientific expertise	5	0	15	8	F	0	24
Cost reduction related to R&D activities	6	5	3	F	F	0	10
Reduce risk exposure	F	0	0	0	F	0	F
Other	3	F	6	0	0	0	9
British Columbia							
Knowledge not available internally; access outside scientific expertise	9	0	4	11	3	0	19
Cost reduction related to R&D activities	F	0	0	F	0	0	F
Reduce risk exposure	3	0	F	0	0	F	F
Other	0	0	0	0	0	0	0

Table 21: Motivations for collborations, by firm size, 2003

	Total firms	Bioproducts firm	Non-bioproducts firm	Academic institution	Government lab or agency	Other	Total arrangements
			-number-				
Small (less than 50 employees	**93**						
Knowledge not available internally; access outside scientific expertise	51	29	73	44	14	11	171
Cost reduction related to R&D activities	25	32	5	5	8	0	49
Reduce risk exposure	9	3	F	F	3	F	24
Other	8	6	19	0	0	0	24
Medium (50-149 employees)	**6**						
Knowledge not available internally; access outside scientific expertise	3	F	F	3	F	0	7
Cost reduction related to R&D activities	F	0	0	F	0	0	F
Reduce risk exposure	F	0	F	0	0	0	F
Other	3	6	0	0	0	0	6
Large (more than 149 employees)	**25**						
Knowledge not available internally; access outside scientific expertise	11	0	9	24	14	10	57
Cost reduction related to R&D activities	8	0	0	14	F	6	22
Reduce risk exposure	6	0	3	0	0	3	6
Other	0	0	0	0	0	0	0

Foreign Collaborations

Foreign collaborations were relatively rare. Only 22 percent of bioproducts firms in Canada had entered into foreign collaborations. Due to confidentiality reasons the only available data is for Quebec, Ontario, Saskatchewan and B.C. who have 18, 9, 7, and 7 collaborations with foreign partners, respectively. Saskatchewan had the most firms involved, at 38 percent, and Ontario the fewest (of the numbers given) at 16 percent. Data is reported for small and large firms only. Only 23 percent of small firms had foreign collaborations, compared to 25 percent of large firms.

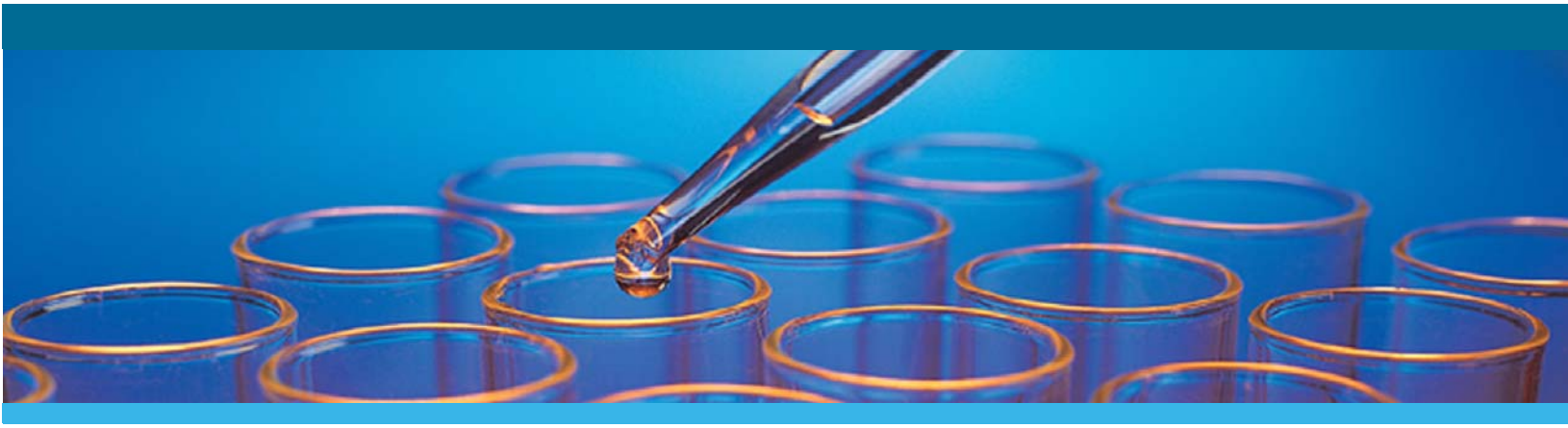
Firms were also asked about the motivation for entering into collaborations with foreign firms, rating each motivation on a five point scale. The overwhelming reason for entering into foreign collaborations was access to foreign markets. This was consistent across all provinces and small and large size categories (Tables 22 and 23).

Table 22: Number of firms by degree of importance of purpose of arrangement with foreign partners, by region, 2003

	Degree of Importance					
	Low	Moderately low	Medium	Moderately high	High	Weighted score
	-number-					
Canada						
Knowledge not available internally; access outside scientific expertise	28.1	20.9	2.9	12.0	36.0	3.07
Cost reduction related to R&D activities	32.3	20.7	28.8	2.9	15.2	2.48
Reduce risk exposure	29.7	37.4	11.8	14.7	6.4	2.31
Access foreign market	0.0	9.1	11.9	16.1	62.8	**4.32**
Atlantic - Not reported						
Quebec						
Knowledge not available internally; access outside scientific expertise	23.9	34.2	0.0	9.0	32.9	2.93
Cost reduction related to R&D activities	23.9	35.2	23.4	8.6	9.0	2.44
Reduce risk exposure	21.2	35.6	8.6	24.9	9.8	2.67
Access foreign market	0.0	0.0	18.1	25.7	56.3	**4.39**
Ontario						
Knowledge not available internally; access outside scientific expertise	17.6	35.0	0.0	18.4	29.0	3.06
Cost reduction related to R&D activities	32.1	0.0	49.5	0.0	18.4	2.73
Reduce risk exposure	32.1	67.9	0.0	0.0	0.0	1.68
Access foreign market	0.0	35.0	0.0	14.5	50.5	**3.81**
Manitoba - not reported						
Saskatchewan						
Knowledge not available internally; access outside scientific expertise	78.3	0.0	0.0	0.0	21.7	1.87
Cost reduction related to R&D activities	54.3	21.7	24.0	0.0	0.0	1.70
Reduce risk exposure	54.3	21.7	0.0	0.0	24.0	2.18
Access foreign market	0.0	0.0	21.7	0.0	78.3	**4.57**
Alberta						
Knowledge not available internally; access outside scientific expertise	22.6	0.0	0.0	27.4	50.0	3.82
Cost reduction related to R&D activities	45.3	27.4	0.0	0.0	27.4	2.37
Reduce risk exposure	22.6	50.0	27.4	0.0	0.0	2.05
Access foreign market	0.0	0.0	27.4	22.6	50.0	**4.23**
British Columbia						
Knowledge not available internally; access outside scientific expertise	32.7	23.7	0.0	21.3	22.3	2.77
Cost reduction related to R&D activities	32.7	0.0	46.0	0.0	21.3	2.77
Reduce risk exposure	32.7	23.7	21.3	22.3	0.0	2.33
Access foreign market	0.0	23.7	0.0	0.0	76.3	**4.29**

Table 23: Number of firms by degree of importance of purpose of arrangement with foreign partners, by firm size, 2003

	Degree of Importance					
	Low	Moderately low	Medium	Moderately high	High	Weighted score
			-percent-			
Small (less than 50 employees)						
Knowledge not available internally; access outside scientific expertise	40.4	25.3	4.2	8.4	21.7	2.46
Cost reduction related to R&D activities	46.4	16.9	24.0	4.2	8.4	2.11
Reduce risk exposure	38.1	27.3	16.9	8.4	9.2	2.23
Access foreign market	0.0	8.4	4.2	23.1	64.2	**4.43**
Medium (50 - 149 employees)						
Knowledge not available internally; access outside scientific expertise	0.0	0.0	0.0	0.0	100.0	**5.00**
Cost reduction related to R&D activities	0.0	77.1	22.9	0.0	0.0	2.23
Reduce risk exposure	0.0	77.1	0.0	22.9	0.0	2.46
Access foreign market	0.0	0.0	77.1	0.0	22.9	3.46
Large (more than 149 employees)						
Knowledge not available internally; access outside scientific expertise	0.0	17.5	0.0	33.0	49.6	4.15
Cost reduction related to R&D activities	0.0	0.0	50.4	0.0	49.6	3.99
Reduce risk exposure	16.6	50.4	0.0	33.0	0.0	2.49
Access foreign market	0.0	17.5	0.0	0.0	82.5	**4.48**



Chapter 6

Financing

Of the 232 respondents from across Canada, 54 percent attempted to raise capital in 2003 to assist in the development or production of bioproducts. Most firms attempting to secure capital funding were at least partially successful. The proportion of firms successful in securing at least partial funding ranged from 75 percent to 92 percent depending on size (Figure 25). A total of nearly $300 million was raised by the 96 successful companies.

Not only were Quebec, Ontario and British Columbia home to the highest number of firms, but companies in these provinces were also most likely to attempt to raise capital (Table 24). However, funding success varied widely from province to province. Firms in Manitoba, Saskatchewan, and Alberta had very high success rates in raising at least partial funding, but the number of firms is relatively low and the amount raised varied dramatically. Quebec, on the other hand, had a high number of firms and a success rate of 86 percent. Quebec firms secured over half of the capital raised in Canada -- over $126 million in total for 2003, and $3.3 million/firm which sought capital. Interestingly, firms in Ontario were least successful in obtaining funding with just over 57 percent of firms able to raise capital, and raising only $700,000/firm seeking capital. Atlantic firms also found it difficult to obtain funding, with only two-thirds successful in their attempts. Alberta firms raised nearly $93 million with an average of $7.5 million per firm seeking capital, over ten times the Ontario average.

Table 24: Financing success, by region, 2003

Region	Number of firms	Sought funding	Percent seeking funding	Raised funds	Percent successful	Total raised $'000	Average raised $'000	Average/firm seeking funding ($'000)
Canada	232	124	53.6%	96	77.4%	297,476	1,280	2,378
Atlantic	15	6	39.2%	4	66.7%	F	x	x
Quebec	72	44	61.4%	38	86.4%	147,438	2,055	3,339
Ontario	53	28	53.2%	16	57.1%	19,975	375	702
Manitoba	9	3	34.8%	3	100.0%	F	x	x
Saskatchewan	18	9	49.9%	8	88.9%	2,011	111	211
Alberta	27	13	47.9%	11	84.6%	92,753	3,449	7,507
British Columbia	38	21	55.0%	15	71.4%	25,790	666	1,192

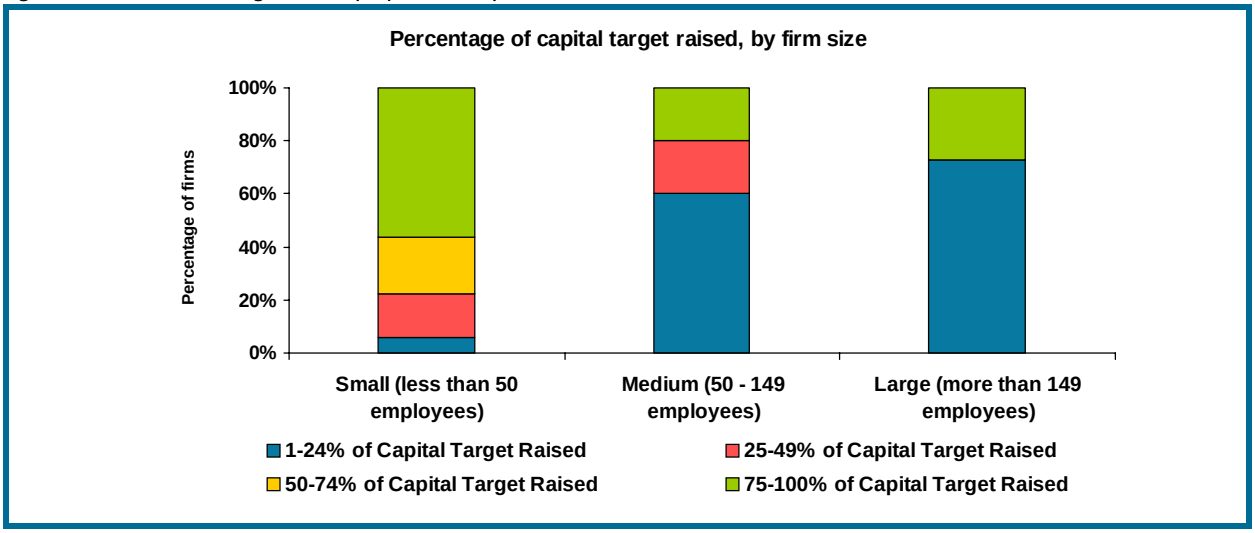
Small firms were more likely to attempt to secure financing than larger firms; 60 percent of small firms across Canada tried to raise capital. While they had a lower success rate than either medium or large firms they raised the most on average. The partial funding success rate was highest for the large firms, however not as many pursued funding, and the average amount raised was lower. Interestingly, funding for large firms was, on average, much lower than for small or medium sized firms and they achieved far less of their target funding (Table 25 and Figure 15).

Table 25: Financing success, by firm size, 2003

Firm size	Attempted to raise capitalg		Successfullly raised capital		Total amount raised	Average amount raised
	#	%	#	%	($000)	($000)
Small	93	60.4	70	75.3	$234,228	$2,468
Medium	18	45.0	15	83.3	$45,725	$2,539
Large	12	31.6	11	91.7	$17,523	$1,441

Medium and large firms also were less likely to reach their funding target than small firms, likely because they had higher goals. Despite the fact that large firms were most likely to succeed in raising funds, few were able to raise more than half their target amounts. Of the small firms that succeeded in raising funds, 77 percent raised at least half their target.

Figure 15: Firm financing success, by firm size, 2003



The number one reason cited by firms for pursuing financing was to fund R&D (Table 26). Firms across Canada were fairly consistent in their purposes for obtaining funding. As might be expected, repaying investors and funding regulatory expenses were only considerations for small firms (likely due to firm structure and relative "newness" to the sector). Similarly, medium and large firms required more funding for production and manufacturing since they had more products on the market. Just over half of firms, regardless of size, cited the need for operating capital as a purpose for raising funds.

Table 26: Purpose of securing financing, by firm size, 2003

Purpose	Number of firms					
	Small		Medium		Large	
	#	%	#	%	($000)	%
R&D purposes/ expand R&D capacity	77	82.3	17	92.1	9	76.6
Proof of concept/pilot project	52	55.4	15	83.9	9	76.6
Regulatory expenses	19	20.1	0	0.0	0	0.0
Production/manufacturing capability	43	45.8	12	66.1	11	90.6
Operating capital	53	57.2	9	52.1	6	51.8
Repay current investors	18	19.5	0	0.0	-	-
Other	10	10.5	-	-	0	0.0
Total firms attempting to raise capital	93	100.0	18	100.0	12	100.0

The most common reason for limitations of capital requests was the lack of availability of capital (Table 27). The other major reasons cited pertained to the development stage of the product/ technology (too early) or a lack of proven market demand.

Table 27: Number of firms by reasons for lender limiting or refusing capital requests, by region, 2003

Region	Number of firms						
	Further development/ proof of concept required	Not market ready	No market demand	Insufficient expertise	Capital not available	Intellectual property protection not available in Canada	Other
Canada	19	7	15	8	47	0	27
Atlantic	F	0	0	0	0	0	F
Quebec	4	3	3	4	19	0	4
Ontario	x	0	7	x	10	0	11
Manitoba	0	0	0	x	F	0	0
Saskatchewan	5	x	3	0	0	x	4
Alberta	3	0	x	F	4	0	3
British Columbia	4	3	x	F	11	0	3

Table 28: Number of firms by reasons for lender limiting or refusing capital requests, by firm size, 2003

Firm size	Number of firms						
	Further development/ proof of concept required	Not market ready	No market demand	Insufficient expertise	Capital not available	Intellectual property protection not available in Canada	Other
Small	19	7	13	8	26	0	24
Medium	0	0	F	F	13	0	F
Large	0	0	0	0	8	0	F

The funding received by these firms came from numerous sources. Government programs comprised 45 percent of all sources of funding for Canadian firms. Other common sources included private placements and angel investors/family (each 13 percent). Less frequently used were financial institutions, public offerings, venture capital, and alliances/collaborations. Quebec companies captured most of the funding, especially from venture capitalists, government loan programs, public offerings, and alliances. Loan programs were often administered provincially. In addition, Alberta firms had a disproportionately high number of the private placements, which might account for their very high levels of funding per firm relative to companies in other provinces.

Table 29: Sources of financing, by region, 2003

Sources	Canada	Atlantic	Quebec	Ontario	British Columbia	Manitoba	Saskatchewan	Alberta
	# of firms	%	%	%	%	%	%	%
Canadian VC	10	0.0	100	0.0	0.0	0.0	0.0	0.0
Banks, etc.	15	F	22.2	29.5	20.7	x	0.0	16.9
Angel/family	19	x	36.1	26.5	x	0.0	21.0	x
Govt. loans	5	0.0	100	0.0	0.0	0.0	0.0	0.0
Govt. matching funds	23	x	24.9	19.7	31.4	F	17.1	0.0
Govt. grants	35	8.9	42.5	19.4	12.3	0.0	17.0	0.0
Govt. other	6	0.0	54.1	x	0.0	0.0	0.0	F
IPO/SPO	6	0.0	77.2	0.0	0.0	x	0.0	F
Private placement	20	0.0	36.6	13.4	27.5	F	0.0	51.5
Alliances, etc.	9	0.0	51.6	F	F	0.0	0.0	F
Other	3	0.0	F	0.0	0.0	0.0	0.0	F

Figure 16: Number of firms using different financing methods by region, 2003

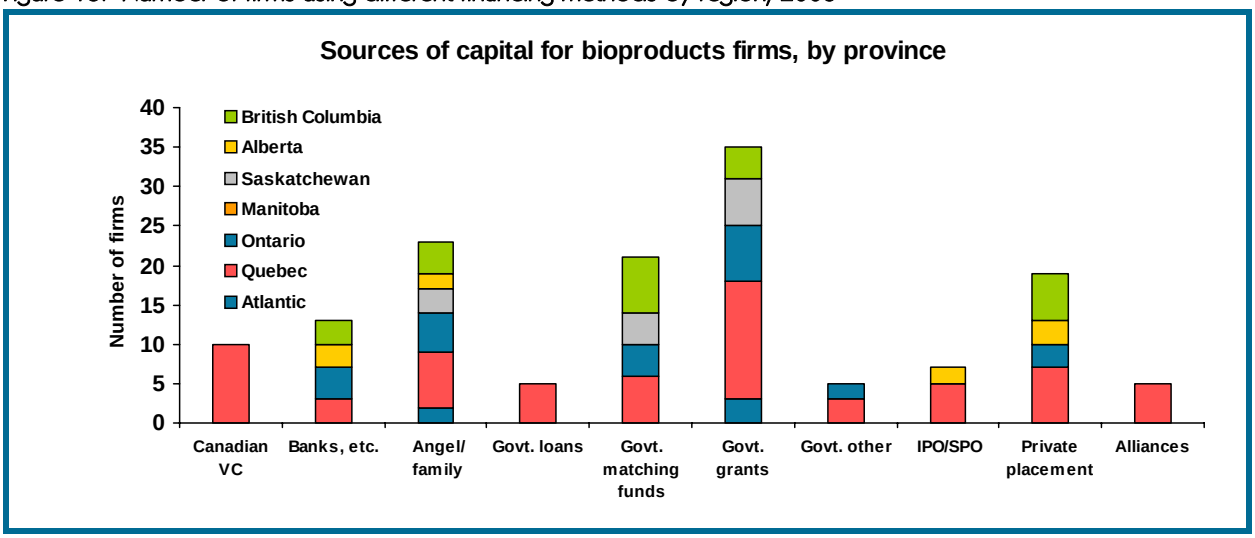
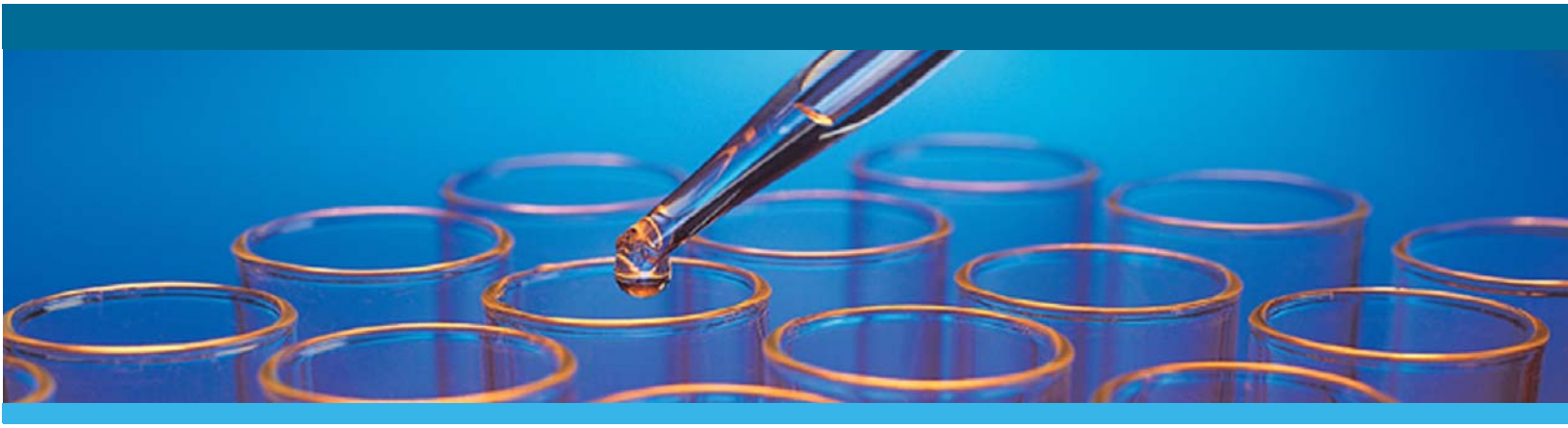


Table 30: Sources of financing, by firm size, 2003

Region	Number of firms			Average % of total for each firm raised from this source		
	Small	Medium	Large	Small	Medium	Large
Canadian VC	10	0	0	4%	0%	0%
Banks, etc.	7	5	3	4%	7%	6%
Angel/family	18	F	x	7%	F	x
Govt. loans	5	0	0	1%	0%	0%
Govt. matching funds	7	9	8	2%	16%	17%
Govt. grants	27	5	3	11%	2%	2%
Govt. other	3	3	0	1%	4%	0%
IPO/SPO	6	0	0	2%	0%	0%
Private placement	19	x	F	10%	x	F
Alliances, etc.	F	6	F	F	5%	F
Other	x	x	0	x	x	0%



Chapter 7

Use of Government Support Programs

Use of funding under the Scientific Research and Experimental Development (SR&ED) tax program varied widely among the provinces and firm sizes. Firms in Manitoba and Quebec were much more likely to use the program but Manitoba and B.C. firms were far ahead in terms of the amount requested by participating firms. Alberta was third, with all other regions trailing.

Table 31: Firm use of SR&ED tax program in the past five years, by region, 2003

Region	Number using SR&ED	Percentage using SR&E	Benefits applied for under program	Average benefits applied for/firms using program	Average cumulative credits/firm in region
	#	%	$'000	$'000	$'000
Canada	90	47.4	87,198	792	1,299
Atlantic	4	26.7	F	F	3,761
Quebec	38	65.3	28,813	613	1,173
Ontario	15	37.7	5,500	275	840
Manitoba	6	55.6	15,873	3,175	1,071
Saskatchewan	5	38.9	x	x	315
Alberta	7	25.9	11,481	1,640	3,891
British Columbia	14	52.6	21,970	3,139	882

Small firms were more likely to use of the SR&ED tax credit program but they applied for and received less than larger firms. Large size firms have been the most successful in securing tax credits over the last five years.

Table 32: Firm use of SR & ED tax program in the past five years, by firm size, 2003

Firm size	Number using SR&ED	Percentage using SR&ED	Benefits applied for under program	Average benefits applied for/firms using program	Average cumulative credits/firm in region
	#	%	$'000	$'000	$'000
Small	77	50.0	21,792	283	795
Medium	19	47.5	26,079	1,373	2,321
Large	15	39.5	39,328	2,622	2,505

Participation in other government programs was also only moderate with approximately one third of firms applying to federal programs and one third applying to provincial programs (Table 33). With the exception of Quebec, applications to federal programs were above those of provincial programs. In Quebec, participation in provincial programs was 70 percent, more than double the national average.

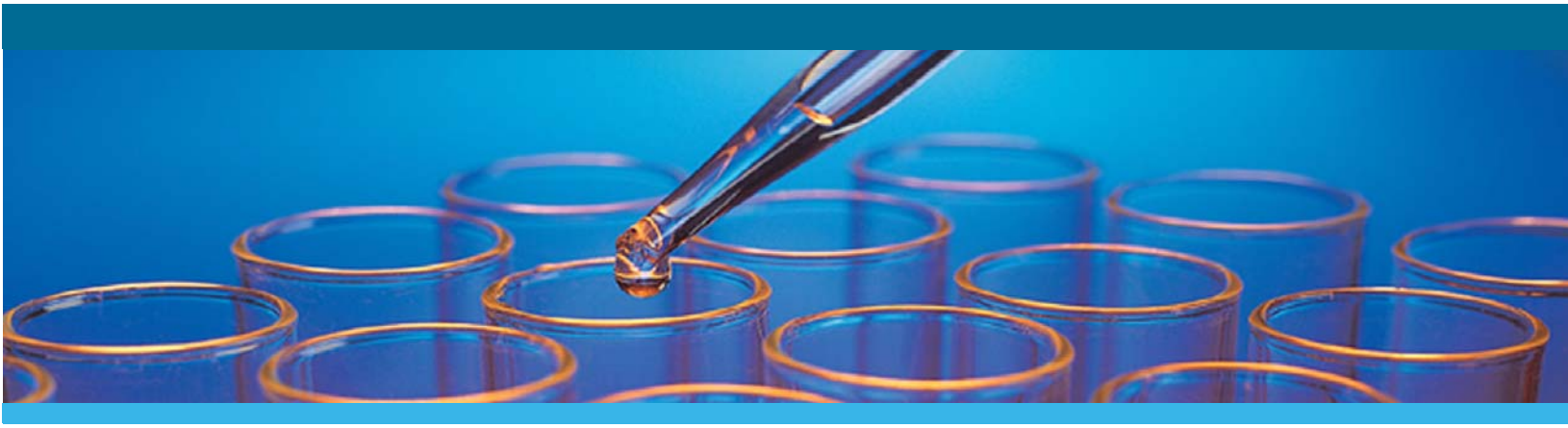
Table 33: Firm use of Government Support Programs in the past five years, by region, 2003

Region	Percentage using Federal Programs	Percentage using Provincial Programs
	-%-	
Canada	33.1	34.8
Atlantic	41.9	29.1
Quebec	38.9	70.4
Ontario	15.6	8.1
Manitoba	59.3	F
Saskatchewan	50.5	46.0
Alberta	38.0	16.5
British Columbia	25.2	18.6

Small firms made more use of support programs than larger firms but both small and large firms used both federal and provincial programs with approximately the same frequency (Table 34). Medium firms presented an interesting anomaly, making relatively little use of either category of support programs but using provincial programs more frequently than federal programs. The major support programs accessed were those providing support for technology development but small firms also made extensive use of loan guarantees, information and training programs. Medium and large firms accessed technology development and training primarily. Both small and medium sized firms used provincial training programs more than federal programs. More details on program use are found in Appendix 2.

Table 34: Firm use of Government Support Programs in the past five years, by firm size, 2003

Firm size	Percentage using Federal Programs	Percentage using Provincial Programs
	-%-	
Small	41.2	41.7
Medium	10.8	18.3
Large	24.2	24.2



Chapter 8

Human Resources

It is estimated that 24,195 people were employed by firms engaged in the development and/or production of bioproducts in Canada in 2003 (Table 35). Of these, the greatest proportion was in Quebec, followed by Ontario, the Atlantic Provinces and British Columbia. Around 75 percent were employed in large firms, with only nine percent employed in small firms, indicating that, even though two thirds of the firms are small, large companies dominate the sector, at least in terms of number of employees.

Table 35: Average employees per firm with bioproduct responsibilities, by region, 2003

Region	Total number of employees	Average number of employees/ firms	Number of bioproduct remployees	Aveage number of bioproducts employees/firms	Bioproducts percentage
		-#-			%
Canada	24,195	104	7,864	34	33
Atlantic	4,007	267	228	15	6
Quebec	5,959	83	2,499	35	42
Ontario	4,075	77	2,065	39	51
Manitoba	928	103	285	32	31
Saskatchewan	2,824	157	216	12	8
Alberta	2,602	96	1,076	80	41
British Columbia	3,801	100	1,496	39	39

Within companies involved in the development and/or production of bioproducts, an estimated 7,864 of employees had responsibilities related to bioproducts. Around 32 percent of employees in these companies were involved in activities related to bioproducts including scientific research and development (1,022), technicians (1,007) and management, marketing, finance and production (5,606), with the remainder (229) engaged in a variety of other related tasks. Over 58 percent of employees with responsibilities related to the development and/or production of bioproducts in Canada were employed by companies in Quebec or Ontario.

Table 36 provides a breakdown of employees in the bioproducts sector according to responsibility across provinces. Over 38 percent of scientific research and development personnel were employed in Quebec, with a further 22 percent in Ontario and 15 percent in British Columbia. The Atlantic Provinces account for almost 8 percent of scientific research and development personnel but only 3 percent of total employment in the sector.

Table 36: Average employees/firm with bioproduct responsibilities, by region, 2003

	Responsibility				
Region	Scientific research & development	Technicians	Management/ marketing/minance/ production	Other	Total
Canada	1,022	1,007	5,606	229	7,864
Atlantic	79	24	123	-	228
Quebec	390	358	1,720	30	2,499
Ontario	226	78	1,609	-	2,065
Manitoba	27	150	93	-	285
Saskatchewan	44	46	126	0	216
Alberta	99	198	778	0	1,076
British Columbia	156	153	1,155	-	1,496

Around 43 percent of employees with responsibilities related to the development and/or production of bioproducts were employed in large companies, with 35 percent employed in medium companies and 22 percent in small companies (Table 37). The relative importance of employees by responsibility differed markedly by company size. In particular, small companies accounted for 43 percent of all employees engaged in scientific research and development across the bioproducts sector, but only 15 percent of those involved in management, marketing, finance and/or production. By contrast, large companies accounted for 51 percent of management, marketing, finance and/or production personnel but only 29 percent of employees engaged in scientific research and development.

Table 37: Total bioproduct firm employee responsibility, by firm size, 2003

	Responsibility				
Firm size	Scientific research & development	Technicians	Management/ marketing/finance/ production	Other	Total
			-%-		
Small	439	395	836	47	1,716
Medium	293	368	1,908	183	2,751
Large	290	244	2,862	0	3,397

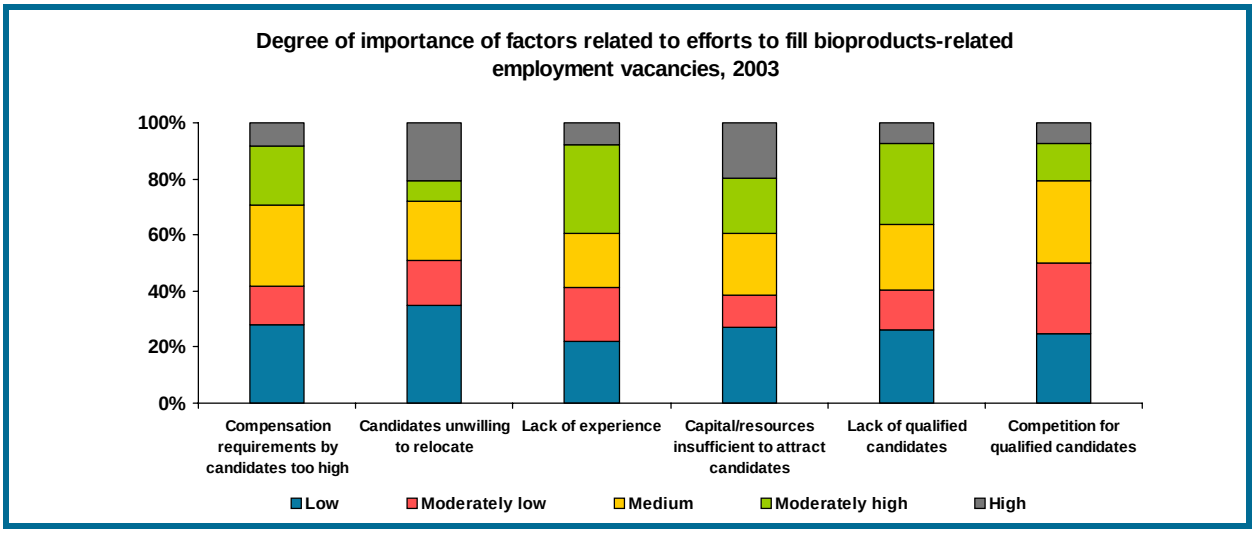
On an individual firm basis small firms committed half of their personnel to development and far fewer employees were focused on production and management (Table 38).

Table 38: Average employees/firm with bioproduct responsibilities, by firm size, 2003

Firm size	Responsibility				
	Scientific research & development	Technicians	Management/ marketing/finance/ production	Other	Total
			#		
Small	2.85	2.56	5.43	0.31	11.14
Medium	7.33	9.2	47.7	4.58	68.78
Large	7.63	6.42	75.32	0	89.4

Respondents to the survey were asked to indicate the importance of a variety of factors related to efforts to fill bioproducts-related employment vacancies on a five-point scale from "low" to "high". The factors considered of "high" or "moderately high" importance by the greatest proportion of respondents were lack of expertise (42.5 percent) and capital/resources insufficient to attract candidates (44.2 percent) (Figure 17), suggesting that the predominant difficulties faced in attracting personnel related both to a shortage of appropriate candidates for positions as well as their own firm's resource constraints. The unwillingness of candidates to relocate and competition for qualified candidates were considered of "low" or "moderately low" importance by more than 52 percent of respondents.

Figure 17: Degree of importance of factors related to efforts to fill bio-products-related employment vacancies, 2003



There were some notable differences in the relative importance of factors in efforts to fill bioproducts-related vacancies across provinces. Table 39 provides a weighted score of the relative importance of each factor in attempting to fill bioproducts vacancies by province. Complete details may be found in Appendix 3. Lack of experience was a less significant problem in the Atlantic Provinces, Saskatchewan and Manitoba, while lack of qualified candidates was considered of greater importance in the Atlantic Provinces, Quebec and Alberta, but less important in Saskatchewan, Manitoba and (to a lesser extent) Ontario and British Columbia. Greater importance was attached to competition for qualified candidates in efforts to fill bioproduct-related vacancies in the Atlantic Provinces, Alberta and Quebec, but lower importance in Manitoba, Saskatchewan and Ontario.

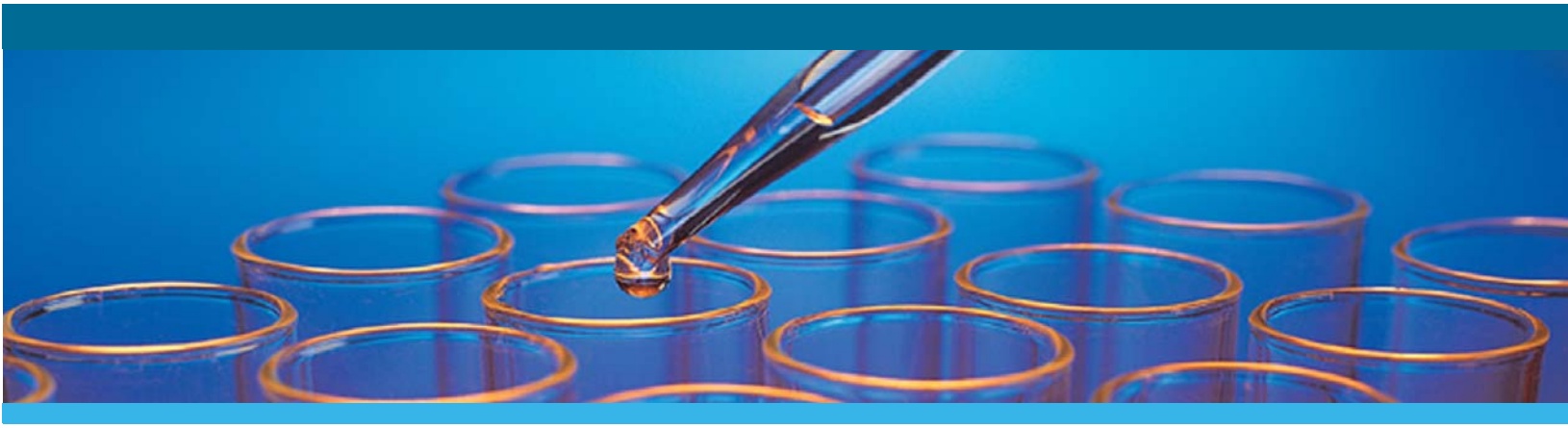
Table 39: Importance of factors in efforts to fill bioproducts-related vacancies, by firm size, 2003

	Candidate factors			Firm factors	External factors	
Region	Compensation requirements by candidates too high	Candidates unwilling to relocate	Lack of experience	Capital/resources insufficient to attract candidates	Lack of qualifiifed candidates	Competition for qualified candidates
Canada	2.72	2.48	2.98	3.18	2.73	2.50
Atlantic	2.73	2.44	3.02	3.23	2.68	2.60
Quebec	2.80	2.48	3.16	3.34	2.85	2.55
Ontario	2.56	2.32	2.86	3.28	2.62	2.37
Manitoba	2.34	2.99	3.01	2.35	2.69	2.32
Saskatchewan	2.79	1.70	2.63	3.00	2.07	2.31
Alberta	2.79	2.94	3.20	3.12	3.14	2.74
British Columbia	2.78	2.62	2.81	3.00	2.72	2.46

There were also marked differences in the relative importance of factors in efforts to fill bioproducts-related vacancies by company size (Table 40). Small companies employees reported that capital/resources were insufficient to attract candidates. Medium size firms found that lack of qualified candidates, lack of experience and competition for qualified candidates were their main problems. Larger companies indicated the unwillingness of candidates to relocate (perhaps indicating that they recruited over a wider geographical area) and lack of experience as the most important challenges in filling bioproduct-related vacancies.

Table 40: Importance of factors in efforts to fill bioproducts-related vacancies, by firm size, 2003

	Candidate factors			Firm factors	External factors	
Firm size	Compensation requirements by candidates too high	Candidates unwilling to relocate	Lack of experience	Capital/resources insufficient to attract candidates	Lack of qualifiifed candidates	Competition for qualified candidates
Small	2.76	2.33	3.06	3.42	2.69	2.44
Medium	2.53	2.47	2.65	2.58	2.69	2.76
Large	2.76	3.12	3.03	2.80	2.98	2.44



Chapter 9

Benefits and Barriers

Benefits From Bioproduct Development and Production

Respondents were asked to rate the importance of various benefits obtained by their firms as a result of bioproduct development or production. The importance of each benefit was rated using a five point likert scale, where a low importance rating was scored as one and a high importance score was rated as a five. A weighted average of the scaled responses is calculated, with the proportion of respondents selecting the various rating serving as weight. This weighted average provides the importance score used to rank the various benefits.

For all firms in Canada, increased sales/market share were ranked as the most import (see Table 41), followed by development of new market niches/new products, reduced damages to the environment, improved product value/performance, increased product range, reduced production cost and finally reduced energy consumption. For convenience, Table 41 has been sorted from highest to lowest importance scores for Canada.

Table 41: Importance scores for benefits, by region, 2003

Region	Increased sales or market share	Developed new market niche or new products	Reduced damages to the environment	Improved product value or performance	Increased product range	Reduced production cost	Reduced energy consumption
Canada	**3.93**	**3.86**	**3.82**	3.68	3.51	3.27	2.76
Atlantic	**3.75**	**3.80**	**4.02**	3.31	3.31	3.73	3.62
Quebec	**4.04**	**4.21**	3.60	**3.82**	3.71	3.04	2.19
Ontario	**3.96**	3.56	**3.95**	**3.58**	3.55	3.23	2.83
Manitoba	**3.92**	**3.27**	3.22	**3.53**	2.36	3.06	2.96
Saskatchewan	**4.42**	**4.86**	**4.53**	4.38	3.93	3.68	3.14
Alberta	**3.94**	**4.13**	3.52	**3.83**	3.70	2.94	2.63
British Columbia	**3.49**	3.11	**3.99**	3.27	3.07	**3.66**	3.25

Note: The three highest ranked benefits are identified by bold and shaded text.

Across regions, either increased sales/market share, development of new market niches/new products or reduced damages to the environment was the top ranked benefit (based on the importance score). Moreover, these benefits are generally in the top three ranked benefits within each region. Exceptions do exist to this general conclusion. For instance, in all but Atlantic Canada, and Saskatchewan, improved product value/performance ranked higher than either increased sales/market share, reduced demand to the environment or development of new market niches/new products.

Reduced production cost and reduced energy consumption were not viewed as important as market growth/expansion and lessening the extent of environmental harm. On a regional basis, however, firms in the Atlantic region, Manitoba, and B.C. ranked reduced production cost and reduced energy consumption higher than other benefits. Regardless, a general conclusion one might draw is that Canadian bioproduct firms view market growth as the main benefit of developing or producing bioproducts.

Responses based firm size (Table 42) indicate that small firms view the most important bioproduct benefits as developing sales, new markets and improving the value or performance of their products. This was very similar for medium size firms except that reduced environmental impact replaced new market development. Improved product value or performance had the highest importance score for medium firms. The importance of environmental impact appears to increase with firm size since large firms ranked reduced damage to the environment as the most important.

The benefit rankings are not entirely unexpected. One might expect smaller firms to be seeking market expansion opportunities as a means to facilitate growth and sustainability. Medium size firms, who might already have well developed product lines and markets, might well focus on generating additional value (or performance) with existing products.

Larger firms may view reduced environmental damage as very important as this lessens the negative publicity they receive and mitigates any liability they may face arising from environmental damage. Larger firms are often more visible and therefore subject to greater scrutiny, as such it is even more important for them to act in an environmentally responsible manner. Note too, that reduced production cost and energy consumption had higher importance scores for

larger firms than for small and medium firms. This suggests larger firms are more focused on cost control than market growth. Such differences in business strategy, based on firm size, are not unexpected.

Table 42: Importance scores for benefits, by firm size, 2003

Firm size	Reduced production cost	Reduced energy consumption	Reduced damages to the environment	Developed new market niche or new products	Increased product range	Improved poduct valueor performance	Increased sales or market share
Small	3.12	2.58	3.76	**4.22**	3.78	**3.87**	**4.12**
Medium	3.27	2.52	**3.55**	3.07	3.13	**3.63**	**3.59**
Large	**3.91**	**3.71**	**4.36**	3.23	2.79	2.93	3.48

Note: The highest ranked benefit for each firm size is identified by bold and shaded text.

Barriers to Bioproduct Development and Production

Respondents were asked to rate the importance of various barriers their firm experienced in the development or production of bioproducts. As with the benefits question, the rating of each benefit was scaled using a five point likert scale and the responses were used to develop an importance score for each barrier, on both a regional and firm size basis. Table 43 shows the importance scores for the different barriers on a regional basis. Barriers have been sorted from most to least important on a national basis. For bioproduct firms in Canada, lack of financial capital, high cost and timeliness of regulatory approval and higher price of raw materials or feedstock were the top three barriers, based on the importance scores. Except for Manitoba, either lack of financial capital or high cost and timeliness of regulatory approval had the highest importance scores across the regions. As well, these three barriers are generally the highest rated barriers on a regional basis. One exception to this was the role of unreliable supply of raw material or feedstock, which had the third highest importance scores in Quebec, Manitoba and B.C.

In Manitoba, the most important barrier was higher transport cost of main feedstock or raw material. The latter ranking reflects the fact that Manitoba's central location makes it difficult to get needed inputs. Given that bioproduct firms in Manitoba use agricultural crop biomass, and that Manitoba has a relatively small agricultural sector (compared to other provinces), bioproduct firms will have to search a wider geographic area to secure biomass inputs. This point is further highlighted by the fact that the high price of raw materials or feedstock and unreliable supply of raw material or feedstock were ranked second and third in terms of important barrier by Manitoba bioproduct firms.

Table 43: Importance scores for barriers, by region

Barrier	Canada	Atlantic	Que.	Ont.	Man.	Sask.	Alta.	B.C.
				-number-				
Lack of financial capital	**3.45**	**3.64**	**3.51**	**3.30**	3.16	**4.09**	**3.38**	**3.25**
Higher cost & timeliness of regulatory approval	**3.17**	**4.03**	**3.53**	3.05	2.70	2.86	2.73	**2.85**
Higher price of raw materials or feedstock	**2.80**	**3.09**	2.80	2.78	**3.37**	**2.87**	**2.75**	2.60
Unreliable supply of raw materials or feedstock	2.70	2.45	**2.97**	2.58	**3.25**	2.76	2.28	2.61
Lack of adequate product standard or certification	2.70	3.00	2.75	2.53	2.70	2.63	**2.75**	2.74
Higher transportation cost of main feedstock or raw material	2.70	2.92	2.49	2.59	**3.51**	**3.00**	2.55	**2.95**
Lack of technology or technical information	2.55	2.09	2.57	2.56	3.19	2.28	2.66	2.58
Difficulty to substitute or integrate into existing processes	2.51	3.08	2.62	2.48	2.50	2.68	2.30	2.15
Lack of skilled human resources	2.48	2.49	2.49	2.22	3.01	2.00	2.77	2.73
Negative public perception or acceptance	2.10	2.93	1.79	2.12	2.08	1.89	2.22	2.36
Restrictions on intellectual property (P) rights	1.99	2.12	2.10	1.87	2.18	1.96	1.91	1.92

Note: The three highest ranked barriers for each region are identified by bold and shaded text.

Table 44 shows the importance of the various barriers based on firm size. For small firms the top three barriers were lack of financial capital, higher cost and timeliness of regulatory approval and lack of adequate product standard or certification. The importance of these barriers is not unexpected. Small firms often encounter difficulties sourcing capital from various sources (i.e. lending institutions, venture capitalists, family members, etc.). As well, smaller firms may lack the resources (either financial or human capital) needed to navigate one's way through the regulatory approval process, but at the same time, these firms may be saying the regulatory approval process takes to long. The importance of lack of adequate product standard or certificate may reflect the fact that smaller firms may have truly novel innovations for which appropriate standards do not exist. In conjunction with the regulatory approval process issues, it would seem that smaller firms not only need additional capital, but also see a need for a more flexible regulatory/standards approval process.

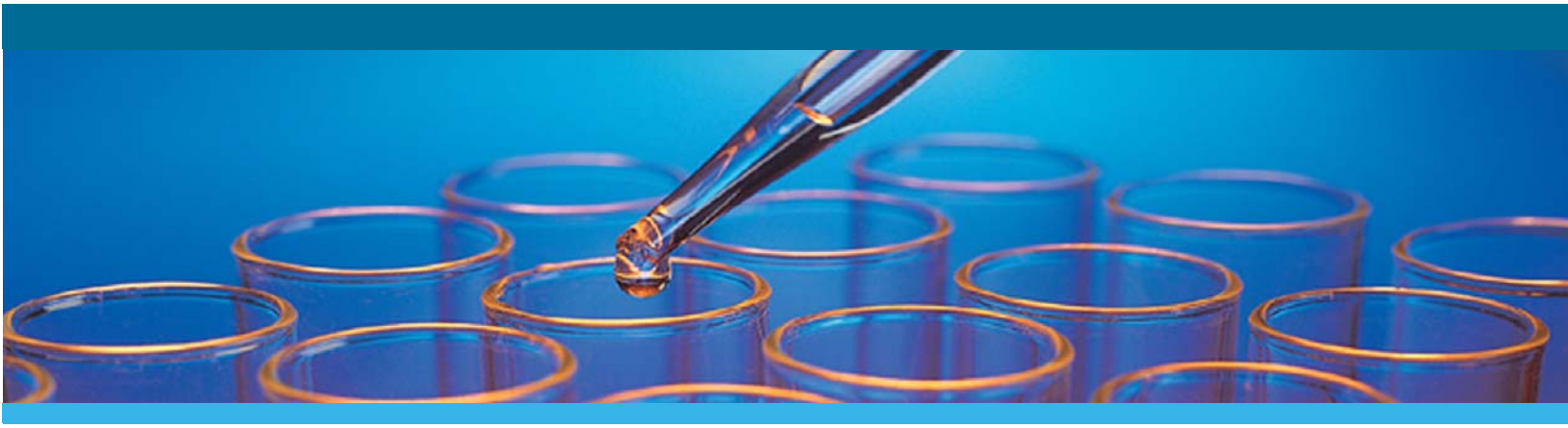
Table 44: Importance scores for barriers, by firm size, 2003

Barrier	Small (less than 50 employees)	Medium (50-149 employees)	Large (more than 149 employees)
Unreliable supply of raw materials or feedstock	2.78	2.57	2.52
Higher price of raw materials or feedstock	2.69	**2.84**	**3.24**
Higher transportation cost of main feedstock or raw material	2.57	2.42	3.56
Lack of technology or technical information	2.58	**2.67**	2.28
La\ck of skilled human resources	2.55	2.48	2.24
Lack of financial capital	**3.79**	2.57	2.98
Difficulty to substitute or integrate into existing processes	2.56	2.37	2.40
Negative public perception or acceptance	2.00	2.41	2.21
Restrictions on intellectual property (P) rights	2.03	1.91	1.90
Higher cost and timeliness of regulatory approval	**3.27**	**2.76**	**3.19**
Lack of adequate product standard or certification	**2.86**	2.16	2.64

Note: The three highest ranked barriers for each firm size are identified by bold and shaded text.

For medium sized firms, the top three barriers are the high cost of raw material or feedstock, higher cost and timeliness of regulatory approval and lack of technology or technical information. The latter barrier is somewhat surprising as one would expect this group of firms to be more mature than smaller firms and have adequate access to technology and information. The top three barriers for large firms are: higher transportation cost of main feedstock or raw material, higher price of raw materials or feedstock and the higher cost and timeliness of regulatory approvals. Larger firms thus perceived higher cost of using bioproducts as a barrier to their development or production, as well as the regulatory approval process.

The higher cost and timeliness of regulatory approval is perceived as a universally important barrier to bioproduct development and production by bioproduct firms in Canada, regardless of their size. It would thus seem important to develop human capital than enables firms to navigate their way through the regulatory system. Alternatively, the regulatory system needs to be modified to make it easier for firms to take a concept from the R&D phase to the market phase of the innovation spectrum. Also note that the importance of raw material cost as a barrier to development/production of bioproducts may well lessen as the market for these inputs develops.



Chapter 10

Business Strategies

Respondents to the survey were presented with a series of strategies related to knowledge development and their overall business and asked to indicate how important each had been for their firm in 2003 on a five-point scale from "low" (1) to "high" (5). Across the sample as a whole, the most important strategy related to acquisition of knowledge from other industry sources, including industry associations, competitors, clients and suppliers (Table 45) and the commencement of new research and development projects. Entering product trials and/or adapting products for increased market penetration were also important strategies adopted by companies in the bioproducts sector. Changes in firm size through downsizing or acquisitions, mergers or joint-ventures were relatively unimportant strategies within the sector as a whole.

Table 45: Mean importance of strategies for firm, 2003

Strategy	Mean Importance Score
Acquired and used knowledge obtained from other industry sources such as industry associations, competitors, clients and suppliers	3.3
Began new research and development project	3.2
Entered product trials/adapted products or processes for increased market penetration	3.2
Developed/encouraged staff education/upgrading	3.1
Acquired and used knowledge obtained from public research institutions including universities and government laboratories	3.0
Developed firm policies and practices for knowledge/intellectual property protection	2.8
Expanded into foreign markets	2.7
Used and updated databases of scientific information	2.6
Conducted an intellectual property audit to ensure protection of products and processes at all stages of development	2.4
Downsized operations of the firm	1.9
Increased firm size through acquisition, merger or joint venture	1.8

Broadly, across the provinces these same knowledge development and business strategies remained important for firms engaged in the bioproducts sector across the provinces (Table 46). However, there were some notable differences. In Quebec, Atlantic Provinces and Saskatchewan knowledge acquisition through public institutions, including universities and government laboratories, were relatively more important strategies of knowledge development. As discussed earlier, Quebec is the only province which considers IP audits a fairly important business strategy.

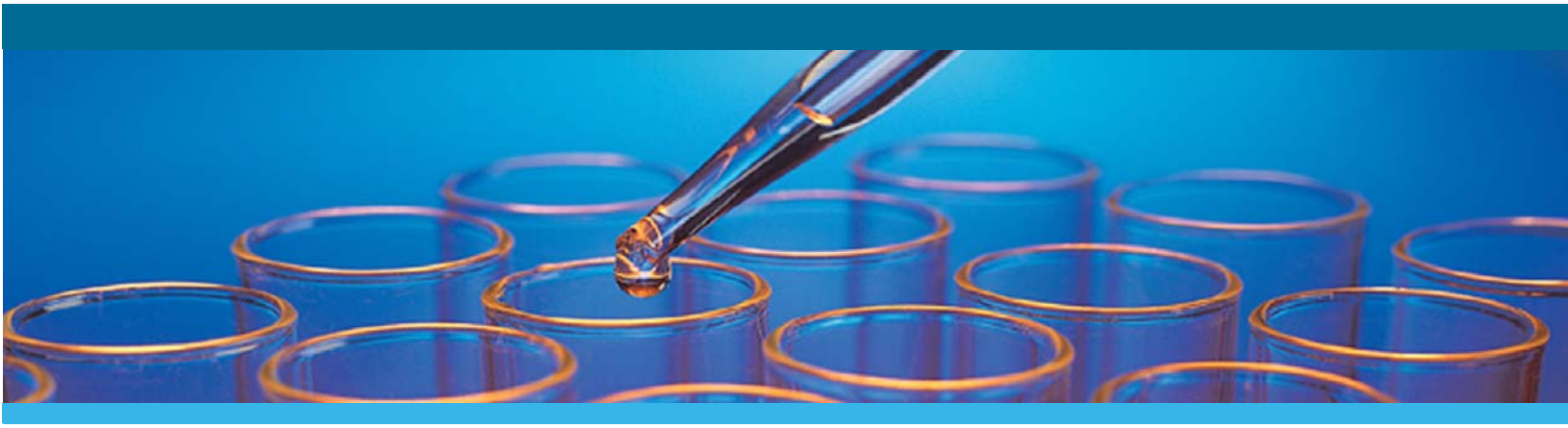
Across respondents by company size, the same knowledge development and business strategies also emerged as most important (Table 47). The most important business strategies across all firm sizes were new R&D projects and product trials. Knowledge development strategies overall, and acquisition and use of knowledge from public research institutions in particular, were of much less importance for medium-sized firms than either smaller or larger companies.

Table 46: Mean importance of strategies for firm, by region, 2003

Strategy	Atlantic	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Knowledge Development Strategies							
Acquired and used knowledge obtained from other industry sources such as industry associations, competitors, clients and suppliers	**3.6**	**3.2**	**3.2**	**3.5**	**3.8**	**3.2**	**3.3**
Acquired and used knowledge obtained from public research institutions including universities and government laboratories	**3.3**	**3.3**	2.7	2.5	**3.4**	2.7	**3.0**
Used and updated databses of scientific information	2.8	2.8	2.4	2.5	2.8	2.3	2.7
Developed firm policies and practices for knowledge/intellectual property protectiong	2.9	**3.2**	2.5	**3.2**	2.6	2.6	2.9
Developed/encouraged staff education/ upgrading	**3.5**	**3.2**	**3.0**	**3.7**	**3.1**	**3.1**	2.9
Conducted an intellectual property audit to ensure protection of products and processes at all stages of development	2.2	3.1	2.1	2.6	1.7	2.0	2.1
Business Strategies							
Increased firm size through acquisition, merger or joint venture	1.5	2.0	1.8	2.2	1.9	1.8	1.8
Downsized operations of the firm	2.0	2.1	1.6	**2.6**	1.7	1.7	2.1
Entered product trials/adapted products or processes for increased market penetration	**3.2**	**3.4**	**3.0**	**3.2**	**3.4**	**2.7**	**3.1**
Began new research and development project	**3.6**	**3.5**	**3.0**	2.2	**3.3**	**2.9**	**3.2**
Expanded into foreign markets	2.6	3.0	2.6	2.3	2.3	2.7	2.6

Table 47: Mean importance of strategies for firm, by firm size, 2003

Strategy	Company size		
	Small	Medium	Large
Knowledge Development Strategies			
Acquired and used knowledge obtained from other industry sources such as industry associations, competitors, clients and suppliers	**3.19**	**3.37**	**3.72**
Acquired and used knowledge obtained from public research institutions including universities and government laboratories	3.06	2.77	**3.23**
Used and updated databses of scientific information	2.70	2.46	2.54
Developed firm policies and practices for knowledge/intellectual property protectiong	2.95	2.56	2.76
Developed/encouraged staff education/upgrading	**3.10**	**3.23**	**3.18**
Conducted an intellectual property audit to ensure protection of products and processes at all stages of development	2.55	1.89	2.29
Business Strategies			
Increased firm size through acquisition, merger or joint venture	1.72	1.89	2.25
Downsized operations of the firm	1.87	2.04	1.96
Entered product trials/adapted products or processes for increased market penetration	**3.17**	**3.15**	**3.12**
Began new research and development project	**3.20**	**3.14**	**3.23**
Expanded into foreign markets	2.69	2.80	2.45



Chapter 11

Discussion and Conclusions

This report provides a first analysis of the Canadian bioproducts sector by province and firm size. As discussed under limitations its objective was not to answer all of the questions concerning the sector; this could come from a much more in-depth analysis. The report does highlight some common observations concerning the firms in the business and a number of differences across the regions and the firm sizes. These were presented in the overview and through the main report. The policy implications were also discussed in the overview. However, further analysis would help in answering some of the questions about why the differences exist and the role that policy might play in supporting and encouraging the sector across Canada.

Suggestions for improvements to the survey instrument

Initial questions: It is important to understand the reasons why firms exit the bioproducts business. Presumably the firms in the current survey will be contacted for the next survey. If they have exited the business they should be asked why.

- Because the business was not sufficiently profitable
- Sold the business to – another bioproducts firm, a firm in another business, other
- Spun the business off to form a new company

Section 1: Products

Since much of the income from bioproducts firms comes from other product lines a question should be added to better understand the nature of the most important other product(s) sold by the firm. These can have a major impact on the use and development of bioproducts.

Section 4:

It would be useful to know if the firm had foreign offices, plants or subsidiaries and if they were involved in bioproducts and their role - development, sales or supply. This question could explore the role of multi-national companies.

Section 5: Human Resources

The HR problem questions are rather restrictive in terms of the categories presented to respondents. This could be improved with a series of in-depth interviews prior to the design of the questionnaire.

The questionnaire also only asks for information on employees in Canada. It would be useful to include non-Canadian employees in the future.

Section 7:

Many new technology firms secure resources by licensing technologies out to other organizations. A question on licensing out should be added. It should collect information on how many licenses the firm gives out and the nature of the organizations acquiring the licenses.

Section 8: Business Practices

Domestic and foreign collaborations are treated differently. In domestic collaborations the objective appears to be to identify the number of collaborations by motivation and partner type. There is no attempt to understand the strength of the different motivations. With foreign collaboration there is no attempt to determine a number of relationships and the motivations examined are for a single foreign collaboration, not necessarily the most important foreign collaboration. This section would provide more useful information if domestic and foreign collaborations received the same treatment.

Section 10: Accessing Government Programs

On average, fewer than 40 percent of firms used government programs. It would be useful to know why firms are not accessing these programs. Adding a question examining whether they did not need the money, did not know about the programs or felt that there was too much paperwork and administration would be useful.

Recommendations for further analysis

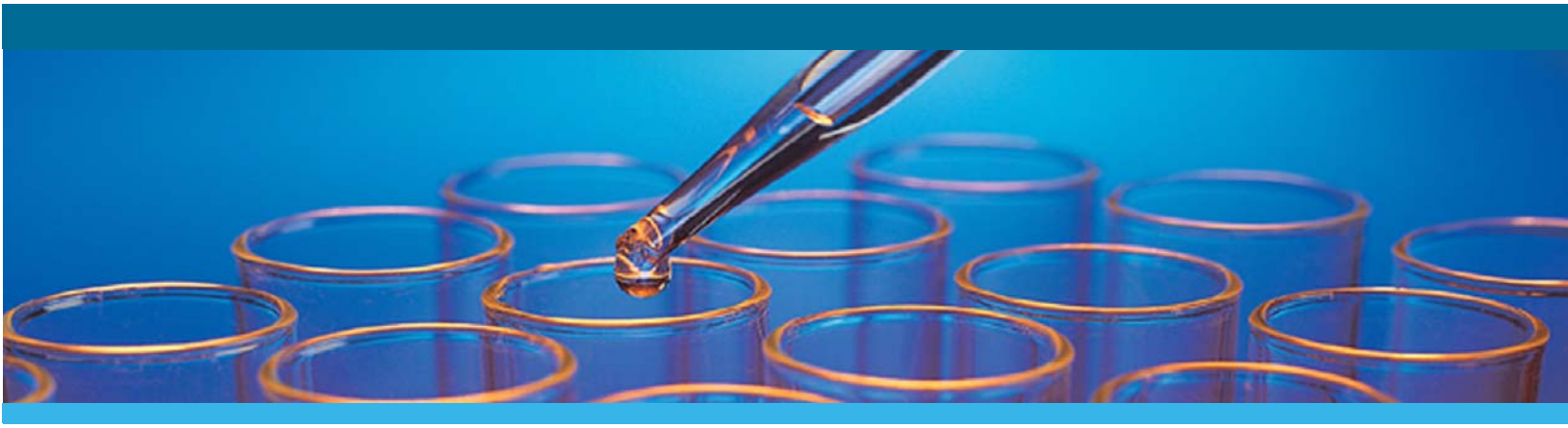
This report represents the first analysis of the Canadian bioproducts sector. While the analysis provides a reasonable overview of the sector it was not intended or able to delve more deeply into the workings of the sector and the factors contributing to success in bioproduct development and commercialization. The analysis contained here was conducted based on regional or firm size differences. As one might naturally expect, this is a limited view of what type of intra-sector differences are present. In this regard, scope exists to develop cross-tabulations that interact not only the regional and firm size variables, but also other variables such as firm age, nature of business arrangements, the impact of collaborations, etc. Such analysis will hone our understanding of the nature of the sector and how best to develop policy that fosters further growth.

At the same time, use of multivariate or other statistical methods can be used to test and measure the relationship between various factors. Examples include developing models to explain:

- the drivers of bioproduct innovation and biomass use,
- success in obtaining bioproduct development financing,
- the role of intellectual property in bioproduct development and biomass use,
- the role of perceived benefits and barriers to bioproduct development and biomass use,
- the importance of collaborations in developing and using bioproducts,
- the role of Highly Qualified Personnel in shaping bioproduct development and use, and
- the role of alternative business strategies in shaping successful bioproduct development and use.

Results from such statistical analysis will again help inform policy makers of the important drivers shaping firm success in developing and using bioproducts.

This survey also presents an opportunity to create a baseline assessment of the sector and the firms. Future studies will facilitate analysis of the development of the sector but also of individual firms common to this and future surveys. Firm level, longitudinal analysis will provide extremely useful information about the nature of firm bioproduct development and the role of different strategies and policy in shaping that development. Given that this sector is predicted to grow at a significant rate over the next few decades, building an understanding of the sector and critical success factors as early as possible is essential.



Appendix A

Bioproduct Development by Region

Product Development by Region, 2003

Region	Total number of firms	Research & development	Proof of concept/ product development	In production/ on the market	Total number of products	Average # of products/ firm in region
			#			
Canada (232 firms)						
Biofuels/bioenergy	77	42	39	120	201	0.86
Biochemicals	77	72	68	292	432	1.86
Biopesticides/biofungicides/ bioherbicides	39	36	25	83	144	0.62
Fiber composites/fiberboard/ agri-fibre panels	43	30	14	67	111	0.48
Biosensors/biocatalysts/ bioplastics/other	50	53	37	70	160	0.69
Total	232	233	183	632	1,047	4.52
Average products/firm in Canada		1.00	0.79	2.72	4.52	
Atlantic (15 firms)						
Biofuels/bioenergy	8	F	x	6	8	0.52
Biochemicals	3	F	F	9	12	0.80
Biopesticides/biofungicides/ bioherbicides	6	x	F	8	13	0.84
Fiber composites/fiberboard/ agri-fibre panels	0	0	0	0	0	0.00
Biosensors/biocatalysts/ bioplastics/other	5	F	F	9	13	0.87
Total	15	8	5	32	45	3.03
Average products/firm in the province		0.53	0.32	2.15	3.03	
Quebec (72 firms)						
Biofuels/bioenergy	16	18	16	36	70	0.97
Biochemicals	23	34	23	72	128	1.78
Biopesticides/biofungicides/ bioherbicides	18	24	7	52	83	1.15
Fiber composites/fiberboard/ agri-fibre panels	10	15	4	20	38	0.53
Biosensors/biocatalysts/ bioplastics/other	17	18	9	20	47	0.65
Total	72	109	59	199	367	5.09
Average products/firm in the province		1.51	0.82	2.76	5.09	

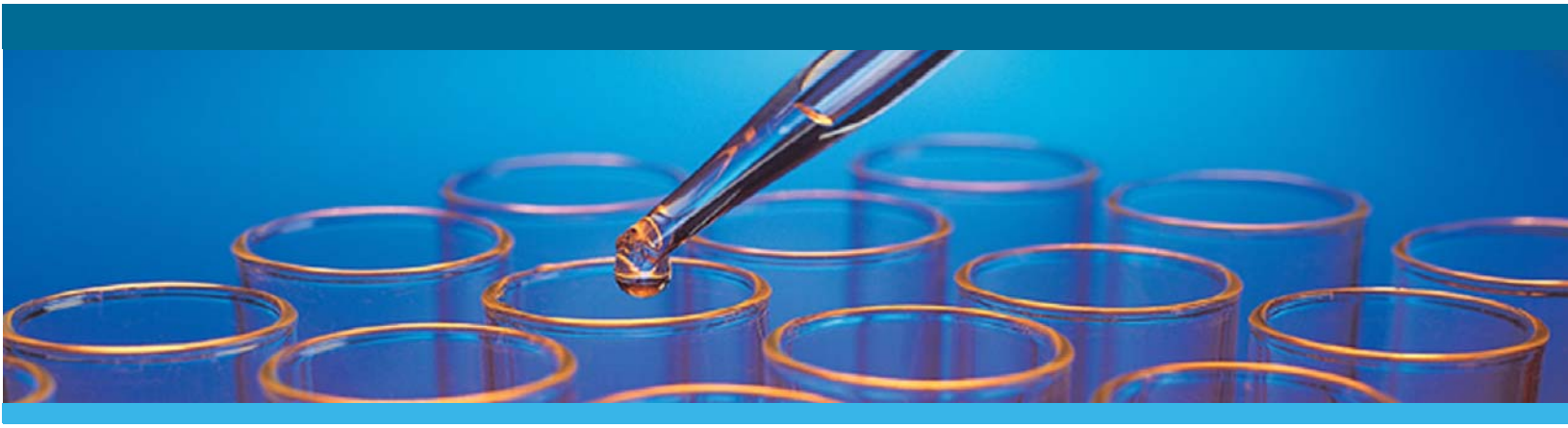
Product Development by Region, 2003

Region	Total number of firms	Research & development	Proof of concept/ product development	In production/ on the market	Total number of products	Average # of products/ firm in region
			#			
Ontario (53 firms)						
Biofuels/bioenergy	17	3	3	18	24	0.45
Biochemicals	19	7	9	78	95	1.79
Biopesticides/biofungicides/ bioherbicides	3	0	x	F	7	0.13
Fiber composites/fiberboard/ agri-fibre panels	8	4	x	x	15	0.28
Biosensors/biocatalysts/ bioplastics/other	12	9	9	12	30	0.57
Total	53	24	27	120	170	3.21
Average products/firm in the province		0.45	0.51	2.26	3.21	
Manitoba (9 firms)						
Biofuels/bioenergy	3	F	F	F	F	F
Biochemicals	F	F	F	F	F	F
Biopesticides/biofungicides/ bioherbicides	X	0	0	0	0	0.00
Fiber composites/fiberboard/ agri-fibre panels	4	x	x	12	14	2.90
Biosensors/biocatalysts/ bioplastics/other	3	F	0	F	5	F
Total	9	12	F	37	F	F
Average products/firm in the province		1.3	F	3.2	F	
Saskatchewan (18 firms)						
Biofuels/bioenergy	8	F	x	7	12	0.69
Biochemicals	10	x	x	28	39	2.16
Biopesticides/biofungicides/ bioherbicides	X	x	1	x	x	x
Fiber composites/fiberboard/ agri-fibre panels	6	8	x	F	12	0.68
Biosensors/biocatalysts/ bioplastics/other	X	9	4	10	23	1.30
Total	18	24	17	48	87	4.82
Average products/firm in the province		1.31	0.93	2.65	4.82	

Product Development by Region, 2003

Region	Total number of firms	Research & development	Proof of concept/ product development	In production/ on the market	Total number of products	Average # of products/ firm in region
			#			
Alberta (27 firms)						
Biofuels/bioenergy	12	F	x	11	16	0.61
Biochemicals	9	12	9	68	90	3.32
Biopesticides/biofungicides/ bioherbicides	X	x	x	x	x	x
Fiber composites/fiberboard/ agri-fibre panels	4	x	x	x	5	0.20
Biosensors/biocatalysts/ bioplastics/other	6	9	12	12	33	1.21
Total	27	24	26	95	145	5.34
Average products/firm in the province		0.88	0.98	3.53	5.34	
British Columbia (38 firms)						
Biofuels/bioenergy	12	12	7	26	45	1.19
Biochemicals	11	8	13	29	51	1.33
Biopesticides/biofungicides/ bioherbicides	10	9	11	18	39	1.01
Fiber composites/fiberboard/ agri-fibre panels	10	x	x	21	26	0.69
Biosensors/biocatalysts/ bioplastics/other	5	x	x	5	9	0.24
Total	38	33	37	100	170	4.47
Average products/firm in the province		0.86	0.96	2.64	4.47	

Notation: Statistics Canada does not report data if it is deemed unreliable or might compromise the confidentiality of a firm. Unreliable information is withheld and denoted by an F while information withheld for confidentiality purposes is denoted by an x.

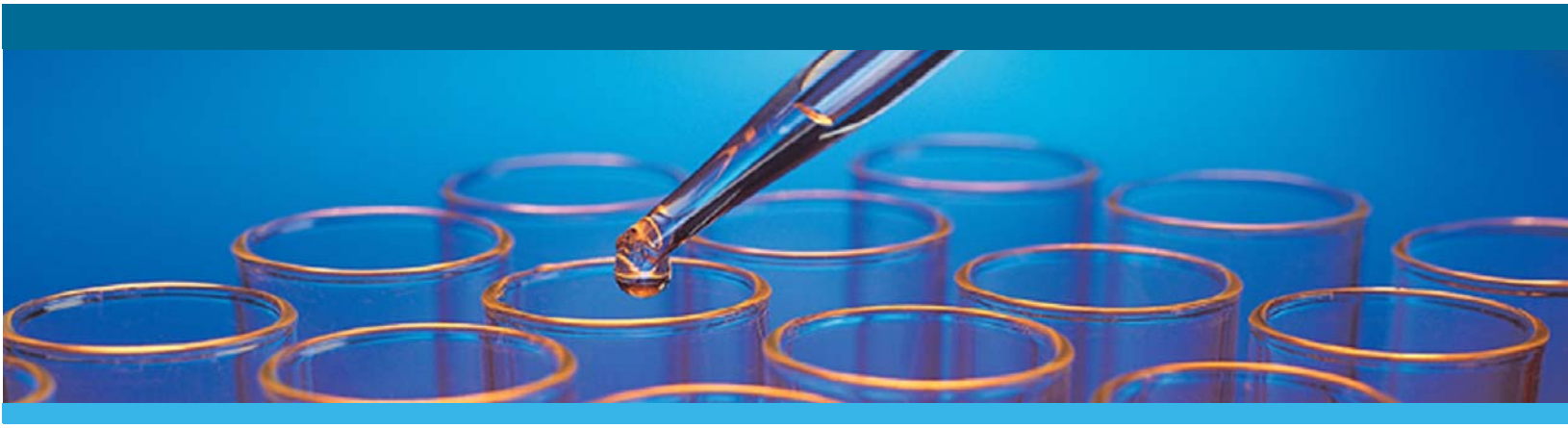


Appendix B

Use of Government Support Programs, 2003

Firms who used government sponsored programs for the development or production of bioproducts in the last three years, by firm size

	Government Programs			
	Federal government		Provincial/territorial/municipal government	
	Number	Reliability	Number	Reliability
Small (less than 50 employees)				
Technology support and assistance program	33	A	17	A
Loan guarantees	3	E	12	A
Export assistance programs	5	A	9	A
Information or internet services	14	A	10	A
Support for training	5	E	15	F
Other	4	E	F	F
Total number of firms applying	63	A	64	A
Medium (50 - 149 employees)				
Technology support and asisstance programs	4	E	3	E
Loan guarantees	0	---	0	---
Export assistance programs	0	---	F	F
Information or internet services	0	---	0	---
Support for training	0	---	3	E
Other	0	---	0	---
Total number of firms applying	4	E	7	E
Large (more than 149 employees)				
Technology support and asisstance programs	5	E	6	A
Loan guarantees	0	---	0	---
Export assistance programs	F	F	0	---
Information or internet services	1	E	0	---
Support for training	F	F	3	E
Other	0	---	0	---
Total number of firms applying	9	A	9	A



Appendix C

Provincial Ranking

Provincial ranking of different reasons for bioproduct employee vacancies, 2003

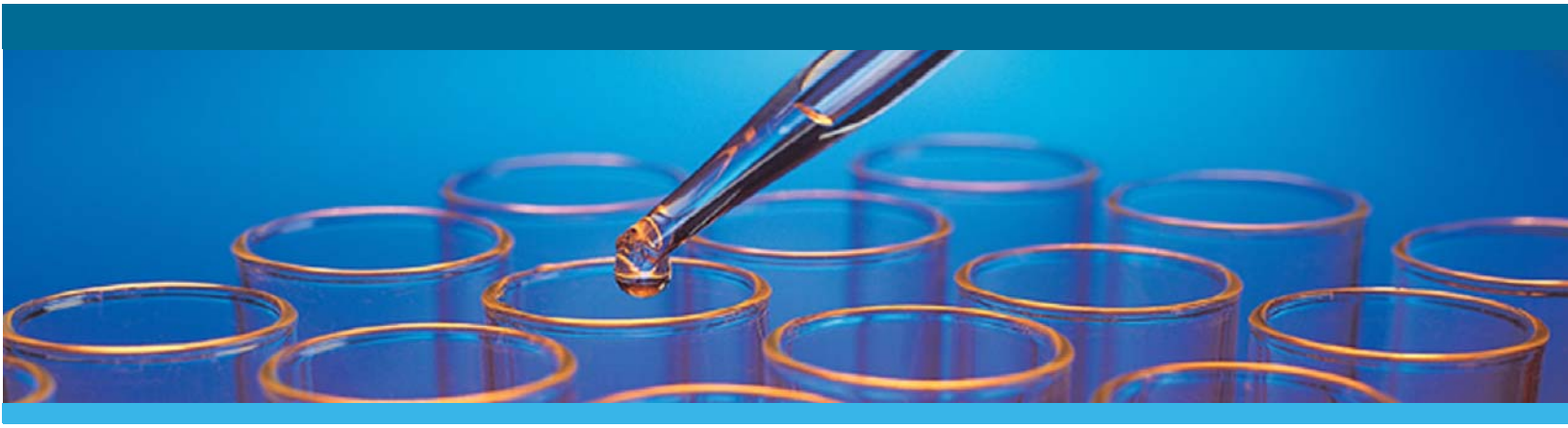
	Degree of importance					
	Low	Moderately low	Medium	Moderately high	High	Weighted score
			%			
Canada						
Candidate factors						
Compensation requirements by candidates too high	25.2	13.5	33.6	19.8	7.9	**2.717**
Candidates unwillling to relocate	36.4	17.1	24.0	7.6	14.9	**2.475**
Lack of experience	21.3	13.9	22.1	30.4	12.1	**2.975**
Firm factors						
Capital/resources insufficient to attract candidates	20.4	10.7	24.7	19.3	24.9	**3.176**
External factors						
Lack of qualified candidates	24.8	16.7	26.7	23.9	7.9	**2.734**
Competition for qualified candidates	25.5	27.3	26.8	13.5	7.0	**2.495**
Atlantic						
Candidate factors						
Compensation requirements by candidates too high	38.8	10.4	10.4	20.1	20.3	**2.727**
Candidates unwillling to relocate	48.7	0.0	30.5	0.0	20.8	**2.442**
Lack of experience	19.8	0.0	38.7	41.5	0.0	**3.019**
Firm factors						
Capital/resources insufficient to attract candidates	11.6	20.8	29.3	10.4	28.0	**3.227**
External factors						
Lack of qualified candidates	32.3	8.2	28.8	20.3	10.4	**2.683**
Competition for qualified candidates	32.3	16.3	20.6	20.3	10.4	**2.599**
Quebec						
Candidate factors						
Compensation requirements by candidates too high	22.2	12.6	34.1	24.9	6.1	**2.798**
Candidates unwillling to relocate	30.3	25.1	22.5	10.3	11.8	**2.482**
Lack of experience	13.6	18.8	24.2	24.9	18.6	**3.164**
Firm factors						
Capital/resources insufficient to attract candidates	14.9	12.2	24.4	20.2	28.2	**3.343**
External factors						
Lack of qualified candidates	28.3	5.9	26.7	30.6	8.5	**2.851**
Competition for qualified candidates	25.5	24.6	24.7	19.3	5.8	**2.55**

Provincial ranking of different reasons for bioproduct employee vacancies, 2003

	Degree of importance					Weighted score
	Low	Moderately low	Medium	Moderately high	High	
	%					
Ontario						
Candidate factors						
Compensation requirements by candidates too high	26.3	22.2	23.0	26.0	2.4	**2.557**
Candidates unwillling to relocate	34.0	27.7	21.9	5.6	10.8	2.315
Lack of experience	22.5	21.9	13.5	31.2	10.8	2.856
Firm factors						
Capital/resources insufficient to attract candidates	18.7	9.8	21.5	24.9	25.1	**3.279**
External factors						
Lack of qualified candidates	20.5	27.1	24.9	24.6	2.9	**2..623**
Competition for qualified candidates	25.5	36.9	18.5	13.2	5.9	**2.371**
Manitoba						
Candidate factors						
Compensation requirements by candidates too high	35.1	14.5	32.0	18.4	0.0	**2.337**
Candidates unwillling to relocate	35.1	14.5	0.0	17.5	32.9	**2.986**
Lack of experience	17.5	14.5	17.5	50.4	0.0	**3.006**
Firm factors						
Capital/resources insufficient to attract candidates	35.1	32.0	14.5	0.0	18.4	**2.346**
External factors						
Lack of qualified candidates	17.5	32.0	14.5	35.9	0.0	**2.686**
Competition for qualified candidates	17.5	50.4	14.5	17.5	0.0	**2.318**
Saskatchewan						
Candidate factors						
Compensation requirements by candidates too high	23.5	8.3	40.4	20.8	6.9	**2.790**
Candidates unwillling to relocate	69.8	6.9	14.8	0.0	8.4	**1.700**
Lack of experience	37.4	0.0	32.4	22.3	7.9	**2.633**
Firm factors						
Capital/resources insufficient to attract candidates	31.4	5.9	15.8	24.5	22.3	**3.001**
External factors						
Lack of qualified candidates	31.4	38.4	22.3	7.9	0.0	**2.067**
Competition for qualified candidates	37.4	25.0	22.3	0.0	15.3	**2.308**

Provincial ranking of different reasons for bioproduct employee vacancies, 2003

	Degree of importance					Weighted score
	Low	Moderately low	Medium	Moderately high	High	
	%					
Alberta						
Candidate factors						
Compensation requirements by candidates too high	17.0	16.8	46.5	10.2	9.6	**2.789**
Candidates unwillling to relocate	26.2	11.0	26.1	16.4	20.4	**2.941**
Lack of experience	20.6	10.2	15.1	37.2	16.9	**3.196**
Firm factors						
Capital/resources insufficient to attract candidates	22.8	4.6	30.9	20.5	21.1	**3.122**
External factors						
Lack of qualified candidates	17.0	15.5	25.0	20.6	21.8	**3.144**
Competition for qualified candidates	16.0	15.1	52.8	11.1	5.0	**2.740**
British Columbia						
Candidate factors						
Compensation requirements by candidates too high	28.1	4.4	44.1	8.3	15.1	**2.779**
Candidates unwillling to relocate	37.7	4.2	35.6	3.5	19.0	**2.619**
Lack of experience	28.6	8.6	24.8	30.0	8.1	**2.807**
Firm factors						
Capital/resources insufficient to attract candidates	26.2	6.8	30.1	14.4	22.5	**3.002**
External factors						
Lack of qualified candidates	25.3	13.4	34.2	19.1	8.1	**2.716**
Competition for qualified candidates	25.3	27.9	30.8	7.7	8.3	**2.458**



Appendix D

Methodology of the Survey

Introduction

The survey provides information on companies that are developing or producing bioproducts using biomass or other renewable or sustainable feedstocks/materials.

The survey is carried out by the Science, Innovation & Electronic Information Division. It falls under the general conditions of the Memorandum of Understanding signed between Agriculture and Agri-Food Canada and Statistics Canada in April, 2004.

Bioproducts are an emerging sector of the Canadian economy. However, data on the characteristics of firms engaged in developing or producing bioproducts are scanty. This survey will collect this information and will improve the data available on bioproducts development or production activities.

This is the first survey of bioproduct development or production activities in Canada. It follows a report on bioproducts development by Canadian biotech firms based on information from the 2001 Biotechnology Use and Development Survey.

The survey addresses the following question: What are the characteristics and activities of firms that develop bioproducts as an important part of their activities? Specifically, it collects data on the characteristics of bioproduct firms including their use of biomass and other renewable/ sustainable biomaterials, the types and number of bioproducts being developed, benefits and constraints related to developing bioproducts, human resources devoted to bioproducts, financial profile, business practices, access to financing capital and the use of government support programs.

Objective of the survey

The objective of the survey is to gather data on the activities of Canadian firms engaged in the development or production of bioproducts. Such data will fill major gaps in our understanding of the changes under way in Canadian firms, thereby improving our knowledge of bioproducts development and production activities in Canada.

Development of the questionnaire

The questionnaire was prepared with the active participation of partners and in consultation with a group of bioproducts industry experts offering a range of skills and interests. After the initial design of the questionnaire, tests were conducted with prospective respondents, whose comments (design) were incorporated into the final version.

Definition of a bioproduct

A Bioproduct is defined as a commercial or industrial product other than food, feed and medicines made with biological or renewable agricultural plant, animal or forestry materials. Example of bioproducts are bio-fuels, bio-energy, bio-plastics, fiberboards/agri-fiber panels re questionnaire..

Target population

The target population for the survey consists of firms that use biomass and other renewable or sustainable feedstocks/materials to develop or produce bioproducts.

The first stage of the 2003 Biotechnology Use and Development Survey was used as a vehicle to identify the bioproducts target population.

Sample

This is a sample survey.

Two types of firms are found in the survey sample: firms that are sampled with certainty, also referred to as a "must-take-all" list, and those that are sampled randomly. The must-take-all list is made of firms whose names and addresses are provided by Statistics Canada, industry experts and other partners to the survey, namely, Agriculture and Agri-Food Canada, Industry Canada and the provincial/territorial bioproducts industry associations.

The sampling of the second category of firms is based on the enterprise database in Statistics Canada's Business Register (BR), which contains an Integrated portion (IP) and a Non-Integrated Portion (NIP). Two main considerations are at play in the selection of these sample units, namely, to reach the target population and to minimize the response burden. To this end, Gross Business Income (GBI), R&D expenditures and the number of employees are used as selection criteria. The selection is also based on three dimensions of the data strata: province/territory, industrial sector based on the North American Industry Classification (NAICS) codes, and firm size.

Industries are surveyed at levels other than 4-digits; small firms with fewer than 5 employees and with R&D expenditures of less than $100,000 are excluded, as are universities/hospitals, contract research organizations (CRO) and not-for-profit organizations.

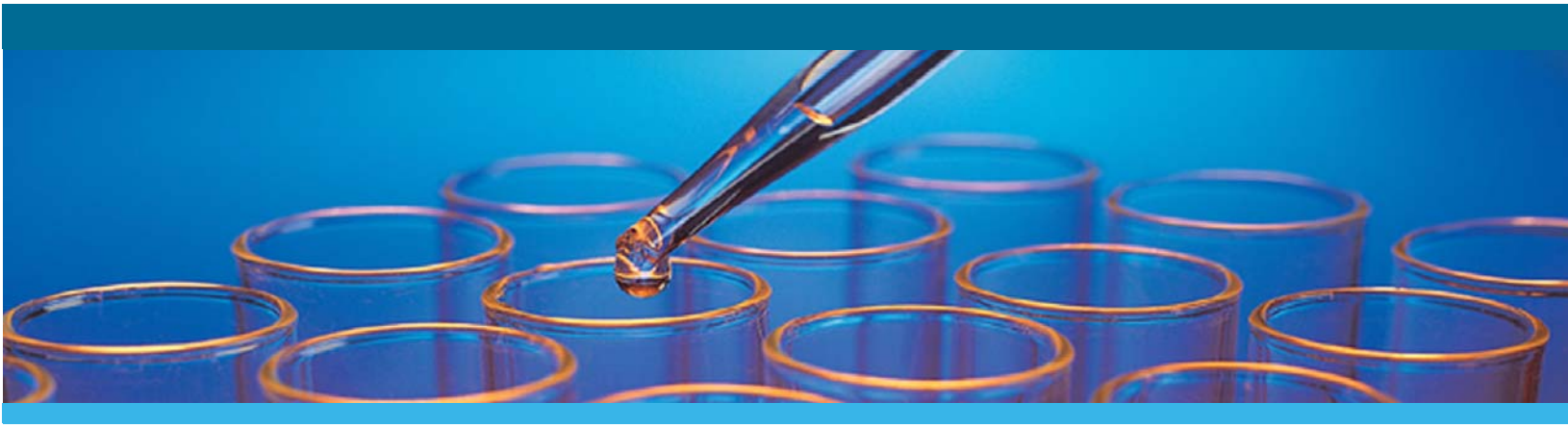
Applying these criteria resulted in a list of 10,427 firms, to which the first-stage questionnaire was sent. The North American Industry Classification (NAICS) codes that were sampled to establish this list are shown in Table 1.

Of these 10,427 firms, those indicating that they have developed or produced bioproducts will receive the second-stage questionnaire. So will all firms on the "must-take-all" list.

Response rate and data quality

The questionnaire was sent to 480 firms. Of these 426 returned the questionnaire, resulting in 89% response rate. Of the returned questionnaires, 161 provided the required information. After accounting for non-response and applying post-stratification techniques, an estimated 232 firms were involved in developing or producing bioproducts in Canada in 2003.

The quality of the data was insured by taking into account and applying throughout the survey process all 6 dimensions of data quality control at Statistics Canada, namely, relevance of data collected, their accuracy, their timeliness, their accessibility, their interpretability and their coherence.



Appendix E

Bioproducts Developmental Survey