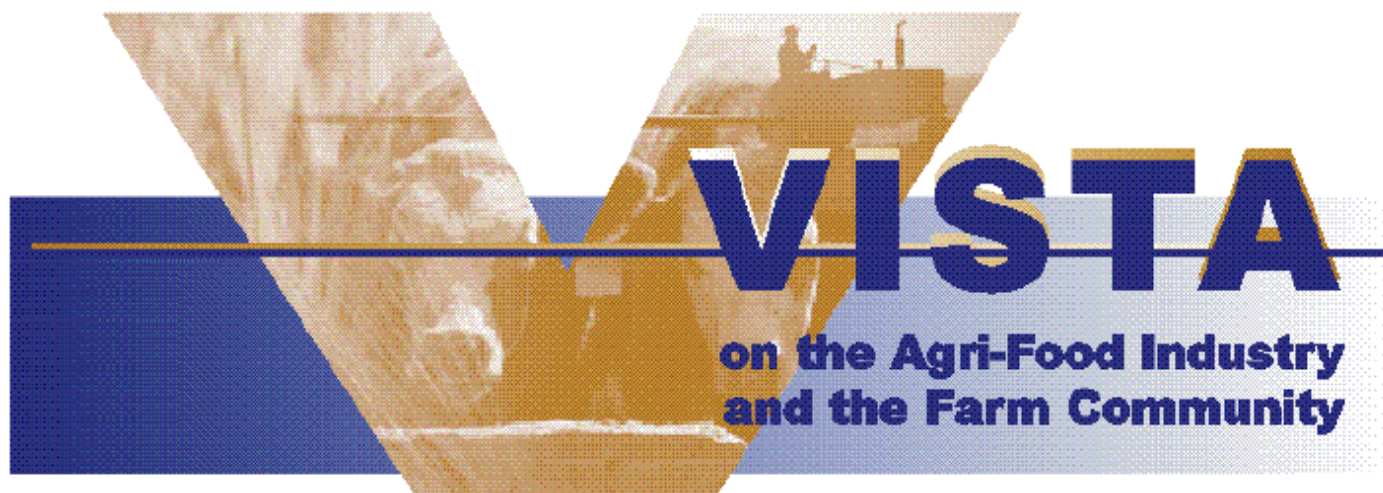




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## The Canadian Bioproducts Industry, 2003 and 2006

June 2009

by David Sparling, University of Guelph  
Pamela Laughland, The University of Western Ontario  
Verna Mitura, Statistics Canada

Agriculture Division  
12<sup>th</sup> floor, Jean Talon Building  
170 Tunney's Pasture Driveway  
Ottawa, Ontario  
K1A 0T6

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Symbols

The following standard symbols are used in this publication:

|                |                                                                                                                    |
|----------------|--------------------------------------------------------------------------------------------------------------------|
| .              | not available for any reference period                                                                             |
| ..             | not available for a specific reference period                                                                      |
| ...            | not applicable                                                                                                     |
| 0              | true zero or a value rounded to zero                                                                               |
| 0 <sup>s</sup> | value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded |
| p              | preliminary                                                                                                        |
| r              | revised                                                                                                            |
| x              | suppressed to meet the confidentiality requirements of the <a href="#">Statistics Act</a>                          |
| E              | use with caution                                                                                                   |
| F              | too unreliable to be published                                                                                     |

## Introduction

Canadian firms are developing and producing industrial and consumer products including fuels, plastics, chemicals, fibres and other materials from biomass. Canada's abundance of biomass, especially from agriculture, forestry, and marine sources, provides a strong base for the bioproducts industry (BioProducts Canada, 2004). These bioproducts hold promise for improved environmental sustainability, reduced greenhouse gas emissions, economic growth and global competitiveness. Their production creates a market for primary and waste agricultural biomass and may benefit rural economies through localised production and manufacturing (BIOCAP Canada, 2004; Steufen, 2005; Urbanchuck, 2006; Sparling and Laughland, 2006). The development of bioproducts in Canada offers opportunities for the agricultural industry to participate in newly developing (and potentially lucrative) markets.

This study is a comparative analysis based on data from the Bioproducts Development Survey (2003) and the Bioproducts Development and Production Survey (2006), conducted by Statistics Canada and sponsored by Agriculture and Agri-Food Canada. These surveys provide an opportunity to assess how Canada's bioproduct industry has evolved in what could be termed its formative years. This study examines the current state of the domestic industry, changes occurring over the period, and implications for agriculture.

### **Box 1 Definitions as per the methodology of the Bioproducts Development Survey (2003) and the Bioproducts Development and Production Survey (2006)**

**Biomass:** Biomass is renewable or sustainable feedstock/materials of agricultural (plant or animal), forestry, or marine/aquaculture origins or from municipal and/or industrial waste.

**Bioproducts:** Bioproducts are products other than food, feed and medicines that are made directly or indirectly from biomass. These products may be new or novel in nature or traditional products made of, or with, new or novel biomass.

**Bioproduct firms:** Bioproduct firms are firms that are developing or producing bioproducts using biomass or other renewable or sustainable feedstocks/materials. Firms selected from Statistics Canada's Business Register had revenues in excess of \$250,000. Firms drawn from lists provided by external sources had a minimum of \$100,000 in research and development expenditures and at least five employees. Excluded from the survey were not-for-profit organizations, universities, government laboratories, hospitals, and firms that provide only services, such as contract research organizations or consulting firms.

**Firm size:** Small firms (less than 50 employees); medium firms (50 to 149 employees); and large firms (more than 149 employees).

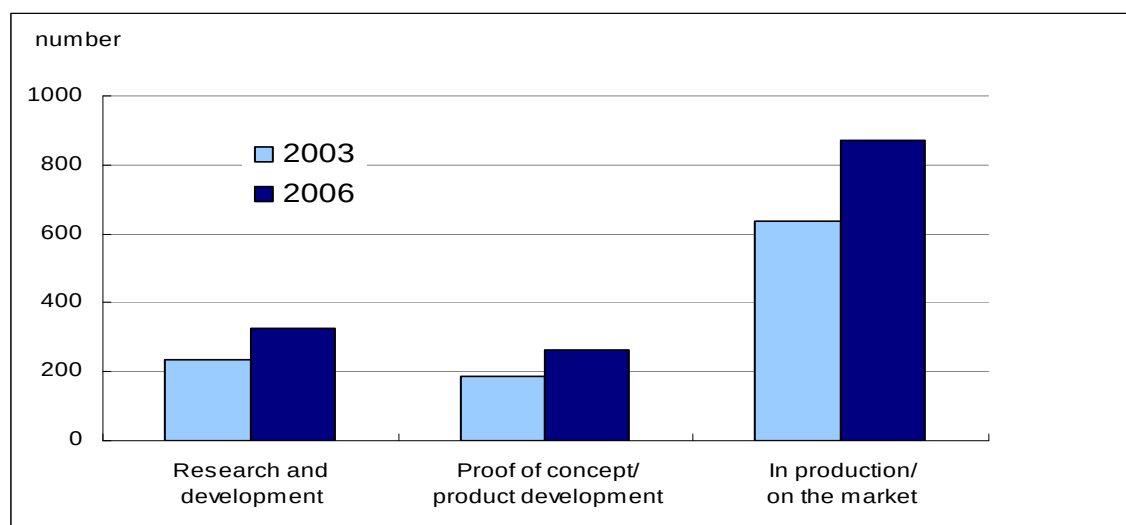
## Innovation remains strong: more bioproducts at all stages

Between 2003 and 2006, the number of Canadian bioproduct firms increased slightly from 232 to 239 as did the number of bioproducts, both under development and on the market, reported by these firms. This increase in the number of bioproducts was due largely to the number of “other” bioproducts reported (i.e. those not covered by the categories of biofuels/bioenergy, biochemicals, biocontrol agents, and biofibres). It is difficult to determine exactly what product types would be included as firms did not provide an indication in the survey. In 2006, 63% of small firms reported that bioproducts constituted their primary activity, a higher proportion than medium (46%) or large (45%) firms.

There were marked differences in product development by firm size. In 2006, large firms had an average of two bioproducts under development or on the market, compared with seven in 2003. It is difficult to determine the reason for this change, but it may be that in 2006 large firms were focusing on a small number of resource-intensive products. Survey results show that large firms were almost exclusively involved in the production of biofuels/bioenergy and biofibre products. By comparison, small and medium firms were involved in a variety of different product lines, including biochemicals and control agents which typically require a smaller production scale and fewer resources for their development and production. This is evidenced as average product numbers in 2006 were 6.9 for medium firms (up from 5.6) and 6.2 for small firms (up from 3.7).

Canadian firms have been relatively successful in commercializing their bioproducts. Between 2003 and 2006, the number of products in production/on the market increased 37% to 870 (Figure 1). In 2006, all sized firms focused on products close to or on the market: 79% of products developed by medium firms and 70% of those developed by large firms were on the market, followed by 57% for small firms (Table 1).

**Figure 1 Total number of bioproducts under development by stage, Canada, 2003 and 2006**



Note: Total number of bioproducts is the summation of the number of bioproducts reported by each firm.  
Source: Statistics Canada, Bioproducts Development Survey (2003) and Bioproducts Development and Production Survey (2006).

**Table 1 Key bioproduct industry statistics, Canada, 2003 and 2006**

|                                       | 2003    | 2006  |
|---------------------------------------|---------|-------|
|                                       | number  |       |
| Firms                                 | 232     | 239   |
| Total bioproducts                     | 1,055   | 1,457 |
| Average bioproducts per firm          |         |       |
| Small firms                           | 3.7     | 6.2   |
| Medium firms                          | 5.6     | 6.9   |
| Large firms                           | 7.0     | 2.0   |
| Firms using agricultural biomass      | 93      | 128   |
|                                       | percent |       |
| Firms by size                         |         |       |
| Small firms                           | 68      | 83    |
| Medium firms                          | 17      | 8     |
| Large firms                           | 16      | 8     |
| Bioproducts by stage of development   |         |       |
| Research and development              | 22      | 22    |
| Proof of concept / market development | 18      | 18    |
| In production / on the market         | 60      | 60    |
| Products on the market                |         |       |
| Small firms                           | 50      | 57    |
| Medium firms                          | 72      | 79    |
| Large firms                           | 75      | 70    |
| Firms using agricultural biomass      | 40      | 54    |

Note: Total number of bioproducts is the summation of the number of bioproducts reported by each firm. Numbers may not add due to rounding.

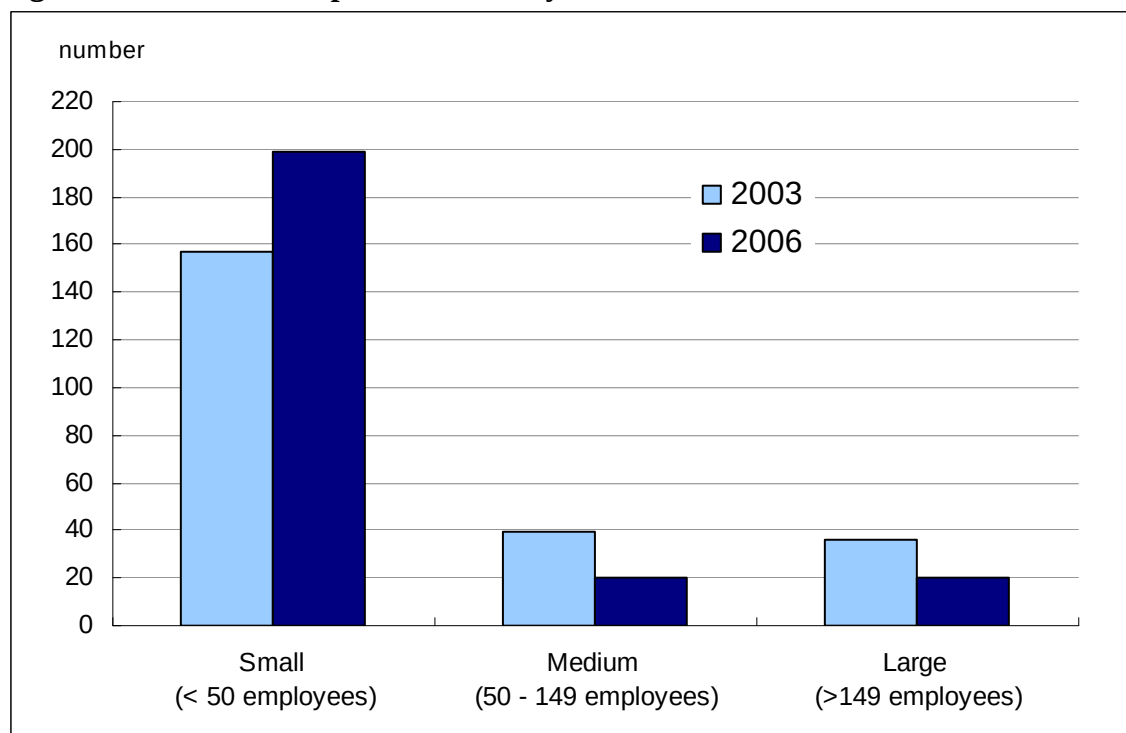
Source: Statistics Canada, Bioproducts Development Survey (2003) and Bioproducts Development and Production Survey (2006).

The total number of products in each stage of development increased during the period. Firms using agricultural biomass expanded their pipelines from 445 products under development and on the market in 2003 to 877 in 2006, a 97% increase. Approximately 60% of the firms' bioproducts were on the market in 2003 and in 2006.

## Structural change in the industry

Between 2003 and 2006, while the number of Canadian bioproduct firms increased slightly, the average firm size declined. In 2003, medium and large firms, defined as those with 50 to 149 employees and over 149 employees, respectively, made up 76 firms (33%) of the bioproducts industry. By 2006, only 40 firms (17%) had at least 50 employees (Figure 2). The survey did not inquire as to what happened to these larger firms or why they were no longer operating in the bioproducts industry.

**Figure 2 Number of bioproduct firms by size, Canada, 2003 and 2006**



Source: Statistics Canada, Bioproducts Development Survey (2003) and Bioproducts Development and Production Survey (2006).

Many bioproducts firms were new — at least new to bioproducts — with about one-third (34%) becoming involved in bioproduct activities within the previous 5 years (2001 to 2005) and another one-third within the previous 6 to 10 years (1996 to 2000). In 2006, just over half of the firms (51%) reported becoming involved in bioproducts as a result of internal activities, down from two-thirds of the firms in 2003. Firms with bioproduct interests arising from collaborations, mergers or acquisitions, rose from 12% in 2003 to 23% in 2006.

## Employment and revenues decline

In 2006, Canadian bioproduct firms had 3,974 persons with bioproduct responsibilities, down almost half from 7,851 in 2003. The reductions were even greater in firms using agricultural biomass. The number of employees with bioproduct responsibilities in firms using agricultural biomass declined 58%

from 2,745 in 2003 to 1,159 in 2006. The average number of bioproduct employees per firm using agricultural biomass dropped from 30 in 2003 to nine in 2006, reflecting the relative increase in the number of smaller firms in the sector and the decline of bioproduct activity by some larger firms. One of the reasons for the change in employment may be related to the difficulties reported by respondents in filling vacant positions due mostly to insufficient capital/resources to attract candidates and the lack of bioproduct-specific education in colleges and universities.

Total bioproduct revenues also declined substantially from \$3.1 billion in 2003 to \$1.8 billion in 2006<sup>1</sup>. While overall research and development spending remained stable at \$242 million between 2003 and 2006, research and development spending on bioproducts declined. However, the reduction in bioproduct research and development spending from \$96 million to \$81 million was far smaller proportionately compared with the decline in bioproduct revenues. As a result, bioproduct research and development expenditures as a share of bioproduct revenue, increased from 3% in 2003 to 5% in 2006. Despite the decline in total bioproduct revenues, bioproduct revenue per employee rose from approximately \$399,000 in 2003 to \$442,000 in 2006 given the decline in the number of employees with bioproduct responsibilities.

### **Agricultural biomass is the leading input for the bioproducts industry**

Agricultural biomass<sup>2</sup> was the most commonly used input for Canadian bioproduct firms. Firms reported that on average 45% of their biomass in 2006 came from agricultural sources (Figure 3), more than double the next most prevalent source, forestry biomass, at 22%. The number of bioproduct firms reporting at least some use of agricultural biomass increased from 93 (40%) in 2003 to 128 (54%) in 2006 (Table 1).

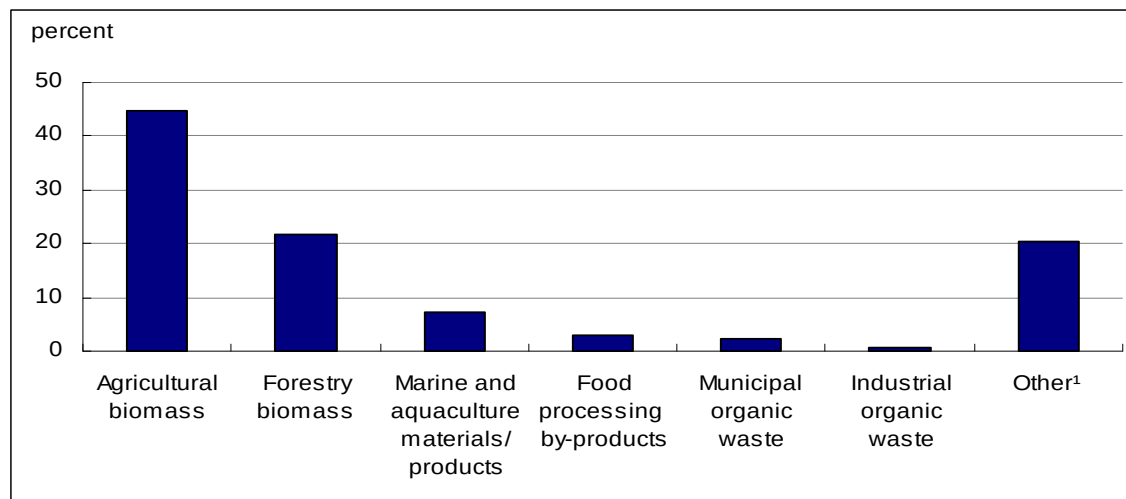
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1. All figures are in current dollars.

2. Agricultural biomass includes biomass from crops (i.e. grains and oilseeds, special crops, horticulture, other), livestock (i.e. dairy, animal products and by-products), dedicated biomass crops (i.e. switchgrass, hybrid poplar, Canada yew, kenaf, wheatgrass, cottonwood, sisal, silver maple, triticale, jute) and crop residues (i.e. corn stover, wheat straw, flax straw, hemp shives, fibres, sugar beet pulps, bagasse).



**Figure 3 Percent of total biomass used as input in operations, by type of biomass, Canada, 2006**



1. Other refers to other sustainable/renewable feedstock/materials not addressed by specific categories.

Note: Each firm was asked what percentage of each type of biomass contributes to its total biomass use. Values represent non-weighted averages of the individual firm responses.

Source: Statistics Canada, Bioproducts Development and Production Survey (2006).

The type of biomass used by firms depended on the size of the firm and the type of bioproduct being developed or marketed. Large firms reported that 70% of their biomass on average was derived from forestry biomass and 20% was from agricultural biomass. For small firms, agricultural biomass comprised 49% of the inputs on average and forestry biomass 17%. This may be due to the greater variety of agricultural biomass compared with forestry biomass, and the ability to create a broader range of products from it. Agricultural biomass also tends to be used for developing biochemicals and pesticides, which are more commonly developed by small firms.

Fifty-four percent of firms using agricultural biomass reported being focused on bioproducts; the remainder continue to be involved, sometimes extensively, in other lines of business. These activities may range from primary agriculture to pharmaceuticals to construction, emphasizing the extensive linkages between bioproducts and other industries.

### **Intellectual property protection is important — but only for some firms**

The number of bioproduct firms with bioproduct-related patents declined slightly between 2003 and 2006, from 84 to 80, with a total of 412 existing or pending patents in 2006. This implies approximately five patents per firm, when only those firms with patents are considered. Just under one-quarter of the patents, (22%) were with the Canadian Intellectual Property Office (CIPO) while the balance were with foreign offices (Table 2). A total of 37 firms (29%) using agricultural biomass had patents or pending patents in 2006, about the same share of firms as in 2003. Firms also used other strategies to protect their intellectual property; for example, 116 firms used a total of 453 registered and 308 unregistered trademarks.



**Table 2 Bioproduct-related patents by patent office, 2006**

| <b>Patent office</b>                         | <b>number</b> | <b>percent</b> |
|----------------------------------------------|---------------|----------------|
| Canadian Intellectual Property Office (CIPO) | 92            | 22             |
| U.S. Patent and Trademark Office (USPTO)     | 157           | 38             |
| European Patent Office                       | 100           | 24             |
| Other                                        | 63            | 15             |
| <b>Total</b>                                 | <b>412</b>    | <b>100</b>     |

Source: Statistics Canada, Bioproducts Development and Production Survey (2006).

### **Bioproduct firms use relationships to extend capacity and capabilities**

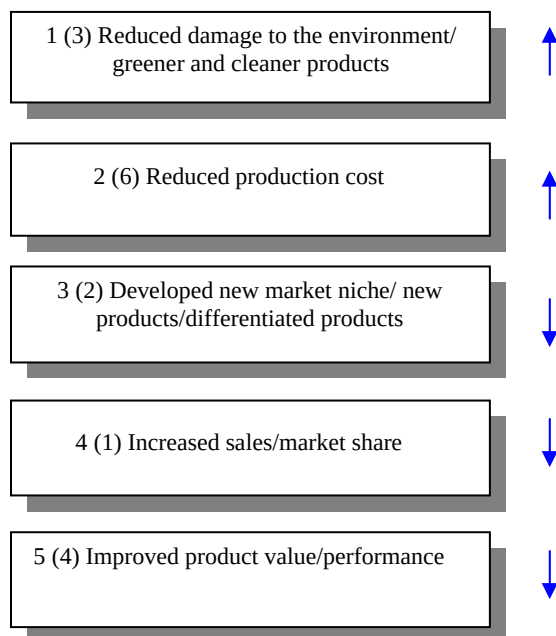
One-third of bioproduct firms reported business collaborations<sup>3</sup> in 2006, and those firms were typically involved with multiple collaborations. Forty-two firms (35%) of those using agricultural biomass were involved in collaborations. This proportion represents a decline from 41% of the firms in 2003. The main purposes for collaboration were to conduct research and development and access biomass. Most arrangements for biomass access were with farmers and other firms. The dependence of bioproduct firms on primary agriculture for research and development and biomass provides an opportunity for farmers to access new partners and sources of funding.

Research and development collaborations were most often with other firms (119 collaborations). Others involved research and development collaborations with academic institutions, government laboratories, and farmers. Other reasons for collaboration were for production/manufacturing, intellectual property access, capital, knowledge/skills, accessing markets/distribution channels, and regulatory affairs. The main focus for most industry contracts was also research and development. Fifty-six bioproduct firms (23%) were involved in 128 contracts, with the majority of the contract value allocated to academia and government laboratories.

### **“Greener and cleaner products” rated as main benefit to bioproducts**

Firms were asked to rate the benefits from and barriers to their bioproduct activities on a scale from low to high importance. While the highest-rated benefits in 2003 were product-related, environmental and cost factors had become increasingly important by 2006. The top five benefits in 2006 (with comparisons to 2003 in brackets) are shown in Figure 4, with arrows representing the direction of the change in rating since 2003. Environmental issues were rated as the highest benefit of bioproducts in 2006, up from third in 2003. Also relatively more important in 2006 was the benefit of bioproducts in the reduction of production costs.

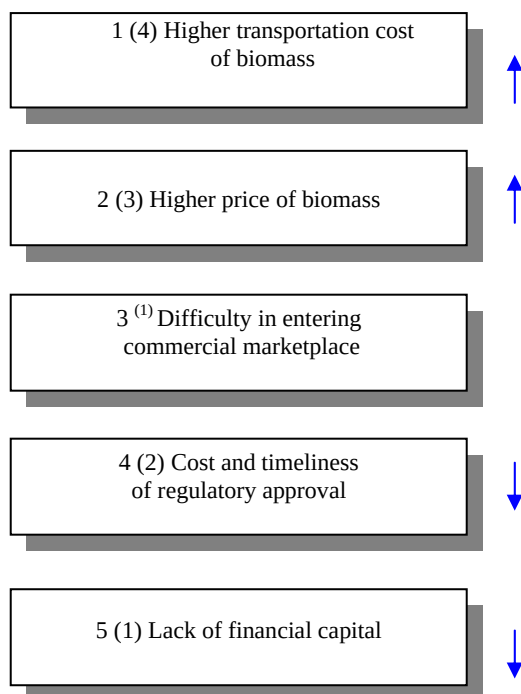
3. Cooperative and collaborative arrangements involved the active participation in projects between the bioproducts firm and other companies or organizations in order to develop and/or continue work on new or significantly improved bioproducts processes and/or products. Pure contracting-out work was not regarded as cooperative and/or collaboration.

**Figure 4 Benefits from developing or producing bioproducts, Canada, 2003 and 2006**

Notes: The first number rating is for 2006 and the rating in brackets is for 2003. The arrows represent the direction of the change in rating between 2003 and 2006.

Source: Statistics Canada, Bioproducts Development Survey (2003) and Bioproducts Development and Production Survey (2006).

While the highest-rated barriers reported in 2003 were lack of financial capital and cost/timeliness of regulatory approvals, in 2006 they were the higher price and transportation cost of biomass (Figure 5). Difficulty entering the commercial marketplace was also rated quite high as a barrier to developing or producing bioproducts.

**Figure 5 Barriers to developing or producing bioproducts, Canada, 2003 and 2006**

1. Item was not included in questionnaire for 2003.

Notes: The first number rating is for 2006 and the rating in brackets is for 2003. The arrows represent the direction of the change in rating between 2003 and 2006.

Source: Statistics Canada, Bioproducts Development Survey (2003), and Bioproducts Development and Production Survey (2006).

## Accessing biomass

While biomass can sometimes be obtained on-site as a waste from another production process, many firms must transport it from other sites and suppliers. In 2006, 10% of firms used on-site biomass, and 28% obtained it off-site but within a radius of 50 km. At the other extreme, one-quarter of bioproduct firms sourced biomass from a distance of over 500 km. Transportation can be extremely costly due to the low value-to-weight ratio of most biomass. The priority placed on these prices and shipping costs may mean that sourcing and transportation will be key determinants of the success and economic viability of production in the future. Possible supply disruptions or rising transportation costs make it important for firms to have other biomass or transport options. This dependence creates opportunities for developing key relationships across the value chain with producers of biomass (including farmers).

In 2006, one-third of firms reported they could substitute other types of biomass into their production process. In 2003, 38 firms used by-products or recycled products as inputs, while the majority of firms using agricultural biomass (55 of 93 firms) used primary products<sup>4</sup>.

4. This question was not asked in 2006.

## **Funding research and development, production, and commercialization activities**

Bioproduct firms raised funds totalling \$219 million in 2006. The most common purpose for seeking funding was to conduct research and development, followed by production/manufacturing capability and marketing/commercialization. Contributions to this funding mainly originated from private placements (30%), government grants (19%), and Canadian venture capital (13%). In comparison, in 2003 these three sources of funding comprised just 8%, 8% and 3%, respectively of the funds raised, though private placements and government grants were still the most common sources. Other funding came from angel investors/family, financial institutions, government loans and matching funds, public offerings, and collaborative arrangements.

In addition to these sources, nearly half (48%) of firms applied for benefits for bioproduct-related activities under the Scientific Research & Experimental Development (SR&ED) tax program between 2002 and 2006<sup>5</sup>. Applications totalled just over \$33 million for 2006. Of those firms using agricultural biomass, half applied under the program compared to 35% of other bioproduct firms. For other government-sponsored programs used during 2005/06; federal programs were accessed by 84 firms, and provincial/territorial/municipal programs by 54 firms. The most commonly accessed programs for firms using agricultural biomass were loan guarantees, technology assistance and training assistance programs.

## **Implications for agriculture**

Firms using agricultural biomass were involved in many areas of bioproducts, especially biofuels/bioenergy and biochemicals. At an individual level, firms reported that on average agriculture provided nearly one half of all biomass inputs. Though much of the biomass is locally or regionally sourced, nearly half of firms obtained biomass from at least 100 km away. This may indicate opportunities for increasing local collaborations, which could benefit producers as well as firms through lower transportation costs. Of firms using agricultural biomass in 2006, one-third established contracts with suppliers to obtain their biomass. This provides opportunities for producers and may also help firms reduce uncertainty as to the quantity and quality of biomass shipments.

Agricultural producers comprise one-quarter of all bioproduct firm partners in collaborations, providing biomass and conducting research and development. The 42 firms using agricultural biomass which were involved in collaborations in 2006 had approximately 186 collaborations—there is clearly a role for collaboration and knowledge sharing in this industry. These relationships become especially important for small firms for whom it may be either infeasible or inefficient to conduct all activities in-house. The continued emergence of regional innovation networks, co-operatives, and other relationship forms serves to illustrate the potential gains from collaboration (Ag West Bio Inc., 2009; SOBIN, 2009; Agriculture and Agri-food Canada, 2009).

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5. The Scientific Research & Experimental Development (SR&ED) program gives claimants cash refunds and/or tax credits for their expenditures on eligible research and development work done in Canada. It is the largest single source of federal government support for industrial research and development (Canada Revenue Agency, 2009).

## **Summary**

Although the size of Canadian bioproduct firms decreased between 2003 and 2006, they continue to be active in bioproduct development and commercialization. Bioproduct revenue and employment declined between 2003 and 2006; however, there were slightly more bioproduct firms and these firms were developing and producing more products than in the past.

Agriculture is an important component of the overall picture since on average firms reported half of their biomass was derived from the sector, and more firms are using agricultural biomass in 2006 than previously. Results from the survey indicate an important opportunity for agriculture in supplying biomass. There could also be opportunities for partnering on research and development activities, especially for small entrepreneurial firms. Biomass-specific challenges in sourcing and transportation, and a focus on accessing knowledge and resources externally means agriculture is a vital component of the bioproduct development process and value chain.

The significant structural shift in the bioproducts industry toward smaller firms and lower revenues and employment from bioproduct activities indicates a need for additional research into such areas as: the causes behind the structural shift; the economic viability of bioproducts in Canada; and the roles that government policies and programs play in supporting the industry.

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