Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Evaluation of the Agricultural Bioproducts Innovation Program (ABIP)

Final Report

Office of Audit and Evaluation

March 2011

AgriDoc #2644365

Canada

The AAFC Evaluation Committee recommended this report for approval by the Deputy Minister on March 21, 2011.

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Cat No. A22-538/2011E-PDF
ISBN No: 978-1-100-18627-6
AAFC No: 11456E

Aussi offert en français sous le titre : Évaluation du Programme d'innovation en matière de bioproduits agricoles (PIBA)

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Executive Summary

In this evaluation we examined the relevance and performance of the Agricultural Bioproducts Innovation Program (ABIP). The objectives were to determine:

- whether there is a continued need to support Canadian networks of research, development and technology transfer and commercialization activity in agricultural bioproducts;
- the extent to which the program overlaps with, or duplicates other AAFC or federal innovation programs;
- whether ABIP is aligned with federal priorities and departmental strategic outcomes; and,
- whether ABIP has achieved its expected outcomes in an efficient and effective manner.

The evaluation was conducted by the Office of Audit and Evaluation between April and December 2010. The evaluation is intended to inform the possible renewal of the program in 2011-12. The evaluation was conducted in accordance with the Treasury Board Policy, Directives and Standards on Evaluation (2009).

Agricultural Bioproducts Innovation Program

The ABIP was announced in December 2006 as a five-year contribution program. The objective of the program is to support the establishment, further development and operation of bioproduct research networks. Under the program, financial support was provided to successful networks and eligible participants identified through a two-step application process. The main activities of the ABIP are the creation and development of research networks and clusters of research, development, technology transfer and commercialization activity in agriculture bioproducts in Canada. The program funds the process for creating networks/clusters and supporting their activities in promising fields of the agriculture bio-based economy. ABIP was effective at bringing together diverse research activities in an emerging field by providing managerial and coordination structure. There were a number of isolated research activities in Canada looking at the bioproducts sector that needed government assistance to maximize their activities and the resulting outputs.

The program's budget is $124.8 million which includes $44.5 million in contributions (Vote 10) funding, $21.6 million for capital costs (Vote 5), and $58.7 million for salaries and operations (Vote 1).

As of November, 2008, ABIP has funded nine approved networks. The networks have cross-Canada participation that involves: 52 industry groups, companies and non-governmental organizations including significant national and provincial producers'

associations and councils along key crop and animal value chains; 36 universities and colleges; and 19 other public sector research and development organizations. The program also includes 603 undergraduate and graduate students and post-doctoral fellows, 158 university researchers, and 84 AAFC researchers.

Funded networks primarily focus on: feedstock production through the development of crop platforms and cropping systems suitable for conversion to bioproducts; first generation biofuel production and effective use of co-products to support government policy of renewable content in transportation fuels; developmental work on second generation biofuels using cellulosic materials and a smaller effort on new uses for crop-based fibres and starches; and enhancement of health and nutritional benefits in crop varieties, such as pulses and potatoes.

Methodology

The evaluation findings presented in the report are based on evidence gathered from five sources: a document review; a literature review; network file review; interviews with program officials, recipients and industry experts; and an environmental scan ascertaining if changes in the economic/biomass industry, since the program's inception in 2006, are still pertinent in 2010. Findings and recommendations are based on multiple lines of evidence.

Key Findings

There is a continued need for government financial support of networks focused on bioproduct innovation and commercialization. However, going forward, some thought needs to be given to formalizing the inclusion of industry partners in research networks to facilitate the advancement of research along the innovation continuum to the commercialization stage and to allow networks to become self-sustaining in the long-term.

The program was found to align with government and AAFC priorities, and with federal roles and responsibilities. ABIP does not overlap or duplicate other AAFC, federal or provincial innovation programs. While the program is making progress in meeting its immediate and intermediate outcomes, three areas requiring attention were identified:

- ABIP's performance measurement strategy (PMS) does not support a robust assessment of program performance.

- Performance monitoring and reporting is not standardized or consistent, making it difficult to track program performance.

- Program effectiveness has been hampered by a lengthy network proposal approval process.

Recommendations

The evaluation has identified three recommendations:

1. The Research Branch should ensure that for any future renewal of the program, the performance measurement strategy contains a clear articulation of program outcomes in relation to program objectives, supported by realistic and measurable indicators and targets.

2. The Research Branch should identify steps to improve ongoing monitoring of projects and reporting by research networks to ensure information is complete and reported in a consistent manner across networks on a regular basis.

3. The Research Branch should assess the current proposal approval process and identify lessons learned or improvements that can be applied to any future similar programming to streamline the process.

1.0 Introduction

1.1 Background

The 2006 Federal Budget articulated a strategy that called for investments in the competitiveness of the agricultural sector. At the same time, Agriculture and Agri-Food Canada (AAFC) acknowledged through its Agricultural Policy *F*ramework (APF) the need to take a leading role in driving the innovation agenda in the agricultural and agri-food sector by bringing partners together to generate new products, technologies and opportunities, and by helping to bring innovations to market. This approach was subsequently reinforced through Growing Forward programs in 2009. The Agricultural Bioproducts Innovation Program (ABIP) was initially announced in December 2006 as a five-year, $145 million contribution program and subsequently reduced to $124.8 as $20.25 million was transferred to other priorities. It was designed to fill a gap in programming at the discovery phase of innovation, and it supports AAFC's Strategic Outcome of "Innovation for Growth". The four objectives of the program are to:

- create nation-wide multidisciplinary and multi-sector research partnerships that integrate the research and development priorities of all participants;
- stimulate internationally competitive, leading-edge fundamental and applied research in areas critical to Canadian economic development;
- develop and retain world-class researchers in areas essential to Canada's productivity and economic growth; and
- accelerate the exchange of research results within the networks and the use of this knowledge (i.e., technology transfer and commercialization) within Canada by organizations that can harness it for Canadian economic development.

Under the program, funding (Votes 1. 5. and 10) is provided to support the establishment, further development and operation of bioproduct research networks, thereby promoting research, development, technology transfer and pre-commercialization activity in agricultural bioproducts in Canada. The program was designed to integrate Canada's creative talent in academia and the private and public sectors, and apply it to the task of developing the bio-based economy in order to stimulate creativity, leverage resources, reduce costs and accelerate progress towards commercialization through the creation of commercialization plans and dissemination of information to potential end-point users. Research networks are defined as organizations forming a critical mass of intellectual capacity to address strategic research priorities.

1.2 Evaluation Scope and Methodology

AAFC's Office of Audit and Evaluation (OAE) evaluated the activities of the ABIP from December 2006 to December 2010. The purpose of the evaluation is to assess the continued relevance and performance of ABIP, as required by the Treasury Board Policy on Evaluation (2009). Under relevance, the evaluation assessed the extent to which the program is aligned with government priorities and AAFC strategic outcomes and with federal roles and responsibilities; the continued need for the ABIP to support networks focused on bioproduct innovation in the agricultural sector; and the extent to which the program overlaps with, or duplicates other AAFC or federal innovation programs.

With respect to performance, the evaluation assessed the extent to which the program has achieved short-term, intermediate and long-term outcomes. It also examined the level to which the program demonstrated efficiency and economy in its implementation.

To avoid duplication with the Auditor General's spring 2010 report which reviewed the program's project assessment criteria and the communication with project proponents, this evaluation did not look at these aspects in detail. The evaluation instead focuses on the program's overall performance and efficiency and economy of program delivery.

The evaluation was national in scope and based on the following five lines of evidence:

- Document Review – including program foundational and management documents and other AAFC and federal government policy documents (see Annex A for a complete list of documents reviewed);
- Network File Review – including reports submitted by the ABIP networks on the outputs and outcomes that they have achieved. All reports submitted by the networks to date were reviewed;
- Literature Review – including reports or studies of the importance of networks and innovation to the economy, barriers to innovation and the need for government support of innovation (see Annex B for a complete list of reports and studies reviewed);
- An environmental scan ascertaining if changes in the biomass industry conditions, since the program's inception in 2006, are still pertinent in 2010; and
- Interviews (n=31) with program officials, expert review panel members and program recipients, including for each network (n=9) the lead scientist, the AAFC lead scientist, and the network manager. Evaluators identified key informants from all stakeholder groups to ensure a broad representation of perspectives and views. The interview guides are attached as Annexes C, D and E.

To the extent possible, evaluation findings are based on multiple lines of evidence.

1.3 Evaluation Constraints / Risks

A key constraint was the limited availability of information on progress towards long-term outcomes of ABIP at the time of the evaluation. These types of innovation/ commercialization projects often require long lead times of 5-10 years before longer-term outcomes are achievable. In addition, the ABIP program was further challenged to achieve the intermediate and long-term outcomes due to lengthy time lags from program implementation to receipt of signed network agreements (averaging 744 days), thereby shortening an already short program timeframe of 5 years to 2.5 years for achieving results. The evaluation therefore reports largely on immediate and intermediate outcomes.

The network file review found the quality and consistency of reported performance data was variable between networks due to different interpretations of the indicators outlined in the performance measurement strategy. This limited the analysis that could be done with the performance data. To mitigate this limitation, the evaluation relied on additional data on program activities and achievements, as well as the limited performance data available on program indicators and targets.

Another limitation is that the evaluation includes limited feedback from program stakeholders, in particular network participants. One reason was the inability to survey rejected applicants to gauge their reaction to the project selection process, as consent to contact rejected applicants for research purposes was not included within the program documentation. Multiple consultations with access to information and privacy (ATIP) representatives led to a recommendation not to contact rejected applicants. To work around this, those interviewed (network participants, program representatives and expert review panel members) were asked about their reaction to the selection process with any insight they could provide regarding the processes used for rejected applicants.

2.0 Program Profile

2.1 Program Governance

ABIP is administered, managed, and delivered jointly by the Science Partnerships Directorate and the Innovation Directorate of AAFC's Research Branch, which together make up the ABIP Secretariat.

The ABIP Secretariat team, which reports to the Science Partnerships Directorate, is located in Summerland, British Columbia. This team, led by a Program Director and support staff, provides the overall management and coordination of the research aspects of ABIP by ensuring effective program delivery and resource management

(Vote 1 and 5); coordinating internal and external communications; overseeing program implementation and coordinating with funded networks; ongoing management of research performance; as well as providing the logistical support to the Expert Review panel.

The Innovation Directorate supports the ABIP program by managing the funding of contributions (Vote 10) to network recipients external to AAFC and provides a due diligence service by reviewing all network claims for eligibility. In particular, the Innovation Directorate processes financial claims for the networks, negotiates, amends and processes contribution agreements, and communicates on processes and resolution of issues related to processing of claims, timing, and eligible costs.

The ABIP Secretariat is further supported internally by the Office of Intellectual Property and Commercialization, Science Partnerships Directorate, Research Branch, which develops, negotiates and modifies ABIP agreements, including network agreements (NA) and letters of understanding (LOU).

2.2 Program Activities and Outputs

ABIP funds the activities of research networks including the administration of the networks, and the specific research, development and technology transfer / commercialization projects. Each network undertakes a set of projects designed to address strategic research issues. Funding for program activities includes $44.5M in Vote 10 (Grants and Contributions) to support the participation of universities and other eligible recipients on ABIP networks, and $28M in Vote 1 (Operating) for AAFC Research Centres to support AAFC participants on ABIP networks.[1]

The program funds networks and associated activities in promising fields of the agriculture bio-based economy in the areas of:

- Feedstock production through the development of crop platforms and cropping systems suitable for conversion to bioproducts;
- Developing effective and efficient technologies for biomass conversion; and
- Product diversification through technologies relevant to production of bioproducts (e.g., industrial chemicals, biomaterials and health products).

As of November, 2008, ABIP has nine approved network agreements, meeting its target of 5 to 10 networks. Two of the nine networks existed prior to ABIP (the Industrial Oil Seed Network existed informally and the Canadian Triticale Biorefinery Initiative existed

[1] Vote 1 (Operating) includes salaries for AAFC researchers involved in ABIP networks ($8.2M); NPO, which includes the cost of chemicals, small equipment and repairs, lab costs, seeds, fertilizer, and greenhouse costs ($14.5M); and transfers to other government departments (National Research Council, Canadian Food Inspection Agency, Natural Resources Canada) ($5M).

in a much smaller form). Each network has its own network management system to monitor the work and progress of the network. Network Managers are responsible for ensuring timely progress of the projects, and for tracking and reporting on project performance.

The networks have cross-Canada participation and involve: 52 industry groups, companies and non-governmental organizations including significant national and provincial producers' associations and councils along key crop and animal value chains; 36 universities and colleges; and 19 other public sector R&D organizations. The program also includes 603 undergraduate and graduate students and post-doctoral fellows, 297 other professionals, 357 scientists and 17 visiting scientists had an opportunity to work on ABIP funded projects helping to support and retain a significant amount of highly-qualified personnel in Canada.[2]

The nine networks are listed below:

- Industrial Oil Seed Network (IOSN)
- Cellulosic Biofuel Network (CBioN)
- Canadian Triticale Biorefinery Initiative (CTBI)
- Sustainable Cropping System Platforms for Biodiesel Feedstock Quantity and Quality (SBQQ)
- Agricultural Biorefinery Innovation Network for Green Energy, Fuels and Chemicals (ABIN)
- Feed Opportunities from the Biofuels Industries (FOBI)
- Natural Fibres for the Green Economy Network (NAFGEN)
- Pulse Research Network (PURENet)
- BioPotato Network

Annex F includes details of the nine networks funded. In October 2010, AAFC and representatives of all nine networks took part in the first Canada-Europe-Australia-New Zealand Workshop on Biotechnologies for Biorefineries and Biobased Materials, held in Saskatoon, Saskatchewan. Topics discussed included production/feedstocks, biofuels and bioenergy, and green chemicals and biomaterials.

Each network may receive up to a maximum of $25 million over the duration of the program and can support 5 to 25 inter-related projects. Individual projects are eligible to receive up to $15 million over the five year period of the program. For contribution agreements, individual project recipients are eligible for a maximum of $15 million over the five-year term of the program.

Funded networks primarily focus on: feedstock production through the development of crop platforms and cropping systems suitable for conversion to bioproducts; first

[2] Data on personnel participating on ABIP networks was provided by the Research Branch and has not been validated by the Office of Audit and Evaluation.

generation biofuel production and effective use of co-products to support the federal government's proposal to regulate renewable content in fuels; developmental work on second generation biofuels using cellulosic materials; new uses for crop-based fibres and starches; and enhancement of health and nutritional benefits in crop varieties, such as pulses and potatoes.

2.3 Program Resources

ABIP was initially allocated funding of $145 million over five years. However, approximately $20.25 million was transferred from ABIP to other priorities within the Action Plan for Agriculture. Accordingly, ABIP's budget was reduced to $124.8 million, as shown in Table 1 below. The budget includes $44.5 million in Contributions (Vote 10) funding, $21.6 million for Capital costs (Vote 5), $50.8 million for salaries and operations (Vote 1), and $7.9 million for employee benefits and accommodations (Vote 1).

Table 1: Agricultural Bioproducts Innovation Program (ABIP) Budget (in thousands $)*

	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	Total
Budget						
Vote 1 – Salary & OM	249	9,574	13,609	13,574	13,779	**50,786**
Vote 5 - Capital	307	1,359	7,162	7,463	5,351	**21,642**
Vote 10 - Grants & Contributions	-	850	7,265	20,676	15,709	**44,500**
EBP	0	803	1,298	1,319	1,346	**4,766**
Accommodations	0	522	843	857	875	**3,098**
Total Budget	**557**	**13,109**	**30,177**	**43,889**	**37,060**	**124,792**
ABIP Actual Expenditures						
Vote 1	**-**	1,189	8,647	11,708	12,675	34,218
Vote 5 - Capital	307	1,359	7,162	7,463	5,351	21,642
Vote 10 - Grants & Contributions	-	646	7,265	20,502	15,709	44,122
Total Expenditures	**307**	**3,194**	**23,073**	**39,674**	**33,735**	**99,983**

*Table provided by program based on expenditures as at December 2010. Claims are still being processed. . Expenditure figures for 2010-2011 are based on forecasts. Totals may not add due to rounding.

3.0 Evaluation Findings

3.1 Relevance

In assessing the relevance of ABIP the evaluation looked at the continued need for the program to support networks focused on bioproduct innovation in the agricultural sector; alignment with federal priorities and departmental objectives; and roles and responsibilities with respect to support for innovation in the sector.

3.1.1 Continued Need for the Program

Findings from the literature review, interviews and economic review all confirmed that financial support for innovation in bioproducts is critical for addressing barriers to the development of a bioproduct industry in Canada. These barriers include lack of private sector funding[3], regulation[4][5] and a lack of qualified human resources.[6] [7] [8]

Statistics Canada's 2006 Bioproducts Development Survey found that the following are the most significant barriers, in order of importance, to developing or producing bioproducts: higher transportation costs of biomass; higher price of biomass; difficulty in entering commercial marketplace; cost and timeliness of regulatory approval; and lack of financial capital.[9]

The bioproducts industry in Canada is still in the research and development stage. It is comprised of small- to medium-sized enterprises that, individually, have limited resources. Network formations were found to be critical for overcoming these barriers to innovation within the bioproducts sector.[10]

The Networks of Centres of Excellence Canada, which is jointly administered in partnership with Industry Canada by Canada's three granting agencies—The Canadian Institutes for Health Research (CIHR), the Natural Sciences and Engineering Council (NSERC), and the Social Sciences and Humanities Research Council (SSHRC)—also funds research partnerships between academia, industry, government and not-for-profit organizations. While the networks target a range of areas, including health, human development, biotechnology, environment, and water quality, they do not specifically target the agriculture sector.

As Canada is a small market, Canadian firms must export their products to be competitive. With the new emerging economies – India, Brazil and China – bringing greater competition to the agricultural sector, Canadian firms need to collaborate to be successful.[11]

While there was innovative research activity in the bioproduct sector prior to ABIP, the activities could be characterized as fragmented, uncoordinated, less-than-strategic and lacking integration. The bioindustry firms also did not have the infrastructure or

[3] World Economic Forum, 2009.
[4] Gray and Weseen, 2008.
[5] AAFC, p.11-18.
[6] Gray and Weseen, 2009.
[7] Labrecque et al, p. 15.
[8] AAFC, p.13-17.
[9] Sparling, David, Pamela Laughland and Verna Mitura, 2009.
[10] Gray and Weseen, 2008; Moorsel et al., 2005.
[11] Conway and Duncan, 2006.

resources to cross what in the industry has been termed "the valley of death"[12] from innovation in the lab to commercialization. ABIP is trying to address the first steps in the movement along the innovation continuum (Figure 1) from the discovery phase, all the way to the commercialization phase.

Interviews with program recipients revealed that while there were other sources of funding to support their work prior to ABIP, the funds were comparatively small and project-based, suggesting that most networks under ABIP would not have been able to operate without the program. Network formations amongst sectors that, prior to ABIP, had traditionally been funded individually and thus worked independently of one another (often competitively), allow the partners to pool resources and knowledge for better coordination and advancement of innovation in Canada's bioproduct industry.
The majority (85%) of network managers stated that incentives (availability and nature of funding) are the most important factor for the development and maintenance of research networks, followed by the need for collaboration, leadership and communication.

While there is a continued need for the federal government to support these types of research networks in the near term, some thought needs to be given to enabling them to become self-sustaining over the long-term. Recipients interviewed stated that, though they valued the opportunity to be involved in ABIP, much has evolved both in the bioscience industry and the evolution of networks in achieving innovation since the program was created. They suggest that the new models need to be revised in this context, before reinvesting in the same program structure. The literature review suggests that governments should not continue to support networks once they become established; networks at this point should contribute their share of operating costs, allowing government to step back and move on to support new networks.[13]

Interviews with program recipients confirmed this; they stated that not only is there a need to maintain existing research networks, but for new networks to have a revised approach to advancing the work by operating largely outside of the AAFC Research Branch and University governance systems to enable a connection with commercialization. This would allow industrial partners to lead, representing forward looking companies with an industry advisory board, whose main function would be to 'own' and share the vision. These findings suggest a need to assess what the next step will be for the existing networks, including potential development of a transitional phase that would enable a wider group of collaborators with the same vision as the networks to take applied research to the commercialization phase. Modification of program eligibility criteria to include industry participation in the networks may help address this need.

[12] As described in interviews with recipients, the gap between research and commercialization is sometimes referred to as 'the valley of death.' This is the gap between the researcher, who demonstrates the product at the laboratory scale (representing 10% of the development cost), and the business interest that brings the product to commercialization (representing the other 90% of the development cost).
[13] Hamalainen and Schienstock, 2000, p.46.

In conclusion, ABIP was found to address a continuing need for government financial support of networks focused on bioproduct innovation in the agricultural sector. However, going forward, the inclusion of more industry participation on networks may propel research further along the innovation continuum towards commercialization while allowing the networks to become self-sustaining.

3.1.2 Alignment with Federal Priorities and Departmental Objectives

A review of Government of Canada publications and policy documents, including Speeches from The Throne and Budget statements, and AAFC's foundational documents that articulate the department's strategic outcomes, confirm that ABIP is aligned with federal priorities and departmental objectives.

For example, in the 2006 Speech from the Throne, the Government committed to making new investments in agriculture biomass science.[14] ABIP is a source of this new investment, as the partnerships formed through ABIP networks (among universities, provincial research institutions and private firms) create the synergy necessary to turn biomass science into a source of commercial opportunity. As a result, ABIP was found to align with federal government priorities.

The ABIP foundational documents reviewed included several statements of objectives and intended outcomes, all focusing on helping the agricultural sector to develop bioproduct research networks to promote research, development, technology transfer and commercialization of bioproducts in Canada. ABIP was found to be in alignment with AAFC's strategic outcome of an "innovative agriculture, agri-food and agri-based products sector," as it addresses the challenges of agriculture biomass, a new and innovative industry.

The program terms and conditions do not include a specific eligibility requirement for inclusion of industry partners in research networks. As a result, some networks have virtually no private sector investment.

The literature review suggests that bio-industry firms often lack sufficient investment and guidance from the business community to commercialize their innovative products. Program recipients expressed the opinion that government departments do not have sufficient business skills to make sound decisions as to what should be invested in, and this is best left to industry. They further state that ABIP should evolve in the direction of including a greater role for industry, including industry engagement in deciding what to produce, more industry co-investment and the evolution of research networks into industry clusters.

[14] Government of Canada, Speech from the Throne, January, 2006, p. 2.

Key informant interviews confirm that industry involvement is essential and that it is happening within the current ABIP model. However, going forward, some thought needs to be given to formalizing the inclusion of industry partners in research networks to facilitate the advancement of research along the innovation continuum to the commercialization stage, and to allowing networks to become self-sustaining in the long-term.

3.1.3 Alignment with Federal Roles and Responsibilities

Program foundational documents were reviewed to identify the policy objectives, rationale for the program, as well as the grounding of the program in AAFC's mandate. Relevant legislation was also examined to assess the alignment of the program with the Department's legal mandate.

The *Department of Agriculture and Agri-Food Act* provides the Minister of Agriculture and Agri-Food with very wide latitude to act in matters relating to agriculture, products derived from agriculture and research related to agriculture or products derived from agriculture.[15] As the innovative research supported by ABIP is relevant both to agriculture and to products related to agriculture, ABIP was found to be in alignment with federal government roles and responsibilities with respect to agricultural / agri-products innovation.

3.1.4 Alignment with Other AAFC Innovation Programming

Figure 1 identifies the location of ABIP on the innovation continuum in relation to other AAFC innovation programs. AAFC also delivers several other innovation programs that have the potential to address the discovery phase, including the following: Developing Innovative Agri-Products (DIAP) program, Canadian Agri-Science Clusters, and Promoting Agri-Based Investment Opportunities. While these programs do not focus specifically on the development of networks that address bioproduct innovation issues, they do work toward mobilizing research capacity and bringing together researchers, entrepreneurs and investors. As such, there is potential for confusion about ABIP's mandate and positioning vis-à-vis these other AAFC innovation programs. It should be noted that ABIP preceded these other AAFC programs, which were launched in 2009 as part of the *Growing Forward* policy framework, and as a result, the potential for program overlap and duplication did not become an issue until later in the ABIP program.

A DG-level committee was put in place following the launch of *Growing Forward* programs, to review project proposals received under the various *Growing Forward* and other AAFC innovation programs, in order to address the potential for program overlap and duplication. Research Branch officials also suggest that some overlap between the programs can be beneficial, as it allows project proponents to select the program

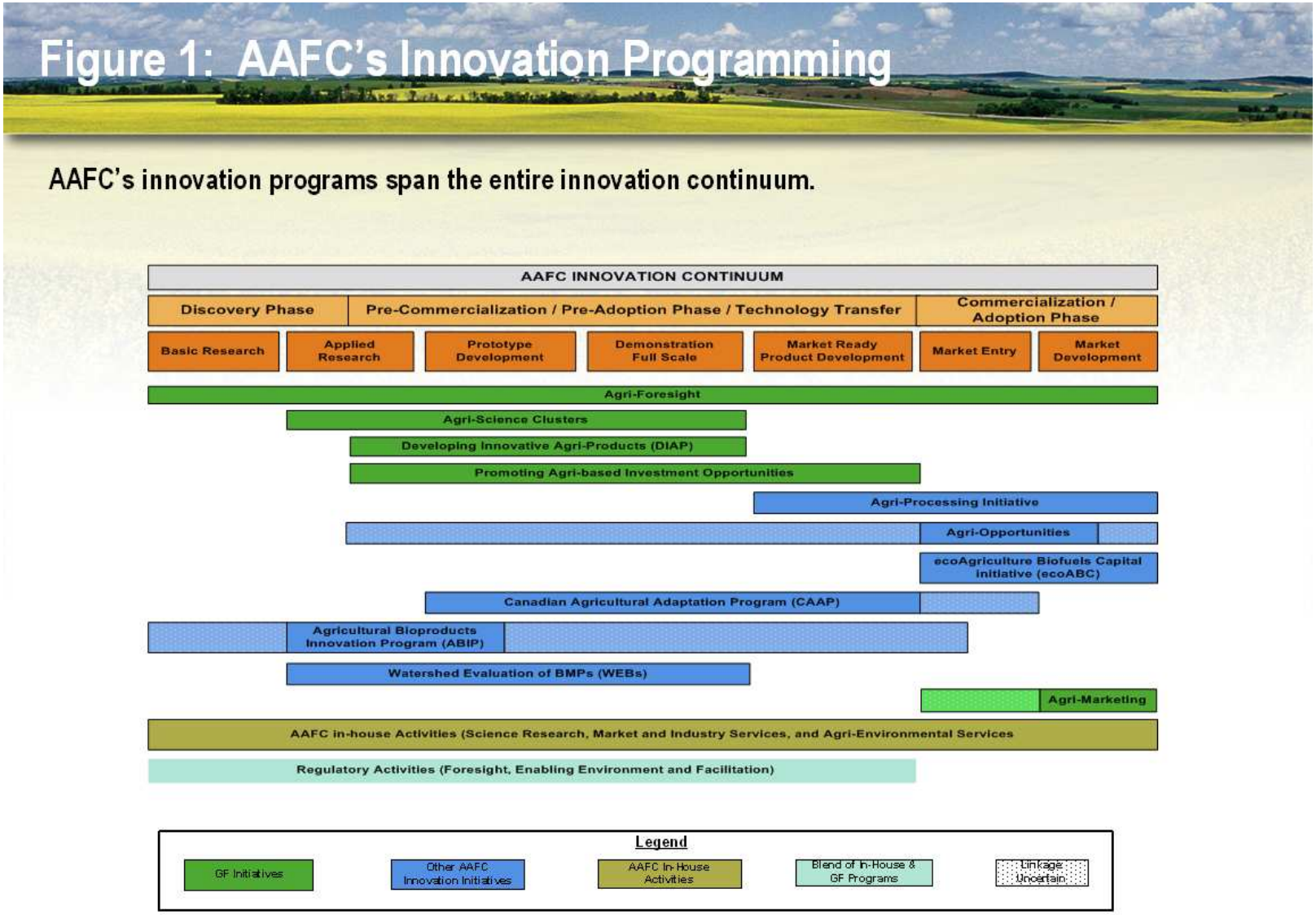
[15] *Department of Agriculture and Agri-Food Act (R.S., 1985, c. A-9)*. *Section 4.*

that best meets their needs and provides sufficient flexibility to accomplish their goals, given their stage along the innovation continuum.

3.1.5 Alignment with Other Federal and Provincial Innovation Programs

A number of federal and provincial government programs support innovation, including: the National Research Council's Industrial Research Assistance Program (IRAP); Western Economic Diversification's Technology, Commercialization and Knowledge Infrastructure Sub-Activities; and the Atlantic Canada Opportunities Agency's Innovation Program Sub-Activity. These programs do not, however, target specific sectors of the economy such as the agricultural sector. Instead, they are focused on local economic policy, programs and infrastructure. There are also a number of provincial innovation programs targeted at the agriculture sector, including: Alberta's Agri-Business and Product Development Grants, Ontario's Agri-Tech Commercialization Centre and Nova Scotia's Agri-Food Industry Development Fund. The document review and interviews indicate that none of these programs were found to overlap with ABIP.

Figure 1: AAFC's Innovation Programming



3.2 Performance

This section summarizes the findings of the evaluation with respect to ABIP's performance, in terms of achievement of intended outcomes, efficiency and economy.

3.2.1 Achievement of Outcomes and Outputs

While ABIP is making progress toward achieving its outcomes, it is difficult to validate the progress based on the program's performance measurement strategy. The existing performance measures, monitoring and reporting do not support a robust assessment of program performance.

ABIP networks are making progress in building greater research capacity in agricultural bioproducts and bioprocesses in Canada as demonstrated through the outputs of the networks collectively. The Research Branch highlighted the following achievements[16] that demonstrate progress against ABIP objectives and outcomes:

- 9 approved and funded networks
- 900 scientists and professionals working on ABIP projects
- 265 peer reviewed publications with joint authorship
- 24 national and international awards for ABIP research
- 17 commercialization plans developed and disseminated.

In terms of progress towards commercialization, ABIP networks have supported progress in commercialization of bioproducts, processes and services through technology transfers, contractual agreements with industry and an increase in meetings between researchers from ABIP networks and potential industry partners. Please refer to Annex I for a listing of the commercialization plans developed and disseminated to date.

Progress in building greater research capacity in agricultural bioproducts and bioprocesses in Canada was also demonstrated by the achievements of the individual networks. For example;

- The BioPotato Network has adapted the potato granulation process to include anthocyanins, natural colourants in fruits and vegetables that have anti-oxidant properties.
- The Canadian Triticale Biorefinery Initiative has developed a blue-coloured seed to track the genetic purity of new lines, to help ensure that new triticale varieties can be grown without adverse effects on existing ones.

[16] Data compiled by AAFC Research Branch based on network progress reports. Data not validated by the Office of Audit and Evaluation

- The Feeds Opportunities from the Biofuels Industry Network has been examining the various nutritional aspects of wheat dried distillers' grains with solubles as a source of energy and protein for livestock.
- Linnaeus Plant Sciences Inc., the network lead for the Industrial Oil Seed Network (IOSN), has entered into a licensing agreement with DuPont to use oil gene intellectual property, advanced gene technologies and biotechnology expertise developed by DuPont to accelerate development and commercialization of value-added Camelina oil which can substitute for petroleum in a variety of applications. In addition the IOSN has also produced a home lubricant kit that is being market tested and biobased hydraulic fluid that is being evaluated by Toronto Community Housing Corporation.
- The Natural Fibres for the Green Economy Network (NAFGEN) is in the near-market stages of product development of flax fibre mats and natural fibre-based bus panels.
- The Agricultural Biorefinery Innovation Network for Green Energy, Fuels and Chemicals (ABIN) is negotiating sales of their mobile pyrolysis units.

While these activities demonstrate that the ABIP networks are making progress in building greater research capacity in agricultural bioproducts and bioprocesses in Canada and moving basic research into application, it is not possible to assess program achievements against the performance measurement strategy.

3.2.2 Performance Measurement Strategy

The Research Branch has raised a number of challenges it faced in developing a performance measurement strategy that adequately captured the outputs, indicators, targets and outcomes for this new type of collaborative research arrangement. At the time of the launch of the ABIP, there was limited collaborative research being undertaken between the federal government, universities and industry. The program was one of the first within AAFC to promote collaborative research arrangements, using Vote 1 (Operating) dollars to fund NPO and the salaries of AAFC researchers involved in the networks, and Vote 10 (Contributions) to support university and industry participation in the networks. This also represented the first time that the Research Branch funded collaborative arrangements through contributions, as opposed to through the use of Specified Purpose Accounts (SPAs). This change was made to support greater accountability for the use of federal research dollars, and to reduce the risks inherent with SPAs, which enabled funds to be re-profiled from year to year, without any specific accountability for research deliverables or results.

The document review and network file review demonstrated there to be four key weaknesses with ABIP's performance measurement strategy:

1. The identified measures for outputs, outcomes and indicators are used interchangeably. Program immediate and intermediate outcomes are articulated as outputs (i.e., the "what" of the program, such as "number of personnel trained"; "generation and dissemination of leading edge research"; "new or improved bioproducts and processes developed"), as opposed to the changes or differences that result from the program outputs (i.e. the "why" of the program). For example, "number of media reports" and "number of invitations as guest speakers" appear as indicators of immediate outcomes; however, these measures are simply outputs of the networks not a consequence or result of them. The confusion makes it difficult to identify causal linkages between outputs and outcomes, and to assess program performance against stated objectives.

2. The three end outcomes of the ABIP program are: a vibrant bioproduct research landscape; optimized technology and knowledge transfers to commercialization agents; and, expert Canadian leadership in specialized areas of the bioeconomy. It is difficult to assess progress against these end outcomes, given that a common understanding of what constitutes "vibrant", "optimized" and "expert" would need to be established so that progress could be assessed against an agreed-upon baseline for the bioproduct research landscape.

3. Indicators are based on outputs (e.g., the number of research projects, publications, awards, presentations, commercialization plans developed and disseminated) as opposed to measures of the achievement of program outcomes (e.g., increased awareness of bioproduct investment opportunities).

4. Targets for indicators were set with wide-ranges with no explanations on how to interpret performance data in relation to the indicators associated with immediate, intermediate and end outcomes. The performance measurement strategy for the program was updated in 2009 to revise the targets based on preliminary experience with the program, with the aim of bringing them more into line with the performance of the networks. Despite this update to the targets, a gap in understanding between the performance data in relation to the outcomes remains.

Evidence gathered as part of the Meta-Evaluation of AAFC's Innovation programs (including ABIP) confirms the challenge of developing good performance measures for innovation. Over the past year, the OECD, the EU and others have been identifying some potential new measures and ways of looking at traditional indicators that go beyond research & development to describe the broader context in which innovation occurs. Furthermore, it is generally recognized that it takes 5-10 years for innovation programs to achieve meaningful results. Accordingly, there is a need to build understanding of the fact that it takes time for innovation programs to achieve long-term, meaningful outcomes, while at the same time there is a need to strengthen the

performance measures at the individual program level, to support the future assessment of AAFC's contribution to innovation in the agricultural sector.

In the event that the program is renewed, significant improvements are required to the performance measurement strategy, to ensure that it contains a clear articulation of program outcomes in relation to program objectives, supported by realistic and measurable indicators and targets.

Recommendation #1:

> **The Research Branch should ensure that for any future renewal of the program, the performance measurement strategy contains a clear articulation of program outcomes supported by realistic and measurable indicators and targets.**

Management Response and Action Plan:

> The Performance Management Strategy (PMS) for similar programs developed since the launch of ABIP (i.e., GF Science Clusters and DIAPs) have incorporated lessons learned and better align program objectives, outcomes, indicators and targets.
>
> Building on the Research Branch Performance Measurement Framework approved in September 2010, additional work is being undertaken across the Department to better define performance indicators as they relate to innovation.
>
> A Performance Measurement Strategy (PMS) will be developed in preparation for a potential renewed program in the next fiscal year. The revised PMS will build on those established for other initiatives (e.g., Developing Innovative Agri-Products Program (DIAP), Science Clusters, Agri-OPS, etc.) and will include clear expected program outputs and outcomes and appropriate indicators. *Target Date: 30 April 2011*

3.2.3 Performance Monitoring and Reporting

The document review confirmed that performance monitoring and reporting is not standardized or consistent, making it difficult to track program performance and demonstrate value for money.

- The ABIP program does not have a database for consolidating performance related information. As a result, data gathering has been fragmented and performance data was not easily located. Of the data that was found, indicators reported on were vague or ambiguous, as no data dictionary exists to ensure that network participants use similar definitions to report on common variables.

- Follow-up on network reporting requirements was inconsistent. Due to the lack of specificity in the wording around the performance data requirements of program recipients, it is possible that different networks interpreted the requirements differently and, as a result, provided performance data that cannot accurately measure the indicators.
- Performance data reported by networks focused on individual outputs, as opposed to overall network achievements in relation to ABIP outcomes (a result of the weak performance measurement strategy for the program).

In conclusion, in the event that the ABIP program is renewed, significant improvements are required to the program's performance monitoring and reporting structure.

Recommendation #2:

The Research Branch should identify steps to improve ongoing monitoring of projects and reporting by research networks to ensure information is complete and reported in a consistent manner across networks on a regular basis.

Management Response and Action Plan:

In response to lessons learned from the implementation of ABIP, a strengthened performance management regime has been created as part of GF Science Clusters and DIAPs initiatives. In addition, a new Collaboration Framework and Guidelines was approved in the spring of 2010 and includes guidelines for good governance including monitoring, performance reporting and evaluation of AAFC collaborations.

Given that ABIP ends 31 March 2011, a Final Report template was developed in consultation with other department teams and ABIP Network participants. To ensure common understanding among Network participants, the template includes detailed guidelines and was presented to Network participants during a Webinar (19 November 2010). The Final Report template and instructions were distributed to Network participants on 24 December 2010.
Target Date: 24 December 2010

A master database template will be created to collate, standardize, and error-check the data gathered from Network Performance Management Reports to ensure the final consistency of Network performance reporting.
Target Date: 1 March 2011

A Secretariat best practice manual and Network reporting guidelines will be developed to ensure information is complete and reported in a consistent manner across networks on a regular basis. *Target Date: 31 Aug 2011*

3.2.4 Program Efficiency

Program efficiency refers to the extent to which maximal program outputs are achieved with a given level of inputs or, conversely, the minimal level of inputs or resources that are used to achieve the maximum level of outputs. Efficiency can be measured in terms of inputs such as timeliness, human resources and demands on participants.

Vote 1 (Operations) costs for ABIP are $6.6M over five years ($1.76M for employee salaries; $1.54M in NPO; and $3.34M for costs associated with legal services, audit and evaluation, communications and other enablers), which represents 7% of the total program expenditures ($99.9M). By comparison, the national component of AAFC's Advancing Canadian Agriculture and Agri-Food program (ACAAF) (now the Canadian Agricultural Adaptation Program), which is delivered by AAFC's National Headquarters, incurred program delivery costs of 12% over the five-year life of the program; delivery costs for the Agri-Opportunities program were 8.3%; and direct delivery costs for the National Research Council's Industrial Research Assistance Program (IRAP) were 17.2%.

Concurrently during the evaluation of ABIP an internal audit was being conducted of the program. To ensure no duplicity of efforts by the Office of Audit and Evaluation, our evaluation reviewed only the administrative costs in relation to total expenditures. The Horizontal Audit of Grants and Contributions reviewed the effectiveness of program-specific controls.

In conclusion, the ratio of delivery costs to total program costs appears to be reasonable when compared to that of other AAFC grant and contribution programs.

3.2.5 Program Effectiveness

A review of program documentation found that program effectiveness has been compromised by an extremely lengthy project approval process.

Approval Process

Evidence obtained through the document review suggests that the length of time taken to process applications and the lack of clear guidelines provided to the individuals reviewing project proposals throughout the approval process (to ensure that project proposals are assessed consistently against the criteria) may have put the achievement of program outcomes at risk.

The approval process for ABIP was extremely lengthy – an average of 744 days from the identification of potential research projects to the conclusion of nine network agreements. (Please refer to Annex H for a process map.)

The first stage of approvals focused on the selection of specific research network proposals, while the second phase of approvals focused on the conclusion of network agreements.

In terms of Phase 1, and the identification of network proposals, the ABIP program administration received an unexpectedly large number of letters of intent (100). The average processing time from receipt of letters of intent to the approved contribution agreement phase was 537 days (approximately 200 days to approve the proposals and 334 days to approve the contribution agreements).

A total of 11 network proposals were accepted for funding, which were compressed into nine networks (three were joined into one network). An additional 209 days were then required to obtain signatures on network agreements, Phase 2. Although the program was launched in 2006, it took two years to establish the networks, and they have effectively only been operating since November 2008.

The lengthy timelines can be attributed in part to the discovery of an intellectual property issue in the original contribution agreements that needed to be addressed through the development of subsequent network agreements. The lengthy timelines can also be attributed in part to the need of network participants to undertake due diligence in reviewing the agreements prior to signature.

To date, program expenditures have been less than budgeted ($99.9M out of $124.75M, or 80%). However, it should be noted that the program is still processing eligible expenditures up to March 31, 2011.

Research Branch officials confirm that lessons learned from the ABIP process have been used to launch subsequent innovation programs under Growing Forward (e.g. Developing Innovative Agri-Products Program (DIAP), and Science Clusters. Furthermore, new service standards have been implemented as part of an AAFC client service initiative implemented in April 2010. These will provide a baseline against which the program can monitor effectiveness in terms of meeting processing times. It should be noted that Growing Forward innovation programs are targeted for evaluation in 2012-2013.

In conclusion, opportunities for streamlining the approval process should be identified with the benefit of hindsight, including ideas for developing a set of clearer guidelines based on feedback from those who participated in the approval process.

Recommendation #3

> **The Research Branch should assess the current proposal approval process and identify lessons learned or improvements that can be applied to any future similar programming to streamline the process.**

Management Response and Action Plan:

Processes for proposal submission, evaluation, recommendation and approval used subsequent GF initiatives (e.g., Clusters, DIAPs) were built on lessons learned from the ABIP experience.

Additional work is being undertaken based on our GF experience to devise a streamlined and scientifically robust system for any future similar programming.

Target Date: 30 April 2011

4.0 Conclusions and Recommendations

4.1 Conclusions

ABIP was found to address a continuing need for government financial support of networks focused on bioproduct innovation in the agricultural sector. Barriers continue to exist to the development of the bioproduct industry for the agricultural sector. ABIP was effective at bringing together diverse research activities in an emerging field by providing managerial and coordination structure. Going forward, some thought should be given to formalizing the role of industry partners in research networks by modifying the program eligibility criteria to include their participation. This may propel research further along the innovation continuum towards commercialization while allowing the networks to become self-sustaining.

ABIP is aligned with Government of Canada and AAFC priorities for agricultural biomass science and bioproduct research. The 2006 Speech from the Throne articulated the government's commitment to making new investments in agriculture biomass science, a sector that may be advanced in part by ABIP. ABIP was also found to align with AAFC's strategic outcome of "an innovative agriculture, agri-food and agri-based products sector."

ABIP focuses on the development of networks that address agricultural bioproduct innovation issues and it does not overlap or duplicate other AAFC or federal or provincial innovation programs. While other government programs that support innovation exist, they do not necessarily require multi-sector collaboration (amongst government, industry and academia) or focus specifically on bioproduct innovation in the *agricultural* sector.

ABIP networks are making progress in building research capacity in agricultural bioproducts and bioprocess in Canada. A review of the activities of the networks

found examples of moving basic research conducted by the networks to near-market for product development, production and application suggestive of a greater research capacity in the agricultural bioproduct and bioprocesses in Canada. In addition, ABIP networks have reported progress towards commercialization through technology transfers, contractual agreements with industry and an increase in meetings between researchers from ABIP networks and potential industry partners.

In the event that the program is renewed, significant improvements are required to the performance measurement strategy to ensure that it contains a clear articulation of program outcomes, supported by realistic and measurable indicators and targets. The outputs, outcomes and indicators are used interchangeably making it difficult to see the causal linkages between outputs and outcomes, and to assess program performance against stated objectives. As well, the end outcomes are too broadly defined and results cannot be achieved within a five-year time frame.

In the event that the ABIP is renewed, significant improvements are required to the program's performance monitoring and reporting structure. More rigorous data collection and consolidation—along with more specificity in the wording around the performance data required for reporting by the recipient networks—would support improved monitoring and reporting on performance.

ABIP administration costs appear to be reasonable when compared to that of other AAFC grant and contribution programs. Program administration costs in Vote 1 (Operations) represent 7% of total program expenditures over a five-year period. These costs include employee salaries, NPO and enablers.

Opportunities for streamlining the approval process should be identified with the benefit of hindsight, including ideas for developing a set of clearer guidelines based on feedback from those who participated in the approval process. The approval process took an average of 744 days from the identification of potential research projects to the conclusion of nine network agreements.

4.2 Recommendations

The evaluation has identified three recommendations:

1. The Research Branch should ensure that for any future renewal of the program, the performance measurement strategy contains a clear articulation of program outcomes in relation to program objectives, supported by realistic and measurable indicators and targets.

2. The Research Branch should identify steps to improve ongoing monitoring of projects and reporting by research networks to ensure information is complete and reported in a consistent manner across networks on a regular basis.

3. The Research Branch should assess the current proposal approval process and identify lessons learned or improvements that can be applied to any future similar programming to streamline the process.

Annex A

Listing of Documents Reviewed

1. Treasury Board Submission – Action Plan for the Agriculture Sector: Part II – Investment in Competitiveness. June 14, 2006

2. Memorandum to Cabinet – Action Plan for the Agricultural Sector: Part II. June 14, 2006

3. Terms and Conditions for Class Contributions Under the Agricultural BioProducts Innovation Program. Approved December 14, 2006 and Revised March 15, 2007.

4. Integrated results-based Management and Accountability Framework and Risk-based Audit Framework for the Agricultural Bioproducts Innovation Program. September 2007.

Annex B

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Annex C

Interview Guide for Internal ABIP Personnel

This interview will assist Agriculture and Agri-Food Canada's (AAFC) Office of Audit and Evaluation (OAE) in carrying out a program evaluation of the Agricultural Bioproducts Innovation Program (ABIP). The evaluation will be assessing the continued relevance of ABIP to current government and AAFC policy objectives related to the agricultural and agri-products sector. It will also assess the performance of the program to date in achieving short-term, intermediate and long-term program objectives.

The interview should last for approximately one hour.

Confidential data and other information you provide will not be attributed to you or your organization in the report and will be reported at an aggregated level only. Also, please feel free to say so if you have insufficient information to answer some questions.

AAFC very much appreciates your participation and thanks you in advance.

1. Please start by telling me a little about your role with respect to ABIP. How long have you been associated with the Program and what are your responsibilities?

Relevance (R2) - Are ABIP's objectives clearly aligned with federal government priorities and departmental strategic outcomes?

(Please refer to the Table in Annex A to respond to Questions 2 to 6)

2. What was the rationale for establishing ABIP?

3. How does ABIP support federal/AAFC priorities for the agricultural sector and for innovation?

4. Are the ABIP eligibility and selection criteria clearly aligned and supportive of program objectives and intended outcomes?

5. How does ABIP complement/ duplicate other AAFC innovation programming?

Performance (P1) - Is the program rationale clear and are outcomes clearly articulated and plausibly linked to the program's activities and outputs as defined in the PMS??

6. What are the expected outcomes of ABIP and what are the linkages between these outcomes and program activities and outputs? Are these clear to all stakeholders?

Performance (P3) - To what extent has ABIP achieved its expected outcomes as stated in program foundational documents?

7. Are all of the networks functioning effectively, as measured by such things as having developed a coherent strategy, established research priorities and projects; make decisions in a timely fashion; work collaboratively?

8. How likely is it that ABIP networks will sustain themselves into the future? Will government financial support be required on an ongoing basis?

9. What are the strengths and weaknesses of ABIP? What factors, if any, have affected ABIP's performance and what have been their effects? Are there ways in which they could be improved?

Performance (P2) - To what extent has ABIP demonstrated efficiency and economy in its implementation?

10. How do the program delivery costs of ABIP compare with other AAFC/federal innovation programs? Do you have specific data to support this?

11. In your role as part of the ABIP Secretariat, what have been the main challenges that you have faced?

Relevance (R1) - Is there still a need for ABIP to support research networks related to the agricultural bio-products industry?

12. What can we learn from other countries in terms of the development and approaches of networks and the results that they have achieved? Are there other activities by government besides research networks that are needed to move knowledge from the research laboratory to commercialization/adoption? What are these?

Annex D

Interview Guide for Internal AAFC Personnel (ABIP Program Director and Managers of Innovation, Science Partnerships and Intellectual Property)

This interview will assist Agriculture and Agri-Food Canada's (AAFC) Office of Audit and Evaluation (OAE) in carrying out a program evaluation of the Agricultural Bioproducts Innovation Program (ABIP). The evaluation will be assessing the continued relevance of ABIP to current government and AAFC policy objectives related to the agricultural and agri-products sector. It will also assess the performance of the program to date in achieving short-term, intermediate and long-term program objectives.

The interview should last for approximately 1.5 hours.

Confidential data and other information you provide will not be attributed to you or your organization in the report and will be reported at an aggregated level only. Provision of the information requested in the interview is voluntary and you may, without prejudice, decline to respond.

AAFC very much appreciates your participation and thanks you in advance.

Relevance (R1) - Is there still a need for ABIP to support research networks related to the agricultural bio-products industry?

1. What was the rationale for establishing ABIP?

2. What are the key barriers that prevent or slow down the transfer of new knowledge from the research lab to commercialization/adoption by the bioproducts industry? How are research networks relevant to addressing these barriers?

3. Were there any research networks in the bioproducts sector prior to ABIP? If yes, who started these? What elements of the sector were involved? Where did they obtain funding? Did they have any tangible results?

4. What factors influence the development and maintenance of research networks (generally, not just the ABIP networks) related to the agricultural bioproducts industry?

5. What type of funding sources are available to agriculture bioproduct networks besides the ABIP funding?

6. Were there worthwhile network proposals that were not funded due to lack of program resources? Have any of these been established anyway? How are they funded?

7. What can we learn from other countries in terms of the development and approaches of networks and the results that they have achieved? Are there other activities by government besides research networks that are needed to move knowledge from the research laboratory to commercialization/adoption? What are these?

Relevance (R2) - Are ABIP's objectives clearly aligned with federal government priorities and departmental strategic outcomes?

(Please refer to the Table in Annex A to respond to Questions 8 to 11)

8. How does ABIP support federal/AAFC priorities for the agricultural sector and for innovation?

9. What are the expected outcomes of ABIP and what are the linkages between these outcomes and program activities and outputs? Are these clear to all stakeholders?

10. Are the ABIP eligibility and selection criteria clearly aligned and supportive of program objectives and intended outcomes?

11. How does ABIP complement/ duplicate other AAFC innovation programming?

Performance (P3) - To what extent has ABIP achieved its expected outcomes as stated in program foundational documents?

12. Can you comment on the success of ABIP in terms of the actual increase in the number of individuals, institutions and corporate partners involved in research networks? Do all of the research networks have the right members? If not, who is not represented that should be? In which networks?

13. Are all of the networks functioning effectively, as measured by such things as having developed a coherent strategy, established research priorities and projects; make decisions in a timely fashion; work collaboratively?

14. How effectively have the networks levered funding from other levels of government? From industry?

15. What is the impact (qualitative assessment) of the ABIP networks on the commodity/industry sub-sectors (e.g. Increased demand/reduced production costs/improved product quality/ safety)?

16. How likely is it that ABIP networks will sustain themselves into the future? Will government financial support be required on an ongoing basis?

17. What are the strengths and weaknesses of ABIP? What factors, if any, have affected ABIP's performance and what have been their effects? Are there ways in which they could be improved?

18. In your opinion, how does the state of Canadian innovation in agricultural bioproducts compare with three years ago?

Annex E

Interview Guide for ABIP Secretariat (Program Director)

This interview will assist Agriculture and Agri-Food Canada's (AAFC) Office of Audit and Evaluation (OAE) in carrying out a program evaluation of the Agricultural Bioproducts Innovation Program (ABIP). The evaluation will be assessing the continued relevance of ABIP to current government and AAFC policy objectives related to the agricultural and agri-products sector. It will also assess the performance of the program to date in achieving short-term, intermediate and long-term program objectives.

The interview should last for approximately one hour.

Confidential data and other information you provide will not be attributed to you or your organization in the report and will be reported at an aggregated level only. Provision of the information requested in the interview is voluntary and you may, without prejudice, decline to respond.

AAFC very much appreciates your participation and thanks you in advance.

Relevance (R1) - Is there still a need for ABIP to support research networks related to the agricultural bio-products industry?

1. What was the rationale for establishing ABIP?

2. What are the key barriers that prevent or slow down the transfer of new knowledge from the research lab to commercialization/adoption by the bioproducts industry? How are research networks relevant to addressing these barriers?

3. Were there any research networks in the bioproducts sector prior to ABIP? If yes, who started these? What elements of the sector were involved? Where did they obtain funding? Did they have any tangible results?

4. What factors influence the development and maintenance of research networks (generally, not just the ABIP networks) related to the agricultural bioproducts industry?

5. What type of funding sources are available to agriculture bioproduct networks besides the ABIP funding?

6. Were there worthwhile network proposals that were not funded due to lack of program resources? Have any of these been established anyway? How are they funded?

7. What can we learn from other countries in terms of the development and approaches of networks and the results that they have achieved? Are there other activities by government besides research networks that are needed to move knowledge from the research laboratory to commercialization/adoption? What are these?

Relevance (R2) - Are ABIP's objectives clearly aligned with federal government priorities and departmental strategic outcomes?

(Please refer to the Table in Annex A to respond to Questions 8 to 11)

8. How does ABIP support federal/AAFC priorities for the agricultural sector and for innovation?

9. What are the expected outcomes of ABIP and what are the linkages between these outcomes and program activities and outputs? Are these clear to all stakeholders?

10. Are the ABIP eligibility and selection criteria clearly aligned and supportive of program objectives and intended outcomes?

11. How does ABIP complement/ duplicate other AAFC innovation programming?

Performance (P3) - To what extent has ABIP achieved its expected outcomes as stated in program foundational documents?

12. Can you comment on the success of ABIP in terms of the actual increase in the number of individuals, institutions and corporate partners involved in research networks? Do all of the research networks have the right members? If not, who is not represented that should be? In which networks?

13. Are all of the networks functioning effectively, as measured by such things as having developed a coherent strategy, established research priorities and projects; make decisions in a timely fashion; work collaboratively?

14. How effectively have the networks levered funding from other levels of government? From industry?

15. How many patents and other forms of intellectual property protection have been generated by ABIP network activities? How do these numbers compare with expectations outlined in the foundation documents?

16. How many license agreements have been generated by ABIP network activities? Is this meeting expectations outlined in the foundation documents?

17. What is the expected value of direct/indirect economic impacts of developed products?

18. What is the impact (qualitative assessment) of the ABIP networks on the commodity/industry sub-sectors (e.g. Increased demand/reduced production costs/improved product quality/ safety)?

19. How likely is it that ABIP networks will sustain themselves into the future? Will government financial support be required on an ongoing basis?

20. What are the strengths and weaknesses of ABIP? What factors, if any, have affected ABIP's performance and what have been their effects? Are there ways in which they could be improved?

21. In your opinion, how does the state of Canadian innovation in agricultural bioproducts compare with three years ago?

Economic Analysis

22. Can you estimate the total expected commercial value of ABIP network's research findings?

23. What is the expected value to primary producers?

24. What is the expected value of direct/indirect economic impacts of developed products, services, and processes?

Performance (P2) - To what extent has ABIP demonstrated efficiency and economy in its implementation?

25. How do the program delivery costs of ABIP compare with other AAFC/federal innovation programs? Do you have specific data to support this?

Annex F

The Nine Networks Funded Under ABIP

- **Industrial Oil Seed Network (IOSN)**
- **Network Lead:** Linnaeus Plant Sciences Inc.
  - Will be developing new oil seeds with the express goal of substituting for petroleum in a variety of applications.
  - Expected results: formulated Canola based hydraulic fluid, home-based bio-lubricant kits, technology to modulate fatty acid methyl esters in mixed solution.

- **The Cellulosic Biofuel Network**
- **Network Lead**: Agriculture & Agri-Food Canada – Research Branch
  - Will be eliminating the wide range of technological and economic constraints that challenge the emergence of a cellulosic bio-ethanol industry from agricultural biomass.
  - Expected results: enhancement cellulosic biomass potential through new physical, chemical and enzymatic technologies for deconstruction of plant cell walls, reduction of enzymatic deconstruction cost by selecting or engineering plants with increased ability for cell wall deconstruction, select or engineer new generation fermentation yeast.

- **Canadian Triticale Biorefinery Initiative (CTBI)**
- **Network Lead:** Agriculture & Agri-Food Canada – Research Branch
- Will develop all aspects of triticale for use as an industrial crop and biorefinery feedstock-vision is to develop triticale as the most important major new crop in Western Canada and a highly renewable source of feedstocks and biomaterials for the Canadian manufacturing industry.
  - Expected results: Triticale is a platform upon which a comprehensive range of biorefining technologies can be built and used as source of fibre, starch, cellulose and other components for developing chemicals, fuels and biomaterials such as natural fibre reinforced composites, and thermoplastic starch based polymers and composites. The target applications for these materials are automotive and aerospace components, building materials, and moulded goods.

- **Agricultural Biorefinery Innovation Network for Green Energy, Fuels and Chemicals**
- **Network Lead:** University of Western Ontario
  - Will develop new technologies to collect, prepare and enhance feedstocks from agricultural raw feed to optimize biomass conversion processes and develop new technologies for cleaning, upgrading, converting separating

and purifying carbon-rich chains, sugars, biogas, biocrude, and syngas developed through biological or thermo-chemical processes ranging from fermentation to gasification.
  - Expected results: Bio-oil fuels and green chemicals including specialty target chemicals, pesticides and insecticides, anti-bacterial and anti-fungal agents, and waxes. Development and assessment of new processing and analyses technologies, yield and product quality, physical characteristics and chemical extraction techniques.

- **Development of Commercial Feed Products from the Wheat Ethanol Process (Feed Opportunities from the Biofuels Industries) (FOBI)**
- **Network Lead:** University of Saskatchewan, Feed Innovation Institute
  - Will work with the wheat-based ethanol industry to maximize profit from the co-product stream.
  - Expected results: Integration of livestock production and wheat-based ethanol production, with a focus on creating novel co-products and new markets for existing co-products. Will extract higher value products, identify and develop ways of reducing the energy consumed, improve the quality of the livestock feed produced, make cellulose in the grain available for ethanol fermentation, and produce energy products (syngas, ethanol) from materials such as distillers' grains, straw and manure co-products from the DDGS/Livestock interface

- **Pulse Research Network (PURENET)**
- **Network Lead:** Pulse Canada
  - Will develop and expand the use of pulses based on their unique and inherent attributes by conducting research in three areas – Bioproduct Development, Sustainable Production of Crops and Feed Development.
  - Expected results: incorporation of pulse-based diets into healthy living guidelines to manage important health conditions faced by many Canadians, improvement of the science of pulse crop breeding through the enhancement of plant varieties by adding nutrients to existing crop varieties and the possible use of pulses in the development of nitrogen forms that can be used in crop planting.

- **The BioPotato Network**
- **Network Lead:** Agriculture & Agri-Food Canada – Research Branch
  - Will develop new potato varieties with high levels of beneficial bioactive compounds.
  - Expected results: Potato varieties for use in the production of value-added functional food, nutraceutical and pharmaceutical products with potential therapeutic benefits in regards to a number of health conditions affecting Canadians including stroke, diabetes, heart disease, obesity-related diseases and many others. New potato germplasm high in slowly

digestible or resistant starches and fibre content which will also benefit human health due to their low glycemic index. Starch-based polymers and blends for bioplastic applications. Novel, environmentally compatible pest-control agents to replace pesticides that have been withdrawn are being developed.

- **The Natural Fibres for the Green Economy Network (NAFGEN)**
  - Will create additional profitable natural fibre-based industrial value chains and position Canada to capitalize on a rapidly expanding sector.

Expected results: Development of a Canadian natural fibres value chain, from feedstock production through to the development and delivery of bioproducts (materials, chemicals, and energy) to market. End market products include the development of Natural fibre-based mats as a replacement for glass fibre re-enforcement in several applications (construction for example) in the emerging green economy.

- **Sustainable Cropping System Platforms for Biodiseal Feedstock Quantity and Quality**
  - Will assist Canola growers to grow more canola more often in response to increased canola production demands.

Expected results: Techniques to improve use of “nontraditional” lands for crop growth, and new crop rotation methods to increase overall production, and exploration of the potential oil and biodiesel quantity and quality of high yielding hybrids and new herbicide-resistant cultivars, and underutilized oilseed species.

Annex G
Innovations from the Agricultural Bioproducts Innovation Program

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Innovations from the Agricultural Bioproducts Innovation Program

The multi-year Agricultural Bioproducts Innovation Program (ABIP) creates networks of talent, creativity and resources from academia, industry and governments to build greater research capacity in agricultural bioproducts and bioprocesses in Canada.

The program promotes research, development, technology transfer and commercialization in areas such as biofuels, other forms of bioenergy, industrial chemicals, biomaterials, and health products. This work will help bring new products and processes to the marketplace, and open the door to greater opportunities for Canadian producers.

ABIP's nine networks, listed below, currently involve 36 universities, 52 industry groups, and 19 government organizations.

- Industrial Oil Seed Network (IOSN)
- Cellulosic Biofuel Network (CBioN)
- Canadian Triticale Biorefinery Initiative (CTBI)
- Sustainable Cropping System Platforms for Biodiesel Feedstock Quantity and Quality (SBQQ)
- Agricultural Biorefinery Innovation Network for Green Energy, Fuels and Chemicals (ABIN)
- Feed Opportunities from the Biofuels Industries (FOBI)
- Natural Fibres for the Green Economy Network (NAFGEN)
- Pulse Research Network (PURENet)
- BioPotato Network

Each ABIP network exemplifies AAFC's commitment to encourage and facilitate collaboration and partnerships across sectors and disciplines to progress from basic research to application. Many of the networks are groundbreaking in the extent of the collaboration they achieve, harnessing strengths from diverse partners to work toward a common goal. Here are some examples of the progress being made by the network partners.

Canada

Research Paints a Colourful Future for Potato Products

The BioPotato Network combines the expertise of plant breeders, food scientists, molecular biologists, and plant production specialists to commercialize potato extracts, develop healthier potato varieties, and discover new uses for potatoes. One of the four areas of focus for the network is the development of potato functional foods and nutraceuticals. This research involves the investigation of potato bioactives and their health interactions at the University of Prince Edward Island, the National Research Council's Institute of Nutrisciences and Health in Charlottetown, Dalhousie University in Halifax and AAFC's Potato Research Centre in Fredericton.

In one research project, scientists at the Food Technology Centre adapted the potato granulation process used to make dehydrated instant mashed potatoes to include anthocyanin-rich colourful potatoes bred at AAFC's Potato Research Centre.

Anthocyanins, the natural colourants found in fruits and vegetables, have recently been studied for their nutritional aspects and anti-oxidant activities. The research chefs at Holland College, Canada's Smartest Kitchen, are using the anthocyanin-rich potato granules to develop new functional food product concepts for commercialization such as colourful mashed potatoes.

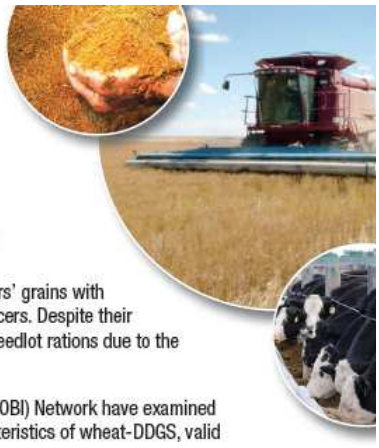
Triticale Poised to Become Canada's Bio-Industrial Cereal

Triticale may never displace wheat as Canada's number one cereal but research through the Canadian Triticale Biorefinery Initiative (CTBI) is bringing the crop closer to being recognized as Canada's bio-industrial cereal.

Triticale, a hybrid of wheat and rye, is a source of carbohydrates including starch, cellulose and hemicellulose that can be used to produce chemicals and fuels derived from simple sugar chemistry, and a competitive source of fibre and raw biomass. The development of new specialty lines of triticale and advanced processing technologies will enable triticale to become a valuable renewable resource for chemicals, fuels and biomaterials such as natural fibre reinforced composites, and thermoplastic starch based polymers and composites.

To track the genetic purity of new lines, scientists at AAFC's Lethbridge Research Centre in Alberta have introduced a blue-coloured seed which will be incorporated into future bio-industrial varieties of triticale. The blue seed colour will be used as a marker by scientists at the University of Alberta to indicate gene transfer to help determine if genes from triticale are transferred to wheat or other triticale crops via pollen. This research will help ensure that new triticale varieties can be grown without adverse effects on existing markets.

Initial results suggest that triticale has a low frequency of crossing with common and durum wheat. Best management practices, however, such as careful seed handling and certified seed production should maintain variety purity while the blue triticale seed for bioproducts will help ensure that mixing of seed is minimized. As genes to improve the bio-industrial properties of triticale are introduced, the blue seed and completion of biosafety work will provide CTBI with the necessary information to deliver new varieties to producers as quickly as possible.



Wheat Distillers' Grains May Benefit Bottom Line for Livestock Producers

With the recent expansion of the wheat-ethanol industry in western Canada, wheat dried distillers' grains with solubles (wheat-DDGS) have become a readily available, low-cost ingredient for livestock producers. Despite their availability, wheat-DDGS are currently used infrequently and at relatively low inclusion rates in feedlot rations due to the limited information on nutrient/feed quality, composition and impact on animal performance.

To address these concerns, researchers with the Feeds Opportunities from Biofuels Industries (FOBI) Network have examined various nutritional aspects and produced a comprehensive set of information on nutrient characteristics of wheat-DDGS, valid for a wide array of livestock operations including beef, dairy, swine, poultry and fish.

The results from animal trials have shown that wheat-DDGS can be used as sources of both energy and protein depending on the type of livestock and, at a significantly higher inclusion rates than previously recommended. For instance, wheat-DDGS can replace 50 per cent of the barley normally used in diets given to back-grounding cattle, while in feedlot animals it can be included as high as 40 per cent of the diet without affecting health, meat quality or performance. Similarly, wheat DDGS can be successfully included in the diets of grower-finisher pigs by up to 25 per cent and 10 per cent in broiler chicken diets.

Inclusion of DDGS means a significant cost savings to livestock farmers while creating a ready market for the wheat-DDGS, a win-win situation leading to a synergetic integration of the wheat-ethanol and livestock industries.

NAFGEN Member Expands both Capacity and Capability

The key focus of the Natural Fibres for the Green Economy Network (NAFGEN) is on developing the full potential of currently underutilized natural fibre crops, such as flax and hemp, and facilitating their entrance into new and expanding fibre markets. This research examines feedstock production, crop management (with emphasis on straw harvesting techniques) and product development.

Schweitzer-Mauduit Canada (SMC), a key member of NAFGEN, processes approximately 100,000 tons of flax straw annually from Manitoba, Saskatchewan and North Dakota to create bast fibre for paper and flax shives for horse bedding, soil erosion control and biofuels. The flax fibre can also be substituted for fibreglass and other petroleum based products to produce superior products and help manufacturers lower their carbon footprint.

Schweitzer-Mauduit has been working closely with other NAFGEN scientists at the Composites Innovation Centre in Winnipeg, Manitoba, Tekle Technical Services in Edmonton, Alberta and AAFC in Morden, Manitoba, to assess fibre quality and its suitability for processing and have produced test scale batches for marketplace assessment. This research has helped generate the technical knowledge and the business case to proceed with a $1,120,000 expansion of SMC's plants in Carman and Winkler, Manitoba.

With the new equipment, SMC will develop and produce a line of renewable and sustainable biomaterials to serve the growing bio-economy throughout North America. Completion of the expansion will allow the company to access new markets, which in turn will provide additional revenue, value chain businesses and jobs on the prairies.

Funding for the expansion came from the Canada/Manitoba Growing Forward initiative, Manitoba's Entrepreneurship, Training and Trade's Technology Commercialization Program, matching funds from SMC and the National Research Council.

'Eco-pactor' Helps Make Toronto Green

Canada's largest landlord has begun using technologically "smart" Eco-pactors containing specially formulated, environmentally-friendly bio-oil as a substitute for petroleum-based hydraulic fluid in trash compactors across Metro Toronto.

The Eco-pactor pilot project was initiated by Linnaeus Plant Sciences Inc., the network lead of the Industrial Oilseed Network (IOSN), in partnership with the Toronto Community Housing Corp. and equipment-maker Metro Compactor Service Inc. Linnaeus has been working with the housing corporation and the compactor-maker to begin roll out of this next generation of garbage compactors.

The Toronto Community Housing Corp., with almost 60,000 units and 160,000 tenants, predicts it could save between $1-million and $2-million a year in waste removal costs by using this next-generation of compactors that feature renewable plant-based fluids and electronic sensors to reduce garbage truck fuel consumption.

The old petroleum-based hydraulic fluid in the garbage compactors has been replaced with a high-performing bio-based lubricant formulated from canola oil grown on farms in western Canada. This new oilseed-based fluid is totally renewable, bio-degradable, and is far less toxic than traditional petroleum-based oil. It reduces greenhouse gas emissions while offering better lubricating qualities and higher viscosity than traditional petroleum-based oil.

Linnaeus Plant Sciences Inc. expects to see wider public use of its innovative, homegrown, 100 per cent renewable bio-friendly vegetable oils – products that can be used as a petro-chemical substitute – to make industrial and household lubricants, motor oils, plastics, nylon and greases. With interest from major end-users such as the Toronto Community Housing Corp., Linnaeus hopes to leverage its flexibility and take this to the next step, making a variety of bio-based oils that will benefit consumers, farmers, and all Canadians while helping protect the environment for future generations.

Agri-Therm Inc. Posts Gains in Technology Transfer and Commercialization

New legislation in Europe and the United States now requires that a sizeable and increasing percentage of domestic energy be derived from renewable sources, yet neither market has the resources or technology to meet this demand. With funding from the Agricultural Biorefinery Innovation Network (ABIN), a Canadian company has created a mobile unit that turns waste from agriculture, forestry and food processing into renewable fuel products.

Agri-Therm Inc., a spin-off company from the University of Western Ontario, has developed the first mobile pyrolysis process to rapidly convert low value bio-residue into higher-value bio-oil and bio-char and decrease the costs of transporting the raw material to conventional fixed pyrolysis plants. For example, the mobile unit can be brought directly to a logging operation where it converts low value wood chips into higher value, low volume bio-oil and bio-char with a much greater energy density than the original feedstock. Pyrolysis breaks down organic matter by using high heat in the absence of oxygen.

The Agri-Therm technology is being tested with a variety of feedstocks including agricultural residues (such as tomato and grape residues from juicing) and co-products of other energy industries (dry distiller's grains and sugar cane residues). The versatile unit has a capacity of 10 tons of dry feedstock per day, and also produces a co-product gas which is recycled as an energy source back into the process. The operating conditions of the unit can also be adjusted, depending on the feedstock, to maximize either the bio-oil or the bio-char products to achieve liquid bio-oil yields of up to 70 per cent of the original feedstock mass.

Agri-Therm is presently designing and manufacturing the second generation mobile pyrolysis pre-commercial demonstration unit and is collaborating with ABIN researchers on bio-oil upgrading, utilization and technology transfer. This allows Agri-Therm to anticipate technological advances and future market needs and improve their mobile technology as they develop new generations of the unit. Agri-Therm will soon launch a pilot study to test their unit in the field and transfer the technology to a commercial industrial scale.

Research Spurs Biofuel Production from Agricultural Cellulosic Biomass

The most abundant biomass feedstock available for renewable bio-energy production is fibre readily found in agricultural food-crop residues such as stalks, straws and chaff, and forestry residues including wood chips and unusable damaged trees, renewable land cover like grasses and trees, plant-based garbage, and waste paper products.

The starch in wheat and corn grains is currently used as a source of fermentable sugar to make bio-ethanol in Canada. But starch is an energy-producing food product, and as a biomass feedstock, it can produce only a small fraction of the ethanol needed on a national and global scale. Cellulosic biofuels are primarily derived from the cellulose, which comes from the fibre in stalks and straws, leaving grains for human and animal consumption. The huge amount of potential energy available from plant fibre is attracting attention and investment worldwide.

In Canada, the Cellulosic Biofuels Network is helping overcome current technological and economic barriers that limit the formation of a Canadian fibre-based biofuel by investigating sustainable low-cost agricultural biomass production and working to decrease reliance on expensive physical and chemical pre-treatments. Researchers are also studying and modifying plant cell-wall composition and developing better enzymatic and fermentation tools to transform fibre efficiently into the fermentable sugars needed to produce bio-ethanol.

The breadth of the Canadian land mass with its vast agricultural and forestry base offers a tremendous advantage for the production of biomass and biofuels. The creation of a cellulosic bio-ethanol industry will also help sustain two viable domains by providing a new source of revenue for farmers, while maintaining food production capacity.

Pulse-based Diets Show Potential Health Benefits

Over the past 20 years, Canada's production of eight major pulses and specialty crops -- pea, lentil, bean, chickpea, mustard, sunflower, canary seed, and buckwheat -- has increased fivefold from 1 million to 5.6 million tonnes per year (http://www.pulsecanada.com/pulse-industry). Canadian pulse exports generated $2.2 billion and accounted for about 35 per cent of the global pulse trade in 2009. Globally, pulse consumption has continued to decline on a per capita basis but this is being offset by an ever-growing population.

With an eye toward protecting a valuable Canadian industry, pulse producers and processors are focused on firmly establishing the health and wellness benefits of pulses, creating high-value novel foods and ingredients for a larger number of food formulations, and nutraceuticals, and proving the environmental benefits of growing pulse crops. Research through the Pulse Research Network (PURENET) is significantly advancing scientists' understanding of how pulse-based diets of peas, lentils, beans, and chickpeas impact human health and has successfully developed new pulse-based food concepts and pilot products.

For example, scientists at the University of Saskatchewan are studying the effects of a pulse-based diet on cholesterol and blood glucose levels in people 50-years and older, a demographic at increased risk of diabetes and heart disease. Eighty people participated in the study and consumed a pulse-based diet twice per day for two months. A comparison of blood chemistry before and after the study period showed that the participants' fasting glucose and cholesterol levels were significantly reduced.


The Sustainable Cropping System Platforms for Biodiesel Feedstock Quantity and Quality (SBQQ) network has developed a strong field-based program for key crop species (e.g., canola, mustard, camelina, flax, soybean) and is working together to achieve their goal of ensuring an adequate supply of Canadian-grown, oil crop feedstock for use by the biodiesel industry in Canada and abroad to produce high-quality biodiesel. The network has made progress in determining how biodiesel quantity and quality are influenced by agronomic and environmental factors and is currently involved in extensive work in profiling oils, determining biodiesel sample adherence to biodiesel standards, and identifying compounds that influence biodiesel quality. They are also determining the pest management and sustainability implications of growing canola in rotations that do not have recommended levels of diversity.
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1-866-912-2247
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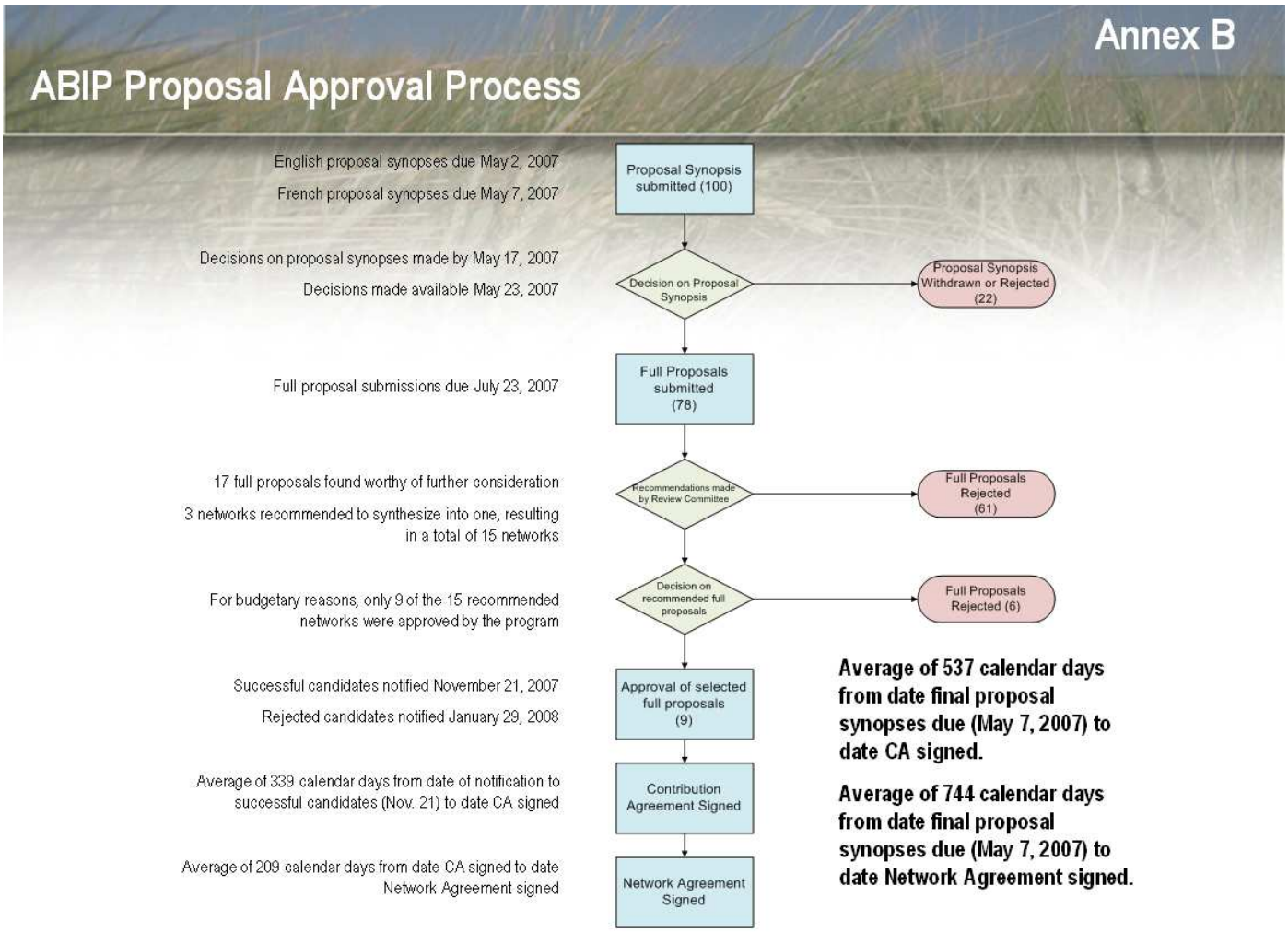
Aussi offert en français sous le titre : *Réalisations au titre du Programme d'innovation en matière de bioproduits agricoles (PIBA)*
AAFC Number 10713E
Catalogue Number A52-179/2010
ISBN 978-1-100-52322-4
SPCS (E. Cadieu)

Annex H

ABIP Proposal Approval Process Map



Annex I
ABIP Commercialization Plans*

YEAR	ABIP #	TECHNOLOGY TRANSFER CATEGORY	CONTRIBUTION	DESCRIPTION
2009	170	Technical Transfer	Pyrolysis of Lignin	Contractual Agreement with Lignol
2009	170	Technical Transfer	Physical Separation of Bio-Char from Ash and Gravel	Contractual Agreement with WoodAsh Industries
2009	170	Technical Transfer	Spin-off company: Agri-Therm Inc.	A spin-off company created in partnership with the university of Western Ontario and private investors has been nurtured and has led to the first commercialization of one of the technologies developed
2009	184	Technical Transfer		New collaboration to apply the patent-applied strain to large-scale production
2010	201	Technical Transfer		Development of wiki for technical information on low carbon, green building materials. Engineers can access latest research and comment on its application in practice.
	201	Technical Transfer	Eastside	The research results of the project 4.5C provide the basis for the development of the "green" sustainable shelter (gazebo). CIC is, in cooperation with its partners, endeavouring to commercialize the product.
	201	Technical Transfer	Frank Fair Industries	The manufacturing of full size J-coach side wall has demonstrated to Frank Fair Industries that the resin infusion method is feasible in manufacturing the bus part and improving the productivity
	201	Technical Transfer	Motor Coach Industries	The development of biofibre bus parts has already attracted MCI's interests to put the "green" component on their bus. MCI, with support of CIC, is going to lauch a separate project to develop new "green" bus parts
2008-09	227	Technical Transfer	Technology Evaluation Agreement signed with two companies.	Cell penetrating peptide mediated transfection in crop microspore transfered for evaluation in other biological systems.
2009	227	Technical Transfer	Isolated microspore culture in cereals	Transfer of protocol to University of Hohenheim (Germany) and Sejet Plantbreeding (Denmark), and training offered to ICARDA employee - 1 month
2009	227	Technical Transfer	Meeting with industries on the use of lactic acid bacteria for production of alternative sweetners and other functional metabolites	Network meetings with industry representatives in June 2009, October 2009, November 2009, February 2009, and April 2009.
2009	227	Technical Transfer		Technology transfer for using starch in packaging applications. It might lead to a license with revenues for IMI
2009	212	Technical Transfer		Meeting to discuss potato granule production with two potato farmers growing high pigment potatoes and Dino Kubik of AAFC.
2009	212	Technical Transfer		Meeting with the Director from "Milk 20-20" group and Dino Kubik of AAFC in NB to discuss the possibility of potato anthocyanins as an ingredient in dairy products, and asked his group to support joining the BioPotato network in order to keep abreast of developments in that project
2009	184	Technical Transfer		Potential company to ask their customer to use our fuel pellets for grain outdoor furnace and multu fuel stoves
2009	170	Technical Transfer	Technology transferred	Lignin depolymerization design
2009-2011	167	Technical Transfer		Provided non-castor derived Hydroxy Fatty Acid for nylon production. Setting stage as potential feedstock source.

*Data provided by Research Branch. Drawn from ABIP network annual reports. Not validated by the Office of Audit and Evaluation.