Development of a Sustainable Flax Value Chain
- *Taking a Strategic Approach*

International Conference on Flax & Other Bast Plants
Saskatoon, Saskatchewan

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Natural Resources Canada

- Natural Resources Canada – Federal Department
- Sectors: Energy, Forestry, Minerals and Metals, Earth Sciences
- Sustainable Development is *integral* to our mandate
- 3 Strategic Outcomes:
  1) Natural resource sectors are internationally competitive, economically productive, and contribute to the social well-being of Canadians.
  2) Canada is a world leader on environmental responsibility in the development and use of natural resources.
  3) Natural-resource and landmass knowledge strengthens the safety and security of Canadians and contributes to the effective governance.

Outline

- Canadian Context for Sustainable Development

- How do we operationalize sustainable development (SD) ?

  - Case: Development of Sustainable Flax Value Chain (new R&D network)

  - Approach: Strategic Sustainable Development

Canada's Commitment

- Bruntland Commission (1987) : "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
  - Integration of 3 pillars: economic, environmental and social
  - Development-related decisions we make today that do not compromise opportunities for next generations
- International Commitments: Agenda 21, Millennium Development Goals, Johannesburg Plan of Implementation, etc.
- Bio-related: IEA Task Forces; Global Bioenergy Partnership (GBEP); etc.

Canada – An SD Snapshot

- Auditor General Act: 32 federal departments and agencies have SD strategies
- 2 provinces have SD legislation
- 1990s – Sustainable Forest Management
- Integral part of forestry (public lands) and agriculture
- Large corporations and utilities – triple bottom line reporting
- **Community development / growth planning**
- Substantial SD expertise
  - SD Activity Survey related to Bioeconomy Act (Feb 2008)

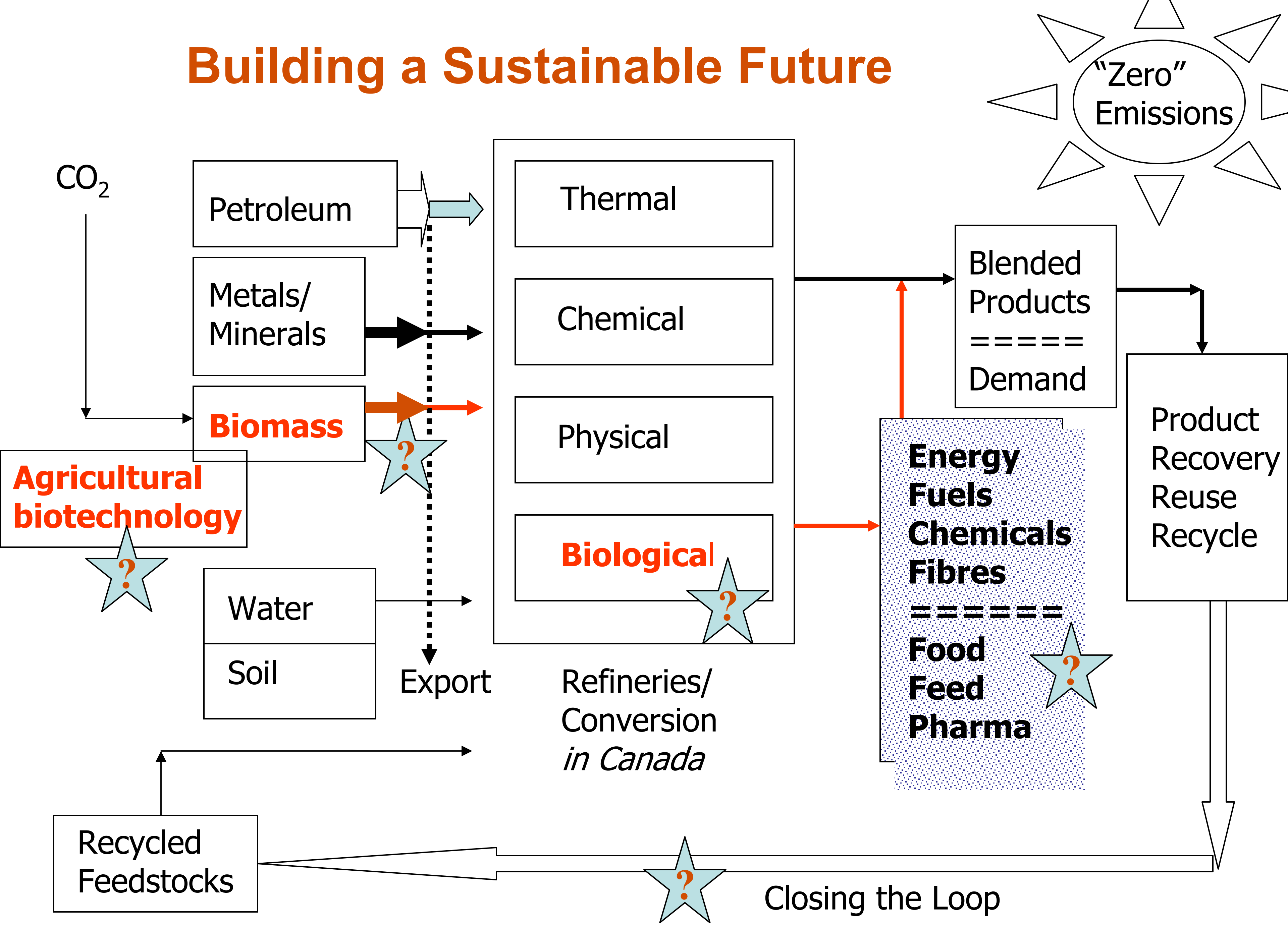
- *More to do … Integration of the 3 pillars, Funding*

Operationalization of SD is essential for bio, and challenging

- 'Food vs fuel' has made it even more necessary for the development of new bio-based industries

- Challenging because …
  - Moving beyond a concept or checklist
  - Multi-disciplinary, multi-party (many parameters, several dimensions)
  - Biorefineries / Value chains are complex systems
  - NA: no common definition outside SD circle
  - Very few dedicated resources
  - High expectations
  - Rapid pace of change "*moving too fast in the fog*?"

Building a Sustainable Future



Q: How to Operationalize SD ?

Bruntland Definition
High Level Strategies of Individual Gov't Departments

Science and Policies – Sustainable Bioeconomy

Specific Crops – Processes – New Bioproducts
(from research to commercial applications that are integrated into Canada's new economy)

Can We Better Incorporate Sustainability into Design ?

How can we incorporate sustainability at an early stage when we are …

- testing concepts

- have little SD data

Investment $

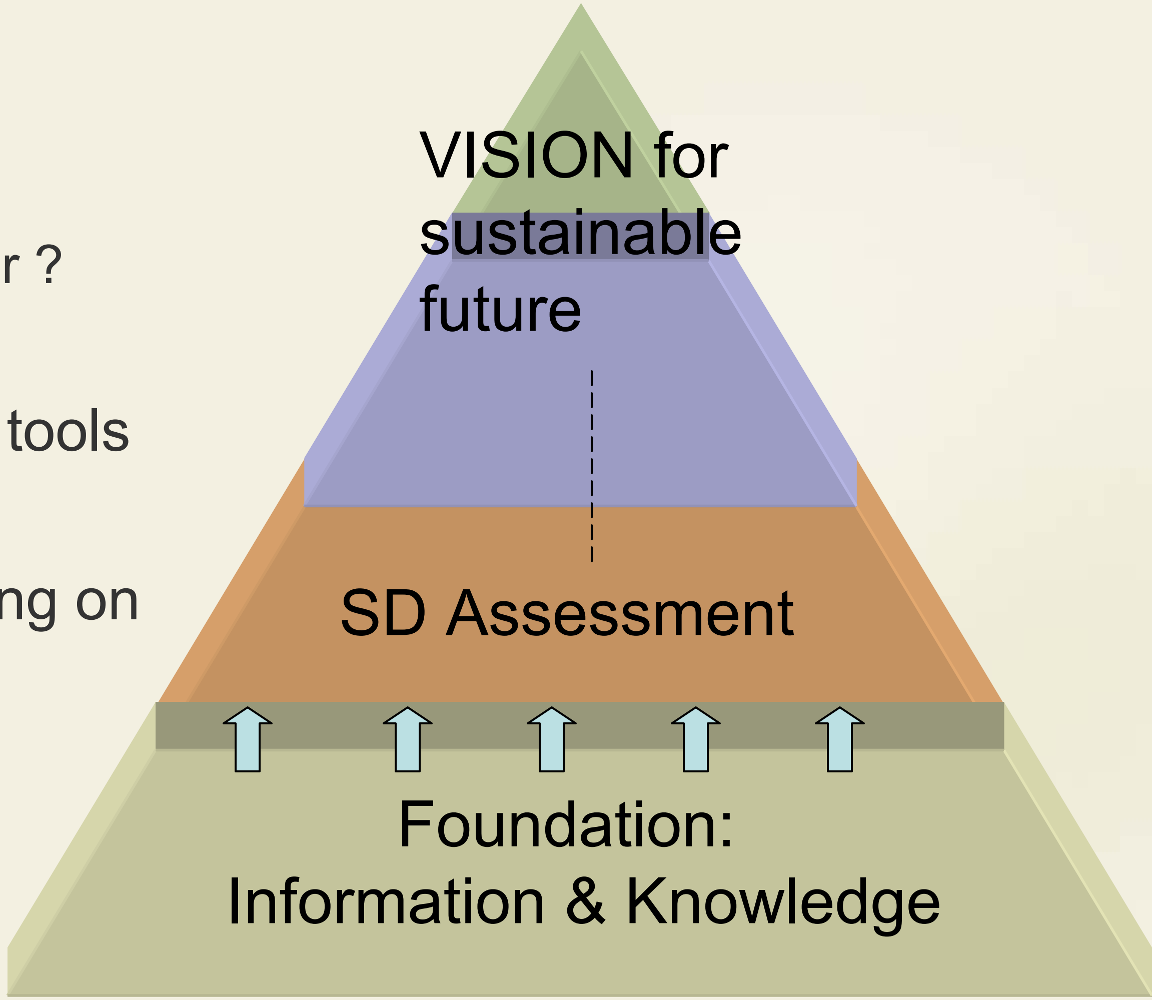
Sustainability Research

ABIP Opportunity !

Concept R&D Pilot Demonstration Commercial

Strategic Sustainable Development

- Strategic Approach
  - what are we aiming for ?
- Combines different SD tools
- Tools will vary depending on where you are on the innovation spectrum



AAFC's new ABIP R&D program

- Agricultural Bioproducts Innovation Program ($ 145M/3 yrs)
- Designed to support new & existing research networks and the development of clusters for the advancement of a sustainable and profitable Canadian bioeconomy.
- Develop new economic opportunities for agriculture in the areas of bioproducts and bioprocesses such as biofuels, other forms of bioenergy, biochemicals, biopharmaceuticals, etc.
- ~ 15 R&D networks have been selected
- **Sustainable Development :**
  1) Implementation is Part of NAFGEN (Natural Fibres for Green Economy) R&D Network
  2) Showcase "operationalization of SD" at annual meeting of R&D networks

Oilseed flax straw - conversion into New, Higher Value Products

600,000 hectares
(Saskatchewan, Manitoba and Alberta)

850,000 t seed

1.4 t/ha

Breeding

High quality fibres

Chemicals

Biocomposites

Industrial Hemp in Canada

- Most important non-food crop in Colonial era … production stopped in 1958
- Re-emerging as an industrial crop – less than 0.3% THC
  - Industrial Hemp Regulations (1998)
- Varying acreage: 2,000 – 20,000 ha/yr grown mostly in Manitoba, Saskatchewan and Alberta (3 Prairie Provinces); strong interest in at least 3 other provinces
- One third of hemp crop is certified organic
- Commercial plant for bast fibres expected to start up in 2009 in Saskatchewan
- National Industrial Hemp Strategy just released
  - Identified opportunities/challenges for 1) health and food; 2) fibre and industrial oil; 3) breeding and production

NAFGEN Network (New Flax and Hemp Value Chains)

National Biofibre Advisory Board

NAFGEN Steering Committee
Lead: Flax 2015

- Flax 2015
- AAFC
- NRC
- Prov of AB
- Saskflax
- U of Toronto

7 Research Platforms :

- Agriculture Feedstock Flax Hemp
- Bioresource Engineering
- Straw Processing & Fibre Properties
- Materials & Manufacturing
- Primary Fractiona-tion & Processing
- Further Processing & Bioconversion

Bast Biorefineries – Sustainable Systems Design

Platform 7 Projects

2008	2009	2010	2011

Biorefinery Design for dual purpose crops:
(1) Oilseed Flax; and (2) Industrial Hemp
* With Univ of Waterloo

Sustainability Vision
* With Stakeholders

Implementation / Follow Up

Pick Tools

Sustainability Issues Identification & Assessment
* With 6 Research Platforms

Biorefinery Modelling

Agriculture Feedstock Flax Hemp

Bioresource Engineering

Seed Processing

Oil
Meal

Straw Processing & Fibre Properties

Recycled Materials

Materials & Manufacturing

End Products ?

Primary Fractiona- tion & Processing

Further Processing & Bioconversion

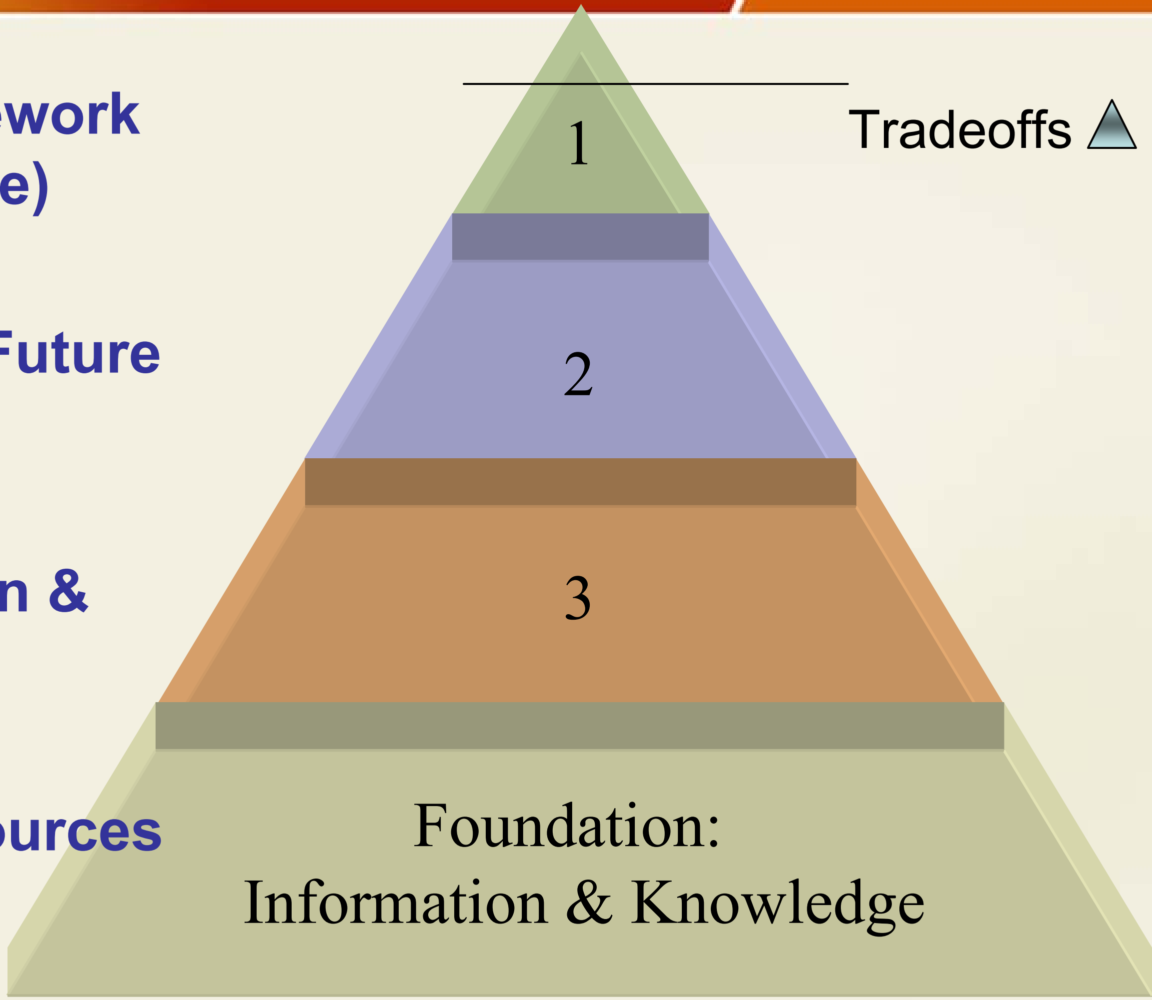
Intermediate Products ?

Residue to Energy (for process use or by-product)

Moving from discontinuous, individual technologies to continuous system

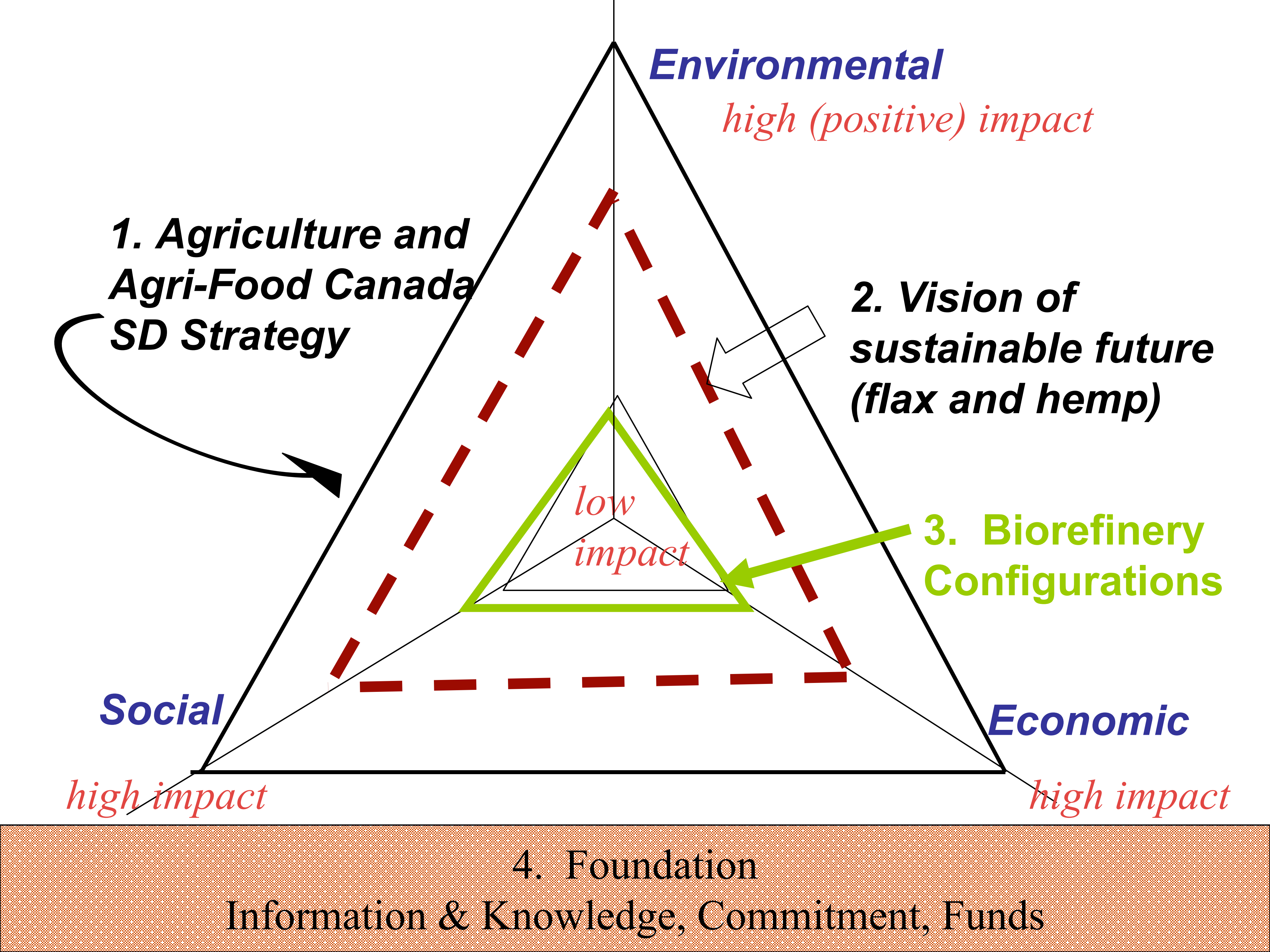
4 Key Elements

1. Overarching SD Framework (sustainable agriculture)
2. Vision of Sustainable Future (for flax and hemp)
3. SD Issues Identification & Assessment
4. Commitment and Resources for Implementation



1. Overarching Framework

- Defines "sustainable agriculture"
- Provides the high level perspective, looks at the agricultural system as a whole
- Explains how different economic, environmental, social activities relate to one another
  - Regional economic model (CRAM)
  - Biophysical models (carbon sinks, water, environmental indicators, etc.)
- Facilitates communication of the SD story and makes SD tangible
- *More to do … Integration of the 3 pillars … next Agricultural Policy Framework (2008)*


Environmental
high (positive) impact
1. Agriculture and Agri-Food Canada SD Strategy
2. Vision of sustainable future (flax and hemp)
low impact
3. Biorefinery Configurations
Social
Economic
high impact
high impact
4. Foundation
Information & Knowledge, Commitment, Funds

2. Vision/High Level Planning – Canada's Flax Industries

"Sustainability Planning"

What does a sustainable future for Canada's flax industry look like ?

- Develop a shared vision for sustainability – together with stakeholders - based on agreed-upon sustainability principles

"If we don't know where we are going, all roads will lead us there."

TODAY

Sustainability Planning

- Define stakeholders & context (including predominant economic, environmental and social issues)
- Builds on Vision Work: Flax 2015; Biofibres Foresighting; National Hemp Strategy
- Develop a shared vision of sustainable flax value chain

Who ?

- NAFGEN Steering Committee + Research Platform Leads
- Growers & Communities: Québec, Saskatchewan
- Key Stakeholders

Tools:

- Foresighting
- Scenario building
- The Natural Step Framework (e-learning; facilitated process)

Tool: The Natural Step Framework

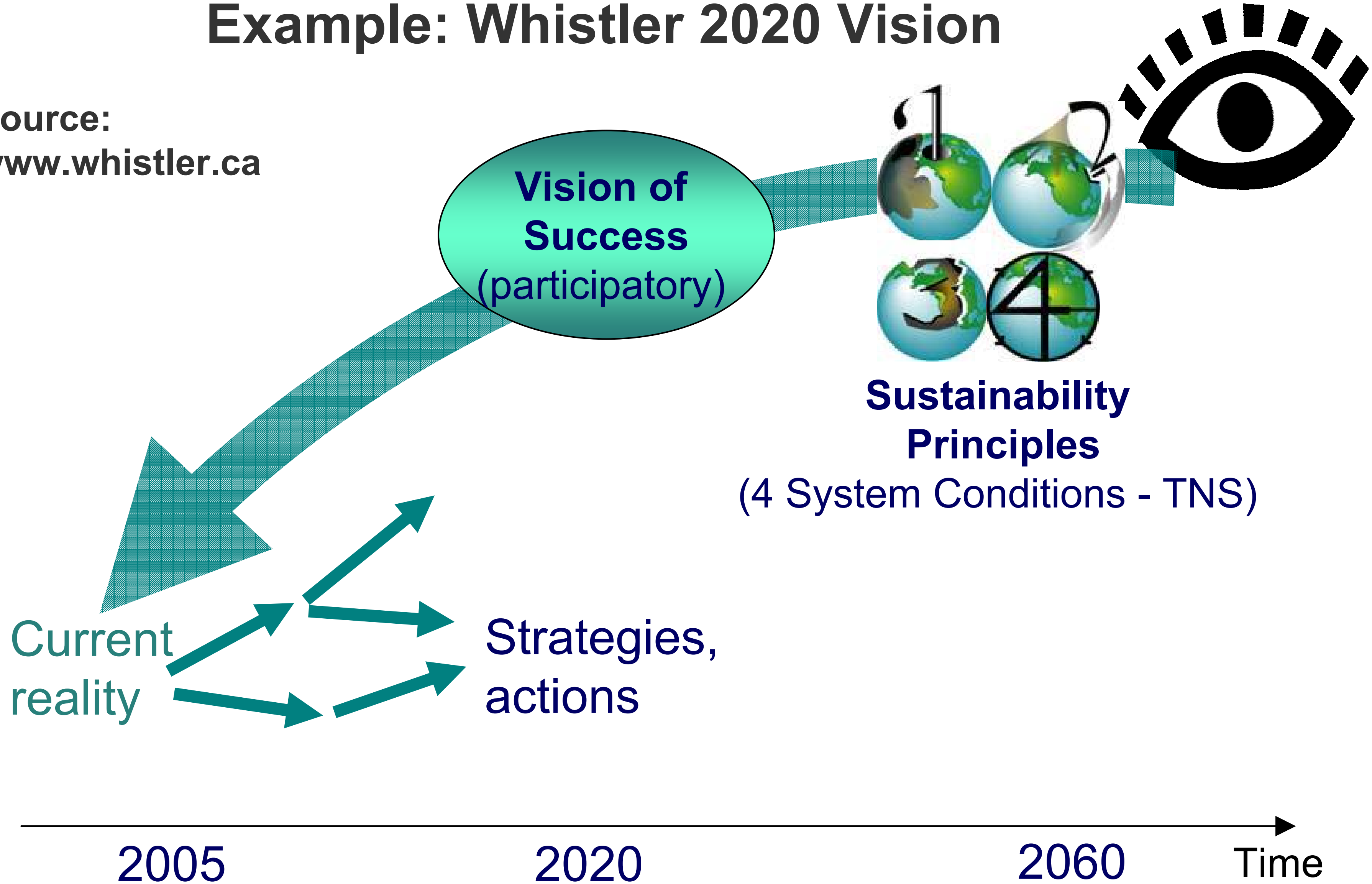
- Process of backcasting from Sustainability Principles
- Goal = To align one's activities with the following Sustainability Principles (also known as 4 System Conditions):

To reduce and eventually eliminate our contribution:

1. to ongoing build-up of substances taken from the earth's crust
2. to ongoing build-up of substances produced by society
3. to ongoing degradation of natural systems by physical means
4. to undermining the ability of other people to meet their needs (social and economic)

Application of The Natural Step Framework
Example: Whistler 2020 Vision

Source: www.whistler.ca



4 Key Elements

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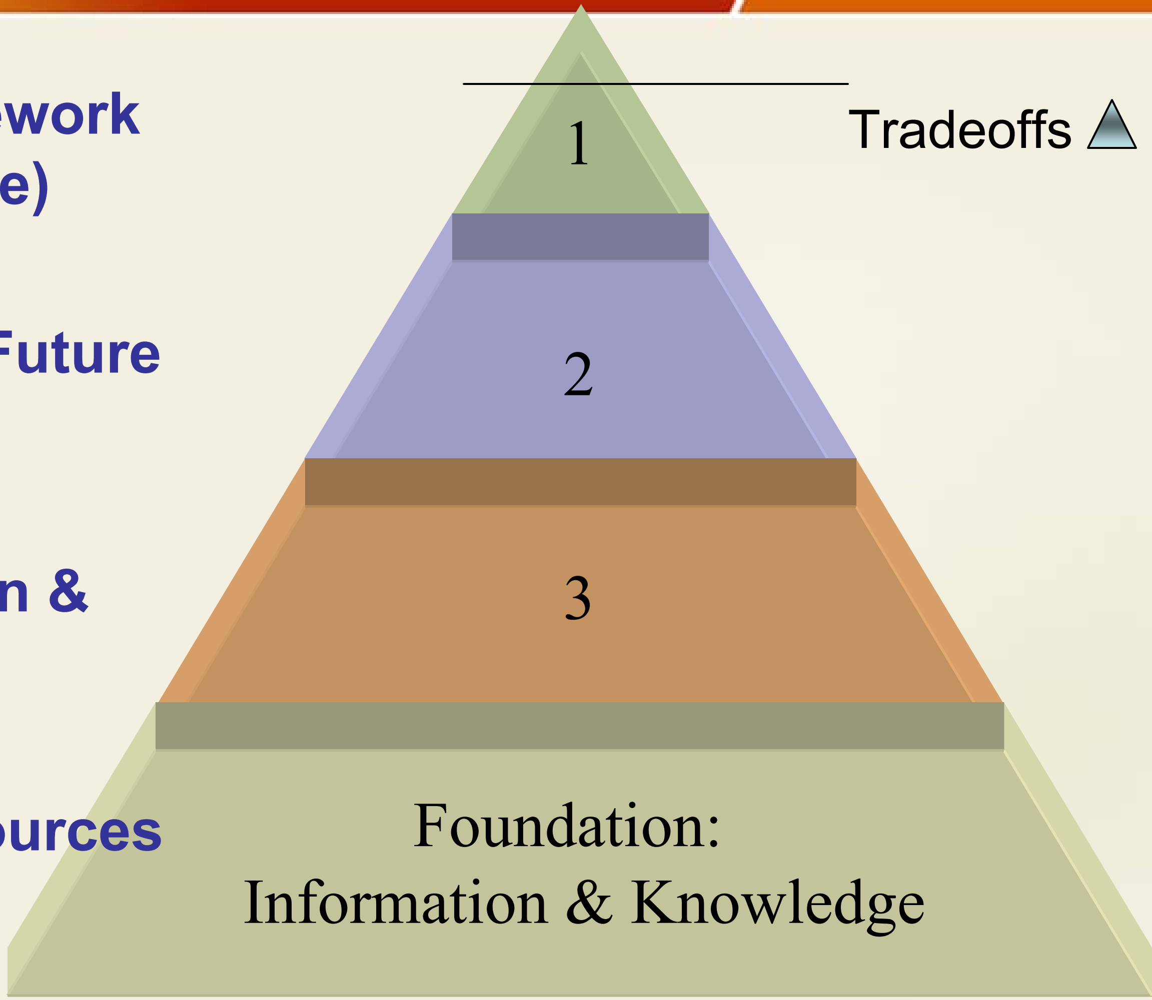
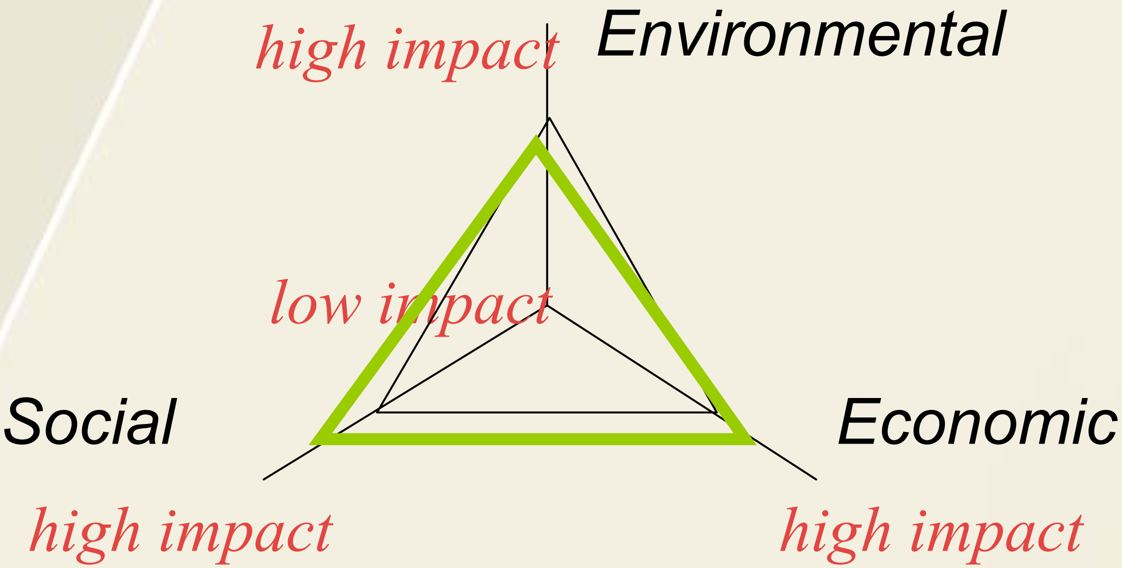


3. SD Issues Identification / Assessment



Process or Product X has a yyy impact relative to the baseline with respect to environmental, economic and social factors.

Bilingual guide for SAFT 2 can be downloaded from www.cbin-rcib.gc.ca

New version V3 includes revised criteria and learnings from applications. Will be available in May 2008.

Tool: SAFT (Sustainability Assessment Framework & Tool)

Baseline	System

Raw Materials (Feedstock)	Manufacturing	Use	End of Life

SD Criteria

- Environmental (7)
- Economic (5)
- Social (6)

• Qualitative assessment tool that reduces the complexity; and supports better understanding of the economic, environmental and social benefits and impacts relative to a base case

• Approach: lifecycle, systems
• 18 SD criteria with guidance tips
• Excel worksheet format

SD Criteria (revised 2007*)

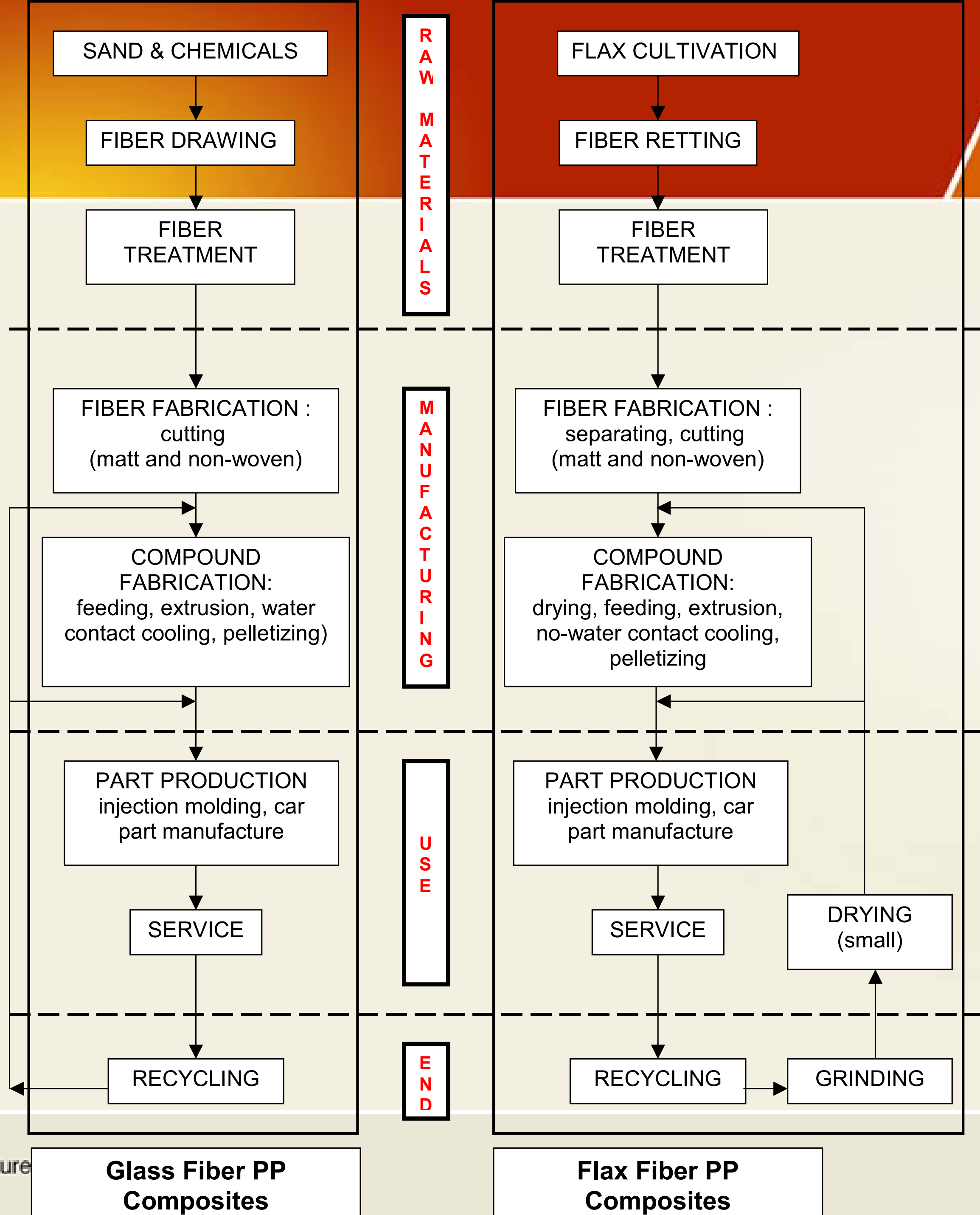
Environmental	Economic	Social
Ecosystem integrity	Microeconomic sustainability	Land and resources available for others
Biodiversity and wildlife (genetic resources)	Macroeconomic sustainability	Participation / Engagement
Local/regional air quality	Employment	Public acceptability
Global air quality	Capital Investment	Distributional/ Regional Effects
Water availability and quality	Longevity	Human Health & Safety
Land availability and soil quality		Quality of Life
Resource consumption (non + renewable)		

* with Élizabeth Paulet, NRC

SAFT Case Studies (2006-07)

- Completed 2 Case Studies with National Research Council & Biolin:
  - ❑ Enzymatic retting of oilseed flax vs. field retted flax
  - ❑ Flax fibre polypropylene composites for automotive applications vs glass fibre
- ❑ Outputs:
  - ✓ Improved description of system / value chain
  - ✓ Understand where the proposed design has the greatest benefits and potential impacts
  - ✓ Provided research direction
  - ✓ Vehicle for communicating with stakeholders (e.g. flax breaders)

Glass fibre polypropylene composites for automotive applications



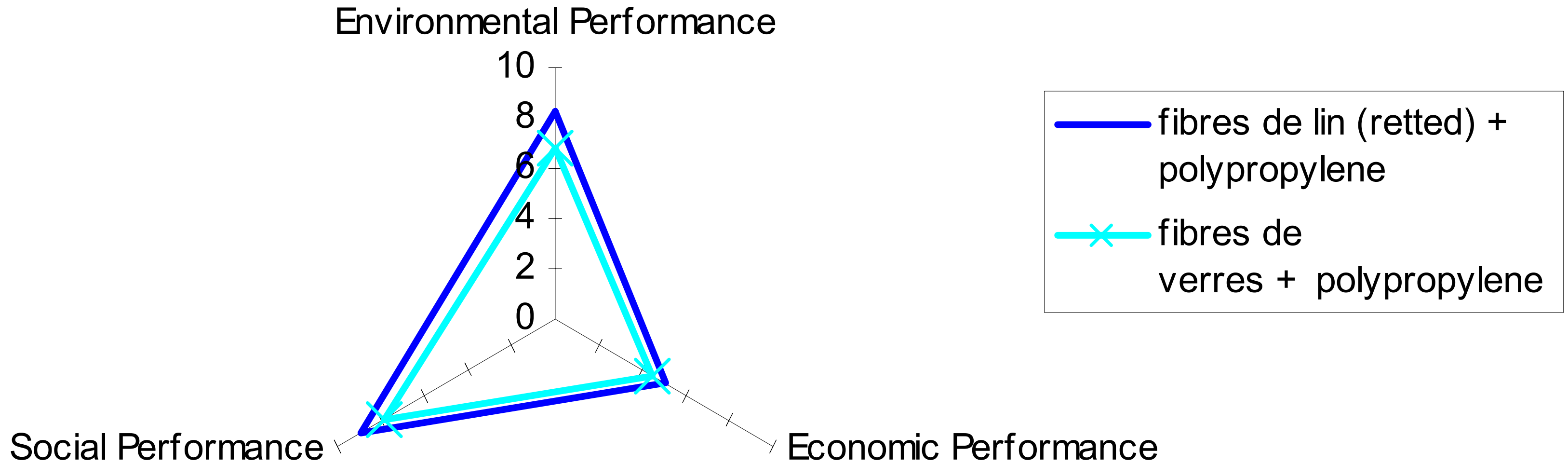
Flax fibre polypropylene composites for automotive applications

Impact Category	Key Question
Environmental	
Ecosystem Integrity	What is the potential threat on natural ecosystem structure, function, lifecycles and integrity (e.g., fragmentation of ecosystems, impact on interspecies relationships, downstream effects on parks, protected areas and wilderness)?
Biodiversity & Wildlife	What is the potential for the system or baseline to have a negative impact on biodiversity and/or wildlife (e.g., intensified monoculture, effects on rare, threatened or endangered species, displacement of native species)?
Air Quality	What is the potential for air quality to be negatively impacted by the system or baseline (e.g., pesticide use, vehicle emissions)?
Greenhouse Gases	What is the potential for greenhouse gas emissions to be increased by the system or baseline?
Water Quality	What is the potential for water sources (ground water or surface water) to be negatively impacted over the life cycle of the system or baseline (e.g., pesticide or nutrient effluent, excessive water use)?
Land Use and Impacts	What is the potential for land use to be shifted from agricultural production for food to other uses (e.g., energy feedstock, displacement of land uses, nature and extent of land use, soil quality and productivity)?
Resource & Material Intensity	What intensity of raw materials or resource inputs are required for this system or baseline over its life cycle (e.g., energy use, pesticide or herbicide use, embodied energy)?
Waste	What intensity of toxic products and releases are involved over the life cycle of the system or baseline (e.g., pesticide use, chemical releases, hazardous waste, landfill requirements)?
Economic	
Economic Returns	Is the system or baseline economically attractive?
Economic Activity	What is the potential for the system or baseline to contribute to economic activity?
Employment	What is the potential for the system or baseline to contribute to employment?
Investment	What is the scale of investment required for the system or baseline, relative to potential benefits?
Longevity	What is the potential for the system or baseline to exhibit longevity?
Social	
Public Acceptability	What is the potential for the system or baseline to have a negative impact on public acceptability?
Distributional / Regional	What is the potential for the system or baseline to have negative distributional / regional impacts?
Human Health & Safety	Is there potential for large scale and irreversible impacts to human health such as risk of transfer of disease or traits to humans?
Quality of Life	What is the potential for the system or baseline to have a negative impact on quality of life?

Sustainability Performance

(Higher is Better)

Flax fibre (field retted) polypropylene composites vs Glass fibre composites



Environmental Performance	(Flax)	22% higher rating (Glass)
Economic Performance	(Flax)	13% higher rating (Glass)
Social Performance	(Flax)	14% higher rating (Glass)

Flax fibre polypropylene composites for automotive applications vs glass fibre

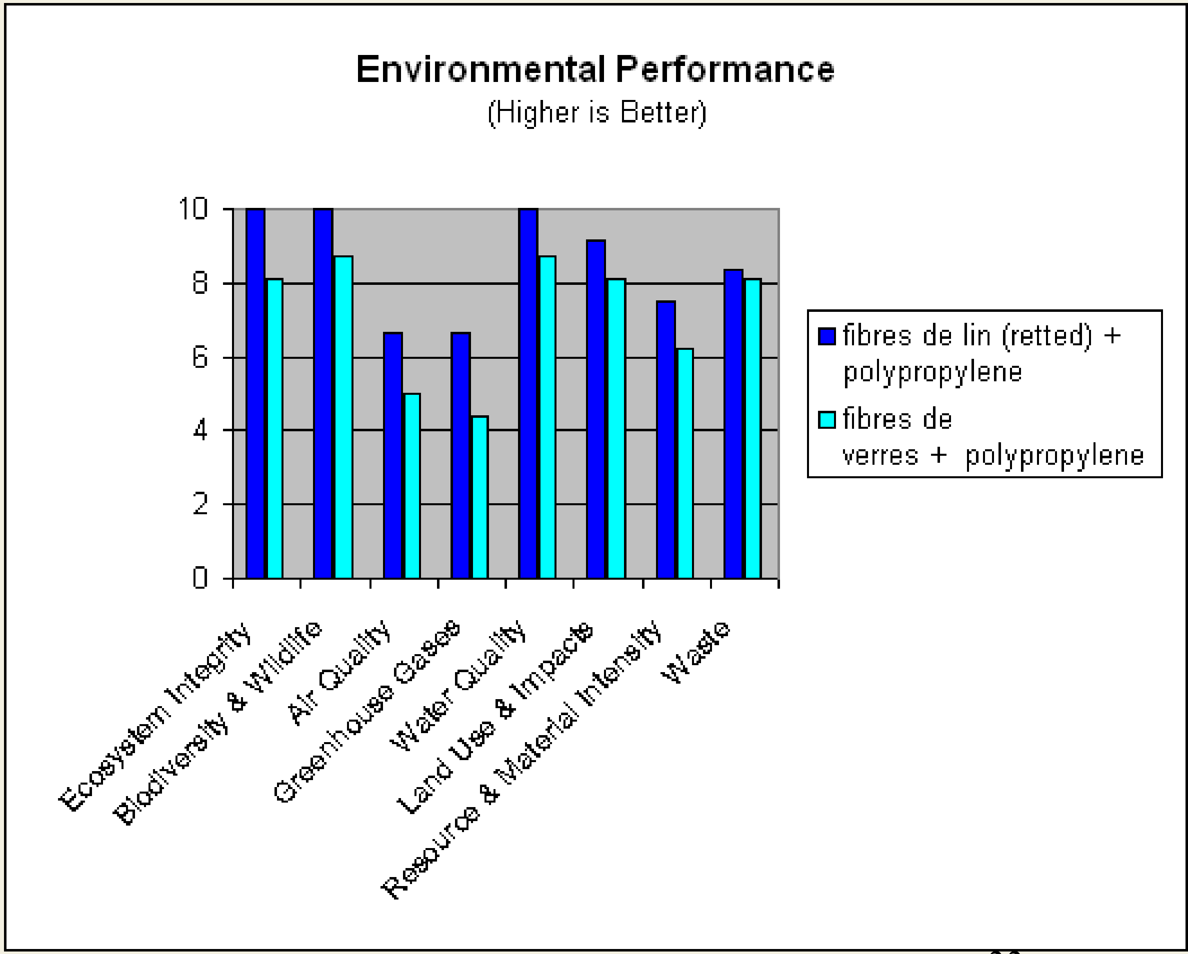
Overall Findings:

- The greatest environmental advantages come from the **Raw Materials** stage (i.e. production of glass vs flax)
- The other stages: **Manufacturing**, **Use** and **End of Life** show smaller differences
  - Flax fibre advantage is lower weight ! Transport, Vehicle fuel efficiency
  - Trade-off : Higher energy & costs of drying natural fibres
- Product recovery, reuse and recycle are needed!
- Overall flax system was superior to glass system
- Bio-based systems are not 'without impact'; when you look at the whole system (to final products), the difference is not always as great as seen from the technology proponents' perspective

Results for Environment Dimension

Flax fibre had advantages in all areas:

- Greenhouse gas
- Ecosystem integrity
- Biodiversity & wildlife
- Air quality
- Water quality
- Resource & material intensity
- Waste



- ***Main benefits were achieved at the <u>raw materials stage</u>***

"So what does this mean ?"

- Need higher fibre yield per hectare
  - Produce more fibre: oilseed flax with higher fibre or fibre flax
- Better management to harvest more straw, incl more fibre
- Develop fibre storage systems that maintain quality
- For industry development need to know: how much straw, how much fibre, what quality can be produced, when ?
- Can field retting be tested in Canada ?
- Enzyme retting: technologies that reduce water, energy and/or enzyme use – R&D on enzyme application options, drying technologies, etc.
- Different concept: some field retting with enzyme polishing (example)
- Fibre modification to avoid moisture issues in composite manufacture

Research Questions & Direction

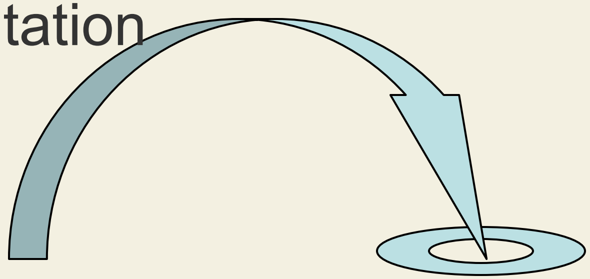
Summary : Key Messages

- Bio-based products and processes have the potential to contribute to sustainable development (i.e. good story to tell)
- Public is informed and has growing expectations (i.e. wanting to do the right thing)
- "Bio" isn't inherently sustainable. Sustainability is deliberately planned and designed.
- Articulate "What is sustainable?"
- SD approaches and practical, cost-effective tools <u>exist</u> that can be applied "early on" in the design process
- Need to commit the time and resources

Overview of Strategic Approach

<u>*Proposed Approach:*</u>

1. Overarching SD Framework for Canadian Agriculture
2. Vision/High Level Planning – Flax & Hemp
3. SD Issues Identification / Assessment / Action
4. Commitment and Resources for Implementation



- *Shows you where you are headed (strategic)*
- *Looks at the lifecyle (entire system)*
- *Reduces the complexity of SD*
- *Generates useful results (relevant)*
- *Does not take a great deal of time and nor resources*
- *Effectively engages stakeholders and enables shared decision-making*

Many thanks to:

- Canadian Biomass Innovation Network (CBIN)
- Natural Fibres for a Green Economy (NAFGEN)
- AAFC Agricultural Bioproducts Innovation Program (Gordon Neish, Benoit Girard)
- National Research Council: Adrien Pilon, Johanne Denault, Minh-Tan Ton-That, Denis Rho
- Biolin: Alvin Ulrich, Saskflax: Linda Braun

\+ *SD international community of practice*

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More on Flax & Natural Fibres

- 2008 International Conference on Flax and Other Bast Plants
  - July 21-23, 2008 Saskatoon, Canada
  - www.flaxbast.2008

- 2009 : International Year of Natural Fibres
  - UN General Assembly
  - will contribute to the Millennium Development Goals by further developing the efficiency and sustainability of these agricultural industries that employ millions of people in some of the world's poorest countries.

Is consideration of sustainability an afterthought, a reaction to ‘food vs fuel’ or a lens through which to create value and competitive advantage ?