Supercluster: Protein Industries Canada
Canola Protein Innovation

Growing the Canola Value Chain to be Healthy & Strong

Curtis Rempel MBA PhD PAg
VP Crop Production & Innovation
Canola Council of Canada

52 BY 2025

KEEP IT COMING

Protein Industries Canada

- Protein Industries Canada (PIC) is requesting $300 million in funding
- PIC member and supporter base over 50 companies/organizations – Western Canada / pan-Canadian
- PIC has assembled over $222 million of cash, $70 million of 'in-kind' support and venture capital commitments of $150 million to match with a $300M funding request

Economic Output

- Generate over $ 850 million in new commercial activity.
- Generate cumulatively
  - more than $37 billion of new output
  - raise GDP by more than $15B
  - create 176,000, person-years of highly-skilled, highly paid, new jobs
- This direct effort is targeted to leverage an additional $15 billion of new exports, or 60% of the growth target in Barton Report over next decade.

PIC will meet the requirements of ISED by:

- Building a shared competitive advantage - world-leading innovation hotbed & economy
- Increasing business expenditures on R&D
- Boosting industrial productivity, integrating Canadian SME into global supply chains
- Bolstering collaborations between private, academic and public-sector

Protein Innovations Cluster Strategy

Create & Grow High Quality Protein

Align with industry plans and objectives. Add in quality improvement research strategies. Leverage existing plant science expertise to accelerate outcomes.

Improve farm production data collection and producer skills with data and knowledge management. Opportunity to ally with IT. Create leading production skill set.

Novel Processing & Formulation

Public/private investment in process & applications research. Functional characterization through to prototype development. Attract leading tech suppliers.

Develop & Serve New Markets

Human resource development. Skills and knowledge acquisition to effectively access new market opportunities. Build market/sell capabilities.

IMPROVE SEED PROTEIN QUALITY AND YIELD

- Advanced plant sciences, genomic technologies, plant breeding
- Seed company investments in breeding & trait conversion
- Increase canola and pulse protein content and quality

SUSTAINABLE PRODUCTION AND AG INFORMATION TECHNOLOGY

- Advance regional agronomic & management practices
- Crop sensing, informatics, software, application validation, advanced weather data
- Sustainable production tech to adapt to climate change

PROCESS TECHNOLOGY INNOVATION FOR PROTEIN ISOLATES & CONCENTRATES

- Novel process technology application
- Separation, purification, isolation technologies and equipment, pilot plant capability
- Characterization, food and feed applications development and prototyping

GO TO MARKET & COMMERCIALIZE

- Build and scale-up new production capabilities, re-tool existing plants
- Customer engagement resources and consumer testing
- Market Insights & Intelligence, demand creation and commercialization

Output Measures

LONG-TERM SUCCESS MEASURES

1. Canada's global ranking of Agri-food exports
2. Agri-food Sector GDP Growth
3. Agri-food Sector Employment Growth

CLUSTER OPERATIONAL SUCCESS MEASURES

1. Direct Investment $ generated through Cluster
2. Direct Employment generated through Cluster
3. Number of patents
4. Number of businesses created

26MM mt crop 12MM mt crush
5% as protein isolates $1.5B
50% as protein concentrates $4.0B
40% as hipro meal $1.0B
Improved Canola Meal = Premium to other press cakes?? Market Value ??

PIC Value Creation is $10.5B in Canola
+$3B at farm gate
+$1B from digital ag & production management
+$6.5 from protein co-products

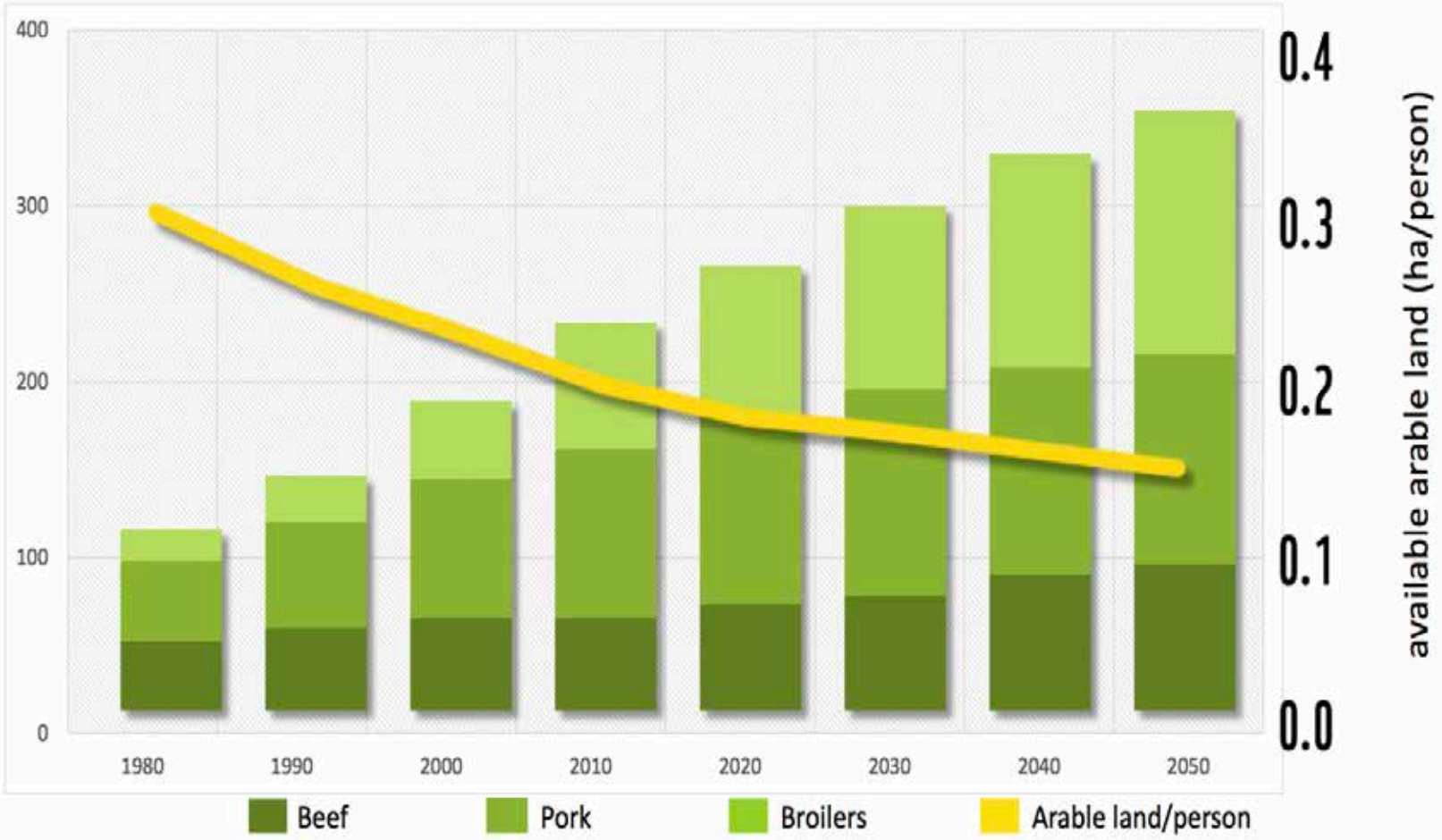
Canola Protein

a) **Demand**
b) Economic Value & Uses
c) Pillar 1 – High Quality Protein Germplasm
d) Pillar 2 – SMART Production
e) Pillar 3 – Novel Processing & Product Development
f) Pillar 4 – Company Support, Marketing, Commercialization

KEEP IT COMING

canolacouncil

World animal protein consumption is growing



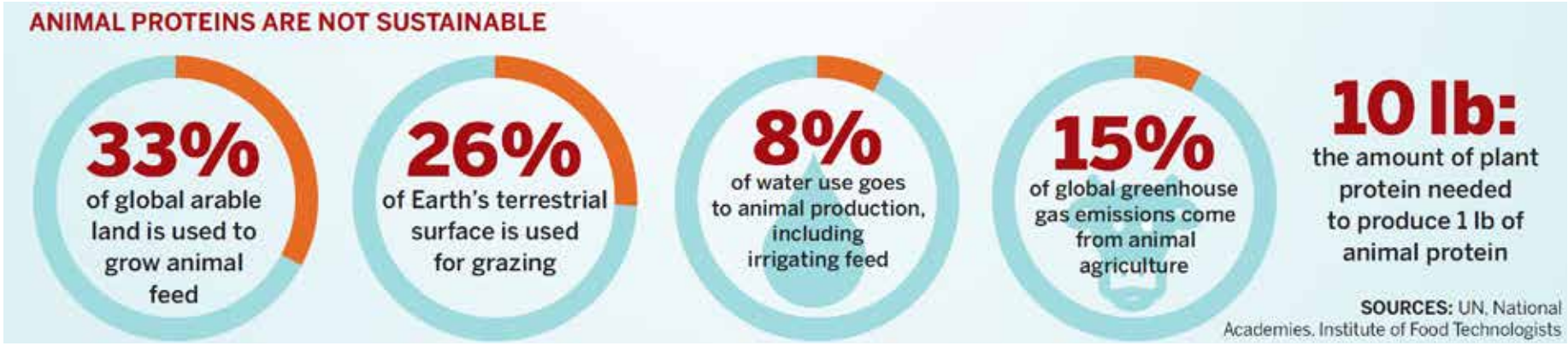
Source: WWF Sandra Vijn

Canola meal – Ruminant animals

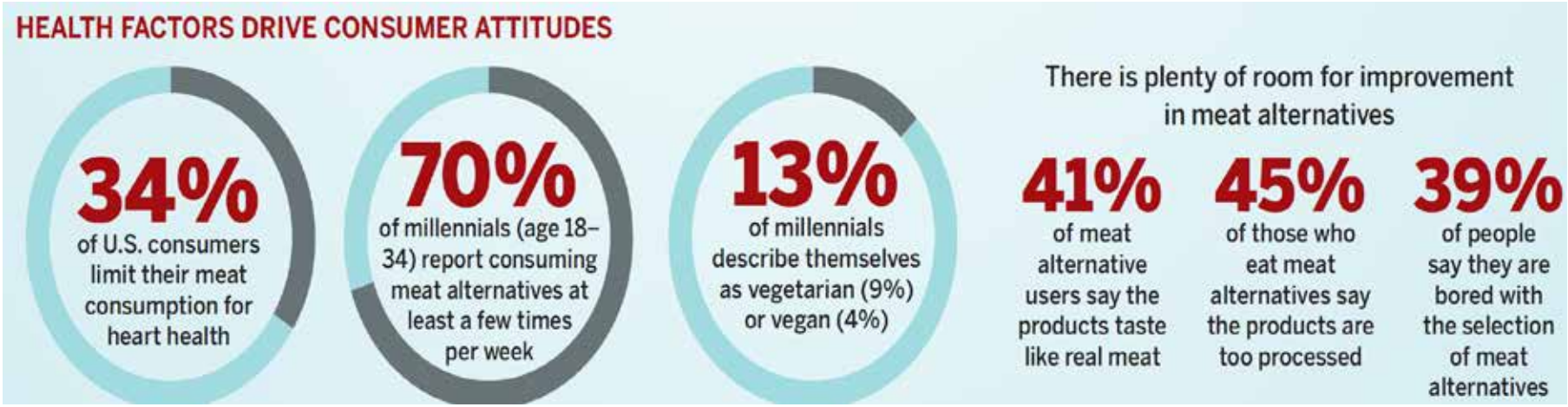
Research shows that using canola meal instead of soy meal =

DAIRY
High quality protein and forage for milk production
Key driver is milk quantity and quality

Increasing Demand for Plant Protein



Aquaculture – Enhanced sustainability?



1 kg animal protein requires 10 kg feed beef; 5 kg pork;
3 kg poultry; 4 kg eggs; 5 kg for milk

Source: Mintel

Canola Protein

a) Demand

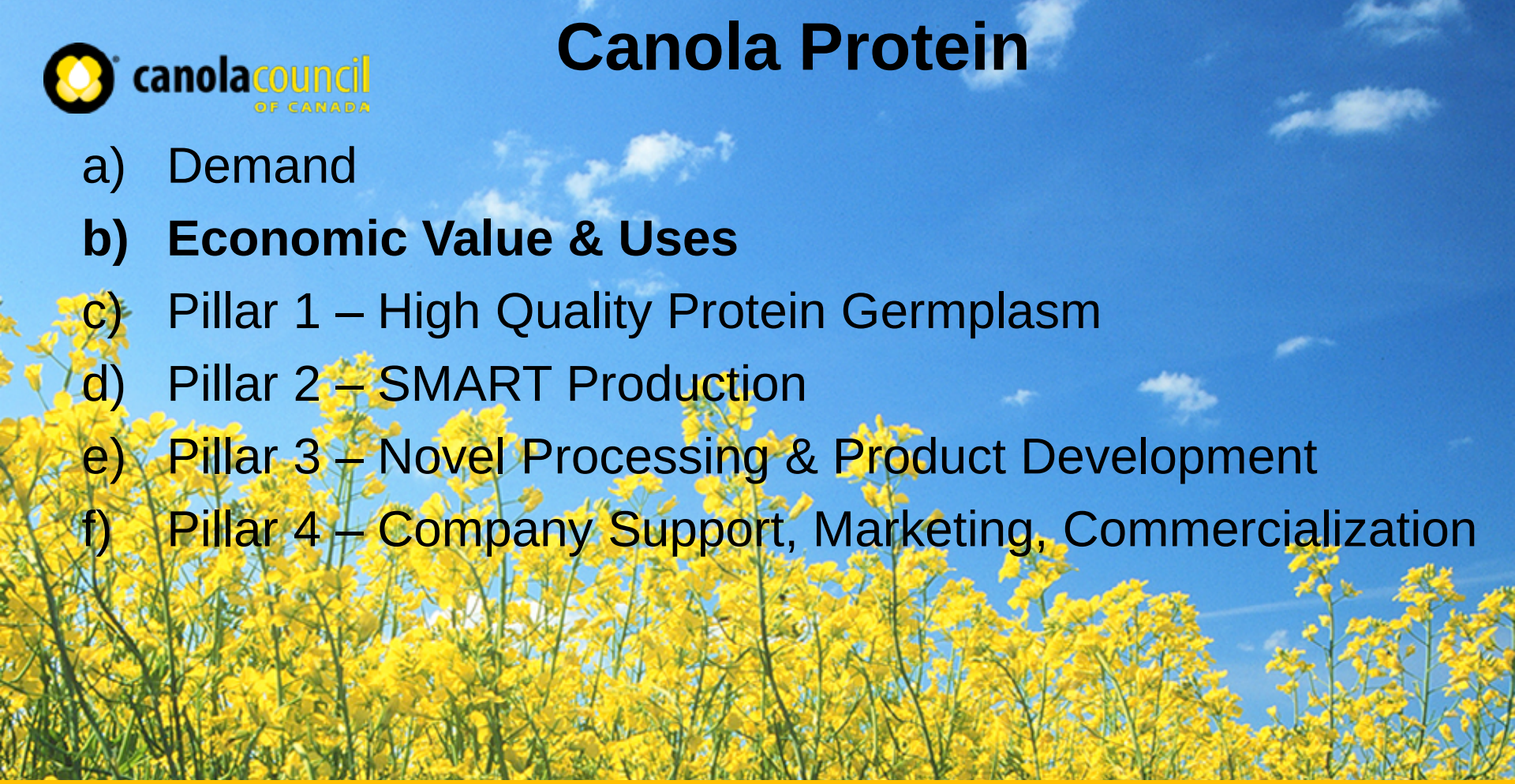
b) Economic Value & Uses

c) Pillar 1 – High Quality Protein Germplasm

d) Pillar 2 – SMART Production

e) Pillar 3 – Novel Processing & Product Development

f) Pillar 4 – Company Support, Marketing, Commercialization



canolacouncil OF CANADA

52 BY 2025

KEEP IT COMING

Protein Factoids

- Between 2011 and 2015, a 63% compound annual growth rate (CAGR) increase was seen in global product launches with plant-based protein claims.[13]
- China is enjoying particularly strong growth for dairy alternative drinks, with a CAGR of 18.7% forecast between 2010 and 2018, reaching a market value of US$6.7 billion, compared with a more modest, but still impressive, CAGR of 10% in the U.S.[17]
- The feed industry requires new sustainable sources of protein meal as demand expands by 40% (88 MM mt) by 2025. Oilseed meal demand is forecasted to expand by 88 MM mt by 2030.[6]
- Aquaculture alone requires an additional 2.5 MM mt of high protein meal18 estimated at $3.5 billion.[19]
- Globally soy protein content is declining, creating greater need for higher protein meals.
- Plant derivatives for pet foods are projected to grow at 4.8% CAGR to 2020 from 2015 levels. The key global market is dog food, where plant derivatives were valued at US$10 billion in 2014.[20]
- In 2015, 20% of global pet food launches featured a “high in” or “source of” protein claim.[21]
- Technology is the key driver for the identification and application of alternative proteins.[22]

Canada's Position

Key market drivers creating significant new business and economic opportunities for Canada, including

Novel packaged plant protein-based foods to meet China's need for food security where food quality is a major concern and where the demand for high- quality protein is on the rise.[24]

Plant-based ingredients to serve the growing animal feed industry where demand has accelerated to 3.3% per year.[25] Rising demand for meat and fish, modernization and intensification of animal production and improved animal genetics are driving increased protein usage in feed rations globally.

A changing food and feed industry is presenting unique opportunities for which Canada is uniquely positioned to

Serve an increasingly affluent middle class (approximately 3 billion people worldwide in 2015) all seeking higher quality foods.[3]

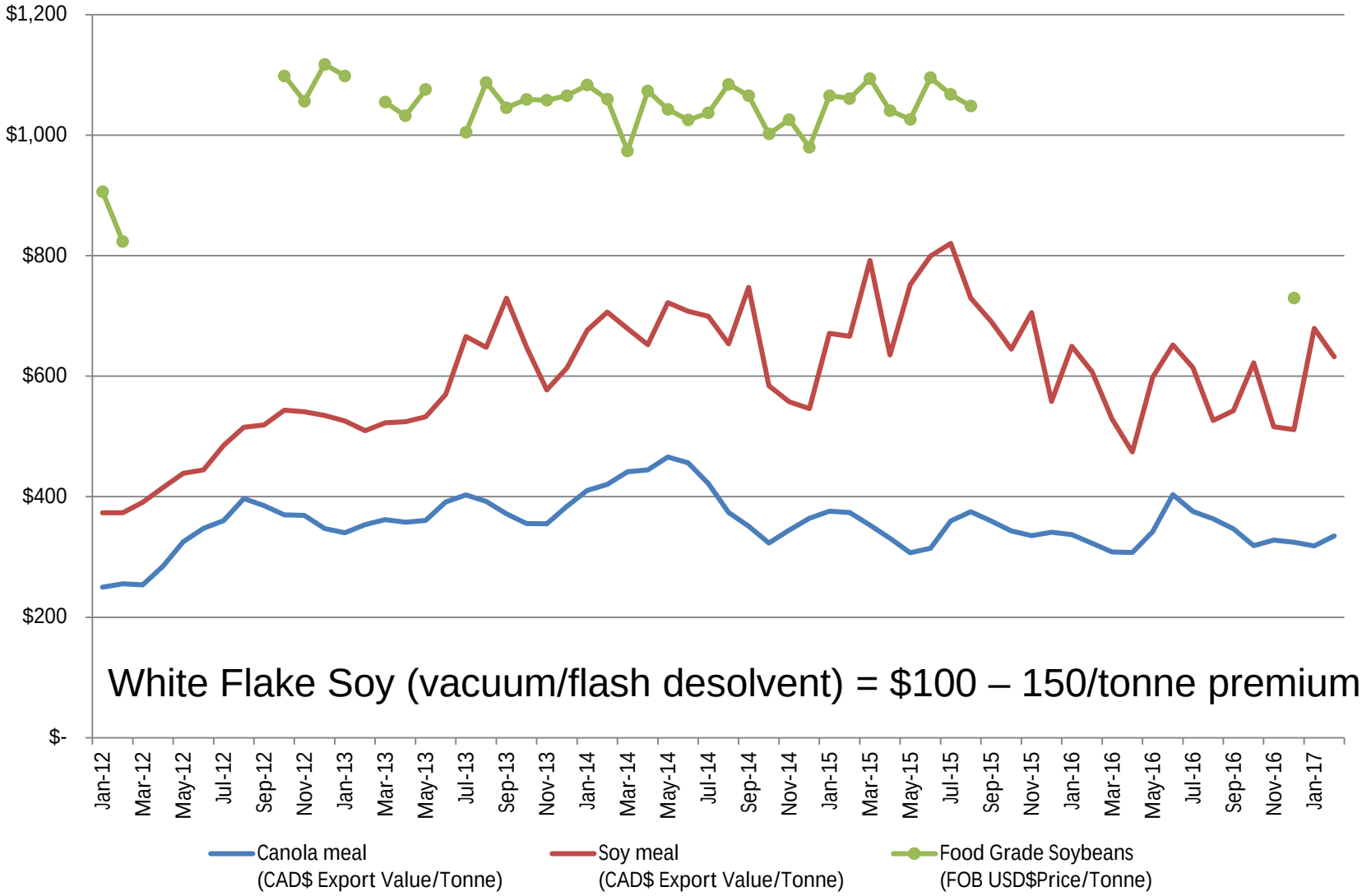
Provide high protein meal for increasing global animal food product demand. Industry requires new sustainable sources of protein meal as demand expands.

By 2020, Generation Z consumers will be the largest food purchasers, representing 40% of U.S. consumers with $44 billion of purchasing power and influencing $600 billion in spending.[4] Gen Z food purchases and eating patterns are geared toward ***natural, high-quality, plant-based protein foods consumed largely through snacking***. Sales of snack foods doubled those of staple foods in 2016 at over $100 billion.[5]

Economic Value: Canola Meal, Soy Meal

Average Value per Tonne

Source of canola meal & soy meal values: Canadian International Merchandise Trade Database)
Source of food grade soybean value: USDA Agricultural Marketing Service



Protein Concentrate / Isolate - CANADA

- Burcon Inc. – Supertein, Puratein, Nutratein
- BioExx Specialty Proteins Inc. (TEUTEXX)

- Isolexx and Vitalexx

- MCN Bioproducts Inc. -
  - IP, trademarked products – licensing agreements, extensive product testing re functionality & hedonic, favorable regulatory status.

- **Ready-to-drink beverages**
- **Powdered beverages**
- **Frozen desserts**
- **Aerated desserts**
- **Nutritional bars**
- **Functional Food**

- **Dressings & Sauces**
- **Meat applications**
- **Protein bars**
- **Baked goods**

NUMEROUS High-Margin industrial – bioplastics, adhesives

Global Market for Meat Replacer

Plant proteins that replicate taste, feel, experience of eating meat attracting significant investment in past 5 years

- Burcon / ADM – pea protein, Clarisoy
- Beyond Meat (California)
- Impossible Foods (California)
- Ripple Foods (California)
- Hampton Creek (California)
- Gardein
- Embria Health Science
- Kellogg
- GTC Nutrition
- Estimated 200 start-up companies

PIC Strategic Pillars

- PIC has identified strategic pillars to further develop the Canadian agri-food ecosystem to address the demand for plant proteins and novel plant-based food and feed ingredients.

Canola Protein

a) Demand
b) Economic Value & Uses
c) Pillar 1 – High Quality Protein Germplasm
d) Pillar 2 – SMART Production
e) Pillar 3 – Novel Processing & Product Development
f) Pillar 4 – Company Support, Marketing, Commercialization

52 BY 2025

KEEP IT COMING

Pillar 1 – Creation High Quality Protein Germplasm

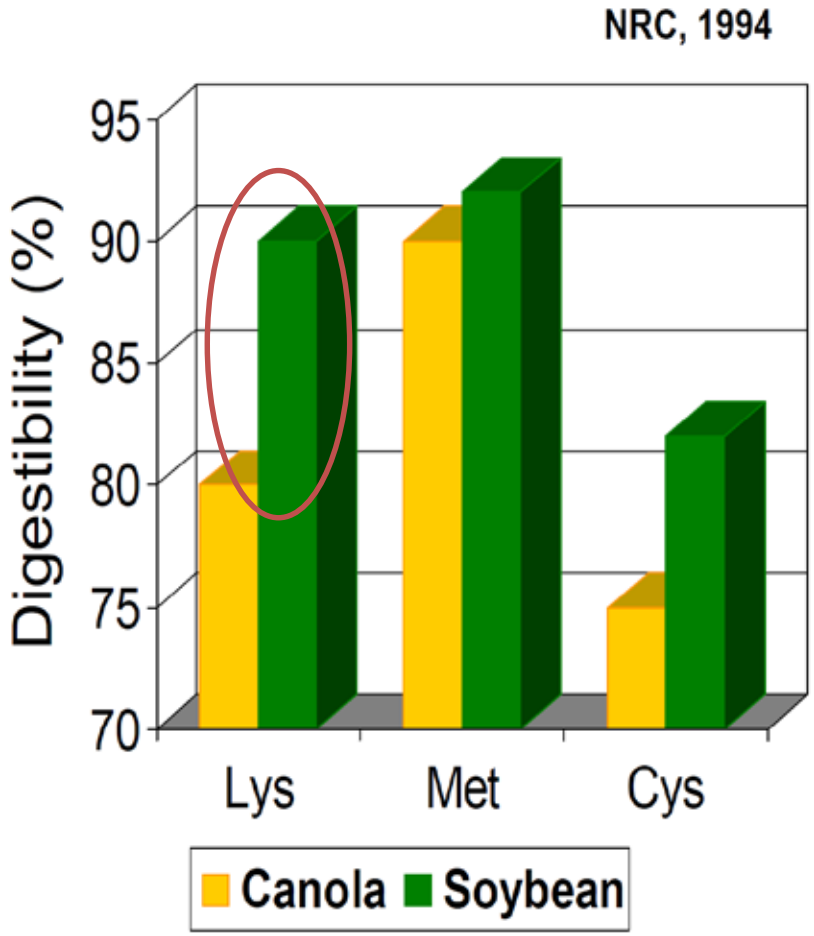
- Increase seed protein content / reduce fiber
- Change amino acid composition / profile
- Manipulate crucifer/napin ratio
- Remove anti- nutritional compounds

Soy is the driver – increase meal value relative to soy meal

canolacouncil

Meal quality - poultry

- Lower amino acid digestibility than soybean meal
- More variable amino acid digestibility
- Contains 75% of the protein of soy, often sells at 60% of the price
- Effect of processing on meal quality poorly understood



Breeding - Amino Acid Composition

Amino Acid	*B. napus* germplasm	Canola Meal (Canada)	Soy Meal (USA)
Alanine	2.18	1.57	2.05
Arginine	2.99	2.08	3.48
Asparagine	3.92	2.61	5.52
Cysteine	0.93	0.86	0.79
Glutamine	8.54	6.53	8.62
Glycine	2.19	1.77	1.97
Histidine	1.30	1.12	1.21

- exceeds national averages for canola meal

- exceeds national averages for soy meal

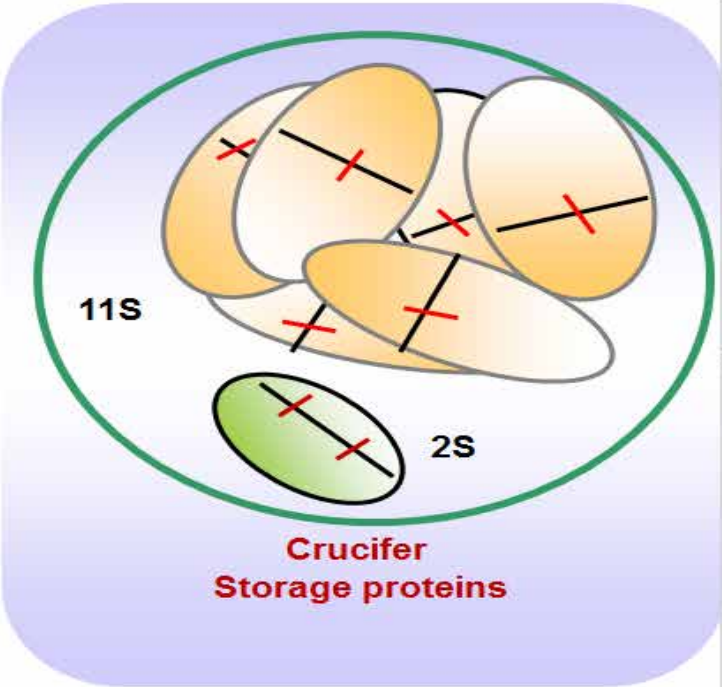
Dr. Rob Duncan, University of Manitoba

Proteins of Canola Seed

Product differentiation

Wanasundara, AAFC

Seed & Meal Protein



Cruciferin: 60%

Napin: 25%

11 S globulin cruciferin	2 S albumin napin
• Larger globular protein mm ~ 340 kDa	• Smaller mm ~ 15 kDa
• Similar to 12S proteins (glycinin) found in soy	• Highly soluble
• Rich in lysine and methionine	• High glutamine, prolinme, cysteine
	• Potentially allergenic
	• Less competitive: ❖ Sensory ❖ Nutritive properties
	• Regulatory

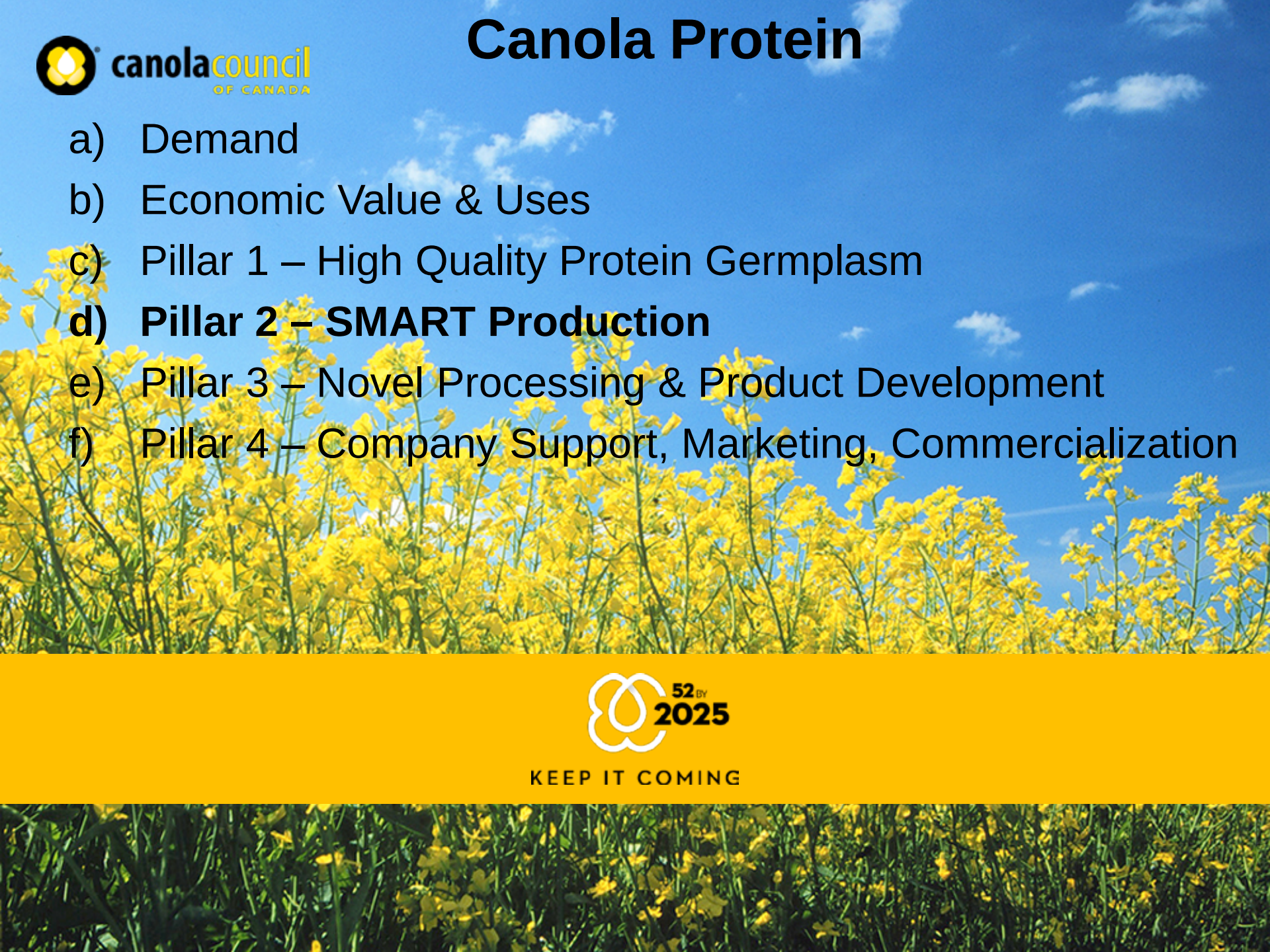
- Napin (albumin) (20%) = Excellent foaming, solubility, heat stability, soluble

High content of sulfur containing amino acids, Cysteine nearly 2x whey

- Cruciferin (globulin) (60%) = Opaque heat induced gels, emulsifier, ingredient binder

Canola Protein

a) Demand
b) Economic Value & Uses
c) Pillar 1 – High Quality Protein Germplasm
d) Pillar 2 – SMART Production
e) Pillar 3 – Novel Processing & Product Development
f) Pillar 4 – Company Support, Marketing, Commercialization



Pillar 2 – SMART Production

This pillar is focused on improving productivity by supporting farm production data collection, analysis and producer decision making and knowledge management.

- Digital technology for farm input management
- Implementation of precision farming methods
- Use of artificial intelligence to:
- support genetic analysis of field traits
- Develop phenotyping and imaging technology for improved and efficient field evaluations.
- Develop autonomous power platforms for agricultural implements
- AI machine learning for uniformity and productivity assessments

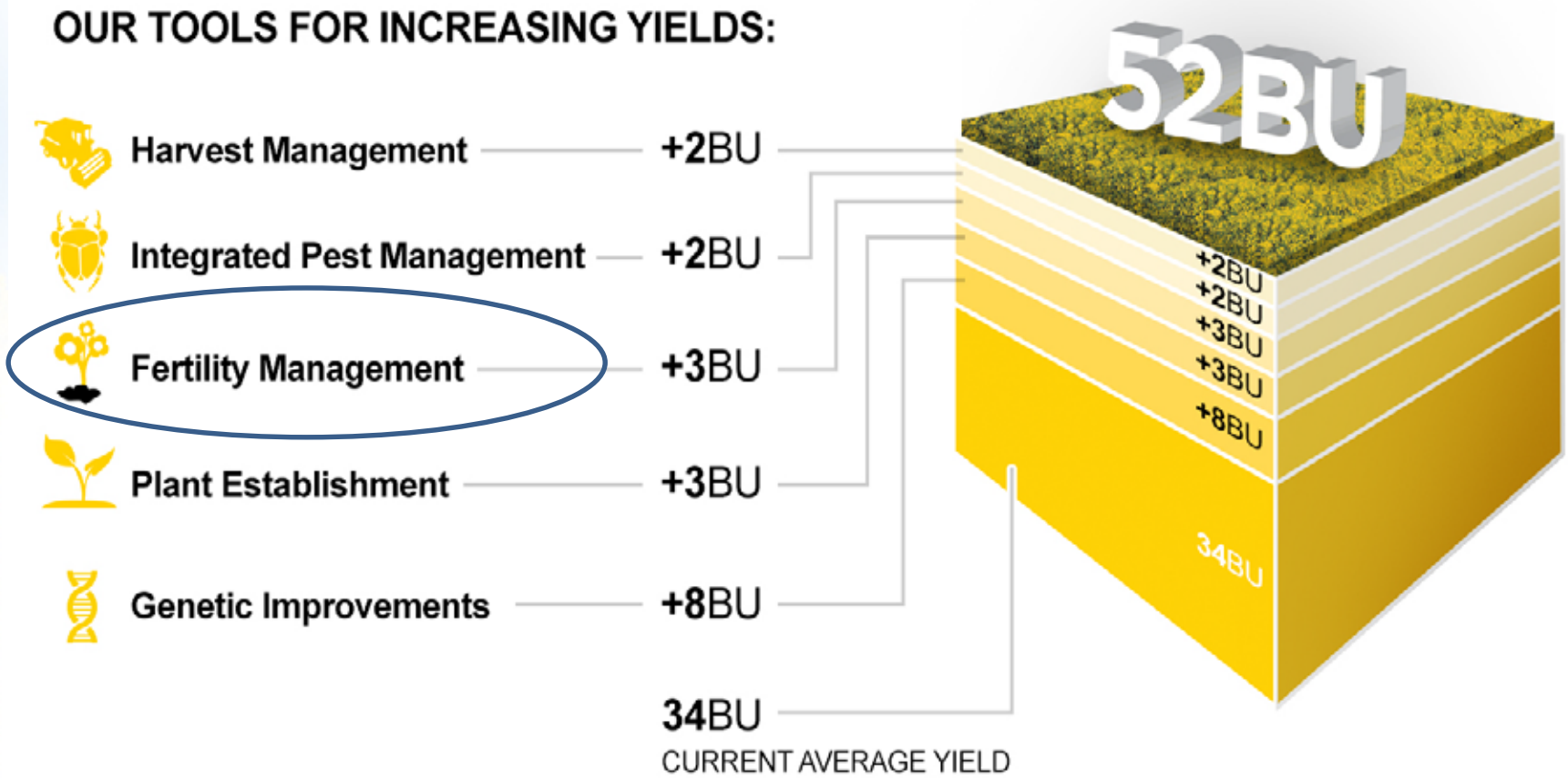
- ***Optimizing fertility, fertilizer technology, fertility management in the landscape and soil microbiome to produce oil and protein in the seed***

CCC - “Big Data” Initiative: NUE Yield & Protein

52 by 2025: How we'll get there?

DEMAND Driven – 26 mmt
Value Chain Execution

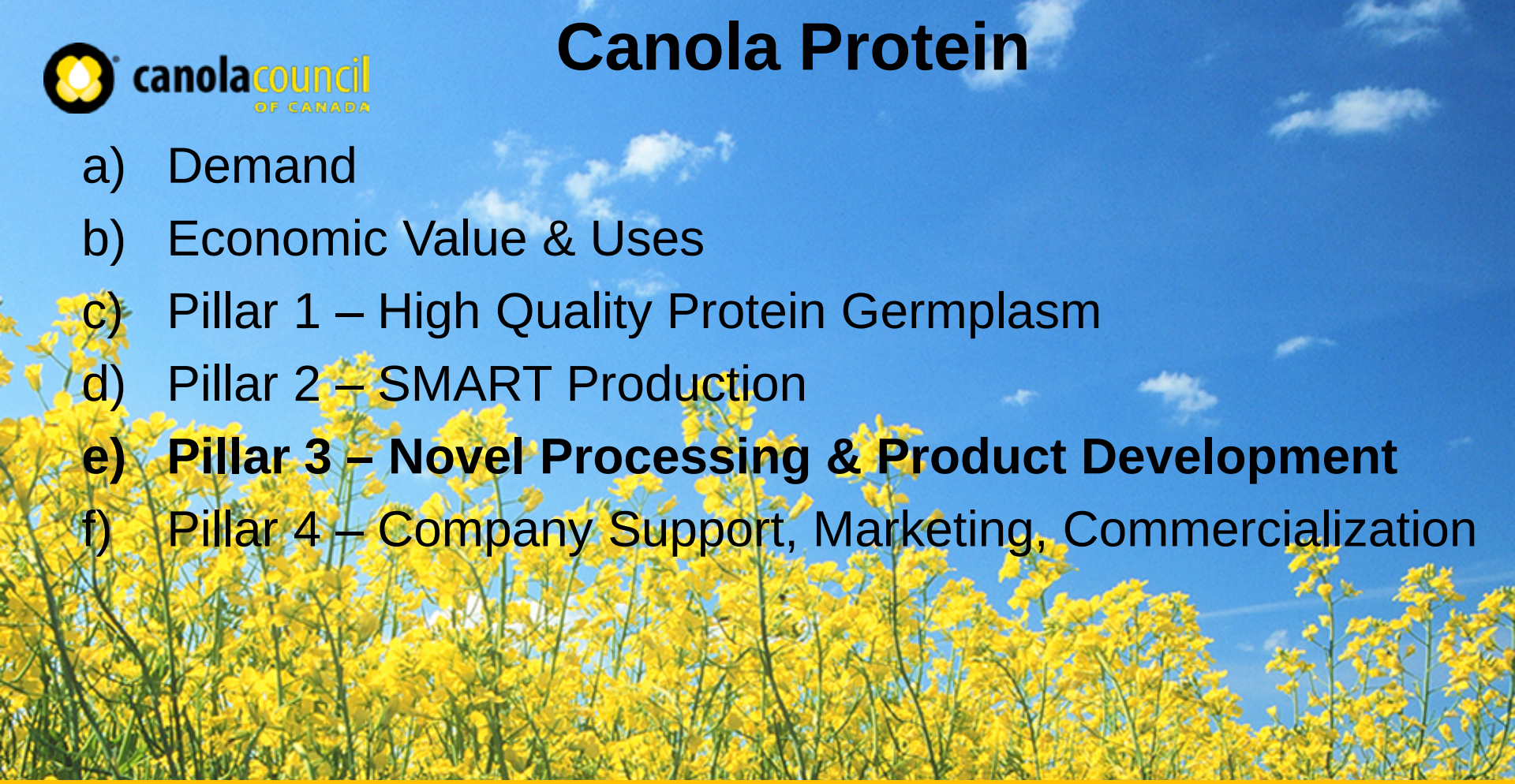
- ***INCREASE Yield, Profitability, Sustainability***
- ***REDUCED (Production) Risk***



Canola meal = Protein Optimization – UN FAO (Amount, bioavailability, functionality)

Canola Protein

a) Demand
b) Economic Value & Uses
c) Pillar 1 – High Quality Protein Germplasm
d) Pillar 2 – SMART Production
e) Pillar 3 – Novel Processing & Product Development
f) Pillar 4 – Company Support, Marketing, Commercialization



52 BY 2025

KEEP IT COMING

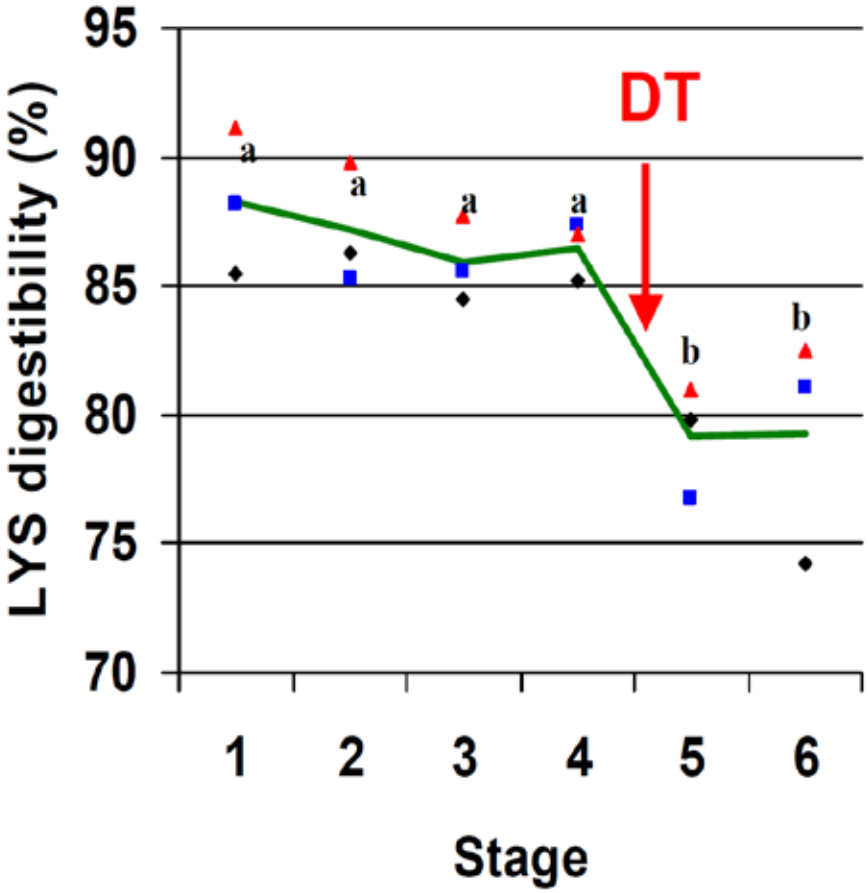
Limitations – Current Processing

- Solvent extraction; Desolventizing / toasting
  - Protein denaturation/degradation
  - Binding of protein/fiber complex
  - Phenolics – flavor taste
- Impact functionality, nutrition

canolacouncil OF CANADA

Amino acid digestibility

- Desolventisation/toasting decreased LYS digestibility
- Desolventisation/toasting decreased digestibility (P<0.05) of most amino acids (CYS, GLU, GLY, ASP, THR, ALA, VAL, ILE, LEU, PHE, HIS, ARG, PRO, & ASN)



Source: Classen, University of Saskatchewan

Novel Processing

- Dehulling – Front / Back End

DRY

- Ohmic Heating
- Supercritical Fluid esp with enzymes
- High Pressure
- Microwave
- Fine Milling & Air Classification

WET

- Aqueous w enzyme

Other technologies…

Challenge – SCALEBILITY, Cost, Need to deactivate myrosinase enzyme

UPSIDE – Reduced water / energy, higher bioavailability, flavors, healthy co-products – canolol, sterols, etc

Canola Protein Extraction

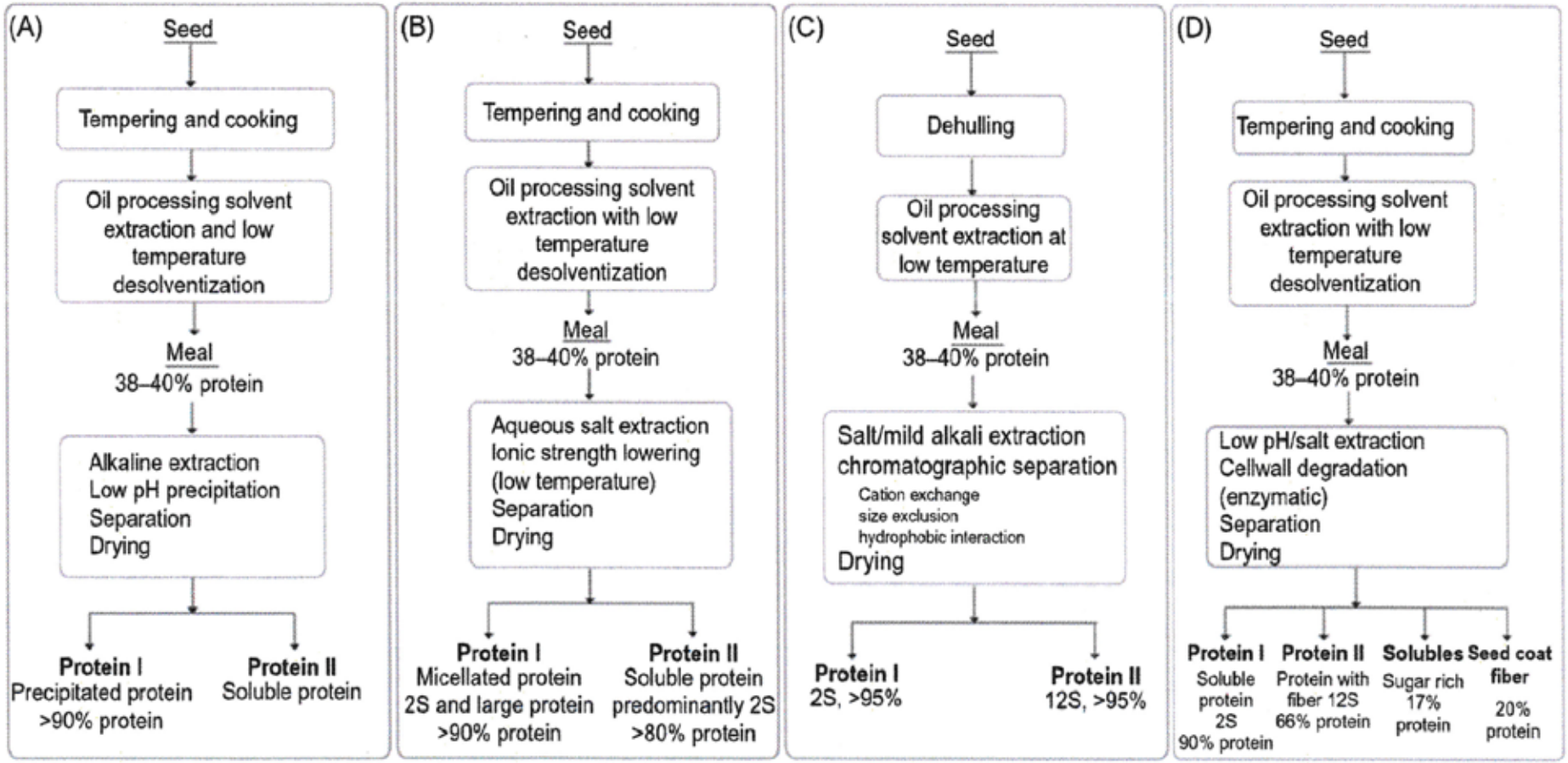


FIGURE 18.1 Flow charts summarizing important processing steps and products for four different methods described and employed to obtain protein products from canola/rapeseed. Processes depicted here are either reported as scaled up to pilot level or patented. (A) Alkali extraction of protein and recovery at low pH (Diosady et al., 2005; Newkirk et al., 2009); (B) protein micelle formation method (Murray, 1999; Schwizer & Greene, 2005); (C) chromatographic separation (Berot et al., 2005); and (D) meal component fractionation method developed by Wanasundara and McIntosh (2013).

Wanasundara et al 2015

Dehulling - Economic Considerations

- Expansion of gross crushing margin is possible with front end dehulling of high protein canola meal versus conventional canola processing
- Assumes canola meal would be 95% value of soybean meal with an equal protein content

	Conventional Canola Process			Dehulled High Protein Process		
Revenue	CDN$/ MT	MT/ MT seed	CDN$/ MT seed	CDN$/ MT	MT/ MT seed	CDN$/ MT seed
Oil	946.32[9]	0.46	435.31	946.32[9]	0.42	398.97
Meal	340.35[9]	0.54	183.79	552.57*	0.42	231.20
Hulls				150.00[8,10]	0.16	24.00
Total Revenue			**619.10**			**654.17**
Seed Expense	534.45		**534.45**	534.45		**534.45**
Gross Crushing Margin			**84.65**			**119.72**

*Calculated based extrapolating value of conventional canola meal and 95% value of soybean meal

Source: DOW AgroSciences

Canola Protein

a) Demand
b) Economic Value & Uses
c) Pillar 1 – High Quality Protein Germplasm
d) Pillar 2 – SMART Production
e) Pillar 3 – Novel Processing & Product Development
f) **Pillar 4 – Company Support, Marketing, Commercialization**

52 BY 2025

KEEP IT COMING

SUMMARY - Canola Protein Future

...new commercial product streams - translate to $1,500 to $12,000/mt of product value versus $500/mt from current conventional processing.

Conclusion

- Canola proteins have significant potential but need to solve some current hurdles
- Demand for canola protein for human consumption & aquaculture will be significant if industry can cost-effectively de-oil/fractionate – even in a crowded marketspace
- Genomics/breeding increases the value proposition
- “Green” or “Clean Label” are more than a passing fade – will drive change in many sectors including food processing
- Cost of these technologies will decrease significantly
- Can we use new technologies on existing infrastructure? If we can do this, opportunity for evolution significant.

canolacouncil OF CANADA

Questions?

52 BY 2025

KEEP IT COMING