Investigating Value Added Potential of Flaxseed and Straw

Final Report

Project for SaskFlax

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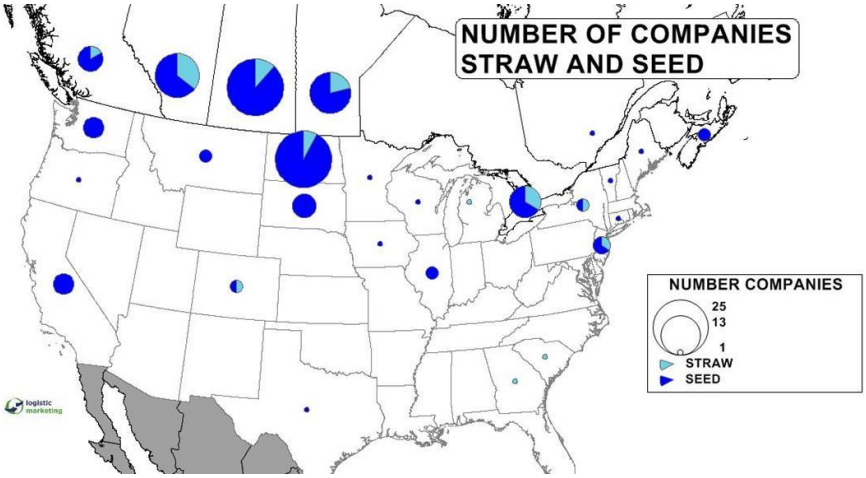
Executive Summary

This study inventories, assesses, and analyzes the current conditions and potential opportunities for the value-added sector of the flax industry in Western Canada. The scope of the project is as follows:

- Review the production and markets for flaxseed (seed, oil, and meal) and straw that are relevant to Western Canada
- Review North America's current flaxseed and straw value added sector
- Analyze the opportunities for growth in the value-added sectors

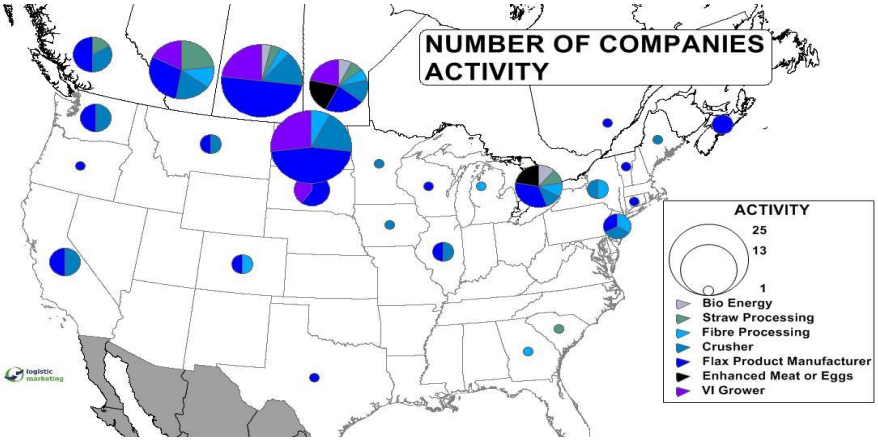
Activity in the North American flax value added sector, both seed and straw, is shown below. Activity in general is concentrated in Western Canada and North Dakota. On the straw/fibre side, 23 companies were identified as adding value, while on the seed side 124 companies were identified (not all distinct companies).[1]



Source: Author

The number of companies by type of value adding activity is shown below. On the straw/fibre side, eight flax straw processors, 12 flax fibre processors, and three bioenergy product manufacturers were identified. On the seed side, 21 vertically integrated growers, 12 Canadian bulk handlers, 28 flaxseed crushers, 58 flax product manufacturers, and five Canadian enhanced meat and egg producers were identified.

[1] This is not intended to be an all-encompassing value added inventory.



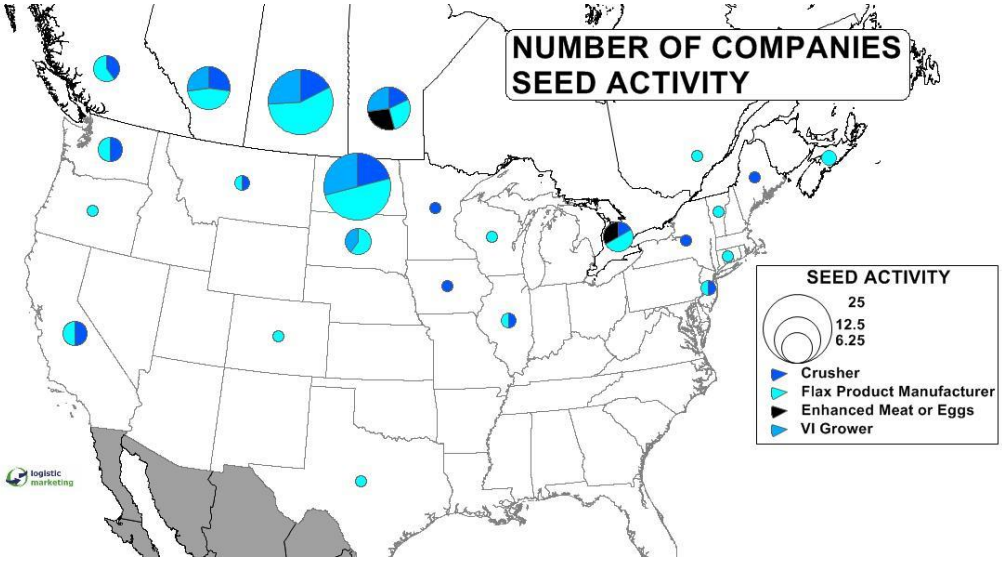
Source: Author

On the Seed Side

On the seed side, the potential opportunities that were valued would utilize an incremental 1.1 M tonnes of flaxseed and require an additional 1.6 M acres of flaxseed – which is a 107% increase in the 2014 harvested area of 1.5 M acres. The incremental value to the grower would be $584 M (assuming no price change). On the straw side, the value of increasing the yield of fibre from straw to 40% from 20% would be worth about $19.1 M to the processor.

Potential Opportunities in Valued Added on Seed Side – At the Farm Gate				
	Opportunity	Incremental Tonnes	Incremental Acres	Incremental Value at Farm Gate
Seed	Increase Canadian yield by 30%	232,422		116,211,136
	Expand Canadian acreage by 10%	100,208	150,000	50,104,145
	Expand Organic Acres to 20% of flax acreage			55,752,000
	Increase exports to China to 1% of Chinese oilseed imports	553,000	1,075,875	276,500,000
	Increase seed usage by bakeries etc. by 50 M lbs	22,700	44,163	11,350,000
	Major food company begins to utilize 250 M lbs of flax	113,500	220,817	56,750,000
	Increase sales for omega 3 feed for eggs in Canada to 25% of market	10,456	20,185	$5,228,000
	Increase sales for omega 3 feed for eggs in United States to 25% of market	14,659	28,299	$7,329,500
	Meet ALA target for dry dog food in North America	7,000	13,514	$3,500,000
Oil	Increase Canadian production of flax oil by 10%	718	1,398	$359,000
	Replace 0.01% of Chinese imported edible oil with Canadian flaxseed oil	2,874	5,591	1,436,782
Total		**1,057,537**	**1,559,842**	**$584,520,563**
		Incremental Fibre (Lower Level) Tonnes	Incremental Fibre (Upper Level) Tonnes	Average Incremental Value to Processor
Straw	Increase the yield of fibre from straw from 20% to 40%	22,400	24,600	$19,129,000

We identified 82 separate companies active in flax seed value added in North America (excluding bulk handlers). Of these companies 59 were located or had headquarters in Canada.



Source: Author

The value added activity breakdown was as follows (firms can be in more than one activity category):

- Vertically Integrated Growers: 12 in Canada and nine in the United States
- Canadian Bulk Handlers: 12
- Flaxseed Crushers: 12 in Canada and 16 in the United States
- Flaxseed Product Manufacturers: 30 in Canada and 12 in the United States
- Producers of Enhanced Meat or Eggs in Canada: 5

At the Grower Level

Yield is the factor most limiting the growth of the flax industry. Agronomic knowledge, a contributing factor to the yield problem, is not always high. Low yields reduce the profitability of flax which makes it less competitive relative to other crops. The northerly movement of corn and soybeans and the expansion of canola acreage have resulted in a loss of flax acres. Increasing the production of organic flaxseed would increase grower returns and slow off-shore imports of organic flaxseed.

With proper agronomic management the yield of flax in the Prairies could increase. The experts we interviewed suggested that an increase of 30% was feasible. The average flax yield in the Prairies over the last 15 years was 20.2 bu/ac (1.27 tonnes/ha). A 30% increase in yield would bring yield up to 26.3 bu/ac (1.65 tonnes/ha), an increase of 6.1 bu/ac (.38 tonnes/ha). If we use the 2014/15 acreage of 1.5 M acres (608,000 ha) and an average of price of $500/tonne, the value of the potential yield increase is $116 M.

- Through the Northern Adapted Flax Variety Development Program, it is possible to increase the yield and acres of flax on the Prairies. If acreage expands by 10% (60,800 ha or about 150,000 acres) and the yield is 1.65 tonnes/ha (with the 30% increase), the incremental value of the flax production is $50 M assuming an average price of $500/tonne.

- There is a strong demand for organic flaxseed. If organic flax acres increase to 20% of total flaxseed acres (of 1.5 M acres) then the incremental value to growers would be $55.8 M. This assumes that the yield of organic is 70% of conventional (14.1 bu/acre rather than 20.2 bu/acre) and the price of organic brown flaxseed is $31/bu while the price of conventional organic flaxseed is $12.5/bu. The value of the organic production on 300,000 acres would be $131.5 M while the value of conventional flaxseed that it replaced is $75.8 M. The differential in value is $55.8 M.

- Currently, there is not a flax grower association in Alberta. The establishment of one would help realize the above opportunities.

Food Market

The market for flax products to be consumed by humans is currently a niche market with many small players. In many applications, 1 M lbs goes a long way.[2] Most growth opportunities would result in only a small incremental increase in the demand for flax and unlikely to increase the price paid to growers. While small, the firms serving it appear to be very good at creating value. Many companies are trying to further differentiate their products to meet more valuable needs in such applications as gums and proteins.

The supply of flax is sufficient to grow the value added sector in North America as shown below. Food manufacturers should not be concerned that the supply might not meet their needs. The typical volume used appears to be almost insignificant in terms of available supply. [3] The only area where there could be concern is if organic flax is required.

[2] If for instance, the company buys flax in 1 M lb increments, the value would be: 1 M lbs of flax is 453.6 tonnes. At a yield of 1.27 tonnes/ha, 1 M lbs of flax requires 357 ha or 883 acres. The farm gate value of the 1 M lbs is $227,000. Each additional 1 M lbs doubles the incremental opportunity.

[3] Total supply equals production plus opening stocks.

North American Availability of Flaxseed			
	Ave 2009/10 to 2013/14	2013/14	2014/15
	Tonnes of Flaxseed		
North American Production	736,000	819,000	1,009,000
Canada	592,000	724,000	847,000
United States	144,000	85,000	162,000
Total Supply			
Canada before Exports	784,000	809,000	952,000
Canada After Exports	251,000	193,000	252,000
United States After Imports	370,151	325,000	

Source: United States Department of Agriculture, Economic Research Service, "Oil Crops Yearbook", March 31, 2014 and Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015

- If Canada could replace 0.01% of the edible oil imported by China with flaxseed oil, the impact could be significant for the domestic flaxseed crushing sector. One-tenth of 1% would be just over 1,000 tonnes. This would require a 40% expansion in Canada's crush (which currently produces an estimated 2,500 tonnes of flaxseed oil). The incremental value of the oil produced (assuming the price held) would be $4.8 M. The incremental oil production would require an additional 2,874 tonnes of seed and 5,591 acres of flax. The value to the grower would be $1.4 M.

- If Canada could grow its flaxseed exports to China to 1% of Chinese imports of oilseeds, the incremental exports would be 553,000 tonnes which would require an additional 1.1 M acres of flaxseed production. If the additional exports were priced at $500/tonne, the added revenue would be $276.5 M. China is a very price sensitive market and the price of flaxseed may have to fall before a significant volume of additional exports would occur.

- The estimated production of flaxseed oil in Canada is 2,500 tonnes which requires 7,184 tonnes (5,613 hectares or 13,870 acres). The value of the flaxseed oil produced assuming that 50% is refined (with a value of $6,331/tonne (export value)) and 50% is crude (with a value of $3,361/tonne (export value) is $12.1 M. Each 10% expansion in the production of flaxseed oil in Canada would be worth $1.2 M (assuming the price held) and require 1,398 acres. The value to the grower would be $359,000 and is based on mechanically extruded oil.

- There are opportunities to increase the use of flax for protein; gums; and breads and cereals. If the amount of flaxseed using in baking increased by 50 M lbs, an additional 22,700 tonnes and 44,163 acres would be required. The value of opportunity is $11.4 M.

- The entry of a major food company into flax products would help grow the sector. The promotion of flax would increase which would increase consumer awareness and help drive the demand for flax products for food. It may also act as a signal to other large food manufacturers that flax has profit potential and that supply is sufficient. If a major food company required 250 M lbs of flaxseed (which is equivalent to 113,500 tonnes or 221,000 acres), the value of this opportunity at the farm gate would be $56.8 M.

- There are opportunities for the flax organizations to grow the industry through research and development, regulatory initiatives and commercialization. There are also several ways that promotion would be beneficial to the industry. For example, the promotion of flax as a plant-based source of omega-3 fatty acids to be incorporated as part of a healthy diet would help counter some negative messaging from marine oil groups that currently exists.

Feed Market

Livestock rations are based on least cost. This limits opportunities for flax to where the special properties of flax are valued. Unfortunately, this does not raise the price at the grower level.

- There is potential to grow the use of flaxseed to produce enriched products such as omega 3 eggs. One expert suggested that omega 3 eggs could capture up to 25% of the Canadian market. If this occurs, the demand for flax would increase to 16,136 tonnes. Demand could also grow in the United States. If flax was used to produce 20% of the 517 M dozen branded eggs in the United States market, then the amount of flaxseed used would double to just over 22,000 tonnes. The Canadian opportunity is valued at $5.2 M for growers while the United States opportunity is valued at $7.3 M.

Pet Food Market

The humanization of pets has created opportunities for flax.

- There is the potential to increase the volume of flax used in North American dog food in order to meet omega 3 targets. The pet food sector requires approval for use of any ingredient by the Association of American Feed Control Officials (AAFCO). It is currently considering requiring all dog food classified as targeting "reproduction", "growth" and "all life stages" to have certain ratios of omega-3 including EPA / DHA AND ALA. Flax seed will likely be the key source of ALA considered ("at this point in time") as canola is not well viewed due to "genetically modified organism". To meet the target in the dry dog food produced in North America for the growth and reproductive stage (approximately 2 M tonnes)[4] would require the addition of 3.5 kg of flax per tonne. The amount of flax required would be 7 M kg or 7,000 tonnes.

Industrial Market

The industrial oil market is mature and likely to continue to contract slowly. No opportunities were identified in it. It may be possible to use flax in the production of biodegradable packaging films for food.

[4] The volume of dry dog food produced in North America is actually 5 M tonnes. However, only the growth and reproductive stage has an ALA target.

Volumes by Market and Product

Data on the actual utilization of flax is very limited. These estimates were assembled from various sources and using many assumptions. They should be treated as very preliminary and used with caution.

Utilization of Flax Seed in North America, Tonnes, Preliminary						
			Seed	**Oil**	**Meal**	**Seed Equivalents**
Canada						
Seed		Production (2014/15)	847,000			
		Exports (2014/15)	700,000			
		Domestic Use For Food	25,000			
		Domestic Use For Feed	70,000			
Crush	Expeller	Amount of Seed Crushed	7,184			
		Amount of oil produced		2,500		7,184
		Amount of Oil Exported		2,000		5,747
		Amount of Oil Imported		2,000		5,747
		Amount of Oil for Domestic Food		2,500		7,184
		Amount of Oil for Feed		negligible		
		Amount of Oil for Industrial		none		
		Amount of Meal Produced			4,619	7,184
		Amount of Meal Exported			3,487	5,423
		Amount of Meal Imported			2,890	4,495
		Amount of Meal Used for Food			3,400	5,288
		Amount of Meal Used for Feed			1,219	1,896
United States						
Seed		Production (2013/14)	85,000			
		Imports (2013/14)	216,000			
		Flaxseed used to produce food	5,000			
		Amount of Seed used for Feed	9,000			
All Crush		Amount of Seed Crushed	283,000			
		Amount of Oil Produced		99,000		284,483
		Amount of Oil Exported		34,000		97,701
		Amount of Oil Imported		2,000		5,747
		Amount of Oil Used Domestically		62,500		179,598
		Amount of Meal Produced			181,000	281,493
		Amount of Meal Exported			4,500	6,998
		Amount of Meal Imported			1,800	2,799
		Amount of Meal Used for Food			36,000	55,988
		Amount of Meal Used for Feed			145,000	225,505
	Solvent	Amount of Oil Produced Used Domestically		40,000		114,943
	Expeller	Amount of Oil Produced Used Domestically		22,500		64,655
	Expeller	Amount of Oil for Food		22,500		64,655
		Amount of Oil for Feed		5,000		14,368
	Solvent	Amount of Oil for Industrial		35,000		100,575

There is no magic bullet that will transform the flax value sector in North America into a mega-industry. The following are insights on what it will take to grow the value added sector for seed:

- Mainstreaming: The sector needs a large scale food manufacturer to enter the food market. The North American value added market will remain niche without this. In the food market, manufacturers have very high standards which must be met along the supply chain.

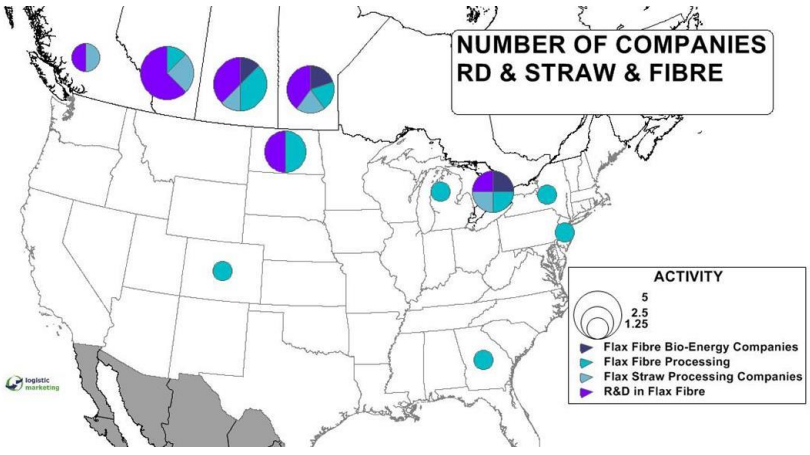
- Research and development: The food sector is increasingly dependent on its suppliers to provide product and ingredient information that can be easily assessed for application in specific products. Research/product development is required for use of flax and flax ingredients in food applications. Functionality, stability, cost and product applications must be developed and demonstrated to attract the interest of buyers/food manufacturers.

- Demand pull facilitated by research and development on functionality and promotion have been successfully used by other commodities. Flax needs a champion. Collaboration between a large branded company and flax organizations with respect to promotion would benefit the entire industry.

- A high level of collaboration within the supply chain can be beneficial in growing a sector. Value chain roundtables can facilitate networking, identify opportunities, and resolve conflicts.

On the Straw Side

Value added activity on the straw side is shown below. Because the utilization of flax straw is an emerging industry, research and development activities were included in the inventory. In Canada, 16 organizations/entities were performing research and development on flax straw/fibre but only two were found in the United States. In terms of fibre processing, all of the processors (eight) were located in Canada. We identified 14 companies adding value to flax fibre, seven in Canada and seven in the United States. These companies produced a wide range of products from bedding to bio composites. Three companies were identified producing bio energy products.



Source: Author

Flax straw and fibre value added activity in North America should benefit from the Green Economy and grow but several factors are holding parts of it back from reaching its potential. Better management of the straw in the field is required to increase the straw quality and the yield of fibre from straw. The straw value added sector is fragmented and lacks scale. Some companies have difficulty in meeting their customers' needs in terms of quality and quantity. Potential end-users are concerned about having to rely on a very small number of suppliers. Blending fibres may resolve some of these issues. The sector has difficulty in attracting investment and has a bad track record in terms of firm longevity. Finally, the lack of a grading system for fibre makes commerce extremely difficult (FibreCity is working on this).

- There may be new entrants into the processing sector. The supply of straw is adequate. Because of transportation costs the location chosen will be critical. Currently many growers manage straw via torch. Attitudes are changing however because there is a need for flax straw by processors. With the expansion of fibre processing the burning of flax straw will gradually decrease. More entrants will help with the overall viability of the industry. It was suggested during interviews that in order to get a functioning supply chain about four or five companies like SWM are required.

- The yield and quality of straw can be improved. For example, with good management fibre yields per acre can be tripled. The yield of useable straw/acre is low, about 0.5 tonnes/acre on average (0.8 tonnes/acre is the maximum). If well retted, the straw will yield 80% fibre but typically only get 18%. Assuming a 20% yield, the amount of fibre produced by the current processing facilities is 22,400 to 24,600. With proper management it is possible to increase yield to 80%. Even doubling the yield would have a very beneficial impact on the sector.

- There is potential to use more flax fibre in bio-composites, bioplastics and building materials. Alberta government officials suggested that the probability of this occurring in Alberta is about 80% and that the time frame for realization is one to two years. CIC has developed a composite that will be used for the hood on the next generation of Buhler tractors. It is trying to get smaller scale projects going to provide credibility for larger scale applications. One expert believes that the system will need to be 'fiber source agnostic' i.e. use fiber blends so if one crop has a poor year the other can make it up. The car companies don't care if the farmers have a bad year. There has to be redundancy in the system.

- There is potential to use more flax fibre in land reclamation/erosion control.

Volumes by Sector

The following table was assembled from a variety of sources and assumptions. Caution is advised. There is a large difference between the demand for straw and the production of fibre. This is because of the current low yield of fibre from straw (20%).

Utilization of Flax Straw in North America, Tonnes		
North American Recoverable Straw	671,017	
Canada Recoverable Straw	543,268	
United States Recoverable Straw	127,750	
	Low	High
Canada Demand for Straw	112,000	123,000
Canada Production of Fibre	22,400	24,600

1. What Drives the Flaxseed Market

According to William Hill, Past President of the Flax Council of Canada, the global market for flax has been significantly affected by four factors over the last 20 years. The first of the factors is the growing demand for health and in particular a growing awareness and demand for Omega-3 fatty acids. This has been the main driver of flax's move into the human food market.[5] In Canada, consumers have readily accepted omega 3 eggs. The second factor was the discovery of genetically modified flax (Triffid) contamination of the flax supply chain. This discovery prevented Canadian flax from flowing to its traditional European markets. Russia, Ukraine, and Kazakhstan have replaced Canadian product in the European market. At the same time, it also forced Canada to develop the Chinese market which is large and growing. The growth of environmental awareness is the third marketer shaper. The demand for flax for industrial products, energy and fabrics due to its renewable nature will become increasingly important as the technology to utilize flax improves. The utilization of flax in livestock, pet health and productivity products is the final factor. Animals also benefit from flax's nutritional properties. New technology is being developed to improve the utilization of flax in feed while research and development has improved the amount of Omega-3 that can be incorporated into livestock and poultry products.[6]

This chapter explores each of these factors

1.1 Health

Health and wellness is the key market driver of the global food industry from a human health as well as an environmental and ecological health perspective. Health and wellness is described through four sub drivers: 1) safety and transparency; 2) population growth; 3) aging demographics; and 4) cost of chronic disease.

1.1.1 Safety and Transparency

Safety and transparency combined to be one of the key market drivers in the food system. Consumers globally are demanding food that is safe and transparent as a result of widely publicized food scandals that have crippled consumer confidence over the last decade.[7],[8] Consumers now demand transparency to ensure that the production and manufacturing of their brand choices result in food that is safe for their families.

Due to quick access of information through social media, tech savvy consumers quickly learn about food products and sources that are unsafe. As John Keogh stated in his presentation to the recent Consumer

[5] Health Canada acceptance of a health claim for flax and the recognition of flax as GRAAS in the United States are helping the use of flax in food to grow.
[6] Flax Council of Canada, "Flax Industry Update, Spring 2013".
[7] Waste Reduction is Top Food and Beverage Trend for 2014. http://www.thinkeatsave.org/index.php/waste-reduction-is-top-food-and-beverage-trend-for-2014
[8] Shepherd-Fidler, S. (2013) Five Consumer Trends Shaking up the Packaging Industry.

Goods Forum GFSI (Global Food Safety Initiative) briefing on food chain transparency, "transparency will no longer be an option."[9]

The impact of this driver has reverberated throughout the system. Retailers such as Whole Foods have now incorporated transparency as a key element of their business model and brand value.[10]

The implication of this driver for flax producers and processors is that food safety and traceability measures must be incorporated into their operations (e.g. On-Farm Food Safety program, On-Farm Quality Assurance Program, Hazard Analysis and Critical Control Points – HACCP).

1.1.2 Global Population Growth

The United Nations expects the world population to increase from its current status of 7.2 B to 9.6 B by 2050. While the population of the developed nations will remain stagnant, growth will largely come from the least developed countries.[11]

The implication of population growth is the concern over both national and global food security. The issue will vary by country and is dependent on several variables including: future per capita food consumption; life expectancy rates; the percentage of populations classified as "undernourished"; and changes in eating patterns (e.g. from plant based diets to increased intake of animal protein and products, or the reverse).[12] Scrutiny over the use of land and food sources therefore will intensify. The following chart demonstrates the expected growth in demand for vegetable oils, oilseeds and products on a per capita basis for the global areas based on population growth patterns.

Expected Growth in Demand for Vegetable Oils, Oilseeds, and Products			
Kg/person/year	2005/2007	2030	2050
World	12	14	16
Developing countries	10.1	13.1	15.4
Developed countries	19	20	21

Source: Food and Agriculture Organization

The flax industry can therefore expect to grow if it takes measures to protect its current market share or indeed expand that share particularly in developing countries. It is well positioned to do so, based not only on the increasing consumer recognition of the healthy benefits of flax, but also the environmentally sustainable practices associated with flax production.

[9] Keogh, J.G. (2014) Transparency will no longer be an option. Presentation to GFSI on February 27, 2014.
[10] Hill, N. (2013) The Transparency Trend. Marketplace. December 11, 2013.
[11] The World Population Prospects: the 2012 Revision. The United Nations, Department of Economic and Social Affairs. 2013.
[12] Alexandratos, N., Bruinsma, J. (2012) World Agriculture Towards 2030/2050. ESA Working Paper No. 12-03. Food and Agriculture Organization.

1.1.3 Aging Demographics

Aging demographics, particularly in the developed countries, links closely with expected growth in global population. Life expectancy has increased dramatically over the last century. Females born in Canada in 1950 for example were expected to live to 71 years of age and males to 66 years. By 2011, females born that year were expected to live to 84 years of age and males to 79 years due to several factors including advances in medicine as well as better nutrition.[13]

As the population ages, the concept of aging is evolving. Consumers are living longer and leading more active lives to remain healthy as long as possible. The significance of the aging population on the food system is that it will need to address the varying nutritional needs of the older, active population as well as those who are elderly with various health problems.[14]

Consequently, the demand for products targeting the aging population will increase. The two key benefits of omega-3 fatty acids and protein in flax make it an attractive ingredient for this age group: omega-3 associations with inflammation and brain health; and protein aimed at maintaining muscle mass.

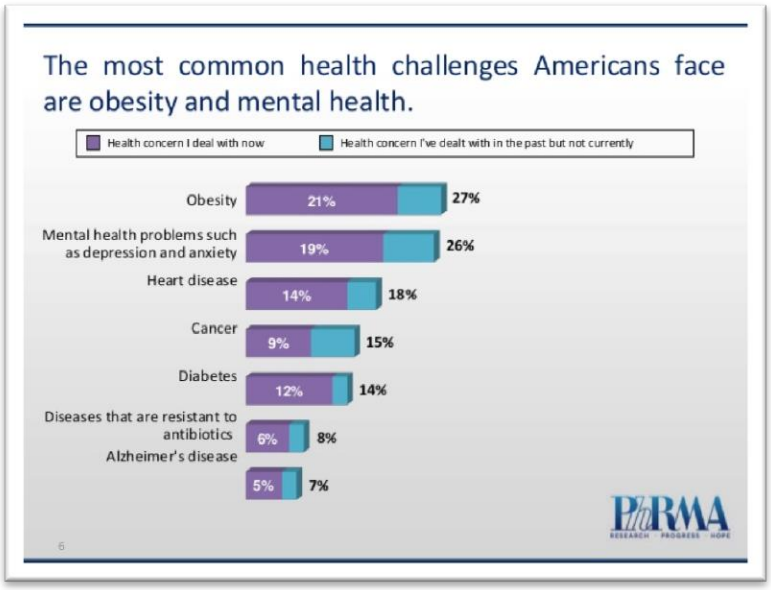
1.1.4 The Cost of Chronic Disease

Although people are likely to suffer from chronic ailments for the last twelve years of life (on average),[15] chronic disease affects people at all life stages. As the population increases and ages, the cost of chronic disease to the health care system will also increase.

Consumers in both Canada and the United States are concerned and affected by chronic disease. A November 2012 survey conducted for the BioAccess Commercialization Centre by Ipsos-Reid found that almost all Canadians (96%) have at least one health concern in their household while 65% claim to have three or more health issues in their household. The survey also found that the top health concerns of Canadians are: heart health (55%); bone/joint health (55%); and weight loss/management (50%). The study revealed that health concerns increase with age with the exception of immunity and sports performance which are both highest among the 18-34 year olds and 35-44 year olds.[16]

Interestingly, mental health is now on the radar of consumers. A survey conducted by Hart Research Associates on behalf of PhRMA in 2013 found that the top two health "challenges" currently facing or having faced by Americans were: obesity (27%) and mental health (26%). Similar to their Canadian counterparts, heart disease (heart health) and diabetes also ranked highly. The top American concerns are outlined in the following chart.

[13] Statistics Canada (2012) Life expectancy at birth, by sex, by province.
[14] O'Donnell, C.D. (2012) 10 Trends and Culinary Tie-In. Food Executive Women Forum.
[15] Deraspe, R. (2011) "Canada's Aging Population and Public Policy: 3. The Effects on Health Care". Briefing submitted to the Parliament of Canada by the Social Affairs Division, Parliamentary Information and Research Service.
[16] Ipsos- Reid (2012) Canadian Baseline Survey: Canadian Consumer Perceptions of Healthy Food, Ingredients and Natural Health Products – 2012. Study conducted for BioAccess Commercialization Centre.



Source: Hart Research Associates

The cost of the health care system is staggering and is expected to continue on an upward spiral. The Canadian Institute for Health Information (CIHR) estimated Canadian total health care spending to be $211B in 2013. The following chart developed by the Canadian Institute for Health Information demonstrates the direct cost of health care as well as growth rates and per capita cost in 2013 ($5,988).[17]

Source: Canadian Institute for Health Research

[17] Canadian Institute for Health Information. National Health Expenditure Trends, 1975-2013.

Three specific chronic diseases can be linked to diet: obesity, cardiovascular disease and diabetes. A brief description of each and their impact on the population and the economy are provided in Annex A.

While the population is not only concerned about chronic disease, consumers have made the linkage between diet and health outcomes. A November 2013 survey conducted by Ipsos-Reid for the BioAccess Commercialization Centre found that 88% of all Canadians believe the food and beverages they consume affect their health. This concern however has only partially translated into action with just under half of the respondents stating that they have made changes to their diet because of specific health concerns.[18] This gap represents an opportunity for the food sector to develop healthier food options that are attractive to the consumers.

Flaxseed can play a role in reducing the burden of health care on the economy. Current research has already proven the linkage of consumption of flaxseed to a reduction in cholesterol levels (5 tablespoons per day of ground flaxseed) which is a major risk factor for cardiovascular disease. The demand for flaxseed will only increase as the results of more research into the benefits of flaxseed consumption are found.

1.1.5 Product Trends

Key product trends arising from the market drivers are evident in the marketplace. They are: the buy local movement, clean labelling, convenience, flexitarianism, and targeted ingredients. Clean labelling and targeted ingredients are specifically applicable to this study and are described below.

Clear Labelling – The Genetically Modified Organism Issue

The market demand for transparency has given rise to the most current terminology - “clear labels”. While there is no regulatory definition of the term or for that of its predecessor term, clean labels, it is deemed to encompass the concept of “free-from” (e.g. free from allergens, gluten, fat, dairy, genetically modified organisms, soy, etc.). The goal of both terms is simplicity and transparency. Definitions of “clear labels” and “clean labels” are shown in the following box. Clear is more all-encompassing - involving not just ingredients but claims and packaging which are not included under "clean" and is used in the remainder of this report.

Clean label: This is an industry term (i.e. no actual standard for clean label) and can have varying definitions depending on the region and demographic profile of the consumer. The focus is on including only ingredients that the consumer understands. This term has been in use for several years. One definition is “Products considered clean label are typically not artificial and are free of artificial ingredients. Further, they are typically preservative-free, have mild to no processing, are cleanly extracted without the use of chemical solvents and are free of additives".[19] Another definition and very simply as defined by Lynn Dornblaser, Director of Innovation and Insight at Mintel is: "a clean label is

[18] Ipsos-Reid (2013) Perceptions of GMO Foods among Canadians. Survey conducted for BioAccess Commercialization Centre.
[19] Berry. D. Clarifying Clean Labels. Food Product Design. May 24, 2011.

one in which they [consumers] recognize the ingredients on the label. In addition, they are products that have more natural ingredients and are less processed".[20]

Clear label is a much more recent term and there appears to be a movement towards the use of "clear labels" spurred on by increasing consumer demand for transparency. This is also an industry term. Mintel, the leading international trend tracker notes that "The move from clean to clear labelling a key trend for 2015 ... reflecting a move to clearer and simpler claims and packaging for maximum transparency," reports Lu Ann Williams, Director of Innova Market Insights.[21] The goal is for fewer ingredients and ensuring that labelling is understandable and believable.

The concern over genetic engineering (GE) or foods containing genetically modified organisms (GMO's) has been of particular interest to the flaxseed industry since 2009 when Canada's flaxseed exports to Europe (representing 70% of the total market for Canadian flaxseed) were stopped when traces of Triffid were found in shipments.[22] Since that time, the Canadian industry has worked hard to cleanse all seed of Triffid and focus solely on the production of non-genetically modified flaxseed.

The demand for a non-genetically modified crop is important in export markets. According to the Non genetically modified organism Project (www.nongmoproject.org), more than 60 countries, including Australia, Japan and all countries of the European Union have either banned the production and sale of genetically modified organisms or put significant restrictions on sales.

While genetically modified crops have not been banned in North America, consumer demand for transparency and sustainability in the food supply is driving the movement for new labelling requirements to identify all food items containing genetically modified organisms.

SPINS research firm states that more than 90% of all Americans want to know if the food products they consume contain genetically modified organisms.[23] With respect to Canada, a BioAccess/Ipsos-Reid survey found that 71% of Canadians say they would avoid buying food containing genetically modified organisms if given the choice. Note however in that same survey only 52% stated that they are prepared to pay more for non-genetically modified foods.[24]

The retail industry as well is reacting to growing market pressures. Whole Foods recently announced a policy that all products on its Canadian and U.S. shelves containing genetically modified organisms must be labeled as such by 2018.

Currently only one organization offers a certification process in the United States and Canada for food manufacturers – the Non-GMO Project. The impact of this certification has been significant. As of

[20] http://live.ift.org/tag/clean-label
[21] http://www.prnewswire.com/news-releases/clear-label-leads-top-10-trends-for-2015-280899252.html
[22] Canadian Broadcasting Corporation (2010) Triffid Seed Threatens Flax Industry. January 20, 2010.
[23] Top Health Ingredients (2013) Understanding the Non-GMO Ingredient Market.
[24] Ipsos-Reid (2013) Perceptions of GMO Foods among Canadians. Survey conducted for BioAccess Commercialization Centre.

January, 2014, annual sales of products utilizing the Non-genetically modified organism Project label reached $4.3 B, not including figures from Trader Joe's or Whole Foods.[25]

Several major brands have also begun the commitment to utilizing only non-genetically modified organism ingredients. In January 2014, General Mills stated that it would stop using genetically modified ingredients for its original Cheerios cereal.[26] Examples of other brands making the switch are: Kellogg's Kashi brand, B&G Food Polaner brand, Post's Grape nuts and Smart Balance. This presents an opportunity for flax and its positioning as a non-genetically modified ingredient.

Targeted Ingredients - Protein

Proteins, both animal and plant, are used in baking, pasta, candy, dairy and dairy free products, nutritional supplements, infant formula, and meal replacements. The quality of protein is a function of the relative proportions of essential amino acids relative to human requirements; and the extent to which protein is digested and absorbed by the body and made available to synthesize proteins. Animal proteins generally score better in amino acids than plant proteins. Plant proteins are blended in order to improve quality. Interactions between blended plant proteins, however, can cause problems. Digestibility is influenced by the presence of anti-nutritional factors and processing techniques. Functionality "refers to any property other than nutritional composition that influences their utilization". In terms of functionality milk and egg proteins are highly rated because of their solubility. Plant proteins, on the other hand, can be more difficult to incorporate because of strong flavour profiles and low solubility. [27]

The global market for protein is expected to be worth $24.5 B in 2015. [28] Frost & Sullivan estimated the global market for plant protein ingredients to be 1.6 M tonnes in 2012 and is expected to grow to 2.3 M tonnes by 2018. For comparison purposes, the global market for animal protein ingredients was 2.3 M tonnes in 2012[29] and is dominated by dairy-based ingredients at nearly 50% of the global share of the animal segment.[30]

North America represents the largest market for plant proteins as ingredients capturing 49% of the market followed by the European market at 29%. The largest demand of plant proteins are in food and beverage applications.[31]

The key sources of plant protein are soy, wheat and pea as identified by Frost & Sullivan.[32]

[25] Aaron Sanger of the Non-GMO Food Project, at a January 2014 BCFPA workshop in British Columbia.
[26] Horovitz, B. (2014) Cheerios drops genetically modified ingredients. USA Today. January 2, 2014.
[27] Nickerson M, J House, and E Li-Chan, "Canadian Proteins", http://canadianfoodinsights.com/2013/07/08/canadian-proteins/
[28] Nickerson M, J House, and E Li-Chan, "Canadian Proteins", http://canadianfoodinsights.com/2013/07/08/canadian-proteins/
[29] Kane, L. (2014) Trends in Protein Ingredients. Food Product Design. September 2014
[30] Shanahan, C. (2013) The Global Protein Ingredients Market. Natural Products Insider. July 11, 2013.
[31] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market
[32] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market.

- Soy derived proteins are the largest segment of plant based proteins with 53.4% of the market.
- Wheat derived proteins represent 44% of the market for plant based proteins but is expected to decrease to 41% of the overall market by 2018.
- Pea derived proteins captured only a small share of the market at 0.4% but with an annual growth rate of 5.7%.
- Emerging plant-based proteins are derived from potato, canola, rice and chia. These new protein sources are expected to enjoy a healthy growth of more than 5% during the next five years.[33] Additional sources of plant proteins including lupin, microalgae and mycroprotein (from fungi) are appearing on the market as the industry searches for sustainable and "free-from" alternatives.

See the Annex for additional information regarding plant proteins as noted above.

While protein appears to be a hot trend, Mintel reported that the United States represents the strongest market globally for foods and drinks making a high protein claim, almost 3 times that of anywhere else, accounting for 19% of global new product launches with that claim in 2012. The following table demonstrates that the global snack, cereal and energy bars category continues to attract the most interest in product development and launches utilizing high protein claims.[34]

High protein claim penetration in selected categories, % of category launches global, 2010-13				
	2010	2011	2012	2013
	%	%	%	%
Snack, cereal and energy bars	10.8	9.7	7.6	10.9
Spoonable and drinkable yogurt	1.0	1.3	1.8	3.2
Bread and bread products	0.5	0.4	0.7	0.4
Note: 2013 includes first eight months of the year				

Source: Mintel GNPD

Several factors are increasing the demand for plant based protein and the trend of "protein mainstreaming" [35]: 1) demand is growing for healthier ingredients; 2) preferences are shifting towards gluten free and vegan; 3) plant protein is less costly and the supply is large relative to dairy based proteins; and 4) the soy sector has spent significant dollars to grow its share (and the plant share in turn). [36] Factors limiting the growth of plant proteins include 1) lower solubility and functionality compared to animal based proteins; 2) allergens associated with wheat and soy; and 3) the strong flavor of legumes is disliked by consumers.[37] Non-soy proteins are also challenged by the lack of consumer awareness. Growth of animal proteins is being negatively affected by growing competition from plant

[33] Shanahan, C. (2013) The Global Protein Ingredients Market. Natural Products Insider. July 11, 2013.
[34] Mintel GNPD.
[35] Kane, L. (2014) Trends in Protein Ingredients. Food Product Design. September 2014.
[36] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market.
[37] Nickerson M, J House, and E Li-Chan, "Canadian Proteins", http://canadianfoodinsights.com/2013/07/08/canadian-proteins/

protein; its price volatility; and the fact that in emerging markets nutrition is more important than functionality.[38]

Opportunities therefore exist for flax in the development of protein based food products: the key elements are that it is not soy and is allergen-free. The flax industry can help manufacturers make the transition to usage of flaxseed in these products by investing in areas of functionality and product development.

Targeted Ingredients - Omega-3 Fatty Acids

In total, the global omega-3 fatty acid human-use products' market was valued at USD $33 B in sales in 2012[39] and is estimated to grow to $37.7 B in 2016.[40]

While fish and marine sources represent the largest source of omega-3, they are under extreme pressure from regulatory bodies and sustainability concerns of consumers. Some of the largest and most productive fisheries that provide omega-3s may not be able to meet growing demand for the ingredient beyond a few more years.[41] Other sources of omega-3 include crops such as flaxseed and chia.

Global production of omega-3 from all sources was estimated at 2.49 million metric tons in 2013. It is forecast to grow to 32.8% annually in volume by 2018. Plant omega-3 production value is expected to grow twice as fast as marine and by 2018 and is predicted to account for 52% of production value.[42]

In 2012, by volume, Europe represented the largest consumer of omega-3 ingredients (60%) followed by North America.[43] North America however represented the largest market based on consumer spending capturing 43% of the dollar share of the overall market in 2012. The North American market has plateaued however and the Asian market is expected to catch up to North America by 2016.[44] The high birth rates in countries such as India and China are expected to increase the demand for the sale of omega-3 ingredients in applications such as infant formula. As well, the shift to western diets in the Asian countries has led to increased focus on health, particularly cardiovascular disease which has directly impacted the demand for omega-3 ingredients. New sources of omega-3 therefore will be required as demand increases.

[38] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market.
[39] Schofield, L. (2013) the Omega 3 Market: Essentially Innovative. Nutraceuticals World. September 9, 2013.
[40] Carr, M. (2014) Meeting Global Omega-3 Demand with Algae. SupplySide Insights. July 2014. Virgo Publications.
[41] Carr, M. (2014) Meeting Global Omega-3 Demand with Algae. SupplySide Insights. July 2014. Virgo Publications.
[42] Schofield, L. (2013) the Omega 3 Market: Essentially Innovative. Nutraceuticals World. September 9, 2013.
[43] Grand View Research (2014) Omega 3 Market Analysis and Segment Forecasts to 2020.
[44] Schultz, H. (2012) Retail omega-3s sales to hit $34.7 billion in 2016, report products. Nutraingredients.

With respect to the ingredient market for omega-3 fatty acids, in 2011, dietary supplements captured 46% of the revenue, pharmaceuticals 20%, and the food and beverage category captured 13% market share. Infant formula, animal feed and clinical nutrition captured the rest.[45]

Omega-3 Fatty Acid Use in Canada

A 2012 BioAccess Commercialization Centre/Ipsos Reid[46] survey examined Canadian consumer perceptions of healthy food (including functional food), ingredients and natural health products. With respect to omega-3 fatty acids, the survey results found:

1. 80% of Canadians are influenced to buy a product if it contains omega-3 fatty acids with Saskatchewan (85%) and British Columbia (83%) showing the greatest uptake.

2. 45% of all Canadians have used or are using omega-3 fatty acids in a natural health product format. The source of omega-3 was not specified.

3. 56% of Canadians who take natural health products, take or have taken omega-3 in dosage format. This finding represents an increase of over 211% over a Health Canada[47] survey (conducted by Ipsos-Reid) taken in 2010.

See the Annex for additional information regarding Canadians' usage of omega-3 fatty acids.

Omega-3 Fatty Acid Use in the United States

A 2013 survey of Americans conducted by the Hartman Group found that 52% of consumers in that country are adding omega-3 fatty acids to their diets. In addition, 45% of them have specifically noted that they have added fish oil.[48]

A recent survey conducted by the International Food Information Council explored American perceptions of various functional nutrients associated with specific health issues. The survey[49] found that there is a very high recognition among Americans of omega-3 fatty acids linked to the reduction of heart disease and cognitive development. Specifically, the survey found:

- 85% of Americans were aware that omega-3 fatty acids reduce the risk of heart disease;
- 48% are already eating omega-3 fatty acids to reduce the risk of heart disease and an additional 44% indicate that they are very or somewhat likely to consume food with omega-3 fatty acid in the next 12 months;

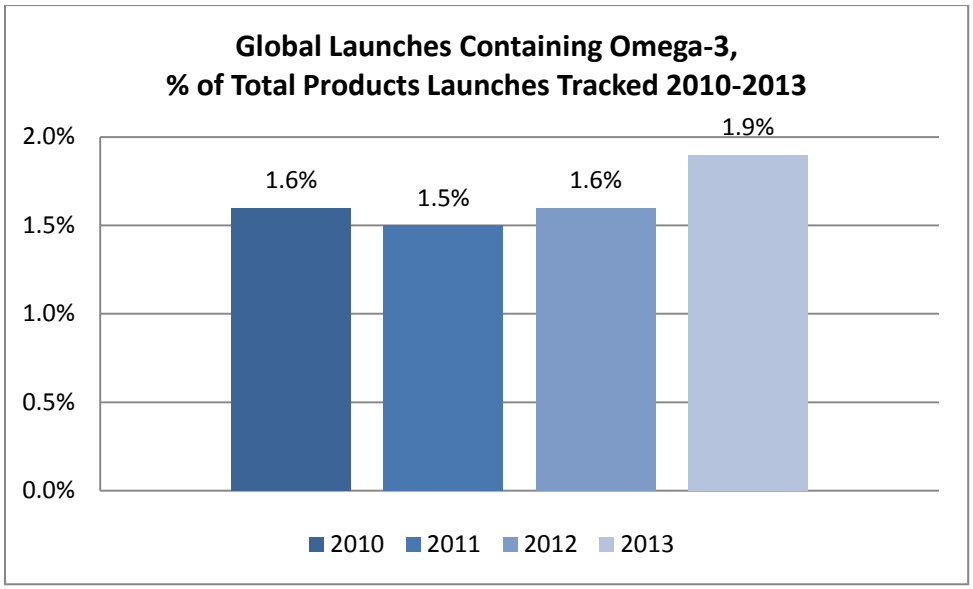
[45] SupplySide Insights. (2013) Defining the Global: Omega-3 On-Track for Expansion & Diversification.
[46] Ipsos Reid (2012) Canadian Baseline Survey: Canadian Consumer Perceptions of Healthy Food, Ingredients and Natural Health Products – 2012. Conducted for BioAccess Commercialization Centre December 2012.
[47] Ipsos-Reid (2010) Natural Health Product Tracking Survey. Conducted for Health Canada.
[48] Demeritt, L. (2013) Reimagining Health and Wellness. Hartman Group
[49] International Food Information Council (2011) A Place on the Plate for Functional Foods: Helping Consumers Achieve Optimal Health with Diet. Sponsored by the American Dietetic Association.

- 73% of Americans associate omega-3 fatty acids with cognitive development, especially in children;
- 45% of Americans are already consuming these food components for cognitive development, especially in children; and
- 39% stated that they are very or somewhat likely to begin eating omega-3 fatty acids for cognitive development.

While omega-3 fatty acids have received significant consumer recognition for their health promoting benefit, half of Americans surveyed in a 2013 functional foods consumer survey conducted by the International Food Information Council believe they either are not receiving sufficient amounts to meet their needs or are not sure.[50]

Omega-3 Fatty Acids' Product Launches

Continued interest in the potential health benefits of omega-3 fatty acids is reflected by the recent increase in new product launch activity containing omega-3 with a wide variety of health claims allowed in the various regions in association with this ingredient. While product launches tracked with omega-3 claims have grown 85% since 2012[51] in absolute numbers, as a percentage of total food launches, it has increased only slightly. The following chart illustrates that global launches of products containing omega-3 as a percentage of total global launches increased to 1.9% in 2013 from 1.6% in 2010.[52]

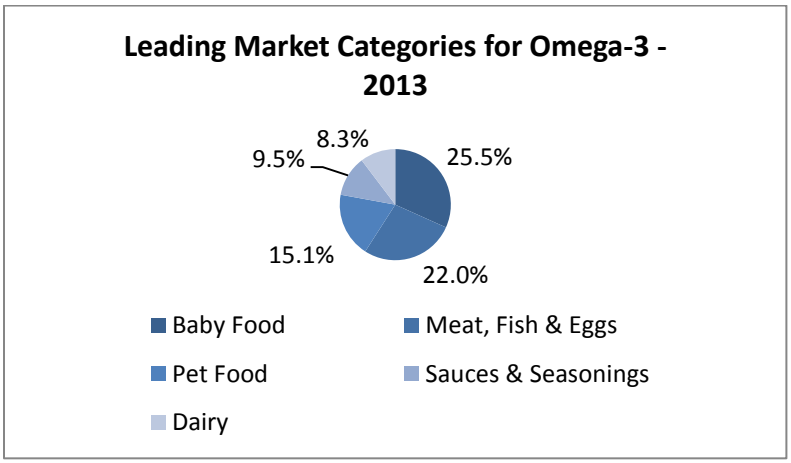


Source: Innova Market Insights

As a result of an increasing body of research demonstrating the benefit of omega-3 fatty acids to brain health in developing brains, it is not surprising that the baby food category leads in new product launches containing this ingredient. In 2013, baby food products containing omega-3 captured 25.5% of

[50] International Food Information Council (2013) Functional Foods Consumer Survey.
[51] Food Ingredients first (2014) Product Launches Tracked with Omega-3 Claim.
[52] Innova Market Insights (2014) Omega-3 Onwards and upwards. September 2014.

all new launches. The meat, fish and eggs category followed closely at 22% as indicated in the table below.



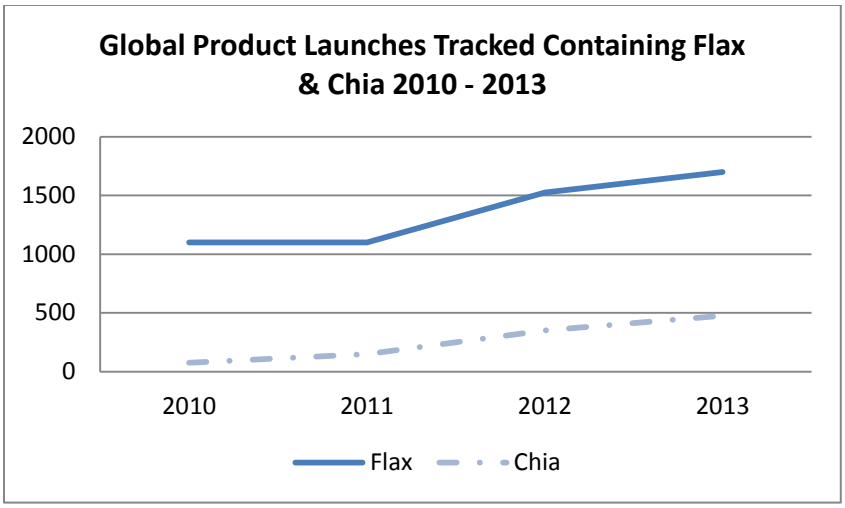
Source: Innova Market Insights

As noted above, dairy products containing omega-3 fatty acids have been prominent. According to Innova Market Insights however, their share of total dairy launches (excluding dairy alternative drinks) fell from 2.4% in the 52 weeks to the end of October 2008 to 1.5% in the same period in 2013. Innova attributes this relative retraction to the "recent tightening up of claims legislation".[53]

From a global perspective, North America leads with the largest number of dairy launches using omega-3 claims, with nearly 35% of the global total. The key dairy sectors utilizing omega-3 claims are yellow fats and milks accounting for approximately 80% of global launches using either omega-3 or DHA claims in 2013.[54]

Plant sources of Omega-3 fatty acids have gained traction in new product development. Flax and chia for example have both achieved growth. Global product launches containing flax garnered a 19% compound annual growth rate (CAGR) between 2010 and 2013 while product launches containing chia increased by 90.5% CAGR[55] over the same time frame as outlined in the following chart.

[53] Innova Market Insights (2014) Omega 3s in Dairy – Down but not Out?
[54] Innova Market Insights (2014) Omega-3 Onwards and upwards. September 2014.
[55] Ibid.



Source: Innova Market Insights

The Annex contains examples of new product launches containing flax.

Flax – Contributing to a Healthy Diet

Flaxseed has attracted added recognition for its human health benefit due to regulatory events in both Canada and the United States (as outlined in the following sections). Most notably in the market, flaxseed is known for as a source of omega-3 fatty acids. Alpha-linolenic acid (ALA) constitutes about 57% of the total fatty acids in flaxseed, making it one of the richest sources of ALA in the diet.[56]

> *"**Alpha-linolenic acid (ALA)** is the true essential omega-3 fatty acid, being required in our diets because our bodies do not make it. ALA has important roles in human health. It dampens inflammation, which is a feature of many chronic diseases like heart disease, stroke and cancer. It is incorporated into cell membranes, promotes the health of blood vessels and is converted to long-chain omega-3 fatty acids. Young women appear to convert more ALA to long-chain omega-3 fatty acids than men do, possibly because of their greater need for omega-3 fats during pregnancy and lactation. The efficiency of ALA conversion by both women and men is affected by diet. Our bodies use ALA to make energy for work and play and to form ketone bodies, which may help preserve cognition in elderly adults. Excess ALA is stored in adipose tissue to meet future energy needs." (Dr. Diane H. Morris – Metabolism of Alpha-Linolenic Acid, Flax Council of Canada)*

[56] Morris, D.H. (2007) Flax – A health and nutrition primer. Winnipeg, Manitoba. Flax Council of Canada.

In addition to flax, ALA is found in other others such as soybean and canola (under 10%) as well as walnuts, brussel sprouts, kale, spinach and salad greens.

Canada's Health Claim for Milled Flax

Only eleven health claims have been approved for use by Health Canada. Milled flax achieved that status in January 2014. *"Health Canada's Food Directorate has concluded that scientific evidence exists to support a claim about ground whole flaxseed and blood cholesterol lowering. The claim is relevant and generally applicable to the Canadian population given that a high proportion of the population (39% of Canadians aged 6 to 79) has unhealthy total cholesterol levels, putting them at an increased risk for heart disease."*[57] The following chart notes the statements allowed by Health Canada that can be used by the food industry and with which quantities.

"The following statements may be made in the labelling and advertising of food products meeting the qualifying criteria.

Primary statement:
[*serving size from Nutrition Facts table in metric and common household measures*] of (*brand name*) [*name of food*] supplies/provides X% of the daily amount [of ground (whole) flaxseed]* shown to help reduce/lower cholesterol.

For example:
16 g (2 tablespoons) of ground flaxseed supplies 40% of the daily amount shown to help lower cholesterol.

The "daily amount" referred to in the primary statement is 40 g of ground whole flaxseed. This amount is based on the evidence available concerning the amount of ground whole flaxseed shown to help reduce cholesterol. In this statement, the percentage of the daily amount of ground whole flaxseed provided in one serving should be rounded to the nearest multiple of 5%."[58]

"The following additional statements could be placed adjacent to the primary statement, in letters up to twice the size and prominence of those in the primary statement:

- *Ground (whole) flaxseed helps reduce/lower cholesterol*
- *High cholesterol is a risk factor for heart disease*
- *Ground (whole) flaxseed helps reduce/lower cholesterol, (which is) a risk factor for heart disease"*[59]

Nutrient Content Claims for Flax in Canada

Nutrient content claims refer to the level of a specific nutrient (e.g. omega-3) in a food and can be noted on the label if it meets the criteria as set out in the Food and Drug Regulations by Canadian Food

[57] http://www.hc-sc.gc.ca/fn-an/label-etiquet/claims-reclam/assess-evalu/flaxseed-graines-de-lin-eng.php
[58] http://www.hc-sc.gc.ca/fn-an/label-etiquet/claims-reclam/assess-evalu/flaxseed-graines-de-lin-eng.php
[59] http://www.hc-sc.gc.ca/fn-an/label-etiquet/claims-reclam/assess-evalu/flaxseed-graines-de-lin-eng.php

Inspection Agency (CFIA). The following table outlines CFIA's specific requirements for an omega-3 nutrient content claim.

Summary Table of Omega-3 Polyunsaturated Claim			
Column 1 **Claim**	**Column 2** **Conditions - Food**	**Column 3** **Conditions - Label or Advertisement**	**Column 4** **FDR Reference**
a) Source of omega-3 polyunsaturated fatty acids "source of omega-3 polyunsaturated fatty acids" "contains omega-3 polyunsaturated fatty acids" "provides omega-3 polyunsaturated fatty acids" Note: "polyunsaturated fatty acids" may be substituted with "polyunsaturated fat" or "polyunsaturates" in the above claims. It cannot be stated as "omega-3" without the "polyunsaturates" added. Refer to Implied Nutrient Content Claims for further information.	The food contains: (*a*) 0.3 g or more of omega-3 polyunsaturated fatty acids per reference amount andserving of stated size; or (*b*) 0.3 g or more of omega-3 polyunsaturated fatty acids per 100 g, if the food is a prepackaged meal.	Must comply with requirements and conditions for making a nutrient content claim. Nutrition Facts table is required on Foods Usually Exempt from Displaying a Nutrition Facts Table by B.01.401(2)(a) and (b) of the FDR [B.01.401(3)(e)(ii), FDR]. When used in an advertisement, must comply with the Advertising Requirements for Nutrient Content Claims.	[B.01.402 (3) and (4)] [B.01.401(3)(*e*)(ii)] Table following B.01.513, item 25
Canadian Food Inspection Agency. Specific Nutrient Content Claim Requirements. Omega-3 and Omega-6 Polyunsaturated Fatty Acid Claims. http://www.inspection.gc.ca/food/labelling/food-labelling-for-industry/nutrient-content/specific-claim-requirements/eng/1389907770176/1389907817577?chap=7			

GRAS Status for Flax in the United States

Food manufacturers, particularly the large companies, are more inclined to incorporate "new" ingredients into their products that have achieved GRAS (Generally Recognized as Safe) by the United States Food and Drug Administration (FDA). GRAS indicates that the ingredient in question is deemed to be free of harmful toxins or unsafe side effects. In 2009, the Flax Council of Canada received a "no objection" letter from the Food and Drug Administration providing whole and milled flax seed GRAS status[60] for use in foods up to 12%.[61]

Structure/Function and Nutrient Content Claims for Flax in the United States

Structure/function claims for conventional foods focus on effects derived from nutritive value, while structure/function claims for dietary supplements may focus on non-nutritive as well as nutritive effects. The Food and Drug Administration does not require conventional food manufacturers to notify it about

[60] https://www.send2press.com/newswire/2009-03-0316-004.shtml.
[61] Prepared Foods, "Flax Heart Health", 2007.

their structure/function claims.[62] An example of a structure/function claims is "omega-3 ALA from flaxseed supports overall health" or "omega-3 helps support a healthy heart".

Utilizing terms "high", "low", "rich in", "excellent source", "good source", "contains" are classified under nutrient content claims and describe the level of a nutrient or dietary substance in the food product. The claim must refer on the nutrient level in the food. With respect to omega-3 ALA for example, the statement must be based on the dietary reference intake (DRI) of 1.3 grams. Food manufacturers do not require pre-approval from the Food and Drug Administration, but the claims must be truthful and not misleading.[63]

This section demonstrates that flax is well positioned to increase its status and share in global food production and manufacturing. It is in line with all major market drivers and trends. The key benefits of omega-3 fatty acids, protein and fibre have consumer recognition that consumption of these attributes positively contributes to their health. Scientific evidence has proven a linkage of consumption of flaxseed to lowering cholesterol levels, also recognized by consumers as a risk to heart health. The demand for plant based proteins, particularly those that are not associated with allergens or genetic modification, is increasing. As well, products containing omega-3 will continue to grow in demand. With fish stocks dwindling, plant-based alternatives are being sought. Flax is therefore has the opportunity set before it in the food industry.

[62] Structure/Functional Claims. United States Food and Drug Administration. February 26, 2014.
[63] Healthy Flax. "The United States Nutrition Facts Label Guidelines for Labelling Whole Milled Flax". 2014.

1.2 Green Economy

The United Nations Environment Programme defines a green economy "as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive. Practically speaking, a green economy is one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. These investments need to be catalyzed and supported by targeted public expenditure, policy reforms and regulation changes. This development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and source of public benefits, especially for poor people whose livelihoods and security depend strongly on nature."[64]

The movement towards a green economy is affecting both the seed and straw side of the flax market.

1.2.1 Food

As the food system comes under closer scrutiny of regulators, social activists and consumers alike, care for the environment and sustainable practices will increasingly drive the market. Consumers will increasingly demand products that demonstrate ethical and welfare standards, fair-trade, provenance and bio-diversity.[65]

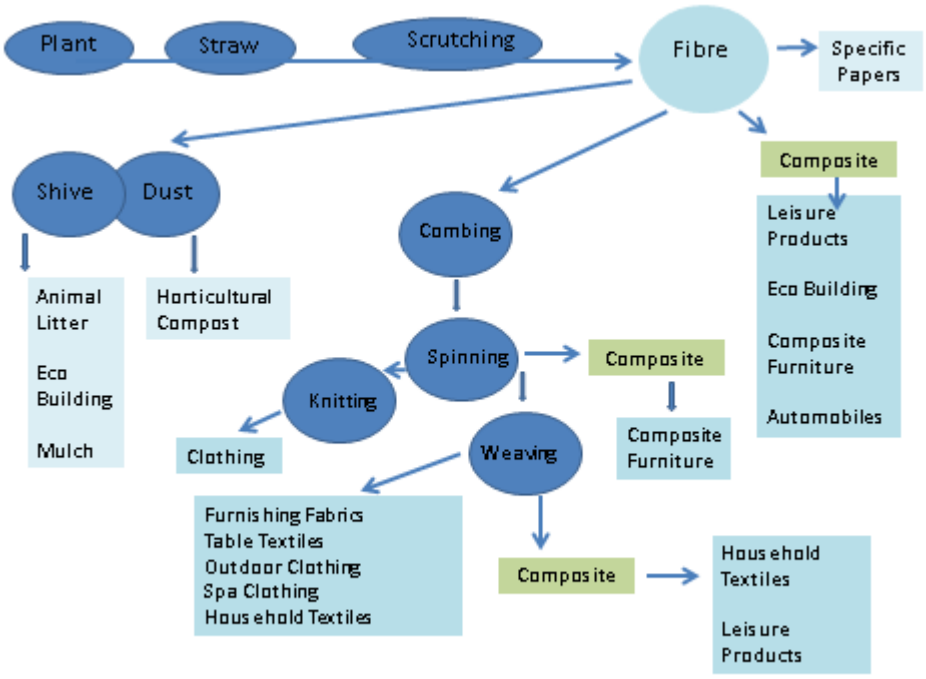
In addition, as environmental sustainability and carbon footprint increase in importance, two key impacts on the food system will be: 1) the increasing shift to eco-friendly packaging[66]; and 2) reducing food loss and waste – food loss during production and food waste at the retailer and consumer level of the food system.[67]

Flax fits well with the trend toward more environmentally and ecologically sound practices. Flax is not genetically engineered, and through total utilization of the crop will therefore meet the demand for sustainability and reduction of loss at the production level. As well, research into the expansion of the use of flax for packaging continues to address the growing demand for eco-friendly packaging.

[64] http://www.unep.org/greeneconomy/AboutGEI/WhatisGEI/tabid/29784/Default.aspx
[65] http://www.foodmanufacture.co.uk/Business-News/Seven-top-trends-for-the-food-industry-in-2013-LFR/?c=QGXiBN2qwM03L8v9jKiJxw%253D%253D&utm_source=Newsletter_Subject&utm_medium=email&utm_campaign=Newsletter%252BSubject
[66] Zafar, S. (2014) Trends in Environmental Sustainability. EcoMENA.
[67] Waste Reduction is Top Food and Beverage Trend for 2014. http://www.thinkeatsave.org/index.php/waste-reduction-is-top-food-and-beverage-trend-for-2014

1.2.2 Fibre Overview

A vast array of products can be made with flax fibre, ranging from animal litter to automobile parts as shown below. Fibre can be made directly into specific papers such as cigarette papers; composite products such as tennis racket; or combed. After combing the fibre is spun and then knitted or weaved or turned directly into a composite material.



Source: http://www.mastersoflinen.com/eng/lin/1-la-filiere-de-proximite

Many of the factors driving the flax fibre markets are related to the environment.

Fibre crops have lost market share over time because of 1) competition from relatively cheaper wood fibre in markets for pulp and paper, composites, and fibre board; 2) competition from synthetic fibres in textile markets; 3) inability to reach the scale necessary to supply a competitively priced bulk commodity; and 4) difficulty in meeting the needs of a volatile high-end textile market.[68]

In the cellulose sector, bast fibre crops have the most value in textiles, followed by non-wovens, and then in pulp and paper.

[68] Van Dam J, "Markets for Fibre Crops in EU and China", Food and Biobased Research, Wageningen UR, July 14, 2014.

In order to grow the use of biobased fibre products, they must be commoditized: easy to transport and store (or have great value in downstream uses), have standardized quality, and the product is interchangeable. Without these characteristics it is difficult for large scale trade to occur. [69]

1.2.3 Pulp and Paper

Flax and hemp chemically pulped bast fibres are used to produce specialty papers that are resistance to tearing and remain strong when wet such as cigarette paper, papers used in bibles, and paper money. Cotton linter is a strong competitor because of the volume of its production. [70]

While the use of flax and hemp is environmentally friendly, one of the major end-uses, cigarette paper, is not. However, globally cigarette consumption is falling by 1% annually (3% without China). In 2013 5.8 trillion tobacco sticks were consumed. In North America and Oceania, consumption is falling by 4% annually while in Europe consumption is falling by 7% annually. Cigarette consumption is growing in China at the rate of 3% annually.[71]

1.2.4 Building Materials

Flax fibre's acoustical and thermal properties are used in non-woven materials such as insulation. Consumers' demands for sustainability are the major market driver.[72] Flax shives can be used to produce particle boards (a thermosetting resin is added). Flax shives have been used in China to make particle boards for over thirty years. [73] Cellulosic fibres such as flax and inorganic binders such as lime and cement are combined to produce light weight building blocks and panels.

1.2.5 Polymer Composite Materials

Fibres such as flax are used in polymer composite materials such as automotive parts (interior and exterior parts). The need to reduce weight and thus reduce energy consumption and the need to improve recyclability drive this market. Flax fibre is used as substitutes for reinforcing glass fibre. In the European Union about 92,000 tonnes of polymer composites are produced annually from fibres such as flax and hemp. A new use of flax fibre is unidirectional fabric made of parallel untwisted flax fibres. Flax and other base fibres are not used to produce resonated fibre boards such as MDF and HDF because wood chips are cheaper to use as feedstock and it is difficult to get long fibres evenly distributed. [74]

"Biocomposites: A material formed by a matrix (resin) and a reinforcement of natural fibers (usually derived from plants or cellulose). Biocomposites are characterized by the fact that: the petrochemical is replaced by a plant resin and/or the bolsters (fiberglass, carbon fiber or talc) are replaced by natural fiber (wood, hemp, flax, sisal, corn, kenaf...) "[75]

[69] Van Dam J, "Markets for Fibre Crops in EU and China", Food and Biobased Research, Wageningen UR, July 14, 2014.
[70] Van Dam J, "Markets for Fibre Crops in EU and China", Food and Biobased Research, Wageningen UR, July 14, 2014
[71] SWM, "Investor Presentation", August 2014.
[72] Van Dam J, "Markets for Fibre Crops in EU and China", Food and Biobased Research, Wageningen UR, July 14, 2014
[73] Van Dam J, "Markets for Fibre Crops in EU and China", Food and Biobased Research, Wageningen UR, July 14, 2014
[74] Van Dam J, "Markets for Fibre Crops in EU and China", Food and Biobased Research, Wageningen UR, July 14, 2014
[75] http://www.mcgbiocomposites.com/bio101.html

The adoption of bio-based materials in the automotive sector is occurring because of regulations, economics, company policies, and product advantages. [76]

- Regulatory: The European Union has very strict regulations regarding recyclability and fuel economy. Some Asian countries have also adopted stringent requirements. Even though regulation in the United States is lighter, United States manufacturers wanting to export cars to Asian markets must comply. This and the use of global contracts for parts is increasing the adoption of bio-based materials. In the United States, auto companies are using bio-materials to replace glass and talc which reduces weight and helps to meet fuel efficiency standards (The United States Government and automotive companies agreed to reach 54.5 miles per gallon by 2020).

- Economics: High petroleum prices and price fluctuations create difficulties for automotive part manufacturers. Bio-based materials can be used to hedge against rising and fluctuating prices.

- Company Policies: Some automotive companies have adopted environmental policies/goals. Environmental sustainability is viewed favorably by some consumers.

- Product Advantages: Sometimes bio-based composites have advantages for conventional parts such as being lighter or more effective in absorbing energy in a crash.

Challenges to using bio-based materials in the automotive sector include the following:

- Bio-based materials can be used successfully in interiors but they are generally not strong or rigid enough for use in structural components.
- Are susceptible to water damage
- Plant oil and fibre varies by season and geography which results in variation in the appearance and texture of bio-based components.
- Can be manufacturing difficulties
- Switching costs
- Not enough suppliers – companies don't want the risk of relying on only one supplier

1.2.6 Textiles

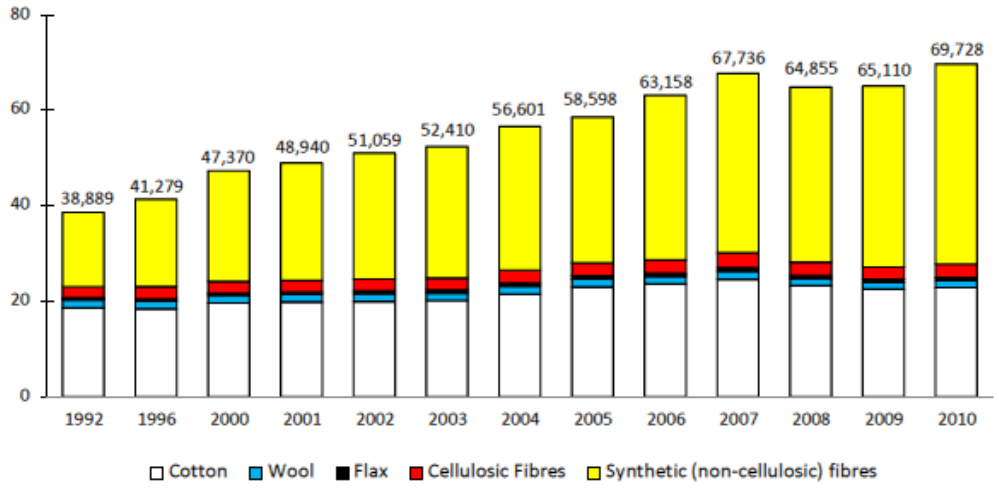
The use of flax to produce linen is an ancient practice yet part of today's green economy.

The global demand for textiles is determined by population, extent of urbanization, consumerism, and applications. [77] The Food and Agriculture Organization and the International Cotton Advisory Committee (ICAC) survey textile manufacturers to estimate the global consumption of textile fibres. The 2013 update provides data for 2010. Textile fibre consumption was almost 70 M tonnes in 2010, an 80% increase from 1992. As shown below global fibre consumption is growing because of increasing

[76] Centre for Automotive Research, "The Bio-Based Materials Automotive Value Chain", April 2012.
[77] https://www.ic.gc.ca/eic/site/textiles-textiles.nsf/eng/h_tx03222.html

consumption of synthetic fibres. Consumption of flax was 682,000 tonnes in 2010 compared to 709,000 tonnes in 2005. The market share for flax is about 1%.

Figure 1. Evolution of world apparel fibre consumption, in million tons



Source: Food and Agriculture Organization and International Cotton Advisory Committee, "World Apparel Fibre Consumption Survey", July 2013.

In developed countries, the apparel fibre consumption shares were: 48.2% synthetic, 43.2% cotton, 4.9% cellulosic, 3.0% wool and 0.7% flax. The shares in developing countries were 68.0% synthetic, 26.0% cotton, 3.3 % cellulosic, 1.5% wool and 1.1% flax. The top consumers of flax for apparel in 2010 were China, Russia, Poland, United States, Italy, France, Saudi Arabia, Pakistan, United Kingdom, and Japan.[78]

Industry experts suggest that the global textile manufacturing sector is suffering from over capacity because of technical change and government policy. The goal of the Multi-Fibre Arrangement was to protect the textile industries in the European Union, Canada, and the United States through the establishment of import quotas that were on individual countries. However this gave buyers an economic incentive to source product from quota free countries. This resulted in the establishment of textile sectors in quota free countries that were inefficient. The Multi-Fibre Arrangement ended in 2005 and since then China, India, Bangladesh, Indonesia, and Vietnam which are low cost producers and adopters of new technology have been crowding out less efficient producers.[79]

The strongest opportunities for flax fibre in the Green Economy lie in composites. Regulations, economics, company policies, and natural advantages are driving the opportunity. The utilization of flax fibre in specialty paper such as cigarette paper is falling as the global rate of smoking declines. Flax fibre utilization for textiles has fallen because of the growth of synthetic fabrics.

[78] Food and Agriculture Organization and International Cotton Advisory Committee, "World Apparel Fibre Consumption Survey", July 2013.
[79] https://www.sourcingjournalonline.com/forces-change-global-textile-industry-transition-robert/

1.3 Utilization for Livestock and Pets

1.3.1 Benefits of feeding flax to livestock:

The nutritional attributes of the major plant based protein meals (plus fish meal) used globally are described in the following table. These values were derived from a number of sources. The values shown are those that would often be used in formulating poultry rations (with the exception of crude fiber which is included for illustrative purposes). As can be seen there is a wide range of values amongst these protein sources.

Nutrient Values of Different Protein Meals									
Meal Type	DM	Protein	Fat	Crude fiber	Poultry ME	TSAA [A]	Lysine	Tryptophan	Threonine
	%	%	%	%	Kcal/kg	%	%	%	%
Flax seed	92	22	34	6.5	3957	0.87	0.92	0.22	0.77
Flax (Expeller)	90	32	3.5	9.5	1540	1.03	1.1	0.47	1.1
Flax (Solvent)	88	33	0.5	9.5	1400	1.06	1.1	0.48	1.2
Canola	90	37.6	3.8	11.0	2087	1.72	2.0	0.5	1.5
DDGS	90	26.4	8.8	8.3	2739	0.99	0.8	0.2	0.9
Peanut	90	47	2.5	8.4	2677	1.10	1.52	0.42	1.12
Soybean	90	48.9	1.0	3.1	2514	1.44	3.1	0.7	2.0
Sunflower	90	40.6	2.2	30.0	1703	2.13	1.6	0.5	1.5
Fish (White)	90	60.3	4.0	1.0	2571	2.37	4.3	0.7	2.6
A) Total sulfur amino acids (methionine plus cystine)									

Source: Various

A second comparison, shown below, shows the relative values of the different meals and compares them to soybean meal. Again the prices were derived from a variety of sources and as much as possible indicate average values for 2012/2013. The comparison is then made of the relationship of the protein content of the different meals to the difference in price relative to soybean meal. If there were no negative attributes associated with a given meal one would expect the price difference to be similar to the difference in protein content. As can be seen from the values there is a huge range in price difference in relation to nutrient values. This indicates that factors beyond just protein are used to value the different meals.

Comparison of Protein and Value Differences Compared to Soy					
Meal Type	**Protein %**	**Protein % of soy**	**$ Value [A]**	**Value % of soy**	**Difference [B]**
Flax seed	22	45	530	103	+58
Flax (Expeller)	32	65	NA	NA	
Flax (Solvent)	33	67	325	63%	-4
Canola	37.6	77%	264	66%	-11
DDGS	26.4	54%	255	63%	9
Peanut	47	96%	129	32%	-64
Soybean	48.9	100%	516	100%	0
Sunflower	40.6	83%	235	58%	-25
Fish (White)	60.3	123%	1125	280%	157
3. US $/tonne; B) Difference between protein and $ value					

Source: Various

Solvent extracted flax meal (linseed meal) appears to trade close to the value that would be expected due to its protein content. It is relatively low in lysine and energy which would limit its use in high energy diets like those for broiler chickens or turkeys. Since the total volume of linseed meal produced is very low in comparison to soybean or canola, it should not be difficult to achieve a market clearing price. Also the amount of meal produced from processing flax seed is low in comparison to soybeans since the oil content is 34% versus 18% for soybeans. Therefore the price of the meal has less influence on the value of the seed.

Expeller meal is slightly higher in fat and lower in protein than solvent extracted meal. The fat content is not enough higher to make it significantly more valuable that solvent extracted meal so it would be expected to trade at pricing that would be similar to the solvent meal.

Whole flax seed is the product that is used to derive enriched feeds and to produce health benefits in livestock.

1.3.2 Enriched Feed

Diet modification/supplementation can be used to adjust the nutrient content of livestock and poultry products. The principle reasons to do so are 1) enhance the nutritional contribution; and 2) produce a premium price branded product. The strategy does work. In Q3 of 2012, Cal-Maine Foods, the largest producer of eggs in the world, reported that specialty eggs were 16.7% of sales volume but 23.6% of sales value. [80] Nielsen data indicates that omega -3 eggs account for 9% of major retail egg sales.

"Enrichment is a strategy appropriate to industrialised countries where there is a demographic willing to pay a premium for an added-value product. In developing countries, supplementing eggs to compensate for nutrient deficiencies may be a viable strategy if supported by a national health agency."[81]

According to Leeson and Summers at the University of Guelph, each 1% increase in the inclusion rate of flaxseed results in a 40 mg increase in omega-3 acids in an egg. To reach the 300 mg of omega-3 required in most markets, the inclusion rate for flax needs to be 6%. Allowing for biological diversity in hens and flax the recommended inclusion rate is a minimum of 8% and a maximum of 10%. For layers, a heat treatment of flax seed reduces anti-nutritional factors such as mucilage and phytic acid. Grinding before use is recommended. [82]

The amount of flaxseed required for omega-3 enhanced beef and pork can be estimated using information from the Oleet web-site where the company seems to recommend 15% of their product for the last 60 days in cattle. Their product appears to be about 60% flaxseed so that would be 9% flaxseed in the diet. A company in Ontario that is promoting Omega 3 pork purportedly uses fish oil as their source.

[80] http://www.worldpoultry.net/Layers/Markets-Trade/2014/1/Egg-enrichment-for-health-and-marketing-1435620W/
[81] http://www.worldpoultry.net/Layers/Markets-Trade/2014/1/Egg-enrichment-for-health-and-marketing-1435620W/
[82] http://www.worldpoultry.net/Layers/Markets-Trade/2014/1/Egg-enrichment-for-health-and-marketing-1435620W/

1.3.3 Pet Food

According to Agriculture and Agri-Food Canada, Mintel suggests that the key global drivers of cat and dog food are 1) health and naturalness; 2) functionality; 3) premiumization; 4) fortification; 5) branding; 6) aging and allergies; and 7) healthy options. Omega 3 is added to products to improve the skin and coats (functionality) and to improve the nutritional value (fortification). The large scale product recall of 2007 raised awareness of the importance of food safety in pet food. [83]

The pet food market is responding to the "humanization" of pets as members of the family by product differentiation and premiumization. There is growing market segmentation in terms of age, breed, and health maintenance. Consumers want their pets to be healthy. The demand for natural health products and nutritional ingredients are growing. They also want their pets to consume food with recognizable and familiar ingredients and this has resulted in more products that are organic, natural, or eco-friendly. Consumers, however, are price conscious and the share of pet food purchased from grocery stores compared to specialty stores is growing. [84]

In 2011 there were just over 5 M dogs in Canada. In terms of cats, 38.5% of households had cats.[85]

Market size and growth in Canada is shown below. The value of the Canadian pet food market for dogs and cats in 2016 is expected to be $1.8 B with a volume of 484,000 tonnes.

Canadian Pet Food Market					
	2006	CAGR 2006 to 2011	2011	CAGR 2011 to 2016	2016
Cat Food Volume (000 of Tonnes)	142.1	1.5%	152.8	0.9%	160.1
Cat Food Value (M of $)	542.6	3.9%	655.9	1.9%	730.3
Dog Food Volume (000 of Tonnes)	282	1.4%	302.2	1.4%	323.8
Dog Food Value (M of $)	799.8	3.9%	969.0	2.2%	1080.7

Source: Agriculture and Agri-Food Canada, "Consumer Trends: Pet Food in Canada", September 2012

Market size and growth in the United States is shown below. In 2013, the value of the cat and dog food market was $21 B US and the volume was 8.3 M tonnes.

Pet Food Market in the United States					
	2000	CAGR 2000 to 2010	2010	CAGR 2010 to 2013	2013
Cat Food Volume (000 of Tonnes)	2,002.7	0.7%	2,126.0	3.3%	2,268.5
Cat Food Value (B of $)	4.32	4.2%	6.25	3.2%	6.66
Dog Food Volume (000 of Tonnes)	5,598.2	0.6%	5,920.2	0.8%	6,016.8
Dog Food Value (B of $)	7.9	5.4%	12.7	4.6%	13.9

Source: http://www.petfoodinstitute.org/?page=PetfoodSales

[83] Agriculture and Agri-Food Canada, "The United States: A Growing Pet Food Market", May 2010.
[84] Agriculture and Agri-Food Canada, "Consumer Trends: Pet Food in Canada", September 2012.
[85] Agriculture and Agri-Food Canada, "Consumer Trends: Pet Food in Canada", September 2012.

1.4 Discovery of Genetically Modified Flax

In 2009 Canadian producers seeded 692,000 ha of flax. After a genetically modified variety, Triffid, was discovered seeded acres fell to 370,000 ha in 2010 (a 47% drop). Acreage did not recover until 2014. This section describes the impact of the discovery of the genetically modified variety of flax.

Of the 0.75 M tonnes of flax produced each year by Canada, about 80% is exported. The largest customer prior to 2009 was the European Union, accounting for about 70% of exports. The Triffid variety was developed by the Crop Development Centre at the University of Saskatchewan. It received approval for feed in 1996 and for human consumption in 1998. The United States also approved Triffid. When it became apparent that Canada could lose the European Union flax market because of the genetically modified variety, a decision was made to deregister it. Triffid was never produced commercially but it was being multiplied in anticipation. In 2001, initial seed stock was recalled and destroyed and the germ plasm was destroyed. At that point in time it was not possible to test for the presence of Triffid. In July 2009, Triffid was found in a flax shipment in the European Union. Subsequently, it was found in over 100 products. The European Union closed its market to Canadian flax. The Canadian Grain Commission confirmed the presence of Triffid with its own testing. The Canadian Grain Commission in collaboration with the Flax Council of Canada and the European Commission Directorate for Health and Consumer Affairs developed a protocol to allow exports of Canadian flax to the European Union.[86]

1.4.1 Economic Impacts

The contamination was widespread in Canada, with 3.5% of farm and elevator samples testing positive; 10% to 15% of rail shipments testing positive; and 7% of vessel holds testing positive for Triffid. Protocols were developed for exports to Japan and Brazil when Triffid was found in shipments to these countries. Viju found the following economic impacts:

- Canada: decrease in exports to the European Union (some increase to China but at a lower price); lower total exports; lower farmgate price; testing costs for producers ($105/test up to Sept 2010 and then higher price after – Federal funding now provides some funding for testing)
- European Union: cost flax industry about 23.5 M Euros (lower profits, recall costs, destroyed products, storage costs, customer claims, shut down costs); couldn't replace Canadian flax which resulted in significant price increase in European Union

Ryan and Smyth estimated costs to the Canadian industry total $29.1 M. The cost was made up of:[87]

- Demurrage/quarantine costs: $12 M
- Testing Costs: $3.9 M

[86] Viju C, M Yeung, and W Kerr, "Post-Moratorium EU Regulation of Genetically Modified Products: Triffid Flax", CATPRN Commissioned Paper 2011-03, September 2011

[87] Ryan C and S Smyth, "Economic Implications of Low-level Presence in a Zero-Tolerance European Import Market: The Case of Canadian Triffid Flax", AgBioForum, 15(1): 21-30, 2012

- Segregation and other costs for breeders, certified seed suppliers, producers, grain companies, Agriculture and Agri-Food Canada, and SaskFlax: $13.2 M

1.4.2 Impact on Trade

The discovery of Triffid dramatically changed Canadian flaxseed exports. As shown below, in 2008/09 Belgium-Luxembourg accounted for 67% of Canadian exports. The United States and China were the next largest customers with shares of 18% and 11% respectively. Canada was forced to find customers to replace the European Union after the discovery of Triffid. By 2012/13, the top markets were the United States and China with shares of 35% and 33% respectively. Belgium-Luxembourg only accounted for 23% of Canadian exports.[88]

Top Five Export Markets for Canadian Flaxseed					
2008/09			2012/13		
Country	000 Tonnes	Share	Country	000 Tonnes	Share
Belgium-Luxembourg	416.1	67%	United States	168.3	35%
United States	111.7	18%	China	158.2	33%
China	70.6	11%	Belgium-Luxembourg	112.8	23%
Japan	7.9	1%	Vietnam	10.0	2%
Mexico	4.6	1%	Japan	5.5	1%
All Exports	616.8		All Exports	481.7	

Source: Canadian Grain Commission and Statistics Canada

1.5 Other Factors

Historically, the industrial market for linseed oil was the primary driver of the flaxseed market.

The industrial demand for linseed oil has been affected by technical change since the 1950's. Water based paints and petroleum based floor coverings reduced the demand for linseed oil. In the late 1990's, however, environmental awareness began to provide linseed oil new opportunities such as the increased demand for linoleum (which is biodegradable and non-allergenic).Because of its instability linseed oil is not suitable for use as biodiesel. [89]

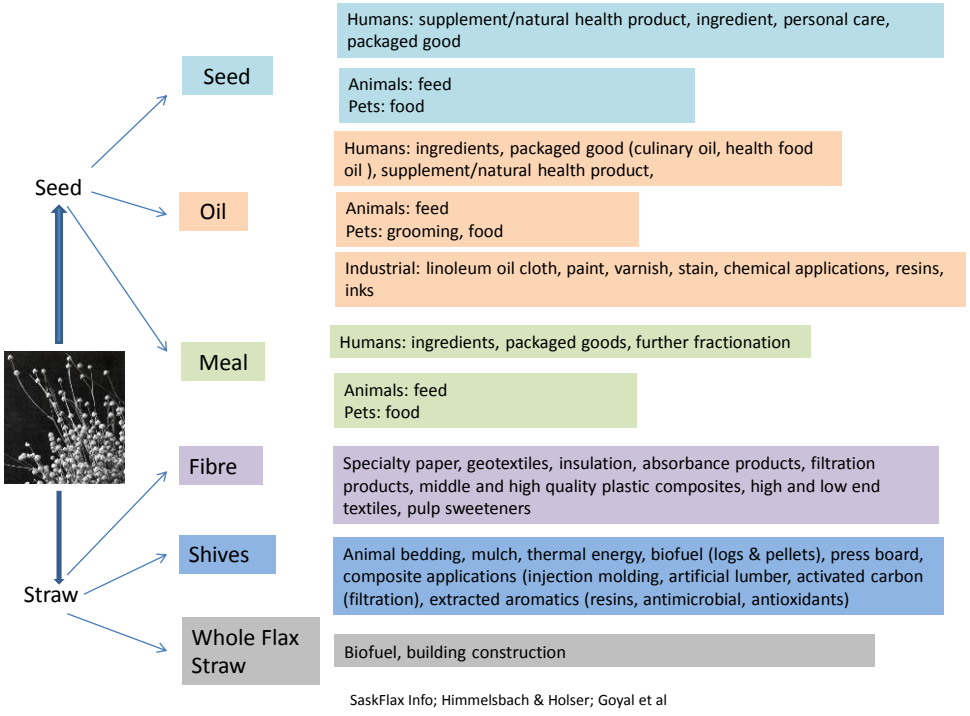
In 2000, the linseed oil produced in the United States was primarily used for the production of resins and plastics (40% of linseed oil production) and paint and varnish (39%).[90] (most recent data available)

[88] ''Canadian Grain Exports'' and ''Exports of Canadian Grain and Wheat Flour'', Canadian Grain Commission and Statistics Canada, International Trade Division (http://www.grainscanada.gc.ca).
[89] Agriculture and Agri-Food Canada Bi-Weekly Bulletin, "Flaxseed Situation and Outlook", February 2007
[90] United States International Trade Commission, "Industry and Trade Summary: Oilseeds", 2003.

2. Overview of the Global Market

Flaxseed has a long history of cultivation and usage. Archaeological finds of flax have been made in Egypt (5,000 BC), Switzerland (8,000 BC) and the Republic of Georgia (34,000 BC).[91] One of the earliest mentions of flax in history is by Hippocrates, the father of medicine, who "prescribed" flax to relieve abdominal pains. There are two basic types of flaxseed: brown and golden. Both types are similar in nutrition and identical number of omega-3 fatty acids.[92]

Flaxseed is very versatile with a plethora of uses. The following chart provides a high level view of how the flax plant is utilized. The seed can be crushed, resulting in oil and meal or used as a seed in its whole form, roasted, sprouted, ground, etc. Seed, oil, and meal are consumed by humans, animals, and pets. The oil is also used by industry to produce linoleum, varnish, ink, etc. Flax straw can be used in its whole form as biofuel and for building construction. Flax fibre is used for products such as specialty paper and plastic composites. Shives are used for mulches, bedding, bioenergy products and composite products.



SaskFlax Info; Himmelsbach & Holser; Goyal et al

[91] http://mostlyaboutflax.blogspot.ca/p/growing-and-processing-flax-class.html

2.1 Global Flaxseed Acreage, Productivity and Production

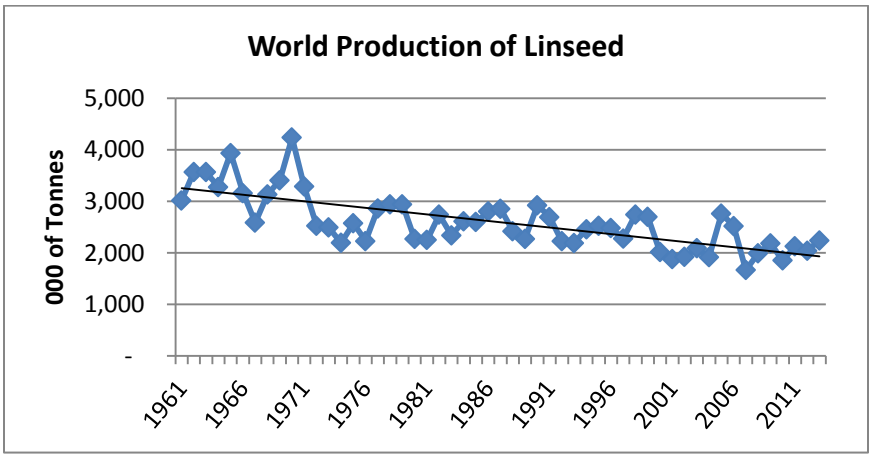
In 2013, 2.3 M ha of flax was harvested throughout the world. The following table provides the acreage, yield, and production for the top ten countries in terms of acreage. The annex contains the data for all countries producing flax in 2013. Canada, Russia, and Kazakhstan had the largest acreages in 2013 and their acreages were above the five year average. World production of linseed in 2013 was 2.2 M tonnes, as estimated by the Food and Agriculture Organization. Canada with 0.7 M tonnes of production was the largest producer with 32% of world production. China, Russia, and Kazakhstan were the next largest producers with between 13% and 15% of the world production each. The table also shows the yield per acre. Of the major producers, Canada has the highest productivity but as the annex table indicates that yield per hectare is higher in Sweden, Tunisia, Switzerland, France, and New Zealand.

2013 Global Linseed Acreage, Yield, and Production: Top Ten in Terms of Acreage						
	Area Harvested		Yield		Production	
	Ha		T/Ha		Tonnes	
	2013	Ave 2009-13	2013	Ave 2009-13	2013	Ave 2009-13
Canada	412,000	404,360	1.73	1.42	712,000	584,480
Russian Federation	410,000	238,940	0.79	1.29	325,756	289,370
Kazakhstan	384,300	269,440	0.77	0.66	295,020	173,648
India	338,000	371,542	0.43	0.42	147,000	153,780
China, mainland	330,000	332,686	1	1.03	330,000	341,918
Ethiopia	105,722	112,927	0.99	0.97	104,948	111,165
United States	56,960	111,836	1.5	1.29	85,242	144,214
Ukraine	38,000	50,560	0.66	0.79	25,000	40,240
United Kingdom	34,000	34,000	1.5	1.71	51,000	58,000
Belarus	29,024	41,906	0.24	0.24	7,005	9,849
World	2,270,353	2,150,745	0.99	0.97	2,238,938	2,087,600

Source: http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E

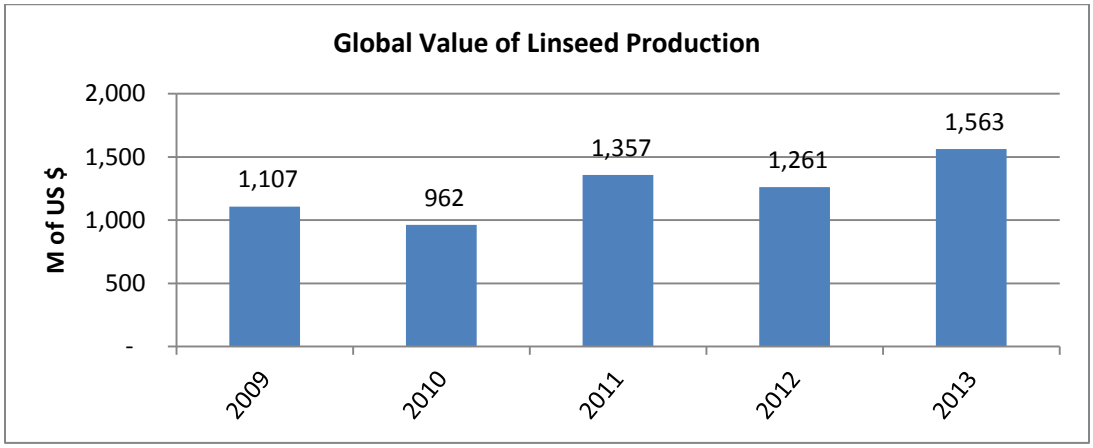
2.2 Global Flaxseed Market Volume, Value and Trade

In 2013, about 2.2 M tonnes of linseed/flaxseed were produced throughout the world compared to 3.0 M tonnes in 1961. As the following chart shows, global production peaked at 4.2 M tonnes in 1970. Throughout the 54 years production decreased at an average annual rate of 0.6%. [93]



Source: Food and Agriculture Organization

The market value of linseed production over the 2009 to 2013 period is shown below. In 2013 the value of the linseed production in the world was estimated to be $1.6 B US. This estimate used the Food and Agriculture Organization global production and the average export value of linseed ($US 698/tonne) from the International Trade Centre.



Source: Author

As shown below, world exports of flaxseed are growing rapidly in terms of value (16% CAGR). Although Canada was the top exporter in 2013, Russian exports are growing very rapidly as are exports from Kazakhstan. Belgium was the largest importer in 2012 with about one-third of total imports. China, the

[93] The terms, "flaxseed" and "linseed" are used interchangeably in this study.

United States and Germany were the next largest importers. United States imports are growing by 12% annually while China's and the Netherland's are growing by 10% annually. In 2013, the volume of exports was 1.3 M tonnes.

Global Trade Overview, 120400 Linseed, whether or not broken, 000 of US $							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	509,556	625,744	651,986	906,244	918,735	16%	
Top Exporters							
Canada	256,668	320,764	238,292	270,235	373,411	10%	41%
Russian Federation	31,680	45,079	118,125	187,364	170,756	52%	19%
Belgium	103,369	76,271	90,070	100,431	121,795	4%	13%
Kazakhstan	7,666	14,988	50,005	177,567	79,467	79%	9%
United Kingdom	19,247	30,565	37,440	34,697	30,082	12%	3%
Imports							
World	596,231	690,145	766,924	850,468	902,353	11%	
Top Importers							
Belgium	230,391	281,516	274,067	283,220	303,088	7%	34%
China	81,423	96,401	58,154	91,858	118,756	10%	13%
United States of America	76,225	87,170	136,813	122,802	118,386	12%	13%
Germany	77,445	58,632	96,368	108,719	98,867	6%	11%
Netherlands	22,084	34,750	35,873	32,377	32,577	10%	4%

Source: International Trade Centre

The following table provides an overview of Canadian trade in flaxseed in 2013. Top export markets were China, the United States, and Belgium. Top export markets in the United States were Minnesota, North Dakota, and Washington. Canada imported less than 20,000 tonnes of flaxseed in 2013 primarily from the United States but also from Russia and Kazakhstan. United States imports were primarily from North Dakota, Minnesota, and Oregon. The average export value was $705/tonne while the average import value was $584/tonne.

Canadian Flaxseed Trade, 2013			
HS 120400 - Linseed			
Exports	Tonnes	$	$/Tonne
World	542,687	382,579,423	705
Top 3 Export Destinations			
China	207,292	141,171,007	681
United States	161,562	118,567,141	734
Belgium	128,008	85,023,390	664
Top 3 States			
Minnesota	98,733	61,866,909	627
North Dakota	13,945	11,656,844	836
Washington	5,519	6,959,412	1,261
Imports	Tonnes	$	$/Tonne
World	16,590	9,693,298	584
Top 3 Import Countries			
United States	14,569	7,495,235	514
Russian Federation	1,100	1,142,824	1,039
Kazakhstan	449	490,201	1,092
Top 3 States	Tonnes	$	$/Tonne
North Dakota	3,487	2,504,837	718
Minnesota	2,361	1,895,051	803
Oregon	7,017	1,006,581	143

Source: Statistics Canada

A snapshot of trade in flaxseed by the United States is shown below. The United States was a net importer in 2013. Canada is the largest export customer of the United States followed by China and Mexico. Almost all of flax seed imported by the United States is from Canada. The imports from China and Peru have a much higher per unit value indicating that they have undergone some processing. The high priced flaxseed could also be organic.

United States Flaxseed Trade, 2013			
HS 120400 - Linseed			
Exports	Tonnes	000 of $	$/Tonne
World	17,943	16,445	917
Top 3 Export Destinations			
Canada	7,977	7,716	967
China	5,918	4,005	677
Mexico	1,166	1,264	1084
Imports	Tonnes	000 of $	$/Tonne
World	164,580	118,386	719
Top 3 Import Countries			
Canada	163,784	116,957	714
China	123	341	2,772
Peru	53	213	4,019

Source: International Trade Centre

In 2013, the United States imported 164,580 tonnes of flaxseed valued at $118.3 M US. Canada accounted for over 99%. The United States imported small amounts from China and Peru. Other small sources of imports were Kazakhstan, Uruguay, Netherlands, and Argentina. States importing flaxseed from China in 2014 and 2013 included California, New Jersey, New York, and North Dakota. Florida, New Jersey, and New York imported small quantities from Peru. Importers from Kazakhstan included

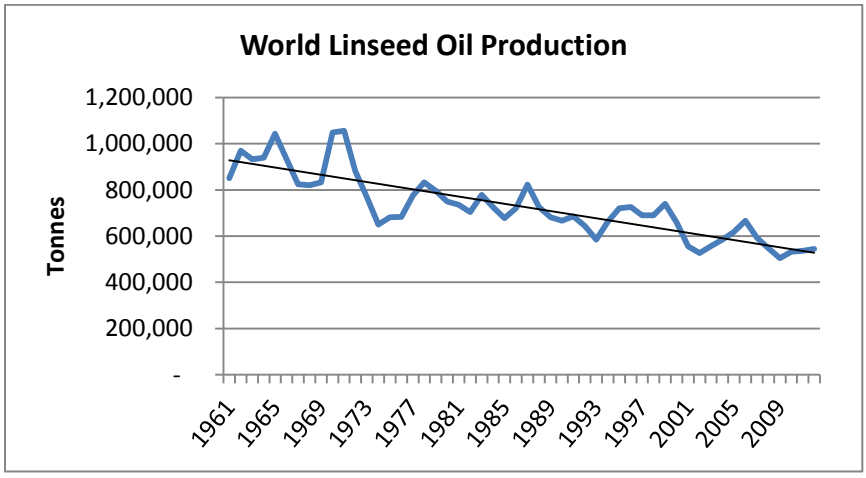
Washington, New York, Minnesota, and California while Minnesota, New York, and North Dakota imported from Argentina.[94]

Trade flows of flaxseed within North America are contained in the Appendix.

[94] State data from USA Trade Online

2.3 Global Flaxseed Oil Market Volume, Value, and Trade

The global production of linseed oil as estimated by the Food and Agriculture Organization for the period 1961 to 2012 is shown below. In 2012 global production was 544,000 tonnes compared to production of 851,000 tonnes in 1961. Production exceeded 1 M tonnes in 1965, 1970 and 1071. Over the period shown below, production decreased at an average annual rate of 0.9%.



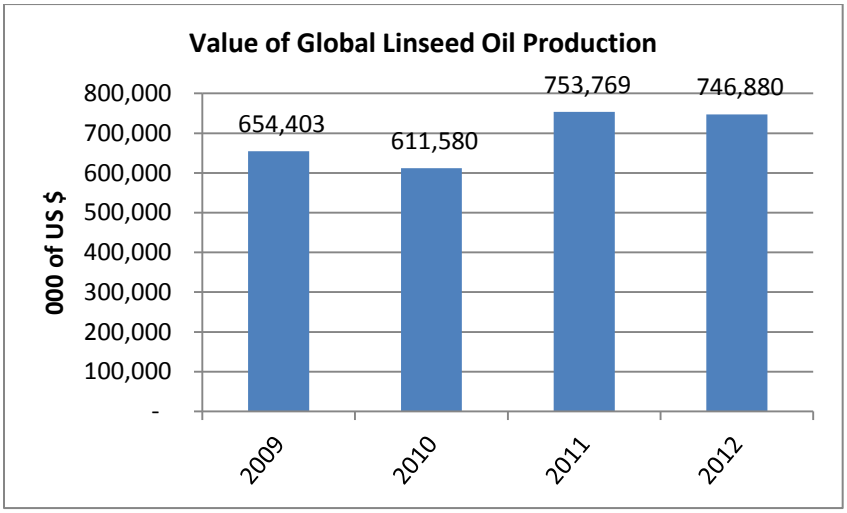
Source: Food and Agriculture Organization

China was the largest producer of linseed oil in 2012 with 22% of global production of 543,977 tonnes. Belgium and the United States were close behind in terms of production both with about 19% of world production. Although the Food and Agriculture Organization pegs Canadian linseed oil production at 12,300 tonnes in 2012, actual production is much lower (because after 2011 none of the large crushers in Canada crushed flax). The Food and Agriculture Organization estimate for the United States in 2012 is 102,965 which is relatively close to United States Department of Agriculture's estimate of linseed oil production in 2012/13 of 97,727 tonnes. China is both a large linseed producer and large linseed oil producer. Canada, Russia, and Kazakhstan were large producers of flaxseed but produced minimal amounts of flaxseed oil. The Annex contains production information for all countries producing linseed oil in 2013.

World Linseed Oil Production, 2012, Top Ten		
Area	Tonnes	Share World
China, mainland	120,400	22.1%
Belgium	104,916	19.3%
United States	102,965	18.9%
India	42,000	7.7%
Germany	41,100	7.6%
Ethiopia	36,258	6.7%
Turkey	12,316	2.3%
Canada	12,300	2.3%
Italy	8,500	1.6%
Egypt	8,100	1.5%
World	543,977	

http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QD/E

The global market value of linseed oil production over the 2009 to 2012 period is shown below. In 2012 the value of the linseed oil production in the world was estimated to be $747 M US. This estimate used the Food and Agriculture Organization global production and the average export value of linseed crude oil ($1,249 US/tonne) and refined oil ($1,497 US/tonne) from the International Trade Centre.



Source: Author

The following table shows global trade of both crude and refined linseed oil.[95] Exports of crude oil are growing slowly (5%). Belgium supplied over 50% of world crude oil exports in 2013. Canada had a 3% market share. Canadian exports of this product are falling. The largest importers of crude oil are China, Netherlands, Chile, Germany, and the United Kingdom with shares ranging from 10% to 16%. Imports by Chile, the United Kingdom and China are growing rapidly. Trade in refined linseed oil is stable, with neither imports nor exports growing. Belgium is the largest exporter of refined oil. Canada had only 4% of the market in 2013 and its exports are declining. Imports of refined linseed oil are somewhat fragmented. The Netherlands' imports represented 27% of total imports. The next largest importer was Germany and it had a 9% market share. The volumes of crude and refined linseed oil exported in 2013 were 106,086 tonnes and 86,260 tonnes (actually for 2012).

[95]"All raw vegetable oils that are derived from industrial oilseeds by milling, pressing or solvent extraction contain various amounts of glycerine free components such as free fatty acids, partial glycerides (mono- and diglycerides), phosphatides, sterols, tocopherols, hydrocarbons, protein fragments etc., Most of the glycerine free components in oil are undesirable because they cause discolouration, darkening or foaming of the oil, they release smoke fumes and can even accelerate these processes. Some of these glycerine free components are desired because of their positive influence on the properties of oil (tocopherols, antioxidants and sterols). The purpose of refining oil is to remove any undesired glycerine free components from the oil with minimal impact on the triglycerides and with minimal loss of the desired glycerine free components. Refining processes include degumming, neutralization, bleaching, deodorization and often even winterisation." (http://www.gea.si/en/health/vegetable-and-plant-based-oils/).

Global Trade Overview, 151511 Linseed oil, crude, 000 of US $							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	117,221	126,466	131,577	139,441	141,522	5%	
Top Exporters							
Belgium	57,166	60,626	61,633	59,426	78,839	8%	56%
United States of America	16,686	28,807	28,416	34,176	23,905	9%	17%
Germany	14,891	4,509	13,267	18,474	14,835	0%	10%
Netherlands	11,201	21,063	11,643	11,498	4,113	-22%	3%
Canada	8,162	2,205	6,211	2,948	3,863	-17%	3%
Imports							
World	106,175	92,502	131,143	148,510	143,827	8%	
Top Importers							
China	11,109	4,661	23,097	48,059	22,835	20%	16%
Netherlands	20,282	11,128	19,298	31,630	20,892	1%	15%
Chile	262	117	76	4,407	18,358	189%	13%
Germany	20,858	27,504	27,980	12,597	18,057	-4%	13%
United Kingdom	4,576	9,005	16,088	15,426	14,933	34%	10%
Global Trade Overview, 151519 Linseed oil and its fractions, refined but not chemically modified, 000 of US $							
Exports							
World	111,489	100,880	132,314	129,090	109,440	0%	
Top Exporters							
Belgium	57,037	44,481	57,434	51,508	52,057	-2%	48%
Germany	11,354	12,093	15,592	13,355	13,148	4%	12%
United States of America	13,848	14,627	15,910	12,069	10,724	-6%	10%
Spain	1,687	2,396	4,676	4,306	6,717	41%	6%
Canada	5,697	4,059	4,409	5,226	4,152	-8%	4%
Imports							
World	177,029	167,771	230,045	182,236	176,300	0%	
Top Importers							
Netherlands	19,630	22,813	55,759	40,977	46,937	24%	27%
Germany	22,356	16,285	21,399	14,489	15,361	-9%	9%
United Kingdom	5,961	7,178	11,386	12,189	11,019	17%	6%
Korea, Republic of	6,370	6,927	8,978	9,174	9,106	9%	5%
Japan	8,001	7,310	10,336	8,318	7,282	-2%	4%

Source: International Trade Centre

Canada's trade in crude linseed oil is very small with exports of just over 1,000 tonnes in 2013. The United States was the largest customer with New York the largest destination. Canadian imports were primarily from the United States with some from Belgium and France. United States imports were primarily from Washington, Minnesota, and Montana. The average export value of Canadian exports of crude linseed oil in 2013 was $3,361/tonne. The average import value was $3,923/tonne.

Canadian Linseed Crude Oil Trade, 2013			
HS 151511 - Linseed Oil - Crude			
Exports	Tonnes	$	$/Tonne
World	1,131	3,799,622	3,361
Top 3 Export Destinations			
United States	1,044	3,461,218	3,316
United Kingdom	34	116,091	3,455
Japan	21	103,236	4,822
Top 3 States			
New York	907	2,904,754	3,204
New Jersey	64	248,162	3,860
South Carolina	37	123,293	3,324
Imports	Tonnes	$	$/Tonne
World	426	1,672,339	3,923
Top 3 Import Countries			
United States	380	1,485,459	3,906
Belgium	41	159,183	3,870
France	3	19,652	6,019
Top 3 States	Tonnes	$	$/Tonne
Washington	162	974,611	6,021
Minnesota	145	346,742	2,385
Montana	70	153,075	2,172

Source: Statistics Canada

United States trade in crude linseed oil in 2013 is shown below. The United States exported over 18,000 tonnes with a value of almost $24 M US. Top destinations were Chile, China and Canada. States exporting crude oil to Chile included Minnesota and Oregon. United States imported just over 1,000 tonnes of crude linseed oil. The top source was Canada. States importing crude linseed oil from Belgium included New Jersey, New York, Indiana, and California. California also imported crude oil from China.

United States Trade in Crude Linseed Oil			
151511 Linseed oil, crude			
Exports	Tonnes	$ US	$/Tonne
World	18,632	23,905,000	1,283
Top 3 Export Destinations			
Chile	9,609	11,784,000	1,226
China	8,000	9,170,000	1,146
Canada	389	1,431,000	3,679
Imports	Tonnes	$ US	$/Tonne
World	1,086	3,495,000	3,218
Top 3 Import Countries			
Canada	1,044	3,353,000	3,212
Belgium	41	134,000	3,268
United Kingdom	1	6,000	6,000

Source: International Trade Centre

An overview of Canada's trade in refined linseed oil is shown below. Canada is a net importer of this product. The United States was both the largest export and import destination. Canadian exports were

primarily to Wisconsin, California, and Pennsylvania while Canada imported primarily from Minnesota. The average export value in 2013 was $6,331/tonne and the average import value was $2,134/tonne.

Canadian Refined Linseed Oil Trade, 2013			
HS 151519 - Linseed Oil and its Fractions - Refined but not Chemically Modified			
Exports	Tonnes	$	$/Tonne
World	656	4,154,039	6,331
Top 3 Export Destinations			
United States	451	3,020,495	6,703
Japan	89	496,707	5,568
China	56	269,081	4,818
Top 3 States			
Wisconsin	74	751,386	10,184
California	121	426,616	3,514
Pennsylvania	21	237,386	11,047
Imports	Tonnes	$	$/Tonne
World	1,396	2,979,957	2,134
Top 3 Import Countries			
United States	1,306	2,571,199	1,968
China	78	367,339	4,681
Canada	5	19,356	4,174
Top 3 States	Tonnes	$	$/Tonne
Minnesota	1,091	2,571,199	2,356
Washington	75	1,887,918	25,125
New York	86	345,829	4,029

Source: Statistics Canada

The average value of refined linseed oil exports by Canada in 2013 was $6,331/tonne.

A snapshot of the United States' trade in refined linseed oil is shown below. In 2013, the United States exported just under 12,000 tonnes valued at $10.7 M US. The top destinations were Canada, Mexico and Japan. A small amount of refined linseed oil was imported with Canada, China and Philippines the top sources. The volume from China was significantly higher than the amount imported from Canada. Importers of refined oil from China included New Jersey, New York, California, and Florida. States exporting refined oil to Mexico included California, Minnesota, New Jersey, New York and Texas. Minnesota and New Jersey were exporters to Japan. Comparing the United States' trade in refined and crude linseed oil reveals that the United States is exporting low priced oil and importing higher priced oil. This could reflect exports of industrial oil and imports of flaxseed oil for the food market.

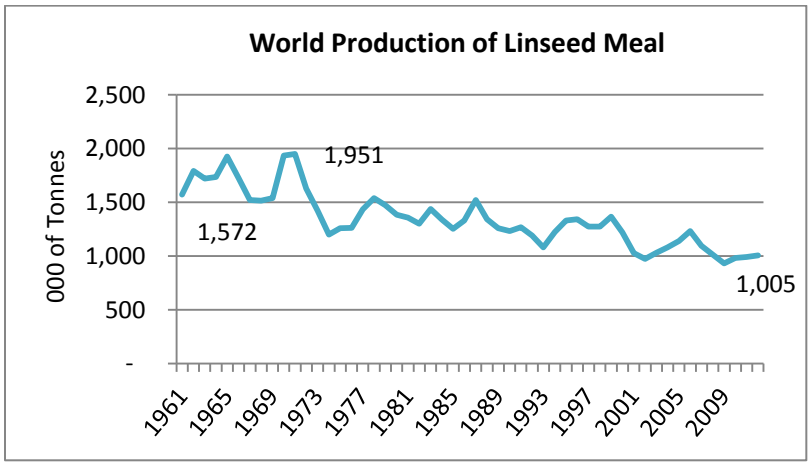
United States Trade in Refined Linseed Oil			
151519 Linseed oil and its fractions, refined			
Exports	Tonnes	$ US	$/Tonne
World	11868	10,724,000	904
Top 3 Export Destinations			
Canada	3146	2,594,000	825
Mexico	2910	2,307,000	793
Japan	1777	1,333,000	750
Imports	Tonnes	$ US	$/Tonne
World	1410	6,013,000	4,265
Top 3 Import Countries			
Canada	451	2,939,000	6,517
China	897	2,816,000	3,139
Philippines	15	112,000	7,467

Source: International Trade Centre

Trade flows of linseed oil within North America are contained in the Appendix.

2.4 Global Flaxseed Meal Market Volume, Value, and Trade

There is no data on the production of linseed meal at the global level. World production was estimated from the Food and Agriculture Organization data on linseed oil production.[96] In 2012, global linseed meal production was 1 M tonnes compared to 1.6 M tonnes in 1961 and 2.0 M tonnes in 1971.



Source: Author

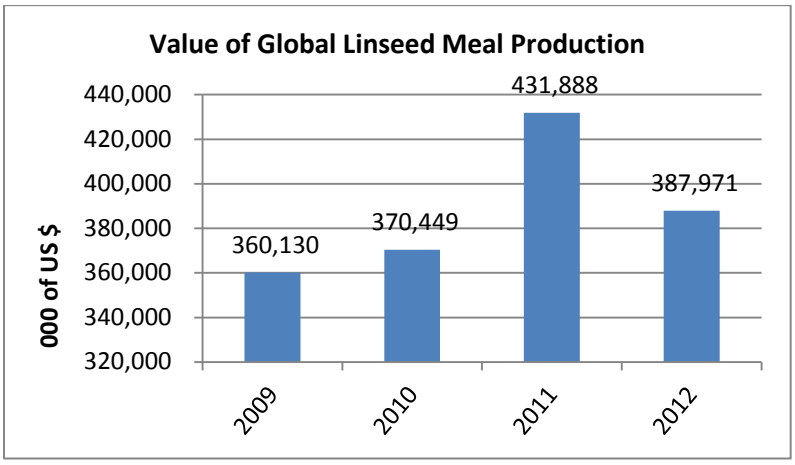
Using the same conversion factor provides estimates of the linseed meal production of the top ten linseed oil producers for 2012. China, Belgium, and the United States together accounted for 60% of global linseed meal production. Canada's share of global production was estimated to be 2% but as will be explained later, actual production was much lower.

Top Linseed Meal Producers, 2012		
	Tonnes	Share
China, mainland	222,499	22%
Belgium	193,884	19%
United States	190,279	19%
India	77,616	8%
Germany	75,953	8%
Ethiopia	67,006	7%
Turkey	22,760	2%
Canada	22,730	2%
Italy	15,708	2%
World	1,005,269	

Source: Author

The global market value of linseed meal production over the 2009 to 2012 period is shown below. In 2012 the value of the linseed meal production in the world was estimated to be $388 M US. This estimate used the Food and Agriculture Organization global production and the average export value of linseed meal ($386 US/tonne) from the International Trade Centre.

[96] When crushed, 1 tonne of flax results in 0.348 tonnes of oil and 0.643 tonnes of meal. 1 tonne of oil has 1.848 tonnes of meal associated with it.



Source: Author

Global exports of flaxseed meal were $81.1 M US in 2013. Belgium is the top exporter because of its dominance in the linseed crush. Canada had only a 3% share in 2013. The largest importer of flax meal is France, accounting for 59% in 2013. In 2013, the volume of meal exported was 168,009 tonnes.

Global Trade Overview, 230620 Linseed oil-cake and other solid residues, 000 of US $							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	64,576	53,514	64,048	65,625	81,063	6%	
Top Exporters							
Belgium	46,520	39,358	45,024	45,646	63,854	8%	79%
Germany	7,292	5,462	6,548	7,610	8,064	3%	10%
Canada	1,290	3,250	3,655	3,839	2,151	14%	3%
Ukraine	1,024	541	2,868	2,363	1,867	16%	2%
Netherlands	1,806	698	1,485	2,047	1,540	-4%	2%
Imports							
World	65,627	55,967	61,611	61,731	74,123	3%	
Top Importers							
France	40,220	34,580	34,896	34,161	43,671	2%	59%
Italy	2,740	2,245	3,274	2,330	6,020	22%	8%
Netherlands	8,088	6,038	5,526	6,624	5,370	-10%	7%
Belgium	5,920	1,396	1,897	3,399	4,038	-9%	5%
Poland	1,778	2,194	3,509	2,636	3,237	16%	4%

Source: International Trade Centre

An overview of Canada's trade in flax meal is shown below. Canada is a net importer of flax meal. Most of the exports in 2013 were to the United States and primarily to California, Missouri, and Washington. Most of Canada's imports were from the United States and primarily from Minnesota. The average export value was $767/tonne while the average import value was $449/tonne. The low import value could be because the largest crusher is in Minnesota. It crushes for the industrial market and the by-product is solvent meal which has a relatively low value. Meal which imported from Washington has a higher value and is meant for the food market.

Canadian Flax Meal Trade, 2013			
HS 230620 - Oil-Cake and other Solid Residues - of Linseed			
Exports	Tonnes	$	$/Tonne
World	2,890	2,215,044	767
Top 3 Export Destinations			
United States	2,559	2,084,710	815
Korea, South	321	127,498	398
Taiwan	8	2,453	300
Top 3 States			
California	1,315	1,195,105	909
Missouri	712	623,230	875
Washington	220	104,165	473
Imports	Tonnes	$	$/Tonne
World	3,487	1,566,205	449
Top 3 Import Countries			
United States	3,266	1,390,487	426
China	220	175,718	798
Top 3 States	Tonnes	$	$/Tonne
Minnesota	2,358	960,769	407
Washington	185	170,278	921
North Dakota	344	131,039	381

Source: Statistics Canada

The United States only exports linseed meal to Canada and only imports from Canada and China. [97]

United States Trade in Linseed Meal, 2013			
230620 Linseed oil-cake& other solid residues			
Exports	Tonnes	$ US	$/Tonne
World	5012	1,461,000	292
Top Export Destinations		-	
Canada	5012	1,461,000	292
Imports	Tonnes	$ US	$/Tonne
World	2834	2,208,000	779
Top Import Countries			
Canada	2559	2,041,000	798
China	275	167,000	607

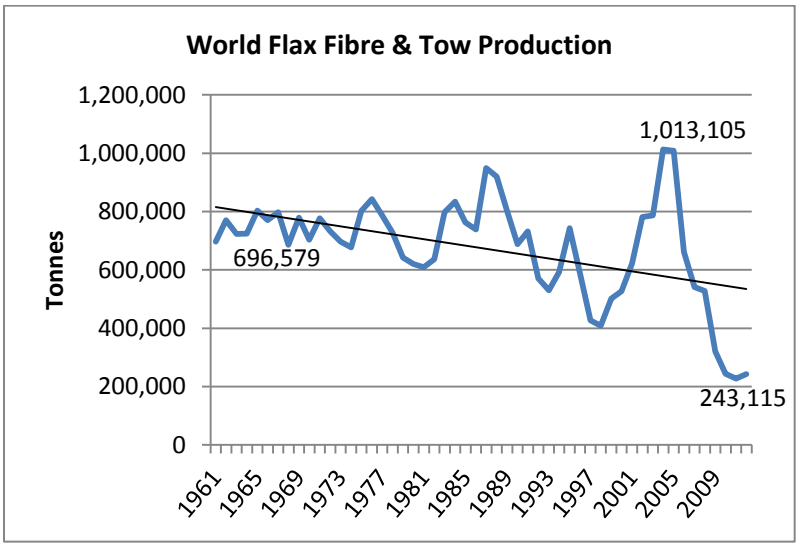
Source: International Trade Centre

Trade flows of linseed meal within North America are contained in the Appendix.

[97] Although it should be symmetrical, United States imports and Canadian exports (and vice versa) do not always match.

2.5 Global Flaxseed Fibre Market Volume, Value and Trade

Global production of flax fibre and tow as estimated by the Food and Agriculture Organization is shown below. In 2012, global production was 240,000 tonnes compared to 1.0 M tonnes in 2004 and 700,000 M tonnes in 1961.



Source: Food and Agriculture Organization

The Multi-Fibre Agreement which governed world trade in textiles ended in 2005. This resulted in a steep reduction of fibre production in the European Union.[98]

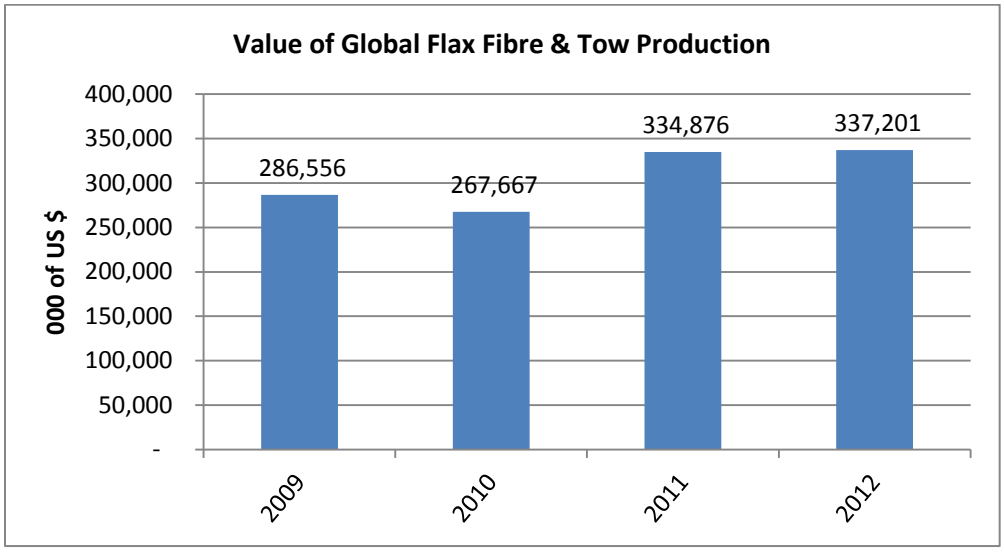
France, Belarus, Russia, and China are the largest producers and accounted for 78% of production in 2012. The Food and Agriculture Organization does not provide any data for Canada and the United States. See the annex for more fibre and tow producers.

World Production of Flax Fibre and Tow, 2012, Top Ten		
	Tonnes	World Share
France	52,400	22%
Belarus	51,615	21%
Russian Federation	46,054	19%
China, mainland	40,000	16%
United Kingdom	13,825	6%
Netherlands	13,290	5%
Belgium	10,000	4%
Egypt	8,300	3%
Chile	2,857	1%
Argentina	2,600	1%
World	243,115	

Source: Food and Agriculture Organization

[98] Ernst and Young, "Evaluation of the Common Market Organization for Flax and Hemp", September 2005

Using Food and Agriculture Organization production data (243,115 tonnes) and International Trade Centre export value data ($1,387/tonne), the estimated value of global flax fibre and tow production was $337.2 M US in 2012. [99] The following chart shows the estimated market value from 2009 to 2012.



Source: Author

The HS code 5301, Trade in flax fibre raw or processed, but not spun; and flaw tow and waste consists of four codes that refer to raw or retted fibre; tow and waste; fibre broken or scutched; and fibre hackled but not spun. The following box provides a brief explanation of these terms.

Raw or retted fibre: Unprocessed fibre or fibre that has been retted/rotted to remove pectins and lignans.
"Scutched flax fiber: Not less than 60 cm. length with cleanness not less than 96% can be used in producing yarns which are used for textile.
Hackled flax fibre: Is produced from the long fiber with a natural smell and natural color which is pale yellow. It consists of parallel regular fiber not less than 60 cm. length with cleanness not less than 98% and moisture not more than 12%. It is used in producing yarns which used for textile.
Flax tow:
Flax fiber 8:15 cm. length prepared from the roots parts . unparallel and free from shives with cleanness not less than 85% used for manufacturing paper and twine .
Flax waste: Very short fiber less than 8 cm. length with cleanness not less than 70% prepared for exporting and manufacturing fine paper."[100]

In 2013, global exports of raw or retted flax fiber were $6.7 M US. Belgium was the top exporter (27%) while Canada was the second (17%). Canadian exports have been decreasing. Belgium was also the top importer of raw or retted flax fiber. In 2012, the global volume of exports was 9,681 tonnes.

[99] The $1,387/tonne is the world export value in 2012 for HS 5301 which contains raw or retted flax, tow and waste, scutched flax, and other.

Global Trade Overview, HS 530110 - Flax Fibre - Raw or Retted, 000 of US $							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	5,699	6,679	10,073	6,226	6,704	4%	
Top Exporters							
Belgium	463	444	1,052	722	1,825	41%	27%
Canada	1,314	1,482	1,564	1,881	1,172	-3%	17%
Egypt	2,345	1,849	3,804	1,077	1,105	-17%	16%
United Kingdom	22	82	2,304	1,427	950	156%	14%
United States	443	399	72	167	757	14%	11%
Imports							
World	8,929	7,783	7,143	6,345	10,101	3%	
Top Importers							
Belgium	6,027	3,709	3,343	3,845	6,697	3%	66%
Italy	78	1,529	245	213	668	71%	7%
United States	425	374	353	619	631	10%	6%
India	90	186	759	725	548	57%	5%
Canada	193	86	70	81	340	15%	3%

Source: International Trade Centre

Global exports of flax tow and waste exceeded $100 M US in 2013. The largest exporters are France and Belgium. Canada had 10% of global exports. China and Belgium are the largest importers. In 2013 211,775 tonnes of tow and waste were exported globally.

Global Trade Overview, HS 530130 - Flax Tow and Waste (including Yarn Waste and Garnetted Stock), 000 of US $							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	80,499	99,476	114,660	95,344	102,682	6%	
Top Exporters							
France	29,820	40,765	47,887	40,622	41,006	8%	40%
Belgium	22,089	28,661	39,517	32,944	35,967	13%	35%
Canada	13,362	8,122	10,423	7,638	10,386	-6%	10%
China	3,107	4,711	4,361	5,088	5,282	14%	5%
Lithuania	2,216	3,943	3,256	2,283	4,666	20%	5%
Imports							
World	82,435	87,533	125,302	106,724	106,266	7%	
Top Importers							
China	17,856	20,158	41,659	31,948	32,022	16%	30%
Belgium	16,776	15,680	26,179	19,333	23,762	9%	22%
United States of America	17,111	12,357	11,078	12,876	16,378	-1%	15%
France	9,176	12,466	16,381	14,457	11,251	5%	11%
Japan	3,268	4,538	3,464	4,024	4,787	10%	5%

Source: International Trade Centre

The value of global exports of scutched flax in 2013 was $347 M US. France and Belgium accounted for 97% of exports. China was the largest importer (71%) followed by Belgium (14%). While the United States exports and imports a small amount of scutched flax Canada only imports a small quantity. The volume of scutched flax exported in 2013 was 158,033 tonnes.

Global Trade Overview, HS530121 Flax fibre, broken or scutched, 000 of US$							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	154,182	235,468	255,329	252,019	347,108	22%	
Top Exporters							
France	87,993	131,599	126,816	144,189	198,001	22%	57%
Belgium	54,894	90,327	108,597	92,227	138,129	26%	40%
Netherlands	7,234	6,450	9,356	10,352	4,784	-10%	1%
Belarus	2	2,242	5,076	1,712	2,350	485%	1%
Ukraine	952	1,089	593	830	846	-3%	0.2%
Imports							
World	194,396	300,328	390,382	262,581	398,960	20%	
Top Importers							
China	138,370	214,181	304,266	191,473	282,850	20%	71%
Belgium	29,131	47,850	41,782	28,193	57,374	18%	14%
India	4,700	5,601	3,763	5,970	11,351	25%	3%
Poland	4,962	7,552	9,279	2,970	10,769	21%	3%
Lithuania	4,232	9,166	11,673	9,248	8,667	20%	2%

Source: International Trade Centre

The final HS code for flax fibre is fibre that is processed in some other way than above and not spun. In 2013, global exports were $143 .3 M US. France and Belgium were the largest exporters while India, Tunisia and Belgium were the largest importers in terms of value. In 2012 the global volume exported was 59,956 tonnes.

Global Trade Overview, HS 530129 Flax fibre, otherwise processed but not spun, 000 of US $							
Exports	2009	2010	2011	2012	2013	CAGR	Share 2013
World	97,192	128,994	151,657	129,979	143,347	10%	
Top Exporters							
France	55,602	76,112	81,734	63,056	75,370	8%	53%
Belgium	16,673	21,219	24,270	27,481	29,232	15%	20%
Belarus	5,088	8,723	15,835	12,836	15,666	32%	11%
Lithuania	3,871	5,881	10,275	10,032	7,761	19%	5%
Egypt	7,668	9,100	12,827	8,897	7,489	-1%	5%
Imports							
World	40,311	58,387	78,101	80,155	74,519	17%	
Top Importers							
India	2,879	3,660	7,432	9,853	9,513	35%	13%
Tunisia	4,526	8,437	14,401	17,444	9,124	19%	12%
Belgium	7,805	8,876	12,191	8,809	8,320	2%	11%
Turkey	1,478	3,131	4,220	3,935	5,840	41%	8%
Italy	4,093	5,074	6,586	5,810	5,455	7%	7%

Source: International Trade Centre

In 2013 Canada exported 848 tonnes of raw or retted flax fibre valued at $1.2 M. As the following table shows, the top destination was Ireland and the top provincial exporter was Saskatchewan. Manitoba was the sole exporter of flax tow and waste in 2013. 13,000 tonnes worth $10.7 M was exported to one destination, the United States. Canada exported very small amounts of flax yarn and fabrics. All of these exports came from either Ontario or Quebec.

Canadian Exports of Flaxseed Fibre in 2013, Top Destinations and Top Provincial Exporters									
	Exports 2013			Top 3 Destinations Value Share			Top Provincial Exports Value Share		
HS Code	Tonnes	$	$/Tonne						
HS 530110 - Flax Fibre - Raw or Retted	848	1,205,409	1,422	Ireland 59%	South Korea 20%	Taiwan 4%	Saskatchewan 65%	Alberta 20%	Ontario 9%
HS 530121 - Flax Fibre - Broken or Scutched But not Spun	No Exports in 2013								
HS 530129 - Flax Fibre - Hackled or otherwise Processed But not Spun	No Exports in 2013								
HS 530130 - Flax Tow and Waste (including Yarn Waste and Garnetted Stock)	13,128	10,690,052	814	United States 100%			Manitoba 100%		
HS 530610 - Flax Yarn - Single	2	19,712	8,020	United States 100%			QC 100%		
HS 530620 - Flax Yarn - Multiple (Folded) or Cabled	0.2	1,547	9,491	United States 100%			ON 100%		
HS 530911 - Woven Flax (>85%) Fabrics - Unbleached or Bleached	0.3	5,696	20,056	United Kingdom 52%	SZ 48%		ON 100%		
HS 530919 - Woven Flax (>85%) Fabrics - Printed or Dyed	0.3	6,005	20,565	United Kingdom 100%			ON 100%		
HS 530921 - Woven Flax (<85%) Fabrics - Unbleached or Bleached	No Exports in 2013								
HS 530929 - Woven Flax (<85%) Fabrics - Printed or Dyed	0.1	1,033	17,508	PA 100%			QC 100%		
HS 630252 - Table Linen - Woven - Flax	No Exports in 2013								
HS 630292 - Toilet and Kitchen Linen - Flax	No Exports in 2013								

Source: Statistics Canada

Information on the United States' exports of flax fibres is shown below. The number of tonnes exported is very small.

United States Exports of Flaxseed Fibre in 2013, Top Destinations						
	Exports 2013			Top 3 Destinations Value Share		
HS Code	Tonnes	$	$/Tonne			
HS 530110 - Flax Fibre - Raw or Retted	253	757,000	2,992	Mexico 43%	Canada 28%	Dominican Republic 17%
HS 530121 - Flax Fibre - Broken or Scutched But not Spun	39	63,000	1,615	Pakistan 44%	Canada 28%	Barbados 8%
HS 530129 - Flax Fibre - Hackled or otherwise Processed But not Spun	59	190,000	3,220	Israel 42%	Pakistan 27%	
HS 530130 - Flax Tow and Waste (including Yarn Waste and Garnetted Stock)	99	182,000	1,838	France 77%	Morocco 23%	Mexico 11%

Source: International Trade Centre

3. Introduction to Inventory, Analysis and Assessment

This brief chapter describes the approach used to development the inventory of value added activity and our framework for the analysis and assessment. Also described is our approach to gathering information from industry experts.

3.1 Inventory Approach

We used a supply chain approach to compile the inventory of value added in the North American flax sector. On the seed side the supply chain consisted of growers, vertically integrated growers, bulk handlers, crushers, flax product manufacturers, and producers of enhanced meat and eggs. On the straw side our supply chain consisted of research and development, fibre processing, value added manufacturing, and flax fibre bio-energy.

Bulk handlers have an important role in sourcing and supplying the needs of firms involved in further value added activity. This study focused on those with facilities in Canada because of the large numbers of firms in the United States. Facilities associated with bulk handlers were not mapped.

Only Canadian firms were included in the enhanced meat and egg producer inventory. It was possible to determine if Canadian firms were using flax but because it was not possible to do this for firms in the United States, the United States firms were excluded.

3.2 Framework

The analysis of the value added activity within each subsector covers aspects such as

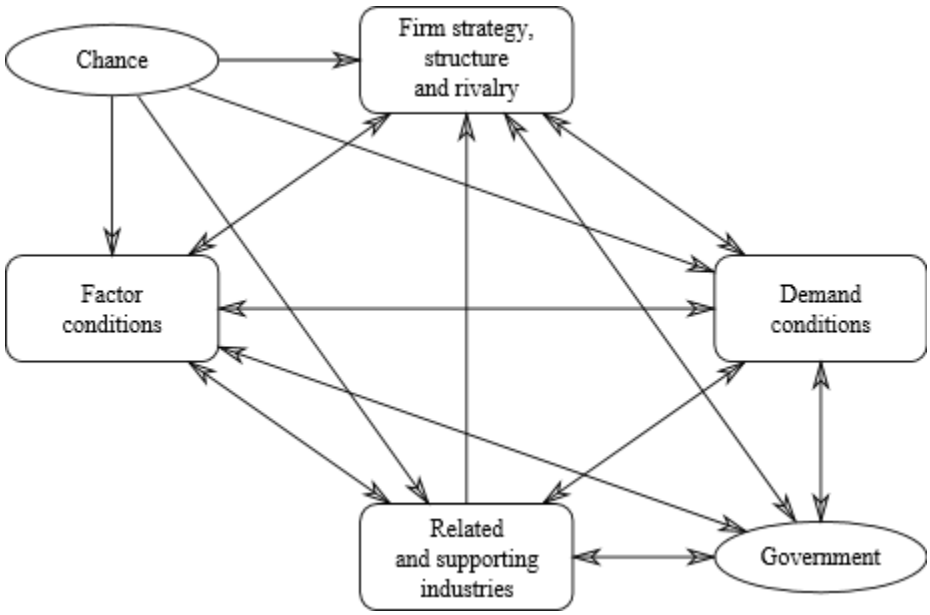
- Market size and growth
- Flax requirements (volume and source)
- International trade
- Firm numbers and concentration
- Dominant firms
- Market drivers
- Developmental factors – what helped the subsector grow
- Challenges – capital, flax supply, policy, market access, etc.
- Research and development investment (public and private)
- Extent of vertical integration
- Agglomeration/location concentration
- Linkages to other subsectors

Our assessment examines the impact of the current activity in North America on Western Canadian growers and value added companies. For producers, the impact is through the volume of flaxseed demanded and its price and changes in production or management processes in order required to have their product enter the value added stream. For value added companies in Western Canada, the issue is their competitiveness relative to the rest of the North American subsector. How does the state of the

flax-value added sector impact their competitiveness in terms of profitability, market share, growth, innovation, and productivity?

We selected a framework developed by Michael Porter to unify the analysis and assessment and then modified it.

Porter developed a framework to examine the competitiveness of nations. How competitive a country is depends on the impact of four main and two subordinate variables, singly and in terms of their interactions. The four main factors influencing competitiveness are factor conditions (basic factors of production and advanced skills and technology), demand conditions (the characteristics of demand in the domestic market and how much customer push firms to innovate), related and supporting industries (such as input suppliers and other entities that push innovation), and firm strategy, structure and rivalry (the domestic rivalry and firm organization and structure). Government policy, which can impact each of the factors, and chance (exogenous events that affect the competitive environment) are the subordinate variables. The framework is shown below.[101]



Source: http://upload.wikimedia.org/wikipedia/en/0/09/The_Porter_Diamond.svg

A brief overview of this competitive advantage framework includes:

- *Factor conditions* relate to the input side of the industry and include the acreage, yield, and production of flax, the factors influencing acreage, the adequacy of supply, prices, value, special requirements, and research and development.
- *Demand conditions* refer to market place issues and covers market size and growth, market drivers, and developmental factors.

[101] Porter, M. The Competitive Advantage of Nations, The Free Press, 1990.

- *Firm strategy, structure and rivalry* refers to the structure of the sub-sector and includes fragmentation/concentration, dominant firms, vertical integration, strategic alliances, locational choice, and challenges such as adequate capital.
- *Related and supporting industries* refers to industries that are somewhat related and those that support the sector such as sector organizations.
- *Government and the regulatory environment.* From a competitiveness perspective, ideally the role of government is to positively influence the other determinants. This includes the regulatory environment, funding innovative activities, supporting commercialization centres, conducting basic research; ensuring coordinating mechanisms are functioning well, and ensuring sector viability.
- *Chance* refers to events that are outside the control of firms and governments such as loss of market access.

3.3 Market View - Seed

Our assessment and analysis of the seed side was completed using a market view. On the seed side the markets we examined were the human/food, feed, pet, and industrial. The products produced from seed (not crushed) include whole, ground, roasted, hulled, bakery, etc. Seed can be crushed using either extrusion or solvent to produce oil and meal.

Market View of Flax Utilization - Seed					
		Human/Food	Feed	Pet	Industrial
Flax Products from Seed	Whole	Yes	Yes	Yes	
	Ground (Full Fat Meal)	Yes		Yes	
	Roasted	Yes			
	Hulled	Yes			
	Flour	Yes			
	Sprouted	Yes			
	Cereal/Bars	Yes			
	Bakery	Yes			
	Natural Health Products	Yes			
	Extracts	Yes			
Crushing - Extrusion	Oil	Yes	Yes	Yes	
	Meal (Partially De-Fatted Meal)	Yes	Yes	Yes	
Crushing - Solvent	Oil		Yes		Yes
	Meal (Fully De-Fatted Meal)		Yes		

3.4 Supply Chain View – Straw

The analysis and assessment of the straw sub-sector focused on the following components of the straw-subsector: fibre processing, value added manufacturing, and bio-energy. The R&D component was inventoried and is discussed in the assessment of the fibre processing and value added manufacturing.

3.5 Interviews

We interviewed 32 experts about value added activity in straw and seed. The interviewee list is contained in the Appendix. The areas for discussion with respect to current value added activity were as follows:

- Companies that we may not have identified and what area they are in
- Market size and growth for areas (likely qualitative)
- By area:
    - Which firms dominate the area?
    - Is this area concentrated or fragmented? (few firms or many)
    - What factors drive the market?
    - What factors helped the area grow?
    - Does the flax seed or straw need special attributes for the area?
    - What are the challenges the area faces? (I.e. capital, flax supply/quality, policy, genetically modified organisms, technology, market access, etc.)
    - Has there been R&D in the area and by whom (private companies versus governments)?
    - Are any of the firms vertically integrated?
    - Is there an area/location where many of these firms chose to locate? Why?
    - Is the area linked (via ownership, strategic alliance, supply, etc.) to another part of the supply chain?
    - Is there more activity in the United States then in Canada? Why?
    - In the straw area, we should ask for some background about the industry. Which firms entered, existed, and why (and some time frames)?

Discussion areas regarding potential were as follows:

- Where do you see opportunities?
- By opportunity:
    - What is the source of the opportunity?
    - What does it provide (i.e. the benefit)?
    - Any idea about how big or how valuable the market could be?
    - What is the probability that this opportunity will actually come about?
    - What is the time frame that the opportunity could come about?
    - What are the critical requirements for the opportunity to succeed?
    - What are the challenges the opportunity faces (capital, capital, flax supply/quality, market development, policy, genetically modified organisms, technology, market access, etc.)
    - What factors would help the opportunity be successful?
    - Is R&D required? By whom?
    - Does the opportunity have synergies with other parts of the flax supply chain or other supply chains?

4. Inventory of Current Value Added Activity

The inventories of current value added activity on the seed side and the straw side are presented in this chapter using a supply chain approach.

4.1 Seed

This section presents the current inventory of value added activity in the flax sector in North America. Firms were identified as being vertically integrated growers, bulk handlers, crushers, flax product companies, feed manufacturers, food manufacturers, enhanced meat producers, and enhanced egg producers. Firms could be classified as more than one type. Firms are also classified as being ingredient suppliers (B to B) or retail suppliers (B to C). The level of value added activity is discussed in the assessment and analysis section.

4.1.1 Growers

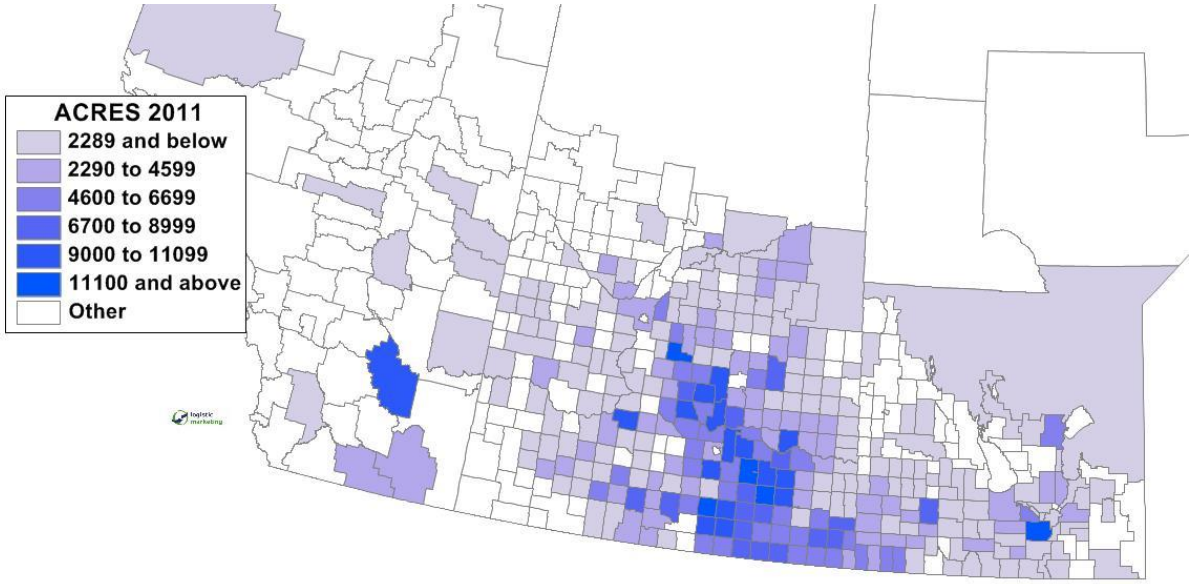
Canada

The following table shows the number of Canadian farms reporting flax production in 2011 and 2006. In 2011, only 4,477 farms produced flax compared to 9,005 in 2006, a 50% reduction. The discovery of Triffid and the resulting impact on markets is primarily responsible for the dramatic reduction.

Canadian Farms Reporting Flaxseed			
	2006	2011	% change
Alberta	379	332	-12%
Manitoba	2,212	920	-58%
Saskatchewan	6,414	3,225	-50%
Total	9,005	4,477	-50%

Source: Statistics Canada

The location of flax production in Western Canada in 2011 is concentrated in Saskatchewan as shown below.



Source: Statistics Canada

The 2011 Canadian Census of Agriculture identified 2,383 certified organic farms and 225 transitional organic farms in 2011. This is a reduction from the 2,462 certified organic farms and 451 transitional organic farms in 2006. In 2011, 42% of the certified organic farms were in Saskatchewan, 11% were in Alberta, and 6% were in Manitoba. In 2009, Canada had a total of 1.7 M acres of certified organic land. The number of certified organic acres in the Prairies was 1.4 M with Saskatchewan accounting for 69%, and that there were 59,893 acres of organic flax in Western Canada. [102] The 2014 Organic Producers Directory for Saskatchewan and Alberta lists 134 producers of organic flax who will sell wholesale. [103]

United States

In 2012, 1,676 farms in the United States produced flax compared to 1,429 in 2007, a 15% reduction. State data is shown below.

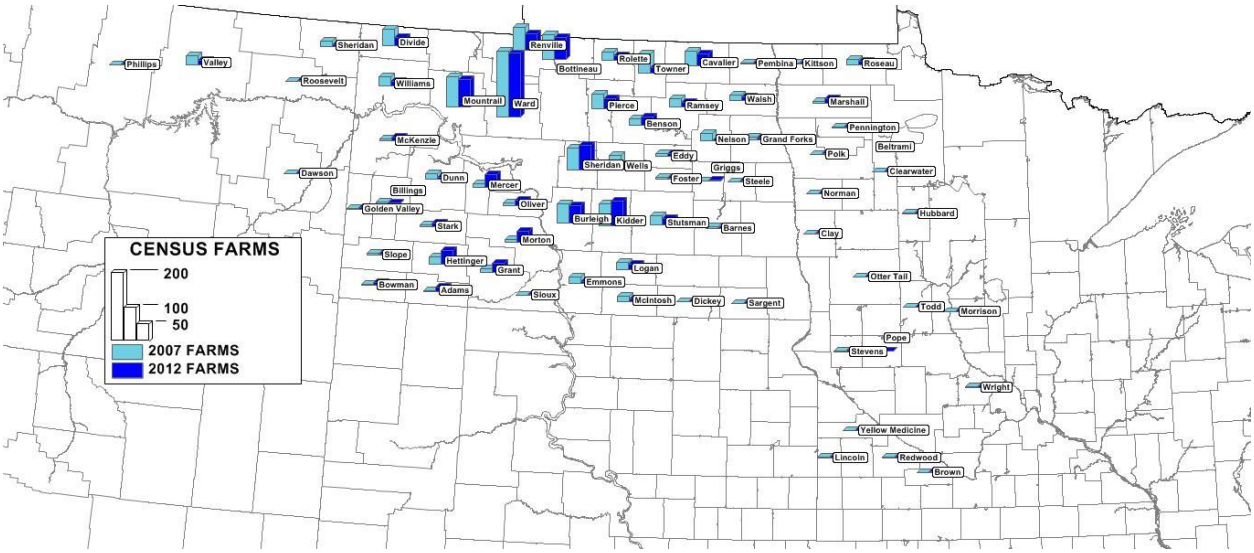
United States Farms Reporting Flaxseed			
	2007	2012	% Change
Minnesota	56	42	-25%
Montana	64	44	-31%
North Dakota	1,515	1,310	-14%
South Dakota	41	33	-20%
Total	1,676	1,429	-15%

Source: United States Department of Agriculture, National Agriculture Statistics Service

The distribution of these growers by county is shown below. The area were flax is produced has become more concentrated.

[102] http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/organic-products/organic-production-canadian-industry/certified-organic-production-statistics-for-canada-2009/?id=1312385802597

[103] http://www.organicfarmdirectory.ca/producers-western-flax.php?pageNum_rsSearch=1&totalRows_rsSearch=134

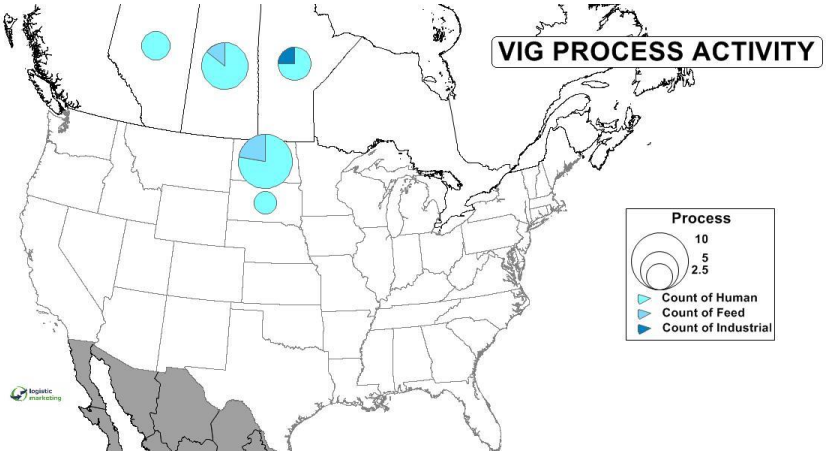


Source: United States Department of Agriculture, National Agriculture Statistics Service

In 2011, there were 12,880 certified organic farms in the United States with 3.1 M acres of certified land (total of 5.4 M certified organic acres). There were 555 certified organic farms in Minnesota, 156 in North Dakota, 154 in Montana and 93 in South Dakota. Organic flax was produced on 21,468 acres in 2011. Almost three-quarters of the organic flax acres were in North Dakota. [104]

4.1.2 Vertically Integrated Growers

Some flax growers participate in other parts of the flax supply chain. The location of these growers is shown below.



Source: Author

[104] http://www.ers.usda.gov/data-products/organic-production.aspx

In Canada, we identified 12 growers that had vertically integrated further up the flax value added supply chain. Of these companies, five acted only as ingredients suppliers while three sold only at the retail level. Four of the growers sold at both levels.

Canadian Vertically Integrated Growers				
1	Dale Thacker Specialty Crops	http://www.mintfarm.ca/	Canada	Alberta
2	Grain Works	http://grainworks.com/about-us/	Canada	Alberta
3	Highwood Crossing Foods	https://www.highwoodcrossing.com	Canada	Alberta
4	De Ruyck's Top of the Hill Farm	none	Canada	Manitoba
5	Johnson Seeds	http://www.johnsonseeds.com/	Canada	Manitoba
6	Vandaele Seeds	http://www.vandaeleseeds.com/	Canada	Manitoba
7	Farmer Direct Co-Operative	http://farmerdirect.coop	Canada	Saskatchewan
8	Mumm's Sprouting Seeds	http://sprouting.com/	Canada	Saskatchewan
9	New Life Organic Foods	http://www.newlifeorganicfoods.ca	Canada	Saskatchewan
10	Northern Quinoa	http://www.quinoa.com/	Canada	Saskatchewan
11	Poplar Valley Organic Farms	http://www.cluborganic.ca	Canada	Saskatchewan
12	Prairie Heritage Seeds Organic	http://www.phsorganics.com/	Canada	Saskatchewan

In the United States, 9 companies were vertically integrated growers. More than half (5) sold at the retail level. Only two were solely ingredient suppliers. Two sold at both levels.

United States Vertically Integrated Growers				
1	Farmers Elevator	http://www.topplandandcattle.com/	United States	North Dakota
2	Flax USA	http://www.flaxusa.com	United States	North Dakota
3	Golden Flax 4U	http://www.goldenflax4u.com/	United States	North Dakota
4	Golden Valley Flax	http://www.flaxhealth.com/	United States	North Dakota
5	Healthy Oilseeds	http://www.healthyoilseeds.com/	United States	North Dakota
6	Reimers Seed Company	http://www.reimersflax.com/	United States	North Dakota
7	Stevens Family Farm	http://www.stevensfarm.com	United States	North Dakota
8	Heintzman Farms	http://heintzmanfarms.com/	United States	South Dakota
9	Howe Seeds	http://www.howeseeds.com/	United States	South Dakota

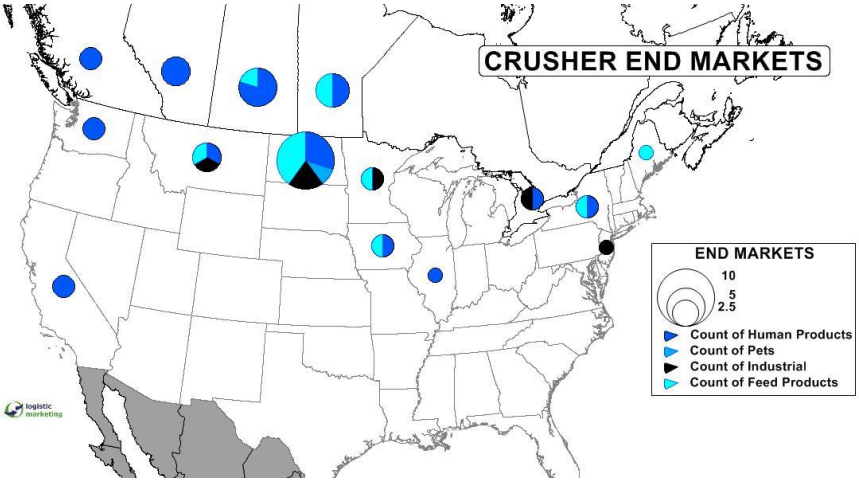
4.1.3 Bulk Handlers

The following companies handle bulk flax, purchasing it from growers and selling to end-users. While the list is representative with respect to Canada, is it not with respect to the United States. The level of value added activity is low; however, these companies are important intermediaries between flax growers and users of flax. The volume and growth in volume would be very similar to the production of flaxseed by growers.

		Bulk Handlers		
1	Tradin Organics USA	http://www.tradinorganic.com/	United States	California
2	Cargill	www.cargill.com	Canada	Manitoba
3	Growers International Organic Sales	http://www.giosi.com/	Canada	Manitoba
4	Horizon Agro	http://www.horizonagro.com/	Canada	Manitoba
5	Legumex Walker	http://www.legumexwalker.com/	Canada	Manitoba
6	Linear Grain	http://www.lineargrain.com/	Canada	Manitoba
7	Parrish & Heimbecker	http://www.parrishandheimbecker.com	Canada	Manitoba
8	Paterson Grain	http://www.patersongrain.com/	Canada	Manitoba
9	Richardson International	http://www.richardson.ca/	Canada	Manitoba
10	AGT Food & Ingredients	http://www.alliancegrain.com	Canada	Saskatchewan
11	Viterra	www.viterra.ca	Canada	Saskatchewan
12	Western Grain Trade	http://www.westerngrain.com/	Canada	Saskatchewan

4.1.4 Crushers

Flaxseed crushers in North America and the markets that they produce for are shown below (some produce for more than one market).



Source: Author

We identified the following companies that crush flaxseed in Canada. None of these crushers use solvent extraction. Half of these companies act only as ingredients suppliers while five sell exclusively at the retail level. One company sells at both levels. Complete information is contained in the Appendix.[105]

[105] Flax Energy recently went out of business.

Canadian Flaxseed Crushers				
1	Gold Top Organics	http://www.goldtoporganics.com/	Canada	Alberta
2	Highwood Crossing Foods	https://www.highwoodcrossing.com	Canada	Alberta
3	Nature's Nutraceuticals	http://www.naturesnutraoils.com	Canada	Alberta
4	Alligga	http://www.alligga.com/	Canada	British Columbia
5	Flora Manufacturing & Distributing	http://www.florahealth.com	Canada	British Columbia
6	Polar Foods	http://www.polarfoods.net/	Canada	Manitoba
7	Shape Foods	http://www.shapefoods.com/	Canada	Manitoba
8	Flax Energy	http://flaxenergy.ca/	Canada	Ontario
9	Golburn Valley Oilmill	http://www.gvo.ca/	Canada	Saskatchewan
10	Northern Nutraceuticals	http://www.northernnutra.ca	Canada	Saskatchewan
11	Specialty Distributing	http://specialtydistributing.ca/	Canada	Saskatchewan
12	TA Foods	http://www.tafoods.ca	Canada	Saskatchewan

Currently, there are no official estimates of the amount of flaxseed crushed in Canada. Agriculture and Agri-Food Canada produces a supply and disposition table for flaxseed but removes the amount of flaxseed used in Canada for food and industrial purposes from the number for total domestic use.

Food and Agriculture Organization data is based on numbers reported by Canadian Oilseed Processors Association and would capture larger scale flaxseed crushing. The Food and Agriculture Organization data after 2011 can't be used as none of the large scale crushers in Canada currently crush flax.

Canadian Oilseed Processors Association provided numbers for flaxseed crush in 2011. None of its members currently crush flaxseed.

In 2011, 36,000 tonnes of flaxseed was crushed to produce 12,000 tonnes of oil and 22,000 tonnes of meal. (this is a ratio of 33% oil, 61% meal and 6% waste and this ratio is very similar to the one used by United States Department of Agriculture which is 34.8% oil and 64.3% meal)

For the oil in 2011: production = 12,000 tonnes; imports = 4,000 tonnes; exports = 4,000 tonnes; domestic use = 12,000 tonnes

For the meal in 2011: production = 22,000 tonnes; imports = 2,000 tonnes; exports = 6,000 tonnes; domestic use = 18,000 tonnes

Canada's exports of flaxseed oil can be used to estimate a lower bound for the size of crush. The volume of exports and imports from 2006 to 2013 are shown below. According to Canadian Oilseed Processors Association its members imported and exported about 4,000 tonnes of flaxseed oil in 2011 which roughly corresponds to the volumes below.

Canadian Trade in Flaxseed Oil								
Canadian exports			tonnes					
	2006	2007	2008	2009	2010	2011	2012	2013
crude	1,591	2,678	3,817	6,314	679	2,551	890	1,131
refined	9,996	11,321	5,739	1,439	591	797	993	656
Total	11,586	13,999	9,556	7,753	1,270	3,348	1,884	1,787
Canadian Imports			tonnes					
	2006	2007	2008	2009	2010	2011	2012	2013
crude	1,871	1,572	882	1,459	2,199	2,408	997	426
refined	7,327	2,128	2,404	2,924	1,028	1,216	1,273	1,396
Total	9,198	3,700	3,285	4,383	3,227	3,624	2,270	1,823

Source: Statistics Canada

In 2012 and 2013 exports were just less than 2,000 tonnes. This is the lower bound for the size of the Canadian crush. If we assume that 75% of the flaxseed oil is exported then the total amount of oil produced is 2,500 tonnes.

For context, 2,500 tonnes of oil equates to 2.7 M 1 litre bottles or 5.4 M bottles of 0.5 litres using the following calculation.

> 2500 Tonnes (metric ton) into Liters
> For substance with density: 929.07 kg/m^3
> Result: 2,690,862.91
>
> http://www.thecalculatorsite.com/conversions/common/liters-to-metric-tons.php

The total amount of flaxseed oil produced domestically can be used to calculate the amount of flaxseed crushed and the amount of meal produced.

- 2,500 tonnes of oil / 34.8% = 7,184 tonnes of flaxseed crushed
- 7,184 tonnes of flaxseed crushed * 64.3% = 4,619 tonnes of flaxseed meal

We exported 3,487 tonnes of meal and imported 2,890 tonnes.

We identified the following 16 companies that crush flaxseed in the United States. Three quarters of the companies act only as bulk ingredient suppliers. Three of the companies sell only at the retail level and one sells at both levels.

United States Flaxseed Crushers				
1	Adams Vegetable Oil	http://www.adamsgrp.com	United States	California
2	Spectrum Organics	http://www.spectrumorganics.com	United States	California
3	American Natural Soy Processors	http://www.americannaturalsoy.com/	United States	Iowa
4	Columbus Vegetable Oils	http://www.columbusvegoils.com/	United States	Illinois
5	CHB Proteins	http://www.chbproteins.com	United States	Maine
6	ADM Northern Sun	www.adm.com	United States	Minnesota
7	Montana Specialty Mills	http://www.mtspecialtymills.com	United States	Montana
8	ADM Northern Sun	www.adm.com	United States	North Dakota
9	Cargill	http://www.cargill.com/	United States	North Dakota
10	Flax USA	http://www.flaxusa.com	United States	North Dakota
11	Heartland Flax	http://www.heartlandflax.com/	United States	North Dakota
12	Stevens Family Farm	http://www.stevensfarm.com	United States	North Dakota
13	Penta Manufacturing Company	www.pentamfg.com	United States	New Jersey
14	Ag Pro	http://www.agprosoy.com/	United States	New Jersey
15	Barleans	http://www.barleans.com	United States	Washington
16	Omega Nutrition	http://www.omeganutrition.com/	United States	Washington

Of the companies identified above only four use solvent extraction.

The supply and disposition for flaxseed/linseed oil in the United States is shown below (see Annex for complete data). The five year average flaxseed/linseed oil production was almost 99,000 tonnes. Over the last five years 52% of production was used domestically while 35% was exported.

Linseed Oil Supply and Disposition in the United States								
Year	Supply			Disappearance				
beginning	Beginning						Ending	Price
June 1	stocks	Production	Total 1/	Domestic	Exports	Total	stocks	Minneapolis
	Tonnes			Tonnes				$/Tonne
2000/01	22,273	106,364	134,314	80,709	33,196	113,905	20,409	792
2001/02	20,409	88,636	113,859	76,775	22,948	99,723	14,136	838
2002/03	14,136	93,182	113,218	66,040	31,843	97,883	15,335	877
2003/04	15,335	100,000	121,904	78,236	34,648	112,883	9,020	924
2004/05	9,020	120,455	136,757	67,660	48,578	116,239	20,518	1,309
2005/06	20,518	145,455	170,536	112,620	44,689	157,309	13,227	1,188
2006/07	13,227	132,273	149,291	91,775	34,425	126,200	23,091	976
2007/08	23,091	103,636	132,286	86,753	33,615	120,368	11,919	1,547
2008/09	11,919	72,273	86,737	23,756	30,026	53,782	32,955	1,903
2009/10	32,955	106,364	141,864	78,148	46,914	125,062	16,802	1,485
2010/11	16,802	103,182	122,741	59,219	46,164	105,383	17,358	1,496
2011/12	17,358	93,182	112,828	56,384	40,535	96,919	15,909	1,496
2012/13	15,909	97,727	116,054	57,371	42,774	100,145	15,909	1,496
2013/14	15,909	93,182	111,364	61,364	34,091	95,455	15,909	NA

Source: United States Department of Agriculture, Economic Research Service, “Oil Crops Yearbook”, March 31, 2014

The linseed meal supply and disposition for the United States is shown below. Average production over the last five years was 182,000 tonnes with over 99% being used domestically. See the Annex for complete data.

Linseed Meal Supply and Disposition in the United States									
Year	Supply				Disappearance				Price
beginning	Beginning							Ending	Minneapolis
June 1	stocks	Production	Imports	Total	Domestic	Exports	Total	stocks	34% protein
	----------1,000 tonnes ----------								$/tonne
2000/01	4.5	196.0	4.7	205.2	178.1	22.5	200.7	4.5	105.4
2001/02	4.5	163.3	5.3	173.1	112.5	56.1	168.6	4.5	108.5
2002/03	4.5	171.5	17.6	193.6	161.3	27.8	189.1	4.5	111.5
2003/04	4.5	184.2	23.9	212.6	179.1	28.9	208.1	4.5	144.2
2004/05	4.5	222.3	20.6	247.4	186.7	56.1	242.9	4.5	103.6
2005/06	4.5	267.6	16.4	288.5	244.1	39.9	284.0	4.5	113.1
2006/07	4.5	243.1	15.5	263.1	249.5	9.0	258.6	4.5	113.0
2007/08	4.5	191.4	8.2	204.2	190.5	9.1	199.7	4.5	173.8
2008/09	4.5	133.4	9.3	147.2	117.6	25.1	142.7	4.5	206.5
2009/10	4.5	196.0	3.1	203.6	190.4	8.7	199.0	4.5	197.1
2010/11	4.5	189.6	6.0	200.1	189.1	6.4	195.6	4.5	202.5
2011/12	4.5	171.5	6.8	182.8	175.6	2.7	178.3	4.5	216.2
2012/13	4.5	179.6	5.6	189.8	180.5	4.8	185.2	4.5	290.4
2013/14 1/	4.5	171.5	1.8	177.8	168.7	4.5	173.3	4.5	
1/ Forecast.									
Sources: USDA, Economic Research Service estimates and USDA, Agricultural Marketing Service, *National Monthly Feedstuff Prices* and USDA, Foreign Agricultural Service, *Global Agricultural Trade System*.									

Source: United States Department of Agriculture, Economic Research Service, "Oil Crops Yearbook", March 31, 2014

According to United States Department of Agriculture, "there isn't actually any reported data for the United States production of linseed oil and meal. The figures are United States Department of Agriculture estimates derived from historical relationships between product yields and the flaxseed crush (which is also a United States Department of Agriculture estimate). United States Department of Agriculture assumes a standard extraction rate of 19.5 pounds per bushel for linseed oil (34.8 percent) and 36 pounds per bushel (64.3 percent) for linseed meal. The deficit against a 56 pound bushel assumes a small shrinkage factor."

4.1.5 Flax Product Manufacturing

We identified 30 Canadian companies that process flaxseed and sell whole seed, ground seed, flour, meal, hulls, or extract components from hulls, meal, or oil. Some of these companies also crush flaxseed. Canadian companies seem to be more likely to specialize in being an ingredient supplier (15). Ten companies sold only at the retail level and five sold at both levels. Complete information is contained in the Appendix.

Canadian Flax Product Companies				
1	Dale Thacker Specialty Crops	http://www.mintfarm.ca/	Canada	Alberta
2	Gold Top Organics	http://www.goldtoporganics.com/	Canada	Alberta
3	Grain Works	http://grainworks.com/about-us/	Canada	Alberta
4	Highwood Crossing Foods	https://www.highwoodcrossing.com	Canada	Alberta
5	Nature's Nutraceuticals	http://www.naturesnutraoils.com	Canada	Alberta
6	Alligga	http://www.alligga.com/	Canada	British Columbia
7	Avafina Commodities	http://www.avafina.com	Canada	British Columbia
8	Fieldstone Organics	http://fieldstoneorganics.ca/	Canada	British Columbia
9	JG Pizzey	http://www.jgpizzey.com	Canada	Manitoba
10	Polar Foods	http://www.polarfoods.net/	Canada	Manitoba
11	Prairie Flax	http://www.prairieflax.com/	Canada	Manitoba
12	Omega Crunch	http://www.omegacrunch.com	Canada	Nova Scotia
13	Valley Flax Four	http://www.valleyflaxflour.com/	Canada	Nova Scotia
14	Bio Essentials Botanicals	http://www.bioessentialbot.com	Canada	Ontario
15	Natunola Health	http://www.natunola.com	Canada	Ontario
16	Port Royal Mills	http://www.portroyalmills.com/	Canada	Ontario
17	Semican International	http://www.semican.ca	Canada	Quebec
18	Bioriginal Food & Science Corp	http://www.bioriginal.com	Canada	Saskatchewan
19	CanMar Grain Products	http://www.roastedflax.com/#	Canada	Saskatchewan
20	InfraReady Products	http://www.infrareadyproducts.com/	Canada	Saskatchewan
21	Mumm's Sprouting Seeds	http://sprouting.com/	Canada	Saskatchewan
22	Northern Nutraceuticals	http://www.northernnutra.ca	Canada	Saskatchewan
23	Northern Quinoa	http://www.quinoa.com/	Canada	Saskatchewan
24	O & T Farms	http://www.otfarms.ca	Canada	Saskatchewan
25	Poplar Valley Organic Farms	http://www.cluborganic.ca	Canada	Saskatchewan
26	Prairie Heritage Seeds Organic	http://www.phsorganics.com/	Canada	Saskatchewan
27	Prairie Tide	http://prairietide.com/Home.html	Canada	Saskatchewan
28	Specialty Distributing	http://specialtydistributing.ca/	Canada	Saskatchewan
29	TA Foods	http://www.tafoods.ca	Canada	Saskatchewan
30	Willow Creek Organic Grain	https://www.willowcreekorganics.com/	Canada	Saskatchewan

The following companies were identified in the United States that process flaxseed and sell whole seed, ground seed, flour, meal, and hulls. Some of these companies also crush flaxseed. Most of these companies sell at the retail level (16) only; ten act only as an ingredient supplier; and two sell at both levels. Complete information is contained in the Appendix.

Unites States Flax Product Companies				
1	New Organics	http://www.neworganics.com/	United States	California
2	Spectrum Organics	http://www.spectrumorganics.com	United States	California
3	Great Plains Flax	http://www.greatplainsflax.com/	United States	Colorado
4	Beveri	http://beverinutrition.com	United States	Connecticut
5	Mid America Food Sales	http://www.midamfoodsales.com/	United States	Illinois
6	Montana Specialty Mills	http://www.mtspecialtymills.com	United States	Montana
7	Flax USA	http://www.flaxusa.com	United States	North Dakota
8	Golden Flax 4U	http://www.goldenflax4u.com/	United States	North Dakota
9	Golden Valley Flax	http://www.flaxhealth.com/	United States	North Dakota
10	Healthy Oilseeds	http://www.healthyoilseeds.com/	United States	North Dakota
11	Heartland Flax	http://www.heartlandflax.com/	United States	North Dakota
12	North Dakota Innovations	http://www.ndinnovations.com	United States	North Dakota
13	Pride of the Prairies Dakota Flax	http://www.dakotaflax.com/	United States	North Dakota
14	Red River Commodities	http://www.redriv.com/	United States	North Dakota
15	Reimers Seed Company	http://www.reimersflax.com/	United States	North Dakota
16	SK Food International	http://www.skfood.com	United States	North Dakota
17	Specialty Commodities Inc	http://www.specialtycommodities.com/	United States	North Dakota
18	Stevens Family Farm	http://www.stevensfarm.com	United States	North Dakota
19	Carrington Farms	http://carringtonfarms.com	United States	New Jersey
20	Bob's Red Mill	http://www.bobsredmill.com/	United States	Oregon
21	Glanbia Nutritionals	http://www.glanbianutritionals.com/	United States	South Dakota
22	Heintzman Farms	http://heintzmanfarms.com/	United States	South Dakota
23	Howe Seeds	http://www.howeseeds.com/	United States	South Dakota
24	Arrowhead Mills	http://www.arrowheadmills.com/	United States	Texas
25	FW Cobs	http://www.fwcobs.com/grains/	United States	Vermont
26	Barleans	http://www.barleans.com	United States	Washington
27	Omega Nutrition	http://www.omeganutrition.com/	United States	Washington
28	Omega Field	http://www.flax.com/	United States	Wisconsin

4.1.6 Producers of Enhanced Meat or Eggs

In Canada we identified some companies producing omega enhanced meat or eggs using flax and these are shown below. All of these companies sell only at the retail level.

Canadian Producers of Enhanced Meat or Eggs				
1	Countryside Farms	http://www.countrysidefarms.ca/	Canada	Manitoba
2	Nature's Farm	http://naturesfarm.ca/contact/	Canada	Manitoba
3	Prairie Orchard Farms	http://www.prairieorchardfarms.com	Canada	Manitoba
4	Burnbrae Farms	http://www.burnbraefarms.com/	Canada	Ontario
5	Gray Ridge Egg Farms	http://www.grayridge.com	Canada	Ontario

There are companies producing enhanced eggs in the United States but we did not identify them.

4.2 Straw

This section presents the current inventory of value added activity in the flax straw sector in North America. We identified companies that processed straw into fibre, companies that processed fibre into value added products, and companies that used seed, straw or shives to produce bio-energy. We also identified where R&D on flax fibre was occurring.

4.2.1 Research and Development

In Canada, 16 companies/institutions are conducting research on flax fibre.

Flax Fibre Research in Canada				
	Company	Website		
1	Alberta- Innovates - Technology Futures	http://www.albertatechfutures.ca/	Canada	Alberta
	(AITF)			
2	Alberta Innovates Bio Solutions	http://bio.albertainnovates.ca	Canada	Alberta
	(AIBS)			
3	Alberta Biomaterials Development Centre	http://www.albertabiomaterials.com/	Canada	Alberta
	(ABCD)			
4	Agri-Food Discovery Place	http://www.afdp.ualberta.ca/	Canada	Alberta
5	Decortication Plant	http://www.albertatechfutures.ca/	Canada	Alberta
6	Bio Conversions Network	http://www.bcn.ualberta.ca/	Canada	Alberta
7	Lipid Program	http://www.lipid.ualberta.ca/	Canada	Alberta
8	Olds College Centre for Innovation	http://www.oldscollege.ca/research-innovation/index	Canada	Alberta
9	SAIT Green Building Lab	http://www.sait.ca/research-and-innovation/applied-research.php#Green Building Technologies	Canada	Alberta
10	Teckle Technical Solutions	http://www.ttsfpl.com	Canada	Alberta
11	Advanced Materials Canada	http://www.afmcanada.ca/	Canada	British Columbia
12	Fibre City	http://www.fibrecity.ca	Canada	Manitoba
	Composite Innovation Centre	http://www.compositesinnovation.ca/		
	(Fibre City is part of CIC)			
13	National Research Council of Canada	http://www.nrc-cnrc.gc.ca/eng/rd/aquatic/index.html	Canada	Ontario
14	Genome Prairie	http://www.genomeprairie.ca/project/current/total-utilization-flax-genomics/	Canada	
	TUFGEN (Completed)	www.tufgen.ca		
	(Total Utilization of Flax Genomics)		Various Locations	
15	Biolin	http://www.biolin.sk.ca/	Canada	Saskatchewan
16	Saskatchewan Ministry of Ag, Strategic Research Chair in Bio Process Engineering	not in place yet	Canada	Saskatchewan

North Dakota State University (NDSU) is where flax fibre research is being conducted in the United States.

Flax Fibre Research and Development in the United States				
1	Flax Institute, North Dakota State University	http://www.ag.ndsu.edu/plantsciences/flax-institute/	United States	North Dakota
2	Department of Mechanical Engineering, North Dakota State University	http://www.ndsu.edu/me/faculty/ulven.php	United States	North Dakota

4.2.2 Value Added Activity

Before discussing value added activity in flax fibre, we begin with some basic information about decorticating and retting. [106]

Decorticating – Sometimes bast fibers are only partly retted or not retted at all before the stems are put through a series of rollers, hammers and/or shakers to extract the fibers. This process is called decorticating and it is used to replace the processes of breaking, scutching and hackling but it generally produces a very coarse fiber that is not used in textiles but is rather used for industrial purposes like paper making and geotextiles.

Retting – "Retting" is from a Dutch word meaning to "rot" or break down. The bast fibers of plants form part of what the layman might call the "inner bark" of plant stems. These fibers are tightly held within the plant by glue-like substances called pectins and lignins. Before clean bast fibers can be easily removed from the stems, the pectins and lignins must be softened and/or removed. The most common and cheapest method of doing this is to allow microorganisms to grow on the surface of the stems. As they grow, these organisms dissolve the pectins and lignins and hence make it easier to remove the fibers from the stems. However, if the straw is allowed to ret for too long a period, the organisms will also start to dissolve the fibers and hence the fibers will get weaker. This is done in Western Canada by placing it in a thin layer next to the ground (dew or field retting).

Scutching – After flax straw is broken and the straw has been shaken to remove the loose shives, there are generally some shives still stuck to or tangled within fibers. The scutching process attempts to scrape loose and/or disentangle the remaining shives from the fiber by stroking the fibers in a manner similar to combing fibers with a comb that has no teeth. In modern flax straw mills this is done by having straw which has already been broken and shaken, pass between rotating beaters or turbines which have paddles or arms that beat and scrape the remaining shives from the fibers.

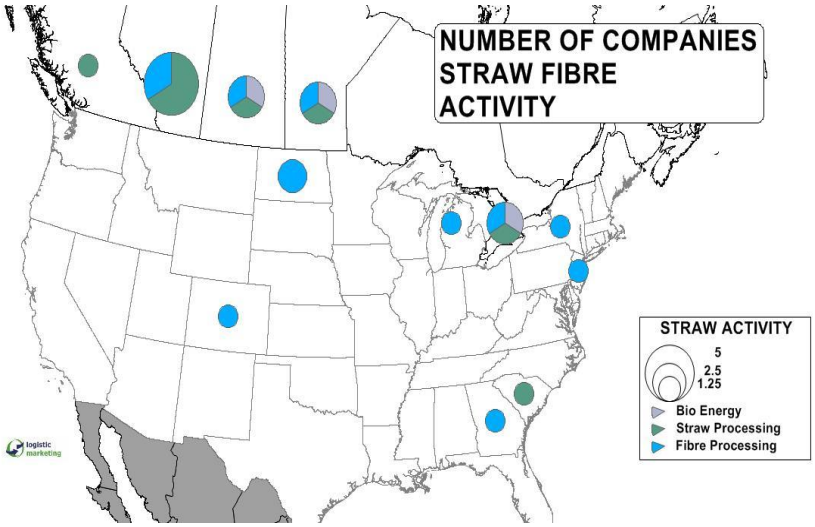
Shives – The shives are the non-fiber parts of the stems of flax plants.

We identified six firms processing flax straw, 14 firms processing flax fibre, and three firms using flax to produce bio-energy products.[107]

The location of the companies and their activities is shown below. Alberta has four companies adding value to flax straw while Saskatchewan, Manitoba, and Ontario each have three firms. There is one firm headquartered in British Columbia (but with operations in the United States). There are seven firms in the United States.

[106] The material in this introduction is from http://www.saskflax.com/definitions_fiber.html.

[107] One of the bio-energy companies recently ceased operations.



Source: Author

4.2.3 Fibre Processing

The following companies are processing flax straw in North America.

Flax Straw Processing Companies				
	Company	Website		
1	Decortation Facility	http://www.albertatechfutures.ca/	Canada	Alberta
2	Stemia	no web site	Canada	Alberta
3	Crailar Flax Fibre[108]	http://www.crailar.com/	Canada	British Columbia
5	FlaxStalk (SWM)	http://www.flaxstalk.ca	Canada	Manitoba
6	Stemergy	http://www.stemergy.com/	Canada	Ontario
6	Biolin	http://www.biolin.sk.ca/	Canada	Saskatchewan

4.2.4 Value Added Fibre Manufacturing

The following companies are adding value to flax fibre in Canada.

Canadian Companies Adding Value to Flax Fibre				
1	Genics	http://www.genicsinc.com/	Canada	Alberta
2	Synermulch	http://synermulch.com/	Canada	Alberta
3	FlaxStalk	http://www.flaxstalk.ca	Canada	Manitoba
4	Flax Farm	https://www.facebook.com/Flaxfarmbedding/	Canada	Ontario
5	Biolin	http://www.biolin.sk.ca/	Canada	Saskatchewan

The following companies are adding value to flax fibre in the United States. This fibre has been processed by fibre processors.

[108] Crailar Flax Fibre was formerly known as Naturally Advanced Technologies. Its headquarters are in British Columbia while its North American processing plant is in South Carolina.

United States Companies Adding Value to Flax Fibre				
1	Enviro Textiles	http://www.envirotextile.com/	United States	Colorado
2	Georgia Pacific	www.gp.com	United States	Georgia
3	RheTech	http://www.rhetech.com/	United States	Michigan
4	C2Renew	http://www.c2renew.com/	United States	North Dakota
5	Flax Tech	http://flaxtech.us/	United States	North Dakota
6	SWM	http://www.swmintl.com/	United States	New Jersey
7	e2e Materials Inc	http://www.e2ematerials.com/	United States	New York

4.2.5 Flax Fibre Bio-Energy Companies

The following companies are creating bio-energy products from flax straw. Flax Energy recently ceased operations.

Flax Fibre Bio-Energy Companies				
1	Flax Power	http://thepowerlog.com	Canada	Manitoba
2	Flax Energy	http://flaxenergy.ca/	Canada	Ontario
3	Titan Clean Energy	http://www.titan-projects.com	Canada	Saskatchewan

5. Analysis and Assessment of Current and Potential Value Added Activity - Seed

This chapter examines value added activity in the seed sector at the grower level and in the human/food, feed and animal health, pet food, and industrial markets and identifies potential value-added opportunities. The analysis and assessment is conducted using the framework discussed earlier. The discussion begins with factor conditions, followed by demand conditions for flaxseed, then firm strategy, structure and rivalry of firms in the flax industry, related and supporting industries, government and the role of chance. (See also the figure in Section 3)

5.1 Factor Conditions

Factor conditions include seed production as well as the research and development supporting genetic improvement and varieties supporting specific end uses.

5.1.1 Flax Seed Production

Canadian Production

This section discusses what varieties are grown in Canada, the acreage and productivity of flaxseed in Canada, the supply and disposition of flax in Canada, and then the factors that influence acreage. [109]

Varieties

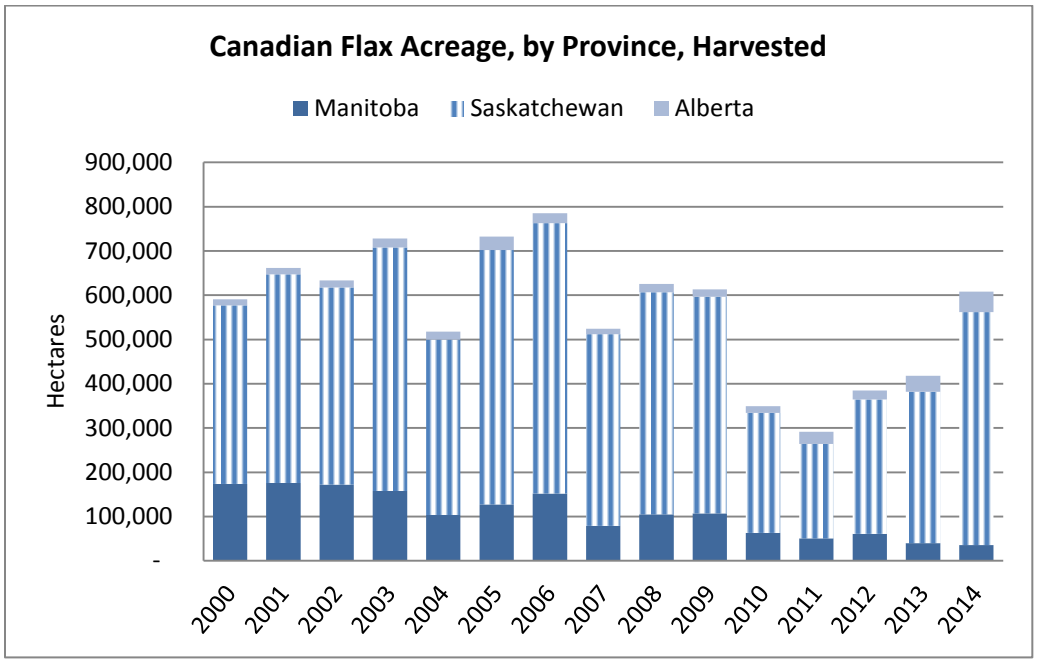
Flax is grown in Canada for the whole seed and its products, meal and oil. Canada has brown and yellow registered varieties. Yellow registered varieties such as VT50 are grown under contract. [110] Solin, a yellow flaxseed with low levels of alpha-linolenic acid, was deregistered as of August 1, 2013. This will allow for easier and faster registration of yellow seeded varieties. [111] Information on the yield, fibre content, and oil content of Western Canadian flax varieties is contained in the Annex.

Acreage, Production, and Yield

The discovery of a genetically modified flax variety in 2009 that was never to have reached the supply chain disrupted flax production in Canada. Acreage, however, has begun increasing again. In 2014/15 the harvested acreage of flax in Western Canada is currently forecast to be almost 1.5 M acres. Saskatchewan accounts for 86% of this acreage followed by Alberta with 8% and Manitoba with 6%. There has been a shift in the flax acres within Western Canada. Traditionally, Manitoba was the

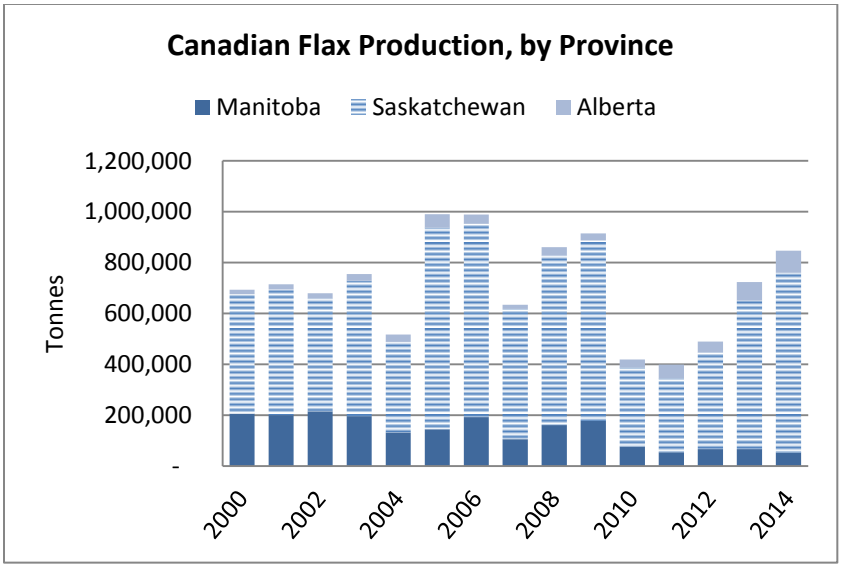
[109] The data for Canada in this section is from Statistics Canada and Agriculture and Agri-Food Canada and is dated January 23, 2015.
[110] http://www.grainscanada.gc.ca/legislation-legislation/orders-arretes/2014/2014-39-en.htm
[111] http://www.farmingsmarter.com/canada-western-solin-no-longer-regulated-as-of-august-1-2013/

dominant flax producer but in 1993/94 Saskatchewan took over the top share. Manitoba's current 6% of harvested acreage is significantly below its 17% average share from 2008/09 to 2012/13.[112]



Source: Statistics Canada

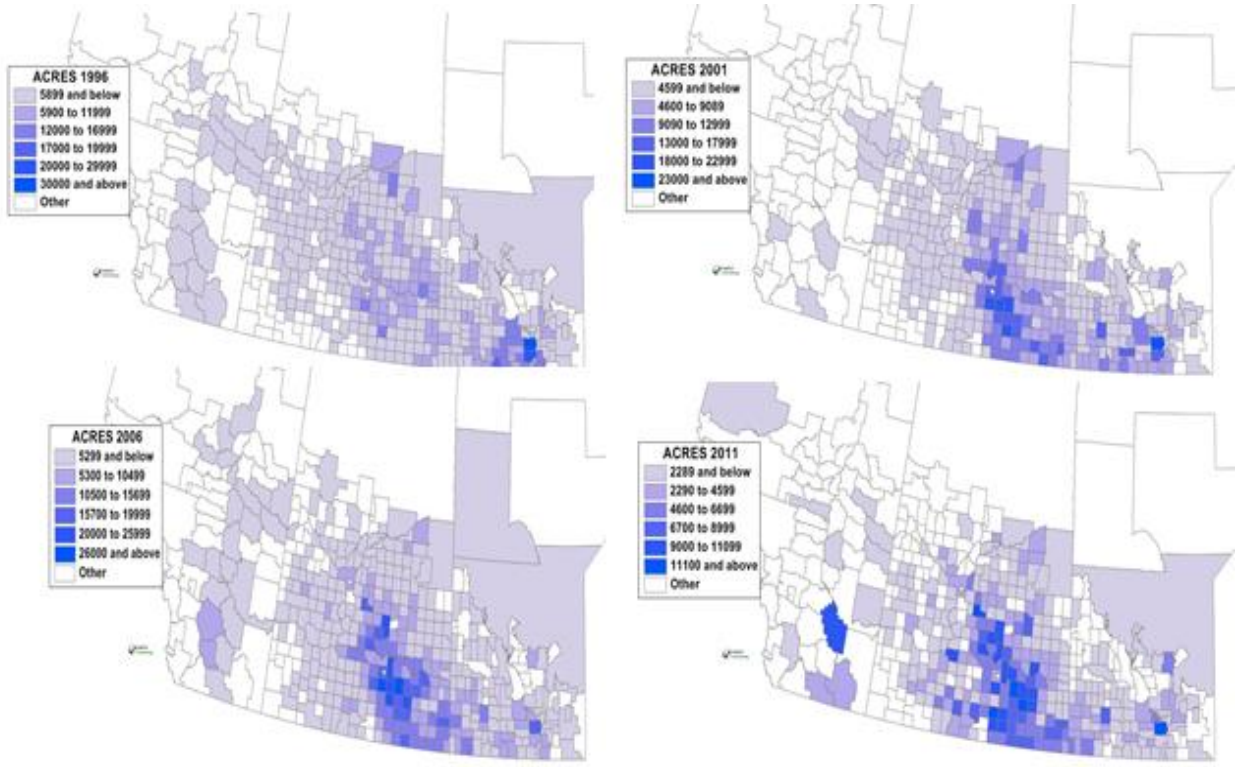
Over the last 15 years, flax production reached its peak in 2005 at almost 1 M tonnes. Production is expected to be 847,000 tonnes in 2014/15 this year. Saskatchewan is the dominant producer followed by Alberta and then Manitoba.



Source: Statistics Canada

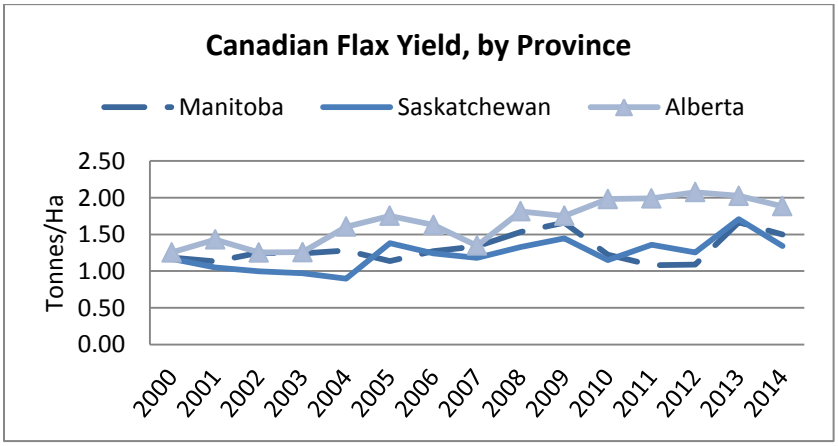
[112] Flax may be grown in other provinces but Statistics Canada only collects data for the Prairie Provinces.

The following chart shows the dramatic shift in the location of flax production since 1996.



Source: Statistics Canada

Flax productivity is highest in Alberta with a 15 year average of 1.67 tonnes/ha. Manitoba's average productivity of 1.3 tonnes/ha is 28% below Alberta. The average productivity in Saskatchewan was 1.23 tonnes/ha, 36% below that of Alberta. There has been a general upward trend in flax yields. Alberta's productivity is higher because some flax is produced under irrigation. Flax grown under irrigation in Alberta can yield 2.57 tonnes/ha.[113]



Source: Statistics Canada

[113] Alliance Seed Corporation Technical Bulletin, "Prairie Sapphire Flax".

Supply and Disposition

The following table contains the supply and disposition of flaxseed in Canada from 2000 to 2014 (as of January 23, 2015). In 2014 production is estimated to be 847,000 M tonnes. Exports are forecast to increase to 700,000 M tonnes because of higher demand by China and the European Union. The price, currently forecast at $465/tonne to $595/tonne, could be lower because of a large global supply of flaxseed. Statistics Canada does not provide information on the amount of flax used for food and industrial purposes. Unlike the United States, the majority of flax produced in Canada is exported. Over the last five years, an average of 92% of production is exported. Stocks have been burdensome at times. Data from 1982 to 2014 is contained in the Annex.

Canadian Flaxseed Supply and Disposition												
Crop Year	Area Seeded	Area Harvested	Yield	Production	Imports (b)	Total Supply	Exports (c)	Food & Industrial Use (e)	Feed, Waste & Dockage	Total Domestic Use (d)	Carry-out Stocks	Average Price (g)
	thousand ha		*t/ha*	*thousand metric tonnes*								*$/t*
2000	595	591	1.17	693	11	1,090	613	N/A	186	218	259	261
2001	672	662	1.08	715	24	998	618	N/A	160	205	175	320
2002	692	633	1.07	679	27	881	577	N/A	144	176	128	402
2003	745	728	1.04	754	20	903	609	N/A	171	202	93	382
2004	700	518	1.00	517	39	648	468	N/A	119	156	24	n/a
2005	761	733	1.35	991	38	1,053	537	N/A	145	180	336	276
2006	805	785	1.26	989	8	1,333	682	N/A	252	280	372	302
2007	528	524	1.21	634	8	1,013	684	N/A	129	163	166	611
2008	631	625	1.38	861	7	1,034	639	N/A	132	167	229	500
2009	682	613	1.49	915	6	1,150	772	N/A	73	90	288	424
2010	370	349	1.20	419	8	715	404	N/A	105	118	193	530
2011	299	291	1.37	399	9	601	391	N/A	56	74	137	525
2012	397	384	1.27	489	15	640	481	N/A	70	89	71	580
2013	425	418	1.73	724	14	809	616	N/A	86	113	80	510
2014	629	608	1.39	847	5	932	700	N/A	82	102	130	480-520

Source: Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015

Profitability

Producers strive to maximize profits when making their acreage decisions subject to rotational, agronomic, and management constraints. In the prairies flax is not always a strong competitor for acres because of price volatility, costs associated with the Triffid cleanup and testing, and higher profitability of other crops. The following table illustrates the relative profitability of crops in 2014 in Manitoba and Saskatchewan. Flax was expected to be quite profitable when cropping decision were made in 2014. It is also interesting to note the differences in the planning prices used by the provincial departments of agriculture.

Crop Planning Guides, 2014							
	Wheat	Soybeans	Corn	Canola Inv	Canola Nex	Canola	Flax
	Planning Price						
Manitoba	6.15/bu	10.5/bu	4/bu	10/bu	11/bu		11.75/bu
Saskatchewan	5.75/bu	6.25/bu				9.8/bu	12.90/bu
	Returns over Operating Cost, $/Acre						
Manitoba East	80.38	118.48	44.98	38.13	57.47		53.88
Manitoba West	78	160	79.95	85.34	105.88		97.28
Saskatchewan Brown Soil	65.92	85.72				60.64	95.21
Saskatchewan Dark Brown Soil	79.59	118.83				142.29	160.39
Saskatchewan Black Soil	118.39	119.52				174.51	157.59

Source: Manitoba Agriculture, Food and Rural Development, "Crop Production Costs", 2014 and Government of Saskatchewan, "Crop Planning Guide 2014"

Production in the United States

This section discusses what varieties are grown in the United States, the acreage and productivity of flaxseed in the United States, the supply and disposition of flax in the United States, and then the factors that influence acreage.

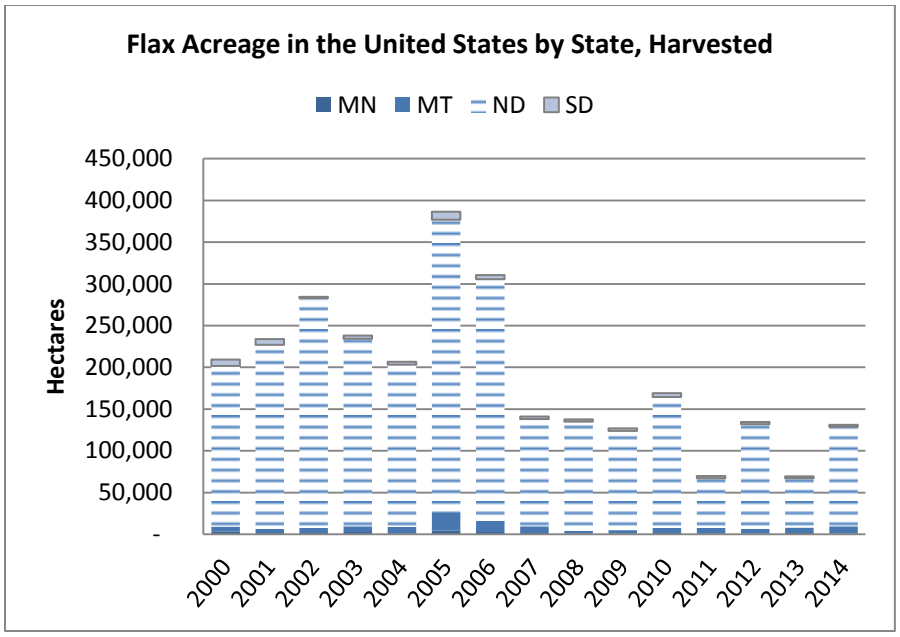
Varieties

Growers in the United States use both United States and Canadian varieties and produce both yellow and brown flax. [114] Information on the performance of varieties grown in the United States is contained in the Annex.

Acreage, Production, and Yield

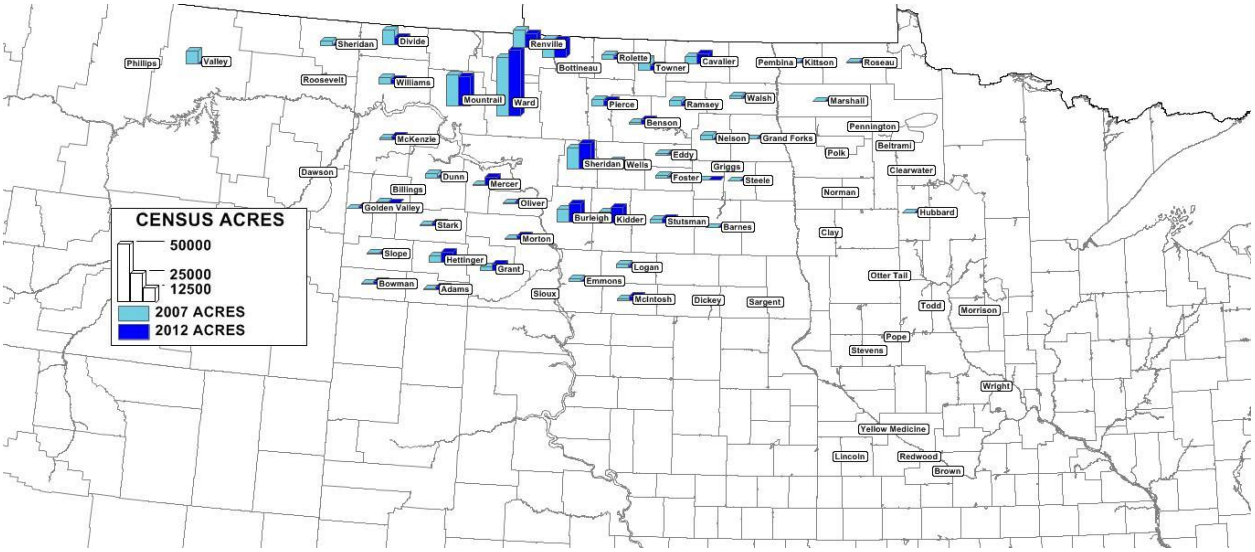
Over the last 15 years, flax acreage in the states with data rose until 2005. It has been volatile over the last four years. In the United States, North Dakota is the dominant flax producer. In 2014 North Dakota expects to harvest 119,380 hectares. Montana has the next highest acreage with 8,903 hectares in the same year. South Dakota is the next largest producer. Of the states with data for flax production Minnesota has the lowest acreage. Total United States harvested acreage in 2014 was 131,116 ha.

[114] Source: http://igrow.org/up/resources/ExEx8055-09.pdf



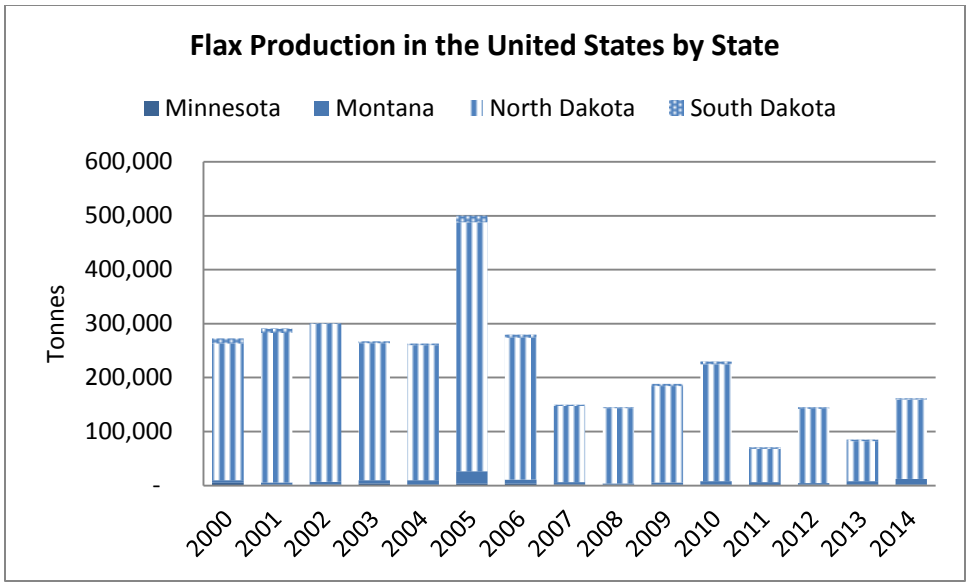
Source: United States Department of Agriculture, National Agriculture Statistics Service

The acreage of flax in the United States in 2007 and 2012 is shown below at the county level.



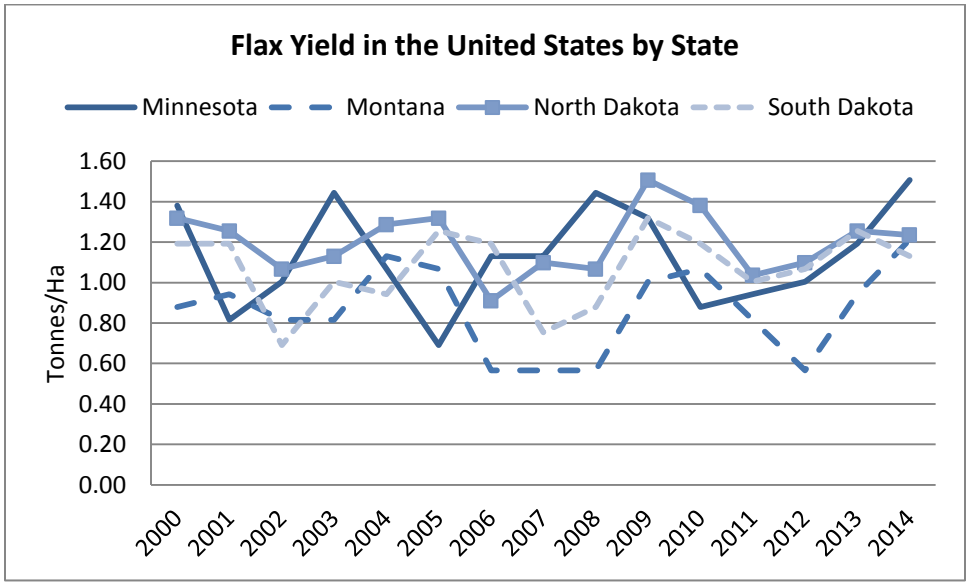
Source: United States Department of Agriculture, National Agriculture Statistics Service

United States flax production was 161,759 tonnes in 2014. Production by the four largest producers peaked at 500,279 tonnes in 2005. North Dakota produced 147,455 tonnes in 2014.



Source: United States Department of Agriculture, National Agriculture Statistics Service

In terms of productivity, North Dakota has the highest average productivity (1.2 tonnes/ha from 2000 to 2014) followed by Minnesota. Montana is the least productive with an average yield of only 0.86 tonnes/ha.



Source: United States Department of Agriculture, National Agriculture Statistics Service

Supply and Disposition of Flax in the United States

In the United States, domestic production of flaxseed has fallen over time while imports of seed have risen. The majority of the flax total supply is used for crush. Over the 2009/10 to 2013/14 period an

average of 76% of total supply was used for crush while only 8% was exported as seed. See the Annex for the complete data set from 1980/81 to 2013/14.

Flaxseed Supply and Disposition in the United States										
Year	Supply				Disappearance					Price
beginning June 1	Beginning stocks	Production	Imports	Total	Crush	Exports	Seed	Residual	Total	Average received by farmers
	Tonnes				Tonnes					$/Tonne
2000/01	44,884	272,556	72,359	389,800	304,816	25,827	12,040	13,892	356,575	130
2001/02	33,225	290,972	48,367	372,564	254,013	60,607	16,130	19,131	349,881	169
2002/03	22,683	301,336	73,686	397,705	266,714	80,795	12,243	10,570	370,323	227
2003/04	27,383	267,121	116,339	410,842	286,019	63,901	10,770	17,435	378,125	231
2004/05	32,717	263,361	137,501	433,579	345,458	38,346	20,219	7,634	411,657	318
2005/06	21,921	500,279	108,105	630,306	416,582	96,005	16,739	11,185	540,512	234
2006/07	89,794	279,897	138,789	508,481	378,480	45,414	7,290	15,215	446,400	228
2007/08	62,081	149,766	203,703	415,550	297,196	56,404	7,290	16,253	377,143	512
2008/09	38,407	145,194	121,777	305,378	207,021	10,981	6,528	16,024	240,554	500
2009/10	64,824	188,554	159,597	412,975	304,816	44,494	8,662	15,453	373,425	321
2010/11	39,550	230,035	153,418	423,003	295,545	54,117	3,658	14,562	367,882	480
2011/12	55,121	70,895	210,468	336,484	266,714	17,519	5,868	17,934	308,035	547
2012/13	28,450	146,363	178,851	353,663	279,415	12,701	6,071	17,375	315,561	543
2013/14	23,471	85,247	215,911	324,629	266,714	16,511	6,173	11,380	300,777	531

Source: United States Department of Agriculture, Economic Research Service, Oil Crops Yearbook, March 31, 2014

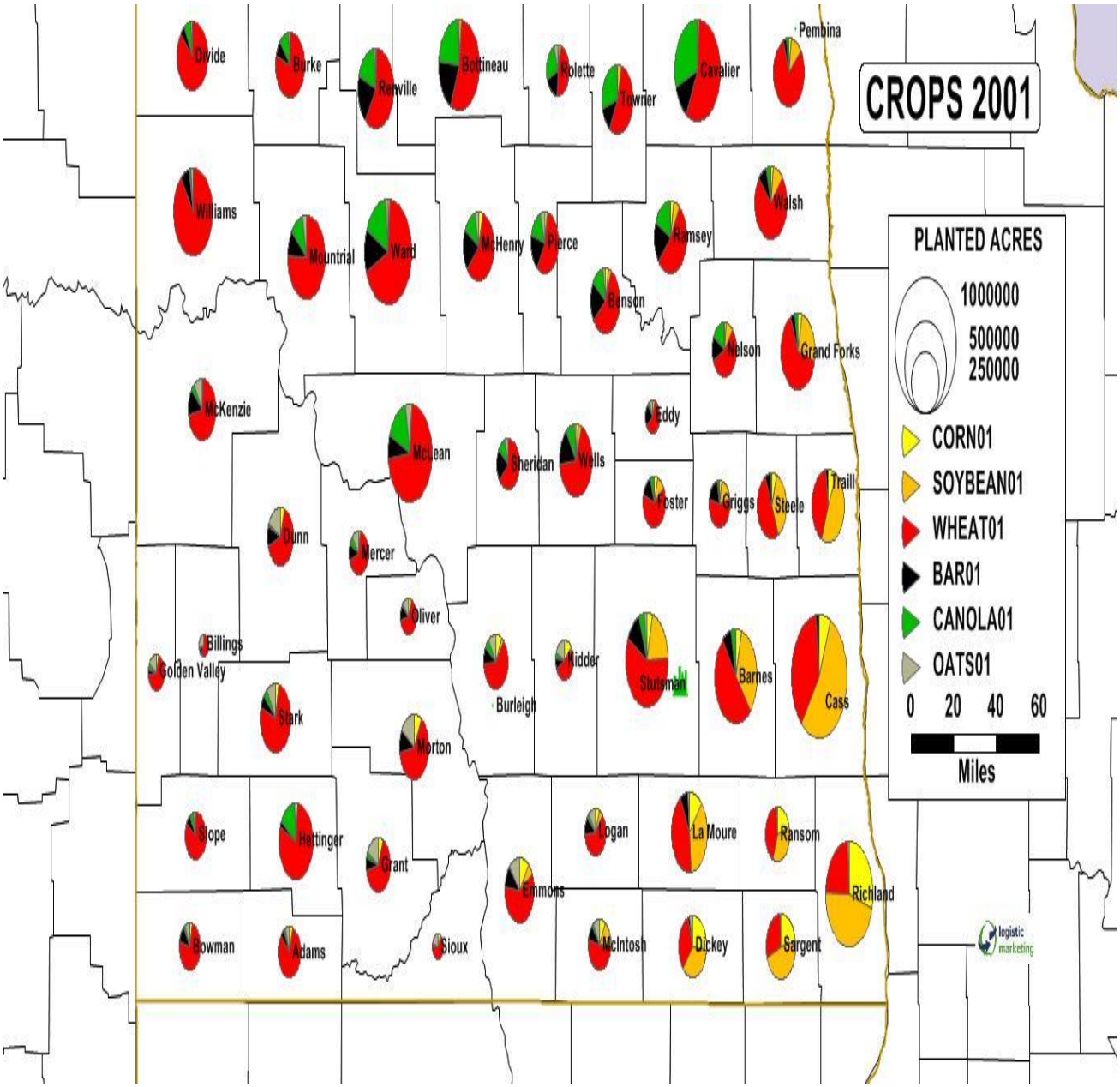
Profitability

Producers will grow the most profitable crops subject to rotational, agronomic, and management constraints. Flax is not always a strong competitor for acres. The following table shows crop budgets used for planning purposes in two regions of North Dakota in 2011 (when flax acres were very low) and in 2014 (when flax acres were higher). Prices used to plan crop acreage decisions are also shown. The price of flax was higher in 2014 than 2011 while the prices of the other crops shown were lower in 2014 than 2011. In the North West of North Dakota flax's profitability was below canola in 2011 but greater than canola in 2014. Flax was also more profitable than corn and soybeans. In the Red River Valley area corn and soybeans were very profitable in 2011. In 2014, the relative profitability of flax improved over time.

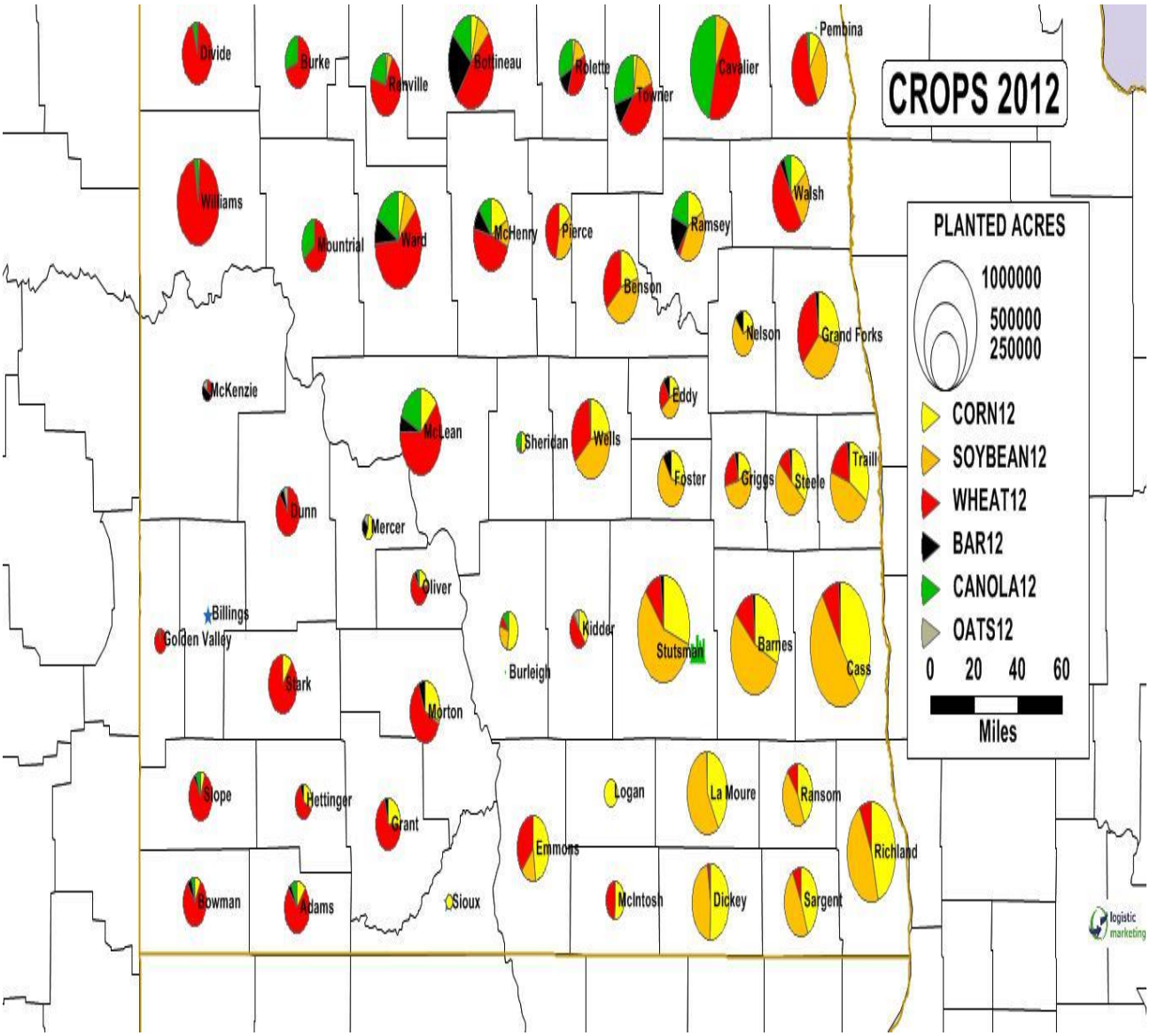
North Dakota Crop Budgets ($/Acre)								
	North West 2011				North West 2014			
	Planning	Mkt & LDP	Direct	Ret. Over	Planning	Market	Direct	Ret. Over
	Price	Revenue	Costs	Dir. Costs	Price	Revenue	Costs	Dir. Costs
HRSW	7/bu	203	125	78	6.7/bu	201	140	61
Durum	7.31/bu	212	128	84	7.01/bu	210	142	68
Corn	4.71/bu				4/bu	332	231	101
Soybeans	11.45/bu				10.85/bu	250	149	101
Canola	.221/lb	290	171	119	.201/lb	263	180	84
Flax	11.49/bu	195	97	99	12.72/bu	229	109	120
	Red River Valley 2011				Red River Valley 2014			
	Planning	Mkt & LDP	Direct	Ret. Over	Planning	Market	Direct	Ret. Over
	Price	Revenue	Costs	Dir. Costs	Price	Revenue	Costs	Dir. Costs
HRSW	7/bu	352	183	169	6.7/bu	344	191	153
Durum	7.31/bu	306	164	142	7.01/bu	315	176	139
Corn	4.71/bu	489	290	199	4/bu	484	334	150
Soybeans	11.45/bu	346	126	220	10.85/bu	342	159	182
Canola	.221/lb	336	188	148	.201/lb	321	201	120
Flax	11.49/bu	282	116	166	12.72/bu	302	124	178

Source: http://www.ag.ndsu.edu/farmmanagement/crop-budget-archive

The following charts show the north western drive of corn and soybean acres in North Dakota.



Source: United States Department of Agriculture, National Agriculture Statistics Service

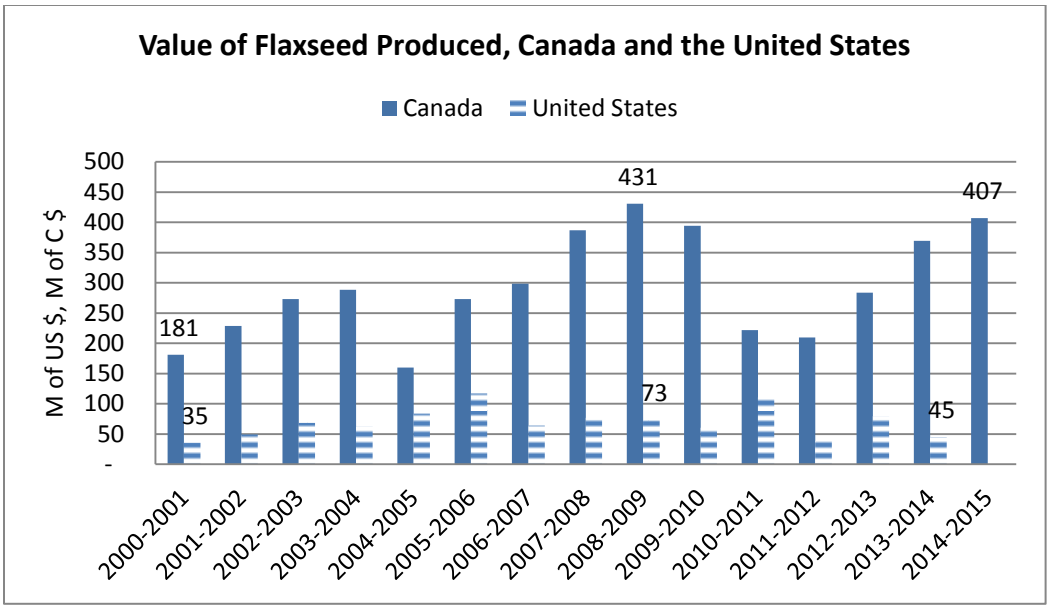


Source: United States Department of Agriculture, National Agriculture Statistics Service

Growth in Value and Volume of Production

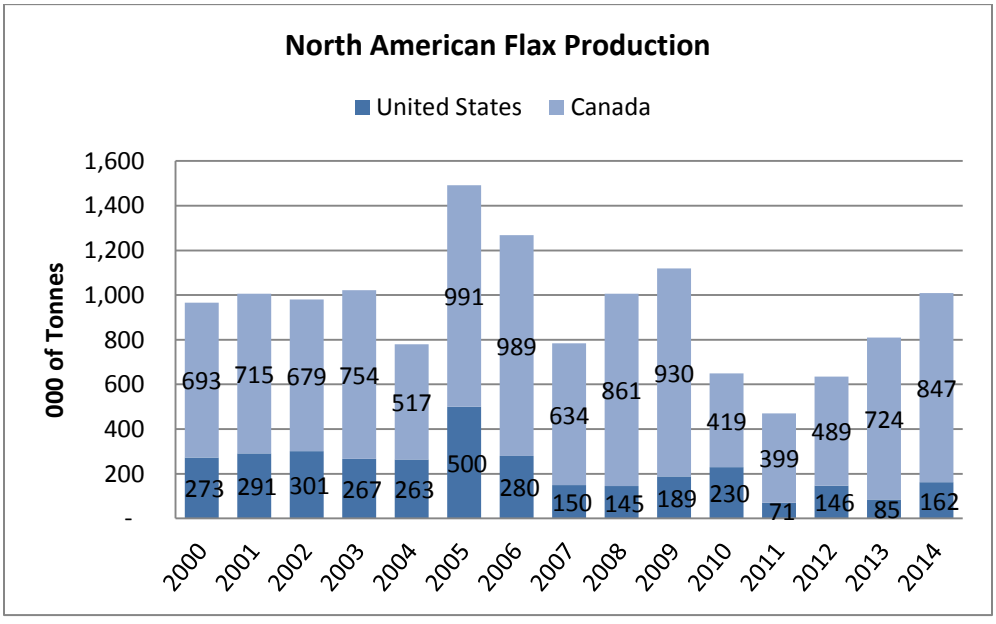
The value of flaxseed produced in North America from 2000 to 2014 is shown below. The expected value of production in Canada for 2014/15 is $407 M. The value of flax produced in the United States in 2013/14 was $45 M US.[115] Over the time period shown even though the value of production in Canada was volatile the average annual growth rate was 6%. Value in the United States grew much more slowly (average annual rate of 2%).

[115] Canada's crop year runs from August 1st to July 31st. The United States crop year for flax runs from June 1st to May 31st.



Source: United States Department of Agriculture, Economic Research Service, "Oil Crops Yearbook" and Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015.

The volume of North American flax production is shown below. From 2000 to 2014, North American flax production increased at an average annual rate of 0.3%. Production in the United States decreased at an average annual rate of 3.6% while Canadian production grew by 1.4% annually. Flax production peaked at 1.49 M tonnes in 2005 and hit bottom at 470,000 tonnes in 2011. In 2014, production was estimated at 1,001,000 tonnes.



Source: United States Department of Agriculture, National Agriculture Statistics Service and Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015.

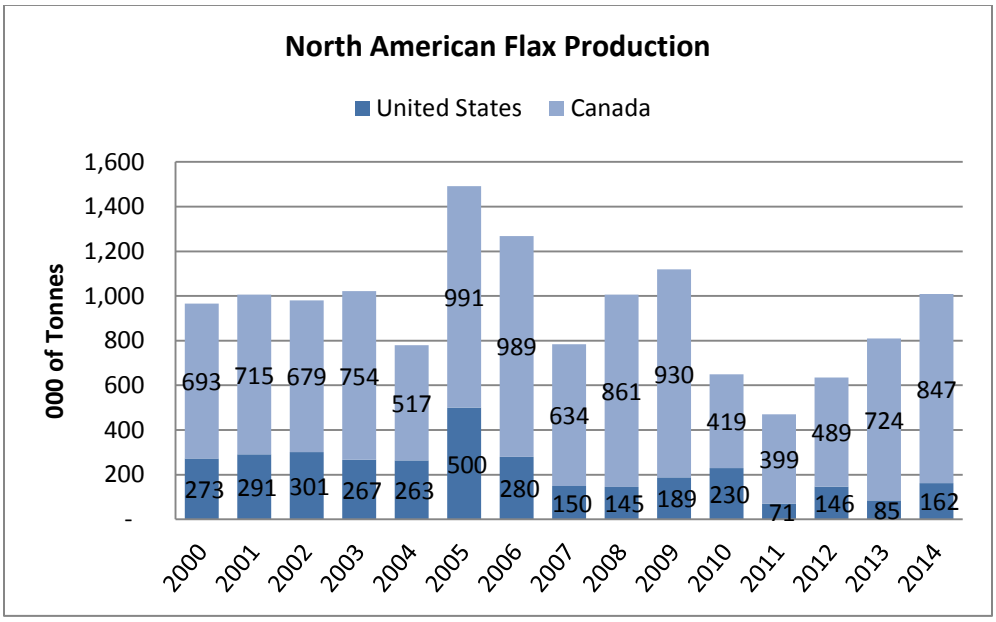
Organic Premium

Organic flaxseed commands a significant premium over conventional flaxseed. In August 2014 the price for golden organic flax at the grower level ranged from $38/bu to $40/bu while the price for brown organic flax ranged from $30/bu to $32/bu. The price of conventional brown flax was $12/bu to $13/bu. The price premium for brown organic flaxseed at that time was 246%.[116]

Sufficiency of Supply

During the interviews we heard that one of the key success factors for growth of the industry in general is if a major food company like Kellogg's or Kraft wanted to incorporate flax into their products. The question would be whether the industry could handle the increased demand – supply of the raw material would be a big issue. Without the demand from one of the large companies, flax and its uses will be targeted at "micro markets".

This section addresses the sufficiency of supply for the human food market. In 2013/14, 809,000 tonnes of flaxseed was produced in North America. Production increased to just over 1,000,000 tonnes in 2014/15. While production in Canada has mostly recovered since the discovery of Triffid, United States flax production is trending downwards. North Dakota, the primary producer in the United States, is losing flax acres to crops such as corn and soybeans.



Source: United States Department of Agriculture, National Agriculture Statistics Service and Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015.

[116] http://organicalberta.org/resources-for-producers/pricing

For 2014/15:[117]

- Flax production is estimated to be 847,000 tonnes
- Flax total supply is estimated to be 952,000 tonnes
- Flax exports are estimated to be 700,000 tonnes
- Flax closing stocks is estimated to be 150,000 tonnes

Because of confidentiality, Agriculture and Agri-Food Canada removes the amount of flaxseed used for food and industrial use from the total domestic use estimate. Using trade data we estimated that at the amount of flaxseed oil produced in Canada annually is 2,500 tonnes. This level of production requires 7,184 tonnes of flaxseed and produces as a coproduct 4,619 tonnes of flax meal. The flaxseed oil is produced using extrusion and is used primarily for food although some production is used for livestock/pets. There was one company attempting to use flaxseed oil for bio-diesel.

Although we don't know the total amount of flax used for food in Canada, it is clear that the Canadian supply is more than sufficient to meet Canadian flax value added companies' volume requirements.

In the United States, according to United States Department of Agriculture, on average during 2009/10 to 2013/14[118]:

- Flax production was 144,219 tonnes
- Flax imports were 183,649 tonnes
- Flax total supply was 370,151
- Flax crushed was 282,641 tonnes
- Flax exported was 29,068 tonnes
- Flax used for seed was 6,086 tonnes
- Flax in closing stocks was 37,015 tonnes
- Flax as a residual was 6,086 tonnes

The average amount crushed in the United States, 262,641 tonnes, would produce 98,359 tonnes of oil and 181,738 tonnes of meal. The large scale crushers such as ADM and Cargill do not crush for the food market.

The residual category will contain uses such as feed, waste, dockage, seed, and food (not crushed).

Without imports, of which Canada accounts for 99%, the United States flax value added sector would be constrained by low and decreasing flax acres.

[117] Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015.
[118] The most recent supply and disposition table for flax in the United States (Oil Crops Yearbook) contains data for 2013/14 but not for 2014/15.

5.1.2 Desired Attributes

In terms of desirable seed attributes, our interviews revealed that:

- Consumers like yellow or golden flax better than brown, according to processors
- Plant breeding has resulted in a homogeneous seed and this benefits industry (chia is not homogeneous)

According to one company, the ALA content in flax is declining over the 20 years it has been monitoring levels. Twenty years ago, they could count on a 60% ALA content. The content has now dropped to approximately 49% and "from a buyer point of view, that's not good". The speculation is that the demand for a more "stable" product has resulted in breeding of seed that has a reduced ALA content. Given that Natural Health Products (NHPs) must contain a therapeutic dosage, flax oil companies targeting the NHP industry need:

- A standardized amount of the active ingredient (consistency of the ALA content therefore is critical);
- Must be unadulterated; and
- Must not change.

Consistency in the seed is an ongoing issue. When the demand for flax is for seed in toppings or inclusion in bars, appearance is critical and requires a "premium product". Food companies require "99.9% of purity" which is based on weight. Issues of cleanliness and consistent size of seed are ongoing issues for suppliers.

Product Quality

Not all flax products are of high quality. Products found in some retail outlets, according to those interviewed, are of poor quality, have outrageous claims, and harm legitimate companies. While charlatans do sometimes operate on the health side, industry can't do too much about it. The Flax Council could deny membership and ensure a supplier list is of credible firms. The flax industry is not ready for a logo to provide credibility that is identification or "proof" of quality (may be able to look at a logo system such as was implemented in the early days of canola marketing)

Other interviewees also complained about low grade oil and poorly cleaned seed in the consumer market resulting from inadequate processing.

5.1.3 Research and Development

SaskFlax, Manitoba Flax Growers Association (MFGA), and the Flax Council of Canada collaborate on the coordination and funding of research and development. Current priorities are agronomy, variety development, value added processing, fibre processing, human health, and flax in animal diets. SaskFlax

also works with other producer organizations such as the Western Grains Research Foundation, SaskCanola, and Sask Pulse Growers in order to optimize the value of the producer check off.[119]

Interviewees were asked about the amount of research and development done by private companies. Responses included:

- The ALA in flax seed is not worth much – about $1 per pound. As a result, the larger companies are not putting money into research and development
- From a product development perspective, Vega is the company that "others are trying to catch"[120]
- One company is linked with a research and development company to apply protected technology across several crops.
- JG Pizzey's is doing (which is confidential).

Some required research and development was identified:

- Definitive answers are required with respect to benefits of flax consumption
- Need to link into the broad medical community and do similar studies to fish – some GPs are promoting it to patients but they really don't have enough information similar to the fish studies
- "Formulation" research is also required to answer how people can get sufficient flax seed throughout the day to provide the health benefit

[119] http://www.saskflax.com/research/index.php

[120] Vega is not included in the companies because it has outsourced production of its products (protein) and is focusing on marketing. (www.myvega.com)

5.2 Demand Conditions

Flax seed is used in foods, as animal feed, as an ingredient in pet foods, and as industrial oil.

5.2.1 Human Food

Drivers

The primary factor driving the demand for flax for human consumption is the demand for health and wellness. The literature review identified safety and transparency, population growth, aging demographics and the cost of chronic disease as elements of health and wellness. Clear labeling (genetically modified organisms) and targeted ingredients are the key product trends.

The global protein market is expected to be valued at $24.5 B in 2015. The volume of plant protein used globally was 1.6 M tonnes in 2012 and should reach 2.3 M tonnes by 2018. The plant protein market is dominated by soy derived protein (53% market share), followed by wheat (44%), pea (0.4%), and emerging proteins such as chia and canola. Although very small, the markets for emerging proteins and pea proteins are growing at 5% and 6% respectively each year.

The global market for omega 3 was $33 B in 2012 and is expected to reach $37.7 B in 2016. The volume of omega 3 material used in 2013 was 2.49 tonnes and the volume could reach 3.44 M tonnes in 2018. In Canada and the United States, consumers are very aware of omega 3. Between 2010 and 2013, the number of products with flax launched throughout the world grew at an average annual rate of 19%.

The demand for flax is supported by a health claim in Canada (as of January 2014) and nutrient content claims. In the United States, flax received GRAS status in 2009 and there are structure/function and nutrient content claims that are applicable to flax.

Those interviewed clearly agreed that health and wellness was the major factor behind the demand for flax. However, the need for consumer education was also clear.

- Consumers perceive flax to be healthy
- Consumer awareness of the need for omega but there is still confusion about the ratios of omega that are required (3 vs. 6 vs. 9)
- Consumer awareness linking flax with health
- The average consumer perceives a ''halo of goodness'' around Omega 3's even if they do not understand the chemistry. One company surveyed 5000 consumers at the retail level and found that and the awareness of Omega 3 was 97%. This person said that even marketing people at major food companies had no idea what it was, just that it was good.

Not everyone agreed that the demand for omega was a key market driver. According to one expert, the research and science does not support the claim for ALA to the extent of DHA/EPA.

Consumer demand for non-genetically modified organism products and the response by companies was brought up during the interviews.

- Flax is non-genetically modified organism and demand for non-genetically modified organism is growing – non-genetically modified organism project certification is gaining influence in food industry; sources say that Loblaw's is going to introduce a policy on genetically modified organism labelling

Consumers seem to be influenced by celebrity doctors. One interviewee mentioned that flax sales spike whenever Dr. Oz (or other celebrity doctors) mention flax.

Consumers are looking for the "new vegetarian source" of protein and omega 3 but flax faces stiff competition in the protein market.

- While there are problems with pea protein (bad taste, difficulty in formulating recipes, issues of consistency of product, often sourced from China), customers still want pea because of the level of protein in it
- The challenge with the protein side is that it is up against whey which is about 80% protein content. Vegetarian/plant sources have difficulty achieving 45 – 55% protein content ("if you can get that, then it's attractive because it is a plant source")

Flax is an alternative to fish oil as a source of omega 3 and does not have environmental concerns and a fishy taste associated with it.

Milled flaxseed received a health claim in Canada in 2014 while milled and whole flaxseed obtained GRAS status in the United States in 2009. Opinion regarding the impact that Canada's health claim and GRAS status in the United States was having on the market was mixed.

- Some suggested that the health claim will create growth and will increase consumer knowledge; health claim quantifies how to eat flax, how much to eat, and its benefit
- GRAS status helped a bit
- Health claim not really a driver in Canada; flax has been around a long time
- GRAS – small companies don't know about what it is
- The health claim in Canada and GRAS status in the United States have made no difference to date (GRAS made a difference in baby food as regulations are very strict for ingredients in this area).
- Flax meal/cake, which is not part of the Canadian health claim, is often confused with milled flax in the market.
- The health claim is a challenge:
    - States that the amount of flax must be listed in grams
    - Consumers would not be attracted to something that says ".3 g" – so they just state flax and depend on consumer association of flax with health

  - The health claim is very general. Small companies struggle to formulate around it. More work is required in developing formulations and in health science. How does the company show that it meets the terms and conditions of the health claim? Does processing reduce omega 3?
  - Milled seed health claim in Canada is for 40 g; that much consumption is challenging unless have an urgent health need
- While companies are looking at the health claim as being of vital importance, 30g of flax are required per serving. That amount affects formulations and taste and not much is happening.

Numerous other factors that are helping to grow the flax value-added sector were mentioned including the following:

- The growth really started to occur when Whole Foods and Save-On Foods in British Columbia (OWFG) took flax oil out of the health food stores and put it on their shelves (Scobey's and Loblaw have followed suit).
- Industry education
- Consumer education
- Increased interest in flexitarian diets ("The **flexitarian** diet is a plant-based diet with the occasional addition of meat.")[121]
- Growth in nutraceutical products (global market expected to grow at an average annual compound rate of 6.3% from 2013 to 2017)[122]
- Greater nutritional awareness
- Flax is gluten free

Market Size

Regarding the size and growth of the market for flax products

- Some companies did provide volumes.
  - One company buys 5 to 10 M lbs of flax annually, 5% of this is organic
  - Another company sold a couple of thousand lbs of flax products in 2006 and now sells tens of M of lbs (90% of private label flax seed and meal in United States is from this company)
  - Sprinkling flax on crackers could require 2 M lbs per year which is only 4 or 5 truckloads
- In food, flax is still a niche market.
  - 1 M lbs of flax is 453.6 tonnes. At a yield of 1.27 tonnes/ha, 1 M lbs of flax requires 357 ha or 883 acres.
  - It's too much of a micro niche – health food – some people are making very good money on flax but not enough to say that the industry is growing

[121] http://theflexitarian.co.uk/the-flexitarian-diet/
[122] http://www.nutraceuticalsworld.com/issues/2013-09/view_industry-news/nutraceuticals-market-to-reach-2048-billion-by-2017/

Market size in general:

- Flax for food is a niche market – not a big demand
- The market has been going well for last 15 years and the animal side had been increasing. Now a mature market with more players. With increase in food demand side more players buying smaller quantities which have helped keep price stable or higher.
- California is biggest market, followed by east coast and Florida.
- Demand for flax is higher in Canada than the United States due to the efforts of Canada Bread and Weston Foods who have been supportive of the industry. No major company in the United States is incorporating flax.
- The size of the market all depends on increasing the stability and quality of flax and the ability to develop flax ingredients that can be added to food products – "something a lot higher value than the seeds or meal"

Market/Consumption Estimates

In the United States, food is part of the residual category. Over the last five years, the average volume of whole flaxseed in the residual category is 15,341 tonnes. We have estimated that 7,341 tonnes of whole seed are used to produce enriched eggs and so will peg feed use at 9,000. This leaves 6,000 tonnes and we will assume that the United States uses 5,000 tonnes of the whole flaxseed to produce food products. The remaining 1,000 tonnes of whole seed is assumed to be waste and dockage.

Any data on the use of flaxseed for food and industrial purposes in Canada has been cleansed from public data because of confidentiality concerns. If we use the ratio of flaxseed production in Canada and the United States (which is approximately 5) to estimate the volume of flaxseed used in Canada for the food market the resulting estimate is 25,000 tonnes (with most exported).

The flax oil produced in Canada (estimated 2,500 tonnes) is primarily used for food with a small amount used for pets. Exports and imports of flax oil by Canada are approximately equal so domestic consumption of flax oil is about 2,500 tonnes.

We can use the population ratio for Canada and the United States to provide a rough estimate of the consumption of flax oil as food in the United States. The Canadian population is about 34.2 M while the United States population is about 310 M. Based on the ratio of population United States demand will be 9 times higher than Canada. Consequently the estimated demand for flax oil for human food in the United States is 22,500 tonnes.[123]

[123] We used the population ratio to estimate United States oil demand and the production ratio to estimate Canadian utilization of flaxseed for the food market. The production ratio appears to be a better indicator given the importance of exports to the Canadian value added flaxseed sector.

Some of the 4,619 tonnes of flax meal produced in Canada will be for the food market. We have assumed that 75% is used is for the food market and 25% is for the feed market. Thus, 3,400 tonnes of partially defatted flax meal are used in the Canadian food market.

In the United States, average production of flax meal is 181,000 tonnes. We have assumed that 80% of this is for the feed market (145,000 tonnes) and 20% (36,000 tonnes) is for the food market.

Market Growth

Market growth is occurring in some segments of the flax market:

- Flax is one of our top 10 ingredients by sales in specialty part of business and is growing because of demand by baking sector for healthier ingredients
- Demand for organic growing – currently 50% of one company's products are organic and 50% are conventional but by next year organic volume will exceed conventional volume
    - Those orders can't be filled "and that doesn't help sustainability of the industry"
    - The company hears from food manufacturers that they are just "backlogged" because they can't get enough organic flax
    - The growth area is for organic flax ("only the baking industry using conventional flax")
- Demand for flax oil is growing
- Interest is growing in flax protein

Interviewees suggested that growth is not occurring for use in nutraceuticals and for use in baking. It was suggested that the market for little bottles of flax oil (culinary or health) was saturated. Other factors limiting market growth include:

- Buyers are price sensitive. There are many small "entrants" in flax. The plethora of crushers is holding the industry back. Most crush about 5 – 10 tonnes a day whereas Cargill crushes about 300 tonnes a day. The crush cost for the smaller players keeps the cost of flax oil "artificially high". The crush cost needs to be reduced and would result in the ability to take on larger markets
- In omega 3 market there is lots of discrimination against plant based omega 3 by media and marine omega 3 companies
- The existence of Linola confuses manufacturers and customers.
- Flax isn't sexy like chia and hemp; it is the old lady in the room
- Taste of it – some consumers don't like it Lack of consumer knowledge about how to use it
- Competition from other products such as chia
- Competition from other growing countries: Some companies are sourcing organic flax from China or Argentina
- Growing competition for flax seed between the natural health products sector and the food sector – the growth of flax seed use in the food sector is taking away the purchasing power of the NHP companies.

- The cost of flax as a protein source is not competitive. Some companies are looking at the protein content in flax but there are so many other cheaper options to get it – would be a mistake to look at flax for protein.
- For the food sector, flax hasn't really captured the market
    - Processes at the outset were not food grade nor was the seed cake
    - Consumers in general looked at this as "linseed oil" and associated it with paint and animal feed thus stalling the interest in flax
    - Only Europeans in the late '80s were using flax oil for human nutrition use.
    - In the United States, milled seed has GRAS status but not oil or extracts. Collaboration will be required to obtain GRAS status for the other products.

Functionality in Products

Flax has positive attributes in terms of functionality such as its nutritional profile, acting as a replacement for fat in food, and replacing gums in food.

- For baking: non-genetically modified organism; nutritional profile; appearance (of seed)
- Key attributes: it's not soy (allergens and genetically modified organism); its natural; flax protein behaves well in terms of functionality
- Source of ALA omega 3; dietary fibre; plant protein; SDG lignans
- Gluten free
- Can replace fat in food
- Milled and meal can replace gums in food

However, there are challenges associated with using flax in products. These include:

- Providing a product that is perceived to be "natural" to the consumer.
- Formulation and stability issues. In baking, stability is not such a large issue because the flax is generally used within 30 days.
- Food safety - Many of the bakeries don't have verified kill steps in their operations and they are beginning to see demand from these bakeries for some form of assurance that the flax (seed and meal) has been "treated" to get rid of any pathogens. One company does not have the equipment at this time to "treat" the flax but if the demand grows, they will need to address this issue. Sprouting flax is dangerous because it magnifies natural toxins
- Rancidity: For every 10 degrees C flax oil is raised and maintained, the shelf life is reduced by half. The result is an accelerated rancidity and bad taste. At 2% rancidity, the "gag threshold" is reached resulting in difficulties in producing a good tasting oil with a good shelf life
- If you put the seed in water, it forms a gelatinous medium. If you add too much flax to a baked good, it alters the characteristics of the product. It needs to be ground to get any health benefit but then it isn't stable. If you use a flax cake, it is too difficult to deal with in the baking process

Competitive ingredients

- Chia and fish are the competitors
- While chia is much more expensive, the chia people have done a lot to promote it as a super food
- Chia is coming on strong; It doesn't need to be ground to get the nutritional benefit; It's easy to use; There aren't "many issues" in using chia (i.e. doesn't have rancidity issues); Cost has come down substantially for chia
- Soybean is trying to incorporate omega properties in to varieties

Demand Conditions – Organic Flaxseed

The demand for certified organic flax in North America exceeds the local production of organic flax. Because demand is outpacing supply, processors are importing it from countries such as India, Argentina, and European Union. This creates an opportunity for Canadian farmers.

Some processors complained about the **cost of organic flaxseed** and in particular, the cost of golden organic flaxseed. While a 10% premium was perceived as fair, the current premium for golden organic flaxseed relative to conventional brown flaxseed is over 300%.

5.2.2 Feed and Animal Health

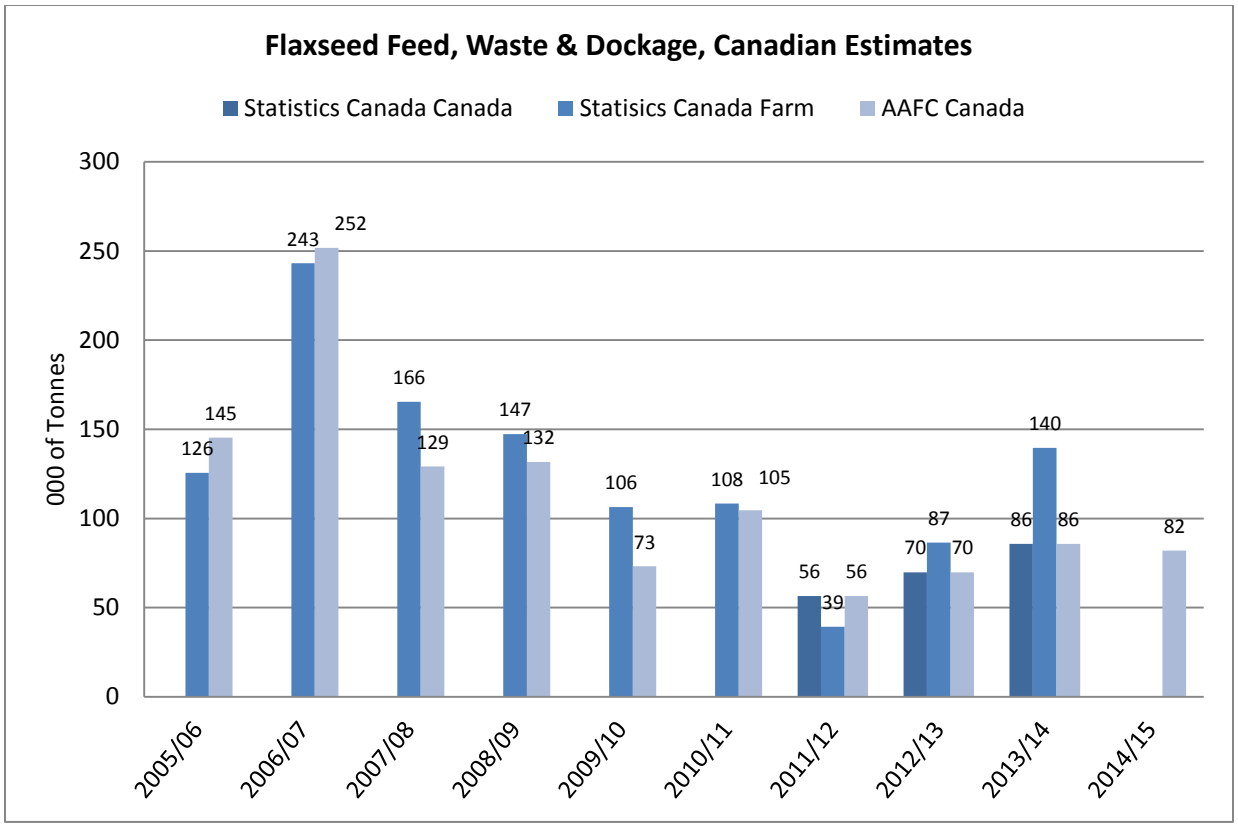
Flax does have some desirable properties when used as livestock feed. Previous discussions have shown that there is an adequate supply of flaxseed for this market segment.

Our interviews found that there are issues in using flax in animal feed.

- One company purchases the whole seed and then grind it themselves due to stability issues (will grind as required – but stability is the biggest issue when utilizing flax).
- Flax oil is "interesting but the key issues are shelf life and rancidity so we don't use it".

Market/Consumption Estimates

Both Agriculture and Agri-Food Canada and Statistics Canada calculate feed, waste and dockage for flaxseed as a residual. Statistics Canada provides estimates at the Canada level and at the farm level. Agriculture and Agri-Food Canada provides estimates at the Canada level. Estimates for nine years are shown below. There are large differences between Agriculture and Agri-Food Canada's estimates at the Canada level and Statistics Canada's estimates at the farm level. The estimates for the farm level typically exceed the Canadian level. This study uses the Agriculture and Agri-Food Canada estimate of feed, waste, and dockage for 2013/14 of 82,000 tonnes. We assume that 70,000 tonnes is fed to animals each year, which in most cases would be purchased as whole seed by feed manufacturers and then included as an ingredient in the prepared feed.



Source: Statistics Canada. Table 001-0041 - Supply and disposition of grains in Canada as of March 31, July 31, August 31 (soybeans only) and December 31; Statistics Canada. Table 001-0043 - Farm supply and disposition of grains as of March 31, July 31, August 31 (soybeans only) and December 31, and Agriculture and Agri-Food Canada, "Canada: Grains and Oilseeds Supply and Disposition", January 23, 2015.

According to our calculations regarding the amount of flaxseed oil produced in Canada, 4,619 tonnes of flaxseed meal is produced by crush operations. Some of this meal will be sold into the human market because it is a higher valued use. We identified 3 crushers of the 12 in total that sold partially defatted meal in the feed market. If we assume that 25% of the partially defatted flax meal is sold in the feed market, then the volume of flax meal in the livestock feed market is 1,200 tonnes.

In the United States, the flaxseed supply and disposition does not have an explicit category for feed, waste and dockage but is contained along with food use in the residual category. The average amount of flaxseed classified as residual during the last five years was 15,341 tonnes. We are assuming that 9,000 tonnes are feed to animals (this includes the volume used as feed for omega-3 eggs that is estimated below), that 5,000 tonnes are used for human food, and that the remainder is waste and dockage.

Also over the last five years, 62,497 tonnes of flaxseed oil was consumed each year in the United States. The oil would be utilized in the human, industrial, and feed markets. ADM and Cargill, the largest

crushers, vigorously promote the flaxseed oil that they produce in the feed market. Based on some information about the size of the industrial market and an estimate of the food market, the residual left for the feed market is 5,000 tonnes (about 8% of production).

Although flaxseed meal is sold in the human food market, most of this product is used as a source of protein in animal feed. Average flax meal consumption over the last five years was 181,000 tonnes. Assuming that 80% is used in the feed market (the large crushers are producing for the industrial and feed markets so this ratio should be high), then 145,000 tonnes of meal would be used for animal feed each year in the United States.

Feed for Enriched Products

Consumers are demanding products such as omega enhanced eggs. Flax is promoted as the sustainable source of omega as opposed to fish which is regarded as not sustainable. It is ''all natural and land based''. People don't want to hear that their dairy products are ''loaded with fish oil''. Oleet does not sell their products as least cost feed ingredients but as innovative health based products.

We identified five companies in Canada producing omega-3 enriched meat and eggs using flax. Four of the companies produced omega enriched eggs (two companies produced both organic and conventional eggs and two produced only conventional eggs). One company produces omega enhanced pork using flax.

In Canada, omega 3 eggs represent 8.8% of the market. According to Nielsen, 26 M dozen of omega 3 eggs are sold in Canada at major retail stores. Over all Canadian table egg sales, the volume of omega 3 eggs would be 40 M dozen. There is also a demand for omega-3 processed egg products.

To produce the omega enhanced eggs, each dozen eggs requires about 142 grams of flaxseed. This translates into 5,680 tonnes of flaxseed for 40 million dozen eggs.

In the United States 6.7 B dozen eggs were produced in 2012 with 69% of these marketed in the shell (1.5% were exported). Of the 4.7 B dozen eggs marketed in shell in the United States:

- 86% were non-branded commodity eggs
- 11% were branded
- 3% were branded by a specific store (private label)

Of the 517 M dozen eggs marketed as a branded product (but not private label), some portion are enriched.[124] (This is about 8% of total shell eggs.) Flax is not the only source of omega 3 used in the United States to produce omega enhanced eggs. Algae and marine oil are also used.

[124] http://www.worldpoultry.net/Layers/Markets-Trade/2014/1/Egg-enrichment-for-health-and-marketing-1435620W/

If we assume that flax is used to produce 10% of the 517 M dozen branded eggs, then the total amount of flaxseed used would be 7,341.4 tonnes.

In the United States, Eggland's Best is one of the major companies that spent a lot of time developing the market for omega 3 eggs and now are doing very well.

5.2.4 Pet Foods

Drivers

The demand for pet food in North America is growing. In 2016, the North American market for cat food is expected to be valued at $7.4 B and have a volume of 2.4 M tonnes. For dogs, the market is expected to be worth $15 B and have a volume of 6.3 M tonnes.

Flax used in pet foods must be "food grade". The flax requires even more testing than for human food applications – e.g. extra testing for salmonella.

Pets are being humanized and the market is responding with product differentiation and premiumization. Consumers want their pets to be healthy and the demands for natural health products and nutritional ingredients are growing. [125]

The pet food market does currently utilize flax and it is a well-accepted ingredient. According to an expert, dog food manufacturers prefer milled/ground flax over canola due to the following properties: omega-3, lignan and fibre and it is a non- genetically modified organism. Flax meal has little value to the pet food sector.

In the premium brands, the demand for non-genetically modified organism ingredients is growing.

5.2.5 Industrial Oils

Drivers

The demand for linseed oil for industrial purposes has been declining for a long period of time and now the market is deemed mature. [126]

The European Union and United States oleo chemical industries face stiff competition from competitively priced tropical oil from Philippines, Malaysia and Indonesia. While linseed oil is used for coatings and inks, its use is declining in Canada because of the relocation of manufacturing off-shore.[127]

[125] Agriculture and Agri-Food Canada, "Consumer Trends: Pet Food in Canada", September 2012.
[126] Agriculture and Agri-Food Canada Bi-Weekly Bulletin, "Flaxseed Situation and Outlook", February 2007
[127] SJ Campbell Investments Ltd, "Flax Council 1015 Oleochemcial Industry Research", 2006.

According to an expert, uncertain supply and price volatility has made industrial oil risky. Companies that could have formulated away from linseed oil have done so.

Market Size and Growth

There is some older data on the use of fats and oils for industrial purposes in the United States. The paint and varnish and the resins and plastics categories are the most relevant for flaxseed oil. From 2006 to 2010 the average annual utilization of fats and oils for paint and varnish was 45,350 tonnes and for resins and plastics was 76,564 tonnes. The utilization for paint and varnish declined at an average annual rate of 1.7% from 1980 to 2010 while the utilization for resins and plastics grew at an average annual rate of 0.9%. See the Annex for the complete data set.

Industrial Use of Fats and Oils in the United States									
				Paint	Resins	Lubricants	Methyl	Other	Total
Calendar	Fatty	Animal	Soap	and	and	and	esters	inedible	use
year	acids	feeds		varnish	plastics	similar oils		products	1/
2000	956,105	1,180,123	191,826	51,755	69,264	58,287	NA	193,323	2,700,684
2001	934,410	1,202,304	165,888	45,071	63,910	54,119	NA	215,794	2,877,394
2002	987,927	1,210,928	169,548	50,382	62,713	50,655	NA	221,673	2,753,826
2003	1,013,636	1,248,027	137,891	49,279	64,147	50,015	NA	201,662	2,764,657
2004	1,076,700	1,343,917	113,335	41,402	73,195	50,655	NA	205,007	2,904,210
2005	1,030,050	1,461,746	116,570	47,272	71,067	165,291	NA	225,767	3,117,764
2006	1,146,295	1,376,394	110,313	46,794	74,528	176,676	819,060	312,502	4,062,561
2007	1,223,046	1,389,119	107,953	38,939	81,346	124,876	1,699,763	219,992	4,884,990
2008	1,196,056	1,229,809	106,232	45,768	78,615	136,103	2,691,599	216,977	5,701,158
2009	1,032,423	989,092	117,409	43,228	73,039	102,838	1,865,676	210,900	4,434,605
2010 2/	1,211,794	886,953	122,357	52,020	75,295	106,651	1,073,493	219,879	3,748,443
1/ Total includes factory use in linoleum. 2/ Preliminary.									
Sources: U.S. Census Bureau, *Fats and Oils: Production, Consumption and Stocks*.									

Source: United States Department of Agriculture, Economic Research Service, "Oil Crops Yearbook", March 2014

Market/Consumption Estimates

In 2000, the linseed oil produced in the United States was primarily used for the production of resins and plastics (40% of linseed oil production) and paint and varnish (39%).[128] (most recent data available)

In 2000, the United States produced 106,000 tonnes of linseed oil of which 81,000 tonnes was used domestically. Using 79% as the share for industrial production and the amount of oil used domestically, results in an estimate of 64,000 tonnes for industrial use in 2000. If we assume that the demand for linseed oil for industrial purposes has fallen at an average annual rate of 5% then current industrial

[128] United States International Trade Commission, "Industry and Trade Summary: Oilseeds", 2003.

utilization of linseed oil is 31,000 tonne. The United States' imports of linseed oil are minimal (approximately 1,000 tonnes).[129]

An old market research report pegs the United States' industrial linseed demand at 45,813 tonnes and it was expected to remain steady until 2006. From 1987 to 1996, the demand contracted at an average annual rate of 11%. If demand continued to contract instead of steadying, then at a 5% contraction rate the volume in 2014 would be 40,000 tonnes.

The Freedonia Group's 1998 United States Linseed Situation - Historic					
	1987	1992	1996	2001 (Forecast)	2006 (Forecast)
	Tonnes				
Total Industrial Demand	132,450	73,483	45,813	45,813	45,813
Chemicals	113,399	52,164	21,773	15,876	13,608
Plastic and Rubber	15,876	17,237	23,133	26,309	28,123
Other	3,175	4,082	2,268	3,629	4,082
	M of US $				
Total Industrial Demand	82	50	38	44	50
Chemicals	70	35	17	15	15
Plastic and Rubber	10	12	19	25	31
Other	2	3	2	4	4

Source: SJ Campbell Investments Ltd, "Flax Council 1015 Oleochemcial Industry Research", 2006

We will use 35,000 tonnes as our estimate for the size of the current industrial market for linseed oil in the United States. Canada does not currently produce linseed oil for industrial purposes.

End-Users of Industrial Oils

Paint, varnish, coating, and resin manufacturers are the most likely to utilize linseed oil. There is no definitive information on the number of customers for linseed oil in Canada and the United States. The following data uses NAISC classifications and provides an indication of the number of customers, purchases, etc.

In Canada industry data is available at the 5 digit NAISC code. In 2012, there were 193 paint and coating manufacturers in Canada, primarily in Ontario and Quebec. The value of shipments was $1.7 B in 2011 while the cost of materials and supplies was $940.4 M. Canada is a net importer. In 2013, Canada exported $392 M of paint and coating and imported $1.2 B resulting in a trade deficit of $701.2 M. The trade deficit has been increasing. [130]

Data from the 2012 United States Economic Census has the following information about the manufacture of paint and varnish and plastic materials and resin manufacturing.

[129] Total consumption of flaxseed oil in the United States is 62,500 tonnes. The food market consumption was estimated at 22,500 tonnes. If industrial use is 35,000 tonnes, then feed use is 5,000 tonnes.
[130] https://www.ic.gc.ca/app/scr/sbms/sbb/cis/internationalTrade.html?code=32551&lang=eng#int3

United States Companies that May Use Linseed Oil				
Industry	Number of Companies	Number of Establishments	Total Value of Shipments	Cost of Materials, Parts, Containers, and Packaging
Paint and Varnish (NAISC 325510)	965	1159	$24.4 B US	$13 B US
Plastics Material and Resin Manufacturing (NAISC 35211)	883	1141	$91.7 B US	$60.3 B US

Source: United States Economic Census, Survey of Manufacturers, 2012

5.3 Firm Strategy, Structure and Rivalry

The size, structure and strategy of firms in the industry can have a significant impact on competitiveness, the pursuit of identified opportunities, and the creation and capture of value by the industry within Canada.

5.3.1 Firm Strategy, Structure and Rivalry – Seed Production

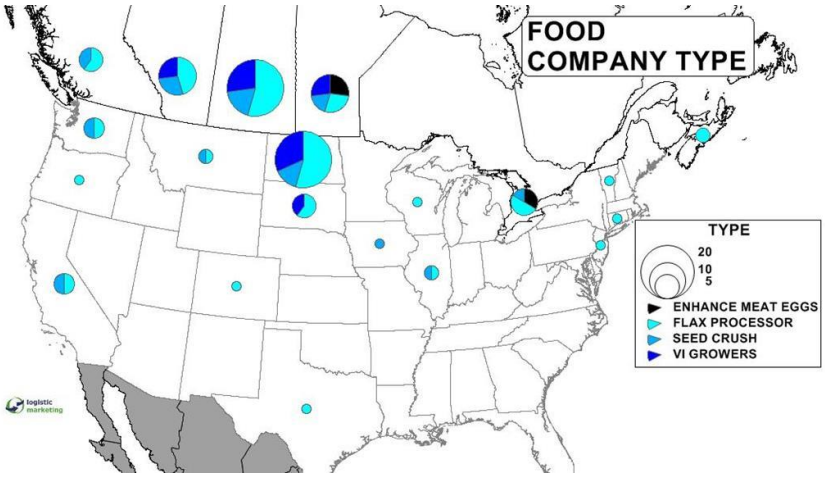
In 2011, only 4,477 farms produced flax in the Prairies compared to 9,005 in 2006 according to Statistics Canada. The discovery of Triffid and the resulting impact on markets was primarily responsible for the dramatic reduction. SaskFlax currently represents approximately 7,500 flax growers in Saskatchewan while the Manitoba Flax Growers Association represents over 1,500 growers. Although good information on the production of organic flax is lacking, according to the 2014 Organic Producers Directory for Saskatchewan and Alberta there are 134 producers of organic flax who will sell wholesale. [131] In 2009, Agriculture and Agri-Food Canada reported that there were 59,893 acres of organic flax in Western Canada, with over 52,000 acres in Saskatchewan.

In 2012, 1,676 United States farms produced flax compared to 1,429 in 2007, a 15% reduction. There were 555 certified organic farms in Minnesota, 156 in North Dakota, 154 in Montana and 93 in South Dakota. Organic flax was produced on 21,468 acres in 2011. Almost three-quarters of the organic flax acres were in North Dakota. [132]

5.3.2 Firm Strategy, Structure and Rivalry – Firms Involved in Adding Value to Raw Seed

We identified 12 crushers and 29 value added flax companies in Canada that operate in the food/human market. In the United States, 12 crushers were in the human market as well as 28 value added companies. The companies have generally located in areas where flax has been grown. Some companies have moved operations to the United States. Omega Nutrition moved across the border to Fernadale, Washington due to non-tariff barriers – Flora, Barleans, Spectrum (now owned by Hains Celestial) are all manufacturing in the United States

[131] http://www.organicfarmdirectory.ca/producers-western-flax.php?pageNum_rsSearch=1&totalRows_rsSearch=134
[132] http://www.ers.usda.gov/data-products/organic-production.aspx



Source: Author

It was suggested that there is more activity in the United States because of government incentives, larger population, investment dollars, and the United States government assistance in export markets.

In Canada, 11 vertically integrated growers were identified with more than half processing flax to produce products such as whole seed and ground seed for the human/food market. There is one crusher that produces oil and partially de-fatted meal. Three quarters of the vertically integrated growers are organic. The level of value added activity is low (bulk raw seed) or medium (products of oil, meal, seed, hull, flour, etc.). Three of the growers also produce food products (cereal or granola),

We identified nine United States growers that have vertically integrated forward in the supply chain. Most of these growers process flax and produce flax products such as whole seed, ground flax and hulls. Two of the growers have crush operations. One of the growers sells the flax they produce directly to flax product manufacturers. None of the growers are only organic and five sell and produce both organic and conventional products. The level of value added activity is low (bulk raw seed) or medium (products of oil, meal, seed, hull, flour, etc.). Two of the growers are producing partially defatted meal from their crush operations.[133]

In Canada, all 12 of the crushers produce oil for the food/human market and all oil is produced using the extrusion method. Most of the crushers (seven) only produce organic flax oil while three produce both conventional and organic oil and two produce only conventional oil. Most of the meal produced is sold in the human market. The level of value added activity is medium.

[133] Sales of bulk raw seed was classified as being a low level type of value added. Sales of flax products such as whole seed, ground, seed, flour, hulls, meal, sprouted flax, and oil was classified as being medium in terms of value added. Of course, there is a lot of variation is this value added level. We did not rank the value added of manufacturers of cereal and granola and just noted that the value added was food. Companies that produced enhanced feed products were also not ranked and just noted that the value added was feed. Companies produced omega 3 enhanced meat or eggs were denoted as enhanced meat or eggs in terms of value added. Companies producing higher tech products for the nutraceutical markets were classified as high while companies that produce for the specialty chemical market were termed as being very high in terms of value added.

In the United States, 16 flaxseed crushers were identified. The large crushers, ADM and Cargill as well as one other crusher used the solvent process to crush conventional flaxseed for the industrial and feed markets. The other crushers produce partially de-fatted meal for the human/food and feed markets. Five crushers specialized in organic oil while five crushers produced both organic and conventional oil and meal. Six crushers produced only conventional products. The level of value added activity is medium.

In Canada, 30 companies that produce flax products such as whole seed, ground flax, hulls, roasted flax, sprouted flax and flour were identified. All but one of the companies sell in the human/food market and five also sell in the feed/pet market. Whole seed is sold by 20 companies and ground flax is sold by 20. There are also companies selling roasted, sprouted, or flax sprinkles (four); two companies producing cereal and granola; and two include soft gels in their product lines. As with the United States companies, this group of companies was categorized as being medium in terms of value added. The companies producing cereal and granola have a different level of value added activity.

We identified 28 companies in the United States that produce flax products such as whole seed, ground flax, hulls, roasted flax, sprouted flax, and flour. All of the companies produce products for the food/human market. Some of them also sell in the feed, pet and industrial markets (one of the companies is a crusher that also sells oil in the industrial market). Some produced both organic and conventional products (13). Slightly fewer produced only conventional (10) and even fewer produced only organic products (5). The level of value added activity by this group is medium although there is variation.

Five Canadian companies were identified that produced either omega enhanced meat or eggs. Two of the companies produced both organic and conventional products while three produced only conventional product.

Interviews identified dominant firms:

- B2B: JG Pizzey's, Johnson Seeds, Heartland
- B2C: CanMar
- On food side: Heartland, Flax USA, Omega Nutrition, Barleans
- In terms of innovation: Barleans, Shape Foods, Bioriginal, Prairie Tide Chemicals, Heartland

Industry participants view the food flax market as very fragmented. There are a lot of small players from a marketing and crusher perspective. From an ALA perspective our interviews indicated that no one is dominating at this point – used to be Glanbia but it doesn't appear "to be on their radar anymore – not sure what happened". Equally from a DHA perspective (marine oil) the industry is fragmented – "there are too many to count"

According to one interviewee, there is no market leader (in food) using flax (i.e. Kraft) – he "heard" that Kraft didn't want to get into the market because it would require a lot of acres planted – they weren't convinced that they could get sustainable supplies and stable prices.

Value Creation

The firms in the flax food market appear to be creating a significant amount of value. The following tables show the prices of various products and their value on a per tonne basis where possible.

Value Along the Supply Chain – Whole Seed

		Organic	Volume	Volume Unit	Value	Currency		Value per gram	Value per lb	Value per tonne
Amazon.ca	Swanson 100% Certified Organic Whole Flaxseed	Yes	435	g	39.88	CDN		0.09		91,678
Amazon.ca	Premium Gold Flax Whole Golden Flaxseed		26	oz	21.79	CDN		0.03		28,899
Amazon.ca	Spectrum Naturals Flaxseed Whole		15	oz	39.57	CDN		0.091		90,966
Amazon.ca	Spectrum Essentials Organic Whole Flaxseed	Yes	15	oz	99.73	CDN		0.087		86,667
co web	Stevens Family Farm Whole Golden Flax Seed		3	lbs	35	US			11.67	25,720
co web	Stevens Family Farm Whole Golden Flax Seed		50	lbs	132	US			2.64	5,820
Conversions: 26 ounces = 754 grams; 435 grams = 15 ounces; 2204.6 pounds in a tonne; 1 tonne = 1,000,000 grams										

Value Along the Supply Chain – Meal/Ground Flaxseed

		Organic	Volume	Volume Unit	Value	Currency		Value per gram	Value per lb	Value per tonne
Amazon.ca	Bob's Red Mill Organic Golden Flaxseed Meal	yes	453	g	6.02	CDN		0.01		13,289
Amazon.ca	Bob's Red Mill Organic Flaxseed Meal	yes	907	g	9.66	CDN		0.01		10,650
well.ca	Webber Naturals Ground Flaxseed		435	g	8.99	CDN		0.02		20,667
well.ca	Gold Top Organics Cold Milled Golden Flax Seed	yes	454	g	7.29	CDN		0.02		16,057
well.ca	Gold Top Organics Cold Milled Brown Flax Seed	yes	454	g	7.29	CDN		0.02		16,057
co web	Stevens Farm Ground Golden Flax Seed		6	lb	44	US			7.33	16,167
co web	Stevens Farm Ground Golden Flax Seed		50	lb	155.5	US			3.11	6,856
Conversions: grinding 1 tonne of seed gives .643 tonne of meal (United States Department of Agriculture conversion); 1 cup of ground/milled flax seed = 4 oz										

Value Along the Supply Chain - Oil										
		Organic	Volume	Volume Unit	Value	Currency		Value per gram	Value per lb	Value per tonne
Amazon.ca	Nature's Bounty Organic Cold Pressed Flaxseed Oil	Yes	8	oz	9.99	CDN		0.04		
Amazon.ca	Barlean's Organic Clear Flax Oil	Yes	477	ml	24.99	CDN		0.05		
Amazon.ca	FSC Organic Flaxseed Oil	Yes	500	ml	31.44	CDN		0.06		
Well.ca	Now Foods Organic Flaxseed Oil	Yes	750	ml	26.99	CDN		0.04		
co web	Bulk Flaxseed Oil from JD Edwards		3.5	kg	18.06	US			5.16	5,160
co web	Bulk Flaxseed Oil from JD Edwards		18	kg	90	US			5.00	5,000
co web	Bulk Flaxseed Oil, Refined Organic from JD Edwards	Yes	3.5	kg	25.14	US			7.18	7,183
co web	Bulk Flaxseed Oil, Refined Organic from JD Edwards	Yes	18	kg	108	US			6.00	6,000
Conversions: 1000 kg in 1 tonne										

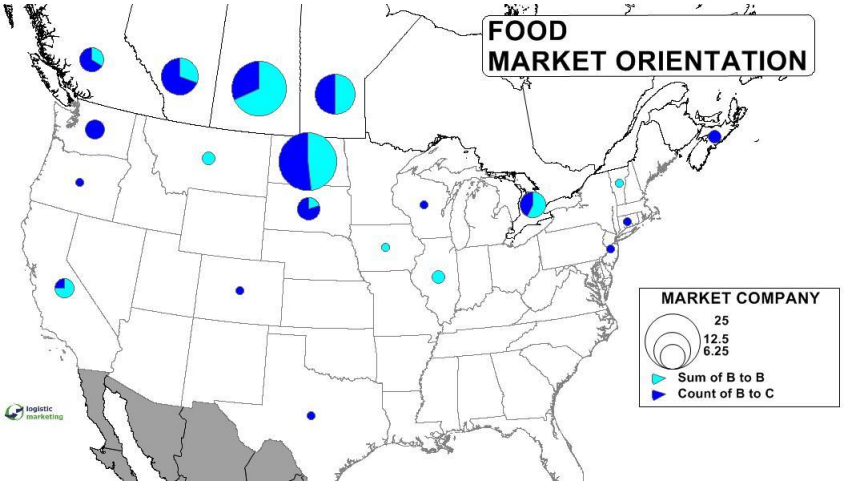
Value Along the Supply Chain – Roasted Flax										
		Organic	Volume	Volume Unit	Value	Currency		Value per gram	Value per lb	Value per tonne
co web	Carrington Farms Organic Roasted Flax Seeds	Yes	283	g	5.69	US		0.02	20,106	
co web	Omega Crunch Super Sprinkle (kernel and hull)		200	g	10.95	CDN		0.05	54,750	
co web	Omega Crunch Shelled Flax		1	kg	29.95	CDN		0.03	29,950	
co web	Omega Crunch Large Table Shakers 6 Pack		1200	g	59.95	CDN		0.05	49,958	
co web	Omega Crunch Maple Refill Bag		375	g	14.95	CDN		0.04	39,867	
co web	Spectrum Essentials Organic Dry Roasted Flaxseed	yes	400	g	22.99	CDN		0.06	57,475	
Conversions: 283 g =10 oz										

Value Along the Supply Chain – Sprouted Flaxseed Meal										
		Organic	Volume	Volume Unit	Value	Currency		Value per gram	Value per lb	Value per tonne
Well.ca	Good Karma Flax Delight Fortified Flax Beverage		946	ml	3.23	CDN				
Well.ca	Nature's Path Organic Flax Plus Pumpkin Raisin Crunch	yes	350	g	6.99	CDN				

Value Along the Supply Chain – Food										
		Organic	Volume	Volume Unit	Value	Currency		Value per gram	Value per lb	Value per tonne
Well.ca	Good Karma Flax Delight Fortified Flax Beverage		946	ml	3.23	CDN				
Well.ca	Nature's Path Organic Flax Plus Pumpkin Raisin Crunch	yes	350	g	6.99	CDN				

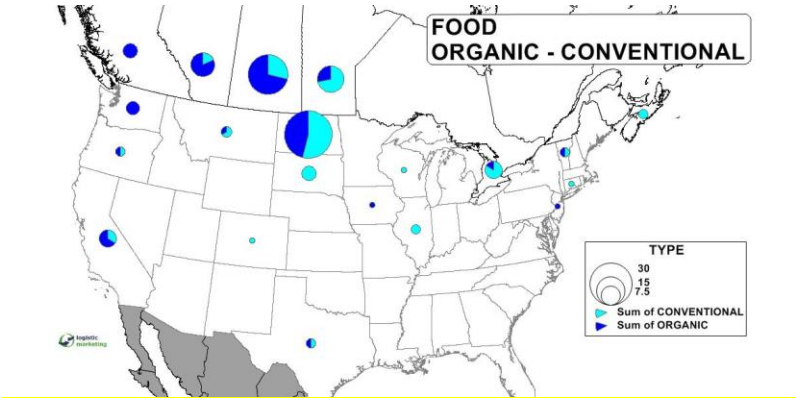
Strategic Orientation

One choice that firms must make is to decide which segment of the market to serve. Some companies choose to be ingredients suppliers (B to B); some chose to sell at the retail level (B to C); and some choose both.



Source: Author

Another choice firms must make is which type of flaxseed to process – organic or conventional. Many appear to be focusing on organic flax.



Source: Author

Differentiation

According to one successful company, after health and wellness the most important factor driving the value added flax sector is the need to develop/find unique features - after a product becomes mainstream firms must find a way of differentiating themselves. This expert believes that there is a lot to done with products like meal for feed and food

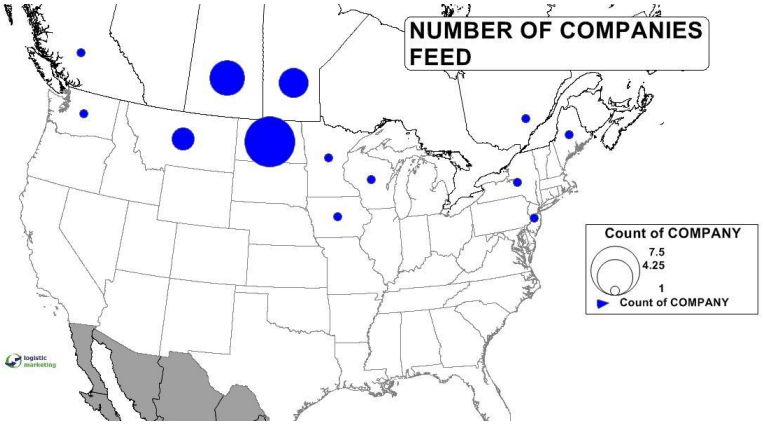
Processing

Interviews revealed that processing issues include the following:

- Achieving the correct scale and accessing enough capital
- Alignment from source for ingredient suppliers
- Creating a value proposition
- Product differentiation
- The biggest barrier for the industry is capital for machinery/plant as entry to develop a new crush plant is costly.

5.3.3 Firm Strategy, Structure and Rivalry - Firms Supplying the Feed Market

In the United States, we identified two vertically integrated growers selling flax products in the feed market. In Canada, we identified only one vertically integrated grower doing this.



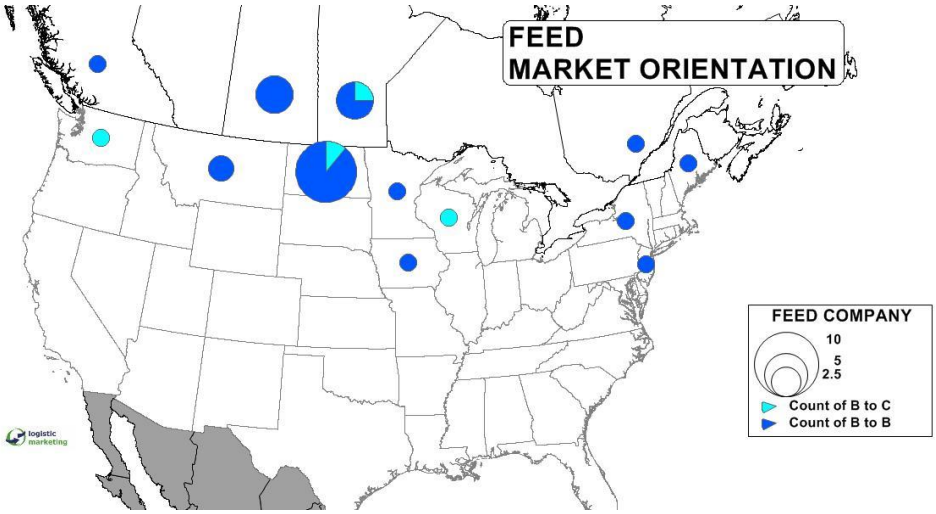
Source: Author

In Canada, we found three crushers producing partially defatted meal for the feed market. We found nine United States crushers selling product in the feed market. Three of the crushers use solvent extraction and produce fully de-fatted meal. The rest produce partially defatted meal.

In the United States, five of the flax product manufacturers also produce products for the livestock feed market. They produce a variety of products: ground flax, whole flax, and partially defatted meal.

In Canada four flax product manufacturers also produce products for the livestock feed market. Products produced include ground seed, whole seed, and blended extruded seed.

Not surprisingly, most feed product manufacturers have chosen to be ingredient suppliers.



Source: Author

5.3.4 Firm Strategy, Structure and Rivalry - Firms Supplying the Pet Food Market

In the United States, we found one vertically integrated grower selling flax products in the pet food market. In Canada, we identified two vertically integrated growers doing this.

One United States crusher produced partially defatted meal for the pet/horse market.

Four United States flax product manufacturers produce products for the pet/horse market. The products are either partially defatted meal or full fat meal.

Four Canadian flax product manufacturers also produce products (ground, whole, and extruded) for this market.

The dog and cat food manufacturers in North America are concentrated. In Canada in 2010, Nestle Purina had a 26.5% share of the pet food market while Mars Canada had a 19.2% share. Smaller manufacturers tend to compete and be very competitive in the natural or organic segments. [134]

5.3.5 Firm Strategy, Structure and Rivalry - Firms Supplying the Industrial Oil Market

In the United States, four flaxseed crush operations were identified as selling flaxseed oil in the industrial market. The large crushers, ADM (with two plants) and Cargill as well as one other crusher used the solvent process to crush conventional flaxseed for the industrial oil and feed markets. The meal these companies produce is fully de-fatted and is sold in the feed market.

According to experts, ADM and Cargill are the **dominant firms** and can control the industrial market as they could crush for additional week and make more oil to capture any demand increase. It would be difficult to enter the industrial crush sector because of strong competition from the incumbents.

Potential for Another Crusher

Interviewees were asked if there was room for another crusher. Some felt that the market for oil for culinary and health uses was saturated. Others felt that there is always room for another artesian crusher (small cold press crusher).

Other experts suggested that the crush sector must be consolidated in order to achieve the scale necessary to reduce the processing cost and thus the price to the consumer. A large scale plant would need a guaranteed market that could be gained through a strategic partner for SE Asia. Domestically a way to the retail market would be required.

The stability of the cold pressed oil is also an issue. It is not clear if the oil would have a long enough shelf life to be shipped to Asia.

[134] Agriculture and Agri-Food Canada, "Consumer Trends: Pet Food in Canada", September 2012.

Potential for an Industrial Crusher of Flaxseed in Western Canada

There are no large scale crushers in Canada that currently crush flaxseed. Is the lack of a large scale Canadian crusher due to lower gross margins? The following analysis attempts to explore this. Because of the lack of Canadian data on flaxseed oil and meal, United States prices are used for both canola and flaxseed. Crushing 1 tonne of flaxseed results in 0.348 tonnes of oil and 0.643 tonnes of meal. Crushing 1 tonne of canola results in 0.42 tonnes of oil and 0.56 tonnes of meal. Over the period 2009/10 to 2012/13, the gross margin of crushing 1 tonne of flax varied from $113 to $323 while the gross margin of crushing 1 tonne of canola varied from $155 to $281. Sometimes the flax margin was higher and sometimes the canola margin was. This analysis suggests that other reasons are also at play. The industrial oil market is mature while the canola oil market is growing rapidly. The size differential between the canola and potential flaxseed crush would also suggest that concentrating on canola is a better business decision.

Profitability Analysis				
Flax Prices in United States, $ US/Tonne				
	2009/10	2010/11	2011/12	2012/13
Seed	321	480	547	543
Oil	1485	1496	1496	1496
Meal	197.1	202.5	216.2	290.4
Canola Prices in United States, $ US/Tonne				
	2009/10	2010/11	2011/12	2012/13
Seed	357	425	529	584
Oil	945	1294	1261	1238
Meal	248	291	339	391
Profitability of Crushing 1 Tonne of Flaxseed				
	seed	oil	meal	Gross Margin
2012/13	543	521	187	164
2011/12	547	521	139	113
2010/11	480	521	130	171
2009/10	321	517	127	323
Profitability of Crushing 1 Tonne of Canola				
	seed	oil	meal	Gross Margin
2012/13	584	520	219	155
2011/12	529	530	190	191
2010/11	425	543	163	281
2009/10	357	397	139	179

Source: United States Department of Agriculture, Economic Research Service, “Oil Crops Yearbook”, March 2014

5.4 Related and Supporting Industries

Flaxseed producers in Saskatchewan, Manitoba, and North Dakota are represented by levy funded organizations.

- Manitoba Flax Growers Association's (MFGA) mandate is to "improve the economic returns and agronomic benefits to Manitoba flax growers through research, promotion and communication".[135]
- Saskatchewan Flax Development Commission (SaskFlax) invests "in research, communication and market facilitation activities to further develop the flax industry. The Saskatchewan Flax Development Commission also works to promote production and value-added processing of flax in the province. We partner with the flax industry and other agricultural organizations to ensure quality flax and flax products worldwide."[136]
- AmeriFlax works "to increase the use and sale of U.S.-grown flax and by-products in domestic and foreign markets. AmeriFlax guides programs on public relations, advertising, nutrition research, market research and consumer and industrial education".[137]

Canada also has a national organization. The Flax Council of Canada "promotes Canadian flax and flax products for nutritional and industrial uses in domestic and international markets. Established in 1986 with full representation from all agricultural and industrial flax interests, the Flax Council promotes the advancement of flax and flax products."[138]

SaskFlax, Manitoba Flax Growers Association, AmeriFlax, and the Flax Council have an initiative underway to educate consumers and companies about flax.

In the interviews, the need for a producer organization in Alberta was raised. The creation of such an organization would help with industry growth and knowledge dissemination.

[135] http://mfga.ca (2014)
[136] http://www.saskflax.com/about (2014)
[137] http://www.ameriflax.com/default.cfm?page=whoweare (2014)
[138] http://www.flaxcouncil.ca (2014)

5.5 Government Policy and Regulatory Environment

Companies viewed the Canadian regulatory and political system positively.

- Canadian flax and flax products are desirable because
    - Health Canada provides a trusted regulatory environment resulting in high quality products;
    - Canada has a good national organic program that is recognized globally; and
    - Global buyers prefer Canadian products over those of the United States due to the political environment.
    - Canada is a pristine environment;

In Canada, omega enhanced pork was treated as a novel food by Health Canada. It was determined that there was no human safety issues associated with the consumption of the meat.[139] Omega enhanced eggs were approved in 2008. [140]

Market access for flax seed into Japan and South Korea is an issue because of cyanogenic glycosides. Two companies are working together to develop a thermal process to destroy it. It is unlikely that the Trans Pacific Partnership Agreement will eliminate this non-tariff barrier.

The general import tariff rate on flax seed into South Korea is 3%. With an implemented free trade agreement between Canada and South Korea this 3% rate will be removed. On the surface, this does not suggest a large trade creation opportunity for flax into South Korea. However, on $500/tonne landed cost, this is $15/tonne.

The public sector has the vast majority of research and development initiatives such as:

- North Dakota State University : has 1 flax breeder and tests at 5 research stations; are 5 or 6 researchers that do things with flax (but not full time); Dr. Ulven turning flax straw into products; Carrington research site does research on meat quality and flax (not sure if it is economical to feed flax to cattle)
- Agriculture and Agri-Food Canada, Agricultural Development Fund (Saskatchewan), and Western Diversification have supported research
- Dr. Martin Reaney at the U of S is doing some work
- Natural Science and Engineering Research Council (NSERC) and National Research Council (NRC) are supporting work at the Proteomics Lab at the University of Manitoba

During the interviews, several challenges to growing the flax market (as noted above) were mentioned including the lack of funding at public institutions (e.g., at North Dakota State University there is no longer any funding for flax utilization (for food)).

[139] http://www.hc-sc.gc.ca/fn-an/gmf-agm/appro/dd109_v3-eng.php
[140] http://www.hc-sc.gc.ca/fn-an/gmf-agm/appro/index-eng.php

5.6 Chance

An earlier section discussed the economic and trade impacts that the discovery of a genetically modified flax variety had on the industry.

In 2009/10 the flax acreage in Western Canada was 623,000 acres. After the discovery of Triffid acreage fell by 43% in 2010/11 to 353,300 acres. Acreage fell even further the next year. Acreage is now recovering.

The importance of maintaining a genetically modified free supply of flax was repeatedly stressed in the interviews. The demand for non-genetically modified organism ingredients is growing.

5.7 Potential Opportunities: Identification, Analysis and Assessment

5.7.1 Flax Seed Production

Identification of Potential Opportunities

1) With proper agronomic management the yield of flax in the Prairies could increase. The experts we interviewed suggested that an increase of 30% was feasible.

The average flax yield in the Prairies over the last 15 years was 20.2 bu/ac (1.27 tonnes/ha). A 30% increase in yield would bring yield up to 26.3 bu/ac (1.65 tonnes/ha), an increase of 6.1 bu/ac (.38 tonnes/ha). If we use current acreage of 1,500,000 acres (608,000 ha) and an average of price of $500/tonne, the value of the potential yield increase is $116.2 M.

2) Through the Northern Adapted Flax Variety Development Program, it is possible to increase the yield and acres of flax in the Prairies.

If acreage expands by 10% (60,800 ha or about 150,000 acres) and the yield is 1.65 tonnes/ha (with the 30% increase), the incremental value of the flax production is $50.1 M assuming an average price of $500/tonne.

Growing flax in more northerly areas also increases the quality and quantity of the oil.

3) Increasing the production of organic flaxseed would increase grower returns and slow off-shore imports of organic flaxseed.

There is a strong demand for organic flaxseed. If organic flax acres increase to 20% of total flaxseed acres (1.5 M acres) then the incremental value to growers would be $55.8 M. This assumes that the yield of organic is 70% of conventional (14.1 bu/acre rather than 20.2 bu/acre) and the price of organic brown flaxseed is $31/bu while the price of conventional organic flaxseed is $12.5/bu. The value of the organic production on 300,000 acres would be $131.5 M while the value of conventional flaxseed that it replaced is $75.8 M. The differential in value is $55.8 M.

4) It may be possible to develop a flax variety with straw that decomposes quickly.

The development of a flax variety with a straw that decomposes quickly would help to make flax a more attractive crop and reduce environmental damage caused by burning the straw. It is uncertain if the development of such a variety is technically feasible. The use of the TUFGEN makes breeding more efficient but does not increase the speed.

5) The establishment of a flax producer organization in Alberta should be encouraged.

Such an organization would help disseminate market and agronomic information which would help grow the flax acres and the industry.

Analysis and Assessment Summary

It was suggested by many that yield is the factor most limiting the growth of the flax industry. Agronomic knowledge, a contributing factor to the yield problem, is not always high. Low yields reduce the profitability of flax which makes it less competitive relative to other crops. The northerly movement of corn and soybeans and the expansion of canola acreage have resulted in a loss of flax acres.

The analysis indicated that a 30% increase in yield would bring yield up to 1.65 tonnes/ha, an increase of .38 tonnes/ha. Using current acreage of 1.5 M acres (608,000 ha) and an average of price of $500/tonne, the value of the potential yield increase is $116.2 M. This can be realized with agronomic education.

Our review also indicated a market opportunity for organic flax production, which would both supply organic market channels and displace imports of organic flax, and flax products such as oil and meal.

Flax acreage in the central and northern Prairies has been limited by the lack of suitable varieties. If acreage expands by 10% (60,800 ha or about 150,000 acres) and the yield is 1.65 tonnes/ha (with the 30% increase), the incremental value of the flax production is $50.1 M assuming an average price of $500/tonne.

It can be difficult to manage flax straw. This and the lack of markets for straw also limits acres. The development of a variety with rapidly decomposing straw would be beneficial but the probability of this occurring in the near future is very low.

5.7.2 Flax in Foods

Identification of Potential Opportunities

1) The market for human use flax oil has the potential to grow. One company believes that there is an opportunity to sell oil for the "mass market" (due to rancidity issues, most flax oil is sold in health sections of grocery stores and in refrigerated shelving) as a substitute for refined oils. Another expert strongly believes that there are very large opportunities for flaxseed oil in China. The oil would be blended in China with soy and sold as omega oil (5% flaxseed oil – 95% soybean oil). The by-product would be sold for food or feed.

   "There is a big push in Asia for ALA". The fish sector couldn't possibly supply the demand for omega in China. The key Chinese consumers for omega products are geriatric and child health. The expert suggested that China could utilize 10% of the current flax crop in Canada. Land in China is too valuable to produce oil crops on.

Domestic Market Expansion

With respect to mass market oil, the key benefit for consumers is to bring their omega-3/omega-6 ratios to more appropriate levels. Currently this ratio is too high in omega-6 because of the consumption of refined oils.

The estimated production of flaxseed oil in Canada is 2,500 tonnes which requires 7,184 tonnes (5,657 hectares or 13,977 acres). The value of the flaxseed oil produced assuming that 50% is refined (with a value of $6,331/tonne (export value)) and 50% is crude (with a value of $3,361/tonne (export value) is $12.1 M. Each 10% expansion in the production of flaxseed oil in Canada would be worth $1.2 M (assuming the price held) and require 1,398 acres. The value to the grower would be $359,000.

Chinese Market Expansion

The consumption of vegetables oils in China is growing and imports will be increasingly important.

> "China's high GDP growth and growing consumer affluence is forecast to increase vegetable oil demand by more than 1 million tons in MY 14/15 to meet food and industrial consumption. The forecast per capita consumption of vegetable oil of 21.8 Kg for food use in MY14/15 (based on total population of 1,354 million as of 2012) is still 13 percent less than Taiwan's 2005 per capita consumption of 25.1 kg (See FAS/Taiwan report, TW7001). Even though China's oil consumption has grown rapidly in recent years, there is still significant growth potential before it reaches a level similar to comparable markets like Taiwan."[141]

> "Overall, China's domestic oilseed production remains stagnant while demand for oilseed products surges ahead. For MY14/15, low profits to major oilseed crops, like soybeans and rapeseed, keep planted area expectations to a low 24.78MHa and total production at 57.2 million tons, both down 0.9 and 2.6 percent, respectively, over the previous

[141] United States Department of Agriculture, Foreign Agricultural Service, Global Agricultural Information Network Report, "China: Oilseeds and Products Annual", 2014.

> year. Future production prospects are further dampened by major oilseed crops lackluster revenue as available acreage is increasingly planted to more lucrative grain crops. Furthermore, inadequate production tools - from economies of scale, agronomic practices, technology resources and input quality – limit the potential for oilseed yield gains. Regardless of limited domestic production, consumption of animal protein and vegetable oils in China continues unheeded, fueled by rising affluence and consumer choices. In response to these dietary demands, China must supplement its domestic oilseed resources with imports, primarily from the United States, Brazil, Argentina and Canada."[142]

In 2013, Canada exported a record 207,000 tonnes of flaxseed to China. As the trade data over the last ten years indicates, China became a more important market for Canadian flaxseed exports in 2009. Exports of flaxseed oil to China are generally small and sporadic.

[142] United States Department of Agriculture, Foreign Agricultural Service, Global Agricultural Information Network Report, "China: Oilseeds and Products Annual", 2014.

Canadian Exports of Flaxseed to China			
	Quantity	Value	$/Tonne
	Tonnes	$	
2004	5,388	2,121,287	394
2005	2,750	566,934	206
2006	32,352	10,231,925	316
2007	59,477	22,649,609	381
2008	32,546	20,153,058	619
2009	183,526	88,879,792	484
2010	139,821	61,183,862	438
2011	69,870	45,724,114	654
2012	169,374	103,275,569	610
2013	207,292	141,171,007	681
Canadian Exports of Crude Flaxseed Oil to China			
	Quantity	Value	$/Tonne
	Tonnes	$	
2004	-	-	
2005	916	707,041	772
2006	-	-	
2007	-	-	
2008	2,451	2,599,558	1,060
2009	5,111	3,985,581	780
2010	121	190,962	1,581
2011	0	326	3,361
2012	4	11,062	3,071
2013	19	75,969	3,926
Canadian Exports of Refined Flaxseed Oil to China			
	Quantity	Value	$/Tonne
	Tonnes	$	
2004	-	-	
2005	-	-	
2006	-	-	
2007	-	-	
2008	-	-	
2009	-	-	
2010	-	-	
2011	14	82,192	5,753
2012	15	72,413	4,758
2013	56	269,081	4,818

Source: Statistics Canada

In 2014, Canadian flaxseed production was pegged at 847,000 tonnes. In 2014, total Canadian exports of flaxseed are forecast to be 700,000 tonnes. China is currently importing more than 10% of Canada's flaxseed production or exports.

To capture the value of increased demand in China, we can look at the amount of oilseeds crushed in China. In 2012/13 103 M tonnes of oilseeds were crushed in China and this is expected to reach 109 M

tonnes in 2014/15. While domestic oilseeds supply part of this, 64 M tonnes of oilseeds were imported in 2012/13. Imports are forecast to be 76 M tonnes in 2014/15.[143]

Canadian flaxseed exports to China of 207,000 tonnes represent only 0.3% of total oilseed imports in 2014/15 of 76 M tonnes. If Canada could grow its flaxseed exports to China to 1% of Chinese imports (which would be 760,000 tonnes), the incremental exports would be 553,000 tonnes which would require an additional 1.1 M acres of flaxseed production. If the additional exports were priced at $500/tonne, the added revenue would be $276.5 M.

China consumed 28.3 M tonnes of edible oils in 2012/13 and consumption is expected to reach 30 M tonnes in 2014/15. Imports (10.2 M tonnes) represent a significant portion of consumption (36% in 2012/13). If Canada could replace 0.01% of the imported edible oil with flaxseed oil, the impact could be significant for the domestic flaxseed crushing sector. One-tenth of 1% would be just over 1,000 tonnes. This would require a 40% expansion in Canada's crush (which currently produces about 2,500 tonnes of flaxseed oil). The incremental value of the oil produced (assuming the price held) would be $4.8 M. The incremental oil production would require an additional 2,874 tonnes of seed and 5,591 acres of flax. The value to the grower would be $1.4 M.

Those interviewed mentioned some challenges to increasing exports.

- Flax is a small crop so must have enough supply – but as we have seen, supply seems to be adequate
- Can't do the processing in Canada because oil would be rancid by the time it reaches market – however some companies do produce oil with a 2 year shelf life
- Some experts suggested that the price of oil must fall before markets such as China will be sustainable. Consolidations of the small crushers would bring down the cost of crushing oil - 300 tonnes crush a day. The meal can then go into feed for omega 3 eggs

2) There are opportunities for growth in organic flax products.

According to those interviewed:

- The need for certified organic brown and gold flax: "Even though this costs twice the price", organic is a growth area and they have to source products off shore due to insufficient supply in U.S. and Canada
- Organic acreage of flax is small.

There is a lack of certified organic flax in North America. Because demand is outpacing supply, processors are importing it from countries such as India, Argentina, and European Union.

[143] United States Department of Agriculture, Foreign Agricultural Service, Global Agricultural Information Network Report, "China: Oilseeds and Products Annual", 2014.

Expansion of processed organic flax products appears to be worthwhile. For example, a search found that a Canadian brand of cold milled organic golden flaxseed was selling for $7.29 C for 459 grams. With 1 M grams in a tonne, per tonne the value of this product is $16,057.

This opportunity was valued at the grower level at $55.8 M.

3) There are opportunities to use meal in baking and meal fractions in the pharmaceutical and nutraceuticals sectors.

This opportunity was not valued.

4) There are opportunities to grow the health and wellness products using flax.

Our interviewees suggested that

- Health and wellness products (functional foods, NHPs, functional pet foods) – but studies need to be undertaken that examine how "nutritious" (bioavailability and digestibility) flax is.
- Opportunity to increase the health of products consumed over the course of a day: over the last 20 years fish consumption hasn't increased so people are omega 3 deficient
- Opportunity to provide omega 3 to United States soldiers; omega 3 deficiency (ALA, EPA and DHA) can increase aggressiveness, Post Traumatic Stress Disorder (PTSD), suicide and depression – could increase the market for flax
- Because the health claim is general firms need to show who benefits
- Flax needs to be "out in the mainstream"; One of the big companies needs to "buy into" flax – the others will follow

This opportunity was not valued.

5) There are opportunities to use more flaxseed in breads and cereals.

Interest has been expressed by a major bread company. Flax could replace sesame seed. If for instance, the company buys flax in 1 M lb increments, the value would be: 1 M lbs of flax is 453.6 tonnes. At a yield of 1.27 tonnes/ha, 1 M lbs of flax requires 357 ha or 883 acres. The farmgate value of the 1 M lbs is $227,000. Each additional 1 M lbs doubles the incremental opportunity. If demand increased by 50 M lbs, an additional 22,700 tonnes of flaxseed would be required (an additional 44,163 acres) and the incremental value would be $11.4 M.

6) There may be an opportunity for a major food company to introduce products with flax into its product line.

If a major food company required 250 M lbs of flaxseed (which is equivalent to 113,500 tonnes or 221,000 acres), the value of this opportunity at the farm gate would be $56.8M.

7) There are opportunities to use flaxseed as a substitute for guar gum in food processing.

"Guar and xanthan gums are used on a widespread basis throughout the food industry to help thicken products, and to impart creamy consistency to ice creams and other dairy foods. These gums help to stabilize emulsions, provide good cling, inhibit syneresis by controlling crystallization in frozen products and bind water. Guar gum is a cold water-soluble polysaccharide that has large molecules, allowing it to hydrate easily to produce water-based solutions with a high viscosity (thickness), at low gum concentrations. It is used in the beverage industry as a stabilizer in fruit juices and is utilized in dressings as a thickener. Its ability to thicken liquids allows for better pumpability during the manufacturing process and allows sauces to pour without splashing (such as pouring marinara sauce on a pizza)."[144]

Guar gum is also used in fracking. The expansion of fracking in the United States led to significant increases in the price of guar gum, most of which is produced in India. In March of 2012, the price of guar gum peaked at $1,550 US/100 kg. With the drop in the price of oil and the substitution of synthetic guar gum produced in China, the price fell to $208 US/100 kg in November 2014.[145]

According to one interviewee, as a functional product used in place of gums as thickeners in bakery/bread, flax can compete. And it will save money for the manufacturers and flax is considered to be a "clear" ingredient.

At least one company is currently investigating this opportunity and is confident that with time it will come to fruition.

This opportunity was not valued.

8) There are opportunities to grow the use of flax for protein. The key opportunity is to replace soy protein.

As previously mentioned the global market for plant protein ingredients was estimated to be 1.6 million metric tons in 2012 and is expected to grow to 2.3 million metric tons by 2018. For comparison purposes, the global market for animal protein ingredients was 2.3 million metric tons in 2012.[146] The global market for protein is expected to be worth $24.5 B in 2015. [147] The average value of the protein using the 2015 market value and 3.9 M tonnes of ingredients is $6,282 per tonne.

[144] http://www.preparedfoods.com/articles/103531-ingredients-in-use-guar-xanthan-gums
[145] http://triblive.com/business/headlines/7248947-74/guar-gum-fracking#axzz3NQGEl1Hl
[146] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market.
[147] Nickerson M, J House, and E Li-Chan, "Canadian Proteins", http://canadianfoodinsights.com/2013/07/08/canadian-proteins/

Plant Protein Ingredient Market			
		Tonnes	
	Market Share	2012	2018
Protein		1,600,000	2,300,000
Soy	53%	848,000	1,219,000
Wheat	44%	704,000	1,012,000
Pea	0.40%	6,400	9,200
Emerging	2.6%	41,600	59,800

Growth in the demand for healthier ingredients; a shift in preferences towards gluten and vegan; lower cost of plant protein relative to animal protein; and promotion by the soy sector is increasing the demand for plant based protein. [148] Some flax is currently used for the plant protein market.

There are challenges to growing this opportunity. "Despite Canada's global role in the agricultural export markets, the lack of secondary processing investment in our raw materials to generate high value fractions restricts the economic potential of the agriculture and agri-food sector within Canada. In order for a new protein ingredient to become accepted by the market, several barriers or hurdles need to be overcome first. For instance, proteins need to be evaluated on based on their allergenicity, digestibility, and performance in food products, associated health claims and labelling. And in the case of some proteins, additional considerations are needed in terms of colour and flavour. And finally, public education, ingredient performance and economics must balance to gain acceptance by industry and consumers. Research and innovation in these areas have, or are advancing to support market growth, and market expansion for protein ingredients already in the marketplace."[149]

Other factors limiting the growth of plant proteins include 1) lower solubility and functionality compared to animal based proteins; 2) allergens associated with wheat and soy; and 3) the strong flavor of legumes is disliked by consumers.[150] Non-soy proteins are also challenged by the lack of consumer awareness. Growth of animal proteins is being negatively affected by growing competition from plant protein; its price volatility; and the fact that in emerging markets nutrition is more important than functionality.[151]

This opportunity was not valued.

9) Other opportunities include using peptides from flax in the pharmaceutical sector.

The expert suggesting this opportunity said that while it is a lucrative opportunity, the amount of flax required is very, very small.

Interviewees identified the following factors that could help with the opportunities identified above:

[148] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market
[149] Nickerson M, J House, and E Li-Chan, "Canadian Proteins", http://canadianfoodinsights.com/2013/07/08/canadian-proteins/
[150] Nickerson M, J House, and E Li-Chan, "Canadian Proteins", http://canadianfoodinsights.com/2013/07/08/canadian-proteins/
[151] Frost & Sullivan (2012) Strategic Insight into the Global Plant Protein Ingredients Market.

- For sustainable growth in ingredients and retail sales need: 1) recognition that need to get the hull off to have a health impact; 2) need to be able to get it into diets easily; 3) flax industry should collaborate; 4) strong system in place for fractionation, manufacturing; 5) need market pull but also need supply; 6) if can stabilize the oil can grow the market; and 7) need to do more extension/knowledge transfer to support industry growth
- Trade deals such as those with the European Union and South Korea could help exports. Potential trade agreements such as the Transpacific and Canada's agreement with India have the potential to help grow exports.
- The following types of research and development would be beneficial:
  - Formulations and how to get sufficient flax into your diet to get the health benefit
  - How to stabilize the product when put into food formulations – how to help companies deal with that issue
  - Conduct research into standardization of ALA content – critical for NHP industry
  - Basic research (systematic research) is required for many of the "opportunities" noted above. Private industry cannot afford to conduct basic research but are in the position to commercialize the results of it.
  - Development of a new cultivar of flax that has less cyclolinopeptides in it. (The significance is that a reduction in those peptides will prolong the shelf life (prolong the time before rancidity sets in).
  - Address gaps in applied research and development and commercialization
  - More credible studies about who flax benefits (i.e. old, young, sick, etc.)

The Canadian International Grains Institute has the capability to work on flax. It and provincial food centres could help with product development initiatives/strategies.

Analysis and Assessment Summary

The market for flax products to be consumed by humans is currently a niche market. Most growth opportunities would result in only a small incremental increase in the demand for flax and would be unlikely to increase the price paid to growers. While small, the firms serving it appear to be very good at creating value. Many companies are trying to further differentiate their products to meet more valuable needs in such applications as gums and proteins.

The entry of a major food company into flax products would help grow the sector. The promotion of flax would increase consumer awareness and help drive the demand for flax products for food. It may also act as a signal to other large food manufacturers that flax has profit potential and that supply is sufficient.

The supply of flax is sufficient to grow the value added sector in North America. Food manufacturers should not be concerned that the supply might not meet their needs. The typical volume used appears

to be almost insignificant in terms of available supply. The only area where there could be concern is if organic flax is required.

There is a shortage of organic flax for the food value added market. North American flax growers are losing out on this valuable market as processors are importing organic flax from off-shore.

The best opportunity for growth lies in the expansion of exports to the Chinese market. Canadian flaxseed exports to China of 207,000 tonnes represent only 0.3% of oilseed imports in 2014/15 of 76 M tonnes. If Canada could grow its flaxseed exports to China to 1% of Chinese imports, the incremental exports would be 553,000 tonnes which would require an additional 1.1 M acres of flaxseed production. If the additional exports were priced at $500/tonne, the added revenue would be $277 M. China is a very price sensitive market and the price of flaxseed may have to fall before a lot of additional exports would occur.

While it would be beneficial for the Canadian economy to crush the flaxseed in Canada and export the oil to China, it is unclear if this will happen. Because of stability problems it is unclear if it is feasible to crush the flax here and transport the oil to China. Some crushers say they have solved the stability issue but this is not widespread. At the current scale of the flaxseed oil market, large scale Canadian crushers do not appear to be interested in flaxseed crushing. This could change if the Chinese market develops and stability issues are resolved.

The food sector is increasingly dependent on its suppliers to provide product and ingredient information that can be easily assessed for application in specific products. Research/product development is required for the use of flax and flax ingredients in food applications. Functionality, stability, cost and product applications must be developed and demonstrated to attract the interest of buyers/food manufacturers.

5.7.3 Flax in Animal Feed

Identification of Potential Opportunities

1) There is potential to grow the use of flaxseed to produce enriched products such as omega 3 eggs.

One expert suggested that omega 3 eggs could capture up to 25% of the Canadian market. If this occurs, the demand for flax would increase to 16,136 tonnes.

Demand could also grow in the United States. If flax was used to produce 20% of the 517 M dozen branded eggs, then the amount of flaxseed used would double to just over 22,000 tonnes.

2) There may be opportunities to provide flax for omega enhanced meat production.

In terms of omega enhanced meat, there are currently no companies with enhanced meat products in the United States market, but they are coming. [152]The companies are waiting for the right moment to come into the market. The opportunity could be very valuable as the cost of production doesn't increase much with the addition of flax. The meat is very competitive with conventional meat.

This opportunity will likely be small in terms of the volume of flax used.

3) There may be opportunities to position flax as promoting livestock health.

According to those interviewed:

- Omega 3 improves their health, happiness, reproduction in dairy and hogs (more offspring); increases milk production.
- Kansas State was doing some work in this area. However, the feedlots did not see enough benefit. So they are using alternative ingredients such as canola or DSG (distiller's spent grains) which are flooding the market and much cheaper.
- There is also some interest from Korea as a flax extract that addresses the health of cattle.
- The Prairie Swine Centre recently examined the feasibility of using omega 3 fatty acids to replace antibiotics in swine starter feed.[153]

Analysis and Assessment Summary

There are opportunities to grow the use of flax as feed for enriched meat and eggs. The incremental volumes are small however.

[152] It was mentioned during interviews that BNO3 Technologies was selling omega enhanced beef. A web search, however, did not find the company.
[153] Prairie Swine Centre, "Can Dietary Omega -3 Fatty Acids Replace Antibiotics in Starter Feeds for Piglets?", September 2014.

It is important to remember that because livestock uses least cost rations, most of the opportunities related to flax will likely be in food and high valued feed (pets and aquatics).

5.7.4 Flax in Pet Food

Identification of Potential Opportunities

There is the potential to increase the volume of flax used in North American dog food in order to meet omega 3 targets.

The pet food sector requires approval for use of any ingredient being sold in the United States by the Association of American Feed Control Officials (AAFCO). In other words, AAFCO applies not just to American made pet food but any pet food exported to that country. AAFCO is currently considering requiring all dog food classified as targeting the reproduction, growth and all-life stages to have certain ratios of omega-3 including EPA / DHA and ALA.

According to one industry expert interviewed for this project, flax seed will likely be the key source of ALA considered as canola is not well viewed due to concerns over genetically modified organism content. The expert emphasized that while flax is considered as the likely ingredient of choice to boost the ALA in the food, other sources may be identified in the future. AAFCO meets twice a year and the document has not been adopted as yet. There is still a lot of discussion about it as the changes will have broad ramifications in the industry. If it passes, the ruling should take 3-5 years before it is implemented or companies pass the grace period.

To meet the target in the dry dog food produced in North America for the growth and reproductive stage (approximately 2 M tonnes)[154] would require the addition of 3.5 kg of flax per tonne. The amount of flax required would be 7 M kg or 7,000 tonnes.[155]

The probability of this opportunity occurring is high but not 100%. The timeframe for it to come about could be 3 to 5 years in the future.

Analysis and Assessment Summary

It is very likely that the utilization of flax will grow in the pet market and particularly for dry dog food. The incremental volume is small however at about 7,000 tonnes.

[154] The volume of dry dog food produced in North America is actually 5 M tonnes. However, only the growth and reproductive stage has an ALA target.

[155] There are 2 AAFCO categories for dog food, growth and reproduction, and adult maintenance. There is a spec for ALA of 0.08% for the first and nothing for the second. The calculation of the amount of flaxseed required is this:
.08% = 800 PPM = 800 gm/tonne. Whole flaxseed is 41% oil and the oil is 57% ALA therefore the seed contains 23.37% (41 X 0.57) ALA To get 800 grams ALA would take 3.423 kg of flax seed (800/0.2337). To meet the new AAFCO spec would require 3.5 (3.423 rounded) kg of flaxseed per tonne.

5.7.5 Flax in Industrial Oils:

Identification of Potential Opportunities

None of our experts suggested that there were opportunities in the traditional utilization of flaxseed oil for industrial purposes.

A potential industrial opportunity was identified as producing biodegradable packaging films for food using flax.

According to the expert, biodegradable packaging films for food currently use canola and soy proteins. It is possible to add flax protein to the soy film. Much work remains to be done on this potential opportunity. The right equipment is very costly.

Analysis and Assessment Summary

The industrial oil market is mature and likely to continue to contract slowly. No opportunities were identified in it. It may be possible to use flax in the production of biodegradable packaging films for food.

5.7.6 Supporting Organizations

Identification of Potential Opportunities

There are opportunities for the flax organizations to promote flax. Flax must become "top of mind" and consumers must be educated with respect to how to utilize flax to get its full benefit.

According to those interviewed:

- The flax sector must counter the fish industry lobby against flax. The flax industry/growers need to show or market their products as more sustainable than the fish industry, since wild fish is not sustainable and fish farms may have other issues.
- There is an opportunity to message health – is debate around the healthiness of flax driven by the fish people and this needs to be countered
- The organizations should build the momentum of flax use in the marketplace – currently on a plateau.
    - "if you want to grow the flax industry, you need to promote it directly to the consumers"
    - There isn't enough being done by the industry to promote
    - Need to "jazz" consumers with flax.
    - It needs an industry wide approach.
    - Consumer education is required.
- Flax Council and SaskFlax should leverage government funds and attend more shows to promote flax

There are opportunities for the flax organizations to grow the industry through research and development, regulatory initiatives, and commercialization. Interviewees suggested the following initiatives:

- Increase the ALA content of seed
- Obtain GRAS status for oil in the United States
- There are opportunities to develop food formulations which would make it easier for smaller companies to attract the interest of the processed food companies. Currently flax oil as an ingredient is considered by processors to be rancid
- Examine uses of flax oil by-products - flax protein and uses of the mucilage
- Send prototype protein samples out (get POS Bio-Sciences to produce); this will create awareness and will get feedback

Analysis and Assessment Summary

The Canadian flax sector has overcome the discovery of the genetically modified flax variety and it is now time to adopt initiatives to grow its value added sector, particularly in food. Other commodities such as soybeans, canola, and pulses have used multifaceted approaches to growing their sectors. There may be some best practices that could be adopted by the flax organizations.

6. Analysis and Assessment of Current and Potential Value Added Activity – Straw (Flax Fibre)

This chapter examines value added activity in the straw sector. The analysis and assessment is conducted using the framework discussed earlier.

Before discussing value added activity in flax fibre, we begin with some basic information about decorticating and retting. [156]

Decorticating – Sometimes bast fibers are only partly retted or not retted at all before the stems are put through a series of rollers, hammers and/or shakers to extract the fibers. This process is called decorticating and it is used to replace the processes of breaking, scutching and hackling. It generally produces a very coarse fiber that is not used in textiles but is used for industrial purposes like paper making and geotextiles.

Retting – "Retting" is from a Dutch word meaning to "rot" or break down. The bast fibers of plants form part of what the layman might call the "inner bark" of plant stems. These fibers are tightly held within the plant by glue-like substances called pectins and lignins. Before clean bast fibers can be easily removed from the stems, the pectins and lignins must be softened and/or removed. The most common and cheapest method of doing this is to allow microorganisms to grow on the surface of the stems. As they grow, these organisms dissolve the pectins and lignins and hence make it easier to remove the fibers from the stems. However, if the straw is allowed to ret for too long a period, the organisms will also start to dissolve the fibers and hence the fibers will get weaker. This is done in Western Canada by placing it in a thin layer next to the ground (dew or field retting).

Scutching – After flax straw is broken and the straw has been shaken to remove the loose shives, there are generally some shives still stuck to or tangled within fibers. The scutching process attempts to scrape loose and/or disentangle this remaining shives from the fiber by stroking the fibers in a manner similar to combing fibers with a comb that has no teeth. In modern flax straw mills this is done by having straw which has already been broken and shaken, pass between rotating beaters or turbines which have paddles or arms that beat and scrape the remaining shives from the fibers.

Shives – The shives are the non-fiber parts of the stems of flax plants.

[156] The material in this introduction is from http://www.saskflax.com/definitions_fiber.html.

6.1 Factor Conditions

Adequacy of Supply

A recent report from North Dakota State University presents a methodology to determine the potential availability of flax straw for fibre use. The information required is the harvest index for flax (given as 0.31), yield per acre, and acres. Using this methodology the average amount of flax straw produced in the prairies during 2010 to 2014 was 1.2 M tonnes and in the United States 0.3 M tonnes. Not all of this straw is recoverable or useable for processing. Coons et al state that only 43% of the straw is recoverable. Using this to adjust straw production, results in 0.543 M tonnes of useable straw per year in Canada and in 0.1 M tonnes per year in the United States. Total North American production of flax straw useable for processing is 0.7 M tonnes. The complete methodology is shown in the Annex.[157]

Estimated Flax Straw Production, Tonnes						
	2010	2011	2012	2013	2014	Ave
Manitoba	164,785	117,217	141,478	141,587	97,699	132,553
Saskatchewan	668,463	620,606	817,792	1,253,075	1,631,658	998,318
Alberta	65,467	117,522	89,957	157,997	231,762	132,541
Minnesota	3,053	2,453	2,617	4,143	1,854	2,824
Montana	13,902	11,340	6,379	13,085	16,792	12,300
North Dakota	465,378	132,237	295,768	159,197	321,665	274,849
South Dakota	11,395	6,106	6,488	6,542	5,070	7,120
North America	1,392,443	1,007,481	1,360,478	1,735,626	2,306,499	1,560,505

Source: Author

Estimated Recoverable Straw, Tonnes						
Recoverable Straw is 43% of Straw						
	2010	2011	2012	2013	2014	Ave
Manitoba	70,858	50,403	60,836	60,882	42,010	56,998
Saskatchewan	287,439	266,860	351,650	538,822	701,613	429,277
Alberta	28,151	50,535	38,682	67,939	99,658	56,993
Minnesota	1,313	1,055	1,125	1,782	797	1,214
Montana	5,978	4,876	2,743	5,626	7,221	5,289
North Dakota	200,112	56,862	127,180	68,455	138,316	118,185
South Dakota	4,900	2,626	2,790	2,813	2,180	3,062
North America	598,750	433,217	585,006	746,319	991,795	671,017

Source: Author

About 0.5 tonnes of flax straw per acre is usable for processing although as shown below, this does vary by time and location.

[157] Coon R, N Hodur, and D Bangsund, "Potential Availability and Cost of Flax Straw for Commercial Application", September 2014.

Estimated Recoverable Flax Straw Production, Tonnes/Acre						
	2010	2011	2012	2013	2014	Ave
Manitoba	0.46	0.40	0.41	0.62	0.53	0.48
Saskatchewan	0.43	0.51	0.47	0.64	0.54	0.52
Alberta	0.74	0.74	0.77	0.75	0.77	0.76
Minnesota	0.33	0.35	0.38	0.45	0.40	0.38
Montana	0.40	0.30	0.21	0.35	0.33	0.32
North Dakota	0.52	0.39	0.41	0.47	0.47	0.45
South Dakota	0.45	0.38	0.40	0.47	0.44	0.42
North America	0.47	0.49	0.46	0.62	0.54	0.51

Source: Author

This methodology provides a number that is very close to what Schweitzer-Mauduit Canada's (SMC) uses as a guideline. *"The average flax crop yields 20 bushels per acre of seed and 0.5 tonne per acre of flax straw."*[158]

Fibre Yield and Landed Costs

Transport costs and fibre yields together can have a significant impact on economic feasibility. The average fibre yield is about 20% (for oilseed varieties) but can vary from 2% to 27%.[159]

- If the fibre yield is 5%, with a $50/tonne landed cost of straw, the cost of 1 tonne of fibre is $1000.
- If the fibre content is 20%, with a $50/tonne landed cost of straw, the cost of 1 tonne of fibre is $250.

Straw Prices and Procurement

According to SWM's straw buyer, all straw is baled and hauled to Carman, Manitoba in the fall. Most of the product is shipped from there to New Jersey (fiber) or local dairy producers or greenhouses (shives). A small amount of shives go to Winkler, Manitoba for further processing and grading. They buy the straw from about 200,000 acres (100,000 tons), mainly in Manitoba, North Dakota and south east Saskatchewan. They buy as close as possible to the plant since freight is an issue. Their purchases range from 30,000 to 160,000 tonnes depending on internal demand, straw quality and inventory. In 2014 they only purchased 30,000 tonnes. Quality and yield have been good in 2013 and 2014 so they have needed less. The straw is purchased a year ahead and stored. Straw yield this year averaged 0.67 t/acre whereas it is normally less than 0.5. A cool, wet year favors flax straw yield and quality. They pay the farmer $ 5/tonne and the baler $28/tonne to bale and stack the bales near the road. They do not contract but make arrangement during the season to take the straw from a particular grower. They want

[158] http://www.farms.com/farmspages/expertsbio/tabid/293/default.aspx?newsid=35454&authorid=196

[159] Saskatchewan Ministry of Agriculture, "Flax Fibre Processing in Saskatchewan: Vision for an Industry", Presentation, 2008 and then updated.

straight combined straw cut as close to the ground as possible since that is where most of the fiber is. SWM now purchases straw based on cellulose content and fibre length.

They have straw agents in the field who work closely with producers throughout the growing season. In the past they sometimes had trouble getting enough product, but it has not been an issue in the past couple of years.

Special Requirements

The quality and consistency of flax straw is very important. While lower valued uses of flax fibre (specialty paper, lower end plastic composites) can use straw with characteristics that most growers can deliver, as the value of the fibre product increases so do the requirements for the flax straw. For lower end uses, growers generally receive $5 to $10/tonne. Straw for medium valued products (such as geo-products, middle quality plastic composites) carries a value to the grower of $30/tonne to $100/tonne. Flax straw sold for high end uses such as high end plastic composites and some textiles can have a price to the grower of $60/tonne to $150/tonne.[160]

To get good straw quality and yield the producer needs to start thinking about it at planting (depth, density, row width) through the growing season (good weed control) to harvesting (don't run straw through combine but use a head puller, then rett the straw properly) and accumulating (no dirt, rocks, plastic) to baling (good bales, sisal twine)

There are no commercial varieties specifically for fibre. There are fibre varieties of flax for sale in Canada. The variety Evelin, sold by Richters an Ontario seed company, is meant for very small scale garden production. See the Annex for further information on Evelin.

There is ample flax straw for the processors' needs (total North American useable straw production is 0.7 M tonnes). Transportability is an issue. In order to be profitable, processors must locate close to the straw supply. We assume that the processors have done this as SWM developed a portable processing facility. Straw quality and the yield of fibre are also important.

Assuming that the going rate paid to growers for straw is $5/tonne, the farmgate value of the straw is $560,000 to $615,000.

Competition from Hemp

In 2014, Alberta had about 26,000 acres of hemp. In 2013 Canada had 66,000 acres of licenced industrial hemp. Hemp is Canada's fastest growing crop.[161]

[160] SaskFlax
[161] http://www.grainews.ca/2014/11/27/growing-interest-in-growing-hemp-crops/

6.2 Demand Conditions

Markets

According to an expert the Canadian flax fibre market is: 99% (flax tow for paper, shive products) and 1% (other). This is in sharp contrast to the European Union flax fibre market where the split is: 87% Textiles; paper 9%; composites 6% and other 1%.

Drivers

Some experts suggest that in North America, the flax fibre (and other fibres) sector is being pushed to enter the bio composite market**.** Fuel efficiency requirements are increasing the demand for bio-fibre.

Environmental sustainability is also important in textiles. Environmental regulations are driving the erosion control and land reclamation segment of the market.

Market Size and Growth for Bio-Composites

Flax fiber based products have the advantage of light weight as opposed to mineral filled products. Biocomposites in automobiles lower carbon and increase fuel efficiency. However, fibre supply is not guaranteed and quality is variable.

In the European Union, about 15,000 tonnes of flax fibre was used for composites in the European automotive sector in 2012. This represents almost 20% of the 80,000 tonnes of natural fibres used in the automotive sector in the European Union. The market share for flax has fallen since 2005 because the price of flax short fibre is very volatile relative to hemp, a major competitor. The European Union is however expected to continue to use flax fibre in the automotive sector because the flax short fibre is a by-product of long flax fibre textile production and is thus available and low cost (unless the textile industry demands the short fibres for use with cotton).[162] See the Annex for more information about the European Union.

The North American automobile sector began using bio-based material in the 1930's. The current use of bio-based material in the North American automobile sector is shown below.

[162] Dammer L, M Carus, A Raschka, and L Scholz, "Market Developments of and Opportunities for Bio-Based Products and Chemicals", Nova Institute for Ecology and Innovation, 2013

Selected Bio-Based Automotive Components

Model(s)	Feedstock	Material	Application
Cadillac DeVille	Wood	Polypropylene	Seatbacks
Chevrolet Impala	Flax	Polypropylene	Trim, rear shelf
Ford Flex	Wheat straw	Polypropylene	Interior storage bins
Ford Focus BEV	Coconut	Polypropylene	Loadfloor
Ford vehicles (Multiple)	Soy	Polyurethane	Foam seating, headrests, headliner
GMC Terrain	Cotton, kenaf	Polyester	Acoustic insulator, ceiling liner
Honda Pilot	Wood	N/A	Floor area parts
Lexus CT200h	Bamboo, corn	Polyethylene terephthalate, Sorona	Luggage-compartment, speakers, floor mats
Mazda 5 Hydrogen RE Hybrid	Corn	Polylactic acid	Console, seat fabric
Mercedes-Benz A-Class	Abaca/banana, flax, other natural fibers	Composite material	Underbody panels, seatbacks, spare tire cover
Mercedes-Benz C- and A-Class	Flax	Polyethylene	Engine and transmission cover, underbody panels
Toyota Prius	Corn	Sorona EP	Instrument-panel, air-conditioning vent
Toyota Raum	Kenaf, starch	Composite material	Floor mats, spare tire cover

Source: Centre for Automotive Research, "The Bio-Based Materials Automotive Value Chain", April 2012

The following chart shows the type and amount of bio-based material in some automotive components in North America.

Bio-Based Content of Selected Automotive Components

Model(s)	Feedstock	Material	Application	Bio-Based Content[2]
BMW 7-Series	Sisal	Acrylic polymer	Interior door panel	70 percent
Chrysler Sebring	Kenaf, hemp	Polypropylene	Interior door panel	50 percent
Ford Fiesta and Focus	Kenaf	Polypropylene	Interior door panel	50 percent
Ford Fusion and Lincoln MKZ	Soy	Polyurethane	Seating headrests	13 to 16 percent
Lincoln MKZ	N/A	Polyurethane	Console door	20 to 90 percent
Multiple Fiat vehicles	Castor	Zytel	Fuel lines	60 percent
Nissan Leaf	Corn	Sorona	Floor mats	20 to 37 percent
Toyota Camry	Castor	Zytel	Radiator end tank	40 percent

Source: Centre for Automotive Research, "The Bio-Based Materials Automotive Value Chain", April 2012

In the automotive component industry bio-based materials are used as reinforcement and filler and to create polymers. Corn and soybeans are often used as a chemical feedstock for polymer matrices. Flax and hemp are used as reinforcement and filler in products such as seatback linings, package shelves, door interiors, and floor panels.[163] See the annex for a more complete listing of the utilization of bio-based materials.

[163] Centre for Automotive Research, "The Bio-Based Materials Automotive Value Chain", April 2012.

Market Size and Growth in Specialty Papers

Companies like SWM are actively searching for other markets. SWM's primary market is for cigarette paper and the global consumption of cigarettes is falling.

Market Size and Growth in Textiles

The overall market for flax in the textile market is very small relative to other fibres and is shrinking. In developed countries, the apparel fibre consumption shares were: 48.2% synthetic, 43.2% cotton, 4.9% cellulosic, 3.0% wool and 0.7% flax. Consumption of flax was 682,000 tonnes in 2010 compared to 709,000 tonnes in 2005. The market share for flax is about 1%. [164]

Market Size and Growth in Erosion Control Products

Although market data was not publically available for erosion control products, information about the geotextile industry (of which it is a member) is.

In 2010, the estimated production value of the North American nonwoven geotextile industry was 350 M square metres with a market value of almost $300 M US. [165] The global geotextile industry is growing because of infrastructure development. The major applications are erosion control, road industry, waste management and pavement repair. The value of the North American market for geotextiles is expected to reach $1.7 B United States by 2017.[166]

Flax fibre for Bio-Energy

The green economy and the need by large resource corporations to be seen as being more environmentally friendly drive this sector.

The market sizes were not estimated or identified.

Competition from Hemp

Most fibre firms have moved into hemp because of fibre volume, fibre quality and cache. In hemp, acreage is driven more by the fibre market while in flax acreage is driven by seed price (oil).

[164] Food and Agriculture Organization and International Cotton Advisory Committee, "World Apparel Fibre Consumption Survey", July 2013.
[165] http://www.marketsandmarkets.com/PressReleases/geotextiles.asp
[166] http://www.textileworld.com/Issues/2011/January-February/Nonwovens-Technical_Textiles/Geotextiles-The_Concrete_Alternativ

6.3 Firm Strategy, Structure and Rivalry

6.3.1 Primary Processing of Straw to Obtain Flax Fibre

In our inventory, six firms were identified as currently processing flax straw: FlaxStalk/SWM, Biolin, Stemia, Vegreville Decortication, Crailar Flax, and Stemergy.

Processing capacity is used as a proxy for market size. The processing capacities of the firms in the North American flax fibre industry vary from very small to large. Based on the information collected the processing capacities are as follows:

- FlaxStalk/SWM: processes up to 100,000 tonnes of flax straw each year; assuming that the plant operates five days per week and that it runs 7 hours per day then the daily capacity is 55 tonnes/hour.
- Biolin: new plant has a capacity of 3 tonnes/hour; assuming that the plant operates five days per week and that it runs 7 hours per day, the annual capacity is 5,200 tonnes.
- Stemia: new plant (which processes hemp, canola, and flax) has a capacity of 10 tonnes/hour; assuming that the plant operates five days per week and runs 7 hours per day, the annual capacity is 18,200 tonnes. If we assume that flax accounts for one-third of the processing, then the annual flax processing capacity is 6,000 tonnes.[167] Using one-third of the higher reported capacity, the annual flax processing capacity is about 17,000 tonnes.
- Vegreville Decortication: can process 1 tonne per hour of bast fibres; assuming that the plant operates five days per week and runs 7 hours per days the total annual capacity is 1,733 tonnes. If we assume that flax accounts for 50% of the processing then the annual flax processing capacity is 867 tonnes.
- Crailar Flax Fibre: the South Carolina plant has a reported capacity of 127 tonnes/week; on a yearly basis, the total capacity would be 6,600 tonnes. However, this plant does not appear to be operating currently and the straw for it is produced under contract by nearby producers.

We were unable to verify that Stemergy is operating.

SWM expects its demand to be steady through 2020.

Excluding Stemergy and Crailar Flax Fibre the annual demand for straw for fibre processing is between 112, 000 and 123,000 tonnes. This is about 20% to 23% of the average amount of useable flax straw produced each year in Western Canada.

Until recently the sector was very stagnant. Now some companies are expanding or entering the sector. Experts suggested that the following factors are helping the sector to move forward:

[167] Another source puts the annual expected demand for all types of straw by Stemia at 50,000 tonnes.

- Manitoba's policy on biomass energy did help SWM with shives
- Partnership approach: bring companies in and introduce to technical and business resources
- Government investment in decortication equipment for research and development
- Alberta has progressive farmers and they are environmentally conscious

According to Melitz, in 2000 about 8 M lbs of flax fibre (3,629 tonnes) was used in North America in the composites market. At this time DuraFibre was operating and used flax straw to produce car parts.[168]

Structure

There are currently five flax straw processing companies in North America. Of these companies, the largest FlaxStalk/SWM is located in Manitoba. There is one company in Saskatchewan. There are two in Alberta but one of these is not yet operating. The plant in South Carolina does not appear to be operating.

One company in Alberta may eventually process flax fibre and another company in Alberta could potentially process flax fibre.

More information on these firms in contained in the Appendix.

Dominant Firm Processing Straw

The dominant and largest firm is SWM (Schweitzer Mauduit International) purchasing about 100,000 tonnes of straw annually. Its Canadian flax straw processor is FlaxStalk which is located in Manitoba. It is producing fibre for making cigarette paper. SWM had been paying $300k per year to have the shives hauled to the land fill. They now sell them for almost $ 1M per year, mainly to dairy producers for bedding and to greenhouses for fuel, who burn it as is and get more BTU than from oil. They produce a number of different shive-fiber blends for different markets. Some of their product was used on the banks of the new Panama Canal to prevent erosion while ground cover grew in.

- SWM's primary business is extracting flax fiber for use in cigarette paper. The paper is produced at a plant in New Jersey. They have a plant in Winkler that does the final processing and a plant in Carman that receives the straw and decorticates it (by hammer milling). They also have a mobile plant that does some in field processing.
- The cigarette business declines 1.5 – 3% PA but they have maintained their business by picking up new clients. They have purchased a company called Delstar that makes filters and see that as a growth area. Their current projections are for volume to remain about the same through 2020 unless there is a major breakthrough when it might be more

[168] Melitz S, "A Framework for Assessing the Exchange Costs in the Flax Fibre Supply Chain, Masters Thesis, University of Saskatchewan, 2005.

Location

In Alberta, processing firms are locating in the Lethbridge/Taber area because of flax and hemp acres. There is a bio-cluster in this area.

Vertical Integration

None of the firms would control all steps from production on the farm to final product. SWM has contracts with growers and paper downstream.

Industry Exits

The flax fibre business can be brutal. The following table lists fibre processing plants that have come and gone.

Firms Existing the Fibre Sector	
Firm	Comments
Lin Can (Regina, Saskatchewan)	Used in-field decortication; output not of high quality; partner couldn't produce needle punched mats
Un-named Grower (Birch Hills, Saskatchewan)	Grew fibre type flax and stockpiled straw for a proposed plant funded by Manitoba and Saskatchewan; project not funded
Prairie Fibre (Tisdale, Saskatchewan)	Stationary Plant for decortication; single off-shore buyer that was difficult to please; cost-price squeeze forced closure
Arbokem (British Columbia)	Bought Saskatchewan Research Council's technology for pulping flax and wanted to use it to strengthen paper; lack of capital ended proposed project
Sask-Can Fibre (Canora, Saskatchewan)	Producer co-op; design issues caused end of project; then worked with PAMI; then JV with Cargill (Durafibre) (see below)
Alphafibre (Weyburn, Saskatchewan)	Flax straw processed into a fibre called Fibex for use in composite materials
Durafibre (Canora, Saskatchewan)	Joint venture with Cargill; sold its fibre to Cambridge Industries for car parts – uniformity and scale not there for the plant to be profitable
BioFibre (Canora, Saskatchewan)	Purchased assets of Durafibre; processed flax for composite decking in the United States; had a fire and the United States recession decreased demand for building materials; exited
Nuform Packaging (Tisdale, Saskatchewan)	Can't confirm
Parkland Strawboard (Kamsack, Saskatchewan)	Used wheat straw to produce strawboard
Urban Forest Recyclers (Swift Current, Saskatchewan)	Made commercial egg trays from flax and canary seed straw; discontinued operations in 2013; no reason provided
flax processer in Pilot Mound (Manitoba)	Processed flax for Domtar and the flax was made into Canadian bank notes. Domtar had to stop using flax because of environmental regulations (waste water treatment) and the flax processor ceased business (about 20 to 25 years ago).
Compak (Forestburg Alberta)	Strawboard production; lack of capital and technical issues
AgraFibre (Wanham, Alberta)	particleboard plant; closed because of financial and start-up problems shortly after opening
Ecusta Fibres (Winkler Manitoba)	Processed straw for fibre used by Ecusta Paper, its owner. Ecusta Paper filed for bankruptcy in 2002.

http://www.producer.com/2000/08/strawboard-plant-in-limbo/
http://www.producer.com/1999/07/proposed-plant-converts-flax-to-special-fibre/
https://mountainx.com/news/community-news/0305ecustamoney-php/
http://hillcompanies.com/news/item/?n=13
Saskatchewan Ministry of Agriculture, "Flax Fibre Processing in Saskatchewan: Vision for an Industry", Presentation, 2008 and then updated.

Lessons that can be learned from business failures in the fibre business include:[169]

- Even though, work has been going on in the Prairie fibre industry, it is still an emerging industry.
- Firms need a clear idea of what the target market is before starting construction.
- It is important to spend time on assessing the markets for the fibre and the co-products.

[169] Saskatchewan Ministry of Agriculture, "Flax Fibre Processing in Saskatchewan: Vision for an Industry", Presentation, 2008 and then updated.

- There are opportunities for fibre in the green economy, particularly in the transport sector.
- Taking the quality of straw as a given and trying to work with it has met with limited success.

6.3.2 Firms Adding Value to Flax Fibres

Our inventory identified the following firms as adding value to flax fibres in North America: Genics, Synermulch, FlaxStalk, Flax Farm, Biolin, Enviro Textiles, Georgia Pacific, RheTech, C2Renew, Flax Tech, SWM, and e2e Materials Inc.

In the discussion of flax fibre processing, we estimated that the annual demand for straw for fibre processing by currently operating facilities in North America is 112,000 to 123,00 tonnes. Assuming a 20% yield, the amount of fibre produced is 22,400 to 24,600 tonnes.

Firm Structure

We identified a total of 14 firms (seven in both Canada and the United States) in North America adding value to flax fibre. A variety of products are produced ranging from bedding to bio-composites.

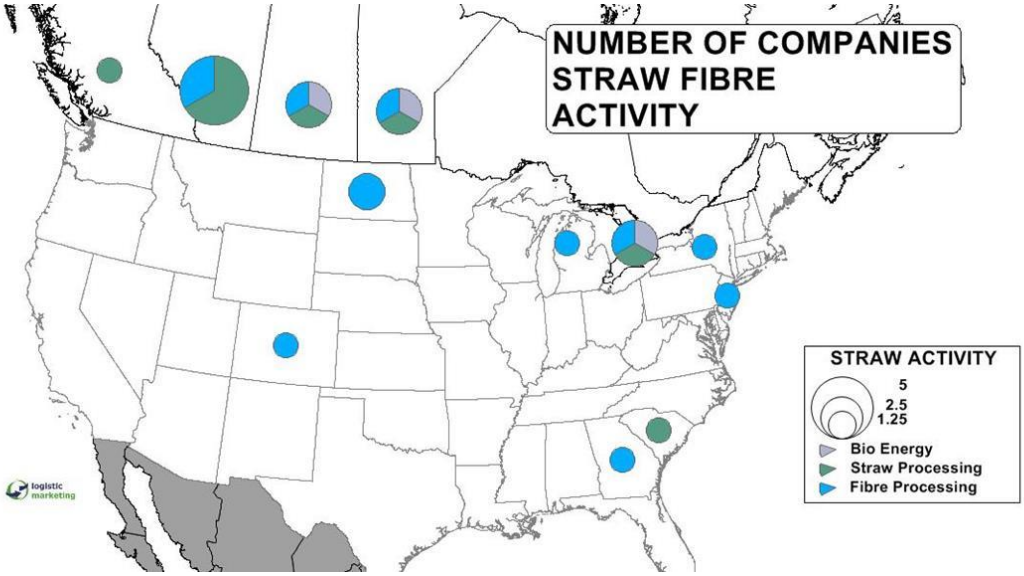
More information on these firms in contained in the Appendix.

SWM is also the dominant firm in paper. Its primary business is extracting flax fiber for use in cigarette paper. The paper is produced at a plant in New Jersey. They have a plant in Winkler that does the final processing and a plant in Carman that receives the straw and decorticates it (by hammer milling). They also have a mobile plant that does some in field processing.

The dominant firm in erosion control/land reclamation is Synermulch.

Location

As the map indicates, these companies are located throughout North America.



Source: Author

Synamulch located in Calgary, close to its customers

Manufacturing Difficulties

It is not easy to work with flax fibre and to meet customer needs. Some of the difficulties mentioned during interviews include:

- Product consistency. The car companies know they can make one of something but are not convinced they can make 100,000, all meeting specs.
- Scale and product uniformity
- Capital investment to get value chain in place
- Consistent fibre supply

6.3.3 Firms Using Flax Fibres for Bio-Energy

We identified three firms in this sector. One produces fire logs from flax shives, one produces or is attempting to produce biodiesel from flax, and the other uses straw and wood residues to produce fire logs and briquettes.

More information on these firms is contained in the Appendix.

6.4 Related and Supporting Industries

FibreCity (part of Composite Innovation Centre) is developing quality standards and grades of natural fibres. This will allow potential users to know what they are getting and how the fibre can be used.

> "The centrepiece of FibreCITY will be the establishment of a one-of-a-kind phenomics capability to rapidly characterize and evaluate the quality of natural fibres (beginning with flax and hemp fibres). This capability is essential to the project because one of the main concerns for the industrial incorporation of biofibres into production of various product lines is the variability inherent in the biofibres and the impact that this variability has on final product performance. Although numerous instruments are currently used for fibre grading and characterization, they are non-comprehensive, non-integrated and are still far from achieving their full potential. To be successful, it is vital to develop a strong, integrated and holistic characterization system for natural fibre properties and modeling, predicting and optimising their effects downstream in industrial processes. A standardized methodology to assess the sum total of the physical and biochemical attributes of biofibres, or 'phenome', would enable the rapid assessment and selection of superior fibre crops, facilitate premiums for high quality fibres, assist in maintaining quality control from crop to crop and provide a means for industry to model and assess the performance of different biomass processing techniques. This is the core of the FibreCITY proposition."

The development of grades and standards will facilitate trade and movement along the supply chain.

There is no industry association that works exclusively on flax fibre. SaskFlax and the Flax Council do provide assistance however.

There is a lack of grades and standards in the flax fibre sector (though as described later FibreCity is working on this). Grades facilitate handling and long distance trade and allow for product differentiation. Without grades it is difficult to move flax fibre through the supply chain. [170]

Firms using flax for bio-energy are supported by initiatives and organizations focused on bio-energy.

[170] Melitz S, "A Framework for Assessing the Exchange Costs in the Flax Fibre Supply Chain, Master's Thesis, University of Saskatchewan, 2005.

6.5 Government Policy and Regulatory Environment

The Canadian federal government as well as the provincial governments of Manitoba, Saskatchewan, and Alberta have been supportive of the flax fibre sector, particularly in terms of research and development.

- The Government of Alberta supports Alberta- Innovates - Technology Futures, Alberta Innovates Bio Solutions, Alberta Biomaterials Development Centre, Agri-Food Discovery Place, Decortication Plant, Bio Conversions Network, Lipid Program, Olds College Centre for Innovation and the SAIT Green Building Lab.
- The Government of Manitoba supports Fibre City which is part of the Composite Innovation Centre.
- The Government of Saskatchewan is establishing a strategic research chair in bioprocessing engineering.
- The Government of Canada supports the efforts of the National Research Council of Canada.

The Government of Manitoba is supporting joint ventures between European and Manitoba fibre firms. The Government of Alberta works with companies to develop and commercialize flax fibre processing and value-added products.

It was noted during the interviews that governments around the world are biased towards bioenergy. Although flax is really good at carbon sequestration it keeps getting ignored.

Governments rely on industry organization for advice in determining where government dollars should be spent. SaskFlax was encouraged to discuss its vision for the fibre industry with the Agriculture Development Fund.

Two bio-energy companies have received funding from Agriculture and Agri-Food Canada.

6.6 Potential Opportunities: Identification, Analysis and Assessment

6.6.1 Identification of Potential Opportunities

1) There may be new entrants into the processing sector. For example, a French firm is looking at building a decortication plant on the Prairies.

Further information about potential investment is confidential. The supply of straw is adequate. Because of transportation costs the location chosen will be critical.

Unfortunately, some straw is still burnt. Attitudes are changing however because there is a need for flax straw by processors. With the expansion of fibre processing the burning of flax straw will gradually decrease.

More entrants will help with the overall viability of the industry. It was suggested during interviews that in order to get a functioning supply chain about four or five companies like SWM are required.

2) The yield and quality of straw can be improved. For example, with good management fibre yields per acre can be tripled.

The yield of useable straw/acre is low, about 0.5 tonnes/acre on average (0.8 tonnes/acre is the maximum). If well retted, the straw will yield 80% fibre but typically only get 18%.

Improving the yield and quality would improve the economic feasibility of fibre processing. As previously discussed the landed cost of fibre depends heavily on the yield.

Research is underway in Alberta about the optimum time to bale. Leaving the straw in the field over winter to ret and then baling it in the spring appears to result in much higher quality straw. If growers are paid more for properly retted flax straw, this will occur.

3) The producer chooses flax varieties based on expected profitability. The seed side will always have a much higher value then the straw side. Because of this the development of a dual variety which has a lower seed yield will likely not be acceptable to growers and could be a poor use of limited research funds.

While one fibre oriented variety (could be a dual variety) was developed, flax is not bred for fibre and there are no breeding projects on fibre.

4) There is potential to use more flax fibre in bio-composites, bioplastics and building materials.[171]

[171] Not all those interviewed believed that there are opportunities in flax fibre and that government funding in this area would be beneficial.

Alberta government officials suggested that the probability of this occurring in Alberta is about 80% and that the time frame for realization is one to two years. Composite Innovation Centre has developed a composite that will be used for the hood on the next generation of Buhler tractors. It is trying to get smaller scale projects going to provide credibility for larger scale applications.

One expert believes that the system will need to be 'fiber source agnostic' i.e. use fiber blends so if one crop has a poor year the other can make it up. The car companies don't care if the farmers have a bad year. There has to be redundancy in the system. He sees that farmers need to take a cooperative approach in order to supply the market consistently.

Experts suggested that biocomposites are growing and will continue to grow but not too quickly because of the risk of supply shortages. Composite manufacturers are very interested in flax fibre but are worried about the lack of suppliers and fibre consistency

Yan et al suggest that flax composites could be the next generation material for consumer, infrastructure and automotive applications.

> "Flax fibres are cost-effective materials have specific mechanical properties which have potential to replace glass fibres as reinforcement in composite. Their main disadvantage is the variability in their properties. Environmental effects (e.g. high relative humidity) will degrade the tensile properties of flax fibres. A suitable chemical treatment (e.g. Silane) can increase the tensile strength and strain of the flax fibres. The tensile strength and modulus of flax fibres decrease with an increase in fibre length, fibre diameter and gauge length. Flax fibres at the mid-span and tip in the stem with high content of cellulose should be considered as the raw materials. Improving the poor environmental- and dimensional stability of lignocellulosic materials is an effective way to modify the mechanical properties of these materials. The tensile properties of flax fibres scatter significantly with the change in fibre diameter, gauge length. An appropriate treatment (e.g. Duralin treatment or drying cycle treatment) can be selected to achieve a higher and more uniform strength with less scatter. Flax fibre with thermoplastic, thermoset and biodegradable polymer matrices exhibit promising mechanical properties. A major limitation of using flax fibres as reinforcement in composites is the incompatibility which results in poor fibre/matrix interfacial bonding and thereby reduces the tensile properties. The selection of suitable manufacturing process and physical/chemical modification can improve the mechanical properties of flax composites. Flax composites have the potential to be the next generation materials for structural application for infrastructure, automotive industry and consumer applications. Future work on flax composites should be focused on understanding the environmental assessment, durability, further improving the mechanical properties and moisture resistance. Additionally, novel manufacturing processes and surface modification methods should be further developed."[172]

5) There is potential to use more flax fibre in land reclamation/erosion control.

This opportunity already exists and is growing.

6) There is an emerging opportunity in the production of linen flax.

Alberta government officials suggest that this has potential because it has the land base and the appetite and interest in linen flax appears to be growing. Obviously, the linen flax opportunity is higher

[172] Yan L, N Chouw, and K Jayarman, "Flax Fibre and Its Composites – A Review", Composites: Part B 56 (2014) 296-317.

risk (50% probability) and longer term (four to five years). There is good access to ports from Alberta. In Alberta a formal collaboration with China has been developed and a government expert will be planting linen varieties in Vegreville in 2015.

Manitoba is experimenting with linen flax at Roblin Manitoba and recently purchased a flax puller. It is collaborating with French companies.

7) The establishment of a flax grower association in Alberta would help grow the flax fibre industry in Alberta.

More promotion and technology transfer to growers would aid the sector.

8) Increasing the yield of fibre from the straw would increase the feasibility and profitability of the sector.

6.6.2 Analysis and Assessment Summary

While the market for flax fibre shows a great deal of potential, some challenges have been identified. According to Ulrich these challenges include weather, scale of operation, farmer incentives, impatience and misunderstanding, mistrust, and yarn colour. Weather is always a factor in production of flax and it can have significant impacts on retting. The supply of flax fibre is not large enough and consistent enough to support large scale operations that could use up to 40,000 tonnes of fibre each year. Farmers and flax fibre processors are still learning how to manage straw and fibre for higher valued markets. Farmers need an incentive before they will change the way they manage straw. However, investors are loath to invest without a consistent useable straw supply. There have been many value added failures and these have been caused by factors such as unrealistic/infeasible selection of a target market, unfavourable weather events, poor straw quality and impatient research funders. In the flax fibre sector many firms do not have patented processes for straw relying instead on trade secrets. When the firm won't share the trade secret about straw production with growers, the outcome is less than optimal. The final factor is the colour of yarn which is impacted by retting which in turn is impacted by weather.[173]

A 2002 United States study found that there were several issues associated with establishing a flax fibre industry including "efficiency of harvest methods, fibre extraction (retting), and the lack of standards for judging fibre quality".[174]

The following was written in 2005 and is still valid today.

> "The flax fibre industry is still in its infancy and, thus far, its growth has been slow. The large number of acres devoted to flax in Canada means that there is a large volume of flax straw available for value added processing. Despite the

[173] Ulrich A, "Challenges to Producing Flax in Canada", SaskFlax

[174] Melitz S, "A Framework for Assessing the Exchange Costs in the Flax Fibre Supply Chain, Master's Thesis, University of Saskatchewan, 2005.

> large potential for utilizing this valuable by-product, growth at all stages of the supply chain has been stagnant, or growing very slowly. Entry into the industry has been slow, with only a handful of processors of flax straw currently operating in Canada. Similarly, manufacturers have been slow to adopt flax fibre in their production processes. "[175]

In 2005, Melitz suggests that the following factors are responsible for the slow development of the flax fibre sector in North America:[176]

- It is an infant industry which means there is a lack of information and a lack of evidence that it can be profitable.
- The processing equipment and knowledge is very specific. A processor must have an ongoing relationship/deal with its customer(s) in order to be sustainable.
- There is a lack of research and development on flax fibre and straw management.
- There are only a handful of processors and manufacturers. End-users of flax fibres do not want to rely on a single supplier.
- A quality and grading regime for straw and fibre is missing. Growers are not compensated based on quality so they have no incentive to manage the straw better. Manufacturers must trust that the processor will deliver the desired quality of fibre.

In 2014, progress has been made on research and development and quality and grading. SWM buys straw based on cellulose content and fiber length which does encourage growers to manage their straw better. FibreCity is developing a grading system for flax fibre.

Potential opportunities were identified. The bio composite market is growing but unless a blended product is used growth will be hampered by supply quantity and quality uncertainty.
Improving the yield of fibre from straw would have a large payoff in terms of industry stability and profitability.

There may be opportunities to utilize more flax in the production of bio-energy. This arises from government/society goals that support whole plant utilization and the development of the bio-energy sector.

Reducing the burning of straw would be beneficial as would the conservation of non-renewable resources. The value of this opportunity was not estimated.

[175] Melitz S, "A Framework for Assessing the Exchange Costs in the Flax Fibre Supply Chain, Master's Thesis, University of Saskatchewan, 2005.
[176] Melitz S, "A Framework for Assessing the Exchange Costs in the Flax Fibre Supply Chain, Master's Thesis, University of Saskatchewan, 2005.

7. Appendix

7.1 North American Product Flows

Flaxseed, oil, and meal is quite fluid within North America. This section presents a synopsis of these and off-shore flows from Canada. While some of these products are destined for other markets besides the food market the higher priced movements should be for the food market.

Trade in Flaxseed by Province, 2013	
(Value of bulk seed exports from Alberta, Saskatchewan, and Manitoba in 2013 was $705/tonne)	
Province	Description of Trade Flows
British Columbia	No exports; imports primarily from United States but some seed from Canada travels through United States to reach British Columbia; United States imports primarily from Washington ($1,981/tonne) and Oregon ($54/tonne) British Columbia is importing higher valued raw seed.
Alberta	Biggest export customers are China, United States and Belgium (raw unprocessed seed); Largest exports to United States are of raw, unprocessed seed to Minnesota and North Dakota; Some higher valued exports to Ireland ($1,415/tonne); Imports from United States and other Canada; high valued imports from California and Minnesota ($1500/Tonne to $1900/Tonne)
Saskatchewan	Biggest export markets are China, United States, and Belgium which are receiving low valued raw seed; Some higher valued exports to Ireland ($1415/tonne); largest exports to United States are of low valued seed to Minnesota and North Dakota; Some higher valued exports to New Jersey ($2020/tonne) and Utah ($2244/tonne); Imports from United States and in particular North Dakota and Minnesota (low value); some higher valued imports from California ($2202/tonne)
Manitoba	Biggest export markets are China, United States, and Belgium which are receiving low valued raw see; some higher valued exports to Ireland ($1415/tonne) and in United States to New Jersey ($2020/tonne) and CT ($7888/tonne). Most exports to United States go to Minnesota and North Dakota (low valued seed); imports primarily from United States (mostly from North Dakota and Minnesota – low valued); some higher valued imports from Wisconsin ($3015/tonne) and Florida ($2015/tonne)
Ontario	There are no seed exports from Ontario; imports primarily from the United States; most of United States imports from Oregon (really low value at $147/tonne) and North Dakota; some higher valued imports from Idaho ($3368/tonne); Wisconsin ($1988/tonne); Minnesota ($2071/tonne), California ($1848/tonne) and Illinois ($4368/tonne).
Quebec	There are no seed exports from Quebec; imports from Russia ($1,039/tonne), Kazakhstan ($1092/tonne) and Turkey ($1019/tonne); very little imported from United States

Source: Statistics Canada

Trade in Crude Linseed Oil by Province, 2013	
Province	Description of Trade Flows
British Columbia	Exports crude oil at an average price of $3,347/tonne; United Kingdom is largest market; no exports to United States; imports primarily from United States at $5,958/tonne with largest supplies from Washington ($6021/tonne) and Montana ($3125/tonne)
Alberta	Exports are primarily to Japan ($5226/tonne); some to United States (only to Delaware at $4996/tonne); imports only from United States($2,132/tonne) and primarily from Montana
Saskatchewan	Exports primarily to China ($4305/tonne) and Japan ($3351/tonne); no exports to United States; no imports in 2013
Manitoba	Exports are mostly to United States ($4096/tonne) but some to United Kingdom ($6360/tonne) and South Korea ($5098/tonne); exports to United States mostly to New Jersey ($3860/tonne) and South Carolina ($3324/tonne) but some to really high value markets like Nevada ($10,096); imports are small and only from United States (Louisiana at $3500/tonne)
Ontario	Exports mostly to United States($2651/tonne); some to Belgium ($3379/tonne); exports to United States all to Minnesota; imports are mostly from United States($2408/tonne) but some from United Kingdom ($7394/tonne); United States imports primarily from Minnesota ($2385/tonne); some higher value imports from New York ($13,850/tonne)
Quebec	Exports are primarily to United States ($3203/tonne); some to China ($1,561/tonne). Exports to United States primarily to New York ($3197/tonne); some to California ($7925/tonne); imports mostly from Belgium ($3870/tonne) but also France ($6019/tonne) and United States($3469/tonne); imports from New Jersey ($3257/tonne) and New York ($3,746/tonne)

Source: Statistics Canada

Trade in Refined Linseed Oil by Province, 2013	
Province	Description of Trade Flows
British Columbia	Exports primarily to China ($6988/tonne) and United States ($5963/tonne); United States exports only to California; imports are primarily from United States ($3,221/tonne) and China ($4,573/tonne); United States imports mostly from Washington ($4602/tonne) and Minnesota ($1870/tonne) but also high valued from California ($14,742/tonne)
Alberta	Exports only to United States ($5,158/tonne) and mostly to California ($3,280); some high valued to Pennsylvania ($14,014/tonne) and Utah ($14,955/tonne); imports primarily from United States($1,357/tonne) but some from France ($4,595/tonne) and United Kingdom ($16,000/tonne); United States imports primarily from New York ($833/tonne); some high valued imports from United States ($22,700/tonne)
Saskatchewan	Exports primarily to United States($7,846/tonne) but also others like Japan ($5885/tonne); exports to United States mostly to Wisconsin ($10,184/tonne), California ($3361/tonne), Pennsylvania ($10,956/tonne) and Illinois ($9474/tonne); imports only from United States and only from New York ($515/tonne)
Manitoba	Exports mostly to United States ($5,320/tonne) but also Japan ($5542/tonne), China ($4320/tonne), etc. Exports to United States mostly to MI ($5228/tonne) and New Jersey ($4956/tonne); some high valued exports to Pennsylvania ($10975/tonne); imports primarily from United States ($4990/tonne) and mostly from New York ($6801/tonne) and Ohio ($3769/tonne)
Ontario	Exports are mostly to United States ($3133/tonne) but some to China ($8450/tonne); exports to United States mostly to OH ($1671/tonne); some higher valued exports such as North Dakota ($12015/tonne); imports are primarily from United States and mostly from Minnesota ($1719/tonne); some high valued imports like NH ($22000/tonne)
Quebec	Exports only to Nicaragua; imports are mostly from United States ($11530/tonne) and mostly from New York ($14234/tonne)
NB	Exports only to United States and only to Arizona ($8781/tonne); imports from United States ($3151/tonne) and France ($3378/tonne); imports from United States mostly from Texas ($2933/tonne); some high valued imports from Oregon ($12273/tonne)
NS	Exports only to St Pierre ($5833/tonne); no imports

Source: Statistics Canada

Trade in Linseed Meal by Province, 2013

Province	Description of Trade Flows
British Columbia	Exports only to China ($300/tonne); imports only from United States and mostly from Washington ($921/tonne)
Alberta	Exports to South Korea at $300/tonne; no exports to United States; imports are only from Montana ($393/tonne)
Saskatchewan	Exports only to United States and primarily to Washington ($671/tonne) and WI ($596/tonne); imports are only from North Dakota ($616/tonne)
Manitoba	Exports primarily to United States ($819/tonne) but some to China ($419/tonne); United States exports mostly to California ($906/tonne) and Missouri ($875/tonne); only imports from U; mostly from North Dakota ($354/tonne) but some from Minnesota ($367/tonne)
Ontario	No exports; imports only from United States and mostly from Minnesota ($437/tonne)
Quebec	No exports; imports primarily from the United States ($372/tonne) and primarily from Minnesota ($407/tonne) and California ($267/tonne); small amount of imports from China

Source: Statistics Canada

7.2 List of Experts Interviewed

The following experts graciously discussed the value added flax sector with us.

Interview List	
Name	Affiliation
Kellie Jackson	Alberta Agriculture and Rural Development
Lori-Jo Graham	Alberta Agriculture and Rural Development
Sheri Coleman	AmeriFlax
Walker Humphries and Jeff Roberts	Bay State Milling
Alvin Ulrich	Biolin
Don Kerr	Flax Council of Canada
Hans Kandel	Flax Institute
Summer Sit	Flora
Tara Anderson	Heartland Flax
Mark Pickard	InfraReady
Linda Pizzey	JG Pizzey
Pam Elliott	LV Lomas
Eric Lui	Manitoba Agriculture, Food and Rural Development
Eric Fridfinnson	Manitoba Flax Growers Association
Steve Chambers	Montana Specialty Mills
Graig Goodwin	Naturally Splendid Enterprises
Clifford Hall	North Dakota State University
Chad Ulven	North Dakota State University
Kelly Fitzpatrick	NutriTech Consulting
Jennifer Adolfe	Petcurean
Bill Vincent	Shape
Karen Logue	Silver Hills Bakery
Abdul Jalil	Saskatchewan Ministry of Agriculture
James Kettle	Saskatchewan Ministry of Agriculture
Shawn Gibson	Saskatchewan Ministry of Agriculture
Ron Kerig and Chandra Mark	Saskatchewan Ministry of Economy
Dennis Magotiaux	SWM International
Carey Charles	SWM International
Michael Nickerson	University of Saskatchewan
Helen Booker	University of Saskatchewan
Martin Reaney	University of Saskatchewan and Prairie Tide Chemicals

7.3 Supply Chain Value Added Activity Inventory

7.3.1 Vertically Integrated Growers

The vertically integrated growers that were identified are shown below.

Canadian Vertically Integrated Growers

					Human	Feed	ts/Hors	Ind	ground flax	flour	hulls	Seed	other	Organic Flax			Conventional Flax			B to C	B to B	Type of VA	Level of VA	Type of Meal
			Country	Prov										Oil	Seed	Meal	Oil	Seed	Meal					
1	Dale Thacker Specialty Crops	http://www.mintfarm.ca/	CAN	AB	yes							yes						yes			Yes	GRV,FL	+	
2	Grain Works	http://grainworks.com/about-us/	CAN	AB	Yes				yes			yes	cereal		yes					Yes	yes	V,FL, F	F	
3	Highwood Crossing Foods	https://www.highwoodcrossing.com	CAN	AB	Yes							yes	gran	yes	yes					Yes		GRV,CR,FL,	F	PDM
4	De Ruyck's Top of the Hill Farm	none	CAN	MB	yes										yes					Yes	Yes	GRV	+	
5	Johnson Seeds	http://www.johnsonseeds.com/	CAN	MB	yes							yes						yes			Yes	GRV	+	
6	Vandaele Seeds	http://www.vandaeleseeds.com/	CAN	MB	yes		yes	yes				yes						yes			Yes	GRV	+	
7	Farmer Direct Co-Operative	http://farmerdirect.coop	CAN	SK	yes							yes			yes					Yes	Yes	GRV	+	
8	Mumm's Sprouting Seeds	http://sprouting.com/	CAN	SK	Yes							yes			Yes					Yes		GRV,FL	+	
9	New Life Organic Foods	http://www.newlifeorganicfoods.ca	CAN	SK	Yes							yes	cereal		Yes					Yes		GRV,FO	F	
10	Northern Quinoa	http://www.quinoa.com/	CAN	SK	yes				yes			yes			yes					Yes	yes	GRV,FL	++	
11	Poplar Valley Organic Farms	http://www.cluborganic.ca	CAN	SK	Yes	Yes	yes		yes			yes			Yes						Yes	GRV,FL	++	
12	Prairie Heritage Seeds Organic	http://www.phsorganics.com/	CAN	SK	yes							yes			Yes						Yes	GRV,FL	+	

United States Vertically Integrated Growers

			Country	State	Human	Feed	ts/Hors	Ind	ground flax	flour	hulls	Seed	other	Organic Flax			Conventional Flax			B to C	B to B	Type of VA	Level of VA	Type of Meal
														Oil	Seed	Meal	Oil	Seed	Meal					
1	Farmers Elevator	http://www.topplandandcattle.com/	US	ND	yes	yes						yes						yes			Yes	GRV	+	
2	Flax USA	http://www.flaxusa.com	US	ND	Yes		Yes		yes			yes		yes	yes			yes		Yes		GRV,CF	++	PDM
3	Golden Flax 4U	http://www.goldenflax4u.com/	US	ND	yes				yes		yes	yes			yes			yes		Yes		GRV, F	++	
4	Golden Valley Flax	http://www.flaxhealth.com/	US	ND	yes				yes			yes			yes			yes		yes		GRV,FL	++	
5	Healthy Oilseeds	http://www.healthyoilseeds.com/	US	ND	yes	yes						yes			yes			yes			Yes	GRVFL	+	
6	Reimers Seed Company	http://www.reimersflax.com/	US	ND	yes							yes			yes			yes		Yes	yes	GRV,FL	+	
7	Stevens Family Farm	http://www.stevensfarm.com	US	ND	Yes				yes			yes					yes	yes		Yes	Yes	GRV,CF	++	PDM
8	Heintzman Farms	http://heintzmanfarms.com/	US	SD	yes							yes						yes		Yes		GRV,FL	+	
9	Howe Seeds	http://www.howeseeds.com/	US	SD	yes							yes						yes		Yes		GRV,FL	+	

7.3.2 Bulk Handlers

The following companies were identified as bulk handlers of flaxseed (December 13th list). The list is representative of Canada but not of the United States.

Bulk Handlers																			
					Human	Feed	Pets/Horses	Ind	Seed	Organic Flax			Conventional Flax			B to C	B to B	Type of VA	Level of VA
			Country	Prov						Oil	Seed	Meal	Oil	Seed	Meal				
1	Tradin Organics USA	http://www	US	CA	yes				yes		yes						Yes	BH	+
2	Cargill	www.cargil	Can	MB	yes	yes		yes	yes					yes			Yes	BH	+
3	Growers International Organic Sales	http://www	CAN	MB	yes				yes		yes						Yes	BH	+
4	Horizon Agro	http://www	CAN	MB	yes	yes		yes	yes					yes			Yes	BH	+
5	Legumex Walker	http://www	CAN	MB	yes	yes		yes	yes					yes			Yes	BH	+
6	Linear Grain	http://www	CAN	MB	yes	yes		yes	yes					yes			Yes	BH	+
7	Parrish & Heimbecker	http://www	CAN	MB	yes	yes		yes	yes					yes			Yes	BH	+
8	Paterson Grain	http://www	CAN	MB	yes	yes		yes	yes					yes			Yes	BH	+
9	Richardson International	http://www	CAN	MB		yes		yes	yes					yes			Yes	BH	+
10	AGT Food & Ingredients	http://www	CAN	SK	yes				yes					yes			Yes	BH	+
11	Viterra	www.viterra	CAN	SK	yes	yes	yes	yes	yes					yes			Yes	BH	+
12	Western Grain Trade	http://www	CAN	SK	yes	yes		yes	yes					yes			Yes	BH	+

7.3.3 Flaxseed Crushers

Flaxseed crushers in Canada and the US are shown below.

Canadian Flaxseed Crushers

											Organic Flax			Conventional Fla			B to C	B to B		
				Prov	Solvent	Extrusion	Human Products	Feed Products		Industrial	Oil	Seed	Meal	Oil	Seed	Meal				
1	Gold Top Organics	http://www.goldtoporganics.com/	CAN	AB		Yes	Yes				Yes	Yes					Yes		CR,FL	PDM
2	Highwood Crossing Foods	https://www.highwoodcrossing.com	CAN	AB		Yes	Yes				Yes	Yes					Yes		GRV,CR,FL,FO	PDM
3	Nature's Nutraceuticals	http://www.naturesnutraoils.com	CAN	AB		Yes	Yes				Yes	Yes	Yes				Yes		CR,FL	PDM
4	Alligga	http://www.alligga.com/	CAN	BC		yes	yes				yes	yes					Yes		CR,FL	PDM
5	Flora Manufacturing & Distributing	http://www.florahealth.com	CAN	BC		Yes	Yes				Yes						Yes		CR	PDM
6	Polar Foods	http://www.polarfoods.net/	CAN	MB		Yes	Yes	Yes						Yes		Yes		Yes	CR	PDM
7	Shape Foods	http://www.shapefoods.com/	CAN	MB		Yes	yes	yes			yes			yes		yes	Yes	yes	CR	PDM
8	Flax Energy	http://flaxenergy.ca/	CAN	ON		yes	yes			yes				yes	yes	yes		Yes	CR,FL	PDM
9	Golburn Valley Oilmill	http://www.gvo.ca/	CAN	SK		yes	yes	Yes			yes	yes	yes					Yes	CR,FL	PDM
10	Northern Nutraceuticals	http://www.northernnutra.ca	CAN	SK		Yes	Yes				Yes	yes		Yes	Yes			yes	CR,FL	PDM
11	Specialty Distributing	http://specialtydistributing.ca/	CAN	SK		Yes	yes				yes	yes	yes					yes	CR	PDM
12	TA Foods	http://www.tafoods.ca	CAN	SK		Yes	Yes				Yes	Yes	Yes	Yes	Yes	Yes		Yes	CR	PDM

United StatesFlaxseed Crushers

											Organic Flax			Conventional Fla			B to C	B to B		
				State	Solvent	Extrusion	Human Products	Feed Products	Pets	Industrial	Oil	Seed	Meal	Oil	Seed	Meal				
1	Adams Vegetable Oil	http://www.adamsgrp.com	US	CA		Yes	Yes				Yes							Yes	CR	PDM
2	Spectrum Organics	http://www.spectrumorganics.com	US	CA		Yes	Yes				Yes	Yes	Yes	Yes	Yes	Yes		yes	CR,FL	PDM
3	American Natural Soy Processors	http://www.americannaturalsoy.co	US	IA		yes	Yes	Yes			Yes		Yes					Yes	CR	PDM
4	Columbus Vegetable Oils	http://www.columbusvegoils.com/	US	IL		Yes	Yes							Yes				Yes	CR	PDM
5	CHB Proteins	http://www.chbproteins.com	US	ME		Yes		Yes						Yes		Yes		Yes	CR	PDM
6	ADM Northern Sun	www.adm.com	US	MN	Yes			Yes		Yes				Yes		Yes		Yes	CR	FDM
7	Montana Specialty Mills	http://www.mtspecialtymills.com	US	MT		Yes	Yes	Yes		Yes	Yes		Yes	Yes		Yes		Yes	CR,FL	PDM
8	ADM Northern Sun	www.adm.com	US	ND	Yes			Yes		Yes				Yes		Yes		Yes	CR	FDM
9	Cargill	http://www.cargill.com/	US	ND	Yes			Yes		Yes				Yes		Yes		Yes	CR	FDM
10	Flax USA	http://www.flaxusa.com	US	ND		Yes	Yes		yes		Yes		Yes				Yes		GRV,CR,FL	PDM
11	Heartland Flax	http://www.heartlandflax.com/	US	ND		Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes		Yes	CR,FL	PDM
12	Stevens Family Farm	http://www.stevensfarm.com	US	ND		Yes	Yes	Yes			Yes			Yes	Yes		yes	Yes	GRV,CR,FL	PDM
13	Penta Manufacturing Company	www.pentamfg.com	US	NJ	Yes					yes				Yes				Yes	CR	FDM
14	Ag Pro	http://www.agprosoy.com/	US	NY		Yes	Toll	Toll			Toll		Toll	Toll		Toll		Yes	CR	PDM
15	Barleans	http://www.barleans.com	US	WA		Yes	Yes				Yes	Yes					Yes		CR,FL	PDM
16	Omega Nutrition	http://www.omeganutrition.com/	US	WA		Yes	Yes				Yes	Yes					Yes		CR,FL	PDM

7.3.4 Flaxseed Product Manufactures

The lists do not include crushers that only crush.

Canadian Flax Product Manufacturers																								
					Human	Feed	Pets/Horses	Ind	ground flax	flour	hulls	Seed	other	Organic Flax			Conventional Flax			B to C	B to B	Type of VA	Level of VA	Type of Meal
														Oil	Seed	Meal	Oil	Seed	Meal					
1	Dale Thacker Specialty Crops	http://www.mintfarm.ca/	CAN	AB	yes							yes						yes			Yes	GRV,FL	+	
2	Gold Top Organics	http://www.goldtoporganics.com/	CAN	AB	Yes				yes			yes		yes	yes					Yes		CR,FL	++	PDM
3	Grain Works	http://grainworks.com/about-us/	CAN	AB	Yes				yes			yes	cereal		yes					Yes	yes	GRV,FL, FOM	F	
4	Highwood Crossing Foods	https://www.highwoodcrossing.com	CAN	AB	Yes							yes	granola	yes	yes					Yes		GRV,CR,FL,FOI	F	PDM
5	Nature's Nutraceuticals	http://www.naturesnutraoils.com	CAN	Ab	Yes				yes			yes		yes	yes	yes				Yes		CR,FL	++	PDM
6	Alligga	http://www.alligga.com/	CAN	BC	Yes				yes				soft gels	yes	yes					Yes		CR,FL	++	PDM
7	Avafina Commodities	http://www.avafina.com	CAN	BC	Yes	yes			yes			yes			yes	yes					Yes	FL	++	FFM
8	Fieldstone Organics	http://fieldstoneorganics.ca/	CAN	BC	Yes							yes			Yes					Yes	Yes	FL	+	
9	JG Pizzey	http://www.jgpizzey.com	CAN	MB	yes				yes			yes						yes		yes	yes	FL	++	
10	Polar Foods	http://www.polarfoods.net/	CAN	MB	Yes	Yes			Yes		yes	yes	soft gels				yes	yes	yes		yes	FL	++	FFM
11	Prairie Flax	http://www.prairieflax.com/	CAN	MB	yes				yes									yes		Yes		FL	+	
12	Omega Crunch	http://www.omegacrunch.com	CAN	NS	Yes						yes		Sprinkles					yes		yes		FOM	F	
13	Valley Flax Four	http://www.valleyflaxflour.com/	CAN	NS	yes		yes			yes								yes		Yes		FL	++	
14	Bio Essentials Botanicals	http://www.bioessentialbot.com	CAN	ON	Yes								sprouted		Yes						Yes	FL	++	
15	Natunola Health	http://www.natunola.com	CAN	ON	Yes				yes	yes	yes							Yes		Yes	Yes	FL	++	
16	Port Royal Mills	http://www.portroyalmills.com/	CAN	ON	yes				yes			yes						yes			Yes	FL	++	
17	Semican International	http://www.semican.ca	CAN	QC			Yes		yes			yes						Yes			Yes	FL	++	
18	Bioriginal Food & Science Corp	http://www.bioriginal.com	CAN	SK	Yes								NHP					yes			Yes	FL	+++++	
19	CanMar Grain Products	http://www.roastedflax.com/#	Can	SK	yes								roasted		yes			yes		Yes		FL	++	
20	InfraReady Products	http://www.infrareadyproducts.com/	CAN	SK	yes				yes			yes			yes			yes			yes	FL	F	
21	Mumm's Sprouting Seeds	http://sprouting.com/	CAN	SK	Yes							yes			Yes					Yes		GRV,FL	+	
22	Northern Nutraceuticals	http://www.northernnutra.ca	CAN	SK	Yes							yes		yes	yes		yes	yes			Yes	CR,FL	++	PDM
23	Northern Quinoa	http://www.quinoa.com/	CAN	SK	yes				yes			yes			yes					Yes	yes	grv,fl	++	
24	O & T Farms	http://www.otfarms.ca	CAN	SK		Yes	yes						extruded					Yes			Yes	FDM	++	
25	Poplar Valley Organic Farms	http://www.cluborganic.ca	CAN	SK	Yes	Yes	yes		yes			yes			Yes						Yes	GRV,FL	++	
26	Prairie Heritage Seeds Organi	http://www.phsorganics.com/	CAN	SK	yes							yes			Yes						Yes	GRV,FL	+	
27	Prairie Tide	http://prairietide.com/Home.html	CAN	SK	yes								peptides					yes			yes	FL	++++++	
28	Specialty Distributing	http://specialtydistributing.ca/	CAN	SK	yes				yes	yes		yes		yes	yes						yes	CR,FL	++	PDM
29	TA Foods	http://www.tafoods.ca	CAN	SK	Yes				yes			yes		yes	yes	yes	yes	yes	yes		Yes	CR,FL	++	FFM
30	Willow Creek Organic Grain	https://www.willowcreekorganics.co	CAN	SK	Yes							yes	defatted m	yes	yes	yes				Yes		CR,FL	++	PDM

This list does not include crushers that only crush.

United States Flaxseed Product Manufacturers

					Human	Feed	Pets/Horses	Ind	ground flax	flour	hulls	Seed	other	Organic Flax			Conventional Flax			B to C	B to B	Type of VA	Level of VA	Type of Meal
1	New Organics	http://www.neworganics.com/	US	CA	yes							yes	meal		yes	yes					Yes	FL	++	FFM
2	Spectrum Organics	http://www.spectrumorganics.com	US	CA	Yes				Yes			Yes		Yes	Yes	Yes	Yes	Yes	yes	Yes		CR,FL	++	PDM
3	Great Plains Flax	http://www.greatplainsflax.com/	US	CO	yes							yes	grinder					yes		Yes		FL	+	
4	Beveri	http://beverinutrition.com	US	CT	yes				yes			yes						yes		Yes		FL	++	
5	Mid America Food Sales	http://www.midamfoodsales.com/	US	IL	yes					yes			nuggets					yes			Yes	FL,FM	F	
6	Montana Specialty Mills	http://www.mtspecialtymills.com	US	MT	yes	yes		yes	yes	yes defatted									yes		Yes	CR,FL	++	PDM
7	Flax USA	http://www.flaxusa.com	US	ND	Yes		Yes		yes			yes		yes	yes			yes		Yes		GRV,CR,FL	++	PDM
8	Golden Flax 4U	http://www.goldenflax4u.com/	US	ND	yes				yes		yes	yes			yes			yes		Yes		GVI, FL	++	
9	Golden Valley Flax	http://www.flaxhealth.com/	US	ND	yes				yes			yes			yes			yes		yes		GVI,FL	++	
10	Healthy Oilseeds	http://www.healthyoilseeds.com/	US	ND	yes	yes						yes			yes			yes			Yes	GVI,FL	+	
11	Heartland Flax	http://www.heartlandflax.com/	US	ND	yes	yes			yes	yes	yes	yes		yes	yes	yes	yes	yes	yes		Yes	CR,FL	++	PDM
12	North Dakota Innovations	http://www.ndinnovations.com	US	ND	Yes						yes							Yes		Yes		FL	++	
13	Pride of the Prairies Dakota Fl	http://www.dakotaflax.com/	US	ND	yes							yes			yes			yes		Yes		FL	+	
14	Red River Commodities	http://www.redriv.com/	US	ND	yes							yes						yes			Yes	FL	+	
15	Reimers Seed Company	http://www.reimersflax.com/	US	ND	yes							yes			yes			yes		Yes	yes	GRV,FL	+	
16	SK Food International	http://www.skfood.com	US	ND	yes							yes			yes						Yes	FL	+	
17	Specialty Commodities Inc	http://www.specialtycommodities.c	US	ND	yes		yes					yes			yes			yes			Yes	FL	+	
18	Stevens Family Farm	http://www.stevensfarm.com	US	ND	Yes				yes			yes					yes	yes		Yes	Yes	GRV,CR,FL	++	PDM
19	Carrington Farms	http://carringtonfarms.com	US	NJ	yes				yes			yes	yes		yes					Yes		FL	++	
20	Bob's Red Mill	http://www.bobsredmill.com/	US	OR	yes				yes			yes			yes	yes		yes	yes	Yes		FL	++	FFM
21	Glanbia Nutritionals	http://www.glanbianutritionals.com	US	SD	Yes				yes			yes						Yes			Yes	FL	++	
22	Heintzman Farms	http://heintzmanfarms.com/	US	SD	yes							yes						yes		Yes		GRV,FL	+	
23	Howe Seeds	http://www.howeseeds.com/	US	SD	yes							yes						yes		Yes		GRV,FL	+	
24	Arrowhead Mills	http://www.arrowheadmills.com/	US	TX	Yes							yes			yes			yes		Yes		FL	+	
25	FW Cobs	http://www.fwcobs.com/grains/	US	VT	yes		yes		yes			yes			Yes	Yes		Yes	Yes		Yes	FL	++	FFM
26	Barleans	http://www.barleans.com	US	WA	Yes				yes					yes	yes					Yes		CR,FL	++	PDM
27	Omega Nutrition	http://www.omeganutrition.com/	US	WA	yes	yes			yes			yes		yes	yes					Yes		CR,FL	++	PDM
28	Omega Field	http://www.flax.com/	US	WI	yes	yes	yes		yes			yes						yes		Yes		FL,FDM	F	

7.3.5 Canadian Producers of Enhanced Meat and Eggs

The following table shows the producers of enhanced meat and eggs that were identified in Canada.

Canadian Producers of Enhanced Meat or Eggs																
					Human	other	Organic Flax			Conventional Flax			B to C	B to B	Type of VA	Level of VA
			Country	Prov			Oil	Seed	Meal	Oil	Seed	Meal				
1	Countryside Farms	http://www.countrysidefarms	CAN	MB	Yes	Omega 3 Eggs		Yes			Yes		Yes		EE	++++
2	Nature's Farm	http://naturesfarm.ca/contac	CAN	MB	Yes	Omega 3 Eggs		Yes			Yes		Yes		EE	++++
3	Prairie Orchard Farms	http://www.prairieorchardfa	CAN	MB	Yes	Omega 3 Pork					Yes		Yes		EM	++++
4	Burnbrae Farms	http://www.burnbraefarms.c	CAN	ON	Yes	Omega 3 Eggs					Yes		Yes		EE	++++
5	Gray Ridge Egg Farms	http://www.grayridge.com	CAN	ON	Yes	Omega 3 eggs					Yes		Yes		EE	++++

7.3.6 Flax Fibre Research and Development

In Canada the following companies/institutions were identified as being active in flax fibre Research and Development.

Canadian R&D in Flax Fibre												
	Company	Website			Multiple Locations	Funds R&D	Does R&D	Does Applied R&D	Supports R&D	Supports Commercialization	Provides Bus & Tech Services
1	AB- Innovates - Technology Futures	http://www.albertatechfutures.ca/	CAN	AB	4				Yes	Yes	Yes
	(AITF)										
2	AB Innovates Bio Solutions	http://bio.albertainnovates.ca	CAN	AB		Yes					
	(AIBS)										
3	AB Biomaterials Development Centre	http://www.albertabiomaterials.com/	CAN	AB					yes	yes	yes
	(ABCD)										
4	Agri-Food Discovery Place	http://www.afdp.ualberta.ca/	CAN	AB				yes			
5	Decortication Plant	http://www.albertatechfutures.ca/	CAN	AB					yes	yes	yes
6	Bio Conversions Network	http://www.bcn.ualberta.ca/	CAN	AB			Yes				
7	Lipid Program	http://www.lipid.ualberta.ca/	CAN	AB				yes			
8	Olds College Centre for Innovation	http://www.oldscollege.ca/research-innov	CAN	AB				Fibre testing Closed			
9	SAIT Green Building Lab	http://www.sait.ca/research-and-innovati	CAN	AB				Yes			
10	Teckle Technical Solutions	http://www.ttsfpl.com	CAN	AB				Yes			yes
11	Advanced Materials Canada	http://www.afmcanada.ca/	CAN	BC	no			Yes			
12	Fibre City	http://www.fibrecity.ca	CAN	MB				Yes			
	Composite Innovation Centre	http://www.compositesinnovation.ca/							Yes	Yes	Yes
	(Fibre City is part of CIC)										
13	National Research Council of Canada	http://www.nrc-cnrc.gc.ca/eng/rd/aquatic/	CAN	ON	6			Yes	Yes	Yes	
14	Genome Prairie	http://www.genomeprairie.ca/project/curr	CAN		Yes		Yes				
	TUFGEN (Completed)	www.tufgen.ca	CAN								
	(Total Utilization of Flax Genomics)		Various Locations				Yes				
15	Biolin	http://www.biolin.sk.ca/	CAN	SK				Yes			
16	SK Ministry of Ag, Strategic Research Chair	not in place yet	CAN	SK			Yes	Yes			
	in Bio Process Engineering										

In the United States, flax fibre research is being conducted at North Dakota States University.

US R&D in Flax Fibre											
	Company	Website			Multiple Locations	Funds R&D	Does R&D	Does Applied R&D	Supports R&D	Supports Commercialization	Provides Bus & Tech Services
1	Flax Institute, NDSU	http://www.ag.ndsu.edu/plantsciences/fl	US	ND			Yes	Yes			
2	Department of Mechanical Engineering, N	http://www.ndsu.edu/me/faculty/ulven.ph	US	ND			Yes	Yes			

7.3.7 Flax Fibre Processing Companies

There are currently six flax straw processing companies operating in North America. One company is Alberta may eventually process flax fibre and another company in Alberta could potentially process flax fibre.

Straw Processing Facilities in North America

	Company	Website			Other Countries	Plant Size	Feedstock	Straw Supply	Products Produced	Other
1	BioComposites Group	http://www.ttsfpl.com/biocomposit	CAN	AB			Wood Chips		Fibre mats	will eventually use ag fibre as well, part of Teckle
2	Hart Fibre Trading	no web site	CAN	AB			Hemp	Textile Scrutching		
3	Decortation Facility	http://www.albertatechfutures.ca/	CAN	AB		1 T/Hr	Bast Fibre		Fibre Samples	
4	Stemia	no web site	CAN	AB		10 T/Hr	Hemp, Flax & Canola		Mats, Building Panels	Cylab International is Chinese owner, still getting finar
5	Crailar Flax Fibre	http://www.crailar.com/	CAN	BC	Belgium, S Carc	127 T/Wk	Flax	Contracts with US Growers	for US paper industry or Crailar in Europe	uses tech licensed from NRC, SC plant not operating
	was Naturally Advanced Technologies		US	SC						
6	FlaxStalk	http://www.flaxstalk.ca	CAN	MB	Yes, but not fla	100,000 Tor	Flax	purchase 90 to 100,000 tonnes annu	Fibre & Shives	At Carmen and portable
7	Stemergy	http://www.stemergy.com/	CAN	ON			Hemp & Flax		Bio-fiber Materials	can't tell if operating
8	Biolin	http://www.biolin.sk.ca/	CAN	SK		3 T/Hr	Flax		fibre and shives	plant at Elstow

7.3.7 Flax Fibre Value Added Processing Companies

The following companies are adding value to processed flax fibres in Canada.

Canadian Flax Fibre Value Added Processing Companies										
	BioPref	Company	Website	Country	State/Prov	FeedStock	Straw Supply	Products Produced	End-user of Product	Other
1	Appl	Genics	http://www.genicsinc.com/	CAN	AB	Ag fibres, mostly flax		Biodegradable wrap for poles	utiliy poles	
2		Synermulch	http://synermulch.com/	CAN	AB	Flax fibre		Hydroseeding of dust suppressent	road work etc	
3		FlaxStalk	http://www.flaxstalk.ca	CAN	MB	Shives	Carmen	Flax Shive Blend, FlaxBed, FlaxFill, FlaxFlour, FlaxMulch, Flax70Blend	Livestock producers, gardeners	
4		Flax Farm	https://www.facebook.com/Fla	CAN	ON	Flax Fibre		Flax Bedding	Animal owners	
5		Biolin	http://www.biolin.sk.ca/	CAN	SK	Flax Shives	Own Plant	Bedding	Pets	
6		Blue Goose Bioref	www.bluegoosebiorefineries.c	CAN	SK	"Brown pulp, kraft pulp, dissolving cellulose, recycled paper, pulpmill screening rejects, cotton linters, hemp and flax bast fibers"		Cellulose nanocrystals, microcrystalline cellulose, lignan, hemicellulose		
7		Pela Case	http://pelacase.com/	CAN	SK	Flaxstic		Cell phone cases	Consumer	formerly Open Mind Developments

The following companies are adding value to processed flax fibres in the United States.

US Flax Fibre Value Added Processing Companies										
	BioPref	Company	Website	Country	State/Prov	FeedStock	Straw Supply	Products Produced	End-user of Product	Other
1	Yes	Enviro Textiles	http://www.envirotextile.com/	US	CO	Hemp, some Flax		Have upholstery material with some flax	Manufacturers, Consumers	
2	Yes	Georgia Pacific	www.gp.com	US	GA	Flax fibre and Tencel (wood chips)	Flax fibre from Crailar	Brawny Industrial (only Flax), Brawny Industrial F800 Wiper, Brawny Dine-a-cloth and Brawny Industrial Wiper (flax and Tencel)	Consumers, Businesses	are mills in OR, FL, and LA
3		RheTech	http://www.rhetech.com	US	MI	Could use flax fibre		*FF:* Flax Fiber Reinforced Polyolefin Compounds	Manufacturers	doesn't make biocomp with flax fibre but could, has product
4		C2Renew	http://www.c2renew.com/	US	ND	Blend of flax fibre, flax shive, wood flour, sunflower hull, DDG, soybean hull, oat, hull, sugar beet pulp	Shives from SWM	Biocomposites	Sprayer boom (AGCO), Parts for JD, Honda, Bobcat	Chad Ulven's company
5		Flax Tech	http://flaxtech.us/	US	ND	Flax Fibre		Sediment retention devices, erosion control products		
6		SWM	http://www.swmintl.com/	US	NJ	Flax Tow	Carman	low ignition propensity paper	Cigarette Manufacturers	
7	Yes	e2e Materials Inc	http://www.e2ematerials.com/	US	NY	Soy Flour, Flax, Jute, Kenaf		biocomposite materials		Subsidiary makes skate board

7.3.8 Flax Fibre Bio-Energy Companies

The following companies produce products from flax that are used for bio-energy. Please note that Flax Energy recently went out of business.

	Bio Energy Flax Product Manufacturers								
	Company	Website	Country	State/Pro	Operations in Other Countries	Biomass	Products Produced	End-user of Product	Other
1	Flax Power	http://thepowerlog.com	CAN	MB	no	flax shives	flax fire log	Consumers	
2	Flax Energy	http://flaxenergy.ca/	CAN	ON	no	flax	biodiesel	Rogers Centre, Steam Whistle Brewery	also makes flax oil, flour, seeds,
3	Titan Clean Energy	http://www.titan-projects	CAN	SK	no	uses wood, flax etc	heat logs, bricquettes, compost	Consumer, Towns	processing at Craik
									new biomas plant in Prince Albert