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Canadian Lentil Market, Supply Chain and Lentil Suppliers and Processors' Qualitative Interview Results - EVOLVES Technical Report



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Executive Summary

Introduction

Saskatchewan is the primary producer of lentils in Canada, accounting for 90% of Canadian production, and is also a major global lentil contributor. Saskatchewan's exponential lentil production is attributed to trials and research for pulse research and development as well as to Saskatchewan's favorable climatic conditions for lentil production compared to most parts of Canada (Nakuja, 2016). Per soil zone and province, Saskatchewan has the greatest lentil adoption rates.

Currently, there is a gap between identifying the major trends within the planting, processing, and manufacturing lentil industry and consumer behavior and consumption. Understanding the connection between changing consumer preferences and how the upstream and downstream players within the supply chain are reacting to them carries significant implications for the success and opportunities of Canada's lentil industry.

Objectives

Our main research goal was to obtain a comprehensive description of the current Canadian lentil and lentil-derived products industry. Our research questions focused on exploring the global and Canadian market trends for lentils, lentil- and pulse-derived products, market opportunities and challenges, as well as on processors' and suppliers' perception of the growing markets for health-oriented and plant-based food products. We investigated processors and suppliers' plans to respond to expanding pulse markets, as well as their vision in terms of new developments in lentil processing and new food product R&D. Last, but not the least, with the goal of refining lentil and pulse breeding efforts, we identified processors and suppliers' opinions with regards to lentil/pulse attributes that would be important in future market trends.

Methodology

First, we carried out a thorough review of the literature of the Canadian and international lentil and pulse market, detailing production, consumption, exports, processing companies, supply chains, as well as the most sought-after or promising lentil attributes. This information adds context to our previous GE3LS research work carried in both AGILE and EVOLVES projects on lentil growers, professional agronomists, consumers, breeders and IT developers, and also contributes to a comprehensive description of the current Canadian lentil and pulse industry.

Then, to evaluate lentil suppliers and processors' opinions, we selected semi-structured interviews (SSI) conducted via telephone. The administered survey targeted companies and individuals early within the lentil and pulse supply chain to recognize the willingness to map out reactions to changing sources of information and the different valuation structures of other players within the industry, including buyers and consumers. Each respondent was tasked with responding to approximately 20 questions in total; however, this differed per individual based on the semi-structured topical variance nature.

Major Findings

- Canada is the world's largest lentil producer, retaining between 33-50% of world production, thus Canada's lentil production drastically impacts the global market and availability.
- The five-year average (2016/17-2020/21) of Canada's price per tonne for lentils averaged year-to-year decrease of 3.4%. However, the number of acres dedicated to lentils sustained an 2.9% year-to-year expansion, while the year-to-year production averaged an 4.1% increase.
- Saskatchewan has between 18-30 pulse primary processing companies, as well as various storage, handling, and cleaning plants. Per province, Saskatchewan is home to the most lentil cleaning, handling, and processing facilities, whereas Ontario controls the highest number of lentil exporting businesses.
- Canada currently has a minimal number of domestic lentil facilities (~7) that manufacture lentil flours and by-products such as protein concentrates; Canadian consumers rely on importing these goods from countries with greater food and ingredient manufacturing capabilities.
- Canadian consumers are very receptive to changing consumer diets and flexitarian ideas. An estimated 10% of the population follows vegan or vegetarian habits, and others are searching for ways to reduce daily meat intake (Charlebois et al., 2018).
- There is a significant consumer opportunity for lentil and pulse development in Canada as Canadian consumers have some of the highest pulse consumption levels across developed countries.
- Interviewees' pool varied widely, from lentil and pulse growers to processors, food manufacturers, wholesalers, or exporters. Thus, responses reflected various opinions depending on the participants' positioning on the supply chain and the characteristics of their final product.
- When asked which lentil' attributes they think buyers value from their products, when referring to the full lentil, interviewees indicated visual aspects such as overall appearance, colour, uniformity, cracks, broken pieces, or lack of stones. Regarding lentil ingredients, numerous answers referred to protein content, low-fat, health, and nutrition attributes as most desirable attributes.
- Regarding their sources of information about lentil market trends, talking to buyers around the province and communicating with farmers, business partners and friends from the industry are major sources of information for the interviewed producers. Pulse Canada, Saskatchewan Pulse Growers, Canadian Special Crops Association, Protein Industry Canada and Saskatchewan Food Innovation Center also represent an important source of information.
- A majority of the respondents stated that currently they do not contact lentil or pulse breeders. Some interviewees know that breeders communicate and work closely with farmers, and that there is communication with the breeders through various industry channels.

- When respondents were asked about lentils' positioning compared to other pulses, most of them believe that both they and their buyers/consumers categorize lentils together with the other pulses in terms of nutritional qualities, taste, or protein content.
- With regards to the current state of health-oriented and/or plant-based food products markets, a majority of those interviewed believe that these markets are currently expanding and that the EU and US markets are expanding fast in terms of products trends, initiative, and volume, while Canada is a trend follower.
- At a national level, a few respondents pointed out that Pulse Canada's "25 by 25" strategic plan and Protein Industry Canada's (PIC) plan "The Road to \$25 Billion" are the main strategies that address the expanding markets for health-oriented and/or plant-based food.
- Most of the respondents believe that at a global level new pulse/lentil processing and new food products R&D are going to further develop in the next years.
- Some suppliers and processors believe that environmental and sustainability claims are important for consumers, even though they may not be responsible for driving up the market value.
- A majority of respondents suggested that marketing the plant-based patty as a separate product as opposed to 'false beef' or 'beyond beef' would have been their preferred option.
- With regards to the current challenges they encounter, interviewees' responses converged towards the need to increase the number of acres cultivated with pulses and the difficulties brought by increased input costs and current inflation. Logistics problems were mentioned numerous times by respondents involved in different stages of the supply chain.
- Lentil and pulse product diversification, better strategies for commercialization and 'adding value to lentils' close to the production place were brought up as opportunities to increase the efficiency and profitability of the lentil and pulse industry in Saskatchewan.
- When asked what long-term trends lentil and pulse breeders should be aware of, respondents brought up improvements related to lentils' visual attributes (e.g., size, colour, thickness), intrinsic characteristics (protein availability and digestibility), and the stringent need of varieties that are resistant to root rot and other soil borne diseases.

1. Introduction

Lentils are a pulse crop that is part of the Leguminosae family. The plant is a nitrogen-fixing, self-pollinated, short plant (25 to 75 centimeters in height) with moderate resistance to high temperature and drought. The plant requires only 15 to 25 centimeters of moisture (Saskatchewan Pulse Growers, 2022 [1]). It is a cool season crop that requires minimal nitrogen fertilizer (lentils still require phosphorous, potassium, and sulfur) and produces one or two seed pods. Based on these attributes, the growing of lentils is best adapted to Saskatchewan's Brown and Dark Brown soil zones but has shown the adaptability to grow in the Thin Black and Black soil zones (Nakuja, 2016).

Lentil seeds break down into categories and subcategories as follows: **Red-3** categories (extra small (3), small (11), large (2)), **Green-4** categories (large (2), medium (5), small (4), extra small (1)), and **Specialty-3** categories (French green (3), green cotyledon (5), Spanish brown (2)). Through field trials, university research and development have successfully expanded red and small green lentil production into areas historically inappropriate for lentil growth (Saskatchewan Pulse Growers, 2022 [1]), such as the Dark Brown and Thin Black soil zones.

As will be discussed throughout this summary, Saskatchewan is the primary producer of lentils for Canada and globally, accounting for 90% of Canadian production. Saskatchewan's exponential lentil production is attributed to trials and research for pulse research and development and Saskatchewan's favorable climatic condition for lentil production compared to most parts of Canada (Nakuja, 2016). Per soil zone and province, Saskatchewan has the greatest lentil adoption rates.

2. Legume and Lentil Production, Importation, and Exportation

Global legume production, including lentils, peas and fababeans, increased from 33.8 million tonnes in 2000-2009 to 55.6 million tonnes in 2010-2019 (FAO, 2022). Worldwide production of lentils has increased more rapidly, from roughly 850,000 tonnes in 1961 to 6.5 million tonnes in 2020 (FAO, 2022). Since 2015 production has further increased due to changing consumption habits and increased incorporation of manufacturing of lentils into finished consumer products. As shown in Table 1, within the past five years, worldwide production has averaged nearly 6.5 million tonnes (Clancey, 2020), with a yearly increase of 2.31%. Global trade of lentils has subsequently expanded as the level of production has grown, averaging 3.3 million tonnes and increasing yearly by 0.99% (Clancey, 2020).

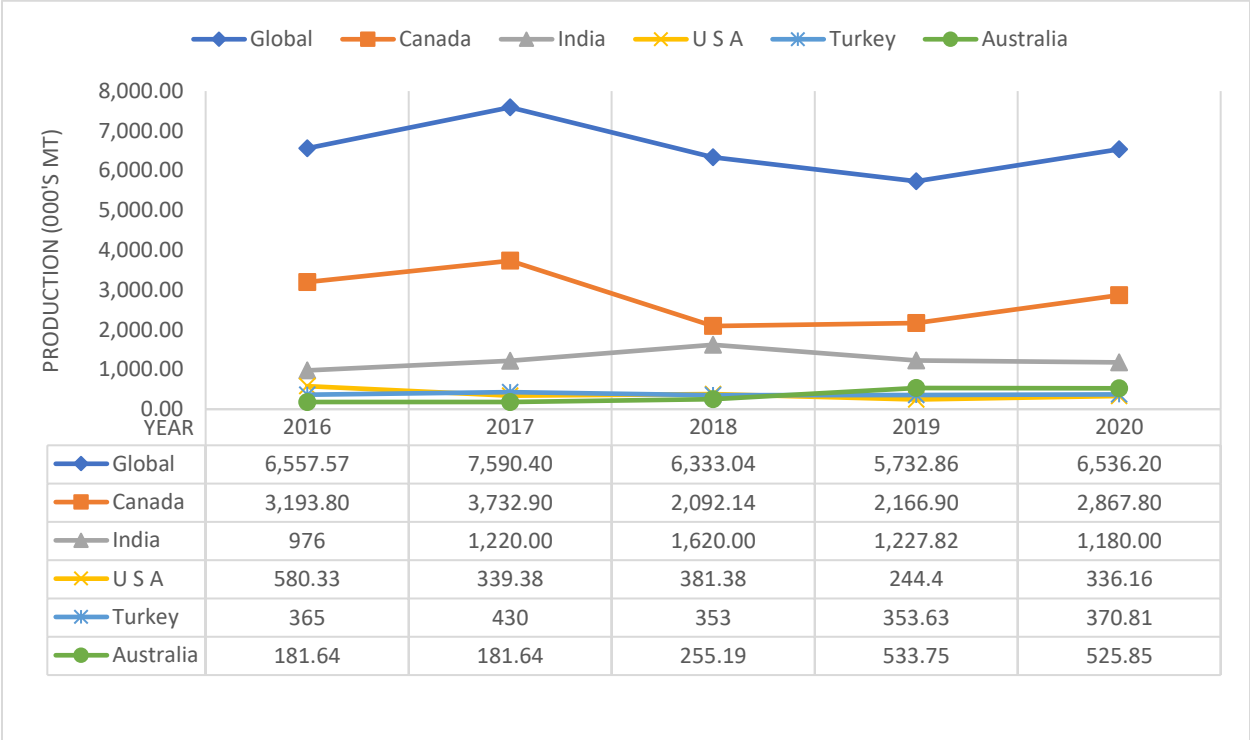
Table 1. Global Lentil Production and Trade

Global Supply and Demand	2015	2016	2017	2018	2019	2020	Average
Production (Metric Tonnes)	6,204	8,291	6,813	5,743	5,556	6,372	6,521
Trade (Metric Tonnes)	3,568	3,212	3,562	3,144	3,095	3,285	3,316
Global Production Growth Year to Year		33.6%	-17.8%	-15.7%	-3.3%	14.7%	2.3%
Global Trade Growth Year to Year		27.4%	-14.8%	-5.5%	-7.1%	4.9%	1.0%

Compiled Source: Clancey (2020), Government of Saskatchewan (2014-2022) Statistics Canada (2022), FAO (2022)

Canada is the primary producer of lentils worldwide, with over 90% of Canadian production occurring within Saskatchewan (Nakuja, 2016). Canada began growing lentils in 1973 and has continued to increase production from 969 thousand tonnes grown between 1980-1989 to 22.2 million tonnes produced between 2010-2019, exhibiting Canada’s importance to the global production of lentils (FAO, 2022). Figure 1 details Canada’s extensive contribution to global production over the past five years. Canada consistently ranks as the largest producer, and the years of more significant production, such as 2016, 2017, and 2020, represent global years of increased crop production. However, 2018 and 2019 showed decreased production due to the India export situation, early-season lack of moisture, and lowered prices (Government of Saskatchewan, 2021); as a result, these years indicate a lessened global production.

Figure 1. Top 5 Lentil Producing Countries



Source: FAO (2022)

Since 2016 Canada’s global production shares ranged from 33% to 50%. India ranked second, with production shares of 14.88%-25.58%. Turkey has always been in the top five lentil-producing countries, with 5.57%-6.17% global production shares. No other country consistently appeared within the top five of lentil production each year. Recently, Australia emerged as a more prominent lentil-producing country, increasing production shares from 4.03% in 2018 to 9.31% and 8.05% in 2019 and 2020. Another growing market is Kazakhstan, which has begun to threaten Canadian exports to Turkey, and whose lentil production has outsized other pulses (Pratt, 2018).

Table 2. Top 5 Lentil Production of Global Shares

Country	2016	2017	2018	2019	2020	Average
Canada	48.7%	49.2%	33.0%	37.8%	43.9%	42.5%
India	14.9%	16.1%	25.6%	21.4%	18.1%	19.2%
U S A	8.8%	4.5%	6.0%	4.3%	5.1%	5.7%
Turkey	5.6%	5.7%	5.6%	6.2%	5.7%	5.7%
Australia	2.8%	2.4%	4.0%	9.3%	8.0%	5.3%

Source: Compiled from Clancey (2020), Government of Saskatchewan (2014-2022) and Statistics Canada (2022)

Table 3 shows measures of the 10-year variance the Canadian lentil supply undergoes yearly. For instance, Canadian lentil production has a roughly 3 MMT range on a year-to-year basis within the analyzed period, similar to the relatively equal variance for harvested acres, i.e., it has roughly 3 million acres difference on a year-to-year basis. One factor relying on production is the number of lentils exported annually, ranging by roughly 2.5 MMT on an annual export basis. The price per tonne also has an extensive range within the past ten years, with the maximum doubling the minimum, which may suggest price pressures throughout the supply chain, especially for growers. Lastly, lentil imports, which Canada does minimally (1.87% import/production rate) compared to exports (86.39% export/production rate), have only a variance of 89, 000 MT within the past ten years.

Table 3. Summarizing Canada’s Lentil Descriptive Statistics from 2011/12-2020/21

	Harvested Acres (‘000 Acres)	Production (‘000 Tonnes)	Imports (‘000 Tonnes)	Exports (‘000 Tonnes)	\$/Ton
Minimum	2,483	1,574	9	1,148	405
Maximum	5,488	4,594	98	3,582	894
Range	3,005	3,020	89	2,434	489
Median	3,867	2,461	43	2,162	521
Mean	3,784	2,615	49	2,259	578

Source: Government of Saskatchewan (2014-2022)

Table 4 illustrates that the past five years of lentil statistics are more significant in numerical value than the previous five years, referring to the production volume by numerical value and ranking it from greatest to lowest. Breaking down each category, the previous five years (2016/17-2020/21) have 5 of the top 7 years by measurement of harvested acres, 3 out of 5 top years in production, 4 out of 5 top-ranked years in imports, 3 out of 5 top years in exports, and 3 out of 5 top years in \$/tonne. These values suggest that the most significant years for Canadian lentils occurred within the last five years. One of the reasons for the 2016/17 increased values may be the attention drawn to lentils during the promoted “International Year of the Pulse” in 2016. A second reason for focusing on the last five years includes political and economic strife caused by tariffs seen throughout the agri-food industry and the impact on supply chains, e.g., Indian tariffs on Canadian lentils and the price per tonne reacting accordingly for the 2018/19 year. Otherwise, the previous five years have been among the highest-priced over the past ten years.

Table 4. Statistically Ranking Canada's Past 10 Years by Numerical Value

Rank	Harvested Acres	Production	Imports	Exports	\$/Tonne
1	2016/17	2012/13	2016/17	2012/13	2015/16
2	2017/18	2016/17	2019/20	2020/21	2016/17
3	2020/21	2020/21	2020/21	2019/20	2020/21
4	2012/13	2017/18	2012/13	2016/17	2014/15
5	2015/16	2015/16	2018/19	2014/15	2019/20
6	2018/19	2019/20	2017/18	2015/16	2017/18
7	2019/20	2013/14	2015/16	2018/19	2012/13
8	2014/15	2018/19	2014/15	2013/14	2013/14
9	2013/14	2014/15	2011/12	2017/18	2018/19
10	2011/12	2011/12	2013/14	2011/12	2011/12

Source: Government of Saskatchewan (2014-2022)

Since 2016/17, Canada has averaged about 2.6 million tonnes of lentils produced (Statistics Canada, 2022), increasing by 4.11%. Canada is also the largest exporter of lentils since 2016/17 (Statistics Canada, 2022), typically exporting 2.2 million tonnes per year, or roughly 85% of domestic production. Globally, Canada's lentil exports have grown by 5.78% yearly, representing about 52% of the world's lentil exports on average. Further analysis indicates that most acres dedicated to lentil production are for red lentils (69-70%) compared to green lentils (28-29%) (see Appendix, Tables 19-22). Additionally, red lentils receive slightly enlarged year-to-year production increases and experience more significant exports as a percentage of production and year-to-year export growth.

Table 5. Canadian Production and Exports from 2016/17-2020/21

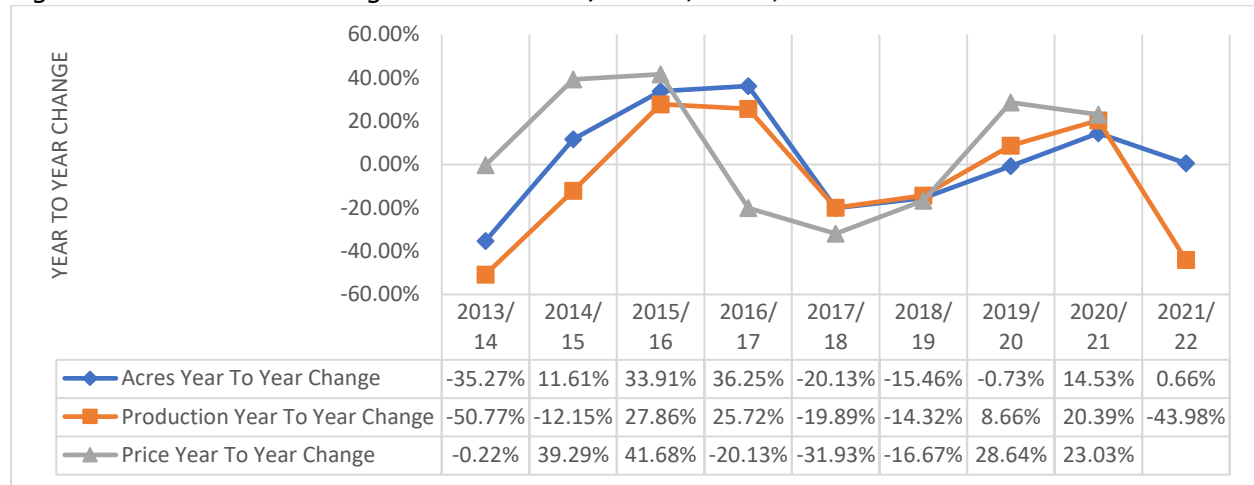
Canadian Supply and Demand	2016/17	2017/18	2018/19	2019/20	2020/21	Average
Production (000 Metric Tonnes)	3,193.8	2,558.5	2,192.1	2,382.0	2,867.7	2,622
Exports (000 Metric Tonnes)	2,455.0	1,538.0	2,033.2	2,734.8	2,325.0	2,205
Canadian Production Growth Year to Year	25.7%	-19.9%	-14.3%	8.7%	20.4%	4.1%
Canadian Exports Growth Year to Year	14.5%	-37.4%	32.2%	34.5%	-14.9%	5.8%
Global Production Traded	38.7%	52.3%	54.7%	55.7%	51.6%	51.8%
Export Shares of Canadian Production	76.9%	60.1%	92.8%	114.8%	81.1%	85.0%
Canadian Shares of Global Production	38.5%	37.6%	38.2%	42.9%	45.0%	40.5%
Canadian Export Shares of Global Trade	76.4%	43.2%	64.7%	88.4%	70.0%	67.3%

Source: Compiled from Government of Saskatchewan (2014-2022) and Statistics Canada (2022)

Figure 2 identifies price as one reason for year-to-year production discrepancy and significant variance in the yearly amount of lentils Canada produces. Although only partly the reason for the lentil production variance, Figure 2 exhibits the prospect of a relationship between prices per lentil tonne and the corresponding farmer's decision to seed a certain number of acres. However, other factors can and do impact production and seeded acres, including prices of inputs, price of substitute crops, crop rotations, disease, and weather. As the chart exhibits, between 2013/14 and 2020/21, farmers responded positively or negatively to the previous year's price by increasing or decreasing the number of acres sown to lentil crops, thereby increasing or decreasing the yearly production. For example, prices drastically increased in 2014/15 and 2015/16, and the two corresponding years of seeded acres and production saw exponential growth. Contrarily, the 2016/17 and 2017/18 price per tonne decreases, and the subsequently

seeded acres and total Canadian production drop-off, suggesting a substantial relationship between these factors.

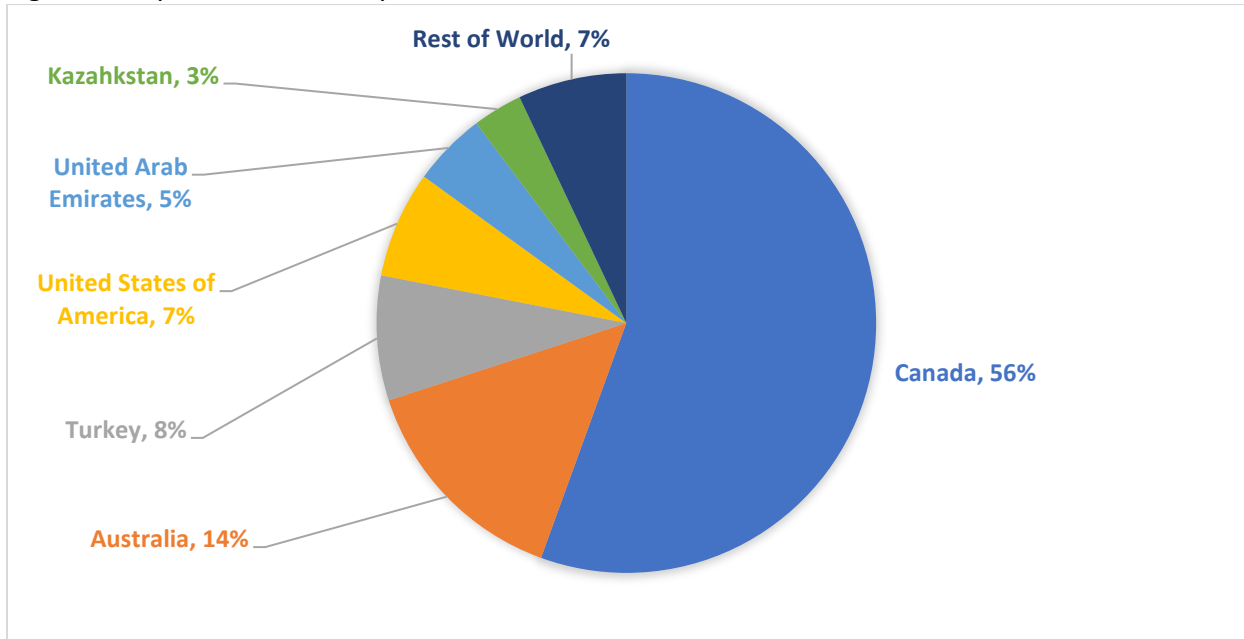
Figure 2. Year-to-Year Changes in Lentil Price/Bushel, Acres, and Production



Source: Compiled from Government of Saskatchewan (2014-2022) and Statistics Canada (2022)

Breaking down the information presented in Figure 3 regarding global lentil exportation, the top 5 exporters account for over 90% of the world's exported lentils (FAOSTAT, 2022[2]). Of these countries, Canada is the world's largest exporter of lentils, accounting for about 56% of globally shipped lentils. Further analysis finds connections between the world's most significant lentil producers and the largest lentil exporters. Australia, the world's 5th largest producer, is the world's second-largest lentil exporter. Turkey, the fourth largest global producer, is also the third largest lentil exporter. While India is the world's second-largest producer it is not in the top 5 lentil exporters - most production remains within the country for processing and consumption to meet domestic needs. As mentioned previously, Kazakhstan is a market to watch. This is due to a meteoric rise through the exporting countries rankings, from being ranked 32nd in 2011, averaging 15th position from 2012-15, before continuously being just outside the top five from 2016-2020.

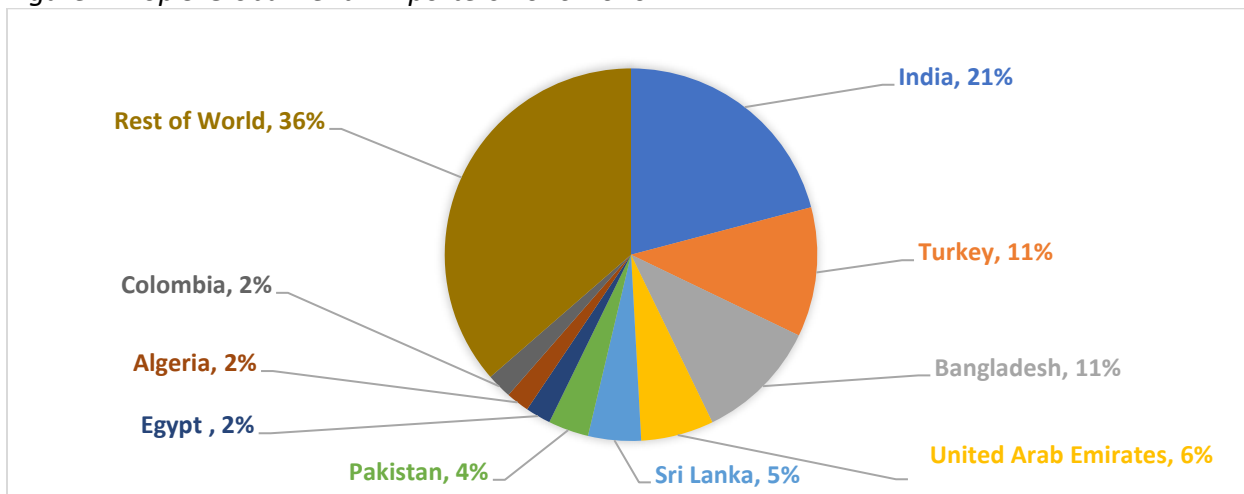
Figure 3. Top Global Lentil Exporters 2016-2020



Source: FAOSTAT (2022[1, 2])

Analyzing the top markets for global lentil imports suggests the top 9 destinations absorb roughly 2/3 of the world's lentil exports over the past five years (Figure 4). India was the top lentil importer during this period, averaging 21% of total imported lentils annually. Turkey and Bangladesh imported more than 10% each. The United Arab Emirates and Sri Lanka round out the top five import markets with 5% or greater share. Egypt should be considered a market to watch as the country has significantly decreased the number of exports within the past two years, falling outside the top 20. Outside the top 9 destinations, the other 36% of imports comprise over 180 other markets.

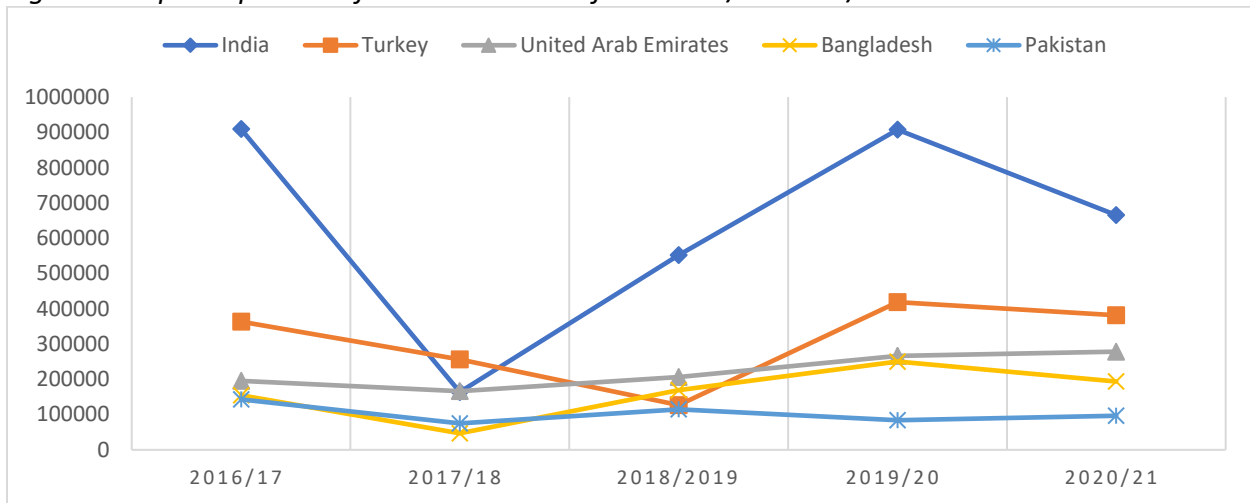
Figure 4. Top 9 Global Lentil Importers 2016-2020



Source: FAOSTAT (2022[1, 2])

Canada has a considerable positive net trade balance for lentils. Figure 5 depicts Canada’s production level and the domestic focus on exporting lentils rather than importation. Turkey, in contrast, is a large lentil-producing country that both imports and exports large volumes of lentils due to its competitive processing infrastructure. The chart elicits interesting results, including the emergence of the United Arab Emirates and Bangladesh as markets for Canadian lentils. During the 2017/18 importing year, India cut imports steeply by levying tariffs on Canadian products, the higher prices for Canadian lentils, and increased domestic production (Government of Saskatchewan, 2019[2]). The second-largest importer of Canadian lentils, Turkey, exhibited a similar dip the following year due to increased market production of lentils from Kazakhstan and increased Canadian lentil prices (Pratt, 2018).

Figure 5. Top 5 Importers of Canadian Lentils from 2016/17-2020/21



Source: Compiled from Government of Saskatchewan (2014-2022)

Table 6 provides additional information to Figure 5 and exemplifies the cumulative top 10 importers of Canadian lentils since 2016/17. These ten countries absorb slightly over 80% of Canada's lentil exports, with eight of ten countries registering single-digit shares of Canadian imports since 2016/17 (Government of Saskatchewan, 2021). India is the largest importer of Canadian lentils, bringing in roughly 30% of Canadian lentil (mainly red) exports since 2016/17. Turkey, a significant exporter of lentils, has been Canada's second-largest import market (red and green), accepting roughly 15% of Canadian lentil exports. The United Arab Emirates is the third-largest importer of Canadian lentils, registering almost 10% of Canadian lentil exports. Bangladesh and Pakistan round out the top five Canadian lentil importing countries.

Three markets to watch include Bangladesh, United Arab Emirates and Colombia. Bangladesh, a large importer of red lentils and a country focused on correcting nutritional lentil deficiencies, represents one of the fastest-growing markets due to inadequate domestic production over the past several years; over the last three years its import share has increased by roughly 5%. United Arab Emirates, also a large importer of red lentils, has seen import shares increase by 4% from 2016/17 to 2020/21. Colombia, a country with rising import shares, has steadily increased the amount of Canadian green lentils imported, expanding from under 2% to over 4% by 2018/19.

Table 6. Importers of Canadian Lentils

Country	Cdn ¹ Tonnes Imported Since 2016/17	% Of Cdn ¹ Tonnes Imported Since 2016/17	Average Tonnage of Cdn ¹ Lentils Imported Per Year
Total Cdn Lentil Exports	11,210,932	-	2,242,186
India	3,196,874	27.0%	639,375
Turkey	1,546,083	13.7%	309,217
United Arab Emirates	1,112,694	10.0%	222,539
Bangladesh	814,224	6.9%	162,845
Pakistan	512,984	4.7%	102,597
Sri Lanka	374,487	3.5%	74,897
Egypt	353,782	3.3%	70,756
Columbia	354,378	3.2%	70,876
Algeria	328,997	3.1%	65,799
United States	292,036	2.7%	58,407
Total	8,886,539	78.3%	1,777,308
Rest (12 Others)	2,324,393	21.7%	464,879

Source: Compiled from Government of Saskatchewan (2014-2022)

Note: 1-Cdn is a shorthand reference for Canadian

3. Lentil Processing

The global lentil market forecasts to increase exponentially as countries push for assets and infrastructure to meet the continued market demand. The International Market Analysis Research and Consulting Group (IMARC, 2021) predicts the global lentil market to exhibit a compound annual growth rate of 11.17% growth and reach 24 million tonnes by 2027. In terms of the lentil protein market, estimates currently place the global value between US\$112 M (Transparency Market Research, 2021) and US\$117.38 M (Maximize Market Research, 2021), with expectations to be US\$181 M by 2030 (Transparency Market Research, 2021).

The lentil protein market is classified into five segments: food processing, animal feed, nutraceuticals, sports nutrition, and infant nutrition. The segments mentioned above produce protein isolates, protein concentrates, and flour, among other products, and is part of the larger pulse ingredients market of US\$21.6 billion in 2023 (Szczebyło et al., 2019). Among the listed segments, food processing is the most valuable destination for lentils, generating 70.5% of the market value; protein isolates are the leading product type, accounting for 46.7% of total market value (Transparency Market Research, 2021).

The pulse ingredients market contributes to manufactured products, including Ready-to-Eat (RTE) foods such as Beyond Burgers. The incorporation of these meals by consumers has enabled the expectations of the plant-based meat sector to increase from the 2021 value of US\$939 M to reach US\$74B by 2027 (Zimmeroff, 2022). Part of the reason for such growth is the North American market, as plant-based food product sales have jumped by 29% between 2019 and 2021 (Zimmeroff, 2022).

Lentil processing is further subdivided into primary, secondary, and tertiary sectors (Joshi et al., 2017; Vandenberg, 2009). Primary processing involves systematic lentil seed processing. This step includes grading, cleaning, and packaging seeds for direct business-to-consumer (BTC) sales

or beginning supply chain transactions between business-to-business (BTB) for further processing. Secondary processing involves splitting, decortication, and polishing of either whole or split seeds using mechanical separation. Tertiary processing represents the final step of the lentil B2B supply chain, involving the grinding, milling, and fractionating whole and decorticated seeds into protein and starch components to be used in the ingredient manufacturing of value-added products.

Tertiary processing includes two methods to break down and isolate protein from the lentil seed: dry and wet protein isolation processing (Joshi et al., 2017; Vandenberg, 2009). Dry protein isolation is the systematic grinding of plant parts into powders, and separating protein and starch based on density. Wet protein isolation involves the dissolution of protein by alkaline solution and precipitating the protein from insoluble materials. Both methods are commonly used, with dry protein isolation the more straightforward but less efficient approach. Both methods fit under the standard pulse processing technique known as extrusion, a thermos-mechanical approach involving high temperature and pressure, resulting in enhanced fibre content, gelatinization, and maintaining natural product colouring (Acquah et al., 2021). Soaking is another well-known pulse processing method, involving drenching pulse seeds with water to reduce the cooking time and any adverse anti-nutritional effects while simultaneously softening the seeds and enhancing the bioavailability of pulse micronutrients (Acquah et al., 2021). For storage and transportation purposes, protein isolate is dried by either spray (high heat), freeze (cold), or vacuum (also low heat) methods. The vacuum drying solution is reported as providing minimal protein denaturation and superior quality compared to the other methods, but the literature is inconclusive (Joshi et al., 2017).

Lentils offer both macro and micronutrient nutrition. The macronutrient composition of a lentil seed consists of about 44-70% carbohydrates (mainly starches, equal to 35-53% of the carbohydrates), 21-31% protein, and 5-27% fibre (Joshi et al., 2017). Table 7 shows that the micronutrients of a lentil seed include iron, magnesium, phosphorous, potassium, zinc, copper, and B9/folate (Divisekara et al., 2021). Macronutrient examination reveals lentils are high protein, fiber, carbohydrates, and low-fat sources. Micronutrient analysis exhibits lentils as a source of phosphorous and potassium but deficient in iron and zinc; micronutrients are currently being examined for biofortification, with more discussion occurring later in this paper.

Table 7. Lentil Macro and Micronutrient Composition

Macronutrient	Content per 100 g of lentils	Micronutrient	Content per 100 g of lentils
Energy (kcal)	324	Iron (mg)	7.1
Protein (g)	25.4	Magnesium (mg)	66
Fat (g)	1.5	Phosphorous (mg)	291
Fibre (g)	17.0	Potassium (mg)	652
Carbohydrate (g)	44.8	Zinc (mg)	3.55
		Copper (mg)	0.41
		B9/Folate (mg)	150

Source: Joshi et al., (2017), Divisekara et al., (2021)

A stylized lentil supply chain is exhibited in Figures 6 and 7. The flow of commodities progresses from breeders and growers to farmers before undergoing various stages of advanced processing to become value-added products. The transformed finished product is then collected and sold from wholesalers to retailers and purchased in different venues by consumers. Figure 6 illustrates that under the primary processing step, lentils that do not undergo further transformation are exported to key markets which have the required infrastructure to add additional value through processing. The lack of domestic refinement facilities in Canada leads to small imports of value-added commodities from nations with more developed supply chains. As shown on Figure 6, this leads Canada to export lentils to the United States, where they are refined at facilities Canada does not currently have, and then re-imported for sale to Canadian consumers. This is an opportunity cost for the domestic supply chain, as the sector currently foregoes local processing.

Figure 6. A Canadian Stylized Lentil Supply Chain



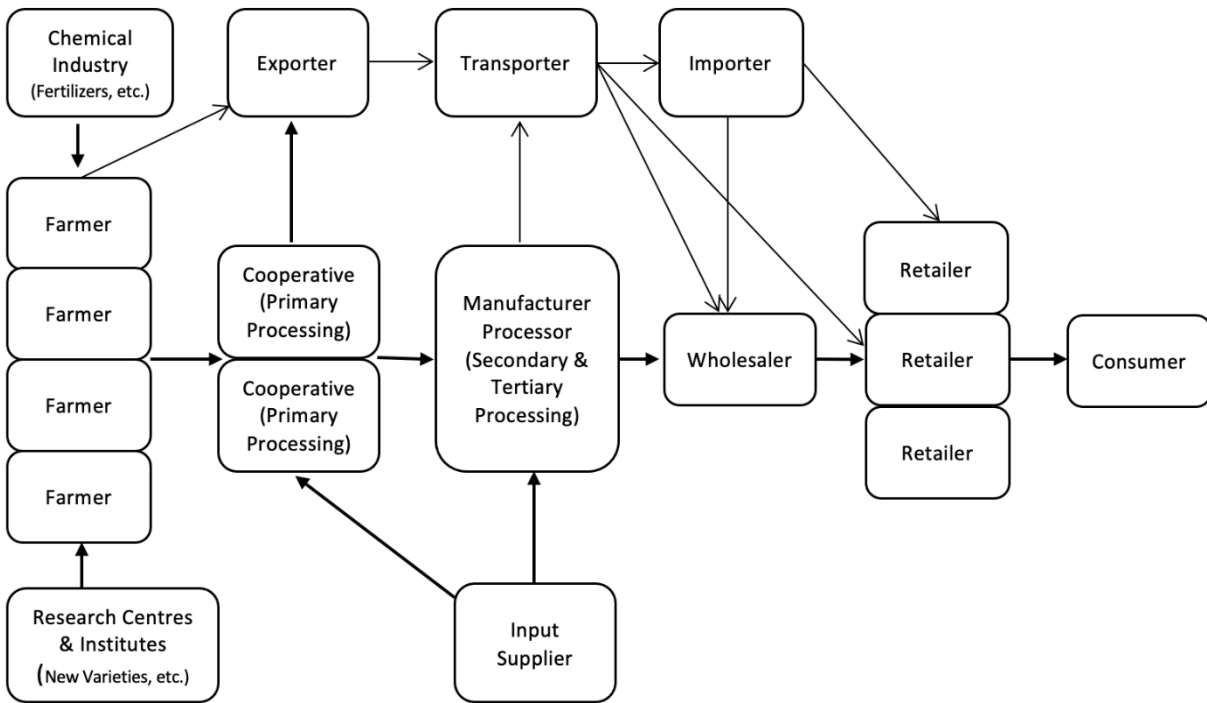
Source: adapted from Hajong et al. (2020)

Rawal and Navarro (2019) outline three supply chain types of the pulse industry, and for the case of this paper, supply chains that can apply to the lentil supply chain. The first and most prominent type refers to the South Asia Value Chain. It refers to the well-developed supply chains in India that contain processing facilities with economies of scale and continually increasing market concentration. The second type, commonly found in less developed nations, is known as the Long Value Chain and is commonly associated with supply chains that contain smaller amounts of products that flow downstream through a considerable number of intermediaries. Lastly, the Short Value Chain, which applies to most developed nations with large-scale production, involves exporting mostly primary processed lentils to countries with additional processing infrastructure.

Examining these definitions of value chains suggests that the Short Value Chain definition corresponds to Canada's lentil supply chain.

Figure 7, adapted from Matopoulos et al. (2007) and Rawal and Navarro (2019), diagrams the primary agri-food supply chain with the pathways outlined by the various types of arrows. For the domestic movement of goods, the diagram is schematized with a thick black line, with input from research centers and the chemical industry providing products for farmer growth and then going through the various stages of processing, wholesaling, and retailing before being purchased via the consumer. The alternate routes along the current Short Value Chain, defined by the thinner arrow-shaped black line, provide a summary of the exportation of commodities without being refined. The flow of commodities takes two varying paths. The first involves the exported commodity remaining within that country for consumption while the second involves re-export of the good after undergoing refinement.

Figure 7. Stylized Lentil Supply Chain

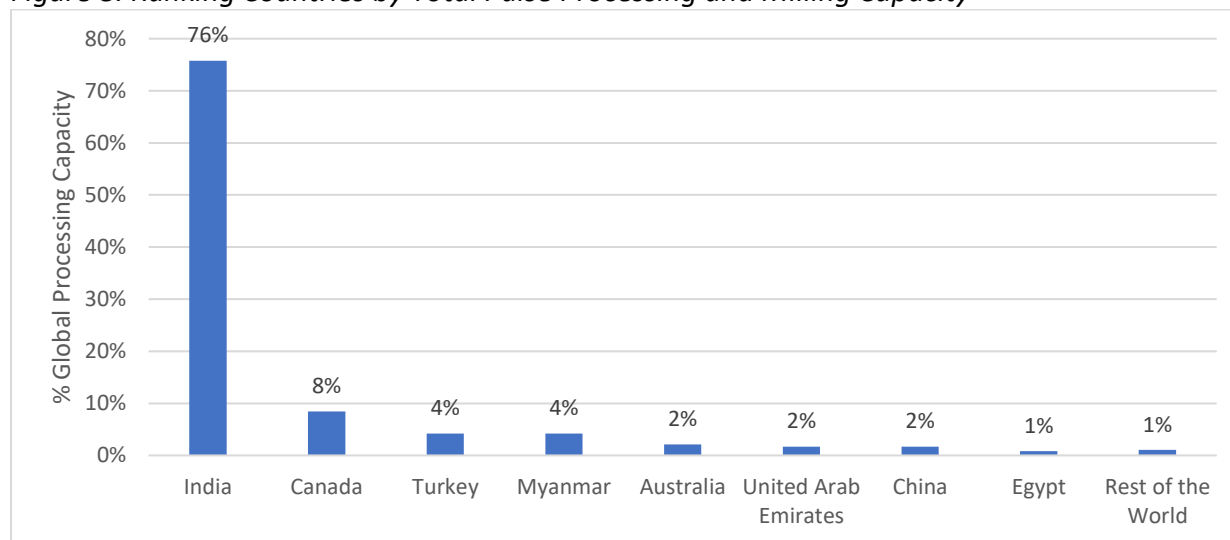


Source: adapted from Matopoulos et al. (2007) and Rawal and Navarro (2019)

Figure 8 outlines the top countries containing the largest global pulse processing and milling capacity as of 2016 (Rawal and Navarro, 2019). This figure encapsulates all processing stages (primary, secondary, and tertiary) discussed earlier in this paper. India controls the most extensive processing capacity, with roughly 76% or 18,000,000 tonnes of the global 23,750,000 tonnes of processing capabilities. Canada ranks second, primarily due to the vast primary processing capacity (2,000,000 tonnes) that focuses on cleaning, grading, and readying the commodity for export in the Short Value Chain. Turkey ranks third for processing capacity

(1,000,000 tonnes), containing more significant concentrations of secondary processing and refining technology than Canada. The rest of the top 8 countries comprise only 11% of pulse processing capacity, including large pulse importing markets such as the United Arab Emirates and significantly developing export markets like Australia.

Figure 8. Ranking Countries by Total Pulse Processing and Milling Capacity



Source: Rawal and Navarro (2019)

Table 8 exhibits Canada’s current structure of lentil businesses based on data collected from Canada’s Special Crops Association, Pulse Canada, Saskatchewan Trade and Export Partnership (STEP), and Saskatchewan Pulse Growers. Cross-referencing between the sources revealed that the different companies engage in a range of supply chain roles. Comparing the data allows for constructing a comprehensive list of mainly Saskatchewan but also Canadian processors, amounting to roughly 32 lentil/pulse-related primary and 7 secondary or tertiary processors.

Table 8. Saskatchewan and Canadian Lentil/Pulse Primary Processing Companies

Website Listed Role	Company Name	Processing Role
Cleaning/ Handling (CSCA)/ Primary (GoS)/ Supplier (STEP)/ Processor	ADM Agri-Industries Company (Multiple SK Locations)	Primary Processing
	Adriot Overseas (5 SK Locations)	Primary Processing
	Agrican International	Primary Processing
	Agrocorp Processing (2 Locations)	Primary Processing
	AGT Food and Ingredients	Secondary or Tertiary Processing
	Avena Foods	Primary Processing
	Belle Pulses LTD	Primary Processing
	Best Cooking Pulses Inc.	Secondary or Tertiary Processing
	Broadgrain Commodities	Primary Processing
	Canmar Grain Products LTD	Secondary or Tertiary Processing
	Condie Seeds	Primary Processing
	Diefenbaker Spice & Pulse	Secondary or Tertiary Processing
	ETG Commodities	Primary Processing
	Etter Seed and Processing LTD	Primary Processing
	Growers International Organic Sales INC	Primary Processing
	Infraready Products LTD	Secondary or Tertiary Processing
	JK Milling Canada Limited	Primary Processing
	K2 Milling LTD	Secondary or Tertiary Processing
	McCracken Grain Solutions LTD	Primary Processing

Natural Specialty Crops Co ULC	Primary Processing
North West Terminal LTD	Primary Processing
Northern Quinoa Corp	Secondary or Tertiary Processing
Parrish and Heimbecker Ltd	Primary Processing
Prairie Heritage Seeds Inc	Primary Processing
Prairie Pulse Inc	Primary Processing
Purely Foods Canada Corp	Primary Processing
Rein Agri Food Corp	Primary Processing
Rudy Agro Ltd	Primary Processing
Schluter and Maack Canada Ltd.	Primary Processing
Scoular Canada Ltd	Primary Processing
Seaboard Special Crops	Primary Processing
Simpson Seeds Inc	Primary Processing
Southland Pulse Inc	Primary Processing
Stonehenge Organics	Primary Processing
Sunrise Foods International	Primary Processing
Three Farmers Foods	Primary Processing
Victoria Pulse Trading Corp	Primary Processing
Veikle Grain Ltd	Primary Processing
Westland Agro Ltd	Primary Processing

Source: Combined Canadian Special Crops Association (2022), Saskatchewan Pulse Growers (2022) [2], Government of Saskatchewan (2019[2]), Saskatchewan Trade and Export Partnership (2022)

Part of the research task encompassed identifying businesses related to the domestic lentil industry and determining whether they are located near production sites or closer to larger consumer centers. Tables 9 and 10 exhibit varied information sources; both data sets show Saskatchewan has the most cleaners and handlers and the most processors, evidence that primary processing and handling concentrate closer to production. However, the number of companies involved with lentil export diversifies by source. Canada's Special Crops Associations (CSCA) reports the exporting companies are located around centers with ports and coastal provinces. In contrast, the Saskatchewan Pulse Growers (SPG) reports most exporters are based in Saskatchewan. This could result from two reasons. First, SPG may define those who arrange shipments to ports as exporters, although they may not be directly responsible for the international shipment. Second, many exporting business are not headquartered in Saskatchewan – e.g. Adroit Overseas and Broadgrain Commodities – they yet own Saskatchewan processors that arrange shipments to export position.

Table 9. CSCA List of Canadian Lentil Businesses

Province	# Cleaning and handlers	%Per province	# Processors	%Per province	# Exporters	% Per province
SK	7	30%	11	46%	9	20%
QUE	2	9%	1	4%	2	5%
ON	4	17%	5	21%	17	39%
AB	2	9%	2	8%	1	2%
BC	3	13%	4	17%	8	18%
MB	5	22%	1	4%	7	16%
Total	23		24		44	

Source: Canadian Special Crops Association (2022)

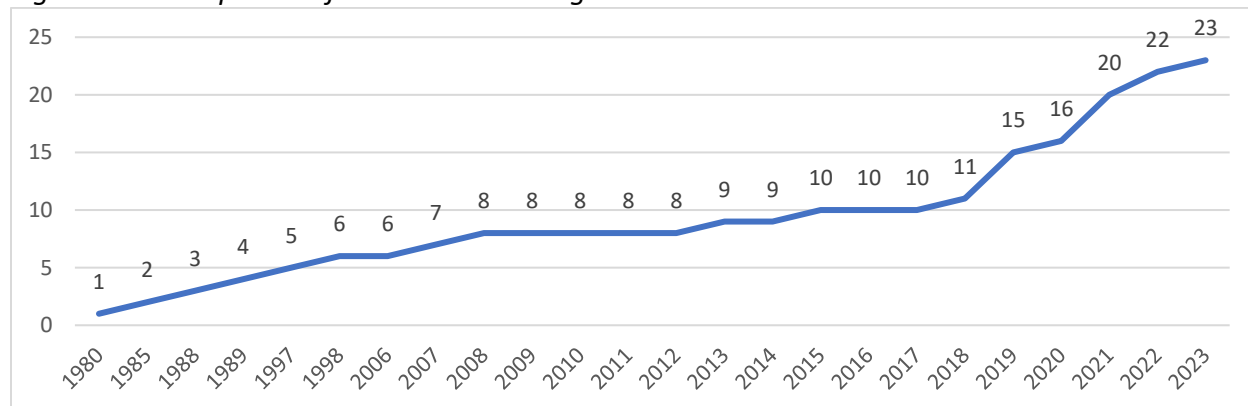
Table 10. Saskatchewan Pulse Growers List of Canadian Lentil Businesses

	# Of Lentil Businesses	# Of Exporters	# Of Processors	# Of Organic Buyers	# Of Organic Processors	# Of Organic Exporters
BC	10	8	7	3	1	1
CDN %	15.2%	17.4%	20.6%	16.7%	11.1%	7.7%
AB	6	4	0	2	0	2
CDN %	9.1%	8.7%	0.0%	11.1%	0.0%	15.4%
SK	29	20	18	10	5	8
CDN %	43.9%	43.5%	52.9%	55.6%	55.6%	61.5%
MB	11	5	6	3	3	2
CDN %	16.7%	10.9%	17.6%	16.7%	33.3%	15.4%
ON	10	9	3	0	0	0
CDN %	15.2%	19.6%	8.8%	0.0%	0.0%	0.0%
CDN Total	66	46	34	18	9	13

Source: Saskatchewan Pulse Growers (2019)

Although sources slightly vary, Figure 9 represents the domestic development of Canada's pulse ingredient processors sourced from Saskatchewan Pulse Growers (2022, [2]). SPG estimates 23 Canadian pulse ingredient processors by 2023, including Merit Functional Foods and Ingredion. The number of domestic pulse processors has effectively doubled within the past six years as the concentrated focus from the 2016 “year of the pulse” highlighted certain advantageous benefits of pulses contrary to other crops. Protein Industries Canada’s Sector Roadmap targets \$25 billion in sales by 2035 while Pulse Canada targets to develop new markets for 25 percent of Canadian pulse production by 2025.

Figure 9. Development of Canada’s Pulse Ingredient Processors



Source: Saskatchewan Pulse Growers (2022, [1])

Canada is just starting to incorporate secondary/tertiary lentil protein processing and food manufacturing domestically for the lentil supply chain. As outlined throughout this report, Canada’s concentration has focused on the Short Value Chain, with primary processing as commodities and quick export to India, Turkey, and West Asian countries, which have more processing experience (Rawal and Navarro, 2019). Compared to the other top 5 lentil producing countries, domestic Canadian milling capacity is vastly outsized by Turkey, a country that both

focuses on importing and exporting lentils, and India, a country that mainly concentrates on importing lentils for the large vegetarian population (Vandenberg, 2009). India’s milling capacity contains an estimated minimum of 7,000 (Ilyas and Goyal, 2005) and 14,000 (Rawal and Navarro, 2019) small pulse dhal (dehulling) mills. Although these mills are quite labor-intensive (but are modernizing), they still substantially outstrip Canada’s capacity (Ilyas and Goyal, 2005). Other countries with notable milling capacity (and high-ranking importers of Canadian lentils) include the United Arab Emirates (third largest importer), Sri Lanka (sixth largest importer), Egypt (seventh largest importer), and Syria (outside of the top 10 importers) (Vandenberg, 2009). These large volume importing countries with larger lentil milling capacity appear to have a comparative advantage over Canada in secondary processing, perhaps partly due to greater familiarity with the product and market.

To date, Canada has minimal milling and commodity production. In 2022, Statistics Canada estimated lentil production to be around 2.1-2.5 MMT, slightly under the five-year average, with approximately 425,000 tonnes of domestic production earmarked for Canadian use (J. Courcelles, personal communication, March 29, 2022). This is focused on seed stores, feed, canning, consumption, and ingredient processing, though, as mentioned above, Canada's domestic ingredient processing is regarded as minimal.

Pulse Canada reports approximately 4-5 small-scale millers (process lentil flour) and two companies produce lentil protein concentrates (J. Courcelles, personal communication, March 29, 2022). However, as Table 11 shows, the Canadian International Grains Institute lists seven lentil millers, with the majority in Saskatchewan, close to where most lentils are cleaned or processed. The recent agreement between AGT Food and Ingredients of Regina and Ulivit will further increase the level of domestic processing of fava bean, lentil, and pea protein concentrates (Research and Markets, 2020), indicating further potential market growth. This cooperation between companies aligns with the 2017 Pulse Canada target of developing new markets for 25 percent of Canadian pulse production by 2025 (Pratt, 2018) – equal to two million tonnes of pulses, including 1.1 million tonnes of peas and 625,000 tonnes of lentils.

Table 11. Canadian Lentil Flour Companies

Province	Company	% Per province
Saskatchewan	AGT Foods, Canmar Grain Products LTD., Diefenbaker Seed Processors LTD., InfraReady Products LTD., Northern Quinoa Corp.	71%
Manitoba	Best Cooking Pulses, Inc.	14%
Ontario	K2 Milling LTD.	14%

Source: Canadian International Grains Institute (CIGI) (2019)

There are multiple end-uses for pulses. Even though domestic secondary processing of products does not occur within Canada, some exported production returns to Canada as value-added, refined goods. Table 12 exhibits the finished goods of the three primary forms of pulses grown within Saskatchewan, with most commodities refined into a snack, pasta, or bread food-labeled category. Compared to meat products, Siva et al. (2019) list weight loss, diabetes prevention, and protein enhancement as the main properties the refined commodities contain that benefit consumers.

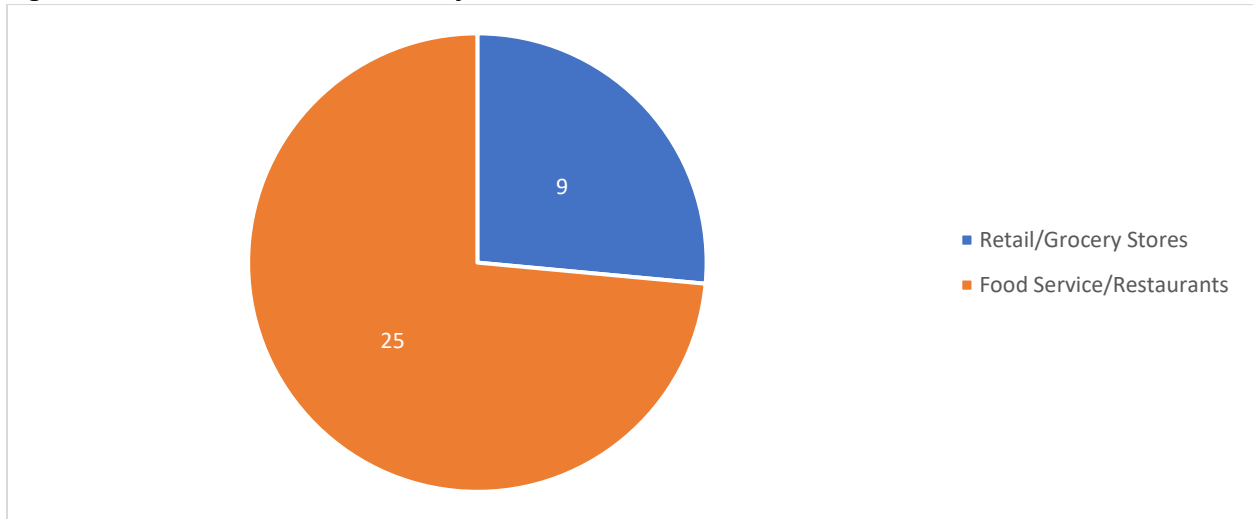
Table 12. Pulse End Use, Specific Bioactive, and Functional Properties

Pulse	Pulse Ingredient	Food Products	Bioactive Properties	Functional properties
Pea	- Pea flour - Protein concentrate - Protein isolate	- Pasta - Breads - Crackers - Extruded snacks - Cookies - Cereal bars - Muffins - Baby food formulations	- Weight loss (low glycemic index products) - Muscle gain food supplements - Prevention of type 2 diabetes	- Technological properties - Microencapsulation of probiotic bacteria in infant formula
Lentil	- Lentil flour	- Pastas - Breads - Crackers - Extruded snacks - Cookies - Cereal bars - Cakes - Muffins	- Weight loss (low glycemic index products)	- Microencapsulation of lipophilic compounds - Emulsifying and foaming properties
Chickpea	- Chickpea flour	- Gluten-free bread - Baby food formulations	- Protein enrichment - Products suitable for consumers with celiac disease	- Emulsifying and foaming properties

Source: Siva et al. (2019)

From wholesalers, marketing plant-based products to consumers is through two different systems. The first stream is composed of 9 Canadian retail and grocery stores that provide lentil and plant-based products to consumers. This list contains both large multinational chains including Costco Wholesale Canada, Walmart Canada, Sobeys Inc, Loblaw's Companies, and smaller, more localized stores such as Farm Boy and Organic Garage. The second stream encompasses 25 restaurant and food service businesses with the list involving larger, well-known franchises such as A&W, Boston Pizza, Starbucks and Tim Hortons, along with less known, regional stores such as Odd Burger, Copper Branch, and "Fresh" restaurants. Between the two streams, there are 34 franchises involved in the retail and food sales of plant-based products in Canada, with the vast majority being available in food service settings. Both streams provide greater accessibility to plant-based food products for Canadian consumers whether the consumption location is inside or outside of home.

Figure 10. Retail and Food Sellers of Plant-Based Products



Source: Report from Natural Products Canada, Humane Society International, Protein Highway, and Protein Industries Canada (2022)

4. Lentil Consumption

World consumption patterns indicate that lentils and pulses, though beginning to trend upward over the last decade, have decreased from levels seen 100 years ago, but this varies by region and country. Melendrez-Ruiz et al. (2020) reported that pulse consumption levels in France were 1.7kg/person in 2016, roughly 5.5 kg/person less than the amount consumed in 1920. Acciani et al. (2020) report that the last decade of global pulse consumption has been steady at 12 kg/year. Latin America, Southern Africa, and South Asia have the highest consumption levels, while North Africa, Europe (2.7kg/year), and North America (4.4kg/year) are markedly lower.

4.1 Global Lentil Consumption

There is a limited but growing body of research and evidence that describes the global lentil marketplace.

Table 13 illustrates the geographical summary of larger areas of lentil consumption. India, a country with a population of about 1.4 billion, has about 20-30% eating a vegetarian diet (Kirsch, 2022). Proteins are mainly derived from pulses such as peas and lentils, making it an ideal market for Canadian exports. Other notable regional markets include:

- i) Pakistan – a top 5 global importer of lentils (IndexBox, 2021)
- ii) Bangladesh – Canada’s fourth-largest lentil import market containing a populace dependent on lentils for cultural and dietary reasons (Hajong et al., 2020)
- iii) Sri Lanka – 57.6% of the country’s populace indicated daily consumption of red lentils and 25.3% reporting eating lentils at least twice per day (Ariyawardana et al., 2015)
- iv) Turkey – the second-largest global lentil importer with residents consuming 5 kg per capita of lentils (USDA, 2016).

Table 13. Geographical Summary of Larger Areas of Lentil Consumption

Lentil Description	Lentil Commercial Form	Consuming Regions
Red	Whole (with seed coat)	Southeast Asia
	Dehulled Football	Southeast Asia, Middle East Notable Markets: <ul style="list-style-type: none"> • India • Nepal • Bangladesh.
	Dehulled Split	Southeast Asia, Middle East Notable Markets: <ul style="list-style-type: none"> • Sri Lanka • Turkey
	Whole (with seed coat)	Europe, South/ North America, Africa, Asia
Green	Dehulled Split	Europe, North America

Source: Siva, Thavarajah, and Thavarajah (2018)

Paffarini et al. (2021) report on Italian purchasing behavior of lentils trends. Only 12.21% of Italians reported lentil consumption at least once every three weeks and the rest of the sample reported less than monthly consumption. However, the research concentrated on organically focused purchase groups, finding that the average respondent reported purchasing 7 kg/year of lentils, with 6 kg being organic. The frequency of low consumption is further affirmed by Jallinoja et al., (2016), that found lentils were the fourth most popular pulse in Finland, with 37% of Finnish respondents reporting no lentil consumption, 24% reporting yearly, 22% a few times a year, 7% monthly, 7% two or three times per month, and only 3% reporting weekly lentil consumption. Comparably, Warne et al. (2019) reports small but increased lentil consumption habits among American consumers: 24% report lentil consumption as a regular part of their diet (more than once per week), 56% reportedly consume lentils weekly, and 20% report consumption frequency several times per year.

4.2 Canadian Lentil Consumption

Multiple Canadian results report relatively equal pulse and lentil consumption, but the sources indicate greater cooking and utilization of these products over the past decade.

- Charlebois et al. (2018) estimated that over 6.4 million Canadians plan to reduce or eliminate meat consumption, with 32.2% of surveyed Canadians acting on reducing their meat consumption within the next six months.
- Mintel (2018) confirms these reports, finding that more than half (53%) of Canadians say they eat meat alternatives, including one in five (18%) who claim to eat them at least a few times a week.
- Mudryj et al.'s (2012) research reported that on any given day 13% of Canadians consume pulses, of which 5.3% of the 13% report consuming lentils. Consumption in western developed nations at 3-5 kg/capita is far less than that of developing countries (10-40 kg/capita).
- However, Ahmadi (2021) reports that the percentage of Canadian people who consumed legumes increased from 6.2% in 2004 to 10.4% in 2015.

- Masuda (2018) lists red and brown lentils as the fourth and fifth most popular pulse choice, combined making up 14% of the consumption, finishing behind chickpeas, black beans, and kidney beans.
- Malik (2019) reports that 63% of surveyed students consume pulses weekly, and 86% of respondents have at least tried pulses, with the majority consuming beans (48%), chickpea (26%), peas (16%), and lentils (15%).
- Phillips (2011) reports the following frequencies of Canadian pulse consumption: never or rarely (21.7%), 1-3 times per month (44%), 1-2 times per week (24.5%), 3-4 times per week (7.3%), 5-6 times per week (1.4%), once a day (0.5%), and two or more times per day (0.5%). Focusing on lentil consumption elicits lower frequencies, with 58% never or rarely consuming lentils and only 42% of individuals with regular consumption: 1-3 times per month (31%), 1-2 times per week (9.2%), 3-4 times per week (0.8%), 5-6 times per week (0.5%), once a day (0.5%), and two or more times per day (0.3%).
- FAO (2022) reports that Canada's pulse consumption per person was about 8.34 kg in terms of kg consumed, which is markedly less than Szczybyło et al.'s (2019) estimates, which ranked Canada as having the most significant pulse consumption among all developed countries at 12 kg/year, ahead of America (4.2 kg/year) and Europe (2.6kg/year).

4.3 Consumer Preference and Value for Pulses and Lentils Globally

Multiple experiments provide context to how lentils are independently valued and associated attributes.

- De Boer et al. (2013) found that lentils were the second most popular snack food (30%) among Netherland trendsetters, finishing vastly ahead of seaweed (12%) and insects (4%) but behind hybrid snacks (part meat, part meat substitute).
- Melendrez-Ruiz et al. (2019) found pulses (10%) were the least likely component of French respondent's overall dish composition, finishing behind vegetables (tomatoes, carrots, zucchini, green beans, and broccoli) (38%), meat, fish, poultry and eggs (27%) and starches (25%). Lentils were, however, the most chosen pulse component.
- Contrarily, Bugera et al. (2013) found a significant purchasing likelihood among Canadian Baby Boomer consumers, with 83% reporting they would definitely or probably would buy tomato lentil pasta sauce.
- In terms of willingness to pay (WTP), many experiments provide measurements for individuals' value of lentils compared to competing products. Lemken et al. (2017) found that German consumers exhibited WTPs between \$0.20 and \$0.24 more for pulse than conventional wheat products. Bugera et al. (2013) found that Canadian consumers exhibited a WTP of \$4.38 for Tomato Lentil Pasta Sauce, which was \$0.34 above the commercially available price. Men were willing to spend \$0.69 more than women.

The results vary for what attributes consumers find most valuable.

- Ariyawardana et al. (2012) found that lentils' visual quality and color outweighed the importance of size, packaging, and price.

- Govindasamy et al. (2014) demonstrated that consumers with increased incomes place higher importance on the country of origin, similar to results from Acciani et al. (2020) and Marette (2021).
- Acciani et al. (2020) and Marette (2021) found that the country and origin, such as being locally produced or organic, increased the WTP to pay for lentils to varying degrees. When products were conjointly locally produced and organic, Marette (2021) found a WTP increase of \$1.45 compared to conventional lentil products.
- Unlike Marette (2021), Acciani (2020) found only marginal differences between the increase of WTP when lentil products were organic (\$1/kg) or locally produced (\$1.1/kg) compared to conventional lentil products.
- Viewing other food labels, Lemken et al. (2017) found no singular claim that provided consumers with the most value within the research. Instead, consumers exhibited the largest WTP when pulse products contained a mix of health benefits (high in protein and fiber) and environmental claims (carbon dioxide emission reduction, reduced mineral fertilizer).
- Apart from food labels seen on products in North America, Paffarini et al. (2021) found quality labels only defined in the EU as the most influential factor in their research, as consumers exhibited a WTP equal to 1.90€.

As of 2010, IPSOS-Reid (2010) reported lentils as the fourth most favorite pulse option among Canadian consumers. Even though most Canadian individuals list the main reasons for pulse consumption in 2010 as tasting good, health-consciousness, and being a source of protein or fiber, lentils still face considerable barriers. The barriers include taking too long to cook or not knowing how to prepare pulses/lentils, individuals or family members not liking the taste or texture, and lacking inclusion in cooking habits or usual meals.

Through stated preference questionnaires, IPSOS-Reid lists the order preference as Beans (67%), Chickpea (53%), Peas (52%), and Lentils (41%). Lentil consumption breaks down into the following frequency segments, with consumers reporting lentil consumption four or more times per week (2%), 1 to 3 times per week (15%), 1 to 3 times per month (45%), and less than once a month (38%). Most of the lentils are used in soups, chilis, casseroles, or salads and are generally purchased in bulk, dry, soups, or canned forms.

Research has identified a variety of reasons responsible for increasing consumer acceptability and consumption of pulses, with a specific application to lentils.

- Warne et al. (2019) identifies increasing lentil consumption as due to increased environmental, economic, and health and nutrition information, contrasting lentil and animal-based sources. They identify considerable agreement that lentil products have improved nutrition (88%), help consumers feel satiated or full (85%), and are either locally produced (66%) or certified organic (56%).
- Interestingly, Warne et al. (2019) further studied the variety of lentils consumers favor, finding consumers order lentil varieties based on colour (red/orange, green, brown, black,

and French/green), the brightness of color, size, and percentage of splits as signals of what constitutes a high-quality lentil.

- Masuda's (2018) results offer more profound insight into health and nutrition-based reasoning behind increased pulse consumption. Their respondents were more likely to increase consumption because they perceive pulses have a higher number of vitamins and minerals (85%), reduce the risk of heart disease (78%), reduce the risk of diabetes (74%), and are high in fiber (72%).
- Interestingly, research completed ten years earlier aligns closer with Masuda (2018) than Warne et al.'s findings. The results of IPSOS-Reid (2010) indicate taste, health, and a source of protein/fiber as the main reasons for plant-based consumption, contrary to recent literature, which implies a more significant emphasis on environmental rather than health.
- Unlike Masuda's research, Phillips's (2011) work also suggests that health is a significant component for consumers when purchasing lentils. Phillips (2011) found the top three reasons for consuming lentils include believing 'healthy food is more important to my child's health', 'would like to eat healthier', and believing 'food choices influence child's eating'.

All the above-listed work contributes to the discussion surrounding the decision to consume lentils based on health-risk factors and could carry implications for individuals choosing products based on family consumption.

4.4 Lentil Consumption Barriers

There are a variety of barriers discouraging individuals from choosing pulses or lentils. Research from Malik (2019) suggests choosing to eat something else (31%), my family does not cook them (21%), non-filling (17%), taste (16%), and time (10%) are key. The study also notes that education surrounding lentil products could be a factor; only 44% of surveyed respondents could accurately identify a lentil picture, while the other 56% were incorrect or declined to try. Fewer individuals could correctly identify lentils compared to other pulses (beans, chickpeas, and peas). Phillips (2011) concludes with a list of reasons why individuals avoid lentil consumption which includes: not knowing how to cook/prepare lentils; taking too long to cook; lack of availability of lentil products when dining out; and the individual believing their family would not like lentils. Again, this suggests family and family health play a prominent factor in lentil consumption.

5. Fortified Lentils

Fortified lentils represent an option to address rising food nutrition deficiency. Roughly one-third of the global population suffers from iron deficiency and one-fifth suffers from Zinc deficiency (Podder et al., 2018; Podder et al., 2020; Podder et al., 2021). There are currently a variety of approaches to address the global deficiency, including food fortification, biofortification, supplementation, public health intervention, nutrition education, dietary diversification, and food safety measures (Podder et al., 2020).

Fortification for pulse crops began at the University of Saskatchewan in 2014, a process that provides more Zinc, Iron, or both in the lentil product, depending on the method. For lentils, the food fortification approach implements a whole-food approach (Podder et al., 2021). A solution applied to the lentil surface coats or absorbs the fortifying agent. Following the absorption and coating, canola oil polishes the lentil's exterior, acting as a protective exterior layer. This method uses 50% less solvent than conventional fortification methods, maintains the accepted moisture content, results in greater mg per lentil (Podder et al., 2021), and has the potential to be scaled into medium or large processing production.

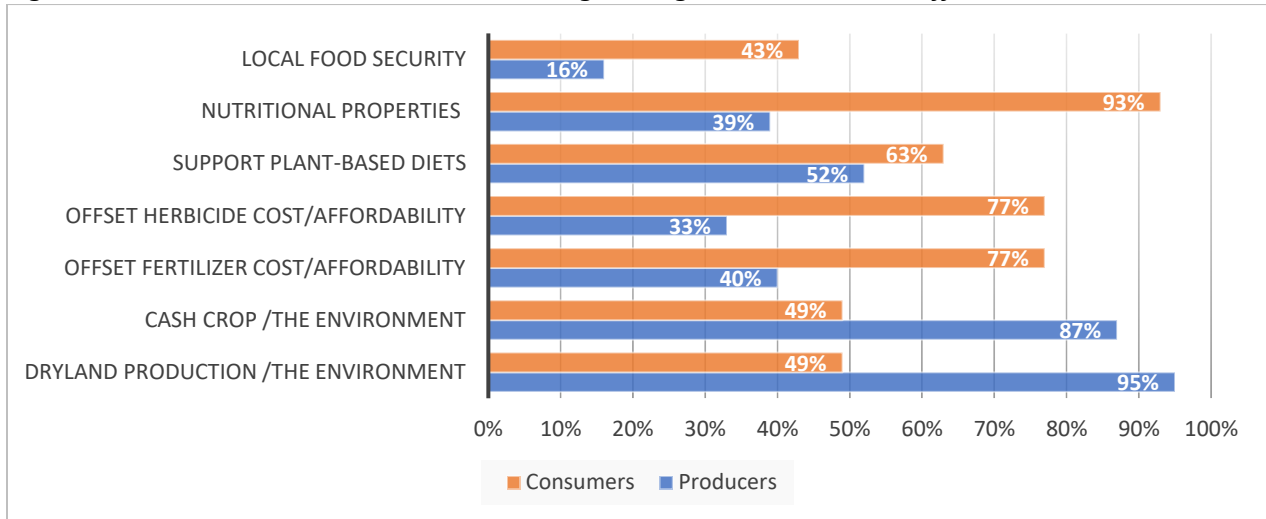
Results from a number of trials for fortified lentils have shown uneven consumer response. Podder et al. (2020) indicated that the dual fortification impact of zinc and lentil did not significantly impact the consumers' sensory characteristics of lentils. There was high acceptability of dual-fortified red lentils. However, unfortified lentils were liked more compared to the fortified versions. Respondents exhibited increasingly adverse reactions towards products that contained progressively more significant concentrations of Iron and Zinc. Podder et al. (2018) found similar results. Iron-fortified lentils did not have impactful adverse effects on respondents. Fortified lentils received better scores for appearance and acceptability among Bangladesh respondents, but fortified lentils were not as well-liked as unfortified versions. The experiment concluded that fortified lentils are a viable and possible economic solution to the global Iron micronutrient deficiency. The downside is that fortification can cause oily smells, a metallic aftertaste, degraded flavor and degradation of both color and vitamins (Podder et al., 2018; Mehansho, 2006).

6. Supply Chain Information Transfer Gaps and Issues

One goal is to explore the transfer of information upstream and downstream throughout the pulse supply chain. The reasoning for researching this is to determine whether the traits and qualities searched by consumers are driving pulse processors, suppliers, or breeders' decisions. The focus is on how pulse processors, suppliers, and breeders make decisions and where they gather information. While a few papers offer hypothetical solutions for how information is transmitted between the different entities within the supply chain, empirical evidence is lacking to support any specific model. Informal discussions with University of Saskatchewan professors and Saskatchewan seed growers confirm this hypothesis. Both groups indicated that competition among actors deterred sharing information and led to an apparent lack of interest in developing new beneficial traits for the pulse food supply chain. The following two figures illustrate the differing perceptions of the lentil supply chain between product origination (producers) and end-users (consumers).

A recent American study revealed common misconceptions throughout the supply chain. Figure 11 illustrates the different viewpoints of producers and consumers about the rationale for growing and eating lentils (Warne et al. 2019). As the figure exhibits, consumers and producers express vastly different views for why we grow (producers) or consume (consumers) lentils. Producers focus on growing lentils because they fit the environment and provide stable cash flow, whereas consumers eat lentils for nutritional properties and affordability. Producers and consumers do agree on one thing: lentils help support plant-based diets.

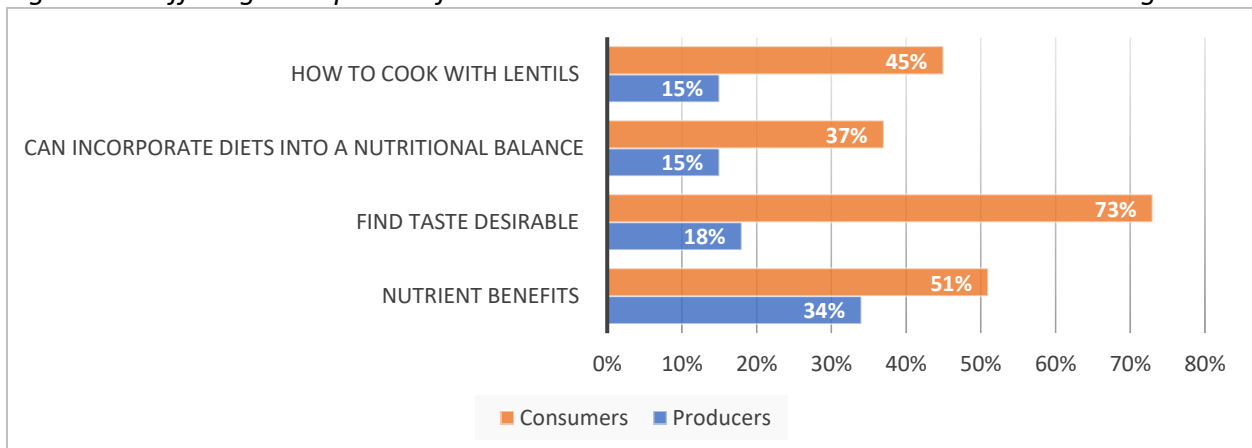
Figure 11. Producers and Consumers Growing/Eating Rationale Lentil Differences



Source: Warne et al. (2019)

Figure 12 further addresses the information gap between producers and consumers. Building upon the rationale of Figure 11, Figure 12 explores the difference in perceptions between 1) what producers believe consumers know about lentil product qualities and 2) what consumers actually believe about lentils. Figure 12 reveals a distinct difference between what producers perceive about consumer knowledgeability and consumers' actual perceptions. Whereas producers perceived consumers would be most knowledgeable about nutrient benefits, consumers instead revealed that they were more influenced by taste and to a lesser extent how to prepare them for eating. Both consumers and producers acknowledged that consumers were least knowledgeable about how to incorporate lentils into a nutritionally balanced diet.

Figure 12. Differing Perceptions of Producer Assumed and Consumer Perceived Knowledge



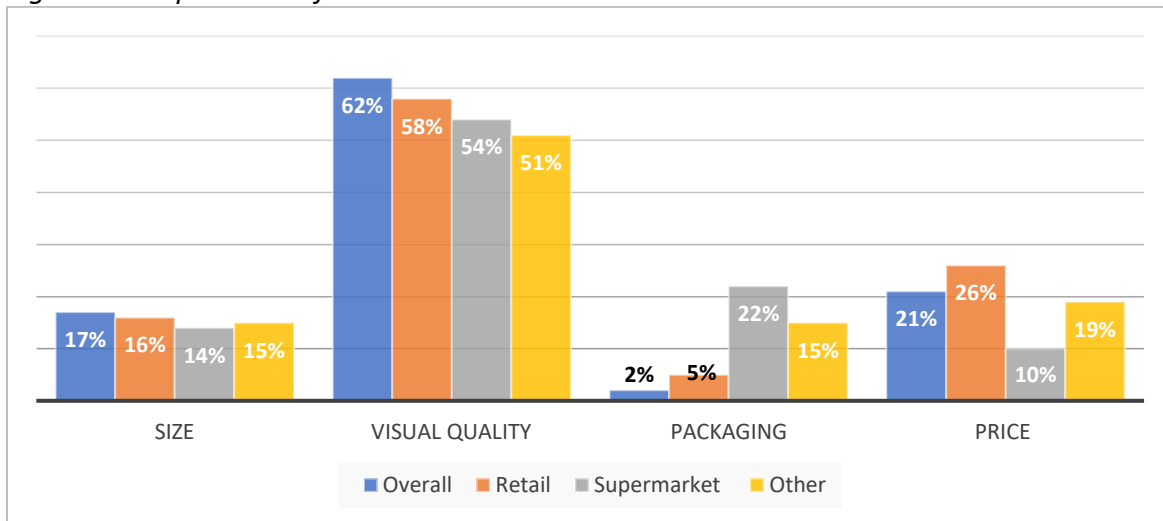
Source: Warne et al. (2019)

Continuing the discussion, we explored the supply chain links between downstream end-users and processors. Canada's agribusiness supply chain can be characterized as having the shape of

an hourglass (Lusk and Wahdat, 2022), with a large number of both farmers and retailers yet a constricted number of processors. Thus, bottlenecking is an issue. The lack of diversification across upstream industries for the lentil supply chain and among processors impairs the flow of information.

Though maintaining a similar hourglass form, Sri Lanka’s lentil industry does not face the same logistical, regional, or comparative production challenges as Canada (Ariyawardana et al., 2015). As shown on Table 13, first, Sri Lankan respondents generally agree that the visual quality of lentils is the most preferred attribute, followed by price, lentil size, and packaging. There is much more consistency of views here. This could result from that lentil inconsistency impacts cooking quality – a trait identified as a barrier to lentil consumption – and visual quality is a key search factor.

Figure 13. Importance of Red Lentil Attributes

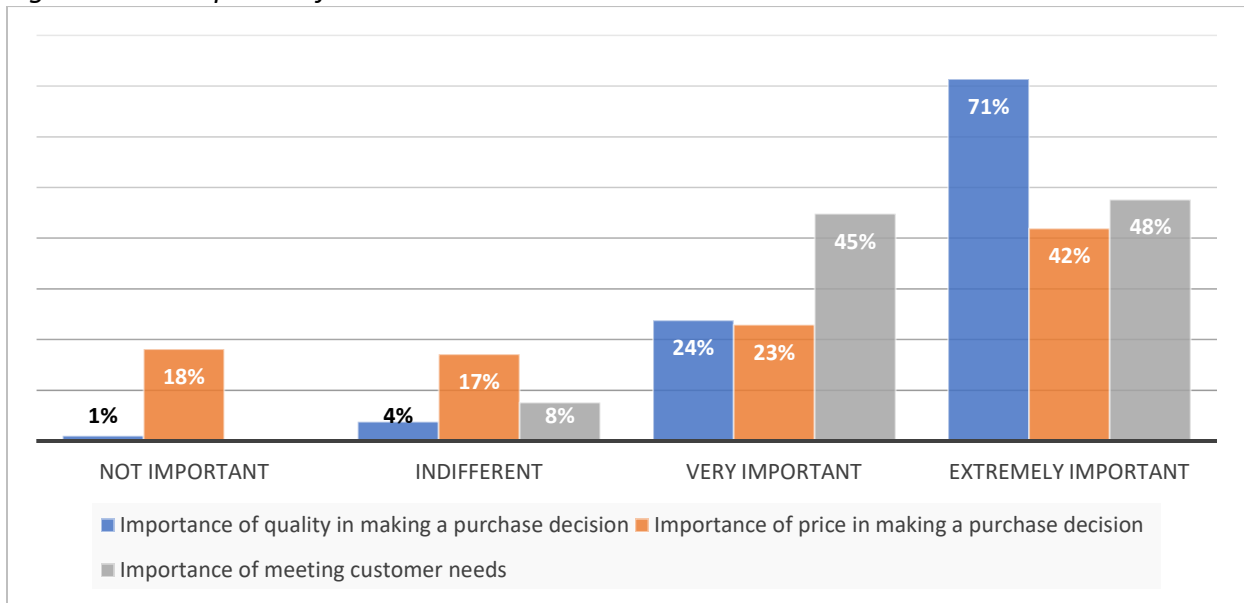


Source: Ariyawardana et al., (2015)

Figure 14 illustrates that wholesalers and retailers in Sri Lanka strongly agreed that visual quality was the foremost important attribute, followed by price. Due to the processors' ability to adapt the size of bulk packaging for shipment to wholesalers and retailers, both industry players preferred selling lentils unpacked. This allows consumers to view the quality of color and texture before purchase, traits identified in this paper as valuable to consumer decision-making.

This focus on visual keys to quality will be important for Canada as it seeks to build upon its globally renowned reputation of good marketability due to outstanding product quality (Gilmour, 2021).

Figure 14. Perceptions of Retailers and Wholesalers



Source: Ariyawardana et al., (2015)

7. Identifying Useful Lentil Traits for Breeders, Farmers, and Processors

A summary article by Gilmour (2021) provides further insight into qualities valued throughout the lentil supply chain, though not necessarily for all lentil processors. First, the article mentioned that the definition of pulse quality has shifted over the past 30 years, with the last decade transitioning focus from aesthetic qualities to traits such as protein concentration and seed coat quality. Gilmour (2021) lists other sought-after lentil traits also include sustainability (country of origin, area of production, pesticide, etc.), food safety, and logistics (quality and timing of delivery). The new two-sided definition of pulse quality addresses the what-it-is (nutritional aspects) vs. how-it-is (how it reacts). However, the article suggests there are common quality attributes for all “stakeholders” of the industry, including pulse performance (starch cooking, gelling performance), functionality and palatability, macronutrient (protein, starches, fiber, fat) and micronutrient accuracy, and denaturation effects. From this list, a few traits can be suggested to be sought-after qualities by companies that process or manufacture lentils, such as the modifications caused by heat (denaturing) and the palatability of the lentil product. One final advantage is provenance. Not only is Canadian origin a very marketable aspect, but the reputation of collaboration between public and private research and high food standards elevates Canada above the competition (Gilmour, 2021). This perception may be tested by responses from Saskatchewan’s processing segment of Canada’s lentil supply chain.

The 2022 EVOLVES conference offers some further insights. A number of designated attributes were labeled imperative to the continued successful production and growth of Canada’s lentil industry by breeders and breeder associates. Jendrashke (2022) identified high protein level as a well-regarded lentil attribute for not only breeders but possibly for processors within the value-added supply chain delivering refined commodities with enhanced nutritional value. Palacios et

al. (2022) specified seed coat thickness, amino acids (tryptophan's, MET, CYS), protein digestibility, glutamates, and color retention within red lentils as characteristics impacting demand from downstream in the supply chain. Remenda (2022) lists other aspects influencing lentils processing ability, including lentil quality (uniform shape and plumpness), lentil shape parameter (height, diameter, plumpness, and circularity), seed coat color retention, seed coat permeability, and phenolic compounds. For example, green seed coat color retention, the seed's ability to maintain "greenness" throughout storage, is imperative to maintaining product value. As green lentils age, the green seed coat color becomes unstable, deteriorating while in storage—potentially caused by the antioxidant properties of phenolic compounds—leading to upwards of 50% profit loss due to consumers' unwillingness to pay for decreased quality (Remenda, 2022). The discoloration of the seed coat could also possibly be the result of the impact of tannins contained within lentils – an anti-nutritional factor (ANF) that can simultaneously decrease lentils' nutritional quality (Hefnawy, 2013).

Table 15 provides a more significant explanation of the bioactive compounds involved in lentil breeding. The compounds provide a vast range of problems, including polyphenolics, lectins, tannins, and trypsin inhibitors, each of which impacts the nutritional capabilities of lentils and pulses, resulting in common consumer barriers. For example, lectins induce bloating, which respondents list as an impediment that mitigates consumer demand for pulses (Henn et al., 2022). Another concern is trypsin inhibitors, which overcomplicate essential amino acids in pulses. Pulses contain fewer amino acids than animal meat, making pulses not as complete a protein; trypsin inhibitors are needed to address this nutrition deficiency.

Table 14. Summary of Lentil Bioactive Compound Definitions

Compound	Description	Benefits/Implication	Adverse Effects
Polyphenolics	-Key group of secondary plant metabolites found in food	-Contain the following properties: -> Antioxidant -> Anti-hypertensive -> Anti-atherosclerotic -> Anti-thrombotic -> Anti-allergic -> Anti-bacterial -> Anti-cancer	- Decreases: ->Bioavailability of certain minerals ->Protein digestibility ->Bioactive peptide absorption.
Lectins	-Sugar binding proteins	- Slows down digestion - Slows down carbohydrate absorption	- Can cause bloating - Can cause blood clotting - Can cause upset stomach
Tannins	-Group of polyphenols	- Provide antioxidant activity	- Decrease energy - Decrease protein digestibility and nutritional value - Negates absorption capabilities of Iron and Zinc -Inhibit the activities of trypsin, chemotrypsin, amylase and lipase
Trypsin and Chemotrypsin inhibitors	-Secondary metabolites -Are the most common class of Anti-Nutritional Factors	-Anti-cancer properties	- Lowers protein digestibility - Lowers Sulphur amino acid quantities -Capable of inactivating the digestive enzyme
Saponins	-Are surface active compounds with detergent, wetting, emulsifying, and foaming properties	-Contain the following properties: ->Reduce the risk of heart disease ->Hypocholesterolemia ->Immunostimulatory ->Anticarcinogenic	- Cause a bitter taste in products - May cause technological disadvantage in processing - Minimize the absorption and utilization of nutrients
Oligosaccharides	-Primarily made of: ->Raffinose ->Stachyose ->Verbascose	- Ease Bowel Movement - Enhances the availability of certain bacteria types	- Cause flatulence and stomach discomfort

Combined Source: Acquah et al. (2021), Hefnawy (2013), Gemedede (2014)

8. Methodology

To evaluate Canadian suppliers and processors of lentil products, we selected semi-structured interviews (SSI) to administer the interview. The administered survey targeted companies and individuals early within the lentil and pulse supply chain to recognize the willingness to map out reactions to changing sources of information and the different valuation structures of other players within the industry, including buyers and consumers. Each respondent was tasked with responding to approximately 20 questions; however, this differed per individual based on the semi-structured topical variance nature.

An SSI is a combination of closed and open-ended questions, followed up by additional questions with the ability to vary into different topics or previously unknown or unforeseen issues (Adams, 2015). There are certain advantages to selecting SSIs against more formal and informal alternatives, including yielding very rich amounts of data allowed by the varied survey structure and multiple administration forms, such as telephone, face-to-face, and the internet (Cachia and Millward, 2011). However, SSIs also contains particular disadvantages, like being a labor-intensive process, lengthy, time-consuming data collection, analyzing large volumes of notes and transcripts, the unlikeliness to encompass a large precision sample, and requiring the interviewer to be sophisticated, experienced, and knowledgeable about the topic (Adams, 2015).

For this study, the conducted survey selected the telephone option. Applying the SSI via telephone allows for multiple benefits, including enhanced accessibility to various businesses without requiring travel (i.e., enhanced opportunity to a larger geographical area), less time and labor cost, communication exclusivity, and quicker survey conduction than face-to-face (Cachia and Millward, 2011). However, choosing the telephone method contains potential issues, such as inaccurate sample representation from lacking telephone accessibility (Mcintosh and Morse, 2015), rescheduling flexibility taking weeks or months to conclude the interview, and the lack of physical presence inhibiting the interviewer's ability to connect with the interviewee and miss specific visual cues evident in face-to-face interviews (Cachia and Millward, 2011).

The administered survey comprised 20 questions separated into four bins of information. Due to SSIs allowing for variation of questions based on the topical nature of the conversation, not every respondent answered the same questions. The survey covered four areas, grouping themed-like questions into sectors, henceforth referred to as bins throughout this paper. Each bin ranged from containing 2-5 questions and capture responses to sections denoted as "Buyer Information," "Sources of Decision-Making Information," "Consumer Value," and "Self-Perceptions, Self-Knowledge, and Market Outlook."

Owners, CEOs, marketing or public relation representatives from 46 Canadian companies were contacted via email and/or phone and asked whether they would be interested in sharing over the phone their professional opinions with regards to the opportunities and challenges of their business in the Canadian and international lentil and pulse market. The EVOLVES research objectives and a quick description of the interview questions were included in the sent emails. Eventually, between July and August 2022, we interviewed 16 people over the phone, which represents 35% of the initial sample of companies we reached out to. The companies contacted ranged from small businesses (with less than 10 employees) to medium enterprises (around 50 employees) to large corporations (more than 100 employees). The companies' profile varied widely from growers/farmers who are also involved in exporting or selling activities to processing or ingredient manufacturing companies, food manufacturers, wholesalers, as well as exporters of lentil, pulses and pulse derived products.

Following best qualitative research practices for SSIs (Jamshed 2014, Elliott 2018), we asked respondents pre-set open-ended questions followed up by 'why' and 'how' questions. We have

chosen this interview format as we wanted interviewees to feel free to discuss ideas, reasons, and experiences as they come up during the interview. Williams (2015) suggests employing semi-structured interviews when wanting to know the independent thoughts of everyone, and on topics where respondents may avoid sharing their thoughts if sitting in with peers in focus groups.

Besides the list of questions for each category of interviewees, based on the paper-based survey results we prepared a framework of themes to be explored and an interview guide (Williams, 2015). Qualitative research theory recommends that a lower number of questions, and implicitly, a relatively shorter interview may insure a higher rate of interview participation. This is why we decided to have four main discussion topics, followed by prospective follow-up questions to be asked by interviewers. During the interview trial runs we estimated that the interview length could be anywhere between 15 to 30 minutes.

According to the literature, when conducting qualitative work, researchers can determine the 'right' sample size once the point of saturation has been reached. Data saturation occurs when no new information is received from interviewees, when similar instances keep repeating and there are no new themes that emerge from interviews (Saunders et al., 2018). When more data is accumulated by increasing sample size, but it does not lead to more information, it is called the point of diminishing returns (Mason, 2010). The data we obtained as of August 31st, 2022, revealed that no new emerging themes were occurring, so we decided to stop interviewing.

Table 16. Topics and Interview Questions

Topic	Questions
Buyer Information	<ul style="list-style-type: none"> • Who is buying from you? (retailers, wholesalers, exporters, processors?) • What lentil/lentil derived products attributes do your buyers value from your products? Which one of these attributes matter the most for your clients? For how long lasts such a trend? Do you think the brand name matter for the final consumer?
Sources of Information	<ul style="list-style-type: none"> • What are your sources of information about lentil market trends each year? Do you do your own research on market trends or final consumers' preferences? • Do you contact lentil/pulse breeders from SK and transmit buyers or exporters' requests about lentils?
Consumer Value	<ul style="list-style-type: none"> • How are lentils positioned on the products market compared to other pulses? Are consumers aware of the nutritious advantages of lentils versus other pulses, or other 'healthy' plant based/protein delivery plants? • Are environmental or sustainability claims (e.g. low carbon versus meat products/other plant-based/protein provider) driving market value? Are consumers actively searching for this info? Would this persuade them to 'switch to' lentils?
Self-Perceptions, Knowledge, and Market Outlook	<ul style="list-style-type: none"> • What is your view about the markets for health-oriented and/or plant-based food products? • What is your vision in terms of new developments in pulse/lentil processing and new food product R&D? • Right now, the plant-based burgers, and in particular the lentils-based ones, are marketed in the patty market as 'false beef' or 'beyond meat'. Would their value be higher if it wasn't marketed against beef? • What are the current challenges/opportunities for your company? How about for Canada when it comes to pulse and pulse-products derived exports? • Do you think the Russia-Ukraine war would have an impact on your business? • Are there any long-term trends that breeders should be aware of beyond what we have discussed already in this interview?

9. Coding

Coding is a fundamental part of the analytical process which allows researchers to break down extensive interview data into categories, themes and nodes and re-organize it and analyze it (Elliott, 2018). Codes are used to label a certain meaning to descriptive or inferential information (Miles et al. 2014) and to reduce information contained in hours of interview transcripts to manageable data. Coding can be done using preset or a priori codes, as well as codes that 'emerge' from the data, often referred to as post priori or emergent codes (Punch, 2014).

Creswell (2013) encourages researchers to utilize both types of coding as emergent coding may contain valuable information needed to refine data analysis. Creswell (2013) explains that 'several codes aggregated to form a common idea' are used to obtain categories or themes. Categories can be further grouped into major concepts (Lichtman, 2013).

In the literature of qualitative research, it is explained that interviews could be coded by hand and/or only then by using specialized software (Elliott, 2018). Further, some authors advocate that interview data should be coded by multiple researchers involved in the project who should attain coding agreement (Miles et al. 2014; Richards, 2015). Thus, in our analysis, with the goal of achieving data reliability, the interviews were coded by hand first using a-priori codes and emergent codes by the research lead as well as by the research assistant; both researchers followed the coding agreement. The a-priori codes were obtained from our previous GE3LS research.

10. Data analysis

Structuring qualitative data results obtained from ample interviews can be challenging. While quantitative research methods are employed to find out the frequency or duration of certain behaviour (Sutton and Austin, 2015), qualitative research methods reveal attitudes, beliefs, and motives and explain why and how these behaviours occur (Castleberry and Nolan, 2018). Therefore, the focus of our findings will not be on responses' frequency, even though sometimes this should be mentioned when analyzing data, but on why and how respondents' stories develop, their reasoning, attitudes, observations, and needs. Quantitative and qualitative methods each have strengths and limitations and can easily polarize researchers on opposing views about which one brings most knowledge with regards to the research questions. However, when used together by researchers aware of their individual shortcomings, they enrich findings (Chiang et al. 2015). A growing body of literature confirms that using both quantitative and qualitative research methods increase research results' reliability and understanding (Johnson and Onwuegbuzie 2004, Anderson 2010).

Further, the qualitative research literature abounds in examples and recommendations to present findings, rather than results, and "findings should be written as if a story is being told; as such, it is not necessary to have a lengthy discussion section at the end" (Sutton and Austin, 2015). This is the reason why, unlike quantitative methods, qualitative research findings should not be generalizable to an entire or specific part of a population (Castleberry and Nolan, 2018). In addition, qualitative research literature recommends that when presenting qualitative research findings, to use and select interviewees' most poignant and representative research statements (Anderson 2010). These quotes should be relatively short and cleaned up of repetitive statements as well as of information that may lead to identifying the interviewee.

Many qualitative research authors do not recommend drawing/writing conclusions after performing data analysis, as the researcher may give an unintentional, and perhaps different twist to interviewees' story, but rather report and briefly discuss the findings. They suggest allowing interviewees' 'voices' to get through to the reader using their own words. In this context,

we included in this report the most representative quotes of the interviewees. This means that we included quotes that show interviewees converged, or unique points of view, as well as contradictory statements. We ‘cleaned up’ the quotes of repetitive words and expressions, and of any hints or information that may lead to interviewees identification. For the same reason, throughout the report, we use the pronouns ‘he’ or ‘she’ or ‘he/she’ – ‘his/hers’ completely randomly.

10.1 Who is buying from you?

Interviewees responded they sold to lentil and pulse growers to processors, food manufacturers, wholesalers, or exporters. Further, some respondents explained that their company has one or multiple roles such as grocery retailers, food manufacturers, exporters, processors, distributors, end-users, ingredient manufacturers, or wholesalers. Depending on their business category, some respondents stated that they sell only pulses or lentils, or both lentils and lentil-derived products, while others acknowledged that they sell to most of the categories listed. As a result, the responses obtained reflected an abundance of opinions which differed depending on the participants’ positioning on the supply chain and the characteristics of the final product.

10.2 What lentil/lentil derived products attributes do your buyers value from your products? For how long lasts such a trend? Do you think the brand name matter for the final consumer?

The next question was related to products’ attributes, trends, and brand name. First, interviewees were asked which lentil’ attributes they think buyers value from their products. As expected, the answers varied as they were referring to products’ attributes for lentils, lentils ingredients or both. When referring to the full lentil, the attributes valued referred to type of grade, type of lentil as well as visual related aspects (overall appearance, colour, uniformity, cracks, broken pieces, lack of stones, etc.).

Regarding lentil ingredients, respondents pointed out attributes such as protein levels (high or low), as well as attributes related to the functionality of ingredients. Numerous answers converged towards the protein content, low fat, health, and nutrition as desirable attributes. Some respondents further detailed attributes they consider important such as starch, gelatinization, protein denaturation, enzyme inactivation, and in-vitro digestibility. A couple of interviewees detailed the differences in the attributes valued by consumers depending on the colour of the lentil and the country or area of export.

[...] it’s more to do with overall cleanliness and quality of the product, so just that there’s not a bunch of damage actually, the MRL levels, so pesticides, herbicides, you know, desiccants, like all of those types of things that could be applied to the product tend to be more important. And some sustainability type things are starting to pop up more, we’re getting a little bit more questionnaires in terms of that in terms of: is it sustainability? So, I would say those are more the factors that our current customers are looking for. [...]

[...] The people that buy these products are primarily looking for something that is clean and looks attractive. And the seed coat thickness has nothing to do with it, that is something that's uh sought by the guy that's doing the processing. You should make a better margin if your seed coat weighs less, you lose less money to the seat coat that's all that's about. In terms of appearance, you want them to be as red as possible, without needing to use a bunch of polishing aids - oil. [...]

[...] I think we here, a lot of interest in the value, like the nutritional value of the protein for Canada's lentils and my sense is that the lentils have a really strong reputation globally for the quality of Canadian products. So, I think that they benefit from the perception that Canadian brand around high quality, sustainably produced crops. So, the nutrition factor is probably the number one sort of attribute that I can think of. [...]

[...] they're looking at protein, they're looking at fiber [...] they also love being a Canadian forward facing brand, it's very exciting for consumers that we are literally grown and manufactured right here in Canada; so, the fact that we're like the number one lentil producer for the entire world and we're located right at the source, being Canadian-made is a big factor for them too.[...]

"[...] Oh well, it doesn't get a lot of press, or you don't see a lot of articles, I don't think, but at the end of the day taste is an underrated attribute in terms of discussion. But of course, nutritional and environmental impact is becoming more and more significant [...].

[...] we just use the same things you would use in your kitchen in terms of making our soups and products, so we naturally cater to retailers that are emphasizing all natural and healthy and organic, therefore our customer base is very much focused in on that, so I would say that 3/4 of our calls are related to health and nutrition [...].

[...] just in terms of flours, I think it's the flavour because often you're looking for an alternative to pea and it's associated with flavour, so, what's the flavour profile for lentil? Does it have as strong of an aroma or our flavour profile as peas? So that comes up. And then colour is not as important, but it depends on the industry that's asking and like as an example, the meat industry, this is a more niche, but the meat industry sells meat that's going to be raw and then cooked and sometimes it's precooked, but colour will play a huge role because there's red lentils and raw meat, sometimes it's a good thing, because you want to have that bright red raw meat but when you cook it you don't want it to be red, so the color is from an end-user perspective important, but that's a decision I think you can pick like you can pick Green lentils as an example. So, I think protein, flavour and colour. [...]

[...] It depends on what you're trying to do, on the type of primary product you're trying to get manufactured, but for us the protein content is sort of a given, but it's the

functionality: how saleable and what is the taste profile once you've got the ingredients [...].

[...] So, let's start with greens. They {consumers} are looking at visual appeal, so they're looking at consistency of color. If you want to buy green lentils and you want number one, you want them all green. If you are buying them for canning or for something else and you care less about the green, you still want them uniform. So, again I always say they're either all green or all brown, they can't be green and brown mixed. [...] So green is very much based on size, colour and consistency. Red is largely going for splitting, so that's back to that end-use market, right? You've got in the red level side again, you're looking at uniformity of size, you're looking at milling efficiency, so things like wrinkled seed coats, things like weathering, staining, those are usually predictors of milling loss or milling inefficiency. So, the more you have a lack of uniformity, the more you have losses when you're peeling the skins. [...]

[...] So those are all again based on how does it look in the package? It's gotta be very clean, it's gotta be very uniform, it's gotta be very bright, it's gotta be... because the consumer is gonna look at the clear cellophane package if they're gonna buy it. [...]

Next, interviewees were asked whether they think the attributes identified are a trend, and if yes, how long will these trends last. Many respondents confirmed that size, colour, protein, low-fat, quality level and functionality have always been a trend. Other respondents integrated these attributes into the sustainability and nutritional benefits trend, which they think it will last for a while.

When inquired whether brand names are important for consumers, only few processors answered this question, and their opinions were evenly divided on this topic.

[...] To be honest, {functionality} has been around for 50 to 100 years. But I think because people didn't have the ability to modify the functionality or understand...I mean it's kind of a trend... everyone were working to get into the building their own burger. Once you understand you want to put lentil protein or lentil starch in your burger, there is a change in the functional aspect to it. I don't think people really look at the functionality of an ingredient or at lentils as an ingredient. So, their functionality analysis has been around forever; I think it's really coming about now as a result of people looking at the plant protein opportunity and the constituent ingredients. [...]

The protein trend is definitely... protein and low-fat have always been a trend I would say.

[...] the protein quality becomes more and more important for plant-based foods, plant-based proteins. There is a protein quality score [...]. PDCAAS {Protein digestibility-corrected amino acid score} is now in this whole market industry, we are trying to replace meat. If you look at meat, there is beef, pork chicken, bison, sea, seafood like fish, crawfish any type of these products. So, those are like fairly high protein, like high quality protein

products. So, if you look at the PDCAAS, the protein digestibility, and the protein quality of these meat products, the PDCAAS score is like close to 1, 0.95-1, a very high level. So, in the pulses, like lentils, they are low, like 0.6-0.7. So, we are really trying to take that protein level up, the protein quality level up close to 1, so that we can not only deliver the same protein level, but we can deliver the same protein quality level. So, the level of quality is important as well. [...]

[...] Absolutely, everybody talks protein, but the business is all about starch and fiber, it's more than protein right, you gotta get rid of the byproducts. I mean you produce 100 tons of lentils into a food ingredient, you're getting 20 tons of protein, and you got 80 tons you gotta get rid of, which are fiber and starch, that's why the coproduct side it's really important. [...]

[...] I think that lentils will become used more, I think that they will be processed more because they have not had a lot of processing done to them really. And just the way the trends are going more to whole foods, more to pulses, and nutrition focused and the green economy. Because lentils fit into all of that being a pulse. Right, so, I think they are one of the pulse sectors less explored for food processing, probably because they command a good price already just as the seed. [...]

[...] The opportunity to substitute or to augment protein sources using plant protein sources and the nutrition benefits that come from that, as well as the sustainability benefits that are long term things that we will continue to see grow. I would say there has been, I would say there was sort of an abrupt peak in the focused early days, but things are beginning to level off to more of a reasonable, to more of a sustainable sort of growth curve, but I think that it is a long-term play. [...]

[...] It's been a trend for a while {for color, size, and price} and don't see much change. They are still going to be interested in a greener color or redder color or the color inspect, specifications, or size or modify or change their adopt or their preference in size. Price is always, the cheaper the better. [...]

10.3 What are your sources of information about lentil market trends each year? Do you do your own research on market trends or final consumers' preferences, or is it industry information, workshops, personal discussions with buyers or hiring consulting companies?

Interviewees pointed out various information sources, however, most of them highlighted that personal communication is the best way to acquire information about the lentil market trends. They explained that talking to their buyers around the province (which again varied for everyone as the companies do business at various stages of the supply chain), as well as communicating with farmers, business partners and friends from the industry are the major sources of information. Further, numerous respondents indicated that Pulse Canada, Saskatchewan Pulse

Growers, Canadian Special Crops Association, Protein Industry Canada and Saskatchewan Food Innovation Center represent important sources of information through their websites, workshops or conferences.

[...] Yeah, I think there is a lot of personal and business relationships that drive market development. So, knowing who the customer is, understanding the relationship with the company that is going to distribute the product into other countries, and having an in sort of with another country to have an in to build that market. I think that there are marketing groups like Pulse Canada and Saskatchewan Pulse Growers that do a great job of raising awareness of Canada's brand and that supports the work that we do individually to sort of build those relationships with that they need to enter into.. [...]

[...] Well, it is a mixture of everything. We get it from various industry publications, get it from weekly reports, you get it from talking to farmers, you get it to talking to grain brokers, you get it talking to other buyers who have talked to Canadian suppliers. It is very hard to get a good read as to what, what size the Canadian crop is by specific lentils and what the quality is and whether how much of it is presold to the big grain companies on a contract basis. You know you are always trying to piece together what everyone else is doing because there is no one source that gives you all this information. [...]

[...] Yeah, so definitely our own research, like lots of our own research is based on just the sales data that we get from our items like what selling across the country. We also lean on our suppliers, so here in SK we obviously work with {company name removed} – which is a key lentil supplier for us, so we would lean on them for any sources of data. And then even just on our retailers or like we subscribe to many different sort of natural foods magazines and blogs and things like that where that will feed us information and the trends. [...]

[...] Oh, some companies have very long-term intelligences, long term establishment knowledge that helps. Some of them they use consultants, some of them they use Pulse Canada. Pulse Canada I mean is trying to generate, trying to help grow industry members and industry quite a bit. So overall, I would say it is a matter of all of them, they are trying to get help from all of these groups as possible from Pulse Canada, consulting companies, sustainability consulting companies, marketing consulting companies, grain buying purchasing consulting companies, everything but again there are several companies that are fairly well established in the market place and they know where these products grow, how they grow, and they could be in a good position to continue to track the data and what is happening in the market. [...]

[...] Definitely our current buyers are sort of our first source, because if, you know, if they're changing and evolving, we try to grow with our current customers, so we work with them first, and then you know, we do attend some webinars and things like that, that talk about some of the new developments in the markets, where the trends are heading [...]

[...] Probably everything but the last one {consulting companies}. So, we are talking to our customers every day, we are reading research from industry people that we either subscribe to or that we find on the internet, and then we go to conferences, there are about 3-4 conferences a year specifically for pulses or lentils that you get information from, from the industry which you go off of. [...]

{on hiring consulting companies} [...] it's mostly those that are totally unfamiliar with the market; they might be foreign companies investing in North America and so they... I've seen several instances of market firms that will hire and do that work for them and then, there's like the ingredient processors - are the people that are in the trade that are trying to get into - they might be import-export in lentils already and they might be selling it in the prairies, but they're trying to expand and make ready-to-eat foods and partner with a contract manufacturer. And so this group uses a bit of intuition: they're taking the traditional and bringing it into the modern demographic in North America, that want the ethnicity, like ethnic flavor but it doesn't have to like be very traditional, so there's that. [...]

10.4 Do you contact lentil/pulse breeders from SK and transmit buyers or exporters' requests about lentils?

A majority of the respondents stated that currently they do not contact lentil or pulse breeders. A few of the interviewees explained that they are aware that breeders communicate and work closely with farmers, and that there is communication with the breeders through various industry' channels. A couple of interviewees indicated that they work closely with breeders.

[...] I mean historically there's been lots of connection and connectivity, and you know we all know each other very, very well, but you're right, we're heading into a new phase of development right, where we're now... a lot of that work over the last 15 or 18 years was based on just getting the acreage to a point where we have enough production. [...]

[...] Yeah, maybe less frequently, we provide information if asked, but I think previous to the last few years, plant-breeding has been very focused on the farmer, and getting better disease resistance and getting better yields, keeping quality better. But now there is a bigger push from the industry to have a higher protein content and vitamin and nutrient, and that sort of stuff. [...]

[...] Oh, there is {contact}. There is definitely contact that is ongoing through the Crop Development Centre, through Pulse Growers, through Pulse Canada, through webinars, through continuous communication so that, that type of information is continuously ongoing. [...]

10.5 How are lentils positioned on the products market compared to other pulses? How are they 'ranked'? Are consumers aware of the nutritious advantages of lentils versus other pulses, and versus other 'healthy' plant based/protein delivery plants?

Besides the few respondents who avoided a direct answer to the questions related to lentils' positioning compared to other pulses, most of the interviewees' stated that their personal belief is that lentils are grouped together with the other pulses, from their own point of view, as well from their buyers or customers' point of view. This is an interesting finding considering that, for instance, compared to chickpeas, lentils are higher in fiber, protein, iron, vitamins B6 and B12, and lower in carbohydrates, fat and calories.

[...] They are all grouped as one, I mean lentils, peas, chickpeas. Chickpeas may have slightly better PDCAAS {protein digestibility-corrected amino acid score} maybe, but it is not that significant, they are still at the low. I mean that the pulses because they are deficient in terms of sulphur amino acids, so like methionine, cystine. If you google lentils, peas, chickpeas, fava beans, they are all like quite deficient in terms of amino acids like in terms of methionine and cystine. And when you have amino acids that are low, then your PDCAAS will go down. [...] So, they are low, so the whole point to find better varieties, new varieties, varieties with better digestibility, better protein quality to elevate them, almost close to like a meat product. [...]

[...] Yeah so, I think people look at the label, I think they look for plant-based protein - the little, like a little symbol or something like that, but I don't think a consumer knows the difference between a pea protein and a lentil protein, and lentil flour and faba bean starch. I don't think they get it, I really think they don't. [...]

[...] Yellow peas really sort of set the bar because that's where a lot of the research and development went into and now we have the fractionation plants dealing mostly in yellow peas, so they're kind of like your established product that food companies are now sort of comparing it to. So, does it have more or less protein, does it have more or less amino acids, what's its functionality properties in comparison to, pea flour or fiber or starch and protein? So, yeah, I think they're looking for different, customers are always looking for other things, so it's definitely becoming of more interest to not only have pea protein and fiber and things like that, but you know what other products like lentils or fava beans um, and there is an advantage to a food company incorporating those, right? [...]

[...] I mean well yeah, whether it is pulses or peas, chickpeas, whole yellow peas, whole green peas, or lentils, they are all kind of in the same category. And it is more of what everybody prefers, of what the actual buyer prefers, we see a bigger increase in the actual usage of lentils in Canada for example than there has been in the past. Now maybe that is due a cultural shift and a change in the immigration policy and growth of Asian culture, which are more prone to supporting lentils or it is just changing habits of traditional Canadians. You know in the past, Canada has produced the most lentils and pulses of any

country in the world, but we probably consume the least per capita of any nation in the world. You know, we are seeing that change, but it is not changing as fast as it has in other areas or other cultures, like in the middle East, or in India. [...]

[...] We don't necessarily rank them differently, so right now within our snack lineup we have a roasted chickpea snack line, the roasted lentil snack line, we have a roasted peas snack line and a roasted fava snack line and we look at the category, you know, generally as this whole roasted beet and pulse category how the lentils are identified a little bit different is there primarily a snack but they also are find usage occasion so some of the customers will use it for salad topping or they sort of have this additional usage because of the size of them and then so they're a different usage occasion and also maybe cater better to children like young toddlers then something like a big chickpea or a big faba bean. [...]

[...] I am not quite sure about that, to be very honest in terms of buyers being very well aware of the protein content or the fibre content. I think every destination has a specific demand because we are not in the ingredients sector, we are more in the wholesale sector, so that is why I think it just comes down to - which commodity they see as a staple. If it is lentils, beans, the chickpeas, the peas, it depends on what staple it is. [...]

[...] I think it is economics, you know, what drives any business owner does and so if there is a market for the product and if there is an agronomic advantage to growing them {lentils}, that gives you another lift and is probably the first driver for producers. Those other benefits, they drive the market, the sustainability, the nutrition quality, but I think from the perspective of the person who is actually growing the crop, and that is the business that they run, there has to be an economic lift. [...]

[...] Well, personally in my mind, lentils are grouped with pulses...as a consumer I would see them as nutritionally comparable to the other pulses and am not even sure why they would be considered superior as the protein content of the beans is very high, and I like lentils more for the sensory benefits. They are a little easier to digest, yep. [...]

10.6 Are environmental or sustainability claims (e.g. low carbon versus meat products/other plant-based/protein provider) driving market value? Do you think these things matter for consumers? Are they actively searching for this info?

Some of the suppliers and processors who answered the questions related to environmental and sustainability claims agreed that these matter for consumers lately, even though they may not be responsible for driving market value. Few of them compared the pulse industry to the cattle industry in terms of environmental and sustainability impact, while a couple of respondents argued that economics is the market value driver in this case.

[...] That is correct, pulses are taking quite a bit of an advantage in terms of environmental sustainability and greenhouse gases, carbon footprint, life cycle analysis, overall complete carbon score of the pulses, they are like much lower than dairy protein or the meat proteins. [...] It so when you look at those numbers {cattle industry}, pulses tend to use much less water, tend to create much less carbon dioxide and carbon. Because of that, in terms of carbon sequestration, in terms of sustainability, lentils, peas, fava beans, chickpeas, they are like ranking much better. That is why is like vegan, plant-based, plant-friendly, flexitarian, are all the sustainability story helps to sell these products. [...]

[...] Yeah, pulses have a good story because they require a lot less water than meat, they are high in protein, they put nutrients back into the ground. I mean, pulses in general and lentils, all cover that stuff. Some of the, some of the, maybe I am getting off track, but some of the innovation that has to happen is to find environmentally friendly ways to process these peas and lentils. A lot of the factories require a lot of water, and the North American people are trying to do it without water. [...]

[...] I think it is definitely benefiting pulses. There has been a lot of marketing going on for a long time for quite a few years and they actually think consumers are starting to appreciate them. I think there are a lot of consumers who are searching for that info on labels. [...]

[...] I think it is economics what drives any business owner does, and so if there is a market for the product and if there is an agronomic advantage to growing them {lentils}, that gives you another lift and is probably the first driver for producers. Those other benefits, they drive the market, the sustainability, the nutrition quality, but I think from the perspective of the person who is actually growing the crop, and that is the business that they run, there has to be an economic lift. [...]

[...] it depends which company we're dealing with, and how they're putting the product into the market. Obviously if you're in a country like Algeria-North Africa I don't think a sustainability thing is as important as just having food supply. So, food security is still a big deal right now, for obvious reasons, so sometimes food security trumps sustainability or even sometimes if it's sprayed with like a glyphosate or something like that. So, it really is dependent on some of those things but definitely still seeing it. I think the end-use customer definitely in North America, Canada, United States and some of the European markets are pushing more for that information. [...]

[...] On the natural food side, I think that it is expanding because younger generations are demanding more transparency, cleaner ingredient decks, and they want a better understanding of where their food is coming from and what it's made from. So, I would say that it is expanding because of younger generations, but also just because of consumer education overall and the impact that food has just on our daily lives and health in general.

[...] no, I don't think so... like if you were to say it's the lentil...I don't think so... like I say that had again, as a consumer and kind of watching this space, I don't think consumers are ... they are in tune to it... but they don't, they don't know about that nitrogen fixation, they know they should be eating plant-based because it's good for the environment, but they don't understand the environment and they don't actually understand all of the stuff that go into it, so I think they are oblivious to it. [...]

10.7 What is your view about the markets for health-oriented and/or plant-based food products? Are these markets faster expanding in Canada, US or EU? Do you have a plan to respond to these expanding markets?

A majority of the interviewees stated that the markets for health-oriented and/or plant-based food products are currently expanding. There was consensus that the EU and US markets are expanding faster in terms of products' trends, initiative, and volume. Canada's market is growing as well, but Canada is seen mainly as a trend follower.

[...] They are expanding but I could not tell which country is expanding quicker. Generally, Canada would not be the leader in the expansion. Generally, it would be in Europe or the States and then we tend to be more of a follower, that is my opinion. [...]

[...] {The United} States is working a bit more towards it where Canada is a little bit farther behind, I feel – in terms of consumption. But the EU and the States have been a little bit more forward thinking of the future, and we will be seeing more of that. Which ones of the pulses - I do not know about that - right now it will depend on what kind of {pulse}, whether it is whole pulses or if it is processed pulses. [...]

[...] definitely in the US and the EU they're, I would say they're sort of like, top one in two areas that have the most gross and the most sort of R&D and product launches happening. Canada – just population-wise – we're just not as big either. I also think education was a big difference, I think the US and Europe, you know, it's a big consumer education thing and consumer driven, and we're just starting to get there in Canada, so it's coming in Canada but it's definitely more US and European driven.

[...] I just pulled some data and looking at the level of innovation with lentils. It's a bit slow in the US. US and Canada are seeing the same trajectory, they follow just a different volume. It's growing but it's quite slow, it's not really getting as much traction as in the EU, in places like the UK or Germany, France and some others, possibly Spain. But generally, in Western Europe it's like almost tenfold higher in activity, in terms of just the number of companies that are using the ingredient regardless of volume - I don't really know the volumes that are actually being used yet. But it's like all the number of companies and the number of products that are that we're seeing in the market getting launched it's a lot more active in the EU and UK. [...]

[...] Well, the EU is growing as well, I mean it really has... it's growing worldwide, okay? But the reality is globalization is over and Canada has to focus on markets that we have an economical future with and those markets do not include India, Pakistan, Bangladesh or Sri Lanka or even East Africa. [...]

When asked whether there is a plan to respond to these changing markets, a majority of respondents declined to respond. Some others explained that constant growth of their business is the best plan to follow.

At a national level, a couple of respondents pointed out that Pulse Canada's "25 by 25" strategic plan and Protein Industry Canada's (PIC) plan "The Road to \$25 Billion" are the main strategies that address the expanding the markets for health-oriented and/or plant-based food.

[...] Yeah, well I mean the Road to \$25 Billion is, and the strategy set out in that document is. That is the strategy to respond to global demand and it really focuses on responding to increasing domestic ingredient manufacturing first, to have that initial processing happening in Canada and only once we are producing the ingredients here, will the food companies be here too, to use those ingredients that we are producing. And, at the end of the day we will see a lift from producing an ingredient rather than a commodity, we already have a value there, right? With an economic benefit. [...]

[...] Yeah, I mean the 25 by 25 initiative which was a Pulse Canada initiative. That initiative is going. You've got the 25 billion, you know, Protein Industries Canada's initiative by 2035, that initiative is going. Listen, the overall market I mean again the US for us as the driver, I mean Canada is too small, so the US and Europe, but our industry will be most competitive into the US. The North American market is ultimately what we need to be focusing on today because from a freight lane perspective and transportation the growth in the US is big. People are focusing too much on meat and meat analogs only. That has been slower! So, what you're hearing about beyond meats and about everything going really slow is true, it's going slow. We think the bigger opportunity is an extruded flours and extruded products, bakery, snacks, pastas, you know those are it and lentils are a really good opportunity to diversify you know the offering from peas into another product. Lentils have a good positive image; they have a good neutral taste profile; you have yellow and red so you can go yellow to be neutral in color and you know there's a good opportunity I think to develop that. [...]

10.8 What is your vision in terms of new developments in pulse/lentil processing and new food product R&D?

When discussing respondents' vision in terms of new developments in pulse or lentil processing and new food products R&D, we learned that most of them consider that this industry is going to further develop in the next years. Some interviewees detailed their vision and explained how and why the lentil and pulse demand is going to increase.

[...] Yeah, I think, I think that we are at the very early stages of it, you know, we are probably like 10 years, probably more like 5 years into something that will be going on for 50-60 years. Absolutely, we are going to see more product development as the industry grows. [...]

[...] I think what it is - is about getting adoption and incorporation. Because again, in order to sell lentil protein profitably (so now I think about it from a dry concentrate), in order to sell your 60% lentil protein concentrate, you need to figure out what to do with the other 75% of percent of your batch, which is your low protein or your starch concentrate. So, I think what's gonna drive consumer behavior is the ability to find other products that are going to be actually supporting the co-product. So, if you could turn your lentil starch into a pasta or you have it as a ... it's incorporated into a Tim Hortons donut or muffin, whatever it is, just to sell the darn stuff, or something other than animal feed, I think those are the things that are gonna really drive the future. [...] I think the demand is going to shift necessarily because of overpopulation and environmental responsibility and sustainability aspects. But I think that the challenge is the protein. If you can solve the protein, what are you going to do with your other products? If we can come up with, as a result of a holistic approach, if somebody comes up with a product that they get a high value product, where you can pay a real value for your coproduct, your starch product, then you're gonna have a company that will last lot for a hundred years otherwise you are always going be chasing the next pulse and the next trend. [...]

[...] We are building this connection back to the farm and how those items are grown and where they are sourced. So, threading through this sort of, trying to bring this full circle right of how these items are grown and putting Saskatchewan on the map. I would say that was snacking trends in general, we see a lot of lentil flowers, lentil extruded snacks, lentil extruded cereals... I do see basically beans and lentils almost being taking over multigrain. Like multigrain used to be like everything, right? In your snacks, in your crackers, multigrain came out and it was like nothing if you don't get white bread anymore, you're buying multigrain. I see pulses coming in and taking that on. Multigrain is diving and everybody wants everything bean based. You see it if you see lentil pastas, you see lentil cereals, you see lentil snacks, you see lentil Cheetos, so that's kind of what I see for that. [...]

[...] We are seeing again natural biofortification being something that is desirable. So, the presence of iron, vitamin B, you know those things, when it comes to the R&D side – we do see the R&D side as valuing that. Because according to US labeling rules and then Canadian labeling rules, and the European as well to a certain extent, if the iron or vitamin B occurs naturally in the product that is the feedstock for the food product, you can list percentage daily intake on the label, but you don't have to include it in your ingredient deck. If you add vitamin B you have to put vitamin B on your ingredient deck. Do you see what I mean by that? Like now all of a sudden said having lentils which have a natural vitamin profile that you can say 18% of daily intake but you don't have vitamin B on your

ingredient label: it's only on the daily intake label. That's desirable because food companies are looking for minimal number of ingredients in a lot of these natural food products. I think that's a big advantage for where we're going with lentils. [...]

[...] I would imagine that there would be more interest using them for meat analogs in that area, I would think. I do not think milk has really been explored much with the lentils. There is a little but not a lot. And then along with that, you can have all the dairy alternative products that go with it, like the yogurts and that could be happening. Tofu perhaps, but I think a lot of the value-add that is happening is tied to how expensive the raw ingredient is and lentils are one of the higher costs' pulses, I think. Like peas have a lot more value-add because they are cheaper and less in demand for other applications. [...]

[...] I think it is going to continue, there is so many people looking at lentils, whole lentils, lentil ingredients, in the innovation space. The main thing that is going to drive this is the availability of the crop, and sustainability of the crop, and to be in a position to order these types of products from different regions. Like if you are only growing in one location, in one place, so many companies will have concern with that because they like to have a fairly well-established supply chain. Canadian product, US product, Australian product, European product, Middle Eastern product, can I source it from other regions, can I source it from other programs, can I source it from other groups, so that is kind of the key point with this. As long as we grow, the companies that are looking at it and the consumers that are looking at it, I mean lentil chips, lentils snacks, are being produced as any ingredients since the 90's in the extrusion and snack application in these areas. There is quite a bit of product and development, and a lot of innovation that we see and keep seeing but it has basically got stuck around the bakery and snack area, so we like to see a little bit more growth than that maybe in pasta, you know they been growing into a lot of chickpea pasta and lentil pasta, and there were a couple of other start-ups that started with the lentil pasta as well and the consumers they keep eating and consuming, and that will continue to grow in different areas as well. [...]

10.9 Right now, the plant-based burgers, and in particular the lentils-based ones, are marketed in the patty market as 'false beef' or 'beyond meat'. Would their value be higher if it wasn't marketed against beef?

Many processors and suppliers preferred not to give a direct answer when asked whether plant-based burgers' value would be higher if it wasn't marketed against beef. A majority of respondents suggested that marketing the plant-based patty as a separate product as opposed to 'false beef' or 'beyond beef' would have been their preferred option.

[...] Yeah, really interesting question, and I mean, we saw a lot of hype around plant-based burgers, a few years ago, it really drove a lot of interest and stock prices went up and now we have seen a huge reversal of that. [...] I do think that there is a marketing challenge

with plant-based meats, but I am far from the person to speak on how to fix that. But yeah, there is a lot to unpack there. [...]

[...] Yeah, because we work with all these different industries, so if I was marketing it, I would market it as a single separate product with a great taste and a great benefit instead of “poo-pooing” the meat industry or the dairy industry. [...]

[...] Absolutely, absolutely, you have to make good products better. You can't slam other products to gain share against it. [...]

[...] No, I do not think so, I think there is a segment of the market that is looking for an alternative to meat, and then there is another segment of the market that is just looking for nutritious products and they are open to plant-based. But I don't think it is turning a lot of people off. There are some people who really are just not interested. They want their meat. Yeah, I do not think it is having as big an impact on the market. [...]

[...] That is a very good question because I always wonder, I'm like: there's a veggie burger which is lentils based and tastes like lentils and they are delicious. You would just eat it like that if you want a veggie burger, but then there is like, yes, you wanted to taste like meat. I think there is a perspective out there of, you know, when you make something taste like it's not, it creates this sort of fake food, or you start questioning like what are all the additives in there? Is it any better than processed meat when you process a vegetable that far? I don't know, I think those questions are being asked, but I don't quite have a firm answer for you on that. So, I don't know if it's... I think when they placed it that way in marketing, they looked at it in a way people want to still taste like beef, but maybe need to eat a little bit less beef, right? So, they're trying to flex, they are trying to say: “I'm not gonna stop eating beef altogether but maybe I can incorporate more vegetables somehow without sacrificing that taste”. And I think they've been successful with that route, but it is a good question on do they continue marketing that direction as it kind of plateaued because at the end of the day there still consumer out there that's going to eat beef, right? [...]

[...] That's a good question. I think that plant-based stuff has to stop comparing themselves to beef, just because it's totally different, right? [...]

[...] I think yeah, I mean I think that would help. I think you have to try to, I mean again you have some different customer classes that you're trying to appeal to, so you definitely have had the beef industry that's not happy with that whole thing {laughing}, but I think again, there's ways they they're trying to work it together, but you know the two actually are quite complementary to have, you know, like a beef or a chicken or other like a meat animal protein paired with a vegetable like a plant based protein. So there's some value there that you know they make it more palatable for a certain consumer group, but yeah, and you see that, I think also in the dairy space right, so all the oat milks, almond milks, cashew milks and they're just like “well, we're not dairy” and dairy is kind of like “well,

what the heck what's wrong with dairy?", right, so again if you can kind of, you know, find a way to make it more palatable to a consumer base that, like you said, maybe it doesn't appear to be like it's in direct competition with another industry and trying to wipe out an industry because I don't think that's what anyone's trying to do. [...]

[...] Well first of all, quite a few years ago when it was primarily soy, it was regarded as it's a terrible thing, you know, the thought of plant protein was thought of a disgrace almost. Now it's like "oh, wow, it's going to make it healthier". That being said, frankly, in the behind meat and meat analogue, trying to make a whole, an analog that's directly comparable, there's struggling with that, a lot of hype, but there is a lot of cooling off in that market. However, I guess when it's done more as an inclusion to another product, whether it's in a soup or chili, that seems to be a very much a growing category and regarded as highly sought after. [...]

10.10 What are the current challenges/opportunities in your 'world', for your company? How about for Canada when it comes to pulse and pulse-products derived exports? Do you think the Russia-Ukraine war would have an impact on your business?

All respondents chose to share with us the current challenges for their company. While there was a wide array of answers, responses converged towards a few challenges, such as the need to increase the number of acres cultivated with pulse, especially as pulses compete with other 'big crops' for land and investment, as well as the difficulties brought by the increased input costs and current inflation. Further, logistics problems were mentioned numerous times by respondents involved in different stages of the supply chain.

Lentil and pulse products' diversification, better strategies for commercialization and 'adding value to lentils' close to the production place were brought up as opportunities to increase the efficiency and profitability of the lentil and pulse industry in Saskatchewan.

[...] Weather and production. There is a lot of investment going into canola right now, in Saskatchewan, and that is going to take away acres from lentils and other pulses. So probably, we need more money put into it to influence farmers to produce more. [...]

[...] I would say obviously the cost. I mean research and development is quite expensive, even the cost to now build these facilities. I mean inflation is definitely a large part of that supply chain issues so it's really increased the cost to build something to enter into the market, so I would say that's definitely something that is a bit of a barrier because of the high cost to put something in place, especially for us. [...]

[...] In my world and for my company, it would be logistics in my opinion. Moving the product from the origin to the source would be logistics for me and cost of fuel for us. {We use} railways, trucks, and ocean containers. So, I think for commodities that associate

worldwide that its so cheap for, it becomes so expensive because of the logistical issues that we are facing in North America. [...]

[...] I think going toward logistics, that would be number one for a challenge right now because right now, I have people that want things, and I can't get it to them. So, logistics is certainly a problem, it is not just for going south, problems in Vancouver, problems in the Fort, problems in the Montreal. Those are the significant issues. Our logistics teams, everybody's logistics teams are just pulling their hair out every single day, trying to make things go. We got buyers that want things, farmers that want to sell things, and we want to ship things, and logistics is the biggest restriction wholeheartedly and I don't know how to fix it. [...]

When asked about challenges and opportunities for pulse and pulse derived products in Canada, logistics challenges, their subsequent complications, and the need for solutions were highlighted by a majority of the respondents. Other topics frequently mentioned included finding the right economy of scale as well as adding value to pulse-derived products by manufacturing them locally, in Saskatchewan or in Canada,

[...] And in terms of Canada, we have massive problems with transportation. Saskatchewan is going to die if we don't deal with transportation. We have no ...there's no rail service, there's no ocean export service, and the government does nothing about it, [...] they promote export of raw material instead of processing it here and employing Saskatchewan people. So, there's a lot of problems when it comes to government, when it comes to railways, and the transportation network. It's a huge problem and it's not gonna get solved anytime soon. [...]

[...] I would say here for Saskatchewan there is significant opportunity on the value outside of lentils, right? We ship these office commodities and buy everything back at twice the price. There is significant opportunity to add value to lentils whether is creating snack foods, whether is creating flour, whether it's, you know, even just splitting them. Whatever it is that value add to do here in Saskatchewan before shipping them off is that's a huge opportunity for us, to do more manufacturing here. And then [...] one of those challenges where we are located: shipping all over the world, you know, our central location isn't necessarily ideal for that... Or scaling the manufacturing or financing all of that [...].

[...] I think the opportunity is just the fact that we do have so much land, and we have a lot of good research and development here in our own province and our own country, and I think if we continue to put those the resources into that, then Canada's gonna continue to be a leader that way and hopefully maybe even the global leader in these types of ways that we improve agriculture and along with keeping the value of what we have in Canada. I think that's one thing that we sort of did poorly is we just started exporting everything and it gets remade into pastas and every other thing and then bring it in. I think it's been highlighted obviously more now with the pandemic and globalization and how dependent we got on importing foods that people are really realizing if we can produce and keep

our...especially when we have it here, can we value out here, can we provide those, keep that in our economy and do those things you know here in Saskatchewan in Canada. [...] Yeah, it would be nice if we can move towards more of those types of product manufacturing in Saskatchewan and Canada and do it right by the field, it's right here! [...]

[...] we gotta move from innovation to commercialization. We haven't done a good job of that in Canada, nobody else in the world – to be honest. Supply chains have to develop. By today the grower to processing, to innovation, to large scale ingredient distribution - there are very few companies in the world that have succeeded at scale. We're probably one of the only ones that are succeeding at scale today and ...but we're when we're investing more. So those are all constrains to the industry I think... And then again that linkage between fundamental research and commercialization - we gotta do a better job getting products to market. And I think we've lost sight of a few things: taste and affordability are two of the biggest drivers of why we haven't succeeded. Because taste profile, I mean there's a natural beanie policy flavor - we've all talked about it for years. We haven't solved it. So maybe that's something that again, as we look at whether it be controlling me certain attributes in breeding that might give a better, a more neutral taste profile. Those are the kind of things that we have to start looking at. So, taste and affordability, those are two things. So, now affordability comes largely from scale, right, that's where you ultimately get it. If you're only producing so much and you're inefficient, you could never offer at scale. So that will ultimately take care of itself but those are three kind of things that lead to two factors: cost and taste - which I think are fundamental to any food industry. [...]

Further, interviewees were asked whether they think their business would be or had been impacted by the Russia-Ukraine war. Some of them answered with respect to the war's impact on international agricultural markets, in particular food security and food supply issues, pointing out the vulnerability of being dependent on very large food producers during circumstances of risk and uncertainty. Several respondents indicated that while lentils and pulses supply or demand were not directly affected by the war, there is an obvious indirect impact not only on the global food systems but also at a global level in terms of increased costs of various goods and, in particular, increased fuel prices.

[...] I mean not just directly in lentils, cause that's not really a huge item that we're competing against, like obviously with some of the cereal crops and peas and things like that, but I think it's just again, the biggest thing it has really put a high degree of awareness about food security and food supply and where your food comes from. I think that's just really what it's highlighted to people is you know where these large producers, including ourselves, of things like peas and durum and wheat and lentils and other things that... how dependent you become you know, if you become too dependent on other countries that really can um impact your ability to have that supply when you want it especially in uncertainty and things like that around the world. [...]

[...] Oh, well I think so, I mean the food system in general is seeing the impact of that. As much as high grain prices are great for Canadian farmers, they are really challenging for Canadian ingredient processors, right? Because the business around stable commodity pricing anticipated it two years ago, and things have fluctuated greatly since then. [...]

[...] Yes, not on the pulse side of things, but on the sunflower oil ... For first there was a shortage on some certain ingredients for sure that we use in our seasonings and/or oil. We didn't necessarily have any impact from the lentil, like, supply. [...]

[...] Yes and no. I am seeing it indirectly impact us because of the cost of goods, raises the cost of fuel, raised it is more of a global situation so than we are going to see global issues affect every individual global organization. [...]

10.11 Are there any long-term trends that breeders should be aware of beyond what we have discussed already in this interview?

The last question of the semi-structured interview asked respondents whether there are any long-term trends that lentil and pulse breeders should be aware of.

Once again, depending on the position on the lentil and lentil-derived products supply chain, interviewees had shared with us their thoughts, needs and long-term vision. Thus, as many of them pointed out, based on their relative limited knowledge about the breeding process, they had expressed their wishes about improvements or changes related to lentils' visual attributes (e.g.: lentils' size, colour, thickness), and lentils' intrinsic characteristics in terms of protein availability and digestibility. Another point brought up frequently by respondents was related to the stringent need of reducing the accumulation of chemicals in the soils, and thus the need of varieties that are resistant to root rots and other soil borne diseases.

[...] I mean basically you want good color, you want reasonable size, you want the seed to be thicker through the middle then so thin, so that you don't chip the edges, you get a better recovery. [...]

[...] Oh, I mean the high protein would be important and you know these varieties as they grow more high protein varieties, it will be important for the market of course. That will be the key, like the high protein lentil varieties, like the high protein, high fibre, low glycemic, like those type of products will be important in the long-term with a good yield. [...]

[...] For me, I think it's breeding towards functionality. So, can you get breeds where the starch and the protein molecules separate easier? Can you get breeds where that whole taste of saponins and flavonoids are a little bit less pronounced because then you would end up with more functional products? That would be my biggest things. Without sacrificing yield or protein content. [...]

[...] Well, if you look at the environmental trends, there is going to be less access to water and to energy, {it} is going to be more of an input cost. And so, the varietal changes that could make them more drought-resistant, or there are seed coat advantages that could hull them with less energy use, or anything related to those trends I think would be the future. And if they want to up the protein too, which they are trying to breed now, leading to higher protein. [...]

[...] It has just gotta be, not so much in terms of breeders, but chemical applications is what is the big one. Glyphosate and phosphate and when to use it and when not to use it, and stuff like that. If you could breed a seed that kills all the weeds around it and doesn't have a glyphosate level, that would be perfect, ha ha ha. [...]

[...] we are also experiencing issues with disease and our soil and how we can properly manage that, so I think that's going to be something we're really gonna have to continue to pay attention to because if we don't have healthy soil that's gonna affect our production as well. So again, just what do we need to start incorporating another crop item to help with our rotations or can we develop breeds that aren't susceptible to the root rots and other things that are sort of soil borne derivatives that are affecting the crops and the land's ability to produce. [...]

[...] as I look at the milling and fractionation industries, whether it be protein or starch or fibers, I think natural biofortification to address a protein deficiency and vitamin and micronutrient or nutrient deficiency I mean within diets is something that has lagged. So, you know governments are recognizing that food security and food... oh and the fighting of hunger and health are interconnected...so, we didn't see that 15 years ago. We're seeing it today. So, I think that's a trend that really plays well into Canada continuing to be the world's largest exporter of lentils and the lentils can be one of those crops that could be a major part of the of this initiative. [...]

[...] So, I think something that has been coming up frequently is that breeders, is like a long-term benefit, is really understanding is what it is that ingredient manufacturers are going to need: varieties to deliver on and figuring out how we build that into variety development, balancing it with everything else breeders need to think about. Right, because there is disease resistance, there is agronomic challenges, and there is just the realities of being able to include pulses in your crop cycle and right now, because of disease pressures, we can be limited in how frequently we grow peas and lentils along with other crops. So, yeah it is definitely thinking about that tieback to the end consumer or the product that it is going to be used in and understanding what changes in variety development are going to be required by those food manufacturers in order to get that back to the variety development. [...]

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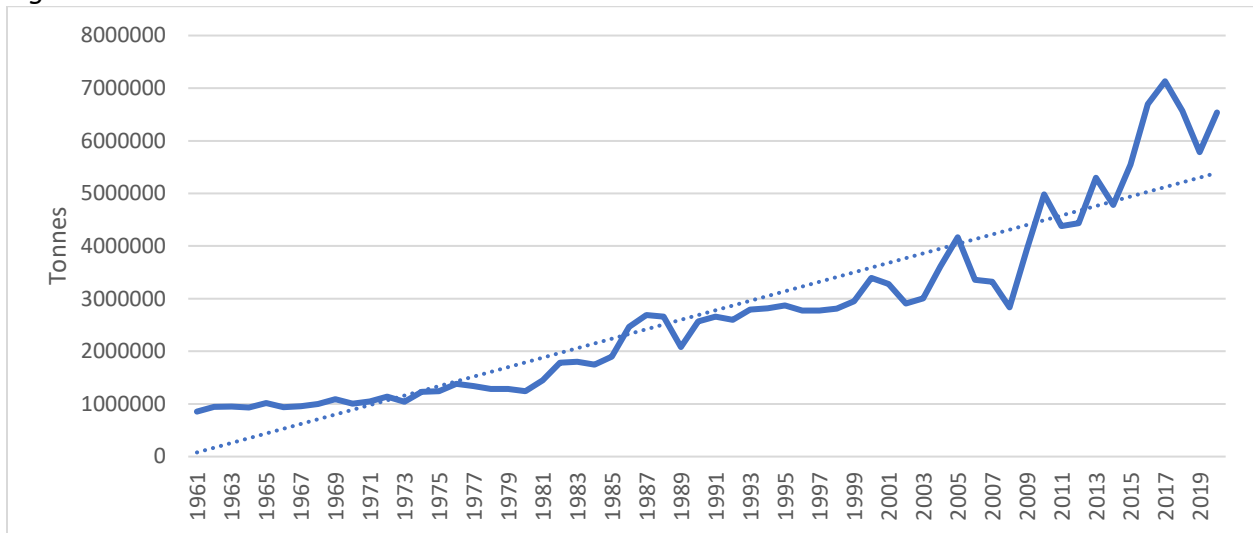
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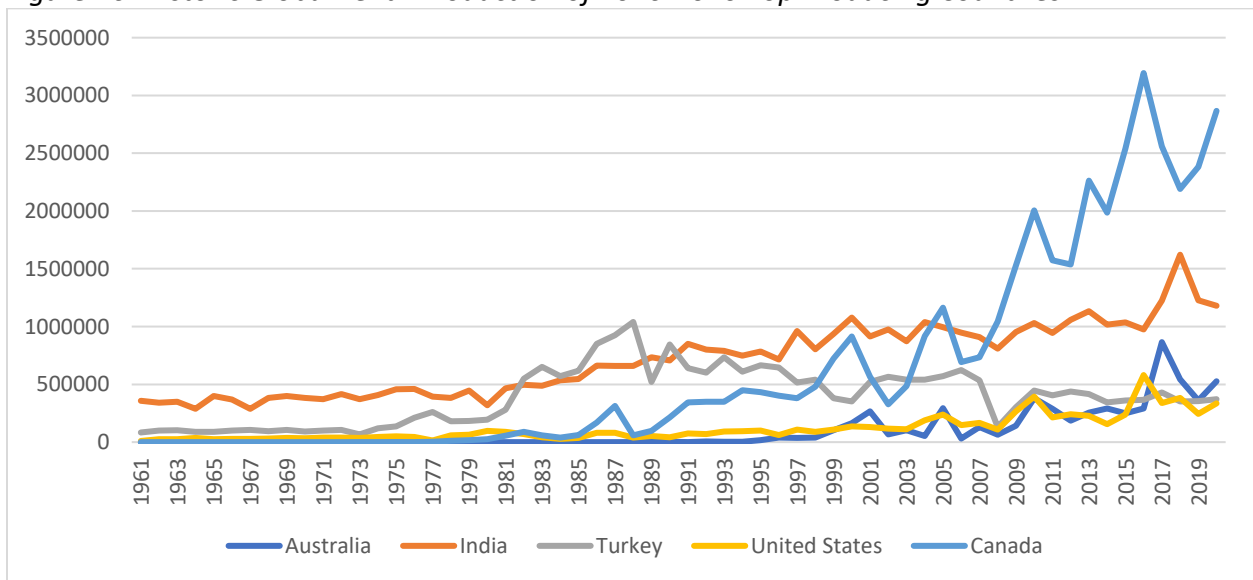
12. Appendix

Figure 15. Historic Global Lentil Production 1961-2020



Source: FAOSTAT (2022)

Figure 16. Historic Global Lentil Production of 2016-2020 Top Producing Countries



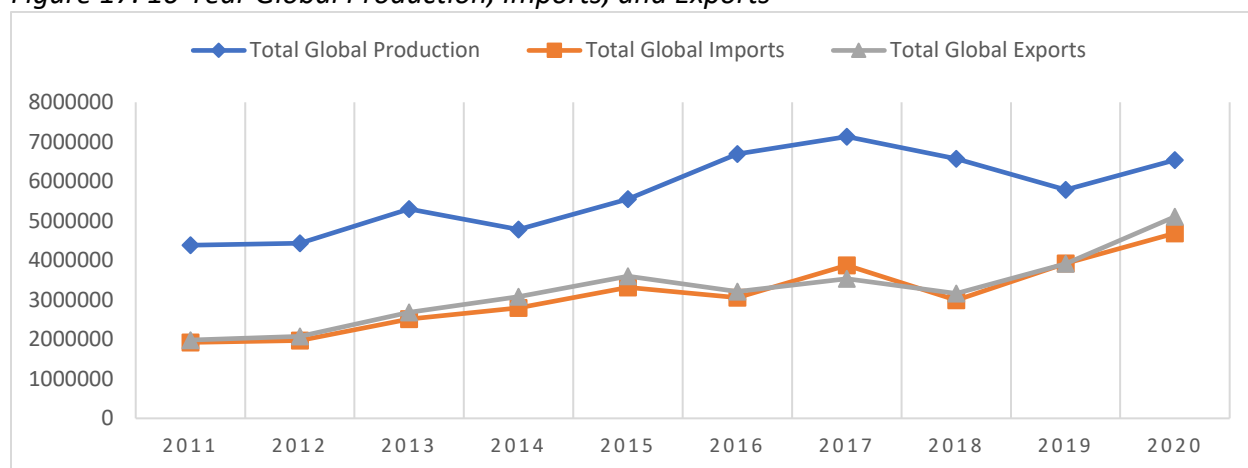
Source: FAOSTAT (2022)

Table 15. Global Lentil Decade Breakdown Analysis

Decade	Tonnes Produced	Decade Production Difference	Decade Growth Rate	Average Yearly Production	Average Yearly Production Growth Rate
1961-69	8,689,945			965,549	
1970-79	12,005,632	3,315,687	38.2%	1,200,563	24.3%
1980-89	19,809,606	7,803,974	65.0%	1,980,961	65.0%
1990-99	27,617,824	7,808,218	39.4%	2,761,782	39.4%
2000-09	33,822,938	6,205,114	22.5%	3,382,294	22.5%
2010-19	55,601,116	21,778,178	64.4%	5,560,112	64.4%

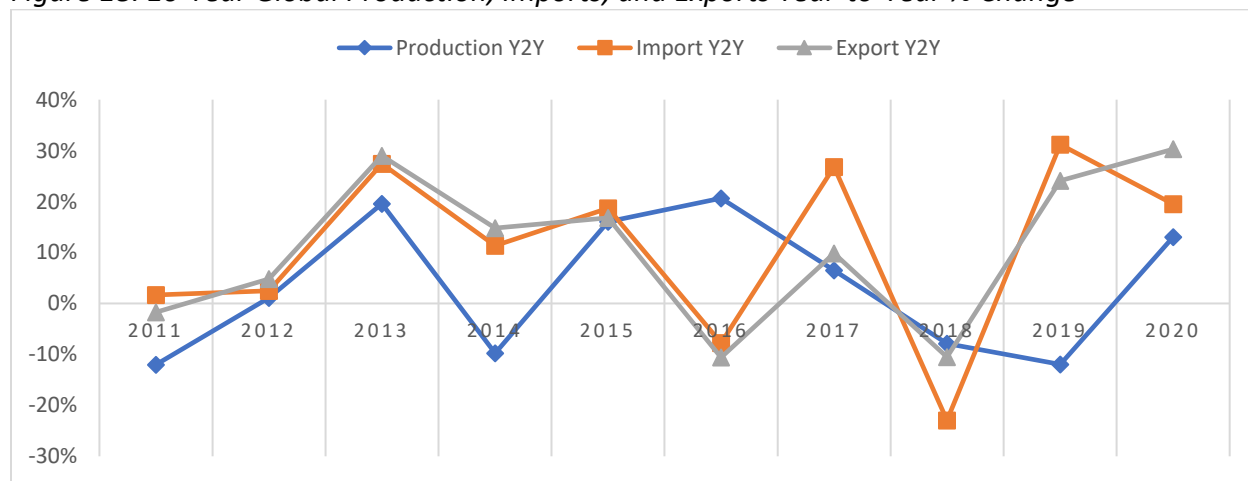
Source: FAOSTAT (2022)

Figure 17. 10-Year Global Production, Imports, and Exports



Source: FAOSTAT (2022)

Figure 18. 10-Year Global Production, Imports, and Exports Year-to-Year % Change



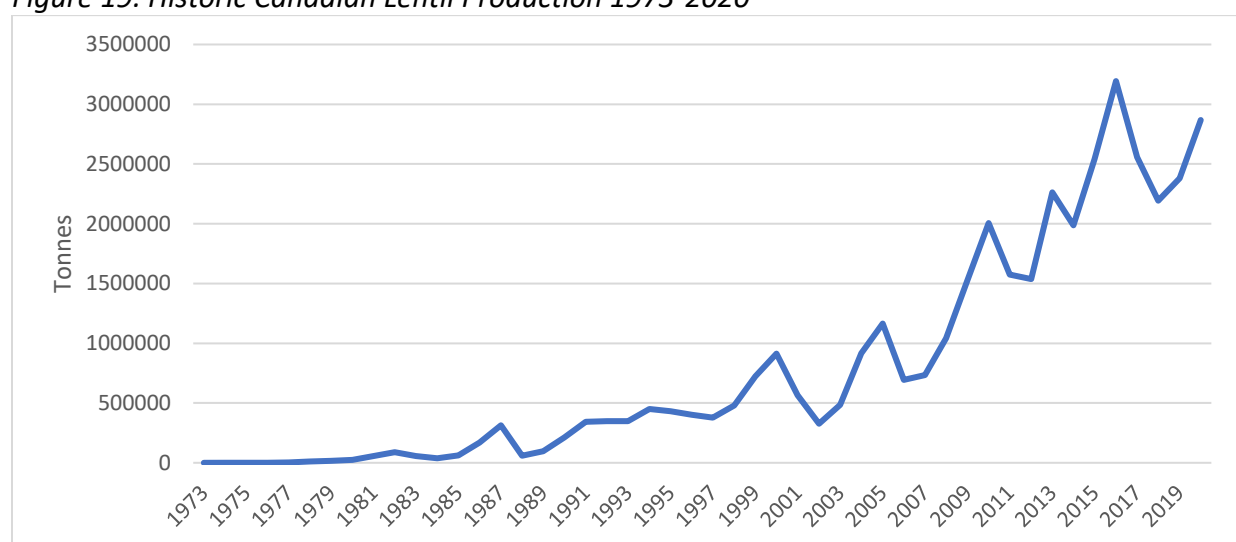
Source: FAOSTAT (2022)

Table 16. Summarizing 10-Year Global Production, Imports, and Exports

Measurement	10-Year Average	5-Year Average
Total Global Production	5,715,779 MT	6,543,233 MT
Total Global Imports	3,103,703 MT	3,705,497 MT
Total Global Exports	3,233,589 MT	3,784,745 MT
Production Year-to-Year Change	3.5%	4.1%
Import Year-to-Year Change	10.8%	9.4%
Export Year-to-Year Change	10.7%	8.6%
Imports/Production	53.9%	57.0%
Exports/Production	52.6%	55.6%

Source: FAOSTAT (2022)

Figure 19. Historic Canadian Lentil Production 1973-2020



Source: FAOSTAT (2022)

Table 17. Canada's Lentil Decade Breakdown Analysis

Decade	Tonnes Produced	Production Difference	Decade Growth Rate	Average Yearly Production (Tonnes)	Average Yearly Production Growth Rate
1973-79	28,949			4,136	
1980-89	968,600	939,651	3245.9%	96,860	2242.1%
1990-99	4,121,000	3,152,400	325.5%	412,100	325.5%
2000-09	8,373,200	4,252,200	103.2%	837,320	103.2%
2010-19	22,231,800	13,858,600	165.5%	2,223,180	165.5%

Source: FAOSTAT (2022)

Table 18. Breaking Down Canada's Combined Red Lentil Production

Red Lentils	2015	2016	2017	2018	2019	2020	Average
Area (acres)	2,987,000	4,240,000	3,003,000	2,036,900	2,330,100	2,932,700	2,921,617
Area Year-to-Year Growth		41.9%	-29.2%	-32.2%	14.4%	25.9%	4.2%
Yield (lbs)	1,394	1,263	1,351	1,308	1,415	1,406	1,356
Yield Year-to-Year Growth		-9.4%	7.0%	-3.2%	8.2%	-0.6%	0.4%
Production (metric tonnes)	1,889,200	2,429,100	1,840,900	1,208,500	1,495,400	1,870,000	1,788,850
Production Year-to-Year Growth		28.6%	-24.2%	-34.3%	23.7%	25.0%	3.8%
Exports	1,532,700	1,806,997	957,961	1,423,029	1,886,800	1,739,600	1,557,848
Export Year-to-Year Growth		17.9%	-47.0%	48.6%	32.6%	-7.8%	8.8%
Export % of Production	81.1%	74.4%	52.0%	117.7%	126.2%	93.0%	90.7%

Source: Compiled from Government of Saskatchewan (2014-2022) and Simpson Seeds (2020)

Table 19. Breaking Down Canada's Large Green Lentil Production

Large Green Lentils	2015	2016	2017	2018	2019	2020	Average
Area (acres)	750,000	948,500	975,000	1,252,600	1,023,500	973,300	987,150
Area Year-to-Year Growth		26.5%	2.8%	28.5%	-18.3%	-4.9%	6.9%
Yield (lbs)	1,375	1,250	1,138	1,048	1,150	1,250	1,202
Yield Year-to-Year Growth		-9.1%	-9.0%	-7.9%	9.7%	8.7%	-1.5%
Production (metric tonnes)	467,800	537,900	503,300	595,700	534,100	552,000	531,800
Production Year-to-Year Growth		15%	-6.4%	18.4%	-10.3%	3.35	4.0%
Exports	440,831	469,200	422,197	421,575	467,500	509,900	455,201
Export Year-to-Year Growth		6.4%	-10.0%	-0.1%	10.9%	9.1%	3.2%
Export % of Production	94.2%	87.2%	83.9%	70.8%	87.5%	92.4%	86.0%

Source: Compiled from Government of Saskatchewan (2014-2022) and Simpson Seeds (2020)

Table 20. Breaking Down Canada's Medium Green Lentil Production

Medium Green Lentils	2015	2016	2017	2018	2019	2020	Average
Area (acres)	25,000	35,000	28,000	48,000	40,500	40,000	36,083
Area Year-to-Year Growth		40.0%	-20.0%	71.4%	-15.6%	-1.2%	14.9%
Yield (lbs)	1,217	1,178	1,181	1,286	1,056	1,268	1,198
Yield Year-to-Year Growth		-3.2%	0.2%	8.9%	-17.9%	20.1%	1.6%
Production (metric tonnes)	13,800	18,700	15,000	28,000	19,400	23,000	19,650
Production Year-to-Year Growth		35.5%	-19.8%	86.7%	-30.7%	18.6%	18.0%
Exports	17,400	15,700	10,900	21,300	19,700	22,400	17,900
Export Year-to-Year Growth		-9.8%	-30.6%	95.4%	-7.5%	13.7%	12.2%
Export % of Production	126.1%	84.0%	72.7%	76.1%	101.5%	97.4%	92.9%

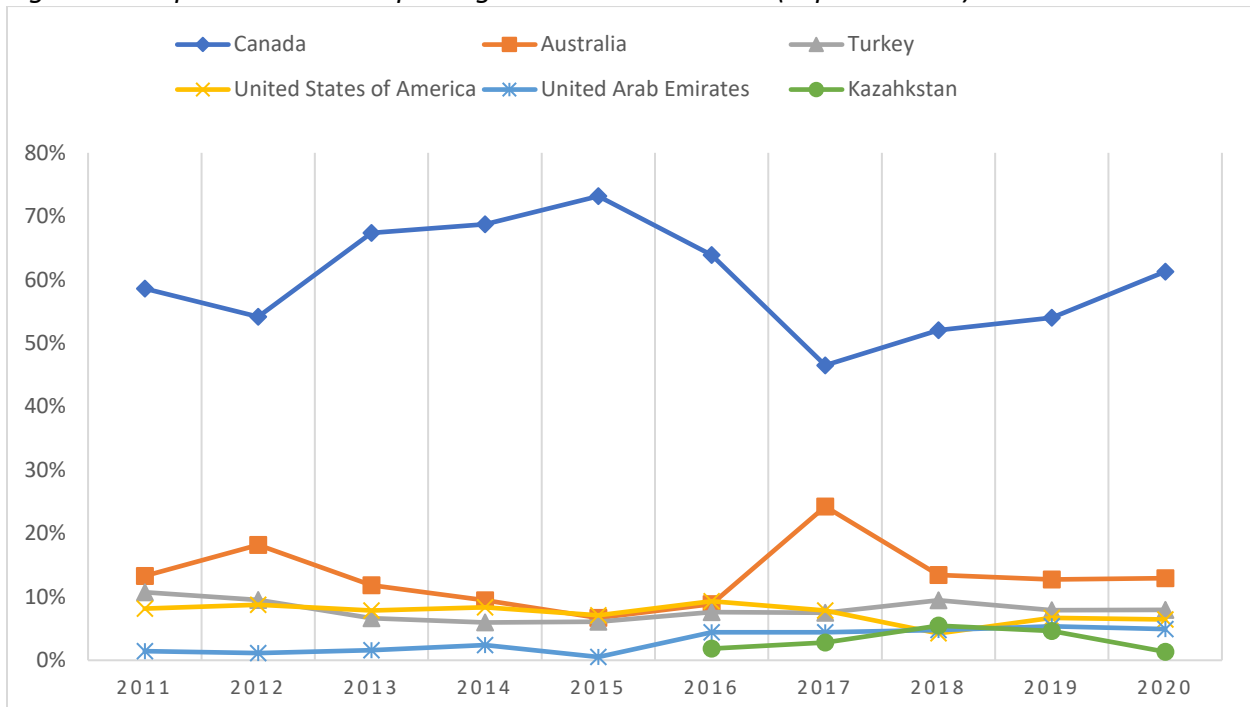
Source: Compiled from Government of Saskatchewan (2014-2022) and Simpson Seeds (2020)

Table 21. Breaking Down Canada's Small Green Lentil Production

Small Green Lentils	2015	2016	2017	2018	2019	2020	Average
Area (acres)	260,000	330,000	385,000	415,600	362,400	265,800	336,467
Area Year-to-Year Growth		26.9%	16.7%	7.9%	-12.8%	-26.7%	2.4%
Yield (lbs)	1,405	1,364	1,113	1,314	1,411	1,393	1,333
Yield Year-to-Year Growth		-2.9%	-18.4%	18.1%	7.4%	-1.3%	0.6%
Production (metric tonnes)	165,700	204,100	194,300	247,700	232,000	168,000	201,967
Production Year-to-Year Growth		23.2%	-4.8%	27.5%	-6.3%	-27.6%	2.4%
Exports	169,000	161,200	144,700	159,100	270,800	162,000	177,800
Export Year-to-Year Growth		-4.6%	-10.2%	9.9%	70.2%	-40.2%	5.0%
Export % of Production	102.0%	79.0%	74.5%	64.2%	116.7%	96.4%	88.8%

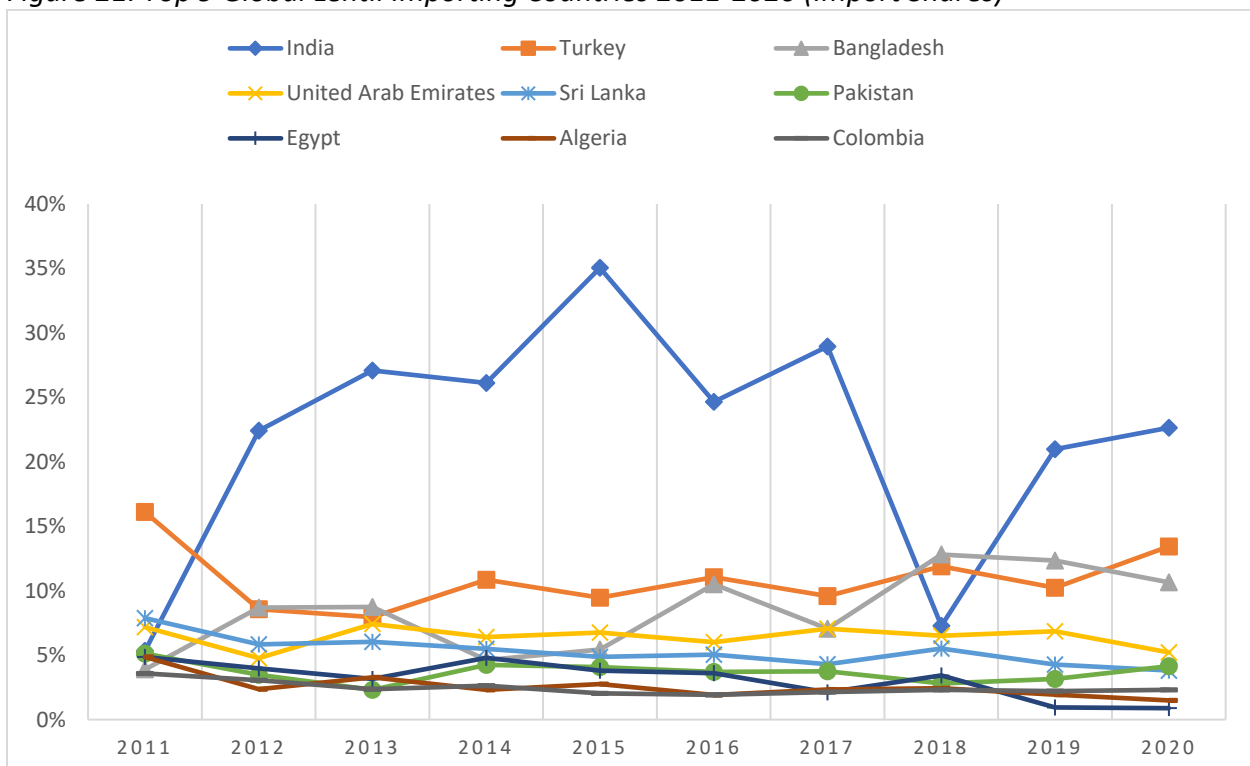
Source: Compiled from Government of Saskatchewan (2014-2022) and Simpson Seeds (2020)

Figure 20. Top Global Lentil Exporting Countries 2011-2020 (Export Shares)



Source: FAOSTAT (2022)

Figure 21. Top 9 Global Lentil Importing Countries 2011-2020 (Import Shares)



Source: FAOSTAT (2022)

Table 22. Overview of Canada's Lentil Companies and Role

Province	Company	Lentil Role
Saskatchewan	Agrocorp Processing Ltd.	Cleaning and Handling, Exporter, Manufacturing, Processor
	AGT Food and Ingredients	Exporter, Packaging, Processor
	Avena Foods	Processor
	Can-Seed Equipment Limited	Cleaning and Handling, Exporter, Manufacturing, Packaging, Processor
	Diefenbaker Spice and Pulse	Cleaning and Handling, Exporter, Packaging, Processor
	Lewis M. Carter Mfg.	Cleaning and Handling, Manufacturing, Packaging
	Purely Canada Foods	Exporter, Importer, Inspection/Verification/Testing, Logistics, Processor, Transportation
	Seaboard Special Crops	Cleaning and Handling, Crop Production, Exporter, Processor
	Simpson Seeds Inc.	Exporter, Processor
	Southland Pulse Inc.	Cleaning and Handling, Processor
	Veikle Grain Ltd	Cleaning and Handling, Exporter, Processor
Viterra Inc.	Cleaning and Handling, Exporter, Manufacturing, Packaging, Port, Processor, Transportation	
Quebec	9405-8245 Québec Inc.	Cleaning and Handling, Inspection/Verification/Testing, Logistics, Ocean Freight, Packaging, Port, Processor, Transportation
	Montreal Port Authority	Port
	Targray	Agency, Broker, Cleaning and Handling, Exporter, Importer, Inspection/Verification/Testing, Logistics, Market Analysis, Ocean Freight, Transportation
	Transco Food Trading Inc.	Broker, Exporter
Ontario	Adascan Grain Corporation	Exporter
	Alpha Field Products Co.	Exporter
	Bonduelle	Manufacturing
	BroadGrain Commodities Inc.	Exporter, Processor
	Canada Trade Pioneers Inc.	Exporter, Importer
	Canadian Grain Inc.	Exporter
	DMI Exim Limited	Exporter, Importer
	ETG Commodities Inc.	Exporter, Packaging, Processor
	Eximcan Canada	Agency, Broker, Exporter, Importer, Logistics, Ocean Freight, Port, Transportation
	Export Packers Company Limited	Cleaning and Handling, Exporter, Importer
	Fieldcrest International Commodities Ltd.	Cleaning and Handling, Exporter, Processor
	Gedco	Broker, Exporter
	Global Commodities Traders Inc.	Cleaning and Handling, Exporter, Processor
	Global Food and Ingredients Inc.	Cleaning and Handling, Exporter, Importer, Inspection/Verification/Testing, Manufacturing, Market Analysis, Packaging, Processor
	Grainport Inc.	Broker, Exporter
	Mandala Trading Canada Inc.	Exporter
	Marina Commodities	Exporter
Meraki Commodities Inc.	Exporter	
Alberta	Hildebrand Farms	Cleaning and Handling, Crop Production, Logistics
	Johnston's Grain	Broker, Crop Production, Logistics, Transportation
	LA Grain Ltd. (Alberta Pulse Traders Ltd.)	Processor
	Scoular Canada Ltd.	Cleaning and Handling, Exporter, Importer, Manufacturing, Packaging, Processor
	Adroit Overseas Enterprises Ltd.	Cleaning and Handling, Exporter, Importer, Processor
British Columbia	Global Agriculture and Transloading Inc.	Inspection/Verification/Testing, Logistics, Packaging, Stuffing Facility, Transportation
	JK Commodities Ltd.	Exporter, Processor
	Natural Specialty Crops Co., ULC	Cleaning and Handling, Exporter, Processor
	Prime Seeds International Inc.	Exporter, Logistics
	Royal Impex (RI) Commodities Inc	Exporter
	Sephina Foods Inc.	Exporter, Importer
	Sum Trade Corp	Broker, Exporter, Importer
	TradeMark Grain	Agency, Broker, Market Analysis
	Victoria Pulse Trading Corporation	Cleaning and Handling, Exporter, Processor
	WTC Group Inc.	Logistics, Ocean Freight, Packaging, Stuffing Facility, Transportation
	ADM Agri-Industries Company	Cleaning and Handling, Exporter

Manitoba	All Commodities (AC) Trading Ltd.	Exporter, Processor
	Cargill Limited	Cleaning and Handling, Exporter
	G3 Canada Limited	Cleaning and Handling, Exporter
	Intertek Testing Services	Inspection/Verification/Testing
	Kalshea Commodities Inc.	Cleaning and Handling, Exporter, Market Analysis
	Mercantile Consulting Venture Inc.	Logistics, Market Analysis
	Paterson GlobalFoods	Cleaning and Handling, Exporter
Red River Global Ingredients Ltd.	Broker, Exporter, Importer, Logistics, Market Analysis, Transportation	

Source: Canadian Special Crops Association (2022)

Table 23. Saskatchewan Lentil/Pulse Primary, Secondary, Tertiary Processing and Exporting Companies

Role	CSCA ¹	SPG ²	Gov of Sask List ³	STEP ⁴
Cleaning/ Handling (CSCA)/ Primary (GoS)/ Supplier (STEP)	Agrocorp Processing Ltd		AGT Foods	
	Diefenbaker Spice and Pulse		Agronart Corporation	
	Lewis M. Carter Mfg. Crops	NA	Agrocorp International	Condie Seeds
	Seaboard Special Crops		Broadgrain Commodities	Crone Farms Inc
	Southland Pulse Inc		ETG Commodities Inc	Dutton Farms
	Veikle Grain Ltd		JK Milling Canada Limited	Etter Seed & Processing Ltd
	Viterra Inc		Keyser Farms Ltd	Grace Hill Farms
			Parrish & Heimbecker Ltd	Grainex Ltd.
			Prairie Heritage Seeds Inc	Holman Farming Group
			Prairie Pulses Inc	JTK Winny Ag
Processor			Scoluar Canada Ltd	Lazer Enterprises Inc.
			Seaboard Special Crops	McCracken Grain
			Simpson Seeds Inc	Solutions LTD
			Toepfer International,	Simpson Seeds
			Western Grain & Processing Division Ltd.	Stonehenge Organics
			Veikle Grain Ltd	
			Ventures West Processing Ltd. DBA Canpulse Foods	
			Victoria Pulse Trading Corp	
		Agrocorp Processing Ltd		
		Alliance Pulse Processors Inc		
		AGT Foods		ADM Agri-Industries Company
		Avena Food Ltd DBA Best		Agrican International Inc
		Cooking Pulses		Agrocorp Processing
		Belle Pulses Ltd		AGT Foods
		Bornhorst Seeds Ltd	Adroit Overseas	Avena Foods-Best Cooking Pulses
		Broadgrain Commodities	Broadgrain Commodities	Broadgreen Commodities
		Diefenbaker Seed Processors & Diefenbaker Spice & Pulse	Diefenbaker Seed Processors	Diefenbaker Spice and Pulse
		Etter Seed & Processing Ltd	ETG Commodities Inc	Etter Seed and Processing Ltd
		Fill-More Seeds Inc	Scoluar Canada Ltd	Growers International Organic Sales Inc.
		Seaboard Special Crops	Southland Pulse Inc	Rein Agri Food Corp
	North West Terminal Ltd	Simpson Seeds Inc	Rudy Agro Ltd	
	Prairie Pulse Inc	Seaboard Special Crops	Schluter & Maack Canada Ltd.	
	Rudy Agro Ltd	JK Milling Canada Limited	Scoular Canada Ltd	
	Scoular Canada Ltd	Viterra Inc	Seaboard Special Crops	
	Section 12 Food Inc	Westland Agro Ltd	Simpson Seeds Inc	
	Simpson Seeds Inc		Sunrise Foods International	
	Southland Pulse Inc		Three Farmers Foods	
	Stonehenge Global Seeds Inc		Westland Agro Ltd	
	Veikle Grain Ltd			
	Westland Agro Ltd			
Exporter	Agrocorp Processing Ltd	Alliance Pulse Processors Inc		Agrican International INC.
	AGT Food and Ingredients	AGT Foods	NA	D.G. Global
	Avena Foods	Avena Food Ltd DBA Best		Green Pulse Export
		Cooking Pulses		Growers International Organic Sales Inc.
		Belle Pulses Ltd		

Diefenbaker Spice and Pulse	Bornhorst Seeds Ltd	JDM Exports
Purely Canada Foods	Diefenbaker Seed Processors	Prairie Heritage Seeds Organics Inc.
Seaboard Special Crops	Diefenbaker Spice & Pulse	Prairie Horizons Industries LTD
Simpson Seeds Inc	Etter Seed & Processing Ltd	RBK International Canada Limited
Southland Pulse Inc	JGL Commodities Ltd	Seaboard Special Crops
Veikle Grain Ltd	Mavigan N.A. Ind	Simpson Seeds Inc
Viterra Inc	Natural Specialty Crops ULC	Sunrise Foods International
	Northwest Terminal Ltd	Westland Agro Ltd
	Prairie Pulse Inc	
	Rudy Agro Ltd	
	Scoular Canada Ltd	
	Section 12 Foods Inc	
	Simpson Seeds Inc	
	Southland Pulse Inc	
	Stonehenge Global Seeds Inc	
	Sunrise Foods International	
	Veikle Grain Ltd	
	XPT Grain Inc	

Source: 1-Canadian Special Crops Association (2022), 2- Saskatchewan Pulse Growers (2022) [2], 3-Government of Saskatchewan (2019), 4- Saskatchewan Trade and Export Partnership (2022)

Table 24. Plant-Based Retail and Food Service Companies

Company Name	List of Retail Service and Grocery Stores	List of Food Service and Restaurants
	Costco Wholesale Canada	A and W
	Farm Boy	Aramark Canada
	Federated Cooperatives Limited	Booster Juice
	Loblaw Companies Limited	Boston Pizza
	Metro	Burger King
	Save on Foods	Compass Group
	Organic Garage	Copper Branch
	Sobeys Inc	Dana Hospitality
	Walmart Canada	Fresh Restaurants
		Gordon Food Service
		Harvey's
		Ikea Canada
		KFC Canada
		Mary Browns
		Mucho Burrito
		Odd Burger
		Panago Pizza
		Pizza hut
		Pizza nova
		Pizza Pizza
		St-Hubert group
		Sodexo Canada
		Starbucks
		Sysco Canada
		Tim Hortons

Source-Report from Natural Products Canada, Humane Society International, Protein Highway, and Protein Industries Canada (2022)

Table 25. Descriptive Statistics Data of Canadian Lentils 2011/12-2020/21

Descriptor	Harvested Acres (‘000 Acres)	Production (‘000 Tonnes)	Imports (‘000 Tonnes)	Exports (‘000 Tonnes)	\$/Tonne
Mean	3,784	2,615	49	2,259	578
Standard Error	282	262	11	227	52
Median	3,867	2,461	43	2,162	521
Mode	#N/A	#N/A	#N/A	#N/A	#N/A
Standard Deviation	891	827	36	718	157
Sample Variance	794,227	684,705	1,297	515,760	24,722
Kurtosis	0.246	3.502	-2.000	-0.054	0.613
Skewness	0.263	1.582	0.201	0.340	1.020
Range	3,005	3,021	89	2,434	489
Minimum	2,483	1,574	9	1,148	405
Maximum	5,488	4,594	98	3,582	894
Sum	37,844	26,151	486	22,593	5,199
Count	10	10	10	10	9
Largest (1)	5,488	4,594	98	3,582	894
Smallest (1)	2,483	1,574	9	1,148	405
Confidence Level (95.0%)	638	592	26	514	121

Source: Government of Saskatchewan (2014-2022)

Table 26. Descriptive Statistics Data of Canadian Lentils 2016/17-2020/21

	Harvested Acres (‘000 Acres)	Production (‘000 Tonnes)	Imports (‘000 Tonnes)	Exports (‘000 Tonnes)	\$/Tonne
Mean	4,293	2,639	71	2,357	553
Standard Error	329	178	12	258	55
Median	4,213	2,559	82	2,455	521
Mode	#N/A	#N/A	#N/A	#N/A	#N/A
Standard Deviation	736	398	27	577	124
Sample Variance	541,488	158,100	733	333,418	15,270
Kurtosis	2	-1	-2	-1	-1
Skewness	1	1	-1	-1	0
Range	1,810	1,002	63	1,362	309
Minimum	3,678	2,192	35	1,538	405
Maximum	5,488	3,194	98	2,900	714
Sum	21,467	13,194	355	11,787	2,767
Count	5	5	5	5	5
Largest (1)	5,488	3,194	98	2,900	714
Smallest (1)	3,678	2,192	35	1,538	405
Confidence Level (95.0%)	914	494	34	717	153

Source: Government of Saskatchewan (2014-2022)