

A photograph of a potato field at sunset. The sun is low on the horizon, creating a bright orange glow and long shadows. The potato plants are lush green with some white flowers. The sky is a mix of orange and blue.

Measuring the Economic Significance of the U.S. Potato Industry

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Letter from our President



On behalf of the National Potato Council (NPC) and the growers we represent, I'm pleased to offer this exciting and impactful insight into the U.S. potato industry and its contributions throughout the American economy.

This analysis marks the first time any organization has measured and reported on the national economic impact of America's favorite vegetable.

Given its prominence in our diet and wellbeing, potatoes provide a significant contribution to America's economic activity, including direct activity (growth, processing, wholesaling, and retail) and job creation—making potatoes an essential component of our prosperity as a nation built and sustained by potato growers who indirectly put people to work in every city and town across our great country.

The U.S. potato sector is vital to America's economic lifeblood, generating an estimated \$100.9 billion in economic activity in 2021 alone. Our sector is responsible for supporting an estimated 714,000 domestic jobs and providing wages of \$34.1 billion annually to those employed along our supply chain. An impressive 0.4% of the entire U.S. workforce relies on our industry for their livelihoods, contributing \$53 billion towards annual GDP growth.

I want to thank the economists and researchers at Michigan State University for this analysis. The staggering results of this study are reinforced by the fact that potatoes are the number one consumed vegetable by U.S. consumers annually and are a beneficial source of vitamins and minerals in all diets.

Thanks to U.S. potato growers, our partners and workers up and down the supply chain, and the consumers who love our products, America is indeed a spud nation.

Sincerely,

RJ Andrus
TBR Farms, Idaho Falls, Idaho
President, National Potato Council

Executive Summary



This analysis assesses the national economic contribution of the potato sector on the United States. It also analyzes the supply chain for potatoes and the level of exports and imports of potatoes and potato products. The 2021 total economic contribution of the potato sector is estimated to be **\$100.9 billion**. The contribution stemming from farm production makes up about **\$10.8 billion**. These estimated economic contribution estimates entail **\$37.2 billion** direct economic activity arising from growing, processing, wholesaling, and retailing potatoes and potato products. The remaining **\$63.7 billion** is made up of indirect activity from affected industries and expenditures from household consumption that can be traced back to activity generated by the potato sector.

Total employment generated by the potato sector is estimated to be in excess of **714,000 domestic jobs**, of which approximately **405,000** are directly employed along the potato supply chain and more than **309,000** are employed in related industries or other

businesses. These jobs command about **\$34.1 billion in wages and salaries** per year and contribute **\$53.5 billion** to the annual gross domestic product (GDP) of the United States. To place these findings into context, about **0.4 percent of the U.S. domestic workforce** is supported by the domestic potato industry supply chain.

The potato industry entails a wide spectrum of activity, from agricultural production, through wholesaling and processing and distribution ending with consumer purchases of final products through retail channels or through food service providers. Farms and businesses producing, processing, and distributing potato and potato products can be found in all parts of the U.S. and accordingly, the potato industry is present throughout the nation.

The U.S. is the **world's fifth largest producer**, and potatoes are the **number one consumed vegetable** by U.S. consumers. Potatoes are a remarkably versatile vegetable and have many desirable characteristics that make it a staple

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food. It is rich in antioxidants, potassium, and potato skins are high in fiber (UC Davis 2022). It is also an inexpensive source of calories which is very important in developing countries where food security is an issue.

In the U.S., the largest producing state of potatoes is **Idaho**, followed by **Washington**. Other major producing states include **Wisconsin, Oregon, North Dakota, Colorado, Minnesota, Maine, Michigan, Nebraska** and **California**. States tend to specialize in the variety categories grown, though all varieties are viable in every state. Many, if not most, of the potatoes grown in the U.S. are produced under contract (Source Trace Systems 2020). Contracts are most pervasive for processing potatoes, especially for potatoes grown for fries and chips.

More than two thirds of the potatoes sold in the U.S. were used for processing in 2018.

One quarter of those were used for sales to households; the rest were allocated to other uses. Food service is an especially important outlet for potatoes primarily in the form of fries.

While most potatoes grown in the U.S. are consumed domestically, foreign trade is an important outlet for potatoes. Approximately **20 percent of the potatoes grown or processed in the U.S. are exported** either as fresh or processed potatoes, though the U.S. both imports and exports fresh, processed and products derived from potatoes. Canada and Mexico are major markets for U.S. fresh and dehydrated potatoes and Japan and South Korea are major markets for U.S. frozen potatoes. Canada is a leading source of imports for potatoes used in processing. These Canadian imported potatoes may be subsequently exported as processed potatoes or in potato-derived products.



Introduction

While native to South America, potatoes are grown around the world. This vegetable is so adaptable and vital to human nutrition that it is now grown throughout the Americas, all of Europe, south and east Asia, Australia and Africa (Monfreda, Ramankutty & Foley 2008). That is, potatoes are grown on six of the seven continents.

Prior to the war in Ukraine, the four largest global producers of potatoes were China, India, Russia, and Ukraine (USDA: Agricultural Marketing Resource Center 2021). The U.S. is the world's fifth-largest producer. Potatoes are a remarkably versatile vegetable and have many desirable characteristics that make it a staple food. It is rich in antioxidants, potassium, and potato skins are high in fiber (UC Davis 2022). It is also an inexpensive source of calories which is very important for food-insecure consumers..

Potatoes are the most consumed vegetable in the United States (Kantor & Blazejczyk 2020) and are the only vegetable whose level of consumption is consistent with U.S. Department of Agriculture (USDA) dietary guidelines (Guthrie et al., 2013). In addition to being cooked and eaten whole, they can be processed into a wide variety of value-added products. Over one-third of U.S.-grown potatoes are processed as frozen potatoes (USDA: NASS 2022) and about 93 percent of those are utilized as fries (USDA: NASS 2022; Lucier, 2020). Fresh table-stock and potatoes for potato chips represent about 25 and 23 percent of U.S. potato utilization, respectively (Potatoes USA, 2021d). Potatoes

are also a common ingredient in soups and salads. Industry statistics often break out potato utilization into three categories: at-home consumption, food service, and institutional utilization. The latter entails consumption at public institutions like schools and hospitals. Food service utilization makes up the largest use of U.S.-grown potatoes, and fries make up the largest portion of food service uses. An additional category of utilization is animal feed, which is usually made up of grower stocks with blemishes or size characteristics that make them less fit for human food markets.

Potatoes are grown throughout the United States. The largest producing state of potatoes is Idaho, followed by Washington. Other major producing states include Wisconsin, Oregon, North Dakota, Colorado, Minnesota, Maine, Michigan, Nebraska and California. States tend to specialize in the variety categories grown. For example, Idaho is an important source of Russet potatoes (Idaho Potato Commission 2023), Michigan is the largest producer of potatoes for chips (Michigan Potato Industry Commission 2022), and 80 percent of Washington's potato crop goes to fry production (Steury 2023). Regardless, all categories are viable in every state.

This analysis assesses the national economic contribution of the potato sector for the year 2021. It also analyzes the supply chain for potatoes and the level of exports and imports of potatoes and potato products. The total economic contribution of the potato sector



The Supply Chain of Potatoes

Table 1 shows U.S. domestic production of potatoes from 2009 to 2021. The data shows a long-term trend of growth in U.S. domestic potato production that has experienced a recent reversal since 2019, primarily due to adverse weather conditions. The decline in production is one reason why the average farm gate price of potatoes has increased from \$8.90 a hundredweight in 2018 to \$10.20 in 2021; an increase of 14.6 percent (USDA: NASS 2022). The onset of war in Ukraine, the general pace of U.S. and global inflation, and the re-opening of

restaurants from COVID-19 closures, have likely placed added upward pressure on potato prices.

Table 1 further shows that farm use makes up about one percent of total production. About 5.5 percent of total production is used for seed and approximately another 5.5 percent of output is lost due to shrinkage and other factors. Potatoes remain one of the most abundantly available vegetable crops for U.S. consumers, as approximately 49.4 pounds of potatoes were available per person in the U.S. in 2019 (Kantor & Blazejczyk 2020).

TABLE 1 *U.S. Potato Production 2009-2021*

Year	Production (Cwt.)	Seed (Cwt.)	Farm Use (Cwt.)	Shrinkage and Loss (Cwt.)	Sold (Cwt.)
2009	432,601,000	24,027,000	4,535,000	29,135,000	398,921,000
2010	404,549,000	25,100,000	4,227,000	24,996,000	375,326,000
2011	430,037,000	26,527,000	4,146,000	27,789,000	398,102,000
2012	464,970,000	25,656,000	4,850,000	28,505,000	431,615,000
2013	434,652,000	25,249,000	4,323,000	26,211,000	404,118,000
2014	442,170,000	26,259,000	4,192,000	26,762,000	411,216,000
2015	441,205,000	25,715,000	4,631,000	26,509,000	410,065,000
2016	450,324,000	26,167,000	4,437,000	26,683,000	419,004,000
2017	450,921,000	24,673,000	4,410,000	25,139,000	421,372,000
2018	450,020,000	24,973,000	4,047,000	25,526,000	420,447,000
2019	424,419,000	22,761,000	4,608,000	25,016,000	394,795,000
2020	420,020,000	23,010,000	4,550,000	23,453,000	392,017,000
2021	409,829,000	22,158,000	3,579,000	23,367,000	382,883,000

Source: USDA, Agricultural Statistics

is estimated to be \$100.9 billion, where farm production alone accounts for \$10.8 billion. Estimates suggest that \$37.2 billion of this contribution is direct economic activity resulting from growing, processing, wholesaling, and retailing potatoes and potato products while \$63.7 billion is indirect activity from related industries and household consumption resulting from activity generated along the potato sector. Total employment generated by the entire potato supply chain is estimated to be in excess of 714,000 of which approximately 405,000 are directly employed in the potato sector and

more than 309,000 are employed in related industries or other businesses. The next section presents an overview of the U.S. domestic supply of potatoes. The supply chain represents all the processes from raw material inputs to final products for human consumption. This is followed by a brief overview of the international trade of potatoes. The next section discusses the methods and data used for measuring the economic significance of the potato industry and the resulting estimates. The final section summarizes the findings and concludes the report.



While there exists a wide range of potato varieties, commercial production of potatoes is largely focused upon a few key varieties. Within each variety there may exist a number of sub-varieties. This is especially true for Russet potatoes (Potato Association of America 2020). Major potato variety classes, and their common uses are:

- **Russet potatoes:** Baked or roasted, mashed, fried, processing for fries and dehydrated potatoes
- **Yellow potatoes:** Grilled, baked or roasted, mashed, salads
- **Red potatoes:** Baked or roasted, salads, soups, stews, grilled, steamed
- **White potatoes:** Mashed, salads, steamed, pan fried or sautéed, processing for potato chips
- **Purple potatoes:** Baked or roasted, grilled, salads
- **Fingerling potatoes:** Pan fried or sautéed, baked or roasted, salads

Russet potatoes are popular for baking, mashed potatoes, and fries. They are often purchased by households as well as processors. Due to their size, Russets are well suited for fry production because they have the potential to be processed into long, thick fries (Potatoes USA 2021a). Yellow potatoes are very versatile and are growing in popularity. They are often purchased by households, as are red potatoes. Also, as is the case with heirloom tomatoes, there appears to be a market for heirloom potato varieties, especially purple varieties. Varieties used for potato chips are round white varieties many of which are proprietary to the potato chip processor or brand. The other potato varieties are somewhat less popular but are representative of the vast varieties available to consumers. Despite having a wide variety of options in the U.S., there are more than 5,000 additional varieties of potatoes grown in South America (Madigan 2021), creating a potential to further expand the varieties produced in the United States.

An expansive and specialized supply chain exists of inputs to produce potatoes. Machinery, fertilizers, land, and management are common inputs to all types of crop farming. Planting, harvesting and processing activities require specialized equipment with limited applications for other crops. Processing and storage facilities are specialized for processing potatoes and often designed to meet a variety of specifications for efficient processing. Potatoes grown for seed are particularly important for the potato industry and require special consideration. In this, the U.S. has a limited generation system that prevents a seed lot from being used for more than five years. This limits the potential for disease build up (Potato USA 2022b).

After being harvested, potatoes either move into storage or are delivered directly to a packing shed or processor. Those sent to

a packing shed are washed, graded, and packaged (Madigan 2021). Potatoes that move into storage are maintained in controlled atmosphere facilities to preserve their quality so they can be sold at a later date.

Potato growers often grow potatoes under contract, especially potatoes grown for fries and chips (Source Trace Systems 2020). The utilization of potatoes is shown in Table 2. While these figures are somewhat dated, they may be more reflective of the market of potatoes post-COVID-19 than potato utilizations during the pandemic.

More than two-thirds of the potatoes sold in the U.S. were used for processing in 2018. One-quarter of those were used for sales to households; the rest were allocated to other uses. Table 3 further breaks down the processing utilization of potatoes in 2016 and 2017.

TABLE 2 *Potato Utilization in the U.S. 2017-2018*

Utilization (Cwt.)	2017	2018
Consumptive Sales		
Table Stock	109,824,000	106,462,000
Processing	284,411,000	289,209,000
Other Sales		
Livestock Feed	1,913,000	697,000
Seed	25,224,000	24,079,000
Other Sales Total	27,137,000	24,776,000
Total Sales	421,372,000	420,447,000
Non-Sales		
On Farm Seed	3,526,000	3,491,000
Household Use and on Farm Seed	884,000	556,000
Shrinkage and Loss	25,139,000	25,526,000
Total Non-Sales	29,549,000	29,573,000
Total Production	450,921,000	450,020,000

Source: USDA, Agricultural Statistics

TABLE 3 *Processing Utilization of Potatoes 2016 and 2017*

Utilization (Cwt.)	2016	2017
Chips and Shoestrings	58,751,000	62,700,000
All Dehydrated (including starch and flour)	45,761,000	49,066,000
Frozen fries	155,798,000	162,640,000
Other Frozen Products	13,803,000	15,956,000
Canned Potatoes	1,152,000	1,113,000
Other Canned Products that use Potatoes	703,000	758,000
Other (fresh pack, potato salads, vodka, etc.)	6,160,000	5,550,000
Total	282,128,000	297,783,000

Source: USDA, *Agricultural Statistics*

In 2017, more than one-third of all the potatoes sold in the U.S. were used to produce fries. About 55 percent of potatoes (by weight) for processing were used for fries. The second largest use of processed potatoes was for chips and shoestring potatoes which accounted for about 16.5 percent of all potatoes used for processing. The third largest use of potatoes by volume was for dehydration. This includes packaged starch, flour and packaged potato products like instant mashed potatoes, scalloped potatoes, and potatoes au gratin. Potatoes are increasingly being used as an input in other processed food products, such as frozen meals, pot pies, and soups.

Some of the largest firms in the agri-food industry are involved in the processed potato industry. Collectively, the food service sector makes up the largest buyer segment for processed potatoes. Fast food restaurants are the largest buyers of frozen potatoes for use in fries, and PepsiCo and Campbell Soup Company, through their Frito-Lay and Snyder-Lance divisions, are the largest producers of chips. Current potato sales growth is largest in craft or specialty chip production. There is also product innovation in the chip sector focusing

on lower sodium varieties, baked chips, and chips with a lower oil content (Diment 2021).

Processed potato production entails vast inputs from producers in other agricultural production sectors, as well as from other manufacturing sectors – particularly for packaging and processing. Processors use inputs to produce finished products. Examples of these are packaging, utilities, salt, breadings, spices, other agri-food inputs, cooking oil, and energy. The types of inputs brought into the processed potato production process depend on the type of product processed. To be sure, potatoes are also inputs to other processed and packaged food products, where potatoes are secondary components. For example, consider shepherd’s pie, where mashed potatoes constitute only one component of the necessary ingredients to complete this traditional dish that is often marketed as a frozen meal.

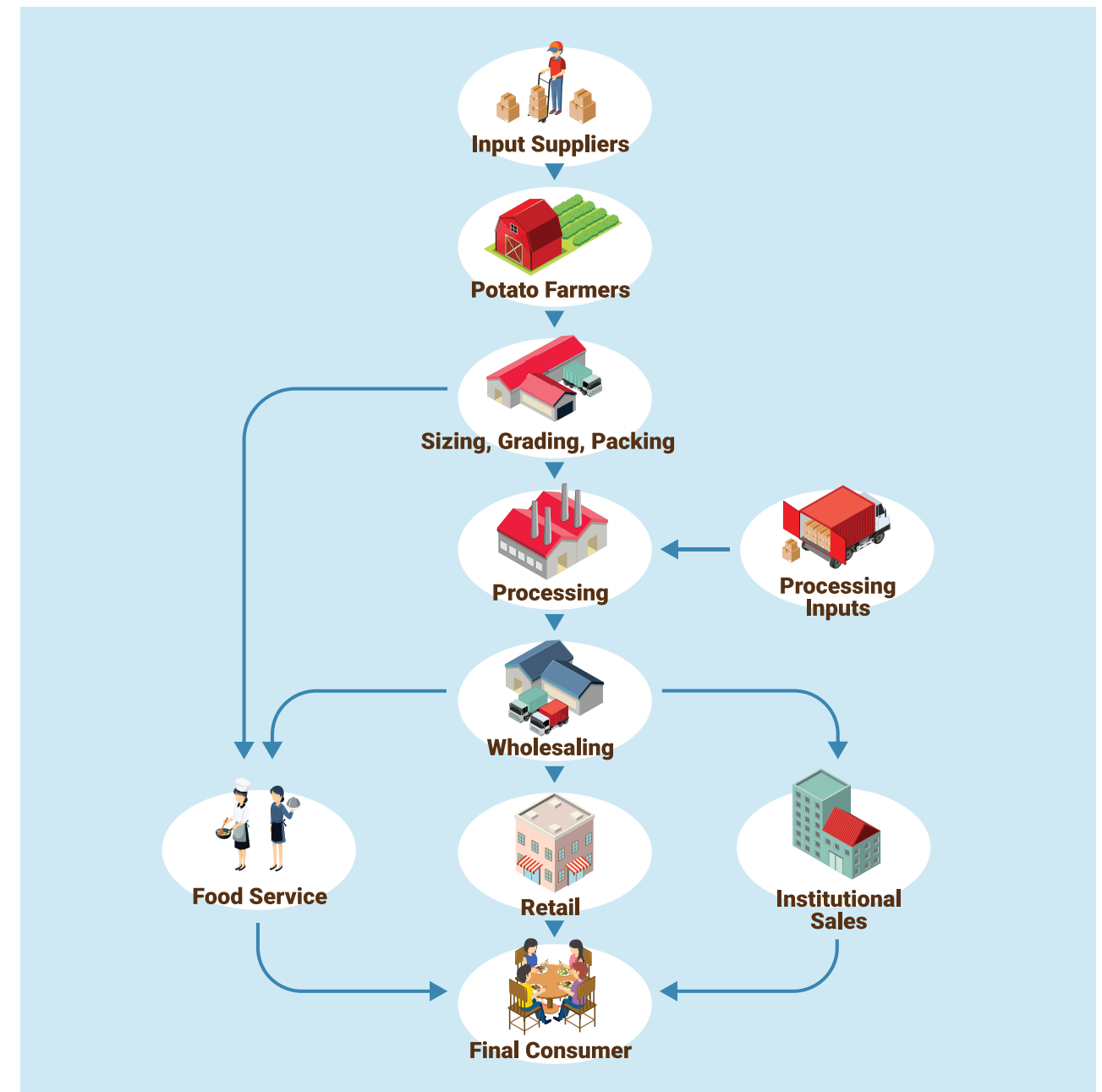
Potatoes and processed potato products are then handled by wholesalers (see Figure 1). In some cases, large firms manage their own warehouses, which means that they do not need to use wholesale services but carry out some of the activities that wholesalers do internally. The potatoes and potato products are then handled

by retailers, food service firms, and institutions such as schools and hospitals. The products are then bought or consumed by the final consumer. A stylized depiction of the complete supply chain from farm input suppliers to consumers is shown in Figure 1.

Potato quality is important for both the fresh and processed potato markets. Since many potatoes

are marketed through contracts, grading and sizing are important activities. Some potatoes destined for the fresh market go straight to potato wholesalers, and then go to either the retail market or food service or institutional sales. Given the popularity of potatoes and their versatility, the supply chain for potatoes is complex compared to many other agricultural commodities.

FIGURE 1 *The Supply Chain for Potatoes*



International Trade

TABLE 4 U.S. Exports of Potatoes (Calendar Year)

	US Dollars		Fresh Weight Equivalent (Metric tons)	
	2020	2021	2020	2021
Total Exports	\$1,667,011,199	\$1,875,477,595	3,063,054	3,377,961
Frozen	\$1,021,182,588	\$1,188,727,694	1,509,984	1,763,058
Fresh	\$233,079,703	\$262,967,809	483,470	570,472
Dehydrated	\$216,105,741	\$213,548,916	865,170	819,234
Chips	\$186,409,856	\$198,411,782	185,432	199,056
Seed	\$10,233,311	\$12,821,394	18,998	26,141

Source: USDA, Agricultural Statistics

Approximately 20 percent of the potatoes grown in the U.S. are exported in either fresh or processed form, representing a combined \$1.88 billion in sales (Potatoes USA 2022c). Despite potatoes being grown and consumed throughout the world, and despite the volume of U.S. potato production and consumption, the U.S. is neither a primary exporter nor an importer of potatoes in the aggregate.

Total U.S. exports of potatoes generated \$1.875 billion in sales in 2021 up from \$1.667 billion in 2020. The total volume of fresh potatoes making up 2021 exports was just under 3.4 million metric tons (Table 4). Processed potato shipments in the form of frozen was the most common form, followed by fresh, dehydrated, chips and seed, respectively. While fresh was the most second most common form of exports by sale value, dehydrated was the second most common form exported by volume.

Table 5 shows that Mexico and Canada were the largest export markets for all potato products

in volume. However, Japan was the second largest market in terms of sales. We should note that trade with Mexico and Canada is often two-way. All three countries participate in intermediate trade exports to one market may be for processing for export to others, including the country of origin.

Similarly, Table 6 shows the top 10 exports for frozen potatoes in 2021, indicating Japan as the top importer of U.S. frozen potatoes. Mexico follows closely, while Canada is the fifth largest importer of frozen potatoes. Table 7 shows export sales and volume for fresh, or table-stock potatoes. Consistent with the intermediate trade of potatoes discussed above, Canada and Mexico are the top export markets for fresh U.S. potatoes. By weight, Canada imported more than twice that of Mexico, but in dollar terms Mexico exports command a relatively higher sale price.

Table 8 shows the top ten export markets for U.S. dehydrated potatoes. Often an intermediate

TABLE 5 Top 10 U.S. Export Markets for Potatoes (2021 Calendar Year) • TOTAL

TOTAL	US Dollars	Fresh Weight Eq. (Metric Tons)
Mexico	\$393,693,595	759,955
Canada	\$324,144,942	739,042
Japan	\$357,882,548	651,251
South Korea	\$123,703,766	194,472
Taiwan	\$79,807,784	124,937
Philippines	\$95,904,337	137,729
Malaysia	\$62,017,657	99,394
China	\$39,405,783	68,219
Guatemala	\$39,212,893	56,228
Singapore	\$38,588,294	52,390

Source: Potatoes USA 2022c

TABLE 6 Top 10 U.S. Export Markets for Potatoes (2021 Calendar Year) • FROZEN

FROZEN	US Dollars	Fresh Weight Eq. (Metric Tons)
Japan	\$290,985,766	445,412
Mexico	\$266,438,431	429,287
South Korea	\$104,227,475	140,814
Philippines	\$66,348,854	101,459
Canada	\$67,450,726	95,316
Taiwan	\$59,183,185	80,726
Malaysia	\$51,888,205	75,460
China	\$37,058,476	59,514
Guatemala	\$34,643,181	47,751
Hong Kong	\$30,643,992	43,819

Source: Potatoes USA 2022c

TABLE 7 Top 10 U.S. Export Markets for Potatoes (2021 Calendar Year) • FRESH

FRESH	US Dollars	Fresh Weight Eq. (Metric Tons)
Canada	\$100,901,646	263,516
Mexico	\$60,313,983	124,449
Japan	\$25,104,798	54,001
Taiwan	\$17,551,595	34,709
South Korea	\$8,752,828	15,311
Dominican Republic	\$9,063,409	14,066
Honduras	\$7,572,872	12,013
Philippines	\$6,751,720	11,692
Malaysia	\$5,345,801	9,781
Singapore	\$3,123,217	4,536

Source: Potatoes USA 2022c

TABLE 8 *Top 10 U.S. Export Markets for Potatoes (2021 Calendar Year) • DEHYDRATED*

DEHYDRATED	US Dollars	Fresh Weight Eq. (Metric Tons)
Canada	\$93,988,140	312,423
Mexico	\$34,721,153	144,983
Japan	\$33,068,320	142,487
United Kingdom	\$10,786,017	52,020
South Korea	\$7,161,889	34,028
Australia	\$6,295,971	28,067
Israel	\$3,985,592	15,067
Malaysia	\$3,305,343	13,221
Indonesia	\$2,368,549	8,860
Taiwan	\$1,895,573	8,125

Source: Potatoes USA 2022c

TABLE 9 *Top 10 U.S. Export Markets for Potatoes (2021 Calendar Year) • CHIPS*

CHIPS	US Dollars	Fresh Weight Eq. (Metric Tons)
Mexico	\$32,220,028	61,236
Canada	\$52,267,076	46,476
Philippines	\$20,965,683	17,408
United Arab Emirates	\$15,730,941	9,844
Japan	\$8,723,664	9,352
Saudi Arabia	\$6,622,760	5,500
Singapore	\$3,896,799	4,880
Netherlands	\$4,354,309	3,220
South Korea	\$2,705,116	3,100
Qatar	\$5,036,595	2,844

Source: Potatoes USA 2022c

processing product, dehydrated potatoes are increasingly found on grocery shelves around the world. Once, again, Canada and Mexico are top markets, where Canada makes up more than twice the value of the Mexican market in both volume and sales. Unlike fresh, however, the Canadian market pays a relative premium for dehydrated potatoes relative to the Mexican market (determined by taking the ratio of dollars to weight).

Finally, Table 9 shows the top ten markets for potato chip form of potatoes. Mexico and Canada remain the dominant destinations. The Canadian market is the top destination in sales, but Mexico is the top destination in terms of volume, the difference indicating that Canadian markets pay a premium for chip-processed potatoes over Mexico.

Data and Methods for Estimating Economic Contributions

Like all industries in the U.S., the domestic supply chain supporting the production of raw potatoes, processing them, and delivering them to consumers in fresh or processed form generates economic activities that exceed the direct value of the final products sold for consumption. This section traces the transactions involved in the production of potatoes from the agricultural inputs all the way to the distribution of final goods for consumption. The corresponding economic contribution estimates recognize that directly associated transactions give rise to secondary transactions as dollars are spent and re-spent in the economy in a reciprocal fashion not unlike the ripples on water created by a tossed rock in an otherwise calm pond. That is, the estimates entail what is commonly referred to as an economic multiplier effect.

One should be careful to note that the estimation framework employed in this section reflects an economic contribution, not an economic impact. Economic impact estimates follow the same approach as economic contribution assessments. However, economic impact estimates must take into account all lost economic activities supplanted by the industry in question, while economic contributions only account for the economic value of activities directly and indirectly attributed to the industry in question. For example, an economic contribution assessment of the agricultural production of potatoes will measure the selling value of potatoes produced and the value of all the inputs required to make that output. An

economic impact assessment of the agricultural production of potatoes will also measure the economic value of the sold potatoes and the associated input values. However, it will go further to recognize the lost revenues of the likely alternative crops that would be grown in the absence of potatoes. For instance, the acres allocated to potatoes may supplant the sale and production values of corn on those same acres. Unfortunately, determining what production potatoes supplant can be challenging as this counterfactual state of production does not exist and cannot be observed directly. An economic contribution assessment does not require conjecturing the nature of agricultural production in the absence of potato production. In total, economic impact assessments impose significant barriers to estimation over that of economic contribution assessments.

One of the shortcomings of any economic contribution estimate, like that provided here, is that other supply chains can also be claimed for some associated economic activities. For example, the mashed potatoes that go into a frozen meal, like shepherd's pie, are co-mingled with other ingredients. Accordingly, the supply chain for minced beef or lamb can also assert ownership to the same value attributed to potatoes. While the estimates provided in this analysis shares out that portion of the finished good that can be attributed to potatoes, the very nature of the economic simulation model assures that if we were to measure the economic contributions of all inputs into final



products entailing potatoes, the total economic contribution would entail excessive double-counting of effects across the multiple inputs.

The USDA National Agricultural Statistics Service (NASS) is the primary source of information for potato production, sales, and trade. This agency also provides breakouts of commodity sales by form (frozen, fresh, dehydrated, etc.). The USDA Agricultural Marketing Services (AMS) provides in-depth coverage of trade flows of raw and processed potatoes. The U.S. Department of Commerce provides detailed transaction data called a social accounting matrix (SAM) that allows measures of inputs into the agricultural production process of growing potatoes, as well as that of processing, wholesaling, and retailing. The SAM traces all purchases and subsequent transactions along all supply chains and forks in channels from raw material inputs to final goods. As a social accounting construct, the SAM is a system of double-entry accounting, where a receipt for one party is an expenditure of another. One's expenditure for potato inputs

reduces their ability to spend on other things, and when one sells potatoes, they make subsequent expenditures from those earnings. Businesses take revenues from sales and pay for inputs and services. Those firms supplying inputs and services take these earnings and pay for inputs, inventory, and services. Firms also pay wages to workers and profits to shareholders, and these beneficiaries take these earnings and spend them on household expenditures, setting off subsequent rounds of transactions that cease only to the extent that purchases are made for goods and services rendered outside the local economy. These cycles continue indefinitely, mitigated only to the extent that individuals and institutions save, rather than re-spend from earnings and the extent to which subsequent purchases go to international suppliers.

The IMPLAN economic simulation model is used to model transactions and subsequent rounds of expenditures using the U.S. domestic SAM. IMPLAN is a well-established economic simulation model developed on over 50 years

of economic research. It provides 544 distinct industry detail, allowing for granular tracking of transactions. Consistent with the economic theory underlying the model, the IMPLAN simulation model is strictly backward-looking. That is, modeling the economic transactions of agricultural output starts with the value of agricultural production and traces all the inputs required to make that output. It is mostly silent about what happens to that output after it leaves the farm. Similarly, if the analysis starts with the value of wholesale activities, the analysis will start with the value of wholesale sales of potatoes and work backward, capturing the value of agricultural production necessary to supply the wholesale sales of potatoes. However, measuring potatoes' share of value becomes increasingly murky moving down the supply chain (Miller & Mann 2020), as potatoes are intermingled with other inputs, value-added

activities, and internationally traded goods and services. Because it becomes increasingly difficult to assign component contributions to final value as we move down the supply chain from raw inputs to retail and food service, the most precise measure of the value of potato production will be found at the farm gate. All value-added attributes beyond this point should be inferred based on the farm-gate values. We use the USDA Food Dollar Series (described below) to project value added along each step of the supply chain.

For estimating economic contribution along the supply chain, we turn to the USDA, Economic Research Service's Food Dollar Series (USDA: Economic Research Service 2022). The Food Dollar Series breaks consumer expenditures on food into component parts based on the industry groups. Each industry group represents the share of value of consumer dollar captured.

TABLE 10 **Food Dollar Series – Industry group value added by factors**

Industry group	Total (cents)	Imports (cents)	Output taxes (cents)	Property income (cents)	Salary & benefits (cents)
All industries	100.0	5.1	5.1	39.4	50.3
Agribusiness	2.2	0.6	0.1	1.0	0.6
Farm production	7.4	1.0	-0.4	5.2	1.7
Food processing	15.2	1.2	0.6	5.8	7.7
Packaging	2.9	1.0	0	0.8	1.2
Transportation	3.6	0	0	1.4	2.2
Wholesale trade	10.7	-0.3	1.7	4.2	5.1
Retail trade	12.7	0.3	1.9	3.9	6.7
Food services	33.6	0.6	0.7	12.2	20.1
Energy	3.2	0.4	0.3	1.6	1.0
Finance and insurance	3.6	0.1	0.1	1.4	1.9
Advertising	3.0	0.2	0	1.5	1.3
Legal and accounting	1.8	0.1	0.1	0.7	1.1

Note: Values may not add to totals due to rounding

Source: USDA, Economic Research Service, Food Dollar Series, 2022

The Food Dollar Series provides two key measures used in this contribution assessment. First, it provides an objective means of measuring the value of final goods created by the agricultural production of potatoes. Accordingly, the Food Dollar Series suggests that 7.4¢ out of every food dollar is captured by the farm. The expected value of consumer goods purchased through retail or food service channels can be estimated simply by taking the ratio of farm gate sales to this farm gate value. For instance, the USDA reports that farm gate sales of potatoes were \$4.17 billion in 2021 (USDA: NASS 2022). Based on the Food Dollar Series, this suggests that the value of final goods for consumption would be \$55.95 billion. This would be an objective measure if all domestic production was processed and consumed domestically. However, as

discussed above, trade constitutes a significant component of U.S. domestic potato production and demand. While imports and exports can take place anywhere along the supply chain, for simplicity we assume it takes place from the farm gate and farm gate sales down by 0.34 percent in the final estimates. Accordingly, we assert the final value of sales from domestic potato production and processing is \$55.76 billion in 2021.

In addition to providing an estimate for the value of final goods produced with potatoes, the Food Dollar Series also provides a means of breaking out value at each stage of the supply chain. Table 11 reproduces the USDA Economic Research Service Food Dollar Series industry component estimates. These objective measures should be consistent with the values

used in the IMPLAN model in simulating economic contributions. The columns in Table 11 show the capture of primary factors of production – or the factor share of value created. With the total value of final domestic goods of \$55.76 billion and the industry group breakouts in Table 11, the economic contribution of the domestic potato production supply chain can be simulated and estimated.

Each industry group can be modeled in isolation, netting out the simulation of other industry groups. Recall that the simulation model is backward-looking, such that all inputs are accounted for in the simulation up to the industry group being modeled. Hence, when modeling wholesale activities, for example, food processing, farm production, and agribusiness activities are automatically built into the simulation. Not netting out these upstream activities will result in double counting those activities. Hence, direct expenditures of upstream activities are netted out in estimates for each leg along the supply chain.

Finally, IMPLAN provides multiple measures of economic effect. First, as established in the economic modeling literature, simulations are undertaken to track the value of transactions – also called output. However, other measures of economic activity can be reported. More common measures of economic activity include employment, labor income and value-added. Each is estimated for each of the 544 industries and simulated based on a fixed relation to the level of output. Hence, there are four measures of economic activity: output, employment, labor income and value-added. Each measure moves in proportion to the level of output by segment.

Three metrics make up economic contribution estimates, regardless of which measure is



used to gauge the value of economic activity. The first is the direct effects, which from an output perspective, is the value of transactions directly observed by the industry group tracked. Secondary effects are the combined economic activities generated from secondary business-to-business transactions or those transactions made by recipients of direct expenditures. As businesses spend from initial sale receipts and households spend from earnings garnered by expenditures along the supply chain, they set into motion secondary transactions not made by the supply chain participants but rather in response to supply chain expenditures. That is, economic effects can be categorized as those arising from activities along the supply chain and those effects arising because of activity along the supply chain. The total economic effect is simply the sum of the direct and secondary effects and is relevant for all measures of economic activity.



Economic Contribution Estimates



Estimating the economic contribution of the U.S. domestic potato supply chain starts with sequentially simulating industry group transactions, netting out the direct transactions of the previous industry group. The first industry group modeled was farm production and agribusiness, of which, the prior value is established by USDA statistics. The second can be estimated as 2.2 percent (See Table 11) of the value of final potato goods. Subsequently, wholesale and production activities are simulated and added to the economic contribution estimates of agricultural production. However, to control for double counting, direct expenditures of agricultural production and agribusiness are subtracted from the wholesale economic effects. Retail and food service contributions were added – once again netting out prior leg direct effects, where prior leg direct effects had to be split between retail and food service channels. Prior leg direct effects were split based on the share

of the Food Dollar Series allocation to each of the two channels. The resulting estimates are shown in Table 11, where the Total is the sum of the estimated contributions by leg.

Accordingly, the estimates suggest that about 404,733 U.S. jobs can be directly linked to the U.S. domestic supply chain for potatoes and potato products (Table 11). Once accounting for secondary effects, the estimates show that about 714,500 jobs are supported directly or indirectly by the domestic potato products supply chain. Relative to the size of the labor force, this suggests that about 0.4 percent of all U.S. jobs can be attributed directly or indirectly to domestic potato production and marketing. Breaking it down, about 66,000 of those jobs can be tied directly or indirectly to agricultural production and agribusiness services (Top level of Table 11), food processing and wholesaling supports over 174,000 jobs, while just under 500,000 retail and food services jobs can be linked to the domestic potato supply chain.

These approximate 714,500 aggregate jobs are estimated to generate around \$34.1 billion in annual labor income and boost annual national income by \$53.5 billion. These earnings are driven by around \$100.9 billion in direct and secondary transactions, while \$37 billion in spending can be directly linked back to the potato supply chain. Collectively, when accounting for all sources of earnings, the estimates anticipate that the domestic potato supply chain boosts annual gross domestic product by \$53.5 billion a year.

Summary and Conclusion

This report outlines the U.S. domestic supply chain of potatoes, recognizing the U.S. as one of the largest potato-producing countries in the world. Potatoes and potato products are an important component of the U.S. and global food systems. Accordingly, they also make up a significant contribution to the U.S. economy, from raw materials, through farm

production, processing, and trade. Processed potatoes make up a significant component of international trade, as well, including frozen and dehydrated products, but also fresh potatoes. Potato production is expansive throughout the world, reflecting the relative hardiness of potatoes relative to other agricultural commodities. Profitably promoting international

TABLE 11 *Estimated Economic Contributions Along the Domestic Potato Supply Chain*

Agriculture Production and Agribusiness Services

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	29,023	\$1,228 Mil.	\$2,175 Mil.	\$4,170 Mil.
Secondary Effect	37,581	\$2,120 Mil.	\$3,535 Mil.	\$6,621 Mil.
Total Effect	66,604	\$3,348 Mil.	\$5,711 Mil.	\$10,791 Mil.

Processing and Wholesale

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	55,392	\$3,779 Mil.	\$4,770 Mil.	\$12,998 Mil.
Secondary Effect	118,951	\$7,687 Mil.	\$12,950 Mil.	\$27,176 Mil.
Total Effect	174,343	\$11,466 Mil.	\$17,720 Mil.	\$40,174 Mil.

Retail

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	73,082	\$1,938 Mil.	\$2,615 Mil.	\$3,527 Mil.
Secondary Effect	28,097	\$1,533 Mil.	\$2,828 Mil.	\$5,432 Mil.
Total Effect	101,179	\$3,471 Mil.	\$5,443 Mil.	\$8,959 Mil.

Food Service

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	247,235	\$7,772 Mil.	\$11,222 Mil.	\$16,466 Mil.
Secondary Effect	125,143	\$8,051 Mil.	\$13,439 Mil.	\$24,519 Mil.
Total Effect	372,378	\$15,823 Mil.	\$24,662 Mil.	\$40,985 Mil.

Total

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	404,733	\$14,717 Mil.	\$20,782 Mil.	\$37,161 Mil.
Secondary Effect	309,771	\$19,390 Mil.	\$32,754 Mil.	\$63,747 Mil.
Total Effect	714,504	\$34,107 Mil.	\$53,536 Mil.	\$100,909 Mil.



trade initiatives may be challenging; however, for the space of potato-based products with value-added properties, like dehydration, frozen for processing and finished consumer.

We use baseline industry statistics to estimate the overall economic contribution, or significance, of the U.S. potato supply chain. The supply chain represents all the legs of production from raw materials, like seed, fertilizer, and soil, to finished goods for consumption. Finished goods can be fresh and processed potatoes for home preparation, as well as prepared meals containing potatoes for consumption at home. It also includes salty snacks made from potatoes, like potato chips and shoestring potatoes. It also entails processed and fresh potatoes used in food services and the food service jobs supported by on-premise sales and preparation of meals entailing potatoes. The estimates also entail all handling of potatoes and potato-related products from raw material to final purchase for consumption.

The estimates suggest that about 714,500 domestic jobs can be directly or indirectly

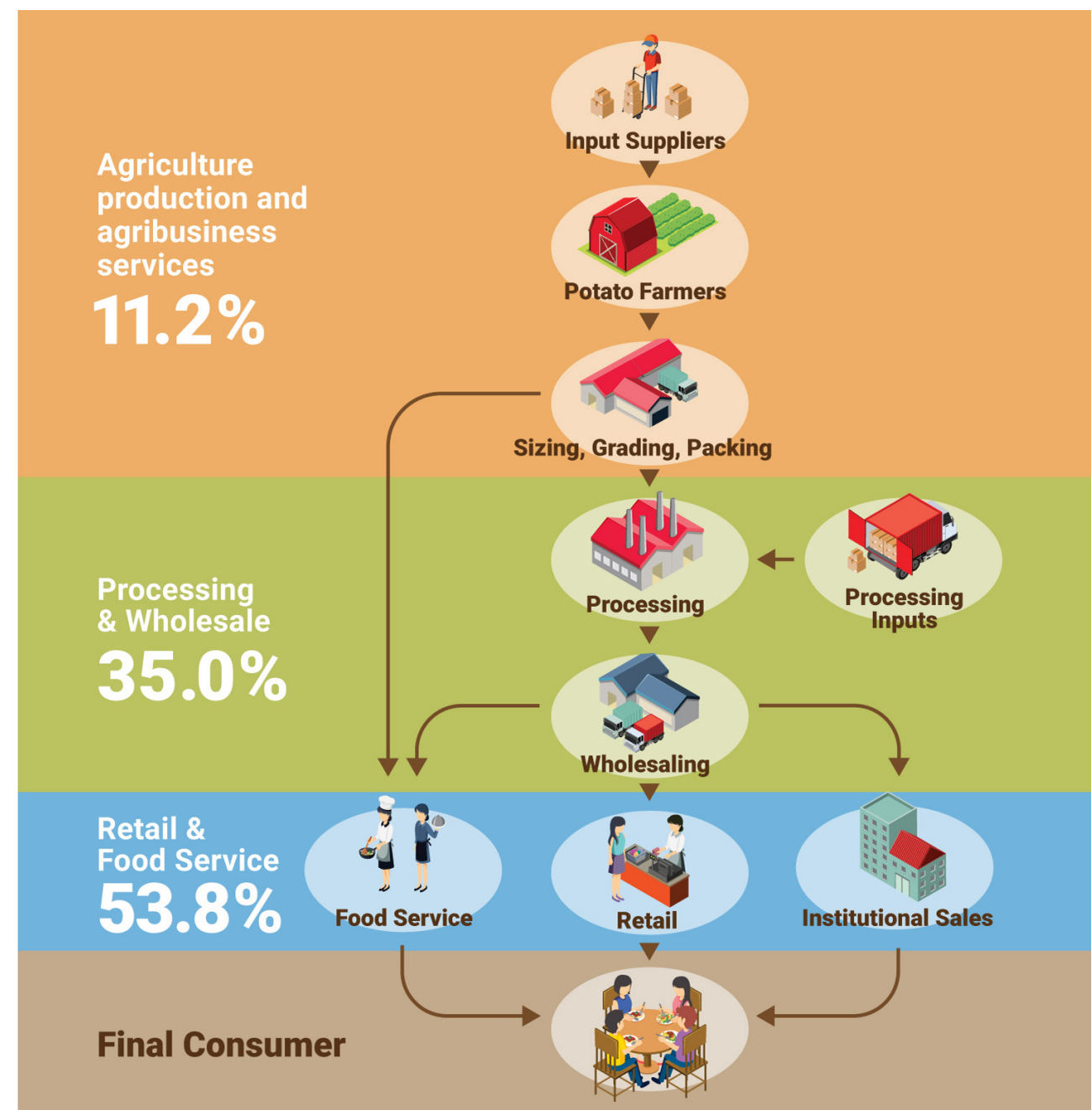
attributed to the U.S. domestic supply chain of potatoes. These jobs command about \$34.1 billion in labor income per year and contribute \$53.5 billion to annual gross domestic product. To place these findings into context, about 0.4 percent of the U.S. domestic workforce is supported by the domestic potato industry supply chain.

Table 11 largely follows the hierarchy of Figure 1. The output and employment numbers for production and agribusiness services are reflected in the input suppliers, potato farmers, and sizing, grading and packing, as shown in the top-shaded area of Figure 2. In these steps, the form of the potato does not change. Table 11 estimates for processing and wholesaling reflect the economic contribution of processing potatoes and wholesaling both fresh and processed potatoes. This also includes the inputs used in processing and wholesaling, as reflected in the second level from the top in Figure 2. The economic contribution estimates for retail capture the economic contribution of retailing potatoes to consumers. This includes fresh and processed potatoes. The numbers for food service capture the economic

contribution of restaurant and institutional sales and utilization of potatoes. Collectively, these are shown as the third level in Figure 2. Using the estimated values of direct expenditures (output) in Table 11, the estimated share of supply chain value is presented in percent form in Figure 2. Accordingly, agriculture production and agribusiness services comprise roughly

11.2 percent of final value, in the aggregate. The combined wholesaling and processing activities account for around 35 percent, while the distribution channels account for 53.8 percent, where food service (food serving establishments and institutions) make up the largest component.

FIGURE 2 *The Supply Chain for Potatoes*



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