IMPACT Center
WASHINGTON STATE UNIVERSITY

COVID-19 AND WASHINGTON STATE POTATOES:

ECONOMIC LOSSES FROM REDUCTIONS IN POTATO DEMAND

A report by Washington State University's IMPACT Center

2020

Washington Potato Economic Contribution Statement

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1. Introduction and Background

The first quarter of 2020 has seen no shortage of problems for the agricultural and food markets. This study discusses the economic harm to the potato sector in Washington State resulting from the demand and supply chain disruptions resulting from the COVID-19 virus and the associated policy requirements resulting from it. We also discuss the potential tax impacts on the state and the primary backward links in the supply chain that are negatively affected by the reduction in potato production and processing. Much of this is linked to the drastic reductions in acres planted and the projected price effects from changes in demand.

There is an immediate and medium-term effect that will occur throughout the rest of 2020, and there is a longer-term effect that we can see stretching into 2021 and beyond as a result of revised planting practices. At the beginning of the outbreak, the shutdown of the restaurant and dining community produced a policy driven reduction in demand for potatoes at the restaurant level. The backward linked purchases from the processors then declined. Processors do not warehouse their inputs but order them throughout the year from growers. Growers typically harvest their potatoes from July through early October when they go into on-farm storage. The storage costs are not free and potato quality is adversely affected by prolonged storage. Thus, the growers dumped large volumes of potatoes through "giveaways" and donations. After the potato growers had drastically reduced their inventory, restaurants began to open back up at limited capacity but there was a drastic reduction in input supplies available to the processors. This limited production is likely to continue throughout 2020, and the data is bearing that out month over month.

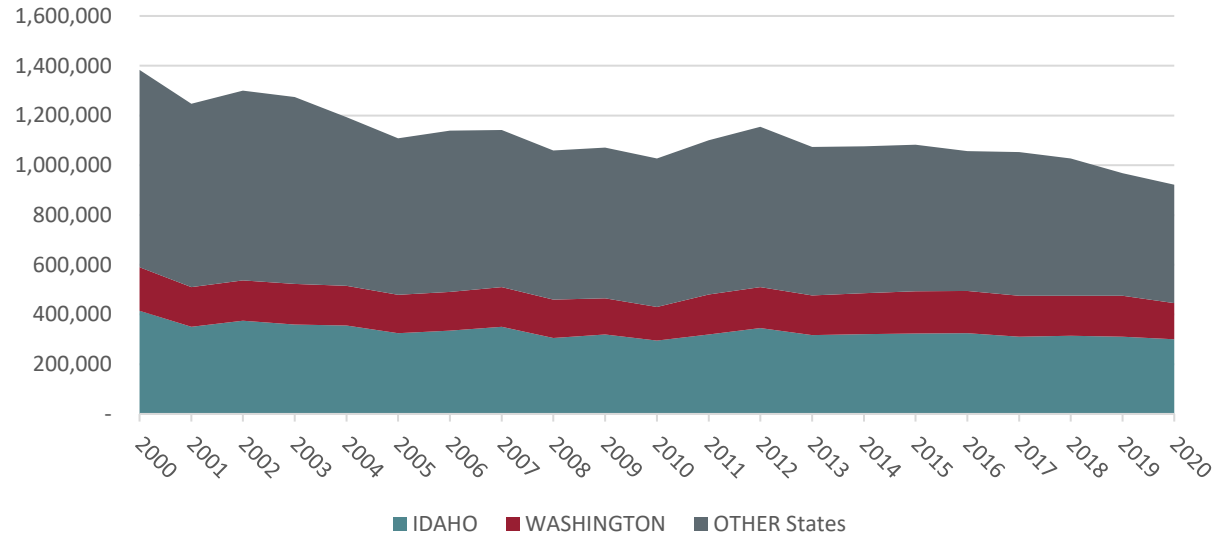
The longer-term effect is that potatoes have had a higher risk associated with their production and farmers have reduced their planted acreage by 13%. Of that, a large shift has been made from fresh market to processed potatoes. We suspect that this is being done to protect any forward contracts that growers may want to have in place while still reducing the farm risk associated with their high-value high-cost potato crop. The reduction in demand and associated long-term reduction in supply leaves the future price indeterminable. What is clear is that production and processing will be reduced for both the 2020 and 2021 years.

Three things need to be measured to assess the effect of COVID-19 on Washington State's potato industry: 1) The lost income to growers in 2020 because the value of their 2019 harvest was, if not eliminated, drastically reduced; 2) The reduction in economic activity associated with the drop-off in processing activity; and lastly, 3) the net 2020 impact stemming from the shift in potato acreage towards Corn and lower valued crops.

2. National Potato Perspective

Soil testing will occur in the fall of the previous year along with fumigation. The first quarter of the year is typically spent buying seed potatoes and preparing for planting in early March. Between April and late September, soil and plant treatments continue along with plant quality assessment. Harvest begins in late July and tapers off in October. Potatoes harvested go into storage and are added to inventory as they wait to be sold to processing or packaged for fresh markets. Figure 2.1 shows the acreage planted from 2000-2020 in Washington, Idaho and nationally. Potato acreage nationally has fallen from just under 1.4 million acres in 2000 to roughly 921,000 in 2020

Figure 2.1: *Idaho, Washington, and U.S. Potato Acreage from 2000-2020*



Source: USDA NASS Quick Stats (2020).

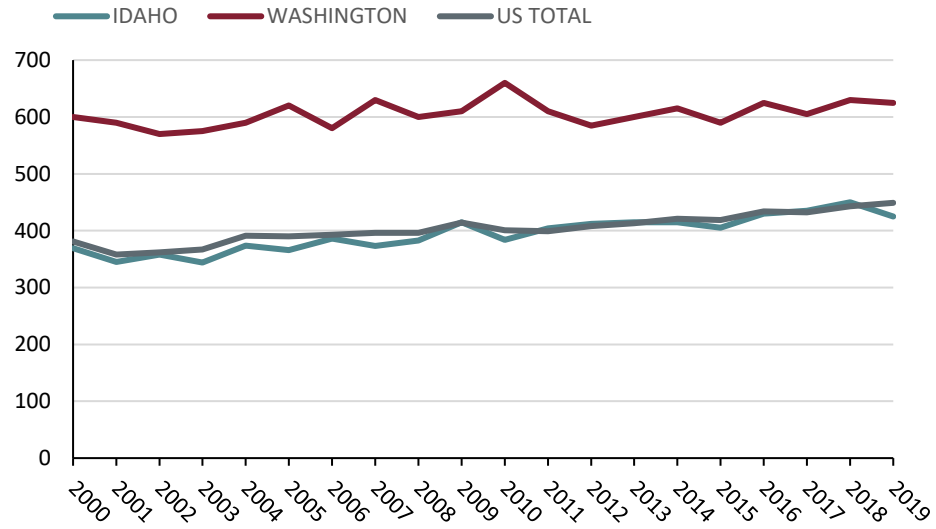
While Washington has far fewer acres in potato production than Idaho it is still the second largest potato producing state in the country. A large part of that has to do with the remarkable yields in Washington, roughly 40% higher than the national average. Figure 2.2 shows the yields for Idaho, Washington, and the U.S. in cwt per acre. Washington has more volatility year over year than Idaho and the national average. However, Washington has had a static trend in yields while Idaho and the national average has a shallow but positive gain in yields.

Table 2.1: *Selected 2019 Potato Production Data*

Region	Acres	Yields (cwt/acre)	Sales
Idaho	310,000	425	$1,108,017,500
Washington	165,000	625	$845,625,000
United States	***968,300***	***449***	***$4,256,365,993***

Source: USDA NASS Quick Stats (2020).

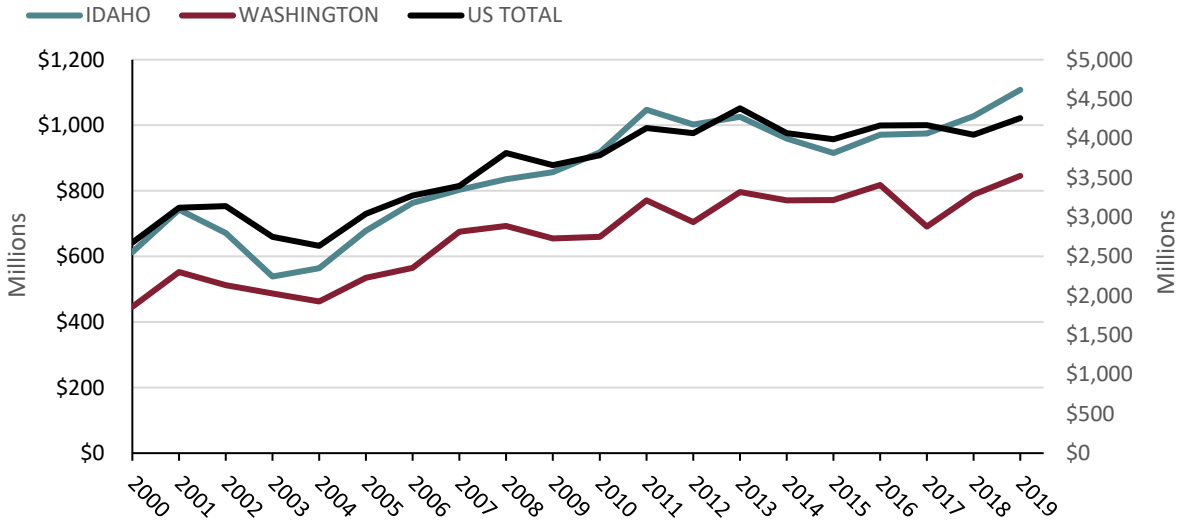
Figure 2.2 *Idaho, Washington, and U.S. Yields (cwt/acre) from 2000-2019*



Source: USDA NASS Quick Stats (2020).

Washington has averaged only 50% of Idaho's acreage but 75% of Idaho's production value. Figure 2.3 shows the growth in production value over the past 20 years. In order to keep the scale of the chart manageable, the U.S. total has been put on the secondary vertical axis. Total Idaho production value has been trending at or above $1 billion since 2011. Washington has been hovering around $800 million during the same period. U.S. total production value hovers near $4 billion. Between 2000 and 2019, Idaho and Washington combine to generate between 41% and 50% of total U.S. annual potato production.

Figure 2.3 *Idaho, Washington, and U.S. Production Value from 2000-2019 (Millions)*

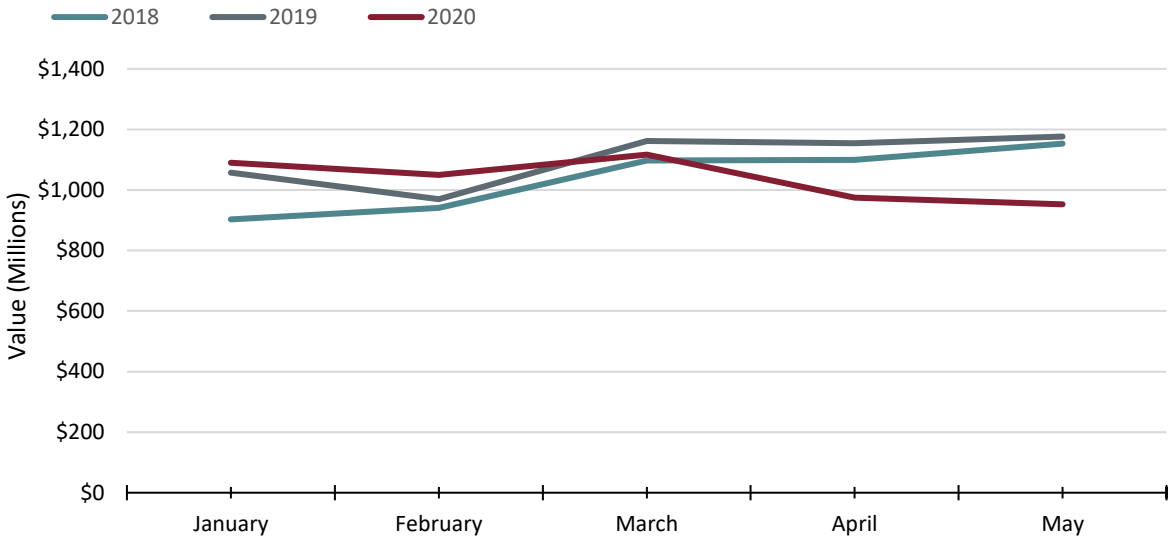


Source: USDA NASS Quick Stats (2020).

For impact analysis it is critical to understand and distinguish between domestic and foreign exports. It is imperative that the reader understand that exports, in this context, are any sales outside the region of analysis. Foreign exports are explicitly international exports and will be identified as such. If the term "exports" is used, we are referring to

exports outside the region and not necessarily outside of the nation. Exports of goods result in importation of new money to the economy. Impact analysis traces those new monies through the economy to assess the volume of transaction associated with the exports. Over time the new money leaks out of the economy through the purchase of imported goods or services. A farmer might export a commodity, bringing new money into the economy, but then buy an implement that is manufactured in another state, causing the money to leak out of the economy before it can circulate locally. This would be an example of a "porous economy" where money flows in and out easily. Figure 2.4 shows the U.S. exports of potato products out of the country. While 2020 started out strong, foreign exports were trending below normal levels by mid-February and very clearly by mid-March. By May 2020 national exports were 19% below the average May exports from 2018 and 2019.

Figure 2.4: *U.S. Potato Product Exports*



Source: USDA NASS Quick Stats (2020).

Table 2.2 shows the main international markets for U.S. potato exports by value. Because most of these nations are in Asia it is reasonable to assume that most shipments are coming out of Pacific Northwest ports. The largest international market is Japan. While most nations have decreased their May 2020 import of U.S. potatoes, Japan and South Korea have both expanded their buying. However, total value of foreign exports has declined. The net loss of new income into the country will slow domestic transactions.

Table 2.2: *Value of International Potato Exports by Destination and Year*

Year	**2018**	**2019**	**2020**
Month	**May**	**May**	**May**
Japan	$33,543,439	$33,717,286	$35,779,666
Mexico	$28,019,192	$30,695,868	$22,284,508
Korea, South	$8,575,549	$10,327,131	$13,053,889
China	$10,905,660	$7,655,144	$7,837,126
Taiwan	$7,713,302	$5,391,571	$7,808,283
Philippines	$7,810,665	$9,105,665	$3,569,226
Hong Kong	$3,575,948	$3,601,937	$2,724,480
Total	$1,153,073,955	$1,176,473,959	$952,599,238

Source: USA Trade Online (2019).

3. Production and Processing Sales During COVID-19

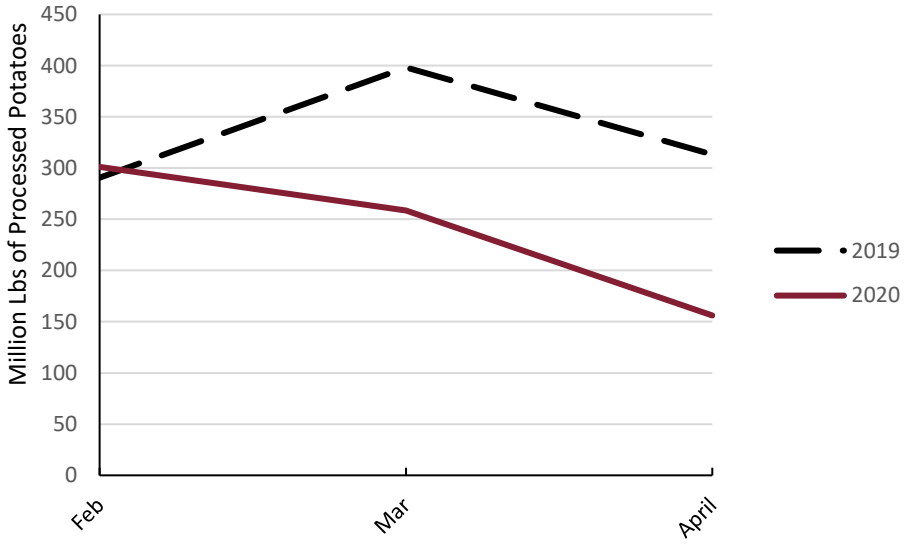
Because Washington and Idaho produce roughly 50% of the nation's potatoes, understanding how COVID-19, and the policy responses to it, have altered aggregate demand is key to understanding how Washington has been affected. We begin by looking at the change in demand for processed potatoes entering broadline distribution channels. The good news is that broadline distribution captures the bulk of processed potatoes (85%-93%). The 2020 volume of processed potatoes entering broadline distribution for the three-month period (February-April) has fallen in 2019-2020. Table 3.1 displays the volume changes per month in 2020 relative to 2019. Figure 3.1 shows the trend during the three-month period in 2019 and 2020.

Table 3.1: *Changes in the Volume (Lbs) of Processed Potatoes Entering Broadline Distribution by Year and Month*

Month	2019	2020	% Change
February	290,577,731	301,150,645	4%
March	398,195,239	258,564,379	-35%
April	313,231,613	156,070,602	-50%

Source: The NPD Group, Inc. (2020).

Figure 3.1: *Volume of Processed Potatoes (Lbs) Entering Broadline Distribution by Year and Month*



Source: The NPD Group, Inc. (2020)

Processed potatoes entering broadline distributions differ by utilization as per Table 3.2.[1] Frozen fries dominate processed potato demand, representing 73% of potato utilization; followed by fresh potatoes (16%).

[1] Because the data is lagged, the 2019 data will not be available until September of 2020. The expected shift from 2019 to 2020 will not be verifiable until September of 2021, and the Acres by Variety Report is scheduled to be discontinued.

Table 3.2: *Average Washington Potato Utilization Rate and Acreage (2008-2018)*

Utilization	Percent	Acres (1,000)
Processing	73%	121
Fresh	16%	26
Chipping	3%	4
Other	9%	14
Total	**100%**	**165**

Source: USDA NASS Acres by Variety (2008-2018).

Figure 3.2 shows the four primary census regions and Table 3.3 shows the drop in the demand for processed potatoes in each region from 2019 to 2020. This drop in demand for processed potatoes must be followed back through the supply chain. The drop in aggregate demand for processed potatoes resulted in a drop in demand for processing itself, leading to a drop in demand for processing inputs, predominantly raw potatoes. The collapse in the demand for this supply chain was disparate by region.

Figure 3.2: *Aggregate Census Regions for the U.S.*

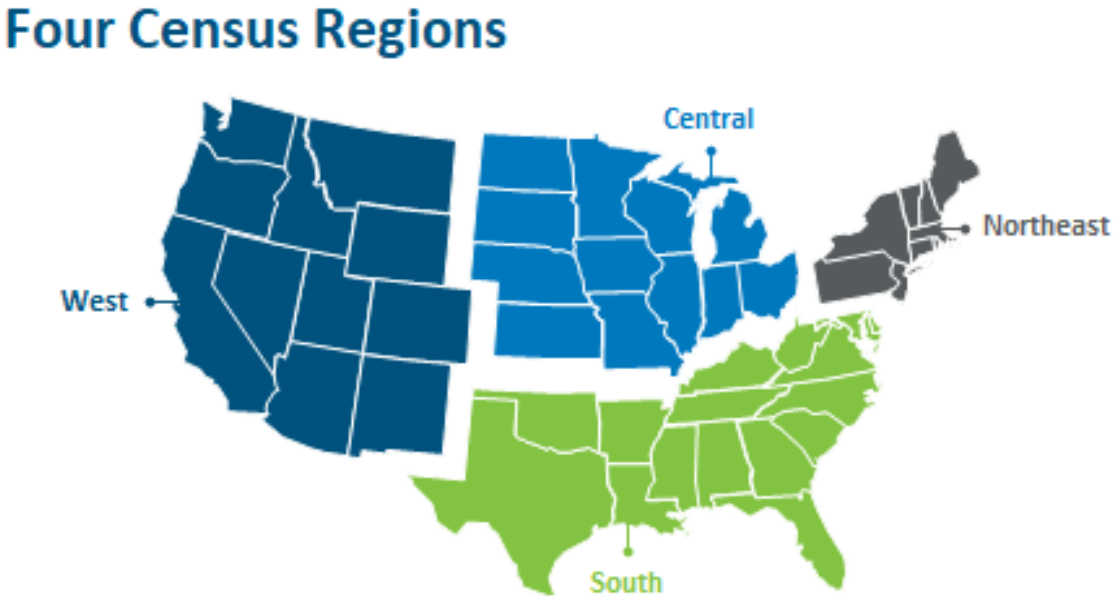


Table 3.3: *Percent Change in Demand for Processed Potatoes by Region, (2019-2020)*

Region	Frozen Fries	All Processed Potatoes
Northeast	-36.4%	-35.4%
Central	-24.2%	-26.6%
South	-24.9%	-25.3%
West	-26.8%	-28.0%
Total	-26.6%	-27.4%

Source: The NPD Group, Inc. (2020)

The Northeast saw a markedly steeper drop than the other regions of the U.S. and it is assumed the drop stems from European pressure. Europe was dumping inexpensive potatoes on the

market and so U.S. grower and processors in the northeast had no home for their product. In this case, demand for U.S. potatoes was drying up faster than in the rest of the nation, not just because of the restaurant closures but also because of cheaper foreign supply.

The drop in acres under production in the 2019-2020 growing season matches the numbers shown above for the first quarter broadline distribution of processed potatoes. Month-to-month reductions are expected to continue for the remainder of 2020. Since potatoes available for processing in 2021 will be reduced as a result of lower acreage in production, it will likely be at least two years before processing exports are back to 2019 levels.

Though we do not measure the expected 2021 processing impacts, it is likely that those impacts will still be below normal levels. Traditionally 73% of potato production goes to processing, 16% go to the fresh market, 4% to chipping, and the remaining 9% goes to other uses. The supply of potatoes to the fresh market in the first two quarters of 2020 stayed relatively stable, but their value declined somewhat as potatoes were given away to consumers and donated to food banks, churches, and families in need.

4. Washington Economic Losses: Actual and Expected

Potato production expenditures (e.g., fertilizers, soil testing, planting, etc.) for the potato crop harvested in October of 2019 were all made prior to the pandemic. Thus, the impacts stemming from the 2019 potato crop had already occurred, but the income to farmers from that crop had not. Farms typically put their harvest in inventory and would sell it to processors and retailers through the next year's harvest. In March of 2020, restaurant closures caused demand for processed potatoes to fall dramatically (see Figure 3.1). With the fall in processing demand for raw potatoes, the value of potatoes in cold storage dropped. Farmers, not wanting to hold high inventories and incur storage costs for a product they would not be able to sell, began dumping potatoes with shorter storage life. Inventories were given away to homes and food banks across the nation. Farm income from the 2019 potato harvest was being given away. In some sense, COVID-19 had no "impact" on the 2019 harvest, since all the backward linked spending had already occurred during production. However, it had, and will continue to have, an impact on farm incomes.

Where COVID-19 will have a measurable impact is on the reduction in potato acreage, associated backward linked spending, and the reduced value of processing exports in 2020-2021. This section of the report covers the net losses by shifting away from potatoes and into corn as an alternative land use. Whereas 20,000 acres of potatoes were taken out of production, corn production added nearly 30,000 acres in Washington during 2020.[2] As will be seen in the following sections, corn tends to generate lower revenues per acre, but the stability in demand, storability of the good, and lower per-acre production costs tend to make it a safe haven in times of uncertainty.

2020 Washington Potato Income Losses

From Washington to Maine, potatoes are being given away or are deteriorating in value as the quality, while in storage, declines. Part of this is a varietal problem as well. Potatoes like the Russet Burbank are great for fries, but do not do nearly as well as the Russet Norkotah in grocery outlets, and white potatoes used for chipping can fail to make reasonable fries. The closure of the hospitality and dinning industry across the nation has meant a dramatic shift in the types of food people are eating and cooking, along with the type and volume of potatoes being demanded. All of these has created a perfect storm for the potato sector because crops varieties were adopted to meet an expected demand that did not materialize. This meant that the potatoes in inventory did not match the demand in the market.

The drop in inventory value from market "mismatch" and reduced demand results in reduced farm income and can be measured as the change in expected inventory value from January 2020 to March 2020. We estimate those changes in expected value by discounting the total 2019 production value of $845.6 million to account for quality loss and "dumping." The last quarter of 2019 (Oct-Dec) and the first 2 months of 2020 (Jan-Feb) saw little change in processing demand from previous years. Prices and sales remained stable during that time. Beginning in mid-March, product entering broadline distribution fell by 50% and is expected to remain there through the 2020 harvest. Beginning in June, processing started to return and inventory began to be sold

[2] Many specialty crops, not just potatoes have come out of production in 2020. Some of the gains in corn may be due to a net reduction in fallowed land as well.

again. Between March and mid-May, Washington saw 200,000 tons of potatoes "returned" to growers as lost processing sales.

The steep drop in sales between March and May seems to have stabilized, and processing is returning to normal. Unlike other industries, those two months of lost sales are truly lost and not simply deferred. People that held off from having elective surgeries or buying retail goods were able to then buy those goods and services latter, merely shifting sales. For potato growers, sales that failed to materialize during those two months could not be recovered in higher future sales because their product had already exited the supply chain in the form of discounted cattle feed, donations, etc. Total losses from the 200,000 tons sales shortfall represented $29.2 million in lost income to Washington growers. As said earlier, this represents a loss in income to Washington farmers but has not had backward linked impacts. In order to be conservative with our estimates, multiplier effects stemming from this lost income were not counted.

Converting Enterprise Budgets to Input-Output Vectors

Whether quality or availability issues arise, what is abundantly clear is that the 2020 harvest is going to be much smaller. The impacts associated with potato production require us to use the farm enterprise budgets for potatoes to begin tracing the expenditures of the farms through the state's economy. This section of the report discusses the basic methodology used to convert average farm spending on potato production into input-output vectors that can be used to trace those monies through the economy before they leak out of the state in the form of import purchases. These budgets were based on 2018 figures and were published in 2019. Even though the 2018 and 2019 expenditures do not match exactly, the basic spending patterns are assumed to be similar between the time the budgets were drafted and today.[3] Table 5.1 shows the 2018 revenues and expenditures for the average potato grower in Washington.

Following the methodology of Willis and Holland (1995) The enterprise data is mapped to IMPLAN industry accounts according to the mapping in column three of Table 4.1. For example, potato seed is mapped to IMPLAN Sector 3 (vegetable and melon farming). Another example is fungicide and insecticide, where 80% of the expenditure is mapped to IMPLAN Sector 167 (pesticide and other agricultural chemical manufacturing) and the remainder is mapped to IMPLAN Sector 19 (support activities for agriculture and forestry).

There are three major steps in converting the expenditures in the crop enterprise budget into input-output accounts after the dollars are allocated to IMPLAN sectors. First, we margin the constructed input-output accounts to convert from purchaser prices into producer prices. Margining is a process of splitting the cost of an item into four primary components that make up purchaser prices: *retail margin*, the portion of the total cost (TC) that the retailer keeps to operate their store, and pay their workers, taxes, and other expenses; *wholesale margin*, portion of TC that the wholesaler keeps for operational expenses; *transportation margin*, portion of TC charged by various forms of transport (air, rail, water, and/or truck) to move products along the supply chain; and *cost of production*, the product's value when it leaves the manufacturer/factory (IMPLAN Group, 2019). For example, looking at the purchase cost for fertilizers, we use the margins built in IMPLAN to split the fertilizer cost into retail, wholesale, transportation, and cost

[3] We are not assuming any large technological changes have occurred since the 2018 budgets were prepared.

to manufacture fertilizer. We also use the adjusted margins in IMPLAN, which account for locally produced inputs.

Second, the margined industry account is allocated into the appropriate sector in IMPLAN; and third, the industry accounts are scaled to the state level. This last step is done since the crop enterprise budget is originally presented in a per-acre basis. Values are multiplied by the total potato acreage in Washington State to scale up the margined industry accounts to the state level. Table 4.2 shows the input-output vector used in our state potato model. Using the previous example, the fertilizer cost Table 4.1 has been margined and allocated to four IMPLAN sectors in Table 4.2 — Fertilizer manufacturing, Wholesale (Other nondurable goods merchandise), Wholesale (Wholesale electronic markets), Retail (Building material and garden equipment), and Rail transportation.

Table 4.1: *Potato enterprise budgets with IMPLAN Mapping*

Category	Total ($)	IMPLAN Sector
Gross Income	$933,281,250	
Variable Costs		
Tillage	$16,500,000	19
Planting	$18,150,000	19
Seed	$87,450,000	3
Fertilizer	$140,250,000	167 (0.8), 19 (0.2)
Fumigation	$62,700,000	170 (0.8), 19 (0.2)
Fungicide and insecticide	$69,300,000	170 (0.8), 19 (0.2)
Herbicide	$12,705,000	170 (0.8), 19 (0.2)
Irrigation water and power	$22,687,500	49
Irrigation repairs - center pivot	$4,125,000	515
Irrigation labor	$13,612,500	Labor
Digging (harvest)	$44,240,625	19
Hauling (harvest)	$42,900,000	19
Cleaning and piling (harvest)	$40,218,750	19
Storage	$124,740,000	422
Monitoring	$4,620,000	19
Interest on operating capital	$35,210,175	441
Total Variable Costs	$739,409,550	
Fixed Costs		
Management, administration and overhead	$28,875,000	Owner (0.5), 19 (0.5)
Regulatory compliance	$4,125,000	455
Land rent	$140,250,000	447
Interest on fixed cost	$8,662,500	441
Total Fixed Costs	$181,912,500	
Total Cost	**$921,322,050**	
Income over all costs	**$11,959,200**	

Source: Galinato and Wohleb (2019).

Table 4.2: *Input-Output Vector*

IMPLAN Sector Number	IMPLAN Sector Description	State Aggregation ($)
3	Vegetable and melon farming	49,424,252
19	Support activities for agriculture and forestry	238,057,875
49	Water, sewage, and other systems	22,687,500
167	Fertilizer manufacturing	55,632,960
170	Pesticide and other agricultural chemical manufacturing	58,263,978
398	Wholesale - Grocery and related product wholesalers	14,530,255
400	Wholesale - Other nondurable goods merchandise	43,235,531
401	Wholesale - Wholesale electronic markets	3,382,164
405	Retail-Building material and garden equipment	64,084,776
406	Retail - food and beverage stores	19,942,670
414	Air transportation	404,458
415	Rail transportation	1,981,427
416	Water transportation	78,098
417	Truck transportation	4,453,431
422	Warehousing and storage	124,740,000
441	Monetary authorities and depositary credit intermediation	43,872,675
447	Other real estate	140,250,000
455	Legal services	4,125,000
515	Commercial and industrial machinery and equipment repair and maintenance	4,125,000
	Value Added	
5001	Employee compensation	13,612,500
6001	Proprietary income	26,396,700
7001	Other property type income	0
8001	Indirect business taxes	0
Total		933,281,250

Source: WSU IMPACT.

This vector also represents the primary backward links in the production supply chain. The forward links in the process can be found by analyzing the grower's revenue stream. Primary potato buyers are outlined in Table 4.3. The single largest buyer is the processing sector, followed by households that capture the retail margins. It looks as though full and limited-service restaurants buy nothing from the growers, but that is because they show up as primary buyers from the processing sector.

Table 4.3: *Potato Revenues by source and value*

Industry	Value
Frozen vegetable manufacturing	$398,028,555
Foreign Trade	$85,307,774
Households 100-150k	$60,283,951
Households 70-100k	$49,708,412
Households 200k+	$38,821,758
Households 50-70k	$35,670,764
Households 150-200k	$27,872,515
Households 15-30k	$21,133,560
Households 30-40k	$19,546,401
Potatoes	$19,430,684
Households 40-50k	$17,161,993
Households LT15k	$12,713,874
All other food manufacturing	$10,582,252
Fruit farming	$4,619,238
Dehydrated food products manufacturing	$4,318,333
Full-service restaurants	$2,556,917
Limited-service restaurants	$1,992,109
State/Local Govt Education	$1,897,915
All other buyers	$121,634,245
Total Revenues	**$933,281,250**

Source: IMPLAN and WSU IMPACT.

2020 Production Impacts

The reduced acreage under potato production caused a fall in expected potato value, from $845,635,000 to $617,817,600. Typically, we only shock exports, but raw potatoes do not typically get exported; rather, they get sent to processors. To account for this, we create a mixed model as per Steinback (2004). This allows us to sever the link between the potato growers and processors by forcing all potato product to be exported. Processors are assumed to buy all their potato inputs from outside the state. This seems like an odd assumption, but it allows us to shock potato production rather than exports while still shocking the exports of the processors.

Basic vs. Non-Basic Impacts: Which Industry Support the Economy?
A small agricultural town may seem to have a large medical industry in terms of employment, while the number of farm employment is fairly low, and often seasonal. However, the farms are exporting their product and bringing money into the economy. The doctor's offices are predominantly serving the residents. In this story, it is the farmers that are supporting the economy and the doctors are retaining the money within the economy. However, it should be clear that the farms would continue to exist in the absence of the doctor's offices, while the doctor's offices would not be likely to stay in the absence of the farms. In this setting, the non-basic medical jobs rely on the basic agricultural jobs. The employment impacts, including many of the doctors and nurses, would be attributed to the non-basic agricultural industries.

This story gets more complex in the case of apples, potatoes, etc. where processing occurs near the primary commodity input. We structure these models to show the interdependency of the grower and processor and assume the grow operation is dominate basic force. This is similar to coal mining or fishing operations where processing is forced to locate where the source of the commodity is located.

The acreage that is not put into potato production is assumed to be put into corn production under the assumption that growers will not let their land sit idle. The 20,000 in acreage at yields of 240 Bu/acre and a price of $4.71/Bu generate an increased value of $22,608,000. Corn is almost all exported outside of the state, so we shock corn exports by that amount. Both potato reduction and corn increasing shocks are run simultaneously in the model to produce Tables 4.4 and 4.5. This results in a net reduction of economic activity of $468.7 million. We refrain to report impacts in terms of sales (see breakout box below). The change in value added activities leads to a reduction of $270.4 million. Table 4.5 outlines the same information as the summary in Table 4.4 but with additional industry detail regarding the potato production supply chain.

Sales vs. value-added
A way to explain why sales overstates impacts is to imagine individuals spending money in a regional economy. Suppose an individual spends $40,000 on a new truck. Another individual spends the same amount on an appendectomy at the regional hospital. From a sales perspective, the impacts are the same, $40,000. However, from a value-added perspective the purchase of the truck provides less to the regional economy. Perhaps $30,000 of the truck purchase had to immediately go to the manufacturer back in Detroit or Japan. Conversely, the appendectomy at the hospital probably saw most of the spending stay local as income to the doctors, nurses and hospital staff. Perhaps only $10,000 leaves the region for importing of capital assets like the hospital bed, scalpels, etc. From a value-added perspective, the hospital is more valuable than the auto dealership even though they are equivalent from a sales perspective.

Impact results are broken down into three categories: **direct** – the primary change in final demand for an industry under analysis; **indirect** – the business-to-business transactions that stem from the direct effects; and **induced** – the household-to-business transactions that stem from the

owners and employees of the primary industries under analysis. See Appendix 1 for an illustration of how the economic contribution of the potato industry spreads through the economy as a result of direct transactions made.

The direct effects are effects related to the production and processing of potatoes. The indirect effects are driven primarily from the spending of the potato and corn growers on their vendors. This includes purchases from themselves. Potato growers buy seed from other potato growers. So intra-industry purchases are captured within the indirect effects. But this also captures the spending of the vendors on their vendors etc. until the money leaks out of the state for the purchase of imports.

The induced effects stem from the wages and salaries of the growers and their farm hands when they spend money at local restaurants, retailers, grocery stores, etc. As the income of the growers and their employees shrink so do their expenditures and the induced effects that stem from those losses in income.

Table 4.4: *Net Impacts from Reduced Potato Production and Increased Corn Production by Type of Impact.*

Economic Effect	Sales	Value Added	Income	Jobs
Direct	-$205,199,400	-$123,331,307	-$77,040,458	-2,550
Indirect	-$99,570,669	-$49,517,682	-$39,385,695	-559
Induced	-$163,881,503	-$97,592,637	-$57,748,939	-1,113
Total	-$468,651,572	-$270,441,626	-$174,175,092	-4,222

Source: IMPLAN and WSU IMPACT.

Table 4.5: *Net Impacts from Reduced Potato and Increased Corn Production by Industry*

Industries	Sales	Value Added	Income	Jobs
Potatoes	*-$232,781,463*	*-$129,817,048*	*-$87,368,948*	*-2,684*
Corn Production	*$23,013,066*	*$3,778,322*	*$8,613,200*	*77*
Support activities for agriculture and forestry	-$18,739,374	-$66,653	-$18,572,294	-82
Water, sewage and other systems	-$200,712	-$128,773	-$33,242	-1
Nitrogenous fertilizer manufacturing	-$549,527	$0	-$48,241	0
Pesticide and other agricultural chemical manufacturing	-$3,432,974	-$975,105	-$204,508	-7
Wholesale - Grocery and related product wholesalers	-$3,775,995	-$3,508,226	-$1,320,587	-2
Wholesale - Other nondurable goods merchant wholesalers	-$9,994,179	-$8,908,555	-$2,234,087	-133
Wholesale - Wholesale electronic markets and agents and brokers	-$349,062	-$260,319	-$560,283	-2
Retail - Building material and garden equipment and supplies stores	-$893,353	-$590,522	-$341,383	-11
Retail - Food and beverage stores	-$1,957,931	-$1,347,830	-$876,693	-22
Air transportation	-$1,784,092	-$850,534	-$494,824	-4
Rail transportation	-$565,226	-$157,778	-$149,085	-1

Water transportation	-$443,214	-$217,345	-$69,475	-3
Truck transportation	-$2,296,192	-$1,517,357	-$989,587	-54
Warehousing and storage	-$863,701	-$631,610	-$402,366	-8
Monetary authorities and depository credit intermediation	-$4,521,450	-$1,442,171	-$1,169,837	-38
Other real estate	-$22,688,973	-$20,498,904	-$3,792,507	-55
Legal services	-$2,881,949	-$2,101,182	-$893,013	-20
Commercial and industrial machinery and equipment repair and maintenance	-$401,420	-$328,809	-$214,757	-5
All Other	-$182,543,851	-$100,871,226	-$63,052,574	-1,170
Total	-$468,651,572	-$270,441,626	-$174,175,092	-4,222

Source: IMPLAN and WSU IMPACT.

A caveat must be noted regarding the job figures in the impact analysis. Job impacts are calculated by taking the income level and dividing those income levels by the average income per employee for each industry. Often those impacts are accurate in terms of the total number of jobs at risk. However, they may be thought of as full-time equivalent jobs and are not necessarily actual numbers of employees.

2020 Processing Contributions

The impacts from reduced processing exports do not capture the purchases from the potato growers. This avoids the double counting of the above impacts. Processors tend to have a high impact because the value-added activities drastically increase the marketing margins of a product. Processed potatoes are worth $2.4 billion in transactions annually. Given the drop in demand at the end of the first quarter and its persistence, the estimated direct reduction in exports amounts to a loss of $698.3 million. The indirect and induced effects generate an additional loss of $571.9 million and $408.1 million, respectively. Total reductions in economic activity within the state were nearly $1.7 billion. Total reductions in Value Added, or gross state product, amounted to $714.3 million, $436.4 million of which would have been salaries and wages for state citizens, including the employees at the processing facilities. This information is captured in Table 4.6.

Table 4.6: *2020 Potato Processing Contributions*

Economic Effect	Sales	Value Added	Income	Jobs
Direct	-$698,304,821	-$168,927,363	-$93,001,399	-1,561
Indirect	-$571,909,892	-$284,094,060	-$200,125,386	-3,373
Induced	-$408,130,486	-$261,229,073	-$143,311,738	-2,288
Total	***-$1,678,345,198***	***-$714,250,495***	***-$436,438,524***	***-7,221***

Source: IMPLAN and WSU IMPACT.

5. Fiscal Impact

It is common to believe that after accounting for subsidies and other fiscal exemptions, farmers pay drastically low taxes. However, there is a clear correlation between productivity and tax generation. Even non-profit entities such as school and churches drive economic activity and transactions. Agricultural production and processing are no different. They increase incomes, which result in increased revenue generation for state activities. This section of the report outlines the lost revenues to state and local governments due to the net change in agricultural production and processing.

State and local governments are expected to lose a total of $13.9 million in property tax revenue, $35.3 million in reduced sales and excise taxes, and an additional loss of $5.3 million in corporate and other tax revenues. While the state generated over $25 billion in general tax revenues in 2019, this $54.6 million tax revenue losses represent a substantial curtailment of government income for the Department of Revenue, and will bring about serious fiscal challenges for the state.

Table 5.1: *State and Local Tax Revenue Losses*

Property	-$13,962,469
Sales and Excise	-$35,344,380
Corporate and Other	-$5,338,354
Total	***-$54,645,203***

Source: IMPLAN and WSU IMPACT.

7. Conclusions

Washington's potato growers and processors have been adversely affected due to the prolonged restaurant closures and associated fall in demand for their product. The fall in demand has been a shock not only directly for farmers and processors but for all the vendors in their specialized supply chains. In all, farmers have lost roughly $29.2 million dollars from the decline in demand and quality for their 2019 harvest. They have reduced potato acreage for their 2020 growing season by 13% and replaced it, primarily with corn, leading to net reductions in purchases from their suppliers. That loss in acreage amounts to roughly 729,120 tons of potatoes, equivalent to the weight of about 76 Space Needles. Net impacts from this change in acreage and spending has resulted in $270.4 million in lost productivity to the state. Processors that have seen the demand for products like French fries, hash browns, mashed potatoes, etc. plummet, have had to watch their spending plummet in lockstep. Lost processing activity has resulted in $714.3 million in lost productivity statewide. Total economic losses from potato production and processing in 2020, stemming from the demand shocks of COVID-19, are expected to amount to roughly $1 billion dollars in gross state product.[4]

Table 7.1 shows the combined 2020 losses in value-added for the processing and production of potatoes in Washington State. This does not include the loss in value of the 2019 potato inventory that was "dumped," given to food banks, or lost due to quality decline. This change in economic activity does include the loss of $54.6 million in state and local tax revenues.

Table 7.1: *Summary 2020 Impact Losses in the Potato Sector*

Economic Effect	Sales	Value Added*	Income	Jobs
Direct	-$903,504,221	-$292,258,669	-$170,041,858	-4,111
Indirect	-$671,480,560	-$333,611,743	-$239,511,081	-3,931
Induced	-$572,011,989	-$358,821,709	-$201,060,677	-3,401
Total	***-$2,146,996,770***	***-$984,692,121***	***-$610,613,615***	***-11,444***

Source: IMPLAN and WSU IMPACT.
*Also referred as "gross state product".

[4] This includes the losses in income from the 2019 harvest that was in inventory.

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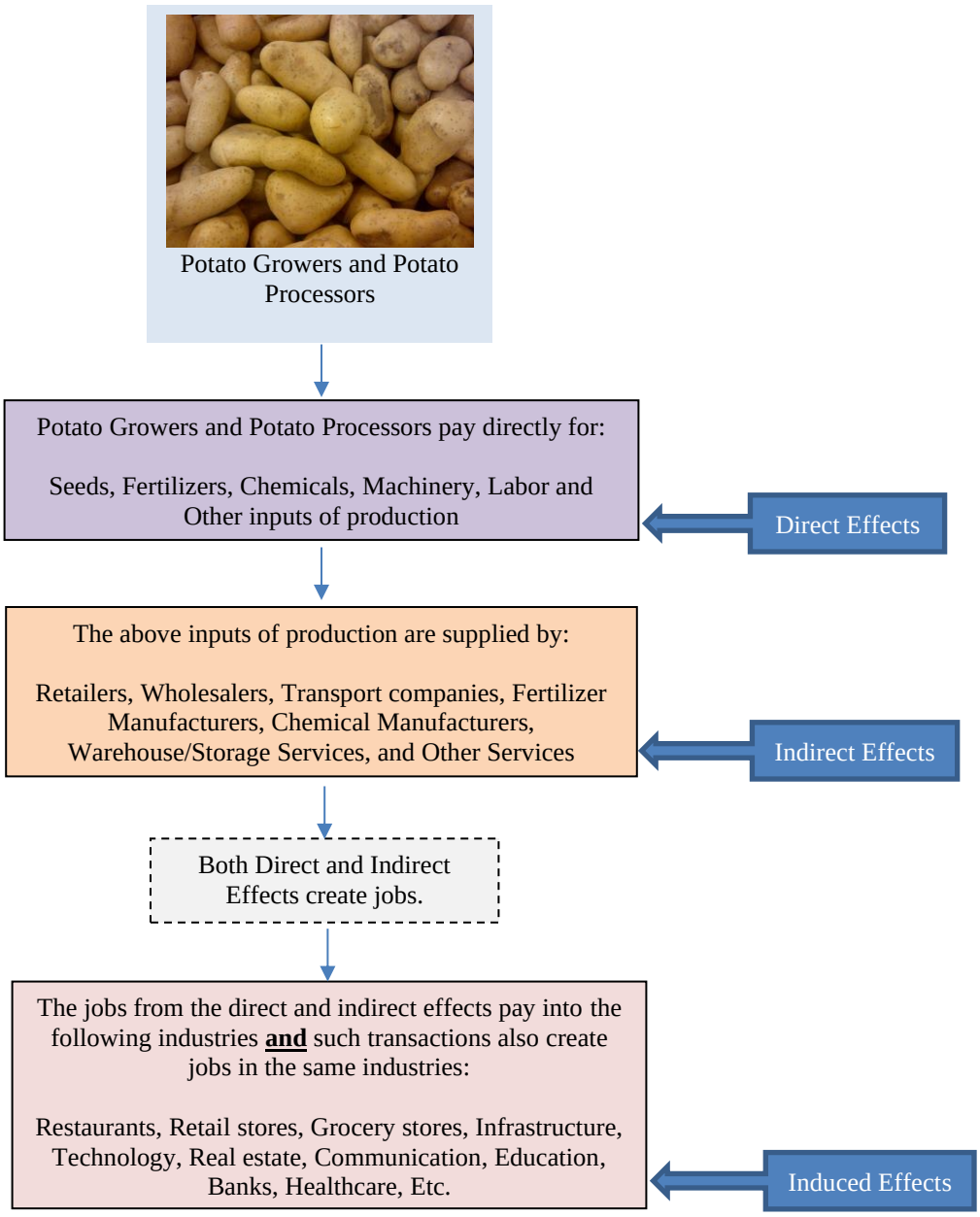
Appendix 1: Economic Multiplier of Potato Industry Activities Captured by the Input-Output Model



Appendix 2: Basics of Input-Output Models and Social Accounting Matrices

The Basic Input-Output model

Before jumping into the Social Accounting Matrices (SAMs) it will be helpful to discuss a system of accounts embedded in the SAM. The system of accounts known as Input-Output (I-O) represents an economist's version of double-entry book keeping for industries. Figure A.2 below shows a simplified version of an I-O matrix with just a hand full of industries.

Figure A.2: Aggregated form Input-Output Matrix

		Producers as Consumers						**Final Demand**			
		Agric.	Min.	Const.	Manuf.	Services	Other	Households	Investment	Government	Net exports
Producers	Agric.										
	Min.										
	Const.										
	Manuf.										
	Services										
	Other										
Value Added	Labor							Gross Domestic Product			
	Returns to Capital										
	Taxes										

Reading down a column of this table shows you what inputs an industry is buying in order to produce their output. If we look at the Agriculture column, they may buy seed from themselves, fertilizer and farm equipment from the manufacturing sector, and legal and accounting services from the service sector. Payments to their employee are captured in the "Labor" row, they receive the returns to the capital that they own, and they pay taxes to the government. Reading across a row tells us where an industry's income originates. Sticking with agriculture, they sell seed to others in the agricultural sector; their crops may be sold to processing plants in the manufacturing sector, or perhaps directly to consumers. A portion of a household's expenditures will go to buying agricultural goods, and even government may purchase agricultural goods. Lastly, the agricultural industry will sell its output abroad via the "Net exports" column. Summing all the labor, capital, and tax payments for all industries gives the sum of all value added and will equal the Gross Domestic Product (GDP) of the region. Similarly summing all the expenditures of households, government, investment, and net exports yields the GDP of the region. These two methods of calculating GDP are known as the Income and Expenditure approaches, respectively, and they represent a check for ensuring all accounts balance. It is through the I-O system that we are able to trace the dollars through the economy and calculate multiplier effects.

The Social Accounting Matrix

The social Accounting Matrices (SAMs) are a bit more robust than the I-O tables. SAMs can be

extremely detailed, embedding commodity purchases, occupations staffing matrices, detailed government accounts, and even demographic information. The social accounting framework used for this report was derived from the IMPLAN data software and has a structure as follows.

		A	C	F	INST	T(FT)	T(DT)
		1	2	3	4	5	6
A	1		MAKE				
C	2	USE			IUSE	CEXPRT	CEXPRT
F	3	FD				FEXPRT	FEXPRT
INST	4		IMAKE	FS	TRNSFR	IEXPRT	IEXPRT
T(FT)	5		CIMPRT	FIMPRT	IIMPRT	TRNSHP	TRNSHP
T(DT)	6		CIMPRT	FIMPRT	IIMPRT	TRNSHP	TRNSHP

The interpretation of this matrix is slightly different than that of the I-O model. Here the rows and columns match so that the entire matrix is square. In this case A represents the set of industries, C is the set of commodities, F is the set of factors used in production (these are synonymous with the value added components of the I-O table), INST represents institutions such as households, governments, and other non-industry organizations, T(FT) represents foreign trade and T(DT) represents U.S. or domestic trade.

Segments of the SAM that are gray represent regions where there are no transactions. For example, in the SAM, industries do not buy from other industries, they buy commodities, and this shows up as the “USE” table. Industries also purchase land, labor, capital, and government services. Those purchases are displayed in the “FD” or factor demand segment of the SAM. Industry output is reported in the “MAKE” matrix, though institutions such as government can produce commodities as well. State run power facilities are a good example of institutions producing a commodity. Commodities may also be imported from other parts of the U.S. and from abroad via the CIMPRT tables. Institutions also buy commodities and transfer wealth amongst themselves. Those activities are captured in the “IUSE” and “TRNSFR” tables. Factors available for productive use are supplied by institutions, “FS”, and may be imported in some cases “FIMPRT”. The “FEXPRT” and “IEXPRT” represent factors of production and institutional output that are sold outside of the regional economy.

Appendix 3: Sensitivity Analysis

This sensitivity analysis varies particular key input assumptions over a range of values to see how final results are affected. The key assumptions focused on here are total change in processing export values, expected prices changes for raw potatoes ($/cwt), and changes in the price for corn. It is not critical to check the acreage since planting has already occurred, and yields have been extremely stable over the last 2 decades. The fluctuations for corn and potato prices tend to move together. What becomes clear is that the price for potatoes, and the volume of processing exports are the critical assumptions being made. A wide range in prices for corn produces fairly stable results. Unfortunately, the price for potatoes is clouded in uncertainty due to the magnitudes of shifts in both supply and demand. Prices have been falling for decades, but if demand rebounds quickly, supply will not be able to climb as rapidly and prices may see a temporary increase, causing overall losses to be less drastic. It is also highly uncertain how international markets will react and those tensions are fueled by continued international trade negotiations and persistent destabilization.

Table A3.1: *Sensitivity Analysis of Processing Export Value*

	-15%	-10%	Base Case	10%	15%
	-$881,556,125	**-$766,570,544**	**-$698,304,821**	**-$627,194,081**	**-$533,114,969**
Sales	-$2,587,433,292	-$2,311,070,459	-$2,146,996,770	-$1,976,085,207	-$1,749,970,161
Value Added	-$1,172,127,938	-$1,054,516,680	-$984,692,121	-$911,957,579	-$815,730,186
Income	-$725,145,159	-$653,279,498	-$610,613,615	-$566,169,606	-$507,370,429
Jobs	-13,339	-12,150	-11,444	-10,708	-9,736

Source: Impact Center and IMPLAN.

Table A3.2: *Sensitivity Analysis of Potato Prices ($/cwt)*

	-15%	-10%	Base Case	10%	15%
	$5.29	**$6.23**	**$6.92**	**$7.61**	**$8.75**
Sales	-$2,485,907,023	-$2,291,213,899	-$2,146,996,770	-$2,002,779,641	-$1,764,821,379
Value Added	-$1,173,929,987	-$1,065,218,872	-$984,692,121	-$904,165,370	-$771,296,230
Income	-$736,283,815	-$664,090,296	-$610,613,615	-$557,136,935	-$468,900,412
Jobs	-14,342	-12,677	-11,444	-10,211	-8,176

Source: Impact Center and IMPLAN.

Table A3.3: *Sensitivity Analysis of Corn Prices ($/Bu)*

	-15%	-10%	Base Case	10%	15%
	$4.28	**$5.04**	**$5.60**	**$6.16**	**$7.08**
Sales	-$2,161,829,763	-$2,153,308,682	-$2,146,996,770	-$2,140,684,858	-$2,130,270,204
Value Added	-$990,915,869	-$987,340,524	-$984,692,121	-$982,043,718	-$977,673,852
Income	-$616,020,743	-$612,914,521	-$610,613,615	-$608,312,710	-$604,516,216
Jobs	-11,520	-11,476	-11,444	-11,411	-11,358

Source: Impact Center and IMPLAN.