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The Economic Contributions of West Coast Forage Exports

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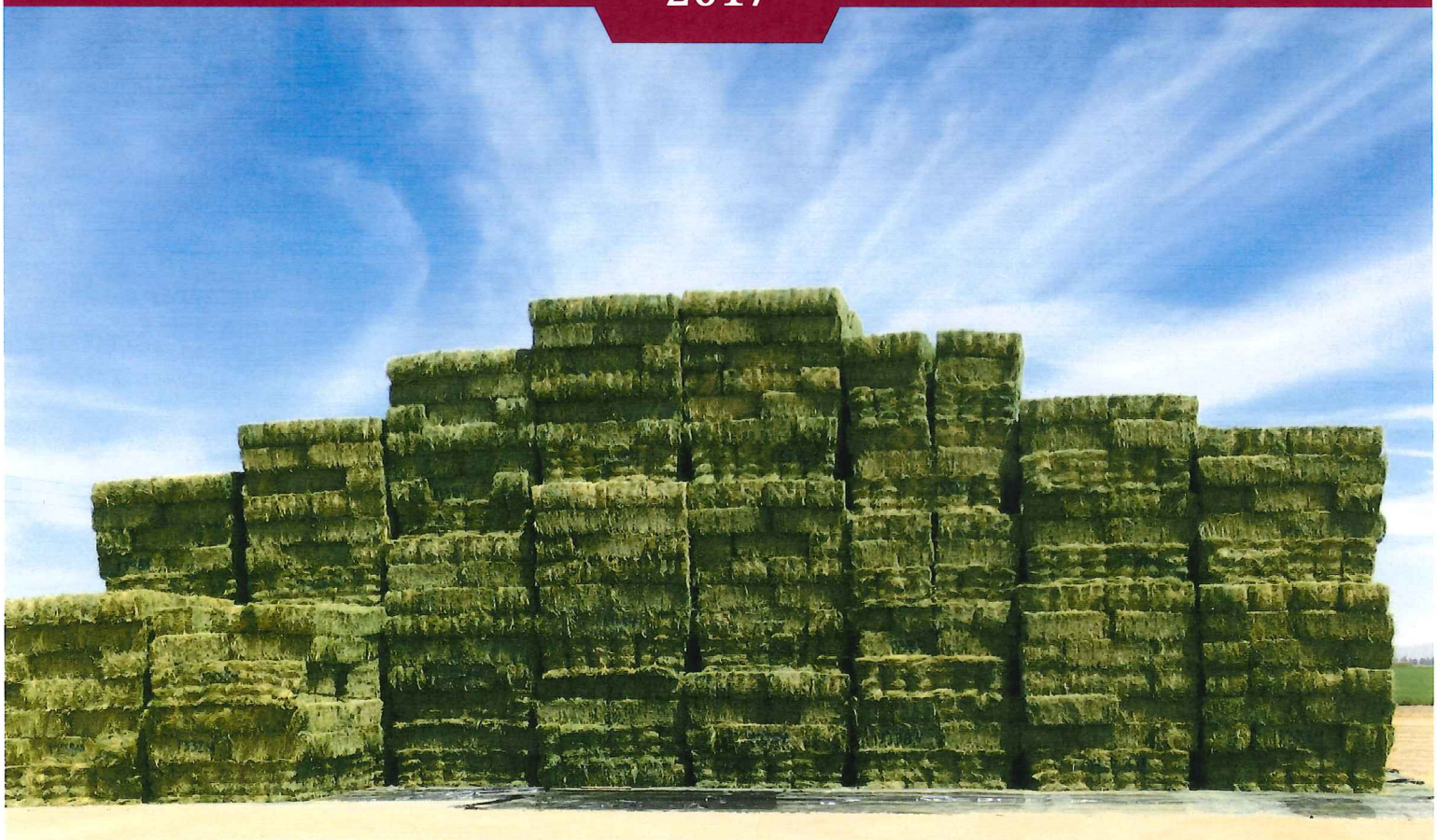

The Economic Contributions of Forage Exports

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Table of Contents

Executive Summary

Members of the United States Forage Export Council (USFEC) located in Washington, Oregon, and California processed and shipped approximately 2.9 million tons of products in 2015. The average price per ton came in at just over $275 and revenues from these exports amounted to roughly $797.9 million. Forage exports from the three western states represent approximately 90% of all U.S. forage exports. Nearly all of these are sold in Asian markets. In 2015 36% of all U.S. forage sales abroad went to Japan, 28% to China and Hong Kong, 18% to South Korea, 9% went to the United Arab Emirates, and the remaining 9% went to other countries.

The economic implication of forage exports tends to be overlooked in the larger context of agricultural products. However, forage crops tend to have a very high value added in foreign markets and often generate more than double the value abroad that they could command domestically. This study brings the Forage export market and its contributions to the Washington, Oregon, and California economies to the forefront.

USFEC Processor/Exporters were surveyed in order to see how the money they bring into the states is allocated across various business expenses. Over 53% of their expenses are payments directly to growers. Another 18% is spent on transportation costs. The full spending profile can be seen in table 3. This spending profile was used to trace the money through the economy and generate the total economic contributions that forage exporters have on the economy. Contributions in this context are measured in terms of value added, or what is more often referred to as Gross Regional Product (GRP). It has also become popular to describe these contributions in terms of the employment they support. Total GRP stemming from USFEC activity amounted to just over $534.6 million, and roughly 5.1 million jobs were supported through the activity of forage exporters.

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Any errors in the document are the sole responsibility of the authors. Questions regarding any aspect of the document may be directed to the authors.

Regional Description

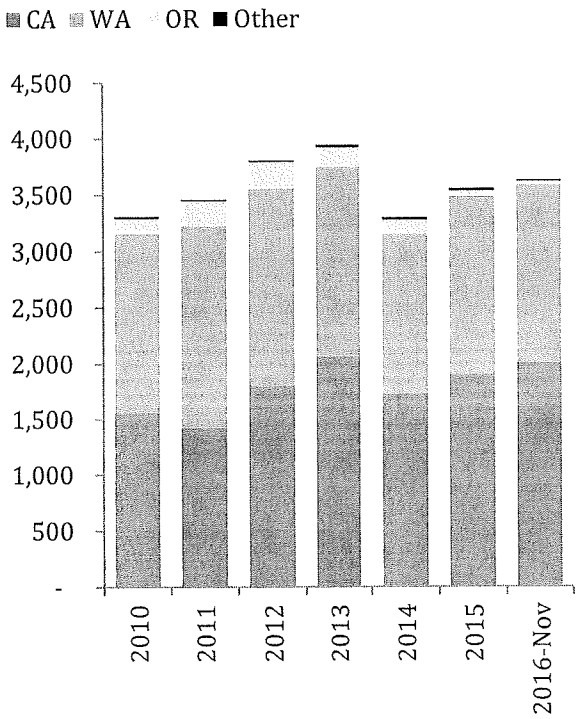
The regional data used in this report comes primarily from the Impact Planning (IMPLAN) software for the year 2014. The contribution results focus on the USFEC members in the west coast states and does not include non-members in the analysis. The background data for the region discussed here will therefore show larger export volumes than are actually analyzed. Appendix B includes a broader analysis from which one can make inferences regarding the larger forage sector.

Exporting regions

It is worthwhile to have a basic understanding of the regional economy being used as the backdrop for this analysis. The region is comprised of Washington, Oregon, and California. The west coast has long dominated the forage export market in the U.S. and 2015 was no exception. While a small portion (8%-10%) of national forage exports are derived from the east coast, typically for race horses, the states used in the analysis represent roughly 90% of national forage exports. Idaho has a modest forage export sector as well, but only contributes 1% to 2% in terms of value. In order to avoid "pass through" issues surrounding the state-of-export vs. state-of-origin, we limit our analysis to the three major west coast export states.

Figure 1 below shows U.S. volume of forage exports by west coast ports of exit and other ports. Unfortunately, data on foreign export *volume* is not available by state though estimates of export *value* by state are available. Percentage of export values by state of origin are provided in Table 1 below. Total U.S. forage export values in 2016 summed to just over $1.3 billion with California, Washington, and Oregon accounting for $577 million, $415 million, and $166 million respectively.

Figure 1: *Total Forage Exports by Volume and State of Export (1,000 tons)*



Source: U.S. Census Bureau Foreign Trade Statistics http://usatrade.census.gov

Table 1: *Percentage of forage export values by state of origin and year*

State	2012	2013	2014	2015	2016-Nov
California	39.3%	42.4%	42.3%	42.7%	44.3%
Washington	39.3%	37.2%	37.9%	36.3%	31.9%
Oregon	15.6%	14.5%	12.6%	11.1%	12.8%
Subtotal	*94.1%*	*94.0%*	*92.8%*	*90.2%*	*88.9%*
Idaho	1.7%	1.6%	0.8%	1.0%	0.1%
All States Combined	**100%**	**100%**	**100%**	**100%**	**100%**

Source: U.S. Census Bureau Foreign Trade Statistics http://usatrade.census.gov

Export Markets and Market Trends

The roughly 3.6 million tons of forage crops that were exported from the U.S. during the January-November portion of 2016 were sold almost exclusively to Asia with approximately 1.13 million tons going to Japan, 1.07 million tons going to China and Hong Kong, 596 thousand tons sold to South Korea, 367 thousand tons going to the United Arab Emirates in the Near East, and the reaming 468 thousand tons being sold elsewhere.

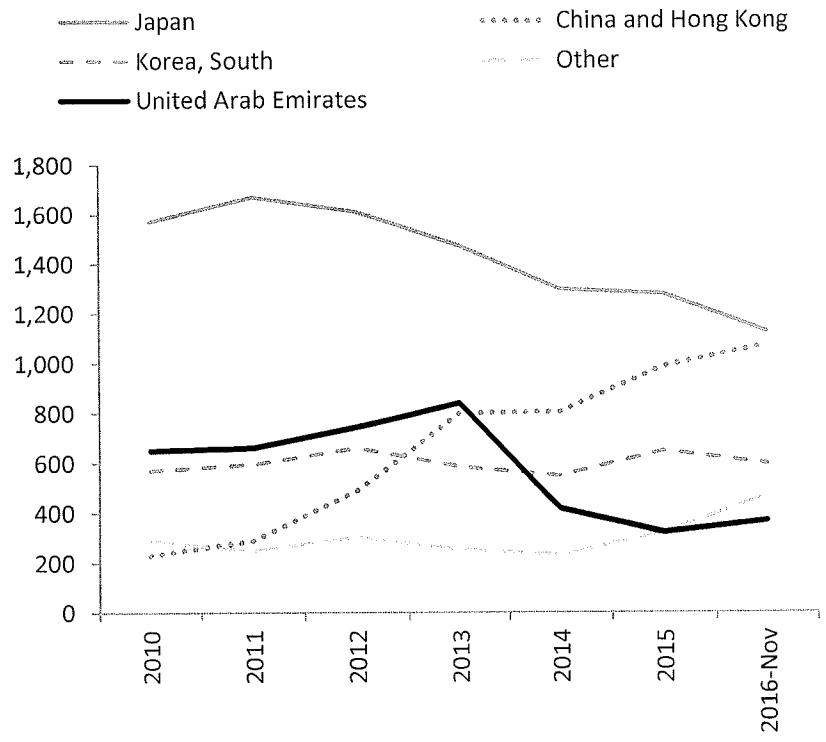
Table 2: *U.S. Forage Export Volume by Destination Country (1,000 tons)*

Country	2010	2011	2012	2013	2014	2015	2016-Nov
Japan	1,570	1,670	1,611	1,472	1,297	1,278	1,126
China and Hong Kong	231	288	487	797	804	987	1,074
Korea, South	570	594	659	584	548	647	596
UAE	649	660	743	839	417	320	367
Other	288	246	303	252	232	322	468
World Total	**3,308**	**3,458**	**3,803**	**3,944**	**3,298**	**3,555**	**3,630**

Source: U.S. Census Bureau Foreign Trade Statistics http://usatrade.census.gov

While Japan is the largest export market, sales there have been in decline since 2011. Though there was growth in sales to the UAE up until 2013 they have been in sharp decline since. What has sustained forage exports through all of this has been the tremendous growth in the Chinese market, rising from 230 thousand tons in 2010 to over 1.07 million tons today. Further, South Korea has been a small but stabilizing factor for forage exporters over the last decade.

Figure 2: *U.S. Forage Export Volume by Destination Country (1,000 tons)*



Source: U.S. Census Bureau Foreign Trade Statistics http://usatrade.census.gov

Industry Description

In order to conduct a contributions analysis it is necessary to look at the exporters from an industry perspective. Forage exporters are captured in the manufacturing segment of the economy since they are processing (i.e., pressing and packaging) crops before shipment. They are included under the North American Industry Classification System (NAICS) as "311119–Other Animal Food Manufacturing." The official definition as reported by the Census Bureau is

> "This U.S. industry comprises establishments primarily engaged in manufacturing animal food (except dog and cat) from ingredients, such as grains, oilseed mill products, and meat products."

"Alfalfa prepared as feed", as an example, is included in in this industry but so too is "bone meal prepared as feed." A full description of all firm operations included in this industry may be found at www.census.gov in the online NAICS manual.

Because we want to analyze the forage exporters explicitly and not include the potential effects of non-forage related animal food manufacturing we worked closely with the U.S. Forage Export Council (USFEC) and the individual processor/exporters in Washington, Oregon, and California to build a specific sector for them in our Input-Output (I-O) model. This allowed us to isolate the broad expenditure patterns of the forage exporters and more closely track the money as it flows through the economy.

Expenditure patterns

In order to generate the basic data necessary to conduct the analysis presented here we surveyed all USFEC exporters in the three-state region. The response rate of the surveys was quite high. Of the roughly 2.9 million tons produced by USFEC members a total of 2.5 million tons was captured from 27 individual surveys collected. The expenditure patterns developed from the surveys are shown in table 3 below.

The process for converting expenditure data into input-output accounts involves mapping the spending categories to industry accounts[1]. Once properly mapped, the data had to be converted from purchaser prices to producer prices using a margining technique. Lastly, we rid the accounts of imports and scale them to the regional level. Full detail of this process can be found in Willis and Holland (1997).

[1] The IMPLAN Pro model with 2014 data, the most recent available at the time, was used to conduct the analysis.

Table 3: *Average Forage Expenditure Patterns by Region*

Expenditure Item	All Regions	PSW	PNW	Oregon
Variable Costs	*88.4%*	*85.6%*	*90.7%*	*86.2%*
Product	**53.8%**	**52.1%**	**62.7%**	**25.6%**
Hay/Straw	53.8%	52.1%	62.7%	25.6%
Outside Products and Services	**6.2%**	**3.8%**	**3.9%**	**19.7%**
Field management & Inspection	0.4%	0.3%	0.2%	1.1%
Bailing	1.2%	0.1%	0.5%	6.1%
Stacking	0.2%	0.0%	0.1%	0.8%
Tarp and or tarping services	1.1%	1.5%	1.1%	0.5%
Warehousing or storage	0.7%	0.3%	0.4%	2.7%
Testing (including mailing)	0.3%	0.2%	0.3%	0.3%
Strap, wrap, & other packing	2.3%	1.3%	1.3%	8.1%
Process-Related	**4.1%**	**4.3%**	**3.9%**	**4.1%**
Energy (utilities, lubricant, fuel)	1.7%	2.2%	1.3%	1.7%
Machinery repair (parts & supplies)	1.3%	1.2%	1.3%	1.3%
Machinery labor	1.1%	0.8%	1.2%	1.1%
Transportation	**18.3%**	**18.7%**	**14.5%**	**31.0%**
Trucking from field to facility	3.4%	4.2%	2.9%	3.0%
Trucking from facility to port	7.4%	8.9%	5.6%	10.3%
Trucking depreciation (amortized value of trucks)	0.5%	0.8%	0.3%	0.8%
Ocean freight	7.0%	4.7%	5.6%	17.1%
Demurrage if applicable	0.0%	0.1%	0.0%	0.0%
Overhead	**6.0%**	**6.7%**	**5.7%**	**5.8%**
Employee compensation	5.6%	6.1%	5.3%	5.4%
Legal and clerical services	0.3%	0.4%	0.3%	0.3%
Travel expenses	0.2%	0.2%	0.2%	0.1%
Fixed Costs	*11.6%*	*14.4%*	*9.3%*	*13.8%*
Equipment depreciation (not including trucks)	1.2%	1.5%	1.0%	1.3%
Machinery interest	0.2%	0.3%	0.2%	0.2%
Insurance, licenses, taxes (fed, state, local)	1.0%	1.5%	0.7%	0.8%
Amortized value of land & buildings	8.6%	10.5%	6.8%	10.7%
Land-specific taxes	0.1%	0.1%	0.1%	0.1%
Rent paid for land/buildings	0.6%	0.5%	0.6%	0.7%
Total Costs	***100.0%***	***100.0%***	***100.0%***	***100.0%***

Source: Survey Data from U.S. Forage Export Council

As can be seen in table3, variable costs represent the bulk of spending for USFEC members, ranging from 90.7% of expenses in the Pacific North West (PNW) to 85.6% in the Pacific South West (PSW).[2] This does not imply that the fixed costs of operating are low. In fact

forage presses can exceed $2 million and operators may need several presses in order to meet threshold volumes. The single largest cost for exporters is purchases of the crop itself, representing 53.8% of total expenses. The majority of the exporter's expenditures are going to forage producers. Overhead, largely employee wages, only accounts for 6% of total expenses, and fixed costs, including annualized value of capital and buildings, is 11%.

Transportation costs are significant but this is not surprising given nature of the industry. Oregon represents an anomaly in this aspect of its expenditures as it's transportation costs are 66% higher than those in the PSW and 113% higher than those in the PNW. Part of this may be due to the fact that Oregon does not see the scale discounts that the other states do.

Employment

The Bureau of Labor Statistics (BLS) provides staffing matrices that allow researchers to see the types of occupations that are typically employed in a specific industry. Those industry employment profiles and average earnings by occupation give us a fairly detailed picture as to how income flows from the industry to households. This is helpful as we will be reporting the impacts of the forage exporters in terms of income.

The BLS does not always report employment at the six digit NAICS level (the most detailed level) as is the case with forage exporters. However, a staffing matrix is provided for animal food manufacturing (NAISC 3111). If Forage exporters follow the standard staffing patterns as this more broadly defined industry category, employment and earnings would breakdown as shown in table 4.

Product

The primary Forage crop exported is Alfalfa at roughly 50% of total exports. Timothy and Fescue represent another 11% each, followed by Sudangrass at 9%. Ryegrass (perennial and annual), Klein, Bermuda, Bentgrass and Orchardgrass account for the remaining 19%.[3]

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[2] The PNW reflects Washington whereas PSW reflects California.

[3] Information provided by the U.S. Forage Export Council

Forage Export Contributions

Economic contributions in an economy are often broken down into two primary components; the direct effects and the multiplier effects. In some situations, the multiplier effects are disaggregated further to show how the business and household income and expenditures ripple through the economy differently. Our objective is simply to show how exports of processed forage crops bring new income into the western U.S. economy. As this new income circulates throughout the states it generates additional rounds of income and spending, all the while supporting employment, until finally those new dollars leak out of the region through the purchases of goods and services imported from outside the region.

A processor-exporter that sells forage crops abroad will receive income from the sale of his shipments. That income will be used to pay his employees, purchase new equipment and additional wrap and straps for next year, perhaps pay for a land lease, and lastly to pay himself (see table 3). His employees may use their income to pay rent, or purchase new school supplies for their children. Some of the business and household expenditures will leak out of the economy. For example, a new press may be imported from overseas or purchases of household goods from Walmart would see a portion of the profits returned to Arkansas, etc. The portion of business and household expenditures that stay in the region would be paying the salaries of the employees at the parts store, retail outlets, grocery stores, etc., where forage sector businesses and employees shop for goods and services.

Though sales are the underlying data used to conduct impact assessments it is not appropriate to use sales as a measure of contributions. This is because if we were to sum the total sales of every firm in the regional economy, it would greatly exceed the true output of the region. For example, total 2014 sales from all firms in Washington were reported by IMPLAN at over $766 billion dollars. However, gross regional product (GRP), which is the same as value added, was only $428.6 billion in 2014, as reported by IMPLAN. The discrepancy comes largely from the sales measure double counting firms' outputs. If a farmer sells wheat to a processor and the processor sells the flour to a baker, and the baker sells bread to a family, the *value* of the wheat is effectively counted 3 times. The value added or GRP measure avoids this double counting by only capturing the increased value of the goods at each step in the production process. In order to avoid double counting, value added data is used to report industrial contributions.

For the sake of completeness we provide the changes in sales, value added, income, and jobs resulting from the activities of the forage exporters, but true economic contributions are only reflected in the value added or GRP measures.

Table 4: Top Occupations and Wages for Animal Food Manufacturers

Occupation Title	Percentage of the Industry	Average Hourly Wage*	Average Annual Wage*
Packaging and filling machine operators and tenders	10.2	$14.31	$29,770
Mixing and blending machine setters, operators, and tenders	9.8	$17.51	$36,410
Heavy and tractor-trailer truck drivers	6.2	$20.43	$42,500
Laborers and freight, stock, and material movers, hand	5.2	$13.39	$27,840
Industrial truck and tractor operators	4.1	$16.39	$34,090
First-line supervisors of production and operating workers	3.9	$28.81	$59,930
Food batchmakers	3.3	$14.04	$29,210
Sales representatives, wholesale and manufacturing, except technical and scientific products	3	$32.11	$66,790
Maintenance and repair workers, general	2.7	$18.73	$38,950
General and operations managers	2.6	$57.44	$119,460
Extruding, forming, pressing, and compacting machine setters, operators, and tenders	2.2	$16.36	$34,030
Helpers--production workers	2.2	$12.50	$26,010
Office clerks, general	2	$15.33	$31,890
Industrial machinery mechanics	1.8	$24.75	$51,470
Crushing, grinding, and polishing machine setters, operators, and tenders	1.8	$17.10	$35,560
Bookkeeping, accounting, and auditing clerks	1.6	$18.74	$38,990
Customer service representatives	1.6	$16.62	$34,560
Secretaries and administrative assistants, except legal, medical, and executive	1.3	$16.92	$35,200
Inspectors, testers, sorters, samplers, and weighers	1.3	$18.95	$39,410
Light truck or delivery services drivers	1.3	$16.38	$34,080
Packers and packagers, hand	1.3	$11.40	$23,710
Industrial production managers	1.2	$49.87	$103,720
Shipping, receiving, and traffic clerks	1.1	$15.55	$32,350
Maintenance workers, machinery	1.1	$21.41	$44,540
Production workers, all other	1.1	$15.15	$31,520
Total	***74%***	***$19.78***	***$41,147***

* Totals represent weighted averages

Source: Employment Projections program, U.S. Department of Labor, U.S. Bureau of Labor Statistics and the Occupational Employment Statistics Survey

As noted earlier, there are generally three types of economic contributions made by an industry to the larger overall economy. The first is the direct effects. These are the effects generated within the sector itself. If an exporter employs a full time laborer, that job constitutes a direct effect of the industry on the larger economy.

Another effect is called the indirect effect. This results from business-to-business transactions. Jobs that exist at the local implement dealer in response to satisfying the business needs of exporters would be included in the indirect effect measure.

The last effect, the induced effect, comes from employees in the industry of interest seeking private goods and services for their personal lives using the income earned from working in the industry. For example, jobs in other sectors that are supported from forage exporters using their income to go to the movies, buy groceries, or purchase a family vehicle, constitute induced effects. Induced and indirect effects are often lumped together as multiplier effects – the measurement of economic activity in other industries that results from the direct activity of the industry being studied.

Direct

There are four ways to measure the contributions of an industry: through sales of goods and services, through value added in the economy (commonly referred to as gross regional product), income earned, and lastly through employment. We analyze and provide data on all of these metrics but the true contribution is reflected in the value added measures.

The direct effects of forage exports from the western states stem from the processing and the portion of transportation, storage, and handling that is paid for by foreign buyers. Total direct sales are estimated at $797.9 million in processed exports. We convert these sales figures into value added, income, and jobs in table 5. The direct effects represent the value of exports only.[4] Similarly, direct jobs do not represent total employment in the industry but the share of total employment supported by the foreign exports of the industry. Any domestic sales, and the associated jobs, would not be captured.

Table 5: Direct Effects due to USFEC Members from the Western U.S.

Industry	Sales (000)	Value Added (000)	Income (000)	Jobs
Forage Processor-Exporters	$797,871	$77,451	$38,694	577

Source: IMPLAN 2014 data and author's calculations

Indirect

The indirect effects represent the business-to-business transactions of the firms in the industry. The first round of these indirect effects are reflected in the industries purchases outlined in table 3 above. Suppose an exporter spends money on a new press that is shipped in from Madras, OR. The press manufacturer might then need to buy grease from a lubricating oil manufacturer in Seattle, which in turn needs to buy petroleum from a wholesaler out of Santa Clara, etc. Each of these transactions results in additional rounds of spending and income that are captured through the indirect multiplier effects. The indirect effects are outlined by major industrial sectors in table 6 below.

[4] Because the exact value of exports for forage crops were based on estimates that only reflect the members of the USFEC a sensitivity analysis of the variable is conducted. The results may be seen in Appendix B.

Table 6: Indirect Effects due to USFEC Members from the Western U.S.

Industry	Sales (000)	Value Added (000)	Income (000)	Jobs
Forage Processor-Exporters	$7,771	$754	$377	6
Agriculture	$75,738	$24,669	$13,434	426
Forestry	$124	$123	$69	1
Mining	$5,309	$4,312	$1,140	16
Utilities	$11,163	$7,162	$1,912	13
Construction	$5,810	$6,614	$1,945	34
Processed food	$147,835	$13,850	$5,858	93
Manufactures	$42,927	$18,983	$5,276	61
Wholesale and retail trade	$136,789	$115,153	$45,818	569
Services	$201,374	$230,640	$76,111	1,120
Miscellaneous	$4,288	$33,256	$1,845	38
Total	***$639,128***	***$455,518***	***$153,786***	***2,377***

Source: IMPLAN 2014 data and author's calculations

Induced

Induced effects represent the household-to-business transactions and the additional spending they generate. As a forage exporter pays himself and his employees they take their income and spend it at local retail stores, gas stations, etc. Induced effects tend to be smaller than the indirect effects in part because household spending leaks out of the region more quickly than business spending does. A household purchase of writing pens might see the majority of the money spent go to Oak Brook, Illinois to the manufacturer of the pens. The money that stays in the region might be going to the income of the store employees and the local utilities provider, etc. These household generated contributions are outlined in table 7.

Table 7: Induced Effects due to USFEC Members from the Western U.S.

Industry	Sales (000)	Value Added (000)	Income (000)	Jobs
Forage Processor-Exporters	$346	$34	$17	0
Agriculture	$2,598	$1,662	$830	16
Forestry	$63	$42	$36	1
Mining	$1,608	$1,077	$302	3
Utilities	$4,784	$2,163	$769	5
Construction	$9,274	$4,040	$3,058	53
Processed food	$9,350	$2,054	$1,190	21
Manufactures	$23,395	$7,448	$3,043	36
Wholesale and retail trade	$36,452	$24,962	$14,385	303
Services	$191,823	$119,836	$67,663	1,270
Miscellaneous	$37,977	$31,732	$28,387	425
Total	***$317,672***	***$195,048***	***$119,680***	***2,133***

Source: IMPLAN 2014 data and author's calculations

Total Contributions

Total contributions represent the sum of the direct and multiplier effects. The USFEC members alone generated roughly $78.2 million in GRP in 2015. However, once all multiplier effects are accounted for the total contributions of the members increased to $534.7 million. The activities of the members support 583 jobs within their own industry and a total of over 5,000 jobs throughout the region.

Table 8: Total Contributions due to USFEC Members from the Western U.S.

Industry	Sales (000)	Value Added (000)	Income (000)	Jobs
Forage Processor-Exporters	$805,988	$78,239	$39,088	583
Agriculture	$78,336	$26,331	$14,265	442
Forestry	$187	$123	$105	1
Mining	$6,918	$4,312	$1,442	19
Utilities	$15,947	$7,162	$2,681	18
Construction	$15,084	$6,614	$5,003	87
Processed food	$157,185	$13,850	$7,048	114
Manufactures	$66,322	$18,983	$8,320	97
Wholesale and retail trade	$173,241	$115,153	$60,203	872
Services	$393,197	$230,640	$143,774	2,390
Miscellaneous	$42,266	$33,256	$30,231	463
Total	***$1,754,670***	***$534,664***	***$312,159***	***5,086***

Source: IMPLAN 2014 data and author's calculations

There is a great deal of discussion surrounding the topic of multipliers. The term has been so abused in the political arena that it tends to detract from the actual and original meaning. Nonetheless, there is value in understanding multipliers, if understood correctly and in the context of the models used. To calculate the sales multiplier the total sales stemming from forage exports, $1.75 billion in our case, is divided by the direct effects, $797.87 million (see table 5). This implies that each dollar of forage exports that enters the region is spent and re-spent in the economy 2.2 times; supporting and sustaining economic activity in every industry it passes through before it entirely leaks out of the region through the purchase of imports.

Fiscal Analysis

There is interest in understanding how a business's operations and subsequent multiplier effects contribute to public finances. To accomplish this we again used the IMPLAN Pro software with the 2014 data set. Because the IMPLAN software does not have the forage export industry specifically within its data set we ran the analysis using the same direct effect but in the more broadly defend "Other animal food manufacturing" category.

The results are broken down into state and local government revenues and federal revenues. It is important to understand that these are general estimates and they reflect the tax collections of three different states. Washington, for example, does not have a state income tax, and thus the $9.1 million in income taxes collected at the state and local level would be collected by California and Oregon only. Similarly Oregon does not have a sales tax and the $16.8 million collected by state and local governments would only be collected by Washington and California.

Even with the host of caveats, the tax analysis provided by IMPLAN does show the contributions the forage sector has on the regional governments overall. Because of the presence of the USFEC members' operations, state and local governments collect a total of nearly $44. 7 million in revenues. Without these forage exporters it is likely those governments would have to increase tax rates in order to meet potential budget shortfalls, however minor those shortfalls might appear in the context of the overall economies. Collections by the federal government represent another $66.5 million in revenues.

Table 9: Total Tax Contributions due to USFEC Members from the Western U.S.

Description	State & Local Taxes	Federal Taxes
Sales	$16,811,982	-
Property	$13,584,535	-
Income Tax	$9,172,288	$61,602,818
Excise Tax	$5,100,664	$4,904,774
Total	*$44,669,469*	*$66,507,592*

* TOPI stands for Taxes on Production and Imports

Source: IMPLAN 2014 data

Conclusions

Forage exporters are a small but significant part of the West Coast economy. They are an integral link in the supply chain between forage producers and foreign buyers, facilitating the export of nearly 3 million tons of product to more than 4 major foreign trading partners. As the value of the dollar increases the ability of these exporters to maintain a competitive edge in international markets becomes challenging but is critical to the thousands of employees supported by the forage sector.

In 2015 USFEC's West Coast members generated roughly $77.5 million in new output. That new money was then spent and re-spent, eventually adding over half a billion ($534.6 million) in additional GRP to the economies of Washington, Oregon, and California. Direct employment by USFEC members amounted to roughly 577 jobs, but their efforts supported over 5,000 jobs in the region, largely because of the new income they brought into the economy.

Not only did these forage exporters bring money into the U.S. and support thousands of jobs, but their business activity generated significant tax revenues for the states and municipalities in which they operated, and to the federal government. Without the roughly $110 million in government revenues that were directly linked to the activities of the USFEC members in the west, taxes on other entities would conceivably, at least at the municipal level, need to be raised in order to maintain the current levels of public services.

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Appendix A: A primer on Input-Output Accounts 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.1 below shows a simplified version of an I-O matrix with just a hand full of industries.

Figure A.1: 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, farm businesses, for example, may buy seed from within their own sector, fertilizer and farm equipment from the manufacturing sector, and legal and accounting services from the service sector. Payments to their employees 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 of 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 of 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 B: Sensitivity Analysis

The sensitivity analysis presented here adjusts the volume and price of forage exports in order to 1) determine how sensitive the results are to those variables and 2) provide a reasonable upper and lower bound to the results. Impact and contribution analyses should be understood in the context of uncertainty and, thus, point estimates must not be "taken as gospel" but give a clear indication of the economic activity associated with a particular industry. Data constraints on commodity exports at state and regional levels are extremely difficult to overcome and often we need to rely on industry knowledge rather than hard and fast data. It is well known that forage exports from the West Coast can exceed 90% of total U.S. exports. For the purposes of our analysis we assumed 2.9 million tons of forage crops were exported by USFEC members in Washington, Oregon, and California. We test this assumption by adjusting it from a low of roughly 2.61 million tons to a high of just under 3.2 million tons (an adjustment of about 10% above and below the current estimated volume).

Table B.1: Sensitivity of Value Added from changes in Direct Effects ('000)

Industry	-10%	-5%	Base Case	5%	10%
Forage Exports (million tons)	2.61	2.76	2.90	3.05	3.19
Total Direct Effects	$69,706	$73,578	$77,451	$81,324	$85,196
Total Multiplier Effects	$411,491	$434,352	$457,213	$480,073	$502,934
Total	$481,197	$507,930	$534,664	$561,397	$588,130

Table B.2 shows employment contributions adjusting similarly from a low of 4,578 jobs to 5,595. Even with the swing in employment the significance of the cluster is still clear, supporting far more jobs than are directly employed in the cluster.

Table B.2: Sensitivity of Employment from changes in Direct Effects

Industry	-10%	-5%	Base Case	5%	10%
Tons of Forage Exports	2.61	2.76	2.90	3.05	3.19
Total Direct Effects	519	548	577	606	635
Total Multiplier Effects	4,058	4,284	4,509	4,735	4,960
Total	4,578	4,832	5,086	5,341	5,595

Tables B.3 and B.4 shocks the assumed $275 average forage price price per ton from a low of $50 per ton to a high of $350 per ton. This range was based on the annual average bid levels for Columbia Basin hay from 2010-2016 and was priced as freight on board (FOB). It is clear that the price is highly volatile and a sensitivity analysis on this variable is warranted. Clearly the impacts of the forage exporters are highly dependent on their ability to navigate price uncertainty. The drastic swings in price could cause the impacts of the

exporters to drop to $97 million in GRP and only support 924 FTE jobs, or increase to $680 million in GRP and support almost 6,500 jobs.

Table B.3: Sensitivity of Value Added from Changes in Price per Ton ('000)

Industry	-82%	-41%	Base Case	14%	27%
Price of Forage Exports	$50	$162	$275	$312	$350
Total Direct Effects	$14,075	$45,696	$77,451	$87,907	$98,528
Total Multiplier Effects	$83,091	$269,755	$457,213	$518,936	$581,637
Total	$97,166	$315,452	$534,664	$606,843	$680,165

Table B.4: Sensitivity of Employment from Changes in Price per Ton

Industry	-10%	-5%	Base Case	5%	10%
Tons of Forage Exports	$50	$162	$275	$312	$350
Total Direct Effects	105	340	577	655	734
Total Multiplier Effects	819	2,660	4,509	5,118	5,736
Total	924	3,001	5,086	5,773	6,471