IMPACT Center
WASHINGTON STATE UNIVERSITY

WASHINGTON AGRIBUSINESS

STATUS AND OUTLOOK

An annual report by Washington State University's IMPACT Center

2018

Contents

Preface

WASHINGTON Agribusiness: Status and Outlook is an annual publication prepared by Washington State University's IMPACT Center and faculty in the School of Economic Sciences. It is intended to be a concise overview of Washington's current and near-term agricultural activity. The publication is broken down into two primary sections. Section I reviews the status of various sub-sectors in agriculture and provides short-term projections or areas of focus moving forward. Section II provides specialty research focused on agricultural economic issues such as agricultural futures markets, organic farming, wheat milling, etc.

A version of this report will be available online through the School of Economic Sciences. Feedback on this issue and suggestions for future featured articles is most welcome. Specific questions regarding focus areas in the report should be directed to the managing editor who will work with the primary authors to provide responses.

T. Randall Fortenbery, Executive Editor
School of Economic Sciences
Washington State University
Pullman, WA 99163
(509) 335-7637
r.fortenbery@wsu.edu

Timothy P. Nadreau, Managing Editor
School of Economic Sciences
Washington State University
Pullman, WA 99163
(509) 335-0495
timothy.nadreau@wsu.edu

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Michael Brady, Ph.D.
Assistant Professor
(509) 335-0979
bradym@wsu.edu

T. Randall Fortenbery, Ph.D.
Professor, Small Grains Endowed Chair
(509) 335-7637
r.fortenbery@wsu.edu

Karina Gallardo, Ph.D.
Associate Professor, Extension Specialist
(253) 445-4584
karina_gallardo@wsu.edu

Mark Gibson, Ph.D.
Assistant Professor
(509) 335-7641
mjgibson@wsu.edu

Thomas Marsh, Ph.D.
Professor
(509) 335-8597
tl_marsh@wsu.edu

Timothy Nadreau, Ph.D. Candidate
Research Associate
(509) 335-0495
timothy.nadreau@wsu.edu

Shannon Neibergs, Ph.D.
Associate Professor
(509) 335-6360
sneibergs@wsu.edu

Alejandro Prera, Ph.D.
Assistant Clinical Professor
(509) 335-5976
alejandro.prera@wsu.edu

Jiehong Qiu, Ph.D. Candidate
Graduate Student
(509) 715-7098
jiehong.qiu@wsu.edu

Peter Tozer, Ph.D.
Associate Professor, Massey University
+64 (06) 356-9099 Ext. 84795
P.Tozer@massey.ac.nz

SECTION I

STATUS AND OUTLOOK

Situation and Outlook for Small Grains

T. Randall Fortenbery (509) 335-7637

Introduction

WASHINGTON grain producers experienced a slight improvement in prices beginning spring 2017 following four consecutive years of decline. However, for most farmers, prices remain at or below break-even levels. Current expectations are for continued price improvement going into 2018, but prices will still be constrained by record or near-record world supplies for most grains.

Despite a slight improvement in national average grain prices, the United States Department of Agriculture's (USDA) 2017 Farm Sector Income Forecast[1] anticipates U.S. cash crop receipts were down about two percent from 2016. Total wheat receipts for 2017 are estimated to lag 2016 by almost six percent due to a reduction in the total quantity sold. This represents a reduction of about $0.5 billion on the part of U.S. wheat farmers.

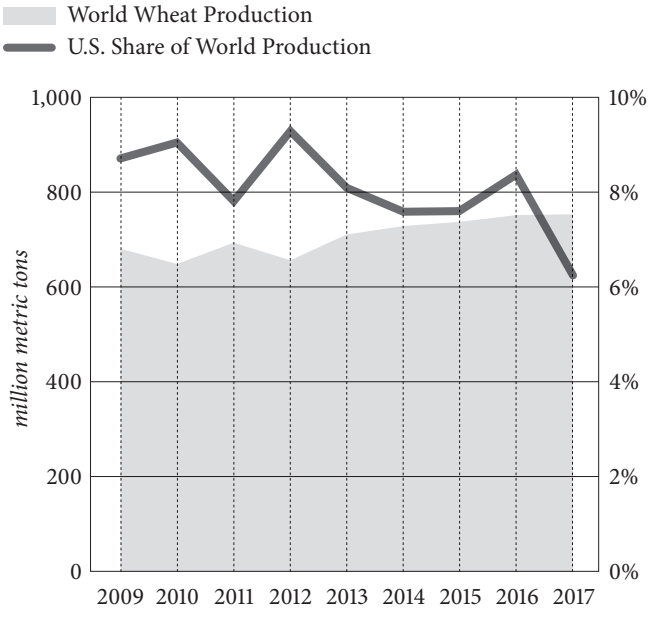
Direct government payments to grain farmers enrolled in the Price Loss Coverage (PLC) program increased from $1.9 billion in 2016 to $3.1 billion in 2017. The largest percentage of the increase represents payments to wheat producers. Producers enrolled in the Agricultural Risk Coverage (ARC) program actually saw total payments decline by about $1.3 billion compared to 2016, so on net total payments under the two programs were near unchanged on a year-over-year basis. Producers had to choose whether to participate in PLC or ARC (they cannot participate in both) in early 2015, and once enrolled they cannot change between programs based on current legislation.

1 https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/farm-sector-income-forecast/

Wheat

World wheat stocks at the end of the 2017/18 marketing year (the marketing year runs from June 1, 2017 to May 31, 2018) will again be record large, making the third year in a row of record stocks. Global wheat production in 2017 was estimated to be 755.2 million metric tons, just slightly above 2016 production (Figure 1). This constitutes the fifth consecutive year-over-year increase in global wheat production.

Figure 1: *World Wheat Production*



Source: Foreign Agricultural Service, United States Department of Agriculture

Table 1: *U.S. Wheat Balance Sheet (June/May)**

	MARKETING YEAR							
	USDA 10/11	**USDA 11/12**	**USDA 12/13**	**USDA 13/14**	**USDA 14/15**	**USDA 15/16**	**USDA DEC Est 16/17**	**USDA DEC Fore 17/18**
	(in million bushels, million acres)							
Beg Stocks	976	862	743	718	590	752	976	1,181
Imports	97	112	123	169	151	113	118	150
Acres Planted	54	54	56	56	57	55	50	46
Acres Harvested	48	46	49	45	46	47	44	38
% Harvested	88.8%	84.0%	87.8%	80.6%	81.7%	86.0%	87.5%	87.5%
Yield	46	44	46	47	44	44	53	46
Production	2,207	1,999	2,266	2,135	2,026	2,062	2,309	1,741
Total Supply	**3,279**	**2,974**	**3,131**	**3,021**	**2,768**	**2,927**	**3,402**	**3,071**
Food	926	941	945	951	958	957	949	950
Seed	71	76	73	77	79	67	61	66
Feed and Residual	132	164	384	228	114	149	156	120
Exports	1,289	1,050	1,012	1,176	864	778	1,055	975
Total Demand	**2,418**	**2,231**	**2,414**	**2,432**	**2,015**	**1,952**	**2,267**	**2,111**
Ending Stocks	862	743	718	590	752	976	1181	960
Stocks To Use	36%	33%	30%	24%	37%	50%	50%	45%
Avg. Farm Price	$5.70	$7.24	$7.77	$6.87	$5.99	$4.89	$3.89	$4.60

Source: World Outlook Board, United States Department of Agriculture

In contrast to the world situation, U.S. wheat production declined in 2017 compared to 2016. As a result, the U.S. share of total world wheat production fell from more than eight percent to just over six percent. A mere five years ago, the U.S. share of global production was almost 9.5 percent.

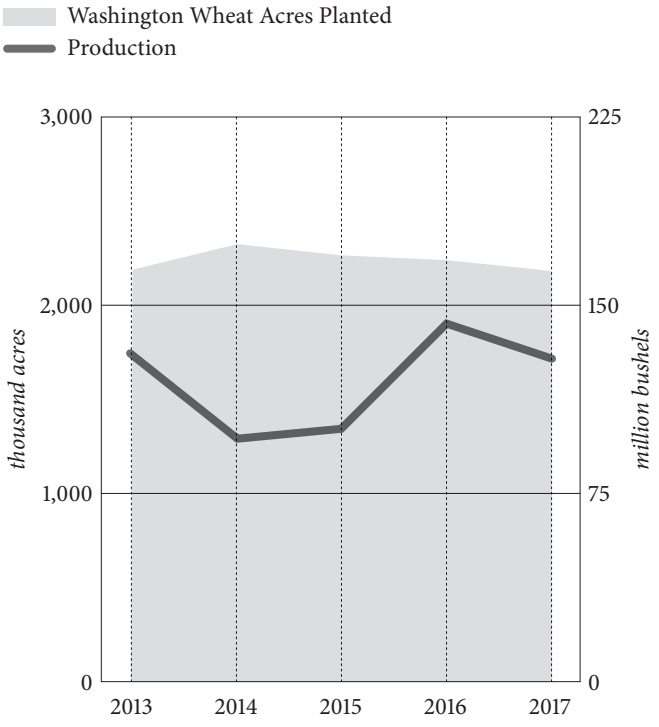
Total consumption of wheat worldwide is expected to increase for the 2017/18 marketing year, but not by enough to offset the production increase, thus the increase in wheat inventories this year compared to last. In addition, global wheat trade is expected to be down this year.

U.S. wheat demand is expected to be a bit softer in 2017/18, but the reduction is not as great as the production decline, so U.S. ending stocks May 31, 2018 are expected to be below last year's levels. This, in turn, leads to expectations of some price improvement relative to last year's market average price for U.S. producers.

Table 1 shows the 2017/18 U.S. wheat balance sheet over the last several years. Note that while ending stocks are quite high compared to most of the years in Table 1, they are lower than each of the last 2 years.

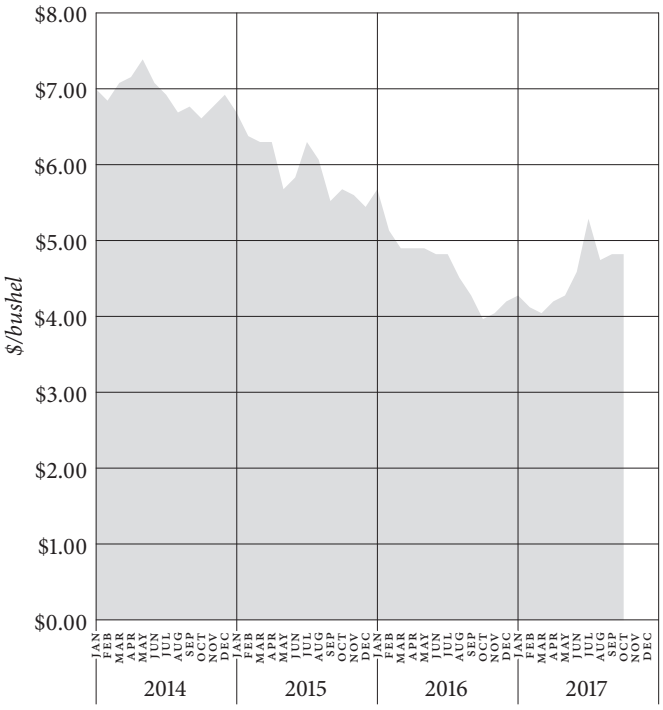
Washington wheat producers followed the national trend by reducing acres planted to wheat in 2017 by a little over two percent. This represents the fourth year in a row with a significant year-over-year reduction in Washington wheat acres (Figure 2). However, despite the wheat acres

Figure 2: *Washington Wheat Production*



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

Figure 3: *Washington Monthly Wheat Prices*



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

in 2017 being well below levels in 2014 and 2015, total Washington wheat production exceeded production in both those years by a considerable amount.

Most wheat produced in Washington is soft white wheat destined for markets in Asia. In 2017, about 50 percent of the spring planted wheat varieties in Washington consisted of soft white wheat, and the winter planted varieties were about 85 percent soft white wheat. At the national level, white wheat production totaled 258 million bushels in 2017, a decrease of about 28 million bushels from 2016 (just under half that U.S. white wheat production comes from Washington alone). In addition, demand is projected to be stronger for the 2017/18 marketing year compared to last year, so overall white wheat inventories are expected to fall this year.

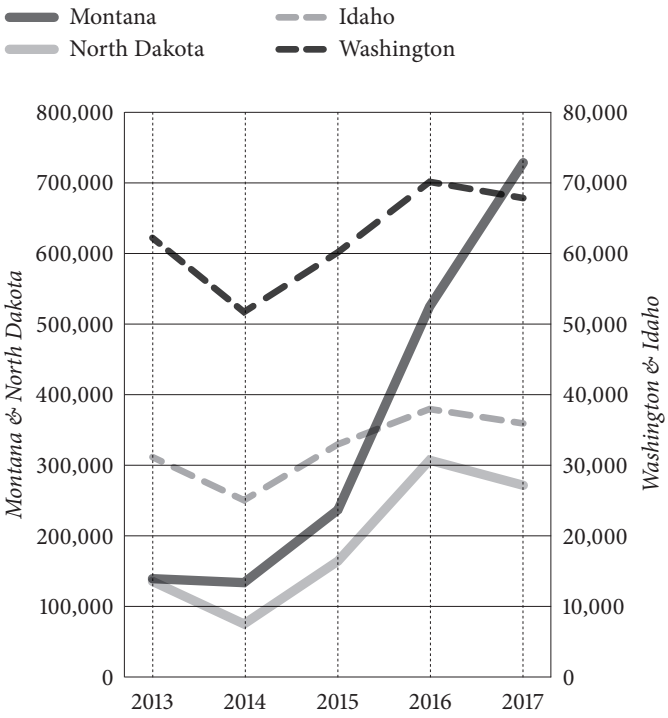
The entire year-over-year increase in demand for white wheat comes from the export market. Through May 2018 (the end of the current wheat marketing year), USDA projects that the U.S. will export 210 million bushels of white wheat, or more than 82 percent of total 2017 U.S. white wheat production (because there was 105 million bushels of white wheat left over from earlier years going into the 2017/18 marketing year, the export projection represents about 58 percent of the total U.S. white wheat supply for 2017/18).[2] As a result of both lower production and an expected increase in exports for the current marketing year, ending stocks of white wheat going into next summer's harvest are expected to total about 67 million bushels, a reduction of about 36 percent from stocks left over at the end of the 2016/17 marketing year.

Based on an improved supply/demand balance sheet, Washington producers have finally started to see a slight improvement in local prices being paid for their wheat crops. Figure 3 shows the average monthly price received across all of Washington, aggregated across all wheat varieties, over the last several years.

Despite the price improvement shown in Figure 3, Washington producers are still facing prices below their total production costs. While costs can vary significantly among

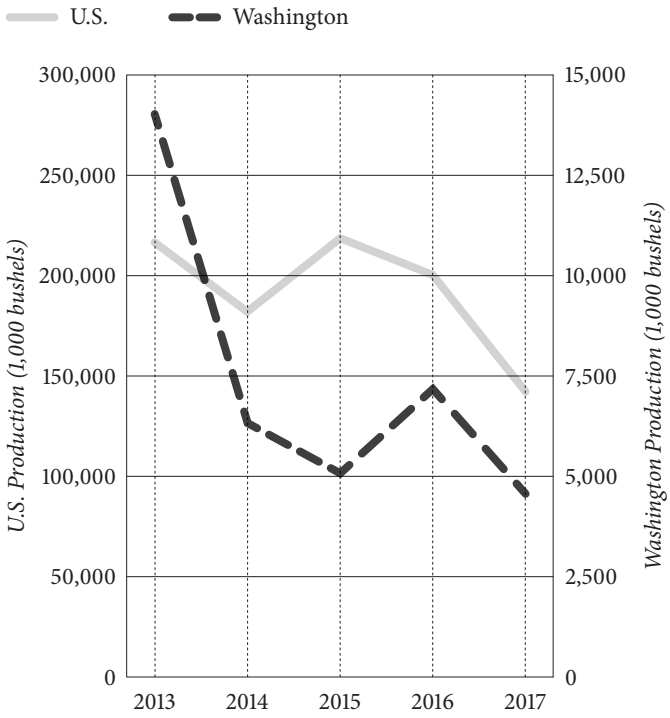
2 World Agricultural Supply and Demand Estimates, USDA, December 12, 2017.

Figure 4: *Lentil Acres*



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

Figure 5: *Barley Production*



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

producers, across geographic regions, by wheat class, and by production systems, most producers need higher prices to cover total costs. Total cost includes not only variable costs of production (the cost of seed, fertilizer, pesticides, and fuel), but also fixed costs that include things like debt service on long-term debt and depreciation on equipment. According to existing Washington wheat production budgets developed by the IMPACT Center at Washington State University, producers, on average, need prices to be above $6.00 per bushel to recoup both the variable and fixed costs associated with wheat production.[3]

Given the challenging economic environment, it is anticipated that total wheat acres in 2018, both nationally and in Washington, will again be down relative to the previous year. While there has been a shift for a number of years from wheat acres to corn and soybean acres in the Dakotas, we are also starting to see other acreage shifts in northern wheat producing states. Figure 4 shows lentil acres over the last five years for several states, including Washington. Notice the tremendous growth in lentil plantings in Montana and North Dakota in recent years (largely coming at the expense of wheat acres). While Idaho and Washington have not had the same magnitude of change as Montana and North Dakota, they too show some signs of shifting from wheat to more lentils in response to the poor wheat price environment.

According to the United States Department of Agriculture,[4] Washington's agricultural production was valued at $10.6 billion in 2016 (the most recent data available). Of that, wheat ranked fifth with a total production value of $657 million. If USDA's current price projections for the 2017/18 crop year hold up, the 2017 Washington wheat crop will likely exceed that value by almost $100 million despite lower total production. While this is still well below the $1 billion crop harvested in the early years of the current decade, it is a significant improvement over the previous three years.

3 Economic Contributions of the Wheat Cluster to the Washington Economy, IMPACT Center, WSU, 2016. http://ses.wsu.edu/wp-content/uploads/2016/09/2014_Final_Wheat_Impacts_v2.pdf

4 https://agr.wa.gov/aginwa/docs/Top10WA_2016.pdf

Table 2: *U.S. Barley Balance Sheet (June/May)*

	MARKETING YEAR							
	USDA 10/11	**USDA 11/12**	**USDA 12/13**	**USDA 13/14**	**USDA 14/15**	**USDA 15/16**	**DEC Est 16/17**	**DEC Fore 17/18**
	(in million bushels, million acres)							
Beg Stocks	115	89	60	80	82	79	102	106
Imports	9	16	23	19	24	19	10	15
Acres Planted	2.9	2.6	3.7	3.5	3	3.6	3.1	2.5
Acres Harvested	2.5	2.2	3.3	3	2.5	3.2	2.6	2
% Harvested	86%	85%	89%	86%	83%	89%	84%	80%
Yield	73.1	69.6	66.9	71.3	72.7	69.1	77.9	72.6
Production	180	156	219	217	182	218	200	142
Total Supply	**305**	**261**	**302**	**316**	**287**	**315**	**312**	**263**
Food	159	155	155	153	151	158	162	162
Feed and Residual	50	38	58	66	43	44	39	35
Exports	8	9	9	14	14	11	4	5
Total Demand	**217**	**202**	**222**	**234**	**209**	**213**	**205**	**202**
Ending Stocks	89	60	80	82	79	102	106	61
Stocks To Use	41.01%	29.70%	36.04%	35.04%	37.80%	47.89%	51.71%	30.20%
Avg. Farm Price	$3.86	$5.35	$6.43	$6.06	$5.30	$5.52	$4.96	$4.50

Source: World Outlook Board, United States Department of Agriculture

Barley

U.S. barley production fell significantly in 2017 compared to 2016 and continued the general down trend of the last few years. After a significant uptick last year, Washington barley production also fell in 2017. Table 2 presents the balance sheet for U.S. barley, and Figure 5 shows Washington versus national barley production over the last few years.

Washington barley acres more than doubled between 2010 and 2013 but fell about 16 percent in 2017 relative to 2016. Additionally, barley acres fell below 100,000 acres for the first time since 2010. Also, Washington barley producers experienced much lower yields in 2017 compared to 2016. In 2016 barley yields across Washington averaged 77 bushels per acre, just under the national average of 77.9 bushels. This fell to 53 bushels per acre in 2017 – almost 20 bushels per acre below the national average.

Unlike wheat, USDA is actually projecting U.S. barley prices will be lower this marketing year compared to last year. This is expected despite a significant reduction in ending stocks relative to last year.

Washington prices have tended to trade in a relatively narrow range over the last year, averaging between the low $2.30 per bushel level to just over $2.50.[5] In general, feed barley prices are lower in Washington compared to the U.S. average. Washington producers selling feed barley

5 This is an average price for all barley. Prices for malting barley were about twice the all barley price.

in the summer months of 2017 were receiving about $0.40 per bushel less than they received in summer of 2016. Also, similar to last year, feed barley prices in Washington seem to be averaging about $0.30 per bushel below the national average feed barley price.

The decline in barley production, both nationally and in Washington, does not appear to be providing much support to the barley price. As a result, we will likely see another decrease in total barley acres for the 2018 harvest. Current price levels make it difficult to compete with wheat and some pulse crops.

Summary

While there has been some marginal improvement in the price outlook for Washington wheat farmers, most continue to face prices that do not cover their total costs of production. As a result, we have seen an increase in pulse acres at the expense of wheat. Producers of barley face an even more challenging price environment, and we will likely see an additional reduction in Washington barley acres for 2018.

The outlook for wheat prices going into the 2018/19 marketing year is a bit better than this year, but the improvement may not be substantial unless there is a production disaster somewhere around the globe. Further, there are market risks associated with both the current international trade environment (i.e., what happens with NAFTA and whether the U.S. successfully peruses more favorable bilateral trade arrangements for commodities with Asian partners) and the new Farm Bill.

The current farm legislation will expire in September 2018. While there have been committee hearings on the part of both the House of Representatives and the U.S. Senate in recent months, as of the end of December 2017 there had been no proposed legislation brought to the floor of either chamber. Given that 2018 is a mid-term election year, it is quite conceivable that the new Farm Bill may be delayed until after the election, suggesting at least a one-year extension of the current legislation. For many Washington grain producers, this delay could be costly because most signed up for the Average Revenue Coverage program (ARC) as opposed to the Price Loss Coverage program (PLC). In the current economic environment, the PLC program is supplying substantially higher income support then the ARC program. Under current law, producers who elected ARC coverage at the beginning of the current Farm Bill cannot change their choice, and thus are stuck with the lower level of support.

It is anticipated that when new Farm Bill legislation is eventually introduced it will maintain Crop Insurance as the primary safety net for grain farmers. It is also likely that the ARC and PLC programs will be maintained in some form, although the triggers that result in payments to producers in times of economic stress may be adjusted. It is also likely that producers will be able to change their selection (between ARC and PLC) once the new Farm Bill is implemented. However, it is unclear whether that would be a onetime choice, or whether the new legislation would allow for changes more often. Regardless, Washington grain producers are likely looking at another challenging year unless there is a major crop disaster in some other production region.

2017 Washington Tree Fruit Outlook

Karina Gallardo (253) 445-4584

WASHINGTON is the single largest producer of apples, pears, and cherries in the nation. The 2016 Washington tree fruit outlook analyzes the production trends and market conditions. We also give an update on research findings in the area of consumer demand for pears.

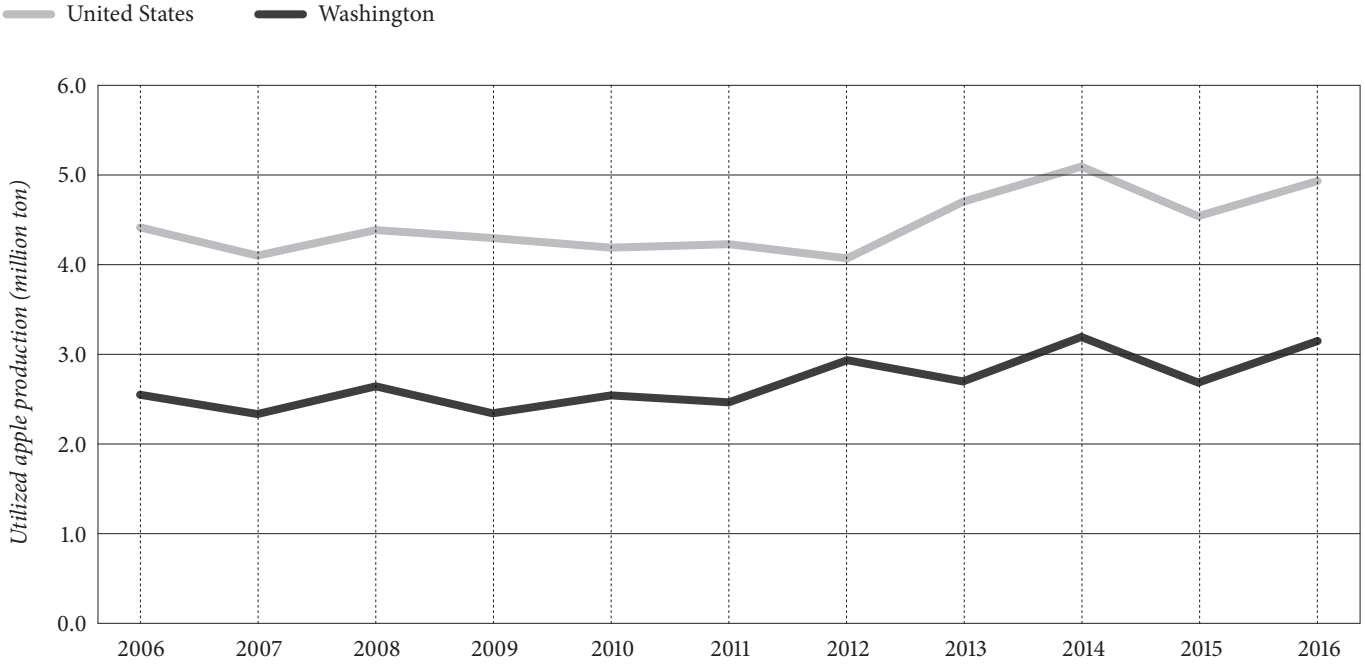
Note that we use two different words to denote year. To denote production related numbers we use year, indicating the year when most of the horticultural management took place and the year when the fruit was harvested. For example, when we write "In 2016, Washington State utilized production was 3.14 million…", that means that the total harvested and utilized production during months August throughout November of 2016. When stating sales figures, we used marketing season. For example, when we write "During the marketing year 2015–2016, Red Delicious represented 25%…" This refers to apples that were harvested on September 2015 and were sold since harvest time until the end of the season in July 2016.

Apples

In 2016, Washington State utilized apple production was at 3.14 million tons, representing 64 percent of all utilized apple production in the United States at 4.92 million tons. Washington apple production typically uses high-density fruit wall planting systems with dwarf rootstocks,[6] which helps the state increase utilized production volume and yields per acre. In 2016, apple utilized production was above the 10-year average at 2.68 million tons but below the 2014 record production at 3.20 million tons. During 2006-16 yield per acre in Washington increased 23 percent,

6 Apple trees are not grown on their own roots. Instead, they are propagated on rootstocks. Rootstocks are divided into three groups: dwarf, semi-dwarf, and standard (Washington State Department of Agriculture, 2011). Dwarf rootstocks control the amount of wood in the tree, directing the tree's energy into fruit production. The more dwarfing the rootstock, the better suited for high-density plantings (>1,000 trees per acre). Dwarf rootstocks—given the narrow canopy—require some type of support for the trees, which is why they are associated with fruiting walls or planar systems.

Figure 1: *Utilized Apple Production 2006–2016*



Source: USDA, 2017

from 18 tons per acre in 2006 to 22 tons per acre in 2016. Note that in 2016, the yield per acre in Washington State was above the United States average at 17 tons per acre. During 2006-16, apple-cultivated surface increased seven percent from 154 thousand acres in 2006 to 165 thousand acres in 2016. In 2016, 75 percent of all Washington apple production was sold in the fresh market.

The Washington apple variety mix has changed during the last 10 years. During the marketing season 2004-05, Red Delicious represented 37 percent of all apples shipped out of Washington, followed by Gala 15 percent, Fuji 13 percent, Golden Delicious 13 percent, and Granny Smith 12 percent. During the marketing season 2015-16, Red Delicious shipments decreased to 25 percent, Gala increased to 21 percent, Fuji remained stable at 13 percent, Golden Delicious decreased to seven percent, Granny Smith slightly increased to 15 percent, , and Honeycrisp emerged to hold six percent. Apple dwarf rootstocks had fostered the investment in new varieties with superior eating quality and higher market prices. In 2015-16, Washington grown Honeycrisp apples sold at $65.93 per 40-pound box, while Fuji sold at $30.77, Gala $26.88, Granny Smith $23.83, Golden Delicious $23.24, and Red Delicious $18.87.

Important for the State of Washington is the release of an improved variety called Cosmic Crisp®, a cross of the Enterprise and Honeycrisp varieties that was bred by the Washington State University apple breeding program. This apple is juicy, with a remarkably firm and crisp texture, and an appealing balance of sweetness and tartness. In addition to its superior eating quality, this apple is slow to brown down when cut and would maintain its texture and flavor in storage for more than a year. More importantly, this apple was bred in Washington State for Washington State growing conditions. As of 2017, 35 growers in Washington State have planted an unprecedented 629 thousand trees. Additionally, 5.5 million trees are expected to be planted in 2018 and another 5.5 more million trees in 2019. From 2017-19, 11.5 million trees of Cosmic Crisp will be grown, representing 12 percent of all trees planted in Washington State as of 2011. Cosmic Crisp will be available in the market by 2019.

In the marketing season 2015-16, 29 percent of all Washington apple production was exported. Main export destinations were Mexico (30 percent), Canada (17 percent), Taiwan (eight percent), India (seven percent), and Indonesia (six percent). Because the United States domestic fresh apple consumption has remained stagnant since the 1980s (at 16 to 19 pounds per person per year) and Washington apple production is expected to increase, maintaining a steady share in established export markets and an increasing share in emerging markets is crucial for the economic sustainability of the Washington apple industry. The marketing season 2015-16 was the first full marketing year with an expanded market to China. Enhancing the United States apple exports to markets such as China could boost the apple industry. If the Chinese market remains open to U.S. apples, it is estimated that by 2019 apple exports to China will amount to $100 million per year.

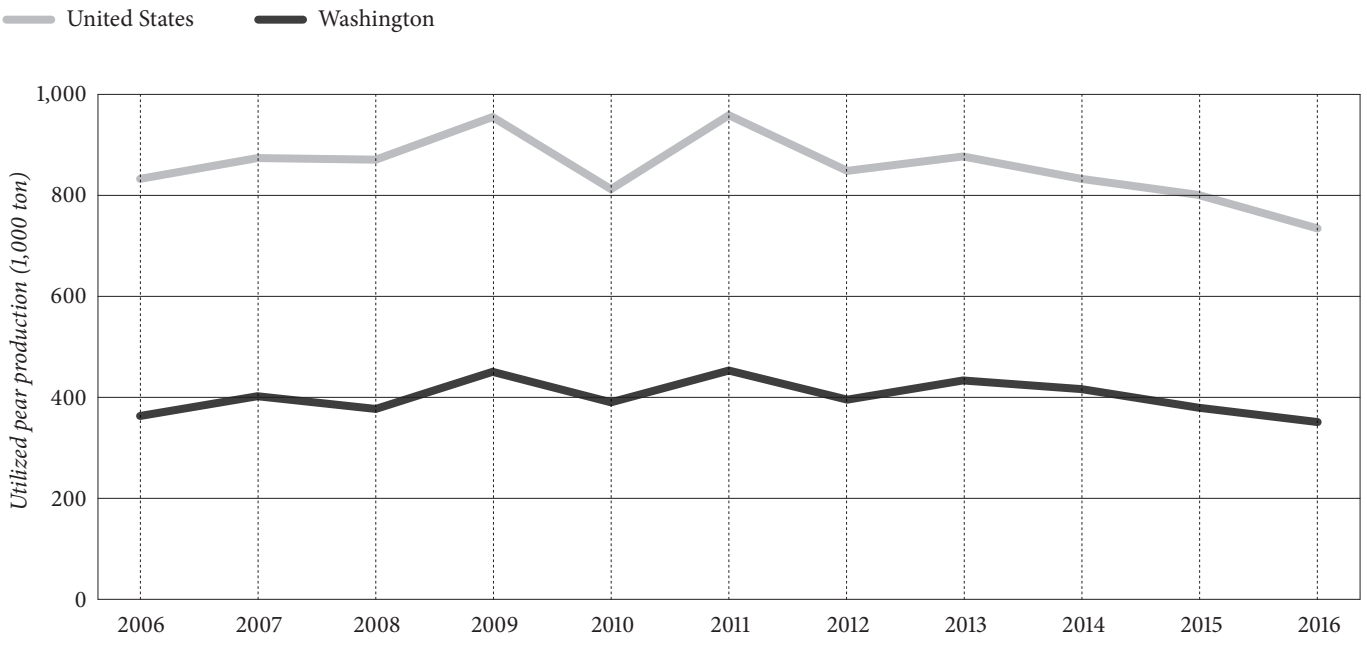
World production for the marketing season 2017-18 is projected to decrease by 2.6 million metric tons to 76.2 million due to freezes affecting orchards in the European Union and offsetting gains to be realized in China. This country is the largest producer of apples in the World and its production is expected to increase in 2017-18 to 44.5 million tons. However, Chinese apple exports are expected to decrease due to the ban on Chinese grown apples imposed by India, China's major exporting market. China's imports are expected to increase to 80 thousand tons, coming mainly from the United States, Chile, and New Zealand.

Pears

Washington is the largest producer of pears by volume in the United States. In 2016, utilized pear production in Washington State was at 347 thousand tons, representing 47 percent of total utilized pear production in the United States at 736 thousand tons. The 2016 pear production in Washington was below the 10-year average (at 400 thousand tons). In fact, the 2016 pear production was the lowest during the 2006-16 period. Since the production peak in 2011 (at 457 thousand tons), pear production in Washington State has declined. The decline is attributed to the reduction in pear-cultivated surface in Washington State. In 2016, bearing acreage was at 20.8 thousand acres, showing a 13 percent decline compared to 2006. During 2006-16, the yield per acre in Washington State increased 12 percent, from 15 tons per acre in 2006 to 16.8 tons per acre in 2016. The later yield per acre was below the 10-year average observed in Washington State at 18 tons per acre. Yet, the 2016 yield per acre in Washington is slightly above the United States average at 16 tons per acre. In 2016, 80 percent of pears produced in Washington State were destined to the fresh market.

Considering the pear variety mix in Washington, efforts to introduce new pear varieties are still in progress. During the last 10 years, a decrease in the production volume of D'Anjou and Bosc pears and an increase of Bartlett was

Figure 2: *Utilized Pear Production 2006–2016*



Source: USDA, 2017

observed. In the 2016-17 marketing season, 53 percent of all fresh pear shipments were of the D'Anjou variety, followed by 28 percent Bartlett and 15 percent Bosc. In the 2004-05 marketing season, 60 percent were D'Anjou, 19 percent Bartlett, and 17 percent Bosc. It is believed that the lack of dwarf rootstocks adaptable to Washington's growing conditions is deterring the investment in planting new pear varieties.

Pear production in the United States is expected to decrease to 640 thousand tons mainly due to lower production in Washington State. United States exports are expected to decrease to 120 thousand tons, while imports are expected to increase to 80 thousand tons. World production of pears is expected to increase to 25.1 million tons as China continues to increase its production. China is the largest producer of fresh pears in the world. It is expected that the 2017-18 season will see Chinese pear production slightly higher than 19 million tons, representing 75 percent of all pears produced on the planet, at 25.4 million tons. Chinese exports are expected to decrease to 480 thousand tons.

Research on consumer acceptance of sliced packed pears

During 2016-17 a group of Washington State University researchers (Gallardo, Dhingra, Ikiz, and Hewitt) conducted a study to assess consumers' preferences for a new product, sliced pears treated with a novel ripening component that would preserve the appearance and eating quality characteristics of the fruit. To conduct this study, the researchers used a dual-discipline approach, combining sensory taste-testing with experimental auctions.

Four samples of packed sliced pears were presented to 120 panelists, who evaluated the appearance and eating quality characteristics of sliced pears under four treatments with varying levels of ripening compound. They then participated in a second-price experimental auction.

Results from the econometric model indicated that treatment-induced quality attribute levels were determinant for willingness to pay. In general, higher ratings for size, firmness, tartness, and sweetness led to higher bids for pear samples. Similarly, higher intensity ratings for firmness, sweetness, and tartness implied higher bids. Panelists were willing to pay a price premium of $0.11–$0.20 per two ounce. package of sliced pears for the samples treated with ripening compound compared to the untreated control sample.

Results from a market segmentation analysis indicate the presence of two groups in our sample panelist population: a group that liked sliced pears and another group that

disliked sliced pears. The group that liked sliced pears assigned higher importance to locally grown and price attributes, shopped at grocery stores, had fewer children in the household, and were younger than the group that disliked sliced pears.

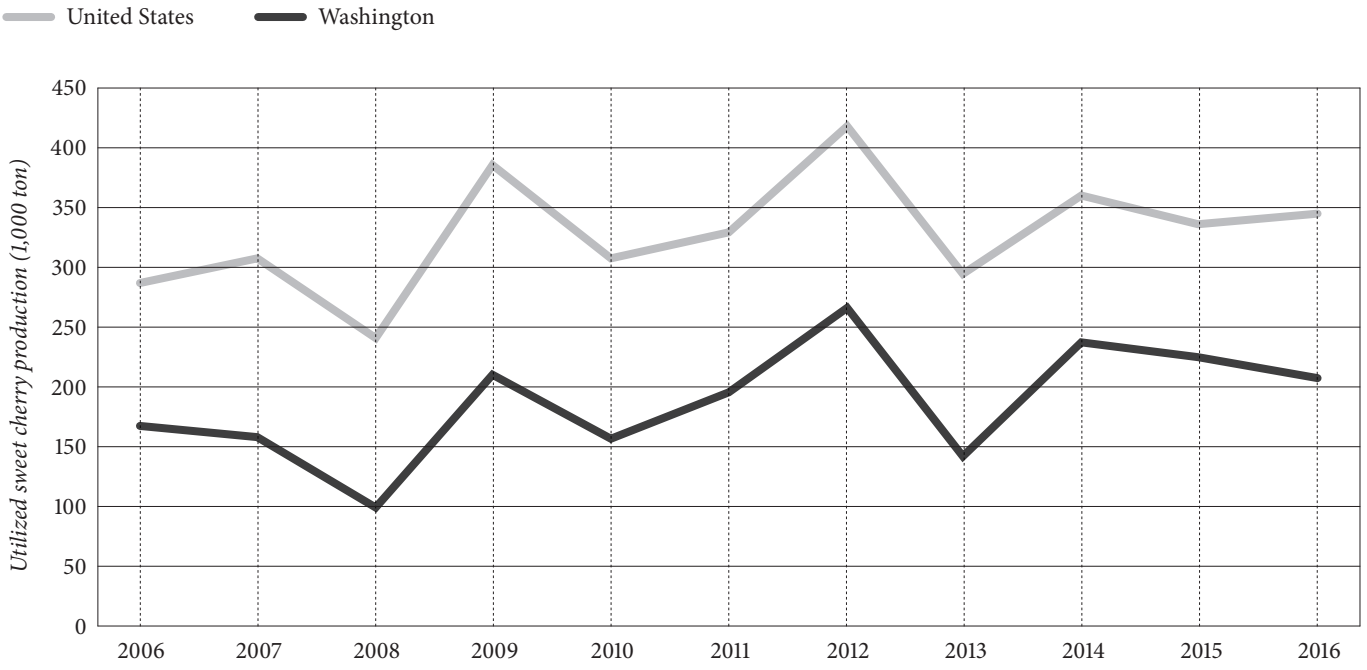
Cherries

In 2016, Washington State was the largest producer, in volume, of sweet cherries in the United States with 60 percent of total utilized production. The 2016 sweet cherry utilized production was at 211 thousand tons, which was higher than the 10-year average at 193.2 thousand tons and lower than the 2012 production peak at 264 thousand tons. Washington sweet cherry bearing acreage has seen a 22 percent increase during the last 10 years, from 32 thousand acres in 2006 to 39 thousand acres in 2016. During 2006-16, the yield per acre increased three percent from 5.25 tons per acre in 2006 to 5.40 tons per acre in 2016. The 2016 yield per acre in Washington State was above the United States average yield per acre at 3.82 tons per acre but below the Washington State 10-year average at six tons per acre. In 2016, 65 percent of all Washington State sweet cherry production was destined to the fresh market.

The Washington sweet cherry variety mix has changed in the last 10 years. In 2007, the Bing variety represented 44 percent of all sweet cherries shipped from Washington State, 11 percent was Rainier, and 10 percent was Sweetheart. In 2017, Bing shipments decreased to 19 percent, Sweetheart increased to 16 percent, and Rainier decreased to seven percent. With the emergence of new varieties, the cherry harvest season has expanded to the first week of June to the last week of August.

For year 2018, the United States production of sweet cherries is projected to increase to 495 thousand tons, the second highest since 2009. United States exports are expected to increase 45 percent to a record of 110 thousand tons with main destinations being Canada and China. The global sweet cherry production is forecasted to decrease three percent to 3.1 million tons due to adverse weather conditions expected in the European Union and Turkey. This will counter the gains in the United States and China. World exports are expected to increase to over 400 thousand tons mainly due to increases in exports from Chile and the United States.

Figure 3: *Utilized Sweet Cherry Production 2006–2016*



Source: USDA, 2017

Specialty Crops

Michael P. Brady (509) 335-0979

Introduction

IT is probably easier to define specialty crops in terms of what they are not (major grains, for one) rather than what they are. However, the USDA does have a specific definition. Under Section 101 of the Specialty Crops Competitiveness Act of 2004 (7 U.S.C. 1621 and section 10010 of the Agricultural Act of 2014, Public Law 113-79) specialty crops are "fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture)." As is provided in more detail below, specialty crops play an outsized role in the agricultural economy relative to their share of acreage. This is particularly true in what the USDA refers to was the "Fruitful Rim," which includes Florida, Texas, and the West Coast from Arizona to Washington. Specialty crops also play a key role in making agriculture a more dynamic industry. Fresh market and direct sales provide opportunities for high margins that can make it possible for new entrants into farming operating at small scales to be financially feasible. This section provides an overview of trends in specialty crop production and markets in 2016 to recent years. For more background on specialty crop production in general, see the 2014 version of this report.

This section provides a detailed summary of prices and production of the major specialty crops in Washington State. The most recent year information available is 2016, and all information is derived from USDA National Agriculture Statistics Service sources. Previous year data for specialty crops is generally available in late-winter to early spring.

The Big Story for Specialty Crops Trends this Year

The large expansion in wine grapes and certified organic acreage were the two big stories in specialty crops in production year 2016. Wine grapes and organic acreage have been a significant growth area for Washington agriculture during the last twenty years. However, the rate of growth of both accelerated significantly from 2015 to 2016 compared to any of the year-over-year changes observed in the last decade. Additional details are provided below.

Figure 1: *White Wine Grape Production Trends*

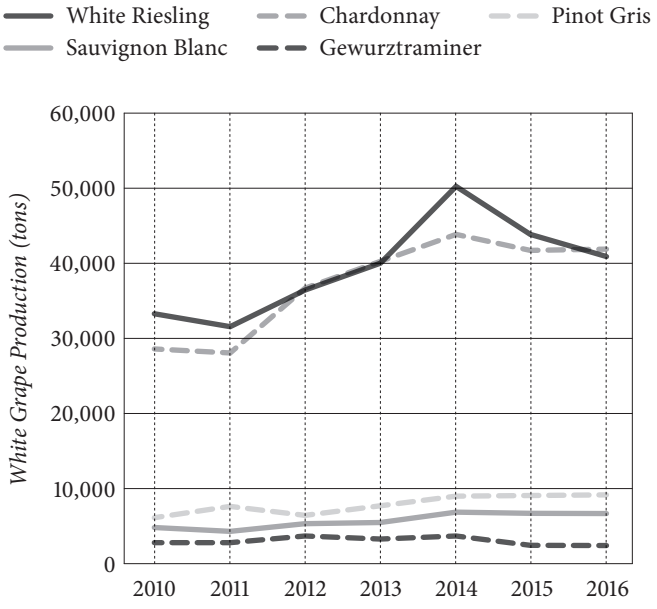
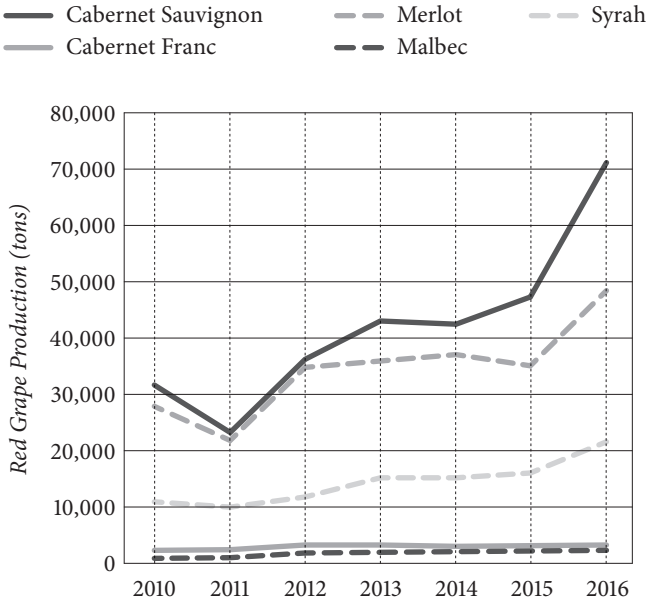


Figure 2: *Red Wine Grape Production Trends*



Wine grapes

The Washington wine industry saw significant growth from 2015 to 2016 (WSAS; USDA NASS). While white wine grape production (Figure 1) and acreage (Figure 5) held steady, there was a 45 percent increase in Cabernet Sauvignon (red varietal) production just from 2015 to 2016. Growth in production for Cabernet Sauvignon is likely to continue given the growth in planted acreage from 2015 to 2016 (Figure 6). Figure 7 compares trends in wine grape acreage in California, Oregon, and Washington. California continues to dwarf the other two states with more than 10-times the acreage of Washington. However, California

Figure 3: *White Wine Grape Price Trends*

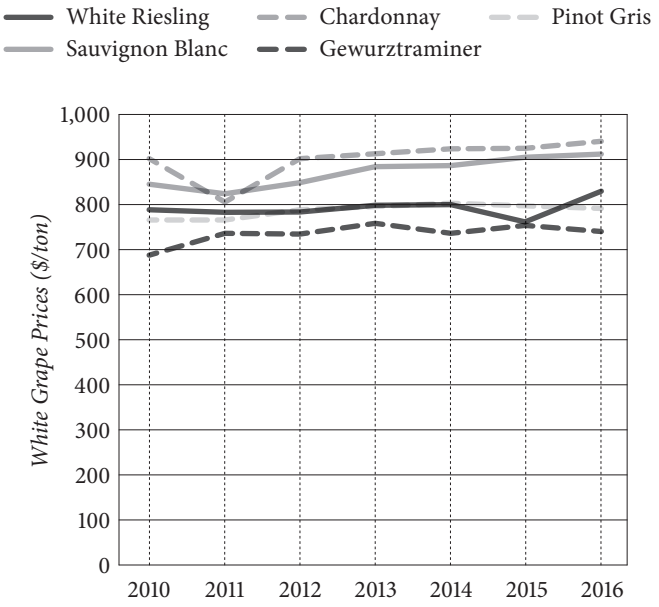


Figure 5: *White Wine Grape Planted Acres by Year*

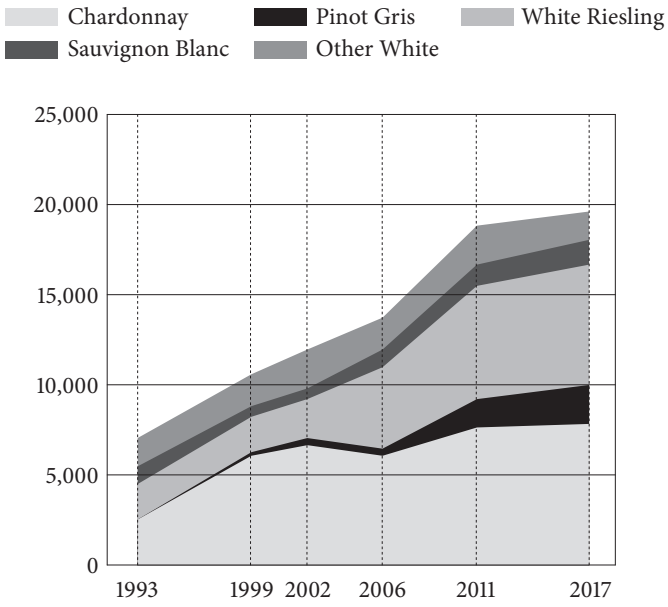


Figure 4: *Red Wine Grape Price Trends*

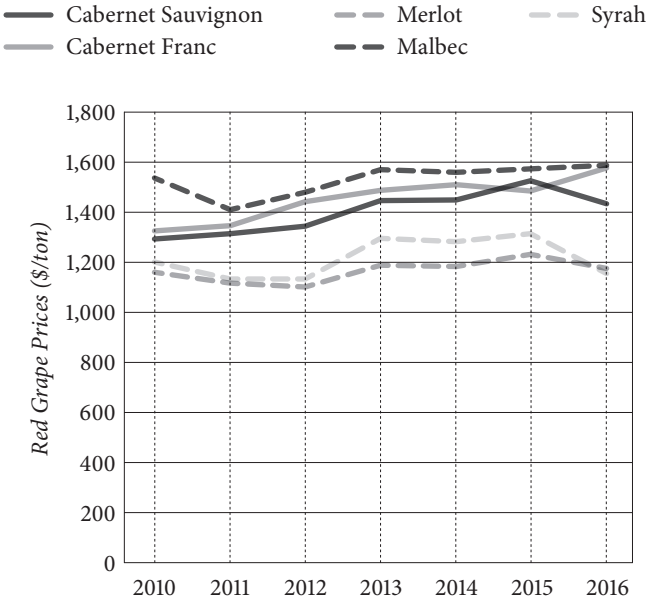


Figure 6: *Red Wine Grape Planted Acres by Year*

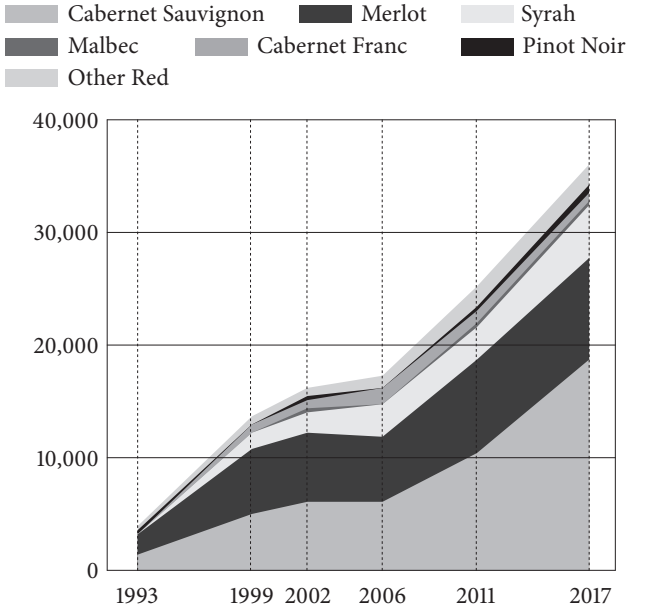
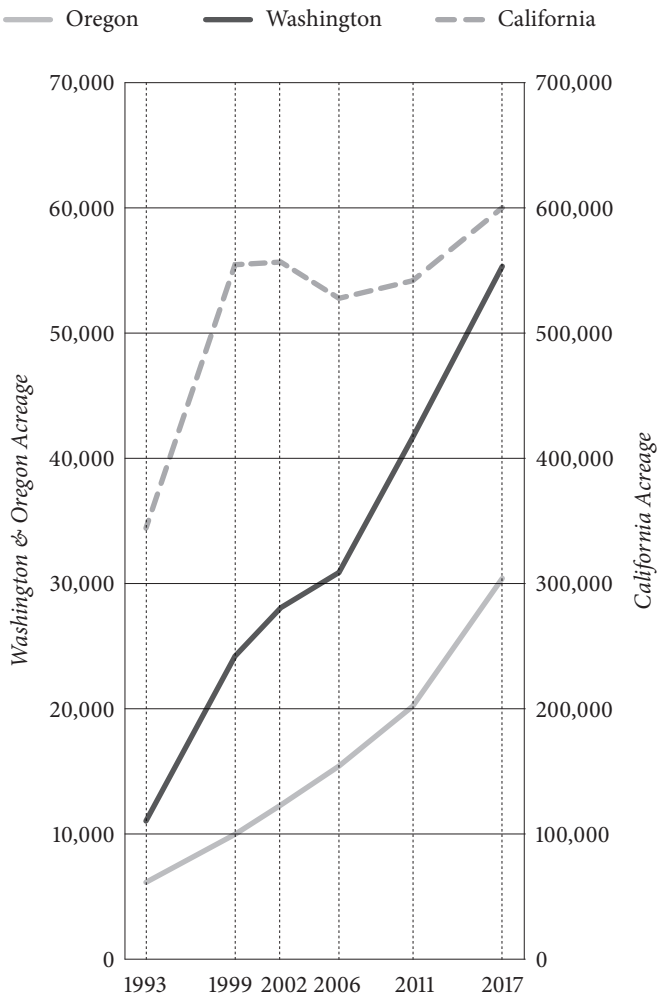


Figure 7: *State-level Comparison of Wine Grape Acreage Trends—All Wine Grapes Planted Acreage by State and Year*



fully shows the signs of being a mature industry as acreage has remained flat for many years. Washington remains in the growth phase.

There does appear to be evidence that growth in production of Cabernet Sauvignon is putting downward pressure on prices. After steady price growth from 2010 to 2015, prices dropped slightly (<5%) from 2015 to 2016. Data reported in this section is provided by the Washington State Wine Commission and the USDA National Agriculture Statistics Service in Olympia, WA. Data on Oregon production is provided by multiple versions of the Oregon Vineyard and Winery Census Report produced by Southern Oregon University. California data was sourced from the Wine Institute.

Vegetables

Table 1 reports production and Table 2 reports prices for major vegetables in Washington. A new categorization for onions was adopted in 2016, which required the start of a new series. See previous versions of this report for summaries of the onion market in terms of storage and non-storage onions. In addition, sweet corn production was not broken out by fresh and processing in 2016.

Total sweet corn production was up in 2016 compared to 2015. Green peas saw a drop in production, which is interesting since they are often grown in the same fields. They are even double cropped in the same year in places where water for irrigation is not limiting, such as within the Columbia Basin Project. However, it is more common that they are rotational crops on the same field. After many years of declines, asparagus production bounced back significantly in 2016. Potato production and prices

Table 1: *Vegetable Production*

Year	Asparagus (cwt)	Onions, fresh (cwt)	Onions, processing (tons)	Green peas (cwt)	Potatoes (cwt)	Sweet corn, fresh (cwt)	Sweet corn, processing (cwt)	Sweet corn (cwt)
2010	228,000			89,910	88,440,000	2,430,000	11,719,258	
2011	220,000			95,700	97,600,000	1,914,000	13,955,324	
2012	202,000			128,040	95,940,000	1,767,000	15,283,535	
2013	188,000			122,380	96,000,000	1,908,000	11,452,115	
2014	182,000			118,440	101,475,000	1,817,000	12,367,827	
2015	167,000			147,210	100,300,000	3,441,000	12,897,112	
2016	211,000	11,150,000	236,700,000	132,328	105,625,000			18,840,000

held have remained very steady the last five years with a minor upward trend in production over time.

Berries

Blueberries continue to be one of the major growth crops in Washington. Blueberry acreage reached 13,400 in 2016, which is an increase of 2,400 from the year previous. After climbing for several years, yields decreased to 8,390 lb/acre in 2016. The growth in yields is mainly driven by the expansion of blueberry acreage in Eastern Washington where yields are higher relative to the traditional growing region of Western Washington. Blueberry prices in the fresh market were up again in 2015 at $1.62/lb, and were $0.52/lb for the processing market. The total value of the blueberry crop was down significantly to $94 million in 2016 compared to $146 million in 2015. The value continues to be about evenly split between the fresh market and processing.

Red raspberry production in Washington has been very steady over the past decade. Total acreage was at 9,610 acres in 2016. Prices in 2016 were down to $0.852/lb in 2016, which was close to a $0.4/lb drop from the year previous. Fresh and processing prices were fairly similar at $0.927/lb and $0.84/lb, respectively. Strawberry acreage continued its long-run gradual decline in 2016 where it reached 900 acres. Prices were largely unchanged at $109/cwt.

Hops

The value of Washington's hop crop skyrocketed to $382 million in 2016 compared to $280 million in 2015. Washington continues to lead the country in hop production by a substantial margin producing about 80 percent of the national total. Prices continued their upward climb reaching $5.84/lb, which was a one year increase of $1.13/lb. The increase in the value of the crop was also due to more acres, which had an annual increase of over 5,000 acres to 37,444 acres in 2016.

Mint

Mint acreage in Washington in 2016 decreased only slightly to 29,600 acres. Spearmint accounts for 2,000 more acres than peppermint. In 2016, prices for peppermint and spearmint were $20.5/lb and $17.1/lb, respectively. The total value of the mint crop in 2016 was $71 million.

Organic

Organic farming continued its rebound that started in 2013 to reach an all-time new high in acreage at 115,156. After many years of significant expansion in certified organic acres, there was a period of decline that started in 2009 (108,000 acres). Certified organic acreage rebounded in 2015, increasing by about 10,000 acres to 95,888 relative to 2014. The growth from 2015 to 2016 was even large at approximately 20,000 acres. The most up to date summaries of trends in organic agriculture are provided by the Center for Sustaining Agriculture and Natural Resources (CSANR) at Washington State University http://csanr.wsu.edu/trends-in-washington-agriculture/organic-statistics/. See section X of this report for a detailed summary of research analyzing trends in the number of organic farms over time.

Table 2: *Vegetable Prices*

Year	Asparagus ($/cwt)	Onions, fresh ($/cwt)	Onions, processing ($/tons)	Green peas ($/cwt)	Potatoes ($/cwt)	Sweet corn, fresh ($/cwt)	Sweet corn, processing ($/tons)	Sweet corn ($/cwt)
2010	77.14			212.00	7.40	38.80	79.80	
2011	78.90			252.00	7.90	41.00	109.04	
2012	90.00			275.30	7.30	33.00	113.27	
2013	95.06			287.06	8.25	37.00	121.49	
2014	75.39			248.51	7.60	27.00	107.84	
2015	93.32			262.07	7.70		105.65	
2016	88.30	16.70	168.00	304.60	7.70	24.40	100.00	5.54

Washington Beef Cattle Sector Review and Outlook

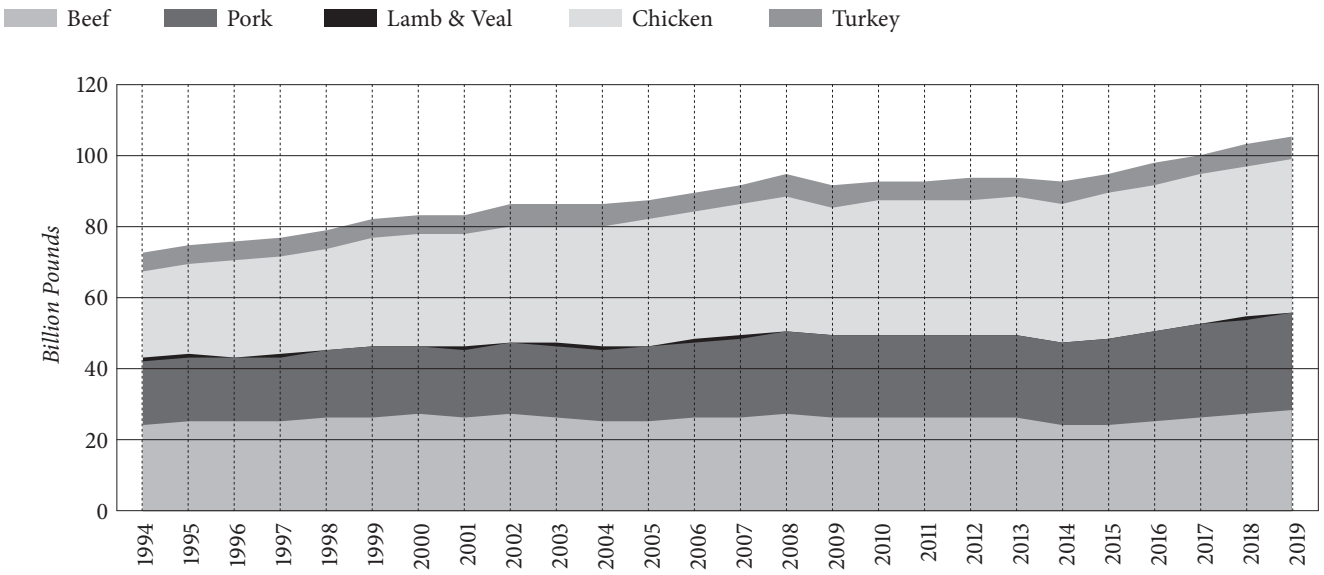
Shannon Neibergs (509) 335-6360

BEEF producers will remember 2017 for an unexpected price recovery while setting records in pounds of beef produced and exported. Strong exports fueled price recovery and improved profitability across each sector in the beef production chain. Market analysts project that 2017 will be the second most profitable year on record, only falling short of 2014 when record high prices were set. Improved profitability in 2017 presents a substantial recovery from 2015 and 2016 when prices set record rates of price declines and fuels expectations for continued supply growth in 2018.

Price recovery occurred in 2017 despite record high levels of meat and poultry production in the U.S. and growing world production levels. The record high commercial meat and poultry production of about 100 billion pounds is shown in Figure 1. All protein sources grew in production except for lamb and turkey, which had minor declines. U.S. beef production grew four percent over 2016 to about 26 billion pounds with pork production also increasing to about 26 billion pounds and poultry production about 42 billion pounds. Increased beef production in 2017 increased per capita beef supply by about two pounds per person. Cattle carcass weights have been 10 pounds under year ago levels for much of 2017 and has helped decrease the supply of beef coming to market. Estimated per capita retail weight disappearance of beef in 2017 will be the largest since 2012, pork essentially unchanged compared to 2016, and chicken a new record high.

Imports further impact supply conditions. The U.S. is on track to import more cattle from Mexico and less cattle from Canada in 2017 than a year ago. The majority of cattle imported from Mexico are feeder animals, but all types of cattle are imported from Canada. USDA's Animal and Plant Health Inspection Service (APHIS) establishes health requirements, reviews documentation, and inspects cattle prior to being allowed into the country. Mexican cattle imports are projected to increase 25% over 2016. The Mexican cowherd has been growing in recent years,

Figure 1: *U.S. Commercial Meat Production and Future Forecasts—Commercial Meat & Poultry Production by Type of Meat Annual*



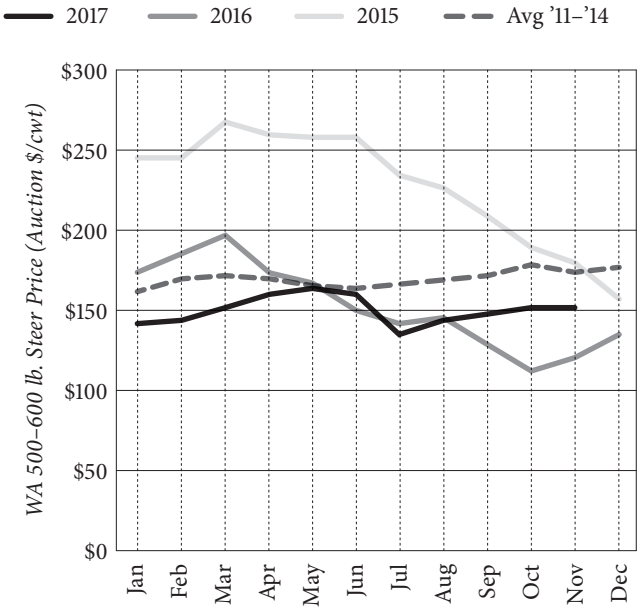
Source: USDA-NASS, Compiled & Forecasts by LMIC

and that has combined with relatively strong U.S. feeder cattle prices to pull animals north. Comparatively, U.S. imports of Canadian feeder cattle overall are on a downtrend but slaughter cattle imports into Washington are increasing. The Canadian cowherd inventory has been stagnate the last two years and is dramatically smaller than it was 10-years ago similar to the cow inventory trend in the U.S. The Canadian beef cowherd is down about 1.2 million head or 25 percent during the last decade. Figure 2 shows the decreasing trend in Canadian feeder cattle imports into Washington, Idaho and Oregon, which is the most detailed level of data reported. Canadian feeder cattle imports have decreased from 76,423 in 2015 to about 25,000 currently, while the amount of slaughter cattle have increased year over year from 2015. In Washington, Canadian cattle buyers were actively purchasing feeder cattle this fall in local auction markets for export into Canada.

For the next two years, the market outlook issue or headwind for all the U.S. livestock and poultry markets is the tonnage of product that will be produced. In both 2018 and 2019, forecasts call for record large total U.S. red meat and poultry output as meat producers integrate low corn prices and world trade projections into their production decisions. U.S. cattle inventory and the resulting beef production will continue to grow until U.S. cow-calf producers end the expansion phase of the cattle cycle. Since record high prices achieved in 2014, the U.S. beef cowherd has grown by more than 2.8 million head and Washington's beef cow inventory grew by 11,000 head. Beef heifer retention, heifer feedlot placements and cow culling rates indicate that herd expansion continued in 2017. Continued herd expansion is dependent on profit margins and pasture conditions into 2018 and beyond. The December 2017 U.S. Drought Monitor saw continued intensification and expansion of areas of drought across portions of Texas, Oklahoma, and Arkansas in the south as well as portions of the Dakotas and eastern Montana, which could impact cattle production and market trends if drought conditions significantly impact pasture and forage availability. Presently Washington and the Pacific Northwest have no indications of drought.

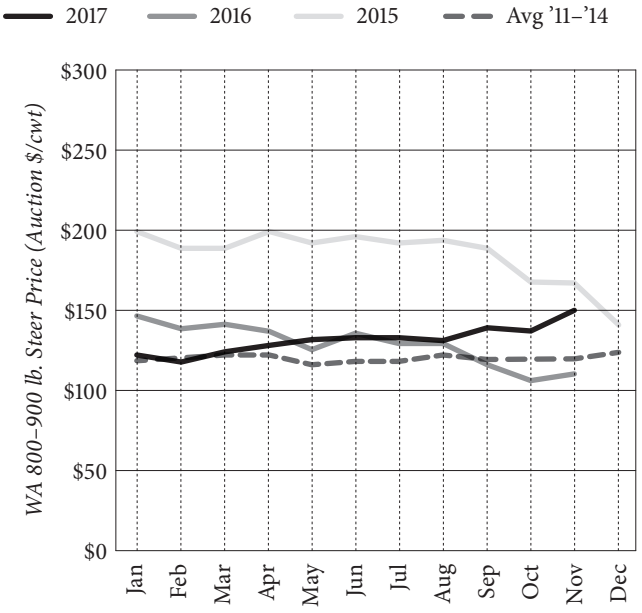
Despite record high meat production, live cattle prices recovered in 2017 as shown in Figures 3 and 4 for Washington cattle producers. The figures show that 2017 market prices in the summer started to strengthen for what Washington cattle producers received for weaned steers weighing 500 to 600 pounds (the typical sale weight for cow-calf producers) and for 800 to 900 pound backgrounded feeder steers (a common in-weight for cattle entering feedlots). In both Figures 3 and 4, the red line represents 2017 prices. The gain in revenue for a 550 pound weaned steer sold in October between 2016 and 2017 represents an increase in revenue of $209 per head. For weaned calves, October is the primary marketing month. The demand

Figure 2: *Washington Weaned Steer Price*



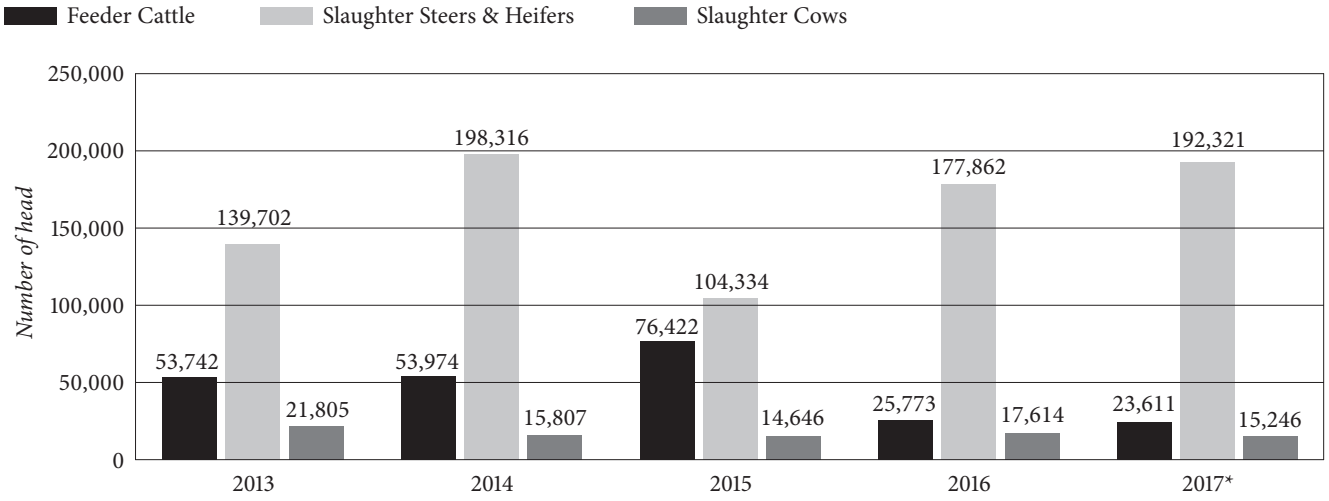
Source: USDA/AMS—Weekly Combined Cattle Report—ML_LS795

Figure 3: *Washington Feeder Steer Price*



Source: USDA/AMS—Weekly Combined Cattle Report—ML_LS795

Figure 4: *Canadian Live Cattle Imports into Washington, Oregon and Idaho*



* up to 11/25/17

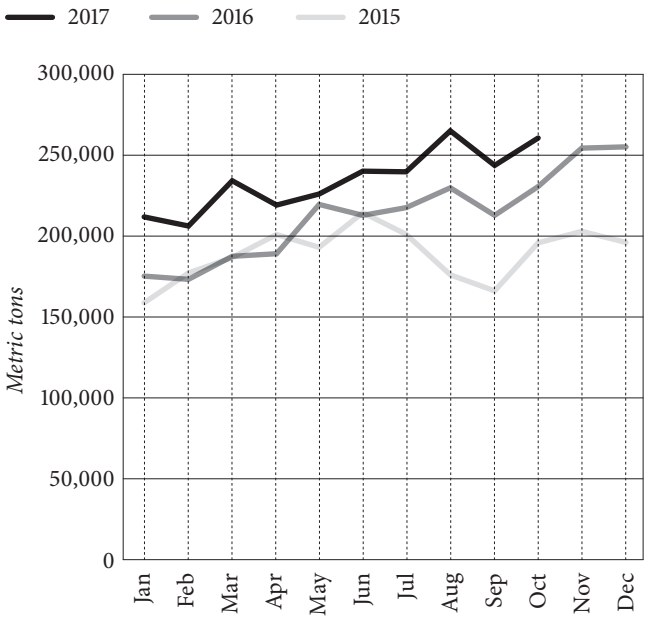
Source: Weekly Canadian Live Animal Imports into U.S. by Destination (WA_LS637) and Canadian Live Animal Imports by State of Entry (WA_LS635)

for feeder cattle from feedlots in the second half of this year has been one of the surprises of the cattle market in 2017. A combination of favorable corn crop weather in July that depressed corn price, strong Live Cattle futures prices for 2018 delivery contracts that began during the summer, and strong exports of beef produced provided the foundation for the increased feeder cattle demand.

With all major proteins increasing production, it places increased importance on export markets to absorb the expanding supply. Figure 5 shows the level of U.S. beef and veal export volume. Beef exports have shown year over year growth with 2017 year to date exports recording a 14 percent increase in volume over 2016, and is on pace to challenge a record high export volume. Beef export issues have been widely in the news throughout 2017. The year started with a largely worldwide trade restriction imposed on Brazil meat exporters that included JBS-Brazil due to bribing government meat inspectors to ignore food safety problems. A multi-billion dollar fine has JBS selling assets around the world including JBS feedlots in the U.S. This depressed Brazil's competitive presence in world markets early in the year, but Brazil has regained market share as trade restrictions on Brazil were relaxed.

A larger trade issue is maintaining beef export market share with Japan. It's taken 14 years to achieve, but 2017 is on track to regain the export market volume the U.S. had with Japan prior to the 2003 BSE trade restriction. Japan is our leading trade partner in beef export value by over $500 million dollars but only leads in volume over Mexico as

Figure 5: *Beef and Veal Export Trends—All Destinations*



Source: http://www.ers.usda.gov/data-products/livestock-meat-international-trade-data.aspx

shown in Figure 6. Beef producers were highly supportive of the Trans-Pacific Partnership (TPP) to establish a free trade agreement with Japan and 13 other Pacific Rim countries. On his first day in office, President Trump signed an executive order removing the U.S. from the TPP and declared an end to the era of multinational trade agree-

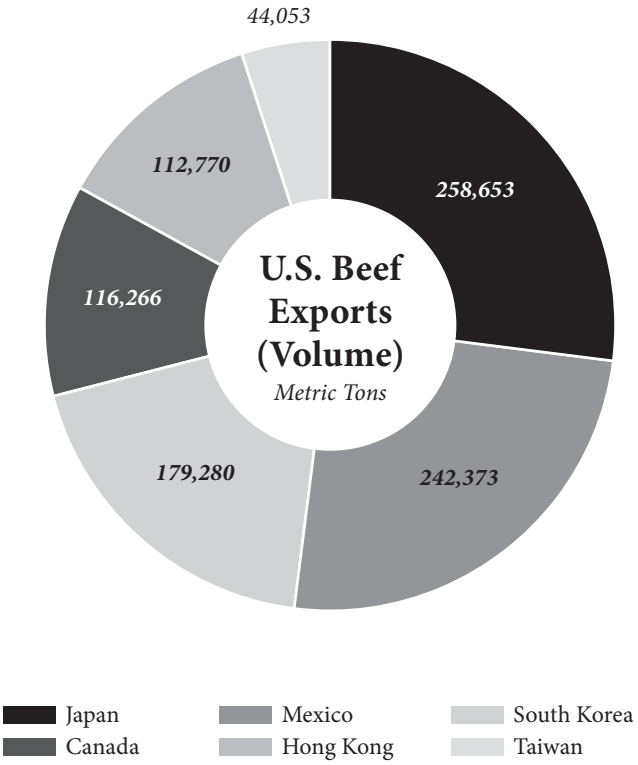
ments. Without a free trade agreement, Japan increased tariffs on U.S. frozen beef from 38.5 to 50 percent creating a direct price advantage to Australia, which enacted a free trade agreement with Japan directly. However sales of chilled and fresh beef actually increased contributing to expanded sales of higher valued beef products. The growth in fresh beef volume comes at the risk of higher tariffs in the future if imports into Japan increase more than 17 percent year-on-year in any given quarter from all countries. Beef marketing officials are calling for an urgent need to develop a bilateral trade agreement with Japan to protect this important market from tariff based price competition.

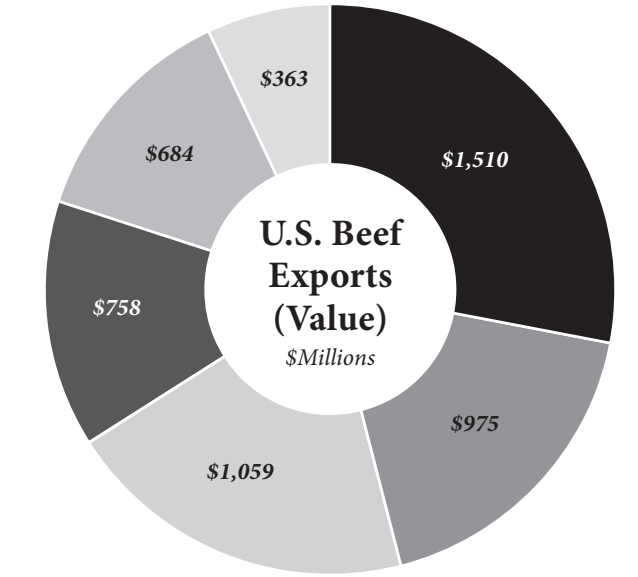
In a second major beef trade development in 2017, China relaxed trade restriction on U.S. beef. China has banned U.S. beef imports since the 2003 BSE case. China represents a substantial growth market for U.S. beef but there are trade rules. To qualify for trade with China, animals must be source identified starting at birth and throughout the production supply chain, animals must be less than 30 months of age, the meat must not contain growth promotants, and beef plants wishing to export to China must be approved by China. U.S. producers can meet these trade rules but will have to segregate product lines. The USDA projects that the combined beef imports by China and Hong Kong could increase almost 42 percent in the coming decade presenting a substantial growth market.

Outlook for 2018

About 15 percent of U.S. beef production is exported and the importance of exports cannot be overemphasized. Japan, Mexico and Canada account for 52 percent of the volume and value of total U.S. exports and are at risk relative to free trade agreement politics. The dissolution of the TPP leaves the U.S. open for tariff rate price competition in Japan with Australia. Discussions on renegotiating NAFTA will continue into 2018. If NAFTA talks fail, Canada could assess a 26.5 percent tariff on all beef imports. Mexico could assess a 20 percent tariff on chilled beef and a 25 percent tariff on frozen beef, and the U.S. would likely respond with retaliatory tariffs with economic consequences that can only be speculated at this point. On the bright side, beef trade with China is expected to grow rapidly, creating a new market for U.S. beef products. Market fundamentals indicate continued record growth in red meat and poultry supply that will require expanded global demand to market the volume produced. Export growth will not come without its share of challenges.

Figure 6: *Major Beef Export Volume and Value Trade partners*





Source: U.S. Meat Export Federation http://www.usmef.org/usmef-statistics-and-trade-access

Dairy Sector Review and Outlook

Shannon Neibergs (509) 335-7637

DAIRY farmers continue to struggle with the excess supply of milk production in the U.S. and in the major milk producing regions of the world that continue to keep milk prices low. Although 2017 showed improvement in milk price, the low price continues to challenge dairy farm profitability, increasing financial risk. Figure 1 shows Washington's annual average milk price from 2013 through October for 2017. Milk price fell below $20 per cwt in January 2015 and has not recovered above that point to date, and prices have been below the breakeven cost of production since 2015, resulting in profitability losses that are straining the financial capacity of dairy farm families. Dairy market analysts of well-managed dairies estimated that the breakeven milk price for Pacific Northwest dairies from January to June in 2017 was $18.58. Washington milk price through October averaged $18.31 in 2017.

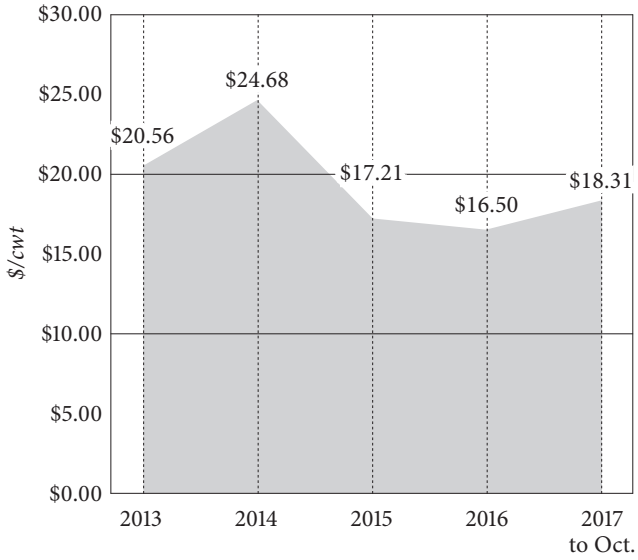
Milk pricing has become a global market with export competition driving price volatility. The weak milk price is part of a global milk crises where over supply has overwhelmed demand, and 2017 is no exemption. Table 1 shows milk production for the major dairy product exporters (Argentina, Australia, EU, New Zealand and the United States). Milk production is forecasted to increase by 1.5 percent over 2016. While not a dramatic increase in production, it is not a contra supply response to low prices. Dairy global trade remains challenged by the Russian food embargo. The Russian government declared a ban on food imports from the EU, U.S. Norway, Canada and Australia until the end of 2017 at least, in retaliation for sanctions over the Ukraine conflict. The EU imposed economic sanctions on

Table 1: *Milk Production for Major Exporters (million tons)*

	2016	2017 Forecast	Change	Percent Change
Argentina	10.2	10.6	0.4	3.9%
Australia	9.4	9.5	0.1	1.1%
EU-28	151	152.5	1.5	1.0%
New Zealand	21.2	21.6	0.4	1.9%
United States	96.4	98.3	1.9	2.0%
Major Exporter Total	**288.2**	**292.5**	**4.3**	**1.5%**

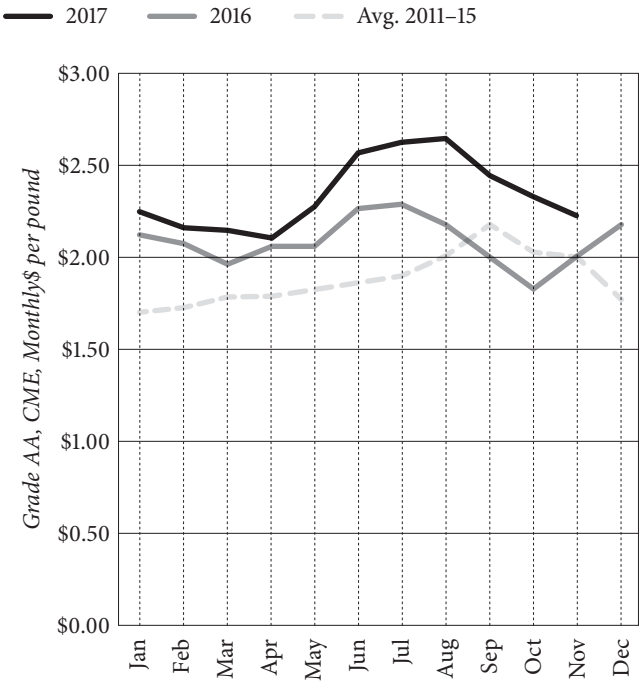
Source: https://apps.fas.usda.gov/psdonline/circulars/dairy.pdf

Figure 1: *Washington Annual Average Milk Price*



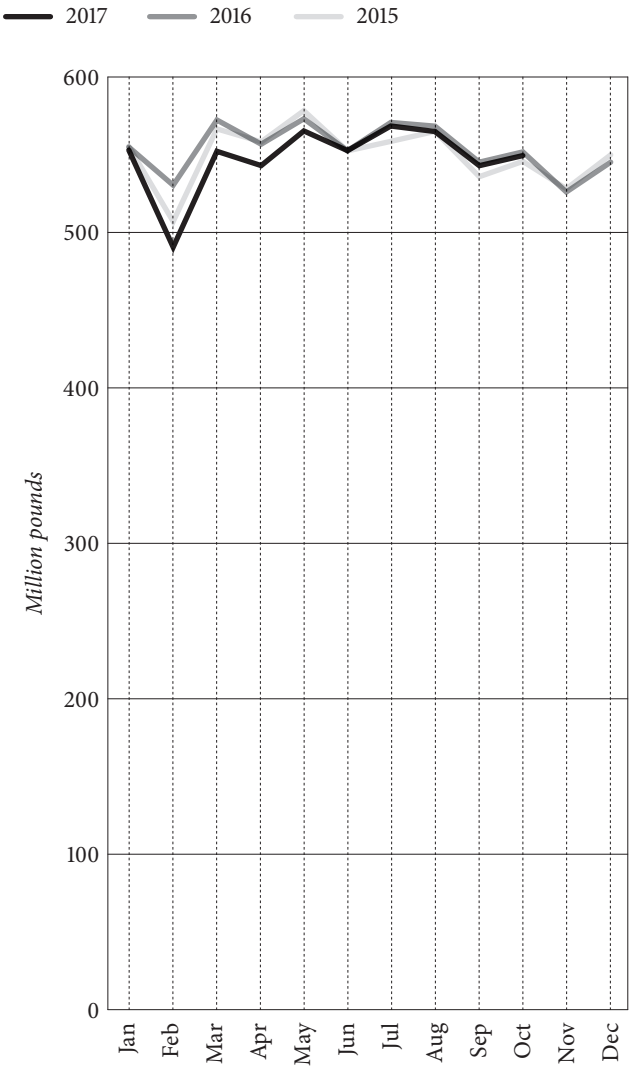
Source USDA NASS Quick Stats.

Figure 2: *U.S. Wholesale Butter Price*



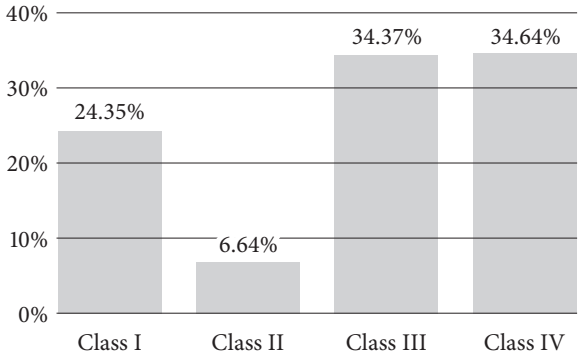
Source: http://www.ams.usda.gov/mnreports/dymaveragesytd.pdf and LMIC

Figure 3: *Washington Monthly Milk Production*



Source: USDA NASS Quick Stats and LMIC

Figure 4: *Pacific Northwest 2017 Milk Utilization—Pacific Northwest Federal Order No. 124*



Source: http://www.fmmaseattle.com/historicaldata.htm

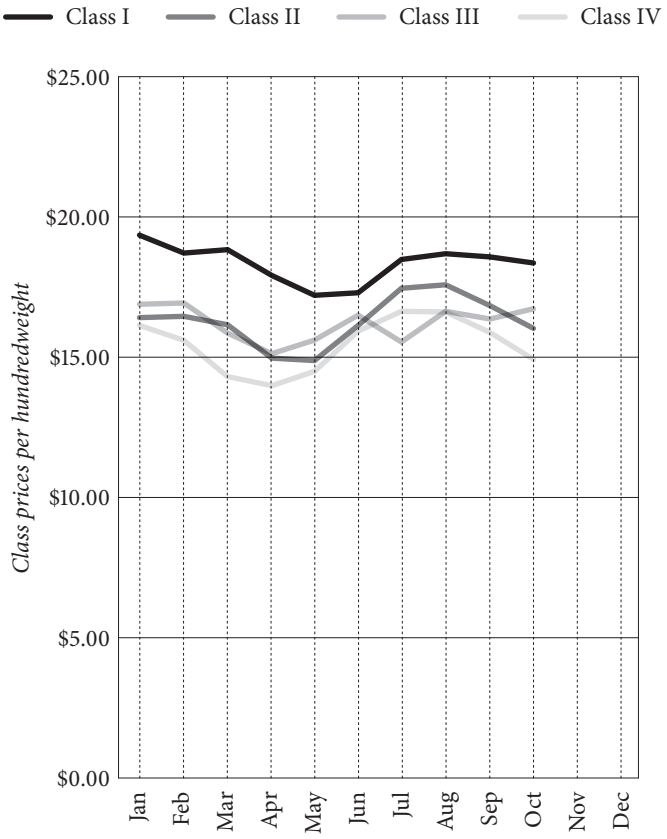
Russia's banking, oil and defense sectors over its annexation of Crimea in 2014, and support for eastern Ukrainian separatists. In response, Russia banned a significant number of EU food products from entering its market. This has forced the world leader in milk production, the EU, to compete for trade in available markets across the world. Together with slowing Chinese demand, Russia's embargo has put negative pressure on global dairy prices with its effect on depressing Washington average milk prices as previously shown.

One positive dairy price aspect has been the strength in the price of butter. Figure 2 illustrates butter price growth in both 2016 and 2017. Butter consumption in the U.S. is forecast to jump eight percent in 2017, due in part to changing health perceptions regarding butter consumption and restaurants like McDonald's switching from margarine to butter and serving it on the all-day breakfast menu on everything from Hotcakes to its Egg McMuffins. Cracker Barrel restaurants are also promoting breakfast dishes made with real butter. As a result, butter is the fastest growing dairy product consumed. However, as butter production concentrates milk fats a byproduct is an increased supply of skim milk powder. Dry milk powder is relatively easy to store and its price is weak due to oversupply so gains from butter are offset by price losses in milk powder.

Milk production in Washington is expected to be lower in 2017 compared to the previous two years depending on production levels yet to be reported for November and December. Lower production at the start of 2017 through June is the cause of a decrease in January to October production in 2017 relative to 2016 by about two percent. The slightly smaller production corresponds to slightly lower number of milk cows in the state.

Washington's milk goes to three primary uses: Class I (fluid milk), Class III (cheese) and Class IV (powered milk and butter), see Figure 4. Only seven percent of milk was used to make Class II milk products (yogurt, cream cheese, ice cream). Class III and IV accounted for 69 percent of all milk utilization in 2017. The balance of 24 percent is utilized as fluid milk. This utilization is almost identical to 2016 levels. Washington farm level milk prices are driven primarily by Class III and IV prices with about a quarter of the price determined by fluid milk. This utilization mix is unique when compared to other major milk marketing orders. The east coast is heavy in fluid milk utilization and mid-west production is more balanced with market access to the east coast for Class II, III and IV.

Figure 5: *2017 Milk Class Prices for 3.5% Milk—Pacific Northwest Order, Federal Order No. 124*



Source: http://www.fmmaseattle.com/historicaldata.htm

Figure 5 provides the Pacific Northwest Order monthly milk class prices for 2017 through October. The price trends and seasonality are similar to previous years but are about $2.00 per cwt higher for all classes in 2017. Class I price peaked at $19.35 in January and seasonally declined to $17.10 in May. Class IV price was the lowest price class in all months except for July and August with seasonal price gains to $16.61.

Exports are a significant portion of Washington's Class III and IV milk utilization. About 20 percent of Class III milk is exported, and about 60 percent of Class IV milk is exported. Washington's location and access to ports make cheese and dry dairy products attractive to foreign consumers, particularly Asian markets. Washington is particularly vulnerable to international markets because of the high Class III and IV utilization and high export volume of those products. Table 2 presents the monthly milk price by federal marketing order. It shows that the Pacific Northwest order has the lowest price of all orders for six of the ten months reported and is about two percent lower than the all markets combined average.

Exports are key to U.S. dairy economics and pricing. A new pricing regime—the National Ingredient Pricing Strategy—was introduced in Canada in February 2017 for certain dairy product ingredients and is creating negative spillover effects for some U.S. dairy producers that export ultrafiltered milk to Canada used to make cheese and yogurt. In recent years, increased demand for butterfat from milk to produce butter and cream has led to an

Table 2: *2017 Uniform Milk Price—Monthly*

	Order Number	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	2017 YTD
		US Dollars Per Hundredweight										
Northeast	1	18.21	17.77	17.3	16.39	16.51	17.53	18.01	18.33	17.89	17.44	17.53
Appalachian	5	20.06	19.09	19.06	17.77	17.65	18.37	19.35	19.53	19.06	18.59	18.85
Florida	6	22.22	21.07	21.28	20.08	19.69	20.39	21.45	21.43	21.14	20.62	20.94
Southeast	7	20.27	19.36	19.15	17.97	17.83	18.7	19.64	20.02	19.61	19.12	19.14
Upper Midwest	30	16.99	16.94	16.05	15.37	15.65	16.56	15.8	16.8	16.54	16.66	16.31
Central	32	17.32	16.83	16.24	15.42	15.5	16.5	16.52	17.13	16.72	16.36	16.44
Mideast	33	17.35	16.92	16.43	15.61	15.67	16.71	17.01	17.47	17	16.57	16.66
Pacific Northwest	124	17.03	16.58	15.93	15.23	15.43	16.49	16.6	17.05	16.59	16.03	16.32
Southwest	126	17.97	17.57	17	16.32	16.37	17.33	17.29	17.98	17.58	17.16	17.28
Arizona	131	17.36	16.73	16.02	15.35	15.53	16.59	17.02	17.4	16.89	16.43	16.52
All Markets Combined*		**17.84**	**17.41**	**16.82**	**15.98**	**16.13**	**17.07**	**17.1**	**17.68**	**17.28**	**17.06**	**17.03**

* All Markets Combined and Yearly Average Weighted by Producer Pounds

Source: http://www.ams.usda.gov/resources/marketing-order-statistics

increase in milk production quotas in Canada, resulting in a surplus of skim milk components including milk protein concentrates, skim milk and whole milk powders as previously discussed. To address surplus skim milk components, Canada adopted a special pricing program that allowed for the sale of skim milk components at international market prices rather than the typically higher prices that otherwise prevailed under Canada's supply management system. U.S. dairy interests contend that this program provides a non-market based pricing program that favors Canadian milk products at the expense of imports, a violation of NAFTA free trade commitments. U.S. dairy interests seek to have this issue addressed in NAFTA renegotiation talks, making it an ongoing dairy issue for 2018.

Financial Conditions

Dairy producers incurred substantial profitability losses throughout 2015 and 2016. Declining milk prices with no offset in reduced production costs results in substantial losses in income per milking cow. The income losses peaked at –$47.37 per cow per month in June 2016. Prices improved in 2017 and, for the first six months of 2017, increased income per milking cow to $17.77. This is the first positive return since 2014. Herd line debt per cow is debt secured by the herd and increased to $799 as of June 30, 2017. This is in part due to a decrease of about 4,000 milking cows in Washington and Oregon from 2016 to 2017. Total debt decreased from year-end 2016, indicating some financial progress, but remains second highest over the years reported. The debt to equity ratio increased to 1.75 : 1 in 2017, indicative of the historic run of poor profitability. The run of challenging profitability continues the downward trend in the number of dairy producers.

Outlook for 2018

With recent price declines for most dairy products in domestic and international markets, lower expectations for exports, and high global stocks of dairy products, the U.S. all-milk price forecast by the USDA ERS for the fourth quarter of 2017 is $17.85–$18.15 per cwt. This is a continued reduction in price forecasts as market indicators weakened through the end of 2017. The 2018 all-milk price forecast is $16.90–$17.80 per cwt, which is now projected to be $0.35 per cwt lower than 2017 at the midpoint of the range. The milk market outlook is heavily dependent on global economic conditions, global milk supply and particularly for Washington, dairy export volumes. Currently there are no indications that Russia will relax its food embargo to help increase demand, but trade negotiations with China in 2017 resulted in a memorandum of understanding that will increase access to China. The memorandum formally outlines a process to audit U.S. dairy facilities to make sure they comply with Chinese food safety requirements and has the potential to substantially increase exports to China. Trade will continue to be a primary issue throughout 2018 as NAFTA renegotiations continue. Mexico is our largest export trading partner with $1.2 billion dollars of trade value, followed by Southeast Asia, $671 and Canada $632 million in trade value in 2016. The NAFTA renegotiations will need to address the previously discussed Canada National Ingredient Pricing Strategy and potentially a range of issues with Mexico. Dairy exports are critical in maintaining and improving U.S. dairy prices.

Improving dairy risk management options are a high priority for policy makers working on the Farm Bill which is expected to be introduced in the 2018 federal legislative agenda. The current Margin Protection Program (MPP) has proven to be ineffective in helping dairy producers manage risk. Potential options being discussed are to change the feed cost formula of the MPP program, or to expand access to the Livestock Gross Margin Insurance for dairy cattle program. Effective risk management is needed to counter the ongoing downward trend in the number of dairy operations in Washington and the U.S.

Table 3: *Summary of Financial Statistics Pacific Northwest*

Date Ending	31-Dec-15	30-Jun-16	31-Dec-16	30-Jun-17
Current Ratio	1.23 : 1	0.95 : 1	1.33 : 1	0.90 : 1
Herd Line Debt Per Cow	$741.00	$827.00	$625.00	$799.00
Total Debt Per Cow	$2,157.00	$2,392.00	$2,873.00	$2,669.00
Debt to Equity Ratio	1.50 : 1	1.58 : 1	1.02 : 1	1.75 : 1
Return on Total Assets	-0.60%	-4.20%	-0.50%	1.60%
Income Per Milking Cow Per Month	-$3.06	-$47.37	-$3.90	$17.77

Source: Dairy Farm Operating Trends June 30, 2017, http://frazerllp.com/wp-content/uploads/2015/06/2017-06-30-Dairy-Trends.pdf

Macroeconomic Conditions and Washington Agriculture

Timothy P. Nadreau (509) 335-0495 / Mark J. Gibson (509) 335-7641

Introduction

WASHINGTON agriculture is highly dependent on exports as well as U.S. and global levels of output. Both domestic and global output levels are rising and have largely recovered from the 2007–2009 recession. Employment levels have grown, though not as rapidly as output, and the short-term macroeconomic outlook for 2018 is moderately strong. However, increased productivity and growth in developing markets is necessary for retaining high agricultural export levels.

World Status and Outlook

Moderate growth in global economic activity is expected to continue in the short run. There are, however, substantial risks associated with geopolitical uncertainty and trade policy negotiations. Table 1 shows output, trade, and inflation statistics for 2016 and 2017 as well as IMF projections for 2018. World output grew roughly 3.6 percent in 2017 and the IMF is projecting that the growth rate will rise to 3.7 percent in 2018. While the growth rate of emerging markets and developing economies (EMDEs) is expected to rise in 2018, the growth rate of advanced economies is expected to slow. The medium-term growth projections for the United States and United Kingdom have been reduced from earlier in the year, largely in response to the increased likelihood of protectionist policies that may hurt world trade and add to the current geopolitical strain.

Nearly three-quarters of EMDEs saw economic improvement in 2017. A notable, large exception is India, which is still recovering from the effects of a currency exchange initiative and a new national tax policy. Brazil saw growth for the first time in two years, but Venezuela continues to be mired in a deep recession and Latin America as a whole is seeing mixed and unstable economic conditions.

United States Status and Outlook

According to the most recent Congressional Budget Office (CBO) 10-year economic projection, the United States is likely to see continued moderate growth (provided current policies remain largely intact). Table 2 reports the CBO's year-end economic data and projections for the U.S. from 2016 through 2018. GDP growth is expected to rise from 2.1 percent in 2017 to 2.2 percent in 2018, and the unemployment rate is expected to fall further. Consumption and investment are projected to grow in real terms by 2.5 percent and 5.3 percent for 2017 and by 2.3 percent and 4.4 percent for 2018. U.S. exports grew by only 1.6 percent in 2016, and that growth rate is expected to remain the same through 2017. The CBO is projecting that figure to rise only slightly in 2018. U.S. imports are expected to grow faster, however, which would result in higher trade deficits. Government budget deficits are also projected to grow due to increased costs of social insurance programs and changes in tax policy. The degree to which this will

Table 1: *IMF World Economic Outlook Annual Percent Changes*

	2016	2017*	2018**
World Output	3.2	3.6	3.7
Advanced Economies	1.7	2.2	2.0
Emerging Markets and Developing Economies	4.3	4.6	4.9
World Trade Volumes	2.4	4.2	4.0
Imports			
Advanced Economies	2.7	4.0	3.8
Emerging Markets and Developing Economies	2.0	4.4	4.9
Exports			
Advanced Economies	2.2	3.8	3.6
Emerging Markets and Developing Economies	2.5	4.8	4.5
Consumer Prices			
Advanced Economies	0.8	1.7	1.7
Emerging Markets and Developing Economies***	4.3	4.2	4.4

* Based on projections for Q4
** Projections
*** Excludes Argentina and Venezuela

Source: IMF World Economic Outlook 2017.4

influence future growth is uncertain.

Current projections are based on holding major legislation constant, and substantial revisions are likely if significant tax reform or trade policies are enacted. The influence of such policy changes will affect segments of the economy in different ways. Protectionist trade policies are likely to cause harm in the agricultural sectors where a significant portion of output is sold abroad. However, domestic manufacturing output may increase due to on-shoring of foreign plants.

Table 2: *Congressional Budget Office Budget and Economic Outlook*

	2016	2017*	2018**
Output			
Real GDP (Billions of 2009 dollars)	16662.1	17019.3	17388.5
Percentage change, annual rate	1.6%	2.1%	2.2%
Components of Real GDP (Billions of 2009 dollars)			
Personal Consumption Expenditures	11522.2	11813.4	12080.4
Gross Private Domestic Investment	2824.6	2973.6	3105.6
Government Consumption Expenditures and Gross Investment	2907	2906	2930
Federal	*1120.5*	*1115.9*	*1114.2*
State and local	*1784.8*	*1788.3*	*1813.6*
Net Exports of Goods and Services	-563.0	-645.6	-698.2
Exports	*2128.2*	*2163.2*	*2197.5*
Imports	*2691.2*	*2808.8*	*2895.8*
Prices			
Consumer Price Index, All Urban Consumers (CPI-U)***	240.0	245.4	250.9
Annual % Change in CPI	1.3%	2.3%	2.2%
Labor			
Unemployment Rate, Civilian, 16 Years or Older	4.9%	4.4%	4.2%
Labor Force, Civilian, 16 Years or Older (Millions)	159.186	160.494	161.681
Labor Force Participation Rate, 16 Years or Older	62.8%	62.9%	62.8%
Interest Rates			
10-Year Treasury Note	1.8%	2.4%	2.8%
3-Month Treasury Bill	0.3%	0.9%	1.5%
Federal Funds Rate	0.4%	1.0%	1.7%
Income, Personal (billions of 2009 dollars)	$16,011.6	$16,687.9	$17,450.2

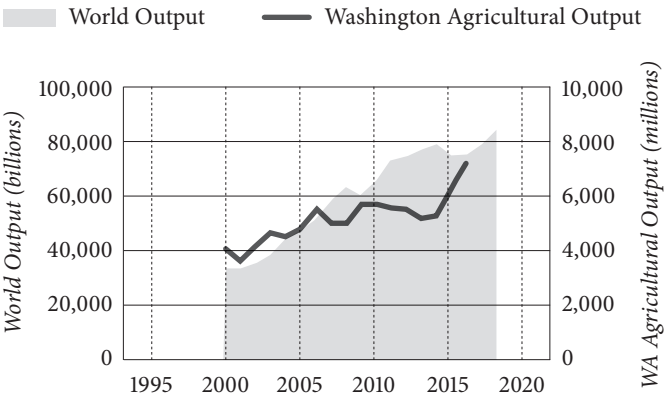
* Based on forecasts of Q2–Q4
** Forecasted
*** The base year for the CPI is 1982 – 84 = 100

Source: Congressional Budget Office.

Washington Agriculture's Relationship to the Macroeconomy

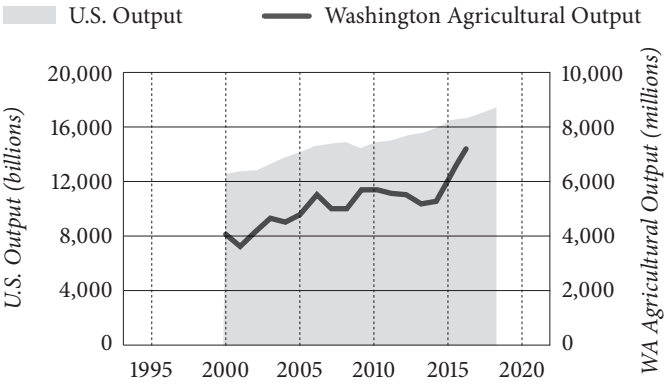
Washington agricultural output is strongly correlated with both world and U.S. market conditions. Figures 1 and 2 show world and U.S. output on the left axis and Washington agricultural output on the right axis. If output in the broader world economy and the U.S. continues to grow, Washington agricultural output is likely to follow suit. A notable feature of each figure is the extended time it took

Figure 1: *World and Washington Agricultural Output*



Source: IMF World Economic Outlook and BEA

Figure 2: *U.S. and Washington Agricultural Output*



Source: Congressional Budget Office and the Bureau of Economic Analysis

for Washington's agricultural sector to recover from the recession relative to broader measures of output.

There are several regional and state-level issues of concern moving forward, such as water curtailments due to drought, increased levels of fire activity within the state over the last two years, and increased input costs for seed, feed, energy, fertilizer, etc. Nonetheless, the growth of EMDEs bodes well for Washington agricultural exports, provided trade is not hindered by new legislation and trade agreements that are set to expire are renewed.

Washington Agriculture and U.S. Trade Relations

Almost half the value of Washington agriculture is exported. Though the outlook for Washington agricultural exports in 2018 appears strong, there is a great deal of uncertainty surrounding international trade negotiations and foreign conflict. Table 3 lists the major export destinations for Washington agricultural products in constant dollar values. These data are estimated by multiplying Washington's total agricultural exports by their export destination shares from the U.S. Census Bureau. As such, these values should not be considered hard and fast, but they show the major international markets with which Washington agriculture interacts. China, Japan, South Korea, and Taiwan are Washington's four largest agricultural export markets and account for roughly three-fourths of Washington's agricultural exports. All four countries are located in a region currently marked by high levels of geopolitical tension.

This international tension directly affects farms and ranches in Washington as well as the ability to forecast longer run market conditions. At least a portion of the state's exports are likely to be absorbed domestically even in the absence of current export markets. Diversification of the state's export portfolio may encourage long-term stability for Washington agriculture but would likely reduce short-run returns.

A large portion of EMDEs show volatile market conditions. Thailand, India, Guatemala, the Netherlands, the UAE, Vietnam, Saudi Arabia, and Pakistan have all seen significant shifts in their Washington agricultural imports. The Netherlands and Pakistan are relatively small markets but show strong growth since the recession, while Vietnam's imports of Washington agricultural goods dropped drastically in 2017. Saudi Arabia and the UAE also saw sharp declines, likely due to their falling oil revenues.

Prospects for U.S. exporters have improved as the dollar has weakened relative to foreign currencies. The Federal Reserve Board's trade-weighted dollar index declined by about eight percent over the past year.[7] Since foreign currencies have appreciated relative to the dollar, Washington's international trading partners are effectively seeing a price reduction, and demand for Washington agricultural goods is rising.

Summary

Both domestic and international markets strengthened in 2017 and are projected to grow throughout the early part of 2018. Increased growth rates in the U.S. and the world will grow the demand for Washington agriculture and open up new markets. Barring trade disruption from policy changes or international conflict, Washington agriculture is likely to benefit from both the weakening dollar and continued growth in Asia and emerging markets.

Table 3: *Total Washington State Agricultural Export by Country of Destination ($1,000)*

Country	2015	2016	2017*
China	$1,695,069	$1,769,261	$1,879,921
Japan	$540,473	$671,331	$671,511
Korea, South	$363,259	$372,089	$410,276
Taiwan	$240,697	$311,322	$291,177
Canada	$220,443	$243,790	$239,817
Philippines	$182,498	$195,654	$206,134
Mexico	$79,964	$68,704	$64,234
Thailand	$82,307	$58,770	$57,813
India	$75,352	$61,795	$53,078
Hong Kong	$41,194	$37,449	$37,830
Guatemala	$56,282	$21,745	$32,086
Vietnam	$35,434	$54,761	$26,236
Netherlands	$14,330	$19,702	$26,112
United Arab Emirates	$42,014	$31,286	$24,703
United Kingdom	$10,835	$13,714	$29,005
Dominican Republic	$7,308	$9,910	$10,527
Colombia	$13,263	$13,233	$7,315
Pakistan	$1,392	$5,381	$7,466
Singapore	$6,337	$7,935	$11,415
Saudi Arabia	$13,033	$8,979	$9,874
Brazil	$6,404	$4,428	$3,998
All other Countries	$64,869	$61,801	$77,785

* Based on fourth quarter forecasts

Source: USDA ERS https://www.ers.usda.gov and U.S. Census Bureau Foreign Trade Statistics http://usatrade.census.gov

7 https://fred.stlouisfed.org/series/TWEXB

SECTION II

SPECIAL FOCUS

Assessing Pest or Disease Outbreaks in Tree Fruit: The Case of Sweet Cherries

Thomas L. Marsh (509) 335-8597 / Jiehong Qiu / Peter Tozer

Introduction

THE U.S. sweet cherry industry is predominantly located in the western states of California, Oregon, and Washington. These three states account for 90 percent of total sweet cherry bearing acreage of 90,100 acres, and Michigan has a further 6,600 acres of sweet cherries (USDA-NASS 2015). In 2014, the value of utilized production of 359,100 tons was $767 million, of which approximately 75 percent was consumed as fresh fruit, with remainder canned or juiced. The U.S. exports a significant quantity of sweet cherries, mostly as fresh product, to a number of countries, with Canada being the largest importer of U.S. sweet cherries, followed by South Korea, China, and Japan. The export value of sweet cherries in 2014 was $440 million from a quantity of 82,460 metric tons. Imports of sweet cherries are relatively small compared to exports with 11,000 metric tons at a total value of $58 million of sweet cherries imported mostly from Chile to fulfil out of season demand (USDA-FAS 2015).

Tree fruit production and trade in the U.S. can be affected by a wide range of diseases or pests. Diseases or pests impact the production of sweet cherries in some way throughout the tree's life or fruit production cycle; while some can be fatal to the tree, others can reduce fruit yield or quality. The challenge for producers and policy makers is that pest and disease outbreaks are often sporadic, and the consequences on either domestic or export markets or both can be substantial depending on the pest or disease and the responses of consumers in either market. For example, the Western cherry fruit fly can infect cherries, and while there is an IPM program in place, some domestic markets and many export markets do not accept any shipments with infestations of fruit fly or fruit fly larvae at any scale (Messina and Smith 2010). The impact on industry of disease outbreaks can be substantial to the industry due directly to removal and destruction of trees, but also exclusive of the costs to growers of lost markets and other costs, as well as costs to final consumers from a reduction in supply due to orchard destruction (Welliver et al., 2014).

Model and Scenarios

We assess selected pest and disease scenarios using a multi-market equilibrium displacement model for sweet cherries at the national level for the U.S. developed by Tozer, Qui, Marsh, and Jiang (2016), accounting for benefits and costs along the supply chain from the grower to the packer/processor to the final consumer. In this model, domestic supply of cherries is derived from a dynamic bearing acreage model that adjusts through annual changes in the bearing acreage decisions of producers. International supply is reflected through imports. Demand for cherries, as noted above is generated from domestic consumers and international exports, which are driven by domestic population growth, demand elasticities (domestic and export) and prices in the domestic and export markets.

We selected scenarios to represent several different types of production impacts or market responses to a pest or

disease event or intervention. Scenario 1 is the base model, to which all other scenarios are compared, wherein no pest or disease outbreaks occur. In Scenario 2, cherry bearing acreage is reduced to simulate a pest or disease outbreak that requires tree removal or causes tree loss. The assumed loss in this scenario is five percent of the total bearing acreage of sweet cherry trees, which is 1,000 acres. In effect this represents an undersupply in the market. To examine an oversupply in the market (Scenario 3), the sweet cherry bearing acreage was increased by five percent or 1,000 acres. Scenario 4 assumes a yield loss for a single year, caused by a pest or disease, of five percent, with no impact on bearing acreage. The types of disease or pests this scenario simulates could be Western cherry fruit fly or one of the newer pests, such as the Brown marmorated stick bug (BMSB). Scenario 5 tests sensitivity of the model due to adverse consumer reaction (i.e., consumers reducing intake of fruit due to real or perceived health impacts of pest or disease control methods). Here, a 2 percent reduction in retail demand is simulated. This reduction is a one off shock to domestic demand, rather than a permanent shock, reflecting a transient reaction. Scenario 6, examines the impact of an export ban from all countries that import fresh sweet cherries from the United States, except for the U.S.'s NAFTA trading partners of Canada and Mexico. This scenario could come into effect if importing countries ban cherries due to pests or disease. In the scenario where yield is affected, it is assumed that yields, in years subsequent to the time of the shock, return to the long term trend value, due to the shock being caused by a short term transient event, rather than a long term consequence, such as tree removal as in Scenario 2.

Table 1: *Changes in consumer, producer, and total economic welfare for selected scenarios. All shocks in the model occurred in 2020. (All values in $U.S. millions).*

	CHANGE IN TOTAL		
Scenario	**Change in Consumer Welfare**	**Producer Welfare***	**Change in Total Economic Welfare**
2	-22.47	4.89	-17.59
3	17.59	-19.29	-1.7
4	-301.29	-494.87	-796.16
5	347.9	-686.35	-338.45
6	306.47	-938.74	-632.27

* Total Producer Welfare includes that of growers, packers, & processors.

Results and Discussion

The outcomes of the different scenarios are reported in Tables 1 and 2. Benefits and costs of each scenario are calculated over time and then discounted using standard present value methods. Table 1 captures the gross effects on consumer, producer, and the total economic welfare. Table 2 breaks the gross effects into the market segments, fresh and/or processing, and their impacts on consumers, cherry growers, fruit packers or processors.

The impact of a reduction in cherry bearing acreage by 1,000 acres (Scenario 2) mostly affects consumers. Supply is restricted increasing prices, thereby reducing consumer welfare by approximately $22 million. Because prices are higher with fewer bearing acres, producer welfare is increased by $5 million, with a total economic welfare loss across the economy of $18 million. A majority of the

Table 2: *Changes in economic welfare across sectors of the sweet cherry industry due to external shocks in selected scenarios. All shocks in the model occurred in 2020. (All values in $U.S. millions).*

Scenario	**Change in Consumer Welfare**		**Change in Producer Welfare Growers**		**Change in Producer Welfare Packer**	
	Fresh	*Processed*	*Fresh*	*Processed*	*Fresh*	*Processed*
2	-20.96	-1.51	4.26	-0.11	0.75	-0.01
3	16.95	0.64	-18.37	0.07	-0.95	-0.05
4	-260.88	-40.41	-486.53	-1.67	-4.86	-1.8
5	337.48	10.43	-664.11	-1.89	-16.72	-3.62
6	319.4	-12.93	-906.38	-2.35	-26.09	-3.91

impact is in the fresh fruit sector, where consumers lose $21 million in welfare, and producers gain $4 million. The effects on the processing sector are relatively small with consumers and producers of processed cherries losing $1.51 million and $110,000, respectively. In the case where supply expands due to an acreage increase (Scenario 3), the effects are not simply reversed relative to Scenario 2, particularly for sweet cherry growers. When acreage is increased by 1,000 acres, consumer welfare rose by $18 million, due to an increase in supply leading to a reduction in sweet cherry prices. However, the lower prices and increased supply reduced producer welfare by approximately $19 million, leading to a small total loss in economic welfare of $1.7 million. Again, when looking at the individual sectors most of the changes in welfare are in the fresh sector, with a small positive change in the processing sector for both producers and consumers. The reduction in returns to the packers is due to the reduction in prices as packer returns are affected by cherry prices. It is important to point out that these results demonstrate outcomes from relatively small impacts on bearing acreage. Large changes in bearing acreage to a tree fruit sector can have much more dramatic economic impacts.

A reduction in cherry yield of five percent (Scenario 4) has a significant increase in loss in consumer welfare, when compared to the acreage loss in Scenario 2, and a loss in producer welfare of $495 million, leading to a total loss in economic welfare of $796 million. Most of the loss in producer welfare is a loss in profits in the fresh cherry market. However, the source of consumer welfare loss is somewhat similar to scenario 2, with most of the loss to consumers due to increased fresh prices, but there is also a large loss in consumer welfare coming from the processed market. When comparing the effects of the 1,000 acre reduction in bearing acreage and the five percent yield loss shown of Scenario 4, there are two main differences. The first is simply a scale effect, particularly in the period immediately after the shock. The second difference is that in Scenario 4 the trajectory of changes in consumer and producer welfare take a significantly longer period to approach the trajectory of the base scenario, and in the case of producer welfare, at the termination of the model time period, was still between $10 and $15 million lower than that in the base scenario.

A reduction in demand, as a negative consumer response to a pest or disease outbreak or control methods (Scenario 5), leads to an interesting outcome, in that consumer welfare increased by $348 million with a reduction in demand. This occurs as the reduction in demand lowers prices to consumers who still wish to purchase sweet cherries, thus these consumers are better off. Producer welfare was significantly reduced by $686 million as prices and quantity consumed both fell. Again the impacts are predominately in the fresh sector, but due to the reduction in price and quantity, profits of fresh fruit packers are more significantly impacted than in previous scenarios.

The final scenario tested, a reduction in export demand in non-NAFTA markets representing a reaction to a pest or disease outbreak in the U.S., leads to an extremely large loss in producer welfare due to lower prices received as all sweet cherries are absorbed on the North American market, hence the gain in consumer economic welfare. Similar to Scenario 5, fresh fruit packers also are significantly affected due to the lower prices as returns are reduced by $26 million. The major differences between scenarios 5 and 6 are the losses in consumer economic welfare in the processed sector of the market. In Scenario 5 consumers of processed sweet cherries gain $10 million, whereas in Scenario 6 consumers lose $13 million. The losses in consumer welfare in the processing market run parallel to changes in producer welfare for Scenario 6, as producers reduced total production due to the loss of a major market. The loss in export markets caused producers to reduce supply in future years leading to a new, lower, equilibrium level of production, which reduced supplies into the processing market, as domestic and export consumers returned to the fresh market after the one-year shock.

A critical observation that arises from analyzing the outcomes of a pest or disease event on tree fruit is that no two event types necessarily have a similar effect. The economic burden on a producer or consumer is sensitive to the type and degree of pest or disease event or intervention, as well as the production process and market structure of the tree fruit sector. This is particularly important from a policy perspective as policy makers cannot develop a uniform policy or strategy due to the different effects on producers and or consumers depending on the outbreak type or reaction in the market. For example, a pest or disease outbreak that results in a small scale reduction in bearing acreage of cherry trees, while having an initial large negative effect on producers, in the long run has a positive effect on producer economic welfare. Yield loss, on the other hand, burdens both consumers and producers. Whereas, what would appear to be a transitory shock through either a reduction in domestic or export demand (Scenarios 5 and

6), has substantial negative impact on producer economic welfare, but consumers are better off, economically.

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Hedging Potential for U.S. Microbreweries

Alejandro J. Prera (509) 335-5976

Introduction

HEDGING in agricultural commodities has a long history of both research and application, and it has been used successfully by the financial markets to minimize price risk (e.g., Howard and D'Antonio, 1984; Gemmil, 1988; Shapiro and Brorsen, 1988; Wolf, 2012). The ability to protect from unexpected price changes may be appealing to producers that require an assortment of agricultural commodities in their production process. This is the case for breweries, that need to have stock on hand to produce beer and may be willing to pay a premium for quality ingredients. In this note, we summarize the findings of Prera, Fortenbery, and Marsh (2018) on exploring the potential to use future contracts of a set of commodities to off-set price changes in commodities that trade in spot markets, specifically hops.

We focus on the craft beer sector, which has been growing over the past 20 years (Carroll and Swaminathan, 2000; Brewers Association, 2016; Tremblay, Iwasaki, and Tremblay, 2005). The growing needs of this sector has meant an increasing demand for certain commodities, such as barley, wheat, and especially hops. Although financial instruments are available for wheat, they are not available for hops. Marginal hops contracts are available in a spot market, but most is contracted well ahead of harvest and is usually sold to an intermediary that can purchase in bulk. For smaller beer producers, this may mean that they must rely on intermediaries to get certain types of hops or pay premiums in the spot market. Given their size and the competitiveness of the craft beer sector, they would not be able to pass unexpected higher input costs to their consumers. Furthermore, beer producers must purchase their ingredients in fixed proportions based on the type of beer produced. As such, price volatility in spot markets for certain ingredients represents as significant margin risk to this type of producer (Wilson, Nganje, and Wagner, 2006).

To analyze the potential for hedging in this market, we investigated the price relationships between commodities with no direct future price contracts (hops and malting barley) and commodities with future contracts (corn and wheat). A necessary condition for an effective hedge is an identifiable stable relationship between commodities traded in the spot market and future prices for commodities traded in an organized exchange. After establishing such a relationship, we then estimated hedge ratios for cash and futures prices using regression analysis.

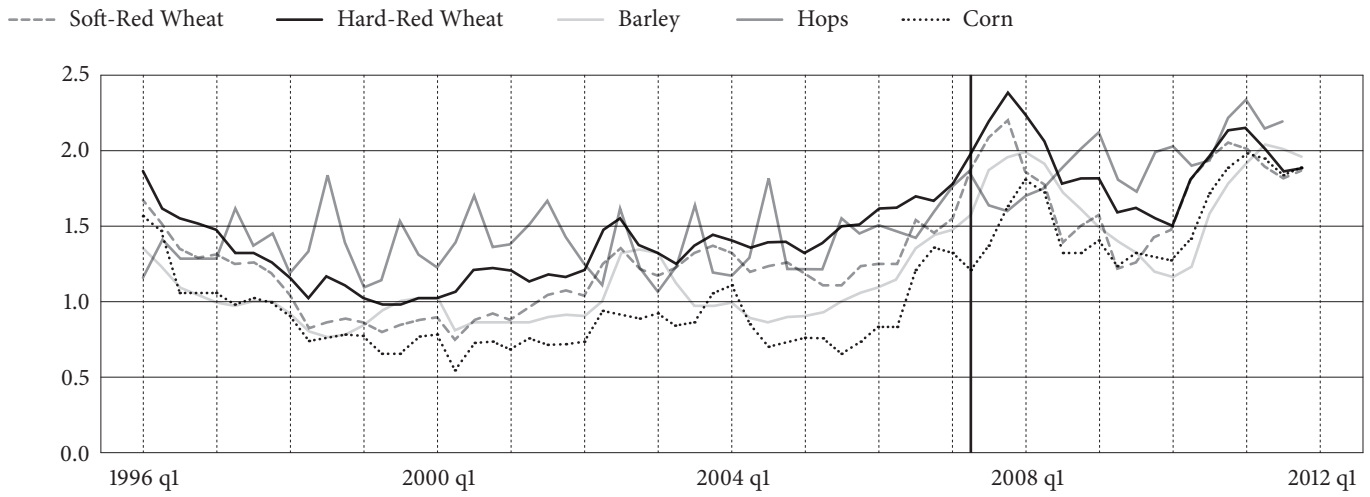
Data

Data for the analysis is described in Table 1 and is available from the first quarter of 1972 to the fourth quarter of 2011. We limited the analysis to the first quarter of 1996 to the fourth quarter of 2011. This is due in part because it corresponds to the emergence of the craft brewing industry. We also separated the study period into two, where the first period is from 1996 to 2007 and the second period from 2008 to 2011. We chose to separate the study periods in

Table 1: *Price Data Sources*

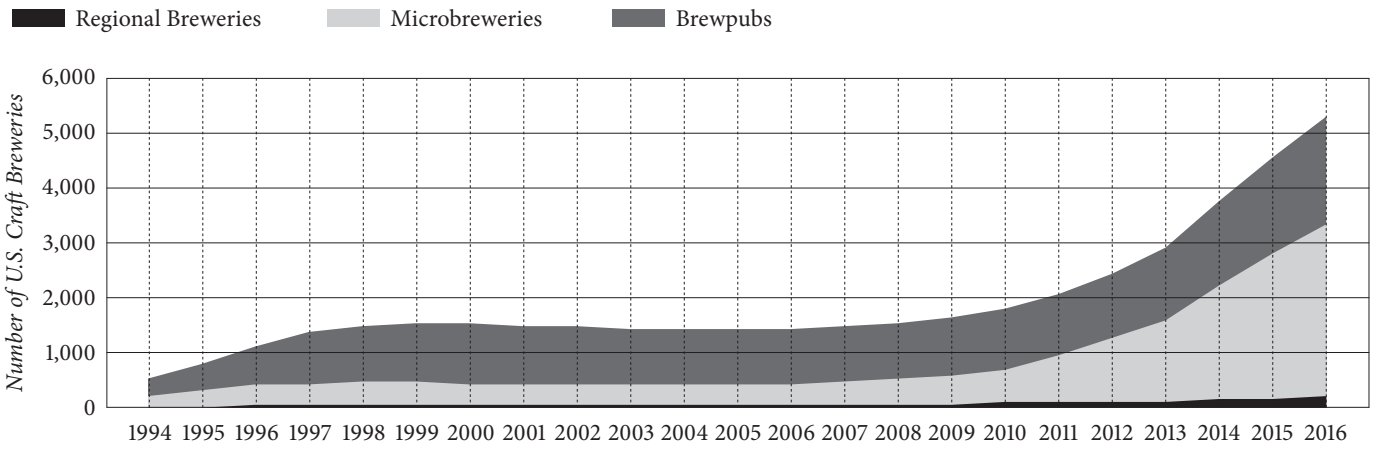
Grain	Source	Price Type
Soft-Red Winter Wheat (Chicago)	Commodity Research Bureau (CRB)	Futures Contract
Hard-Red Winter Wheat (Kansas City)	Commodity Research Bureau (CRB)	Futures Contract
Malted Barley (Export Terminal)	Commodity Research Bureau (CRB)	Cash
Hops (Export Terminal)	USDA Foreign Agricultural Services	Cash
Corn (Chicago)	Commodity Research Bureau (CRB)	Futures Contract

Figure 1:. *Study Period Commodity Prices (prices are scaled by taking the natural log)*



Source: CRB

Figure 2: *U.S. Craft Breweries by Category*



Source: Brewer Association (accessed 12/12/17)

this way because we observed a noticeable break in certain price relationships (see Figure 1) and because it coincided with the prelude to the Great Recession and a shift in federal policies towards bio-fuels (Carter, Rausser, and Smith, 2016; Motamed, McPahail, and Williams, 2016). Furthermore, as Figure 2 shows, the U.S. craft brewery industry experienced significant growth after 2008.

Discussion

As discussed in Prera, Fortenbery, and Marsh (2018), prices in the second period (to the right of the vertical line in Figure 1) showed greater volatility compared to the first period. There is a noticeable growth in prices for all commodities and a switch in correlation among some commodity pairs. As part of the exploratory analysis in cross-hedging opportunities we used a Vector Error Correction Model (VECM) to further understand these relationships. The VECM is a multivariate time-series method that determines both short- and long-run relationships among all commodity (see Zapata and Fortenbery (1996) for a discussion on its application to commodity markets).

During the first period (1996 to 2007), barley prices were influenced by wheat, corn, and hops prices. When barley prices change, hops prices adjust to the barley price level within the same quarter, although the price relationship is negative. We also find the existence of a long-term rela-

tionship between barley and corn prices and a short-run relationship between hops prices and other commodities.

For the second period (2007 to 2011), we find that changes in wheat and barley prices are above hops and below corn. We find that short-run feedback in the second period is stronger than in the first period. There is a stronger relationship among hops, corn, and wheat, and little evidence for the effect of barley prices on other commodities. When hard-red wheat prices changed, they then adjust toward hop price levels. As such, hops prices receive negative feedback from soft-red wheat and positive feedback from hard-red wheat. Barley prices do adjust to changes in wheat prices in the long-run. An interesting result is that changes in corn prices influence barley prices, but not vice versa. One possible explanation to this finding is that corn can be considered a substitute for barley in terms of feed, but barley is not a good substitute for corn in terms of fuel (Gold and Thompson, 2004).

With respect to hedging opportunities, using regression methods (see Hull, 2015 for details), we find that input buyers may enter into futures contract of corn and wheat to offset possible changes in hops and barley prices. However, the impact on hops price is negligible, given the nature of hops contracts. For example, we find that hard red-wheat and corn are better able to protect against price risk for barley compared to hops. Our findings suggest that producers of beer should treat barley and hops as a single commodity, consumed in fixed proportions to produce a type of beer (or to meet the needs of several varieties of beers) and to improve hedging performance.

Concluding Remarks

This exploration has important implications for craft beer producers that rely on smaller grain contracts or spot price through intermediaries to secure their inputs. As more land is devoted to corn, greater pressure is put on prices for other commodities like barley. In the case of hops, according to the 2016 statistical report by the Hop Growers of America, hop acreage and production has increased over the last five years. This growth is tied to increasing demand by brewers. Although price information is hard to find at the farm level, hops farmers have experienced increasing costs of production (George, 2017). This means growing price pressure for intermediaries that secure hops contracts that are then passed on to craft brewers.

Given the nature of this relationship, the price increase may be passed on to the craft brewers but may not be passed on to the final beer consumer. Due to the need to have stock on hand to meet expected demand, craft brewers are exposed to significant price risk, that would then reduce their profit margins. Our findings suggest potential for both consumers and producers of beer grain inputs; for consumers, as way of minimizing the risk of unexpected price changes, and for producers, to show that there is a growing demand for inputs.

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SECTION III

WASHINGTON DATA

Washington ($1,000)*	2011	2012	2013	2014	2015	2016
Gross cash income	$10,550,770	$11,408,165	$11,179,534	$11,341,040	$11,571,919	$10,800,432
All commodity receipts	$9,878,002	$10,710,881	$10,490,673	$10,560,191	$10,357,083	$10,099,891
Crop receipts	$7,217,854	$8,044,058	$7,549,624	$7,225,261	$7,337,134	$7,577,234
Animals and products receipts	$2,660,148	$2,666,822	$2,941,049	$3,334,930	$3,019,949	$2,522,657
Cash farm-related income	$418,943	$477,666	$485,859	$653,137	$1,000,575	$463,043
Forest products sold	$15,910	$15,180	$23,538	$18,347	$16,194	$15,762
Machine hire and custom work	$126,779	$86,340	$101,701	$228,171	$81,439	$91,359
Other farm income	$276,254	$376,145	$360,621	$406,619	$902,942	$355,922
Total direct government payments	$253,825	$219,618	$203,003	$127,712	$214,261	$237,497
Cash expenses*	$6,959,907	$8,428,195	$8,142,866	$8,743,777	$7,946,755	$7,653,607
Interest*	$304,673	$337,307	$295,968	$306,451	$314,962	$329,633
Nonreal estate	$133,687	$136,414	$111,925	$116,376	$123,519	$124,016
Real estate*	$170,986	$200,893	$184,043	$190,075	$191,443	$205,617
Labor expenses	$1,476,624	$1,973,475	$1,906,438	$1,928,106	$1,881,899	$2,088,006
Property taxes and fees*	$214,882	$223,863	$241,583	$292,627	$228,621	$241,954
Farm origin	$1,347,187	$1,435,678	$1,430,424	$1,557,563	$1,353,413	$1,295,096
Feed purchased	$878,580	$873,466	$891,436	$959,093	$773,539	$845,240
Livestock and poultry	$194,050	$271,057	$167,557	$212,748	$208,575	$134,164
Seed	$274,556	$291,155	$371,432	$385,722	$371,299	$315,692
Manufactured inputs	$1,294,504	$1,630,646	$1,601,266	$1,901,872	$1,427,036	$1,342,322
Electricity	$111,724	$150,043	$152,276	$190,880	$143,492	$123,803
Fertilizer and lime	$417,326	$636,228	$626,128	$750,594	$577,576	$509,181
Fuel and oil	$370,093	$359,116	$355,919	$449,577	$241,845	$261,259
Pesticides	$395,361	$485,259	$466,943	$510,821	$464,123	$448,079
Other intermediate expenses	$1,979,575	$2,337,514	$2,138,872	$2,264,085	$2,173,592	$1,917,510
Net rent to landlords	$342,462	$489,712	$528,316	$493,073	$567,233	$439,086
Net cash income	$3,590,864	$2,979,969	$3,036,668	$2,597,263	$3,625,164	$3,146,824

* Data is reported in 2017 dollars

Source: USDA ERS Farm Income and Wealth Statistics

	Employment	Unemployment Rate	Average Annual Wage	Real Gross Regional Product Million (2016)
United States	196,713,959	4.4%	$55,823	$17,935,785
Washington	4,369,405	5.4%	$61,448	$436,273
Adams County	10,377	6.8%	$42,539	$667
Asotin County	8,915	5.1%	$37,868	$565
Benton County	109,288	6.5%	$56,703	$9,298
Chelan County	56,590	5.9%	$41,953	$3,535
Clallam County	33,279	7.9%	$40,658	$2,152
Clark County	216,852	6.3%	$49,949	$17,729
Columbia County	2,059	6.8%	$40,977	$138
Cowlitz County	48,833	7.5%	$50,439	$4,303
Douglas County	16,875	7.1%	$38,009	$1,017
Ferry County	2,816	10.8%	$40,865	$182
Franklin County	43,791	7.6%	$43,043	$2,892
Garfield County	1,250	6.0%	$46,577	$95
Grant County	49,606	7.4%	$43,780	$3,448
Grays Harbor County	29,731	8.7%	$42,240	$2,019
Island County	34,062	6.0%	$43,071	$3,039
Jefferson County	14,665	7.3%	$37,195	$939
King County	1,727,569	3.9%	$78,342	$218,721
Kitsap County	129,025	5.8%	$54,190	$11,764
Kittitas County	21,719	6.0%	$41,426	$1,393
Klickitat County	11,082	7.1%	$46,520	$815
Lewis County	34,143	8.1%	$42,015	$2,430
Lincoln County	4,955	5.7%	$35,628	$293
Mason County	20,295	7.8%	$41,331	$1,372
Okanogan County	25,375	6.9%	$35,337	$1,333
Pacific County	9,831	8.3%	$37,522	$608
Pend Oreille County	4,833	9.1%	$46,856	$479
Pierce County	426,330	6.3%	$52,902	$38,796
San Juan County	11,265	4.8%	$32,513	$657
Skagit County	68,089	6.8%	$48,152	$6,341
Skamania County	3,503	7.2%	$37,130	$241
Snohomish County	387,951	4.4%	$60,296	$40,213
Spokane County	292,016	6.3%	$47,755	$22,120
Stevens County	17,227	8.6%	$36,715	$1,029
Thurston County	145,476	5.8%	$53,327	$11,732
Wahkiakum County	1,409	9.0%	$33,518	$81
Walla Walla County	38,469	5.6%	$43,288	$2,619
Whatcom County	124,532	6.0%	$46,207	$10,642
Whitman County	26,738	5.1%	$48,517	$1,791
Yakima County	139,519	8.0%	$41,733	$8,782

Source: Emsi 2017.4 and BLS LAUS

State Wide Unemployment and Unemployment rates by Industry

NAICS	Industry	Unemployed	Unemployment Rate
23	Construction	25,461	13%
90	Government	21,385	11%
31	Manufacturing	19,049	10%
44	Retail Trade	18,204	9%
72	Accommodation and Food Services	12,305	6%
11	Crop and Animal Production	10,679	6%
62	Health Care and Social Assistance	10,036	5%
81	Other Services (except Public Administration)	9,544	5%
56	Administrative and Support and Waste Management and Remediation Services	9,293	5%
54	Professional, Scientific, and Technical Services	7,832	4%
48	Transportation and Warehousing	5,729	3%
42	Wholesale Trade	3,806	2%
71	Arts, Entertainment, and Recreation	3,475	2%
61	Educational Services	2,844	1%
52	Finance and Insurance	2,739	1%
51	Information	2,477	1%
53	Real Estate and Rental and Leasing	1,707	1%
22	Utilities	566	0%
21	Mining, Quarrying, and Oil and Gas Extraction	488	0%
55	Management of Companies and Enterprises	133	0%
99	No Previous Work Experience/Unspecified	26,355	14%

Source: Emsi 2017.1

Top Growing and Declining Industries In Washington

NAICS	Description	2012 Jobs	2017 Jobs	2012–2017 Change	2012–2017 % Change
331318	Other Aluminum Rolling, Drawing, and Extruding	11	161	150	1364%
488991	Packing and Crating	67	595	528	788%
335129	Other Lighting Equipment Manufacturing	22	126	104	473%
336111	Automobile Manufacturing	12	67	55	458%
525990	Other Financial Vehicles	569	3,073	2,504	440%
333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing	22	118	96	436%
311613	Rendering and Meat Byproduct Processing	158	48	-110	-70%
522294	Secondary Market Financing	81	20	-61	-75%
532230	Video Tape and Disc Rental	760	169	-591	-78%
337920	Blind and Shade Manufacturing	59	11	-48	-81%
326211	Tire Manufacturing (except Retreading)	12	0	-12	-100%
212112	Bituminous Coal Underground Mining	17	0	-17	-100%

Source: Emsi 2017.4