Production and Marketing Reports

Opportunities and Challenges of Organic Highbush Blueberry Production in Washington State

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Summary. **Global production of highbush blueberry (*Vaccinium corymbosum*) has continuously increased since the early 1990s, with substantial growth occurring after 2000. Benefiting from this growth is the organic blueberry (*Vaccinium* sp.) industry, which has been strengthened by increases in organic food sales and the price premiums received for organic products. Washington State is a national and global leader in organic blueberry production, with 47% of the national organic blueberry crop harvested in 2008. As this statewide industry continues to grow, it is important to recognize both the opportunities and challenges related to organic blueberry production and marketing. This paper addresses those issues and describes trends in organic highbush blueberry production using Washington State as a case study due to its scale and distinctive regional differences within the state in regard to climate, horticultural production, and market venues. Challenges related to the introduction and management of new diseases and pests, changes in the federal organic regulations, infrastructural limitations, and climate change threaten current production capabilities in Washington State. However, the industry is still poised to capitalize on organic blueberry markets and has a lower market risk in the medium term compared with other crops.**

Global production of highbush blueberry has expanded due to increased consumption, which has been largely fueled by successful marketing campaigns that advertise the multiple health benefits of eating blueberries (Brazelton and Strik, 2007; Moore, 1994). Coinciding with this growth in consumption is the increase of organic blueberry production. Organic blueberry production has been particularly significant in the western United States, with Washington State leading production in the region [U.S. Department of Agriculture (USDA), 2010]. Along with the growth of this new and emerging industry are both opportunities and challenges related to production and marketing. Information regarding these challenges is critical for growers and investors assessing the status of the industry and subsequent entry into or expansion of production. The objective of this paper is to describe production and economic trends in organic highbush blueberry, with an emphasis on Washington State. Washington serves as a useful case study given the diversity in scale of the industry, including organic and conventional production, as well as distinct regional differences within the state in regard to climate, production practices, and market opportunities.

Methods of data collection

Global, national, and statewide blueberry production data were accessed and reviewed for the purposes of this study, which encompassed the years from 2000 to 2014, depending on the sources of the data. Global data came from world acreage and production reports prepared by Cort Brazelton, Vice President of International Development at Fall Creek Farm & Nursery, Inc. (Lowell, OR), and provided to the U.S. Highbush Blueberry Council and North American Blueberry Council. The reports prepared by Brazelton are the most comprehensive and reliable sources of worldwide acreage and production data available for highbush blueberry. These data are collected through reports, interviews, and targeted surveys among industry intelligence. The USDA National Agricultural Statistics Service (NASS) provided national data, as well as statewide data for all Washington blueberries (organic and conventional combined). Specific years the data were obtained from are referenced

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
25.4	inch(es)	mm	0.0394
0.4536	lb	kg	2.2046
1.1209	lb/acre	kg·ha^{-1}	0.8922
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

herein. Organic acreage data were provided by multiple organic certifiers (Brady et al., 2015). The Washington State Department of Agriculture (WSDA) Organic Food Program provided additional data on individual organic farm sales and production for the period 2009–13. These data are provided by certified growers and are verified through an inspection and review process. The WSDA Organic Food Program includes ≈95% of National Organic Program–certified producers within Washington and as such is representative of organic blueberry in Washington. Separated data for conventional production are not presented because it does not exist and subtraction of organic from total production would be misrepresentative because the WSDA Organic Food Program does not include all certified producers in Washington. Production data reported by volume were converted to weight using standard market guidelines (USDA, 2012a). Summary statistics derived from these data are provided and discussed in this report.

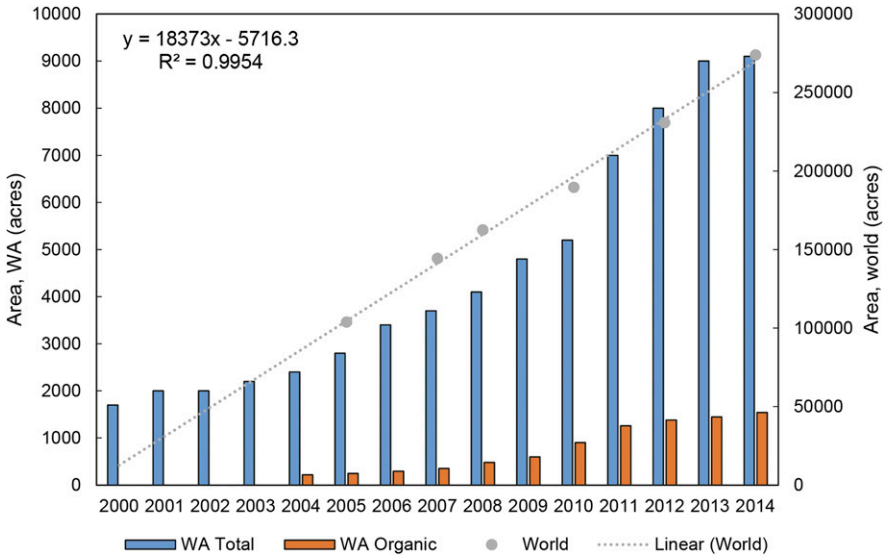

Fig. 1. Worldwide acreage in highbush blueberry production compared with total harvested and certified organic acreage in Washington State (WA), 2000 to 2014 (Brazelton 2011, 2013, 2015; USDA, 2003, 2006, 2009, 2012b, 2015; Washington State Department of Agriculture Organic Food Program); 1 acre = 0.4047 ha.

Blueberry production

Global production. Highbush blueberry acreage has substantially increased worldwide since the early 2000s (Fig. 1). Between 2005 and 2014, total worldwide highbush blueberry acreage grew 164% from 103,778 to 273,880 acres (Brazelton, 2013, 2015). Production grew by ≈146 million pounds (24%) between 2008 and 2010, 275 million pounds (36%) between 2010 and 2012, and 214 million pounds (21%) between 2012 and 2014 (Brazelton, 2011, 2013, 2015) (Table 1). Fresh blueberries are the primary driver for the growth of global blueberry production. Between 2012 and 2014, fresh shipments were 65% to 67% of total production, while 75% of new production was shipped fresh (data not presented). In 2014, the United States had the largest acreage in highbush blueberry production at 108,560 acres, followed by Chile (38,430 acres), China (36,700 acres), and Canada (28,685 acres) (Table 1). Other regions contribute to global highbush blueberry production and many of

Table 1. Worldwide acreage and production of highbush blueberry from 2008 to 2014. Data include organic, conventional, fresh, and processed fruit (adapted from Brazelton, 2011, 2013, 2015).

	Area (acres)[z]				Total production (million lb)[z]			
Region and country	2008	2010	2012	2014	2008	2010	2012	2014
North America	95,597	108,931	123,335	143,636	415.8	491.3	599.6	727.8
United States	74,992	84,688	93,145	108,560	334.0	391.4	468.5	549.0
Canada	19,800	22,580	27,120	28,685	79.6	94.9	118.6	155.5
Mexico/Central America	805	1,663	3,070	6,391	2.2	5.0	12.5	23.3
South America	39,703	43,950	43,640	49,860	115.1	153.4	272.4	268
Chile	26,908	32,250	33,960	38,430	87.5	123.5	220.4	223.2
Argentina	10,900	9,500	7,410	7,420	25.2	26.6	45.5	34
Europe	18,038	20,780	24,001	28,255	56.4	81.1	98.2	142.2
Poland	6,900	7,800	8,545	9,350	18.0	23.8	25.7	34.2
Germany	5,063	5,300	5,580	5,790	16.9	20.0	22.0	28.5
Spain	2,100	2,600	3,050	4,560	9.2	17.6	21.7	43.4
Asia and the Pacific	7,870	14,117	37,615	48,508	17.0	22.5	48.1	82.5
China	2,900	8,645	29,800	36,700	8.8	6.6	25.0	44.1
Australia	1,470	1,530	2,590	2,680	8.2	6.6	10.1	13.4
Africa	1,115	1,609	1,988	3,304	1.9	4.2	8.5	19.8
Morocco	180	450	800	1,970	0.3	1.8	4.9	14.7
South Africa	900	1,120	1,140	1,285	1.5	2.3	3.5	4.9
World	162,473	189,574	230,755	273,880	606.6	752.9	1,027.4	1,241.0

[z]1 acre = 0.4047 ha, 1 lb = 0.4536 kg.

these industries are rapidly growing, including South America (led by Chile, followed by Argentina), Europe (Poland, Germany, and Spain), Asia (led by China), Mexico/Central America, the Pacific (led by Australia), and Africa (led by South Africa and Morocco).

National production. Blueberry is second in value among berry crops in the United States, following strawberry (*Fragaria ×ananassa*) at ≈$825 million in 2014 (USDA, 2015). Production occurs throughout the continental United States, with northern highbush blueberry production concentrated in Washington, Oregon, California, New Jersey, and Michigan. Southern highbush blueberries, which are complex hybrids of *Vaccinium corymbosum* and *Vaccinium darrowii*, are cultivated primarily in southeastern United States. The top six blueberry producing states in 2014 were Michigan (99 million pounds), Georgia (98 million pounds), Washington (94.6 million pounds), Oregon (87.3 million pounds), California (57.1 million pounds), and New Jersey (55.6 million pounds) (USDA, 2015) (Table 2). Note that there are discrepancies between U.S. area and production data reported by Brazelton (2015) and USDA (2015). These discrepancies are attributed to differences in methods of data collection. All of the data prepared by Brazelton come from reports, interviews, and targeted surveys among industry intelligence, whereas NASS represents data from grower surveys. Rabbiteye blueberry [*Vaccinium virgatum* (synonym *Vaccinium ashei*)] and half-high blueberry (*V. corymbosum* × *Vaccinium angustifolium*) are also cultivated on a smaller scale in the United States and are included in USDA data as "cultivated" blueberries. These are different from lowbush (*V. angustifolium*) blueberries that are also reported by USDA as "wild (Maine)" blueberries.

Organic blueberry production. Parallel growth has also been observed in planted acreage of organic blueberry beginning in the early 2000s (Fig. 1). The approximate 20% to 100% price premium for organic relative to conventionally grown blueberries incentivizes many growers to enter into organic production (Strik, 2014). In 2006, worldwide cultivated organic blueberry acreage (certified and transition) was estimated at 1200 ha and increased to over 6000 ha by 2013 (D. Granatstein, unpublished data; Granatstein et al., 2010). The United States and Chile are the primary producers of organic blueberries, with 1665 and 1580 ha in 2011, respectively (Strik, 2014). In the United States, Washington was the largest producer of organic blueberries and was responsible for 47% of the national certified organic blueberry crop harvested in 2008 and 53% of the fresh organic blueberry shipments in 2014 (D. Granatstein, unpublished data; USDA, 2010). Plantings and production of organic blueberry have continued to increase in Washington, but have been difficult to quantify given the rapid growth, mixed ages of plantings with different production capacities, and deficiencies in current approaches for tracking the national and statewide organic blueberry sector. However, overall growth in national retail sales of organic foods has remained strong and increased 11.5% during 2013, with fruits and vegetables accounting for 33% of total organic food sales (Organic Trade Association, 2014). These data suggest the potential for continued growth in organic blueberry demand, but little is known about future production potential and how production will relate to consumer demand.

Table 2. Highbush blueberry area, average yield, and total production in the United States in 2014. Data include organic, conventional, fresh, and processed fruit (adapted from USDA, 2015).

State	Area (acres)[z]	Avg yield (lb/acre)[z]	Total production (1,000 lb)[z]
Alabama	430	1,210	560
Arkansas	230	2,130	620
California	4,800	11,500	57,100
Florida	4,300	4,420	20,400
Georgia	16,600	5,540	98,000
Indiana	690	2,900	2,000
Michigan	20,200	4,900	99,000
Mississippi	1,900	3,840	10,600
New Jersey	9,300	5,980	55,610
New York	700	2,000	1,640
North Carolina	6,900	7,070	48,800
Oregon	9,000	9,700	87,300
Washington	9,100	10,400	94,600
U.S.	84,150	6,690	576,230

[z]1 acre = 0.4047 ha, 1 lb/acre = 1.1209 kg·ha^{-1}, 1 lb = 0.4536 kg.

Blueberry production in Washington state. The Pacific Northwest (PNW) is a major center of highbush blueberry production and includes Washington, Oregon, and British Columbia (Canada). Blueberry is well adapted and productive within the climactic conditions of the PNW and regional yields are expected to increase as more plantings become established and enter into full bearing capacity. Washington's blueberry industry began over 50 years ago as small farming operations that primarily sold fruit directly from farms. Commercial production was initially limited to western Washington, particularly Whatcom and Skagit counties, with limited acreage in Lewis and Clark counties (Fig. 2). Increased demand for fruit within the past decade has supported the expansion of the industry east of the Cascade Mountains, with Benton and Franklin counties experiencing significant increases in blueberry acreage, particularly organic. Additional growth has and is continuing to occur throughout Washington, particularly in Snohomish, Lewis, Walla Walla, and Grant counties.

As blueberry acreage has expanded, statewide production in Washington has increased from 39 million pounds in 2009 to ≈95 million pounds in 2014 (Brady et al., 2015; USDA, 2015). This growth represents an increase in total crop value from $30.5 million in 2009 to $112.6 million in 2014. Statewide organic production has contributed to this growth, with organic acreage increasing from 599 acres in 2009 to

1540 acres in 2014, which was ≈10% and 12%, respectively, of total blueberry acreage. Concurrently, organic production has increased more than 6-fold, from 3 million pounds in 2009 to 18.5 million pounds in 2013. The farm gate value of organic blueberries in Washington has also grown from $7 million in 2009 to over $30 million in 2013. The increasing importance of organic production is evident, with organic blueberries representing 12% of harvested area, 23% of production volume, and 42% of sales value, respectively, of all blueberry production in the state in 2013. Production of both conventional and organic blueberry is expected to increase within the next 5 to 10 years as more acreage is planted and newly established plantings come into full production. This trend is already being observed, as there has been a steady annual increase in production: 45% from 2010 to 2011, 15% from 2011 to 2012, 17% from 2012 to 2013, and 16% from 2013 to 2014 (USDA, 2012b, 2015). A comparison of organic to all blueberries in Washington State is provided in Table 3.

Production characteristics in Washington state. Blueberry production in Washington is both shaped and divided by the Cascade Range, which results in markedly different climatic and soil characteristics. Thus, there are different production practices in western and eastern Washington. These differences provide a unique and important case study by which to examine differences in production, marketing, and economics. Western Washington's maritime climate is mild and humid due to prevailing westerly winds that move moist air from the Pacific Ocean across the region (Western Regional Climate Center, 2015). As this air moves inland and encounters the Cascade Range, it condenses and produces the heavy dew and precipitation that characterize western Washington. A rain shadow is subsequently created on the leeward side of the mountains, leading to the semiarid climate experienced in eastern Washington. Seasonal high- and low-pressure systems further influence western Washington's climate. High-pressure systems in spring and summer result in prevailing northwesterly winds that create relatively cool and dry springs and summers. In autumn and winter, prevailing winds become southwesterly and move warm, moist air across the region. These air masses bring rainfall during fall and winter months in western Washington.

Depending on location, blueberry-growing regions in western Washington can receive 30 to 60 inches of precipitation per year (Washington State University, 2015). Average high and low temperatures for this region are ≈60 and 40 °F, respectively, with an average temperature of ≈50 °F. In contrast, the major blueberry-growing regions in eastern Washington receive less than 15 inches of annual precipitation (as low as 6 inches in some areas) in the form of winter snow or rain. Blueberry production is centered in the irrigated counties of the Columbia River Basin and associated mountain rivers, as irrigation is required. Average high and low temperatures for the eastern Washington production region are 64 and 38 °F, respectively. However, the region experiences more temperature extremes relative to western Washington. For example, from 2009 to 2014, the extreme high and minimum temperatures for Prosser, WA, a major blueberry production area, were 103.9 and 0.6 °F, respectively. These temperature extremes often necessitate evaporative cooling systems in the summer and frost protection systems in late winter/early spring to prevent heat damage to fruit and cold damage to floral tissue, respectively. Production systems in western Washington

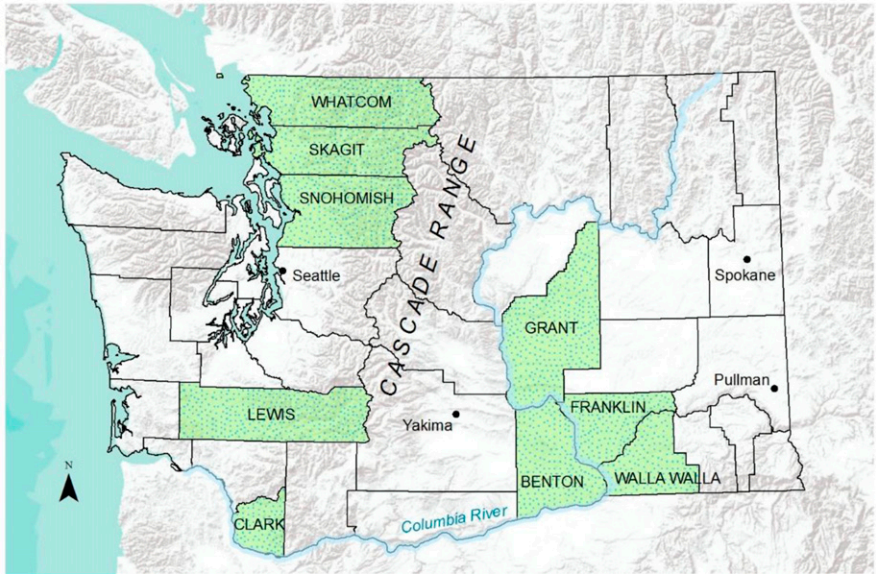

Fig. 2. Primary locations for Washington State highbush blueberry production. Production was historically localized in western Washington, chiefly Whatcom and Skagit counties. Organic production has expanded in eastern Washington, including Benton and Franklin counties. Additional growth in production is being observed in Snohomish, Lewis, Walla Walla, and Grant counties. Map constructed by H. Vogel and R. Rupp (Washington State University, Pullman).

Table 3. Washington highbush blueberry market average yield, price, and gross revenue per acre from 2009 to 2013 (adapted from Brady et al., 2015).

	Yield (lb/acre)[z]		Price ($/lb)[z]		Revenue ($/acre)[z]	
Yr	Total[y]	Organic	Total	Organic	Total	Organic
2009	8,130[x]	6,099	0.78	2.23	6,359	14,111
2010	8,080	6,825	1.30	1.66	10,512	11,195
2011	8,710	5,436	2.00	2.42	17,429	13,097
2012	8,750	9,587	1.22	2.07	10,675	18,563
2013	9,070	11,675	0.88	1.71	7,951	20,977

[z]1 lb/acre = 1.1209 kg·ha^{-1}, $1/lb = $2.2046/kg, $1/acre = $2.4711/ha.
[y]Conventional plus organic.
[x]Data are a composite of fresh and processed fruit, with values weighted by scale of production.

rarely have heat and cold protective systems established in their fields due to the generally mild climate, although this is beginning to be commercially explored as weather patterns become more erratic.

Regional differences in precipitation and soil formation contribute to differences in soil pH and subsequent nutrient availabilities. Soil pH is an important factor for blueberry production due to the crop's requirement for acidic soil conditions, with a soil pH of 4.5 to 5.5 generally considered necessary for optimal production. Soils in western Washington are naturally more acidic and suitable for blueberry production due to leaching of cations as a result of frequent precipitation. In contrast, eastern Washington soils tend to be more alkaline due to less precipitation that allows for the retention of cations. Both regions generally require some degree of soil acidification for commercial production through the addition of preplant elemental sulfur, sawdust mulches, and ammonium-based acidifying fertilizers. However, the native soil chemistries in eastern Washington require greater and more frequent amounts of acidifying amendments to achieve and maintain a desired soil pH for blueberry. Some growers in eastern Washington acidify irrigation water, which can also be alkaline, with sulfuric or citric acids to maintain a low soil pH conducive for blueberry production.

Organic crop management in Washington

One of the primary features distinguishing organic blueberry production is the limited number of available pesticides and synthetic fertilizers as compared with conventional production. Many organic growers also have philosophical reasons to farm organically. Subsequently, these growers often focus more on promoting plant health and productivity through practices that enhance soil health and environmental quality. Despite the limited number of organic-approved agrichemical tools for crop production, blueberry growers still have a range of products and environmental conditions that allow them to produce organic blueberries in Washington.

DISEASES AND PESTS. The PNW region provides several environmental advantages that make organic production more conducive for managing diseases and pests. One advantage is the lack of certain diseases and pests, which is attributable to the low rainfall and humidity experienced during peak periods of the production season (Strik, 2014). These problems are less severe throughout Washington and the greater PNW when compared with eastern and southern production regions in the United States that experience humid, wet summers conducive to disease and pest development. In fact, diseases such as alternaria (*Alternaria tenuissima*), anthracnose (*Colletotrichum acutatum*), and blueberry rust (*Puccinia-strum vaccinia*) are either absent or rarely found within the PNW region. Eastern Washington production regions experience considerably fewer disease and pest problems relative to western Washington. This difference in disease and pest pressure is likewise attributed to differences in climate, with the semiarid climate of eastern Washington being unsuitable for several fungal diseases, particularly mummy berry (*Monilinia vaccinii-corymbosi*) and botrytis (*Botrytis cinerea*). Lack of disease and pest pressure in eastern Washington may also be attributed to the recent introduction of blueberry to this area of the state. Diseases and pests specific to blueberry may not have had enough time to develop host–pathogen/pest relationships with the crop. Both mummy berry and botrytis are primary challenges for organic blueberry production in western Washington.

Spotted wing drosophila [SWD (*Drosophila suzukii*)] damage also appears to be less severe in eastern Washington, although it is present throughout the state. Reduced severity of SWD is again likely due to climate, as activity of SWD is reduced when temperature exceeds 86 °F, which is often achieved during peak blueberry production periods in eastern Washington (Walsh et al., 2011). Growers in eastern Washington still treat for pests like SWD, but overall severity is reduced relative to western Washington. The overall absence or reduced presence of diseases and pests in eastern Washington is a primary reason why eastern Washington dominates statewide organic blueberry production, as fewer pesticides are needed to produce a marketable crop. Higher disease and pest pressures have also been considered a major reason for the generally lower yields of blueberry in western vs. eastern Washington (Table 4), as well as a factor for higher production costs in western Washington due to more frequent pesticide applications needed for crop protection.

WEEDS. Weed management is a challenge in both western and eastern production regions for organic blueberry growers. Unlike conventional blueberry growers, organic growers have fewer and often less effective weed management strategies. Few herbicides are approved for organic systems. Available products are postemergent contact herbicides with active ingredients including acetic acid, lemongrass oil, clove oil, bitter almond oil, and citric acid, either alone or in combination. Efficacy of these herbicides is often poor and the cost is high (Granatstein et al., 2014). Propane flaming may also be used, but care must be taken so as not to damage blueberry plants or irrigation equipment and to avoid setting fire to flammable materials such as sawdust mulch (Granatstein and Mullinix, 2008; Julian et al., 2012).

Table 4. Market average yield, price, and gross revenue for organic highbush blueberry production in eastern and western Washington from 2009 to 2012 (adapted from Brady et al., 2015).

	Yield (lb/acre)[z]		Price ($/lb)[z]		Revenue ($/acre)[z]	
Yr	East	West	East	West	East	West
2009	7,142[y]	5,500	2.21	2.25	15,820	13,187
2010	7,882	3,524	1.61	2.05	12,509	9,055
2011	6,565	2,214	2.33	3.12	15,294	6,916
2012	11,399	3,631	2.06	2.70	23,419	6,162
4-year avg	8,247	3,717	2.05	2.53	16,760	8,830

[z]1 lb/acre = 1.1209 kg·ha^{-1}, $1/lb = $2.2046/kg, $1/acre = $2.4711/ha.
[y]Data are a composite of fresh and processed fruit.

Mulching. Mulching is a prevalent approach to weed management in organic blueberry production and offers several other horticultural benefits. Mulches can improve crop growth and productivity due to their ability to modify and mitigate soil temperature fluctuations, reduce water loss from the soil surface, and provide plant mineral nutrients when they are derived from organic materials, including composts (Burkhard et al., 2009; Clark and Moore, 1991; Cox, 2009). Sawdust or bark derived from douglas fir (*Pseudotsuga menziesii*) applied to a depth of up to 6 inches is commonly used for mulching throughout Washington. However, some organic growers in eastern Washington have transitioned to using "weedmat," a black landscape fabric made from woven polypropylene. Weedmat-based systems performed well in organic blueberry production in Oregon, with greater yields when compared with systems using only sawdust mulch or sawdust with compost (Larco et al., 2013). Other sources of mulch include pine needles and combinations of materials including sawdust, composts, and/or pine needles, but these are rarely used in Washington. Use of compost is generally not recommended nor widely practiced for blueberry production, as composts typically have high pH, electrical conductivity, and potassium content, all of which are undesirable for blueberry growth and development (Sullivan et al., 2014).

Regional differences. Regional differences between eastern and western Washington for organic blueberry production are provided in Table 4. Fruit yields (based on market averages that are weighted by production volume) were higher for every year in eastern Washington and the average over 4 years was two times greater in eastern Washington than in western Washington. Eastern Washington organic yields were slightly lower, on average, than the corresponding yields for all blueberries in the state, but yields for both categories appear to be increasing, likely due to more plantings coming into full production (Tables 3 and 4). Based on production data reported by organic growers, ≈20% of yield observations for eastern Washington organic growers exceeded 10,000 lb/acre compared with 3% in western Washington (Brady et al., 2015). In some cases, yields of 20,000 lb/acre have been reported by organic growers in eastern Washington, suggesting that organic yields can equal or exceed yields from conventional production. One large organic grower in eastern Washington reported a yield of 34,000 lb/acre in 2013 and these exceptionally high-yielding producers influence yield averages (Table 3). Organic growers in western Washington tended to receive higher prices per pound than growers in eastern Washington, but overall gross revenue per acre in western Washington was considerably lower (Table 4). The yield data could not be adjusted for the age of the planting; therefore, the results likely understate the average yields, because eastern Washington has predominately younger plantings that are not yet at full bearing capacity.

Economics and marketing of organic blueberries in Washington

Market entrance. The significant expansion in organic blueberry production in Washington within a relatively short time reveals important economic considerations made at the farm level. Those considerations include the scale at which farms enter organic blueberry production in terms of acreage, the diversity of crops grown organically on the farms, and if new production is coming from existing organic farms diversifying into blueberries or if the perceived economic opportunities presented by organic blueberries is bringing new farms into the organic industry altogether. The first two considerations reveal the degree of economies of scale and scope. Scale economies exist when expanding production reduces per unit costs. Economies of scope exist when expanding the number of crops grown reduces per unit costs of each crop. Because it is very challenging to collect detailed farm-level production cost data, observing scale and scope reveals the extent to which farm managers perceive these factors to exist.

It may seem unlikely that farms would cease producing a perennial crop that has experienced such an expansion in acreage, but there is a vast economics literature showing that even when an industry is growing, there are often many farms exiting and entering production (Dunne et al., 1988). One explanation for this is that a profitable opportunity entices larger and more efficient growers into production and they soon outcompete the smaller incumbent and less efficient growers, causing them to exit. The number of farms growing organic blueberries in Washington for the years 2009–13 was 51, 56, 52, 49, and 51 farms, respectively. Across all years there were a total of 71 unique farms, nine of which exited organic production in 2013 or earlier. Eight additional farms exited blueberry production, but continued to produce other organic crops and four farms that had reported segregated blueberry acreage in some years switched to reporting mixed berry acreage.

Producer characteristics. Across a wide range of industries, it is common to find that new producers are much smaller than existing producers (Geroski, 1995). However, this is not the case for organic blueberries in Washington. In 2009, the average number of blueberry acres per farm across the state was 11.7 acres, compared with 15.8 acres for farms entering certified organic blueberry production for the first time in 2010 through 2013. This demonstrates the impact of new growers in eastern Washington on overall blueberry production in the state. Organic blueberry has expanded predominately from existing organic farms diversifying into blueberries, particularly in eastern Washington where the environment is more conducive to organic production. In this study, 14 farms (20%) entered into organic blueberry production between 2009 and 2012. This is consistent with the findings of Geroski (1995), who found that most businesses that can be considered "new" previously existed and operated in another industry.

Most farms that grow organic blueberries in Washington are fairly specialized. For a subset of blueberry growers that reported production and price data, over half (58%) grew three or fewer crops, including blueberries. Blueberries were the only organic crop for 12 farms (24%) and these

averaged 21 acres of blueberries. Ten farms (20%) reported production of 10 or more types of crops, with an average blueberry area of 4.7 acres. All of these farms were in blueberry production in 2010 or earlier. Twelve farms (24%) also had mixed vegetable production. Based on these data, there appears to be a fairly clear dividing line between farms that exploit scale vs. scope. The most common crops grown with blueberries were either orchard crops [e.g., apple (*Malus×domestica*) or cherry (*Prunus avium*)] or mixed vegetables. There were 13, 5, and 5 farms growing apples, cherries, and pears (*Pyrus* sp.), respectively, when reviewing records from 2009 to 2012. Orchard crops are common among larger growers in eastern Washington where a large tree fruit industry exists. The mixed production of raspberries (*Rubus idaeus*), apples, blackberries (primarily *Rubus ursinus*), strawberries, and other mixed horticultural crops, including vegetables, is more common in western Washington, demonstrating that there are potential economic advantages to a larger scope of crops among farms growing organic blueberry in western Washington.

Cost, revenue, and price. Detailed cost of production studies for organic and conventional blueberries are not currently available for Washington conditions. Thus, when looking at data such as the gross revenues reported in Tables 3 and 4, it is not possible to fully assess the level of profitability. Costs of land, water, and labor, as well as the availability of labor, differ between eastern and western Washington and these would need to be accounted for in future cost of production studies. However, cost of production studies, based on actual field trials, were conducted in the Willamette Valley of Oregon, with conditions more similar to western Washington (Julian et al., 2011a, 2011b). Yields at full production were assumed to be similar and cumulative variable costs and total costs in years 0 to 7 were 12% and 10% greater, respectively, under organic management when compared with conventional management. When compared with the annual total cost of production in Oregon, the gross revenues presented in Table 3 for eastern Washington organic growers often exceeded costs, indicating these growers were profitable. In contrast, revenues for western Washington organic growers did not equal costs.

In the United States, Washington, Oregon, and California have been the leading producers of organic blueberries (Granatstein, 2015). Washington and California dominate the fresh production market. California captures the early markets, while Oregon and Washington captures the later season markets. Organic imports from Chile, the main offshore supplier, are declining for the fresh market due to a new insect pest, european grapevine moth (*Lobesia botrana*), and the resulting fumigation requirement. Thus, more organic blueberries in Chile are being diverted to processing (primarily to the individually quick frozen category) and that product is competing directly with U.S. frozen products. Shipments of fresh organic blueberries in the United States (domestic plus import) have increased from 0.5% of all fresh blueberry shipments in 2008 to 4.4% in 2013, signaling that fresh organic blueberry sales are growing faster than conventional (Granatstein, 2015). Similar data are not available for frozen products, but industry sources suggest that demand continues to outstrip supply (A. McErlich, personal communication). In western Washington, organic growers reported that direct sales of blueberries ranged from 7% to 50% of total blueberry sales from 2009 to 2012 (Brady et al., 2015). In contrast, direct sales reported by eastern Washington producers were less than 1% in all years. Thus, growers in eastern and western Washington are accessing very different marketing channels. In addition, the Washington blueberry industry provides both fresh and processed blueberry products, with eastern Washington focusing mostly on fresh blueberries and western Washington being more processing intensive.

Prices for both fresh and processed blueberries in Washington and Oregon have increased since 2005, along with dramatic increases in production (Granatstein, 2015). However, prices appear to have become more volatile than what was considered normal in the previous decade. Organic price data are limited, but some are collected by the USDA Agricultural Marketing Service for both shipping point and retail venues. Fresh organic blueberry prices at the shipping point were 27% and 35% higher than conventional in 2014 for California and Washington, respectively (Granatstein, 2015). Retail fresh organic blueberry prices nationwide were 25% and 49% higher than conventional in 2013 and 2014, respectively. Recent prices for organic freezer blueberries have been twice or more of those for conventional berries. Using the Oregon blueberry budgets created by Julian et al. (2011a, 2011b) as an example, price, gross revenue per acre, and net profit per acre for organic were 30%, 30%, and 125% higher than conventional, respectively. Industry experts stated that retailers have narrowed the price difference between organic and conventional blueberries and have seen a marked growth in sales as a result. Reliable supply of organic fruit is often a constraint, however.

Conclusion

Opportunities. Blueberry production in Washington is expected to continue to expand, especially under organic management. There are opportunities for organic growers to succeed in both western and eastern Washington, but they will need to use different business strategies. Direct marketing adds value; however, many of the farms in western Washington selling through this channel appear to suffer from low yields. Yields and profitability of organic blueberry growers in western Washington may be improved through targeted research and grower outreach on ways to increase production within the region. Their cost structure may be quite different from large-scale producers and a better understanding of these differences would be helpful. Large-scale organic blueberry producers are enjoying strong fresh and frozen markets and the rate of expansion within this industry as measured by increasing acreage suggests that technical hurdles to production are being overcome. Demand for processed organic blueberries has been as strong as fresh organic blueberries and both have large price premiums. In such a case, the processed market

can provide a floor price for the fresh market that maintains economic viability. Some growers, both organic and conventional, are planting strictly for the processing market by designing their systems for mechanical harvest and calculating that lower labor costs will compensate for the lower prices often associated with processed fruit. By decoupling from the reliance on human labor for harvesting, blueberry growers should also be able to reduce risk associated with the limited availability of labor. There is also optimism that current research efforts on machine harvesting technologies for fresh-market blueberries will enable growers to achieve the benefits of mechanization and reduced reliance on labor, while achieving fruit with fresh-market quality. Mainstream retailers have embraced organic produce, including blueberries, and addressed the previous price barrier that rendered organic produce too expensive for many consumers. Some of these retailers (e.g., Costco Wholesale, Issaquah, WA) will carry only fresh organic blueberries during certain periods if they secure a reliable, high-quality supply.

The semiarid regions in Washington and California provide a more amenable production environment for organic blueberries with regard to diseases and pests. In addition, growers in these areas can more consistently provide high-quality fruit to markets, which is especially important for fresh sales. Growers in these regions are expected to remain the leaders for organic production. More organic production is expected from similar climatic regions in countries such as Chile, Argentina, and Mexico, which will help fill the winter market niche, but could also create additional frozen supply and influence frozen prices. In general, industry leaders in the United States expect strong prices for both organic and conventional blueberries for another 5 to 7 years, despite the continued growth in production output and new acreages being planted.

Challenges. The foreseeable future of organic blueberry production in Washington will depend on growers' ability to control new invasive pests, such as SWD and the brown marmorated stink bug (*Halyomorpha halys*), changes in the organic regulations that would have a major impact on production practices or costs (e.g., loss of sulfur burners to adjust irrigation water pH), and increased environmental stress from climate change that would necessitate production adjustments (e.g., cooling systems and shade cover). The entire Washington blueberry industry will also face continued infrastructural challenges related to their ability to fresh-pack and process fruit, as the current in-state capacity is limited and production continues to expand.

Despite these challenges, the overall Washington blueberry industry has many strengths including a knowledgeable and experienced grower base, the support for continued research and promotion through the Washington Blueberry Commission and other allied commissions in the PNW, and collaborative partnerships among researchers, extension specialists, private crop consultants, and growers. By embodying the twin attributes of "superfood" status and the increased interest in organic products (both driven by health concerns), organic blueberries have lower market risk in the medium term than many other crop choices.

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