From Acta Hort 1137:307-313. 2016.

An analysis of yields, revenues, and prices for select organic fruits and vegetables in Washington State, USA

D. Granatstein[1], E. Kirby[1], and M. Brady[2]
[1]Center for Sustaining Agriculture and Natural Resources, Washington State University, Wenatchee, WA USA
[2]School of Economics Sciences, Washington State University, Pullman, WA USA

Keywords: organic yields, vegetables, blueberry, apple, pear

Abstract

As demand for organic fruits and vegetables continues to grow in the USA, growth in domestic supply has not kept up. This has led to an increase in the organic premium that is generating interest from potential new entrants into organic farming. However, many of them, particularly those that have no background in farming, lack the financial information to evaluate this production option. A study of actual sales and production by certified organic farms in Washington State, USA, showed a wide range in organic horticultural crop yield in comparison with conventional. Crops such as juice grapes and onions yielded as well as or better than the conventional benchmark, while raspberries, hops and snap beans yielded much less. Yield, price, and revenue varied by crop, grower size, market channel, and geographic region. For blueberry, organic yields in central Washington were higher than in western Washington and appeared comparable to conventional yields. Also, simple nonparametric methods were used to characterize yield and price distributions, in contrast with average values used in most published comparisons of organic and conventional yields. The study also estimated the statewide farmgate value of specific organic horticultural crops for the first time.

INTRODUCTION

Organic agriculture continues to expand worldwide. Consumer demand has pushed global sales of organic products to $70 billion as of 2013 (Sahota, 2015). Retail organic food sales have been growing at 10-11% per year in the USA (OTA, 2014) and 6% per year in Europe (Willer and Schaak, 2015). In 2013, fruits and vegetables accounted for 34% of all USA organic food sales and grew at a 15% annual rate (OTA, 2014). With this continued demand growth, food companies are reporting shortages for many organic foods, signaling an opportunity for producers to enter organic production, or expand their production if they are already involved. One barrier to growth of production is the general lack of reliable data on organic yields, production costs, and commodity prices such that a prospective grower can rationally assess the organic option. To address this, a study of sales, production, and area was undertaken for Washington State certified organic producers to generate data on these economic factors and make them available for public use.

METHODS

The authors collaborated with the Washington State Dept. of Agriculture Organic Food Program (OFP) to analyze four years (2009-2012) of sales and production data as reported by certified producers, along with the associated area of production of specific crops. The OFP certifies over 90% of the certified growers in the state. Growers report their gross sales and their production (e.g., kg sold) each January for the previous year. The project started in 2013 and aimed to capture 3-4 complete years of data. A number of crops are reported over several years of sales which complicated the analysis. These data were entered into a spreadsheet by farm and year along with the area of production for the given crop. Sales over multiple years for the same harvest (for example, apples) were tracked in order to link value to the original production quantity. Analysis focused on horticultural crops (apple (*Malus* x*domestica*), pear (*Pyrus communis*), sweet cherry (*Prunus avium*), berries, grape (*Vitis vinifera*), sweet corn (*Zea mays*), green pea (*Pisum sativum*), snap bean (*Phaseolus vulgaris*), potato (*Solamum tuberosum*), onion (*Allium cepa*), carrot (*Daucus carota ssp. sativa*), and hop (*Humulus lupulus*), and is still underway for several. For those completed crops, aggregate values were calculated to determine statewide totals [e.g., for blueberry (*Vaccinium corymbosum*), total hectares, total kg of production, total farmgate sales] for 3-4 crop years.

Aggregate: area (A, in hectares), production (Q, in kg, metric tons, etc.), sales (S, in $)

- e.g. Total state sales $AgS = S_{grower1} + S_{grower2} + \ldots S_{growerN}$

Next, two different methods were used to calculate yield, price, and gross revenue per hectare. The first was 'market average', which divided one aggregate value (e.g. production) by another (e.g. hectares) to derive yield (e.g., kg ha^{-1}). This method is 'self-weighting' and delivers values more representative of the larger producers. These results are also most comparable to those developed by the USDA National Agricultural Statistics Service (NASS).

Market Average: yield (MAY), price (MAP), gross revenue per hectare (MAR)

- e.g. MAR ($ per hectare) = AgS/AgA

The second method calculated 'grower average' by first calculating the value for an individual farm, and then calculating the average of those values.

Grower Average: yield (GAY), price (GAP), gross revenue per hectare (GAR)

- e.g. GAY (kg ha^{-1}) = $(Q_{grower1} / A_{grower1} + \ldots Q_{growerN} / A_{growerN})/N$

More details on the methods and the difference between market average and grower average can be found at http://csanr.wsu.edu/data-and-calculations/.

These organic values were compared to available NASS values for the same crop for Washington State, which represented "conventional plus organic", as NASS does not segregate out organic production at this time. Where available, gross revenue per hectare was compared with published cost of production studies for the specific crop to examine potential profitability. Also, organic yields were compared to NASS yields and a yield ratio was calculated by dividing the former by the latter.

All monetary values are US dollars from the year in which they were reported and were not adjusted for inflation.

RESULTS AND DISCUSSION

Farmgate sales value

For the first time, estimates were developed for the monetary value of various organic horticultural crops produced in Washington State. Tree fruit value was dominant (Table 1), accounting for 57% of farmgate sales in 2011 coming from 22% of the certified area. Organic apples alone were worth $121 million that year, equaling 43% of farmgate sales from 16% of the area. Organic tree fruit value increased nearly 70% from 2009 to

2012 despite a 13% decrease in the certified area during this time. Average prices for organic apples increased substantially during this period, along with total volume of organic apples shipped (Kirby and Granatstein, 2015). The other notable growth was for the value of organic berries, driven by rapid expansion of organic blueberry plantings in irrigated central Washington, a new production region. This semi-arid region faces fewer pest and disease problems and has become a leading national shipper of fresh organic blueberries (Brady et al., 2015). Organic blueberry production in the state tripled from 2009 to 2012, reaching 5.4 million kg. Production is expected to increase due to many newly planted hectares coming into production. Organic blueberry share of all blueberries in the state was 12% of hectares, 17% of production, and 23% of sales in 2012, illustrating the value-added nature of the organic sector.

Table 1. Reported certified organic horticultural crop category farmgate sales in Washington State, USA.

Crop Category	2009	2010	2011	2012
	Million $			
Berry	7.60[a]	12.23	19.14	25.38
Grape	3.53	5.82	5.66	5.86
Tree fruit	103.83	123.10	161.38	>174.40[b]
Vegetables	31.59	32.21	35.90	>37.63[b]
Total	146.54	173.32	222.08	>243

[a]Values are for actual sales in the designated year, but may be from a previous year crop that is sold over multiple years.
[b]Not all sales data for these crops in 2012 were available.

Market averages and grower averages

Results from the calculations of market average and grower average are presented for blueberry as an example (Table 2a, b). The organic market average yield is lower than the NASS yields for all blueberries in the state, except for 2012. The organic grower average yield is consistently below the market average yield, indicating that smaller growers are not achieving yields as high as larger, presumably more commercial and specialized growers. Western Washington growers tend to have a smaller organic blueberry production area (mean of 5.1 ha) compared to central Washington growers (mean of 42.7 ha), and the distribution of yield observations between the two regions is very different (Fig. 1). While both regions have some low yield observations related to unidentifiable immature plantings, over 80% of western Washington yield observations were 4 t ha^{-1} or less. In contrast, about 40% of yield observations for central Washington were above 8 t ha^{-1}. Yield potential for central Washington, for both conventional and organic management, is estimated to be 22 t ha^{-1} or greater (Washington Blueberry Commission, unpublished data). Typical yield for blueberry in full production in the Willamette Valley, Oregon, a region similar to western Washington, is considered to be 18.2 t ha^{-1}, and a multi-year field study found no difference between organic and conventional yields (Julian et al., 2011a, b). The 4-year NASS average yield for all blueberries in Washington was 9.45 t ha^{-1} (Table 2a), lower than the Oregon yield presumably due to the immature plantings in Washington. The ability to look at distributions of actual farm yields over multiple years provides more insight into potential production than simple averages or results from a single side-by-side study, and this is a unique aspect of the analysis presented here.

Organic grower average blueberry prices were somewhat greater than market average (Tables 2a, b). The data were segregated by geographic region, and the grower average prices were 6.34 kg^{-1} for western Washington and 4.99 kg^{-1} for central Washington. Western Washington growers were more likely to sell via direct market channels (data not shown) where they can command a higher price. However, this higher price did not compensate for the lower yields in western Washington, resulting in lower gross revenue per hectare for western Washington ($16,509 ha^{-1}) compared to central Washington ($37,781 ha^{-1}). Thus, research to help western Washington growers increase their marketable yields should be a priority.

Table 2a. 'Market average' yield, price and gross revenue per acre for Washington blueberry.

	Organic				NASS-WA[1]			
Market Average (MA)[2]	2009	2010	2011	2012	2009	2010	2011	2012
Yield (kg ha^{-1})	6,848	7,663	6,103	10,764	9,128	9,072	9,779	9,824
Price ($ kg^{-1})	5.02	3.65	5.32	4.29	1.72	2.86	4.40	2.68
Revenue ($ ha^{-1})	34,854	27,652	32,350	45,851	15,707	25,965	43,050	26,367

Table 2b. 'Grower average' yield, price and gross revenue per acre for Washington organic blueberry. Adapted from Brady et al., 2015.

	Organic				Organic 4 Year Summary			
Grower Average (GA)[2]	2009	2010	2011	2012	Average	Median	S.D.[3]	n[4]
Yield (kg ha^{-1})	5,746	4,833	4,201	5,805	5,093	2,852	5,236	118
Price ($ kg^{-1})	5.74	5.59	6.40	5.32	5.79	5.19	2.86	114
Revenue ($ ha^{-1})	28,771	23,220	22,008	25,809	24,678	15,410	24,421	125

[1]conventional plus organic; [2]composite of processed and fresh market blueberries; [3]S.D. = standard deviation; [4]n=number of observations.

The Oregon study (Julian et al., 2011a, b) estimated that organic blueberry production costs at maturity were about 10% greater than conventional, assuming the same yield level. Hand picking accounted for approximately 53% of the total costs of $48,350 ha^{-1}. The grower average revenue for central Washington shows more potential to cover total costs than that of western Washington. Cost of production studies are planned for eastern Washington blueberry production which will help define the economics of this system, including costs unique to this region such as soil and water acidification and crop cooling.

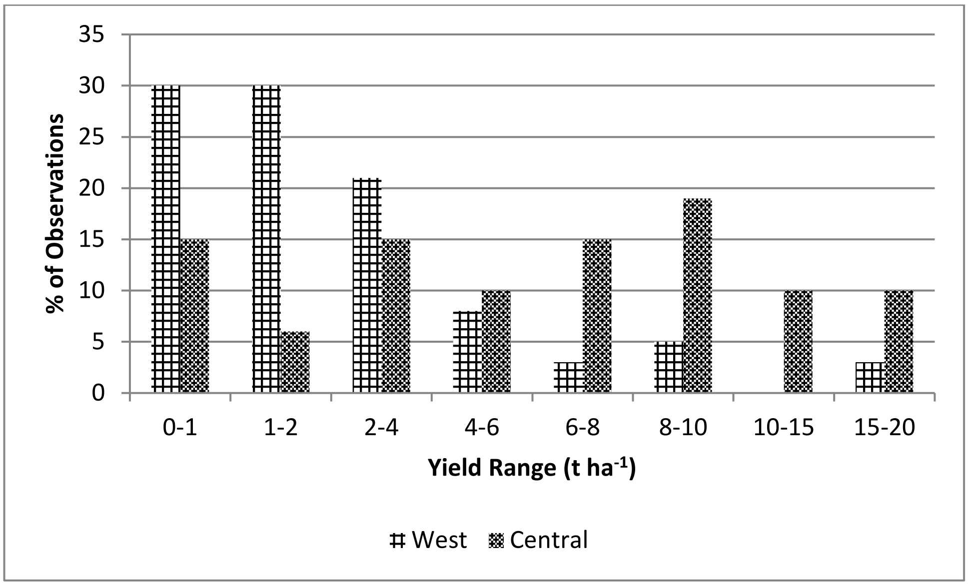

Figure 1. Distribution of organic blueberry yields (t ha^{-1}) for western and central Washington, 2009-2012.

Organic crop yield estimates

As stated above, the dataset used in this study allowed for examination of yield variability, as well as calculation of mean yields. The organic market average yield for 13 horticultural crops was estimated and compared to the NASS yield data for the same crop for all of Washington production. A yield ratio was calculated by dividing the organic yield by the NASS yield, for each of four years (Table 3). Yield ratios spanned a wide range, with certain organic crops such as juice grapes and onion yielding the same as or better than NASS (conventional plus organic). Other organic crops such as hops, raspberry (*Rubus idaeus*), and snap bean had much lower yields and could be targets for research to increase productivity. Several recent meta-analyses of organic versus conventional yields found the yield ratio to be 0.75-0.85 across all crops, with considerable variation depending on the type of crop (Badgley et al., 2007; de Ponti et al., 2012; Seufert et al., 2012; Tuomisto et al., 2012; Ponisio et al., 2015).

Table 3. Yield ratios of Washington organic horticultural crops (organic market average yield divided by NASS yield for all Washington State).

Crop	**2009**	**2010**	**2011**	**2012**	**Average**
Apple	0.90	0.92	0.79	--	0.87
Pear	0.69	0.72	0.63	--	0.68
Cherry, sweet	0.75	0.67	0.64	--	0.68
Grape, juice	1.08	1.24	1.43	0.94	1.17
Blueberry	0.75	0.85	0.62	1.10	0.83
Raspberry	0.36	0.28	0.36	0.78	0.45
Corn, sweet	1.11	0.76	0.72	0.72	0.83
Pea, green	0.85	0.91	0.70	0.68	0.78
Bean, snap	0.75	0.50	0.61	0.48	0.59
Potato	0.68	0.63	0.69	0.70	0.68
Onion	0.91	1.20	0.98	0.93	1.01
Carrot	1.15	0.93	0.82	0.92	0.96
Hops	0.39	0.32	0.24	0.49	0.36

For the major vegetable crops analyzed, the yield distribution varied by crop and was either bi-modal or left-skewed (data not shown). This suggested quite different yields depending on the nature of the operation, with smaller farms having lower yields for certain crops (e.g., onion, carrot, potato) but similar or higher yields for others (e.g., green pea, sweet corn). Thus, relying simply on mean values may be problematic. More complex presentation of results, such as histograms, may be more useful for individual grower decision-making.

The academic literature on comparing organic and conventional crop yields focuses on mean values (Badgley et al., 2007; de Ponti et al; 2012; Seufert et al., 2012), which the results reported here call into question. The evidence for conventional crops is that yield distributions, even before accounting for various sources of variability, are either Normally distributed, or are very close to it (Just and Weninger, 1999; Atwood et al., 2003). Given the diversity of organic operations, this assumption may not hold, as our findings suggest. The difference is important when considering how individual farm level decisions in terms of entry, exit, and growth drive aggregate trends. When possible, studies should consider using statistical methods to compare yield distributions rather than just differences in mean values. The Kolmogorov-Smirnov test is a nonparametric approach that could be used to compare conventional and organic yield distributions unconditionally. If observations are taken over a heterogeneous environment and data describing these differences are available then quantile regression should be considered. We did not include either of these results in this paper because the yield distributions are clearly not Normal. Also, we do not have a set of conventional yield observations to compare against. This analysis is planned for future research where we have access to farm-level yield observations for conventionally grown crops.

Profitability

For those crops where market and grower averages were calculated, organic prices were consistently higher than the NASS prices reported. In many but not all cases, this led to higher gross revenue per hectare. Whether this resulted in increased profits was not clear, since no organic cost of production studies for the state were available. Studies such as that from Oregon were used as proxies where possible, and interpolation from Washington conventional crop budgets was attempted in several cases. For some crops such as onion, where growers were achieving high yields and receiving large price premiums, organic production did appear to be a more profitable choice despite known higher costs for weed control and fertility inputs. For example, 2011 production costs for conventional onions were estimated to be \$11,230 ha^{-1} (indexed from Hinman and Pelter, 2004). Assuming 20% higher production costs for organic and a yield of 70.7 t ha^{-1}, the breakeven cost would be \$190 t^{-1}, compared to the organic market average price of \$290 t^{-1} calculated from the grower data. Organic green peas for processing were estimated to have a breakeven price of \$0.44 kg^{-1}, compared to the 4-year range of market average prices from \$0.44-0.55 kg^{-1}, considerably higher than the NASS Washington prices for the same period of \$0.24-0.31 kg^{-1}.

CONCLUSION

Good data are critical for making good business decisions. The analysis described here developed information about organic yields, prices, and revenues to help growers evaluate organic production. Many organic crops appear to yield less than the conventional counterpart. Research to address key production barriers in organic systems and improve yields would be helpful. More cost of production studies are needed to provide this missing link so growers can do their own profitability and risk analysis and determine whether entry into organic production might be a viable option for them. Such information could serve as an important inducement to expand the domestic production of many organic foods during a time of growing demand and insufficient supply. This, coupled with current assessments of plantings, crop condition, and other statistics as is done for conventional production, would enable a more orderly expansion of organic supply over time and help maintain organic as a value-added enterprise.

ACKNOWLEDGEMENTS

The authors wish to thank the Washington State Dept. of Agriculture for their collaboration on this project. Support for this work came from a WSDA Specialty Crop Block Grant and a WSU BIOAg research grant.

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