Are WTP Estimates for Fruit Quality Similar between Growers and Consumers? Results of a Choice Experiment on Four Rosaceous Fruit Crops

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Abstract

WTP research is typically applied to consumer groups. Scant applied economics research has been done to elicit producers' preferences and values for fruit quality, despite the important role producers play in the supply chain, as they take the financial risk to invest in a promising cultivar, making it accessible to the consumer in the marketplace through a sometimes complex supply chain. Our results show evidence that fresh market fruit producers are generally aligned with consumer preferences, as flavor and textural components were consistently given the highest WTP value among other fruit quality characteristics. However, market intermediaries (e.g., shippers, packers, marketers) do not exhibit the same preferences across all crops. The specific economic valuation placed by growers, market intermediaries, and consumers on individual attributes can now provide breeding programs more specific information to evaluate the fruit quality trait, and the targeted levels for that trait, within their programs.

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Introduction

A plethora of studies in agricultural economics have been conducted to estimate consumers' willingness to pay (WTP) for different aspects of food quality, including eating quality of fresh fruits. In order to better inform plant breeding programs in their goal of developing improved fruit cultivars, it is critical to have input from the entire supply chain. In most instances, plant breeding programs obtain input from what they perceive is their immediate clientele, industry groups. However, there is a perception that, supply chain members' viewpoints for a successful cultivar do not necessarily coincide, and in particular that there is not agreement between lower level supply chain members and final consumers' desires (Gallardo et al., 2012; Yue et al., 2012). Plant breeding programs typically seek to develop and commercialize cultivars that are efficiently managed, productive, and yield high quality products. Knowledge of the relative values of fruit traits to different supply chain members can greatly contribute to improving breeding programs' efficiency, by enabling breeders to focus on improving traits most valued by the entire supply chain.

As the initial link in the supply chain, growers face risks when adopting and diffusing a new cultivar. Adopting new cultivars is a risky decision for fruit growers due to the upfront investment costs to establish and manage their operation until returns start accruing. They run the risk of an unexpectedly long payback period or even a loss on the investment. Therefore, growers have an incentive to provide direct and effective input to relevant breeding programs

and improve their opportunities to choose cultivars most suited to their specific environmental and market conditions (Yue et al., forthcoming).

Besides growers, a continuum of distinct links in the supply chain (i.e., market intermediaries) ---packers, shippers, processors, and marketers---make critical economic decisions and also assume risks when handling a new fruit cultivar. Packers receive, clean, sort, and grade fruit for a range of attributes, making sure their product is packed to meet market specifications and applicable government regulations. Depending on the crop, they store their fruit from short- to long-term and strive to retain critical quality characteristics that permit shipment at opportune market times. Packers place fruit in containers that minimize damage during handling and transporting, while shippers transport and deliver the fruit to locations designated by customers under conditions that maintain appropriate quality standards. Processors provide fruit to their customers in varied and convenient forms: fresh-sliced, frozen, juice, sauce, dried, etc. (Gallardo et al., 2015).

As end-users, consumers are the supply chain members whose preferences and values must be considered by the other members of the supply chain (i.e., growers and market intermediaries), to guarantee successful commercialization of improved fruit cultivars. Grower and market intermediaries' investment decisions must be consistent with consumer preferences and values in order to successfully commercialize their fruit products and to guarantee the economic sustainability of their businesses.

Most previous studies have focused mostly on consumer preferences and scant research focuses on grower and market intermediary WTP elicitation (Yue et al., forthcoming; Gallardo et al., 2015). Yue et al. (2012) and Gallardo et al. (2012) found that one challenge faced by breeding programs is the lack of consensus across interested parties or supply chain groups when

establishing trait priorities. This study attempts to integrate previously obtained information on the growers', market intermediaries' and consumers' WTP for traits of four rosaceous fruit crops widely grown and widely consumed in the United States: apple, peach, sweet and tart cherry, and strawberry.

The objective of this study is to compare and contrast WTP results from different supply chain members (i.e., growers, market intermediaries, and consumers) for a set of internal and external fruit quality traits for four rosaceous fruit crops destined for the fresh market: apple, peach, sweet cherry, and strawberry. This study is based on the following previous studies, Yue et al. (forthcoming), Gallardo et al. (2015), Choi et al. (unpublished), Wang et al. (forthcoming), and Zheng et al. (forthcoming). These studies studied the same set of fruit crops, apple, peach, sweet cherry, and strawberry for the fresh market. In most instances the set of attributes and attribute levels considered for each fruit crop is consistent across growers, market intermediaries and consumers. We anticipate that results from this study will provide insights to fruit breeding programs and other interested parties on the divergence of supply chain viewpoints based on elicited values for fruit quality attributes.

Methodology

Data collection

Surveys in both mail and online formats were used to collect data from growers and market intermediaries. The grower survey was conducted between February and June 2012. The market intermediary survey was conducted from April through August 2011. For the grower survey, a representative mailing list of fruit growers (e.g., apple, peach, strawberry and sweet cherry) was obtained from Meister Media, a company who runs popular media magazines

tailoring the fruit industry. The sample represented major producing states, for example, apple growers were sampled from the top five apple producing states including Washington, New York, Michigan, Pennsylvania, and California. The list of U.S. market intermediaries came from different sources, including Blue Book Online Services (a credit and marketing information agency serving the international wholesale produce industry), Washington Apple Commission, Cherry Marketing Institute, and Yakima Valley Growers' and Shippers' Association.

To mitigate non-response bias from growers and market intermediaries, we used the Dillman total design protocol –survey, then reminder card, and then survey- (Dillman et al., 2009), and included a $4 incentive along with the survey and cover letter. Every mailed envelope included a card with the survey URL and a personal access code for respondents who would prefer to respond to the survey online. For this analysis, we include the survey results for growers, market intermediaries, and final consumers for four crops destined to be sold in the fresh market (i.e., apple, sweet cherry, strawberry, and peach). Of the 2578 grower surveys sent, we received 845 completed surveys (817 of the completed surveys were sent by mail and the remaining 28 were completed online). Across all crops, we obtained a 33% response rate for growers. Of the 937 market intermediary operations on the sampling frame, 201 completed the survey (140 of the completed surveys were sent by mail and the remaining 61 were completed online). Across all crops, a 21% response rate was obtained for market intermediaries. More detail on the grower and market intermediaries surveys can be found at Yue et al. (forthcoming) and Gallardo et al. (2015).

The consumer survey data were collected in October 2013. The survey was online only, and was implemented via Qualtrics™, a professional survey company who possess an extensive database of consumers. The selection criterion to participate in this survey was if respondent had

consumed apple, strawberry, peach, or sweet cherry in the past year. Only those who answered affirmatively were enabled to continue and finalize the survey. The consumer data were collected over a two-week period, from the last week of November to December 6th, 2013. In total, due to incomplete responses, out of 1,000 surveys sent, we used 801 apple consumer surveys, 795 peach surveys, and 743 sweet cherry surveys. Out of 1,500 strawberry surveys sent, 1137 were used. More information about the consumer survey can be found at Choi et al. (unpublished), Wang et al. (forthcoming), and Zheng et al. (forthcoming).

Surveys for all crops and for each supply chain group were designed to include questions as consistent as possible across groups, with variations in questions as appropriate for the crop and the supply chain stakeholders. In general, all surveys included a section with the discrete choice experiments and questions about socio-demographic information. In general, the discrete choice scenarios section presented eight scenarios depicting a situation for producing/procuring/consuming the fruit of interest. Each scenario was composed of two choice options (A and B), each representing different combinations of fruit quality traits and production/handling cost or price levels. Respondents were asked to choose one option from each choice set. If neither option was of interest, respondents could choose a "neither" option (labeled as C). For more information on the detailed survey questionnaire across all supply chain groups, see Yue et al. (forthcoming), Gallardo et al. (2015), Choi et al. (unpublished), Wang et al. (forthcoming), and Zheng et al. (forthcoming).

The scenarios included six fruit quality traits and were selected in consultation with fruit breeders, industry leaders, and fruit business representatives. Each fruit quality trait and cost had two different levels. We used a main effect fractional factorial design to choose sixteen options from the remaining set. The selected options were paired (Options A and B), and Option C was added to each of the eight choice sets. Table 2 includes a list of all attributes and their levels

included in each survey version for growers, market intermediaries, and consumers. Each attribute has two levels, one level generally better than the other. We tailored the descriptions for the attributes and their levels to the consumer, market intermediary, and grower groups surveyed. Tables 1-4 present the quality traits and their levels used in the choice experiment, across supply chain groups. Note that for the grower and market intermediary survey, attributes were in general described by technical measurements, while in the consumer survey, non-technical expressions and visual pictures were adopted to make it easier for consumers to understand. All levels of attributes (including price/cost) were pre-tested with a small group of consumers/growers/market intermediaries before we finalized the surveys and collected the data.

Data analysis

Choice experiments were employed to elicit grower, market intermediary and consumer WTP values for improved quality traits of the fruits included in this study. The theoretical basis of choice experiments is random utility theory and Lancaster's consumer demand theory that assumes consumers derive utility from attributes of a good rather than from the good itself (Lancaster, 1966). Lusk and Hudson (2004) argued that the WTP, which is almost always discussed within the context of utility maximization of consumers, could also be extended to growers. We hypothesize that both growers and market intermediaries derives utility from their decision to invest in a new fruit cultivar, and hence their WTP is their willingness to invest in growing and/or handling the new fruit cultivar considering production and handling costs. Some cultivars with certain attributes require more variable inputs (such as labor and chemicals) while others might be easier to produce or handle and hence lower variable inputs.

Suppose a choice set has M alternatives ($j = 1, 2,..., M$). For each individual responding

to the survey i (i = 1, 2,..., N) the utility derived from the j^{th} alternative, U_{ij} can be represented as:

$$U_{ij} = \alpha Z_j + \varepsilon_{ij} \quad (1)$$

where Z_j is the deterministic component that includes the set of quality traits for each crop group and the cost of handling/storing fruit or retail price for the fruit, and ε_{ij} captures the unobserved characteristics of the crop group or respondents which are not included in Z_j. The term ε_{ij} is usually unknown and is treated as a random component. The assumption is that among the M alternatives, the individual would choose the alternative j if and only if the alternative j *is expected to* maximize their utility. Let Y_i be a random variable whose value indicates the choice made by firm i. The probability that individual i would choose alternative j is:

$$Pr(Y_i = j) = \Pr\left(\mathrm{U}_{ij} > \mathrm{U}_{ik}\right) \quad for\ all\ k = 1,2,\dots,M\ ;k \neq j \quad (2)$$

Different assumptions on the error term lead to different model setups (e.g., conditional logit, mixed logit, heteroskedastic extreme value, among others). In general, for grower and consumer empirical models, parameter estimates were calculated using the mixed logit model specification (Yue et al., forthcoming; Choi et al., unpublished). For the market intermediaries for apples the heteroskedastic extreme value (HEV) model was used, for peach and sweet cherry the mixed logit model and for strawberry the conditional logit model (Gallardo et al, 2015). In depth information on the empirical specification used in each survey group can be find in Yue et al. (forthcoming), Gallardo et al. (2015), Choi et al. (unpublished), Wang et al. (forthcoming), and Zheng et al. (forthcoming). The WTP values reported in these above studies provided the data for this study in which we quantify in an ordinal manner supply chain members' preference ordering or ranking for the quality traits presented in the discrete choice scenarios. To evaluate differences among preference ranking for quality traits across supply chain groups, we conducted

a non-parametric Wilcoxon test. Specifically, we conducted pairwise Kruskal-Wallis tests, in which for example, preference ranking for quality traits from consumers was compared to preference ranking from producers; preference ranking from consumers was compared with preference ranking from market intermediaries' and so on. The test was computed in SAS® 9.3 using the Npar1way procedure.

Results and discussion

Parameter estimates for each model specification across crops and supply chain groups are reported in Yue et al. (forthcoming), Gallardo et al. (2015), Choi et al. (unpublished), Wang et al. (forthcoming), and Zheng et al. (forthcoming). In this paper, we present a summary of the WTP estimates for quality attributes for each fruit and each supply chain group (Tables 5-8). In general across the four crops studied we observed that consumers were willing to pay a price premium for flavor and textural components over fruit appearance traits. For apples, consumers were willing to pay the highest premium for crispness and flavor compared to external appearance, shelf life, and size. For peaches, consumers were willing to pay the highest premium for sweetness and flavor compared to external appearance and size. For sweet cherry, consumers were willing to pay the highest premium for sweetness and flavor compared to size and external color. Different from the other crops, for strawberries, consumers were willing to pay the highest premium for internal color, followed by flavor, and external color.

In general, market intermediaries were willing to pay the highest price premiums for quality traits that would impact handling (e.g., firmness, shelf life) or aligned with traits in U.S. grades and standards (e.g., size, appearance). Specifically, for apples, market intermediaries were willing to pay the highest price premium for shelf life, size, firmness, and appearance. For peaches, market intermediaries were willing to pay the highest prices for firmness and size; for

strawberries, flavor, firmness and size were most highly valued. In contrast to the other crops, market intermediaries for cherries were willing to pay the highest price premium for shelf life, sweetness, and flavor.

For growers, response was mixed across crops. In general, growers expressed a tendency to pay the highest price premiums for consumer-oriented traits (e.g, flavor and textural traits). Apple growers were willing to pay the highest price premiums for shelf life, flavor and crispness. Peach growers were willing to pay the highest price premiums for flavor, external color, and external appearance. Sweet cherry growers were willing to pay the highest price premiums for size, flavor, and firmness; whereas strawberry growers were willing to pay the highest price premiums for flavor, firmness, and external color.

Results from the non-parametric Wilcoxon test are presented in Table 8. For all four crops included in this study, growers' preferences were aligned with consumers; as there were no statistically significant differences across preference rankings for quality traits. This was different from when comparing preference rankings between market intermediaries and consumers. Preference rankings of apple and peach traits were not statistically different between market intermediaries and consumers, but they were for sweet cherry and strawberry. Note that sweet cherry and strawberry had the shorter storage periods compared to peach and apple. Interestingly, preference rankings for all crops were statistically different between growers and market intermediaries.

Conclusions

Considerable research has been conducted to estimate consumers' WTP premium prices for different quality attributes for food products. Comparatively, little research has been done to

estimate other supply chain groups (e.g., grower and market intermediary) WTP for quality attributes of food. Comprehensive supply chain information on WTP for different fruit quality traits could be useful to breeding programs to improve the efficiency of developing breakthrough cultivars by focusing time and funding resources on traits of maximum value to the entire supply chain. Previous studies concluded that one challenge faced by breeding programs is the lack of consensus across interested parties or supply chain groups when establishing trait priorities. In this study we compare WTP values from growers, market intermediaries, and consumers for quality traits of four fresh market fruits: apple, peach, sweet cherry, and strawberry. All WTP information was obtained from previous studies by these authors. We found that growers were more aligned with consumers' preferences compared to market intermediaries. Also, growers were not aligned with market intermediaries when ranking preferences for different quality traits. Market intermediaries for apples and peaches were consistent with consumers ranking preferences, whereas sweet cherry and strawberry market intermediaries were not consistent with consumers ranking preferences. Finally, ranking preferences across growers and market intermediaries were not consistent at all. This study provides evidence of the lack of consensus across supply chain groups grower and market intermediaries, when establishing quality traits priorities for a successful new cultivar. This complex situation merits further research in order to provide breeding programs cohesive and precise information on the ultimate values assigned to fruit quality traits across supply chain members.

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Table 1. Quality traits levels used in the grower, market intermediary, and consumer survey for fresh apples.

Attribute	Attribute level		
	Grower	Market intermediary	Consumer
Flavor	Weak (mild)/full (intense) flavor	Weak (mild)/full (intense) flavor	Mild/intense
Size	Less/more than 2.9 inches (100 count)	Less/more than 2.9 inches (100 count)	Picture
Firmness	Less/more than 14 lb	Less/more than 14 lb	Moderately firm/firm
Crispness	Not/very crisp	Not/very crisp	Not/very crisp
Shelf life	Poor (less than 1 week)/good (more than 1 week)	Poor (less than 1 week)/good (more than 1 week)	Less/more than 1 week in your refrigerator
External appearance-free of defects	Less/more than 3% per lot	Less/more than 3% per lot	Picture
Total cost of	$24-$12/carton (42	$25-$15/carton (42	$1.39-$2.97/lb

production/storage/handling	lbs)	lbs)

Table 2. Quality traits levels used in the grower, market intermediary, and consumer survey for fresh peaches.

Attribute	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Flavor	Weak (mild)/full (intense)	Weak (mild)/full (intense)	Mild/intense flavor
Size	80-56/50 and larger	80-56/50 and larger	Less than 2.5/more than 2.75 inch diameter
External color	Desirable (cream/yellow) background color with a red blush color/Non desirable (lack of skin blush/color)	Desirable (cream/yellow) background color with a red blush color/Non desirable (lack of skin blush/color)	Picture
Firmness	Less/more than 10 lb	Less/more than 10 lb	Soft/firm
Sweetness	Low (less than 11	Low (less than 11	Low/high

	Brix)/high (more than 11 Brix)	Brix)/high (more than 11 Brix)	
External appearance-free of defects	Fair (<70% packout)/Good (>85% packout)	Fair (<70% packout)/Good (>85% packout)	Picture
Total cost of production/storage/handling	$11-$13.75/box (25 lb)	$11-$13.75/box (25 lb)	$1.69-$2.11/lb

Table 3. Quality traits levels used in the grower, market intermediary, and consumer survey for sweet cherry.

Attribute	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Flavor	Weak (mild)/full (intense) flavor	Weak (mild)/full (intense) flavor	Mild/intense
Size	11 row or smaller/10 row or larger	11 row or smaller/10 row or larger	Less/more than 1 inch diameter
External color	Light/dark red	Light/dark red	Picture
Firmness	Soft (less than 300 g/mm)/firm (more than 300 g/mm)	Soft (less than 300 g/mm)/firm (more than 300 g/mm)	Soft/firm
Sweetness	Low (less than 18 Brix)/high (more than 18 Brix)	Low (less than 18 Brix)/high (more than 18 Brix)	Low/high

Shelf life	Less/more than 1 week	Less/more than 1 week	Will last less/more than 1 week in your refrigerator
Total cost of production/packing/handling	$40-$45/box (20 lb)	$40-$45/box (20 lb)	$3.29-$3.78/lb

Table 4. Quality traits levels used in the grower, market intermediary, and consumer survey for fresh strawberry.

Attribute	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Flavor	Weak (mild)/full (intense)	Weak (mild)/full (intense)	Mild/intense
External color	Too light or too dark/ideal red color	Too light or too dark/ideal red color	Picture
Firmness	Soft/firm	Soft/firm	Soft/firm
Internal color	Too light or too dark/ideal red color	Too light or too dark/ideal red color	Picture
Shelf life	4/9 days after harvest	4/9 days after harvest	Will last 4/9 days at home in your refrigerator
Size	Less/more than 25 g/fruit	Less/more than 25 g/fruit	Picture

Total cost of production/packing/handling	$1-$1.15/lb	$1-$1.15/lb	$2.65-$2.99/lb

Table 5. Growers', market intermediaries', and consumers' willingness-to-pay (WTP) for apple quality traits

Trait	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Crispness	0.33	0.002	1.99
Flavor	0.40	0.01	1.20
External appearance-free of defects	0.06	0.12	0.89
Shelf life	0.43	0.13	0.52
Size	0.16	0.13	0.09
Firmness	0.13	0.13	-0.05

Table 6. Growers', market intermediaries', and consumers' willingness-to-pay (WTP) for fresh peach quality traits

Trait	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Sweetness	0.15	0.13	1.43
Flavor	0.21	0.01	0.69
External appearance-free of defects	0.19	0.02	0.49
Firmness	0.08	0.19	0.24
External color	0.20	0.06	0.02
Size	0.15	0.18	-0.12

Table 7. Growers', market intermediaries', and consumers' willingness-to-pay (WTP) for sweet cherry quality traits

Trait	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Sweetness	0.40	0.34	1.90
Flavor	0.65	0.31	1.44
Firmness	0.55	0.17	0.97
Shelf life	0.54	0.36	0.75
Size	0.80	0.18	0.60
External color	0.43	0.26	-0.02

Table 8. Growers', market intermediaries', and consumers' willingness-to-pay (WTP) for strawberry quality traits

Trait	WTP ($/lb)		
	Grower	Market intermediary	Consumer
Internal color	0.56	0.06	1.87
Flavor	1.48	0.24	1.10
External color	0.72	0.07	1.07
Shelf life	0.50	0.04	0.76
Firmness	0.76	0.15	0.56
Size	0.27	0.10	0.32

Table 9. Nonparametric pairwise test to compare WTP between supply chain groups

	Kruskal-Wallis test			
	Apple	Peach	Sweet cherry	Strawberry
Grower-market intermediary	0.04[1]	0.09	0.004	0.004
Grower-consumer	0.26	0.34	0.15	0.34
Market intermediary-consumer	0.20	0.23	0.05	0.004

[1] Values represent the Pr > Chi-Square for the Kruskal-Wallis test, and were computed in SAS® 9.3 using the Npar1way procedure.