FINAL PROJECT REPORT

Project Title: Economic analysis of technology adoption by Washington apple growers

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Total Project Funding: $40,404

Budget History:

Item	2009	2010
Salaries		
Benefits		
Wages	15,557	15,558
Equipment	2,111	1478
Supplies	0	
Travel	3000	
Survey	200	
Extension Support	2500	
Miscellaneous		
Total	$23,368	$17,036

STUDY OBJECTIVES

1. *Evaluate the economic and managerial factors that contribute to a grower's decision to adopt automation and mechanization technologies.*
2. *Use the data collected during this project to support other educational programs, decisions aids focused on technology adoption*
3. *Establish a program for continuously collecting production and management data from tree fruit growers*
4. *Disseminate research results to tree fruit growers, packing houses representatives, researchers from other disciplines and interested parties*

SIGNIFICANT FINDINGS

Objective 1: *Evaluate the economic and managerial factors that contribute to a grower's decision to adopt automation and mechanization technologies.*

The following summarizes the results of the 2010 Grower Survey and the subsequent analysis.

- The objective of this study was to survey apple growers to determine the extent of platform use in Washington orchards. The survey sample was randomly selected from the membership of the Washington Apple commission. Of the 765 Surveys that were sent to growers, 41% were completed and returned for analysis.

- Analysis of the data suggests that the use of platforms in Washington orchards is not prevalent. Survey responses suggest that the primary reasons growers give for not adopting platforms are **unsuitable orchard structure**, **high purchase cost**, and **steep grades within the orchard**.

- The presence of unsuitable orchard structures suggests that extensive adoption of platforms will not occur until modern structures are installed on a larger number of acres. Installation of modern orchard structures will also allow for greater efficiency gains from platforms, due to row spacing and 2-dimentional trees. By improving the efficiency of workers using platforms, purchase costs may be recoverable in shorter periods of time.

- The issue of steepness of slopes as a deterrent to platform adoption may not be easily overcome in the near future. Worker safety is a significant consideration for growers and if platforms are less stable on certain terrains than ladders, platform adoption by those growers will not occur.

Objective 2: *Use the data collected during this project to support other educational programs, decisions aids focused on technology adoption.*

In addition to the grower survey of technology adoption, cost of production data were collected for Gala apples to better understand the management decisions of growers. The intention of this activity was to provide information to decisions aids such as the AgProfit and AgFinance. Clark Seavert has used the data from our cost of production study on Gala apples in these decision aids for grower workshops and educational programming. A crop profile based on our Gala budget is available at the AgTools website: http://agtools.org

Objective 3: *Establish a program for continuously collecting production and management data from tree fruit growers.*

The collection of data for the Gala budget was an important step in re-establishing a budget generating process at Washington State University. We now have a standardized budget format and set of questions we ask to create tree fruit budgets. We have also standardized the process for external review of our work within the WSU Extension publications system. Since the first Gala budget in 2009, we have created (or are in the process of creating) budgets for the following crops: sweet cherries, organic Gala apples, Bartlett pears, and Honey Crisp apples. Updating these budgets and creating new budgets is now spearheaded by Suzette Galinato. Her work has been funded by the WTFRC through a 2011 grant.

Objective 4: *Disseminate research results to tree fruit growers, packing houses representatives, researchers from other disciplines and interested parties.*

Dissemination of our research results includes both WSU Extension reports and industry presentations. The following list describes both outlets:

Extension Bulletins, Published (Available at the WSU-SES Extension Economics website: http://extecon.wsu.edu/pages/Enterprise_Budgets

1. Gallardo, R. K., M. Taylor, and H. Hinman. 2009 Cost Estimates of Establishing and Producing Gala Apples in Washington. Washington State University Extension Factsheet FS005E, January, 2010.

Presentations

1. Taylor, M.R. and R.K. Gallardo. "Cost of Production for Washington Tree Fruits," General session presentation, Washington State Horticulture Association Annual Meeting. Yakima, WA, December 6, 2010.
2. Taylor, M.R. and R.K. Gallardo. "Economics, Horticulture, and Technology," Pre-conference workshop presentation, International Fruit Tree Association annual meeting. Pasco, WA, February 26, 2011.
3. Gallardo, R.K. "What does it Cost to Grow Cherries, Gala Apples and Anjou Pears? Recent Grower Based Studies." Presentation given to Sales Personnel – Domex Superfresh Growers. Yakima, WA. February 14, 2011.

RESULTS AND DISCUSSION

Economic Model Estimation

Growers reported that the most common reason for not adopting a platform was that their orchard architecture structure was not suitable. In the data we found a very strong correlation between planar type orchard architecture and platform use. In order to conduct the next portion of our analysis we made the assumption that having planar architecture would be a prerequisite to adopting a platform. Using this as a basis we proceed to answer the following two questions.

1. Which factors impact the adoption of planar type architecture structures?
2. Of those who have planar type structures, what factors impact the adoption of platforms for the orchard?

To answer the first question we used the full data set containing 316 observations. (Tables describing the variables used in the model and the summary statistics are listed at the end of this report.) For the second question, we reduced the data set to those observations that had at least 1 block in some type of planar structure, whether it is angled or vertical. This reduced sample included 106 observations. We estimated a discrete choice probit model, which provides estimates of factors that influence the decision to adopt a technology or not.

Planar Structure Adoption Model

The first model was estimated to determine which factors impact the probability of having planar-type orchard structures. Using the dataset of 316 observations, we found several factors have a statistically significant effect on the decision to use planar structures. Those factors which had a statistically significant effect on the likelihood of **adopting planar structures** were:

1. Orchard size: Larger orchards are more likely to have planar structures. The effect of additional acres on the probability of adopting planar structures is large for small orchards, but diminishes as the orchard size increases.
2. Production of club varieties: Orchards producing club varieties are more likely to have planar structures.
3. Producing organic apples: Orchards with some organic production are more likely to have planar structures.
4. Apple variety: Orchards with some Honey Crisp and Gala production are more likely to have planar structures. Orchards with some red and golden delicious production are less likely to use planar structures.
5. Internet use: Growers who use the internet as an information source for management decisions are more likely to use planar structures.
6. Personal characteristics: Grower education did not have a significant effect on the choice to use planar structures. However, age and race did impact the choice. Grower age affects the probability of planar structure use by decreasing the probability of use as age increases. The probability of using planar structures increases for growers who did not list their race as White.
7. Geographic location: Orchards in the Yakima region are more likely to have planar structures than orchards in the Wenatchee region. Orchards in the Basin region are no more or less likely to have planar structures than orchards in the Yakima region.

Platform Adoption Model

The second model was estimated to determine which factors impact the probability of using platforms. Using the dataset of 106 observations, we found several factors have a statistically significant effect on the decision to use platforms. Those factors which had a statistically significant effect on the likelihood of **adopting platforms** were:

1. Orchard size: Larger orchards are more likely to use platforms. The effect of additional acres on the probability of using platforms is large for small orchards, but diminishes as the orchard size increases.
2. Apple variety: Orchards with some Honey Crisp and Gala production are more likely to use platforms. Orchards with some red and golden delicious production are less likely to use platforms.
3. Geographic location: Orchards in the Yakima region are more likely to use platforms than orchards in the Wenatchee region. Orchards in the Basin region are no more or less likely to use platforms than orchards in the Yakima region.

Economic Model Summary

Results of the model suggest that the factors influencing both the adoption of planar structures and the adoption of platforms are associated with characteristics of both the grower and the orchard. Larger orchards tend to use both planar structures and platforms. This correlation may be due to a larger asset base to work with then it comes to making management decisions. The cost of a platform and/or the cost of replanting a block to a planar structure can be spread out over a larger number of acres and may be more financially feasible than for smaller orchards. The choice of apple variety and the likelihood of adopting platforms and/or planar structures suggest that growers willing to take on risks with newer varieties are also more likely to accept the risks of new technologies. Finally, differences in the use of both planar structures and platforms by geographic region suggests that some orchards are better suited to certain technologies. As mentioned earlier, steep orchard terrain (more commonly found in the Wenatchee region than the other regions surveyed) will deter the use of platforms.

Table 1: General information on platform use

	Average	Range
Years of use	7.4	0 – 50
Number of platforms in orchard	1.3	0 – 4
Number of people per platform	3.8	0 – 10

Table 2: Activities where platforms are used and payment form

Activity	Frequency	Hourly Pay	Piece-rate Pay
Pruning	32	23	7
Training	24	19	4
Green fruit thinning	22	15	5
Trellis construction	16	13	--
Pheromone placement	10	11	1
Blossom thinning	4	3	2
Harvest	2	--	2
Scouting for pests and/or diseases	0	--	--

*Some of the rows do not add exactly because both forms of payment were used on a single orchard.

Table 3: Sources of information for machinery/equipment purchase decisions

Sources rated as "Very Useful"	Frequency
Other growers	188
Field days or farm tours	115
Tree fruit related conferences/workshops	106
Industry publications	99
WSU extension/research	88
Family members	87
Company selling machinery/equipment	79
Non-WSU extension/research	59
Internet based resources	57
Other: Fieldman	4

Table 4: Characteristics of growers who use platforms vs. full sample

Grower Characteristics	Full Sample		Orchards with Platforms	
Education	Frequency	Percent	Frequency	Percent
Bachelors degree or more	138	43.7%	21	60.0%
Some College	95	30.1%	8	22.9%
High School or less	66	20.9%	5	14.3%
Not Specified	17	5.4%	1	2.9%
Age Group				
25-50	91	28.8%	13	37.1%
50-60	100	31.6%	11	31.4%
60-70	76	24.1%	8	22.9%
70+	49	15.5%	3	8.6%
Gender				
Male	282	89.2%	33	94.3%
Female	21	6.6%	1	2.9%
Not Specified	13	4.1%	1	2.9%
Holds Crop Insurance				
Yes	188	59.5%	23	65.7%
No	128	40.5%	12	34.3%

Table 5: Reasons for USING and NOT USING Platforms

Reasons for USING Platforms		
Reasons rated as "Very important"	Frequency	Percent
Increase in worker productivity	33	94%
Improved worker safety	22	63%
Improvement in quality of work	21	60%
Purchase cost is recoverable	19	54%
Easy for workers to operate	18	51%
Other: Speed	1	3%
Reasons for NOT USING Platforms		
Reasons rated as "Very important"	Frequency	Percent
Orchard architecture is not suitable	152	55%
Purchase cost is high	110	40%
Steep slopes in orchard	82	29%
No improvement in worker productivity	62	22%
Maintenance and repair costs are high	44	15%
Limited availability at implement dealers	28	10%

Table 6: Platform use by type of orchard architecture

Architecture Type	Count of all orchards	Count of orchards with platforms	% Adopted
Strictly Planar	40	9	22.5%
Strictly Round	138	5	3.6%
Strictly Other	37	1	2.7%
Both Planar and Round	63	20	31.7%
Both Planar and Other	1	0	0.0%
Both Round and Other	2	0	0.0%
Planar, Round, and Other	2	0	0.0%
Missing Response	33		
Total	316	35	11.1%

Table 7: Characteristics of orchards with platforms vs. full sample

Orchard Characteristics	Full Sample		Orchards with Platforms	
Architecture Structure	Frequency	Percent	Frequency	Percent
Any type of planar structure	106	33.5%	29	82.9%
Planar, angled structures	53	16.8%	17	48.6%
Planar, vertical structures	48	15.2%	14	40.0%
No type of planar structures	177	56.0%	6	17.1%
Growing Regions*				
Basin	68	21.5%	14	40.0%
Yakima	94	29.7%	12	34.3%
Wenatchee	140	44.3%	8	22.9%
Not Specified	14	4.4%	1	2.9%
Row Space				
Less than 5 feet	42	13.3%	8	22.9%
Between 5 and 6 feet	94	29.7%	15	42.9%
More than 6 feet	157	49.7%	11	31.4%
Not Specified	23	7.3%	1	2.9%
Apple Variety				
Gala	151	47.8%	27	77.1%
Granny Smith	95	30.1%	20	57.1%
HoneyCrisp	53	16.8%	16	45.7%
Golden or Red Delicious	196	62.0%	16	45.7%
Club	34	10.8%	11	31.4%

* **Basin** = Adams, Benton, Franklin, Grant, Walla Walla

Wenatchee = Chelan, Okanogan, Douglas, Skagit

Yakima = Kittitas, Hood River (OR), Yakima, Klickitat

Table 8: Summary Statistics: Full Data Set (N=316)

Continuous Vars	N	Mean	Std Dev	Min	Max
size (in acres)	309	93	169	0.5	1500
age of respondent	301	58	12	25	88
Binary Variables	**Yes**	**No**	**% Yes**		
planar	106	177	34%		
platform	35	281	11%		
yakima	94	222	30%		
wenatchee	140	176	44%		
basin	68	248	22%		
club	34	282	11%		
organic	40	276	13%		
honeycrisp	53	263	17%		
goldreddel	196	120	62%		
gala	151	165	48%		
granny	95	221	30%		
crop_ins	188	128	59%		
internet	187	129	59%		
white	270	43	85%		
other_race	43	270	14%		
highschool	66	250	21%		
somecollege	95	221	30%		
bachelorplus	138	178	44%		
sub5ft	42	274	13%		
btwn5and6	94	222	30%		
morethan6	157	159	50%		

Table 9: Probit Regression for Planar Orchard Structure

planar	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
wenatchee	-0.367	0.210	-1.750	0.081	-0.778	0.045
basin	0.125	0.245	0.510	0.610	-0.355	0.604
size	0.003	0.001	2.420	0.015	0.001	0.006
size2	-0.000002	0.000	-1.260	0.207	0.000	0.000
club	0.556	0.312	1.780	0.075	-0.055	1.167
organic	0.577	0.276	2.090	0.037	0.035	1.118
honeycrisp	0.520	0.231	2.250	0.024	0.068	0.973
goldreddel	-0.307	0.196	-1.570	0.116	-0.691	0.076
gala	0.457	0.202	2.270	0.023	0.062	0.852
granny	-0.035	0.212	-0.170	0.869	-0.451	0.381
crop_ins	-0.160	0.200	-0.800	0.421	-0.552	0.231
internet	0.377	0.202	1.870	0.062	-0.018	0.773
age	-0.014	0.008	-1.730	0.084	-0.030	0.002
other_race	0.721	0.287	2.510	0.012	0.158	1.283
somecollege	-0.203	0.264	-0.770	0.443	-0.720	0.315
bachelorplus	0.375	0.236	1.590	0.112	-0.088	0.838
constant	-0.286	0.605	-0.470	0.636	-1.473	0.900

The base variable for education is 'highschool or less'

The base variable for race is 'white'

Table 10: Probit Regression for Platform Usage (reduced data set, N = 106)

Variable	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
wenatchee	-0.915	0.487	-1.880	0.060	-1.868	0.039
basin	0.228	0.409	0.560	0.577	-0.574	1.030
size	0.004	0.002	1.630	0.103	-0.001	0.008
size2	-0.000002	0.000	-1.230	0.221	0.000	0.000
club	0.298	0.390	0.760	0.445	-0.467	1.063
organic	-0.339	0.391	-0.870	0.386	-1.106	0.428
honeycrisp	1.183	0.412	2.870	0.004	0.375	1.991
goldreddel	-1.114	0.433	-2.570	0.010	-1.963	-0.265
gala	1.015	0.498	2.040	0.042	0.038	1.992
granny	-0.366	0.426	-0.860	0.390	-1.202	0.470
crop_ins	-0.328	0.434	-0.760	0.450	-1.178	0.523
internet	0.386	0.404	0.950	0.340	-0.407	1.178
age	-0.025	0.017	-1.470	0.140	-0.059	0.008
other_race	-0.149	0.823	-0.180	0.856	-1.762	1.463
somecollege	-0.566	0.619	-0.910	0.361	-1.780	0.648
bachelorplus	-0.039	0.528	-0.070	0.941	-1.074	0.996
sub5ft	-0.021	0.536	-0.040	0.968	-1.072	1.029
morethan6	-0.443	0.422	-1.050	0.294	-1.270	0.384
constant	0.415	1.143	0.360	0.717	-1.826	2.656

The base variable for education is 'highschool or less'

The base variable for race is 'white'

The base variable for row spacing is 'between 5 and 6 feet'

EXECUTIVE SUMMARY

The following summarizes the results of the 2010 Grower Survey and the subsequent analysis:

- The objective of this study was to survey apple growers to determine the extent of platform use in Washington orchards. The survey sample was randomly selected from the membership of the Washington Apple commission. Of the 765 Surveys that were sent to growers, 41% were completed and returned for analysis.

- Analysis of the data suggests that the use of platforms in Washington orchards is not prevalent. Out of 316 respondents, 35 (11%) indicated that they use platforms. Survey responses indicate that the primary reasons growers do not adopt platforms are **unsuitable orchard structure**, **high purchase cost**, and **steep grades within the orchard**.

- The presence of unsuitable orchard structures suggests that extensive adoption of platforms will not occur until modern structures are installed on a larger number of acres. Installation of modern orchard structures will also allow for greater efficiency gains from platforms, due to row spacing and 2-dimentional trees. By improving the efficiency of workers using platforms, purchase costs may be recoverable in shorter periods of time.

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