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The Adoption of Drying Added-Value Technologies in the Specialty Crop Industry

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Abstract

Value-added technologies can benefit specialty crops growers by leading to an increase profitability and improving access to markets. This study categorized and explored the main characteristics of farmers on the spectrum of adoption of drying value-added technologies. Farmers were categorized as 1) considering drying, 2) currently drying, 3) stopped drying, or 4) never dried. There were more women and minority farmers drying specialty crops than farmers with genders and races/ethnicities. There was a greater proportion of diversified operations, those selling through local markets, and those using food labels among farmers using drying technologies to add value to their products.

Keywords: market differentiation, agricultural diversification, minority farmers, value-added, food crops, specialty crops, drying foods, food labels.

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Introduction

Consumers are looking for more distinct value-added (VA) products, and healthy local foods have been the niche that provides the answer for many demand trends. Changes in consumer preferences for agricultural products are encouraging markets to evolve and supply more convenient presentations of fruits and vegetables (Pollack, 2001). For instance, an increase in the number of direct and intermediate markets helps facilitate farmer access to more diverse markets. In addition, the proliferation of food labels conveying nutrition, origin, and production of foods is an example of how farmers, food handlers, and retailers have responded to changes in consumer demand (Torres, 2020).

To support new market trends, federal and local governments have developed interventions and incentives that aim to increase the consumption and supply of fresh whole foods (List and Samek, 2015). For example, the Value-Added Producer Grant (VAPG) by the U.S. Department of Agriculture supports farmers' adoption of new technologies with funding of up to $75,000 for planning grants and $250,000 for working capital projects. This funding helps farmers adopt activities that support expenses related to producing and marketing value-added agricultural products.

The adoption of technological innovations is considered a key farm strategy in helping farmers increase market access and manage risk (Sunding and Zilberman, 2001). This strategy is especially important for high-value specialty crops as they are perishable in nature, and greater coordination is needed on how these products are produced, processed, and marketed (Swinnen and Maertens, 2007). Through agricultural innovations, farmers are able to supply innovative VA final products, reduce costs, enhance product quality, and protect human health and environment.

In a survey of Indiana specialty crops farmers, Fulton, Pritchett, and Pederson (2003) found that specialty crops tend to receive higher price premiums, but they also generate additional production costs than non-specialty crops. Demand and supply trends provide evidence of new economic opportunities for specialty crop farmers by adding value to locally grown products and meeting off-season demand for dried fruits, vegetables, and herbs. Drying technologies can lead to a reduction in postharvest losses, which can increase food availability and protect the environment (Kader, 2003). VA technologies, such as drying, can benefit specialty crop growers by increasing farm profitability, improving access to markets, promoting greater competition among middlemen, and increasing their bargaining power (Mittal, 2007).

While most of the literature regarding innovations in VA technologies is focused on U.S. commodity agriculture or developing countries (Chen, 2020), this study focuses on the adoption of VA technologies among U.S. specialty crop farmers. Drawing from the VAPG, we defined value-added as 1) changes in the physical state, 2) value-enhancing, or 3) physical segregation resulting in differentiation of agricultural products. Specifically, we focused on the adoption of drying technologies as VA innovations. Drying of fruits and vegetables can create market opportunities for small- and medium-scale farmers, so they can deliver value to perishable crops while accessing new markets and generate off-season income.

The objective of this study is twofold. First, we categorized and explored the main characteristics of farmers on the spectrum of adoption of drying VA technologies. Farmers were categorized as 1) considering drying, 2) currently drying, 3) stopped drying, or 4) never dried. Second, using an ordered probit model, we investigated the drivers and barriers of adopting drying VA technologies, including solar, electric, freeze, and open-sun drying.

Data and Methodology

Data for this study came from a 2019 web-based survey of specialty crop growers located in 32 states.[1] Growers' email addresses were obtained from lists of grower associations and the Food Industry MarketMaker database. We compiled a list of 3,557 unique email addresses that was screened to eliminate duplicate entries. These databases facilitated access to operations growing fruits, vegetables, and herbs. Our data included farmers selling in direct-to-consumer (DTC) market channels, intermediate markets, and wholesale outlets. DTC markets were defined as those where the farmer sells directly to consumers, such as farmers markets, while intermediate markets were those where the farmer sells to local restaurants or retailers (Torres et al., 2017). Lastly, wholesale outlets were those where the farmer sells to processors, distributors, and wholesalers (Woods et al., 2013).

The web-based survey was conducted using Qualtrics software. To increase participation rate, we included a $10 gift card as an incentive to the first 1,000 farmers who completed the survey. A total of 766 farmers completed the survey, for a response rate of 21.5%, which is considered an acceptable response rate for this type of survey (Dillman, Smyth, and Christian, 2014). The questionnaire included questions related to farmers' demographics (i.e., educational attainment, gender, farming experience), farm characteristics (i.e., crops, markets, and growing technologies), as well as farmers' networks and perceptions of their farm. The questionnaire was approved by the corresponding Institutional Review Board for compliance with ethical standards for human subjects.

The subsample for this study included 580 specialty crop operations that reported their status on the process of drying technologies. We categorized farmers as *never dried* (N = 334; 58%), *considering drying* (N = 95; 16%), *drying* (N = 88; 15%), and *stopped drying* (N = 63; 11%). We analyzed farmers' categories using a one-way analysis of variance (ANOVA) comparison of means. Using an ordered probit regression, we estimated the influence of farmer and farm characteristics, as well as perceptions and networks, on the probability of considering, adopting, or stopping drying specialty crops. The ordered probit regression is an appropriate approach to model ordinal survey responses where the observed dependent variable has an ordinal scale (Greene, 2003). All analyses were conducted using Stata (StataCorp, 2019).

[1] Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Oregon, Rhode Island, Tennessee, Virginia, West Virginia, Wisconsin, and Wyoming.

Results and Discussion

This study investigated the major factors affecting the adoption of drying VA technologies. Table 1 displays the covariates used in the study, as well as the means and standard deviations for the continuous and categorical variables of the study. Table 1 illustrates that farmer demographics, farm characteristics, and perceptions differ among farmers' categories. Results showed that there were more women and minority farmers drying specialty crops than other genders and races/ethnicities ($P < 0.05$). There was a bigger proportion of diversified operations, those selling primarily through local markets, and those using food labels among farmers using drying technologies to add value to their products ($P < 0.05$). Having support networks (i.e. other farmers supporting adoption of technologies) was less common for farmers who never used drying technologies ($P < 0.05$). It is likely that having support from other farmers adopting VA technologies is influencing farmers in our study to dry their specialty crops. Table 1 illustrates that the proportion of farmers perceiving barriers to drying was higher among those drying produce ($P < 0.05$).

Table 2 displays the marginal effects associated with the ordered probit regression. Table 2 shows that race/ethnicity was correlated with the adoption of drying VA technologies. Minority farmers were 7% more likely to dry their crops ($P < 0.10$), which may be helping them access new markets and develop business networks. The fact that minority farmers were also 5% more likely to stop drying is interesting ($P < 0.10$), as this result may be showing that the barriers faced by minority farmers investing in VA technologies remain even after drying and selling value-added products.

Table 1. Comparison of Explanatory Variables for Specialty Crop Operations Categorized as Never Dried ($N = 334$), Considering Drying ($N = 95$), Drying ($N = 88$), and Stopped Drying ($N = 63$)

	Never Dried[z]			Considering			Drying			Stopped		
	Mean	**SD**		**Mean**	**SD**		**Mean**	**SD**		**Mean**	**SD**	
College[y]	0.67	0.47		0.61	0.49		0.67	0.47		0.71	0.46	
Female[y]	0.28	0.45	BC	0.27	0.45	C	0.49	0.50	A	0.46	0.50	AB
Nowhite[y]	0.05	0.21	B	0.06	0.24	B	0.05	0.21	B	0.14	0.35	A
Midwest[y]	0.55	0.50		0.51	0.50		0.44	0.50		0.47	0.50	
Northeast[y]	0.05	0.21		0.04	0.21		0.06	0.24		0.02	0.13	
West[y]	0.22	0.41		0.27	0.45		0.25	0.44		0.33	0.48	
South[y]	0.18	0.39		0.16	0.37		0.24	0.43		0.14	0.35	
Number crops	9.99	11.83	B	17.83	15.35	A	23.02	16.29	A	20.17	16.56	A
Experience	24.27	15.79		21.90	16.00		20.15	12.86		26.48	16.85	
Percentage income	71.45	34.35		69.31	32.43		69.99	32.22		61.52	36.19	
Only dtc[y]	0.22	0.42	B	0.27	0.45	AB	0.34	0.48	AB	0.44	0.50	A
Only wholesale[y]	0.26	0.44	A	0.16	0.37	AB	0.07	0.25	B	0.16	0.37	AB
Mixed[y]	0.25	0.43	B	0.44	0.50	A	0.44	0.50	A	0.29	0.46	AB
Distance	18.66	24.42		24.66	27.63		24.50	25.59		20.98	25.82	
Label[y]	0.37	0.48	B	0.52	0.50	AB	0.61	0.49	A	0.66	0.48	A
Employees	26.28	58.79		24.06	67.51		14.78	45.71		9.86	18.94	
Totalland	349.55	948.95		251.88	625.40		231.68	1011.45		94.44	204.85	
Sole[y]	0.40	0.49		0.41	0.49		0.40	0.49		0.41	0.50	
Partime[y]	0.34	0.47		0.29	0.46		0.28	0.45		0.38	0.49	
Small[y]	0.51	0.50		0.51	0.50		0.65	0.48		0.63	0.49	
Medium[y]	0.12	0.33		0.18	0.39		0.09	0.29		0.08	0.27	
Large[y]	0.26	0.44		0.27	0.45		0.16	0.37		0.13	0.34	
Change sales	1.98	0.64		1.97	0.65		2.04	0.71		2.05	0.66	

Table 1 (continued).

	Never Dried			Considering			Drying			Stopped		
	Mean	**SD**		**Mean**	**SD**		**Mean**	**SD**		**Mean**	**SD**	
Change labor	2.08	0.74		2.24	0.73		2.19	0.80		2.22	0.77	
Networks[y]	0.17	0.38	B	0.36	0.48	A	0.45	0.50	A	0.38	0.49	A
Info industry[y]	0.69	0.46		0.72	0.45		0.64	0.48		0.62	0.49	
Info farmers[y]	0.85	0.36	B	0.96	0.21	A	0.90	0.30	AB	0.81	0.40	B
Info extension[y]	0.83	0.38		0.82	0.39		0.85	0.36		0.78	0.42	
Successfully	0.47	0.50		0.51	0.50		0.56	0.50		0.53	0.50	
Barriers dry	2.07	0.76	B	2.08	0.49	B	2.35	0.49	A	2.09	0.55	B
Financial assist[y]	0.49	0.50	B	0.56	0.50	AB	0.65	0.48	A	0.58	0.50	AB

[z]Upper case letters show statistically significant differences across clusters at the $P < 0.1$ using Tukey's significant difference test.
[y]The mean is the percentage of respondents with that attribute.

Table 2. Marginal Effects Results from Ordered Probit for the Adoption of Drying Value-Added Technologies among Specialty Crop Operations

	Never Dried		**Considering**		**Drying**		**Stopped**	
College	0.98		-0.27		-0.42		-0.29	
Female	-2.92		0.79		1.26		0.87	
Nowhite	-15.11	*	4.10	*	6.51	*	4.50	*
Midwest	6.10		-1.66		-2.63		-1.82	
West	-0.19		0.05		0.08		0.06	
South	0.90		-0.24		-0.39		-0.27	
Number crops	-0.79	***	0.21	***	0.34	***	0.23	***
Experience	-0.20		0.06		0.09		0.06	
Percentage income	0.26	***	-0.07	***	-0.11	***	-0.08	***
Only wholesale	5.74		-1.56		-2.47		-1.71	
Mixed	2.88		-0.78		-1.24		-0.86	
Distance	-0.10		0.03		0.05		0.03	
Label	-21.01	***	5.70	***	9.05	***	6.26	***
Employees	0.03		-0.01		-0.01		-0.01	
Total land	0.00		0.00		0.00		0.00	
Sole	6.43		-1.75		-2.77		-1.91	
Partime	-0.76		0.21		0.33		0.23	
Small	-12.13	*	3.29	*	5.22	*	3.61	*
Large	4.28		-1.16		-1.84		-1.27	
Change sales	-6.90	**	1.87	**	2.97	**	2.05	**
Change labor	-0.99		0.27		0.43		0.30	
Networks	-15.98	***	4.34	***	6.89	***	4.76	***
Info industry	6.48		-1.76		-2.79		-1.93	
Info farmer	-9.86		2.68		4.25		2.94	
Info Extension	-2.93		0.79		1.26		0.87	
Successful	-5.10		1.38		2.20		1.52	
Barriers dry	-11.91	***	3.23	***	5.13	***	3.54	***
Financial assist	-5.22		1.42		2.25		1.56	
Observations							486.00	
Prob > Chi^2							0.00	
Pseudo R^2							0.13	

Note: Marginal effects are expressed in percent points.
$^{***}P < 0.01$, $^{**}P < 0.05$, $^{*}P < 0.1$

Other drivers of adoption of VA technologies included having a diversified crop mix ($P < 0.01$). The fact that horizontal diversification (number crops grown) and vertical diversification (adding value to crops) are positively correlated is interesting. It seems that farmers are looking for strategies to develop and maintain a competitive advantage by investing in diversifying product offerings and innovation strategies (i.e., VA technologies). We expect that pursuing vertical and horizontal diversification can help farmers increase market penetration and market access. It is likely that the adoption of these strategies may be driven by the rapid changes among consumers toward local, authentic, traceable, transparent, and ethical foods.

Results from the ordered probit regression show that using marketing labels on products ($P < 0.01$) increases the likelihood of considering drying and then drying specialty crops. The distance between the consumer and producer in today's food system represents obstacles for effective communication and the establishment of trusting relationships. In most cases, consumers cannot directly observe the food production process, which implies that they have asymmetric information regarding products and farming practices (Messer, Costanigro, and Kaiser, 2017). Farmers using labels can help improve consumers' trust and build long-term relationships. Moreover, farmers using marketing labels may want to communicate the drying process or other VA technology used in their operation.

Interestingly, the likelihood of considering drying and drying agricultural products was higher for smaller operations ($P < 0.10$). This result may inform us about the strategies implemented by small producers to reach new markets and that drying technologies are accessible for them. Consistent with Maertens and Barrett (2013), our results show social networks are important in the technology adoption process. Results from the ordered probit regression suggest that having support networks with experience in VA technologies increases the likelihood of adopting drying VA technologies. Moreover, farmers perceiving important barriers to the drying process were more likely to adopt drying technologies. An explanation of this finding may be that farmers adopting these technologies are the ones facing and reporting barriers to dry specialty crops. Yet, these barriers seem to also be driving farmers to stop using drying VA technologies. Lastly, a major deterrent of drying value-added was the increasing percentage of farmers' income derived from specialty crops ($P < 0.01$).

Conclusions

The adoption of drying VA technologies is influenced by farmer demographics, farm characteristics, access to support networks, and farmer perceptions. Our findings can be used by researchers, policy makers, and industry stakeholders. They can help tailor incentives, Extension programs, and market strategies to improve the supply and demand of local dried agricultural products. Future research should consider the impact of drying technologies on farm economic performance and improve understanding of farmers' adoption of drying VA technologies.

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