Cultivar Diversity as a Risk Management Strategy for Tree Crop Growers

by

Steven C. Blank

Risk reduction through diversification across cultivars is evaluated. A case study of peach growers in California shows that cultivar diversity reduces both yield and revenue variability. As a result, the probability of falling below minimum-income requirements set using a safety-first model is reduced using this strategy.

Cultivar diversification is a traditional production risk minimization strategy still practiced around the world; however in modern agriculture its use differs across commodities. Producers of high-value annual crops, such as vegetables, commonly use diversification across crops, locations and cultivars. For perennial crop producers, diversification across crops is common, while specialization in cultivars is often promoted for both production and marketing reasons. In general, farmers who are reluctant to use cultivar diversification usually practice specialized production as a means of achieving economies of scale in one particular enterprise, or cultivar specialization in response to markets' desires for product standardization. In industries producing tree crops, risk reduction through diversification across cultivars is seldom practiced as more farmers pursue specialization. One notable exception is the peach industry; cultivar diversity is practiced, but peach growers vary widely in the degree to which they use the strategy. This makes the peach industry a good case study for evaluating the benefits of cultivar diversity as a risk management tool.

"For peach growers, diversification is one of the few risk management strategies available or acceptable to a majority of producers."

Farmers use three types of production diversification. The most common type is diversification across products. This strategy can be utilized by any farmer with knowledge of how to grow more than one commodity, including growers with small and/or contiguous parcels of land. The goal of this type of diversification is to reduce variance in sales revenues by participating in more than one product market. For this strategy to be successful, the product markets must have low or negative levels of correlation in their prices and/or yields. The second type of diversification, across locations, has been practiced less often because it requires operating two or more parcels that are geographically separated, which could be infeasible for some growers. Many peach growers use this risk management strategy. Spatial diversification requires that a grower scatter his/her production across locations far enough apart to have low levels of correlation in their weather extremes. Thus, the focus is on reducing yield variance, so this strategy can be applied by growers specializing in one commodity. Finally, cultivar diversity is a form of temporal diversification, but it incorporates aspects of both of the other two strategies. The usual goal of cultivar diversity is to have portions of total acreage (either contiguous or scattered) reach the harvest stage at different times of the year. By selecting cultivars of a single commodity that are not highly correlated in their growth schedules, farmers can both (1) reduce average yield variability by reducing weather- risk exposure (similar to geographical diversification), and (2) raise average price received and/or lower price variance by being able to sell output in more than one market season (similar to product diversification). Practicing cultivar diversity complicates both production and marketing, but can increase profits.

For peach growers, diversification is one of the few risk management strategies available or acceptable to a majority of producers. In California, only 4.2 percent of peach growers have crop insurance and there is no price risk-management tool available for peaches. As a result, peach growers all use some type of diversification.

The objective of this study is to analyze cultivar diversity as a risk management strategy for fresh-market peach growers in California. This industry provides a rare case study allowing comparisons between tree-crop operations that are fairly specialized versus others that are diversified in their cultivars for a single commodity.

Table 1. Peach Yield Mean, Standard Deviation and Coefficient of Variation for Each Season (Boxes per Acre)

	Mean	Standard Deviation	CV (%)
Early-season	592	280	47
Mid-season	929	402	43
Late-season	998	389	39

Note: the early-season is defined to include all peach sales before July 1, the mid-season includes all of July, and the late-season includes everything after July.

Measuring Risk Management Performance

In this analysis, the effects of using cultivar diversification to manage risks are measured using a safety-first criterion. Safety-first models create a rank ordering of decision alternatives by placing constraints upon the probability of failing to achieve certain goals of the firm. This study assumes a farmer's goal is to generate enough sales revenue to produce at least some designated minimum level of profit. The designated safety threshold is a personal preference based on financial obligations, lifestyle goals and opportunity costs—thus, it will vary across individuals.

Empirical applications of safety-first models often use a measure called the "Probability of Disaster," or "risk of ruin." This measure indicates the chance (in percentage terms) that a producer will generate a return below some critical level. A risk management strategy that reduces the probability of disaster, compared to the current situation, is a useful tool.

Empirical Methods

The main variables considered in this study are yield per acre of freestone peach cultivars and revenue in dollars per acre. Yield is reported as the number of 25-pound boxes per acre. Growers' gross revenue per acre is computed as yield times the average price for each season for each cultivar.

The data were collected from a sample of 50 peach growers in Fresno County. Those growers were interviewed in 1999 about their production of peach cultivars over the previous five years, from 1994 through 1998. The 50 farms represent 73 percent of the 15,885 total acres of peaches in Fresno County reported in the 1997 Census of Agriculture.

In this study, two forms of peach cultivar diversification benefits are defined. The first form is the resulting absolute reduction in variance compared to the level observed for a single cultivar. The second form is measured by how much diversity lowers the probability of revenue falling below the farm's disaster level. This is indicated through the difference in probabilities for each farm's diversified versus single-crop operation. The disaster level for each grower was set at the point identifying the lowest ten percent of the (revenue or yield) distribution for the industry in any given year. This level was identified during the interviews by asking each grower to specify a minimum revenue or yield threshold necessary to meet his or her financial obligations.

Three standard statistical measures are used in this analysis: the mean, standard deviation and coefficient of variation. The "mean" is the average value of some group of numbers. It indicates the numerical level of the data in absolute terms. The "standard deviation" refers to the dispersion of the data values. It also is an absolute value. The standard deviation indicates the range of values in the group of numbers because nearly all data values will be within three standard deviations of the mean, and about 68 percent of the data points will be within one standard deviation of the mean. The coefficient of variation (CV) is calculated as the standard deviation divided by the mean. The CV is a relative value, usually expressed as a percentage, that can be used to compare the relative variabilities of two or more groups of numbers. The higher the CV, the more variable is the group of numbers. Thus, it is often used to indicate relative degrees of risk across data series: the series with the highest CV is the "most risky."

Results

Most peach operations are relatively small because no peach grower produces only peaches. The acreages evaluated here are those with peaches only and growers' other crop acreages are not included.

Variability

The mean, standard deviation and coefficient of variation of peach yield for the 50 farms are 707 25-pound boxes, 73 25-pound boxes and ten percent, respectively. The mean yield for all cultivars on a farm ranged from 262 to 1,264 over the data period. The coefficient of variation ranged from two percent to 67 percent for individual farms.

The data (Table 1) indicate that cultivars maturing in the early-season (marketed before July 1) provide lower yield and show relatively higher variation than

mid-season (July 1-31) and late-season cultivars (August 1 or later). This implies that planting combinations of early-, mid- and late-season cultivars may be less risky than relying on cultivars maturing during a single season.

Table 2. Annual Peach Prices in Fresno, California ($ per Box)

	Early-Season			Mid-Season			Late-Season			All Seasons
Year	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean CV %
1994	7.30	3.6	49	6.37	2.1	32	6.70	1.6	24	35
1995	10.49	2.7	19	7.59	1.5	19	8.90	1.2	13	17
1996	11.08	2.6	24	11.21	1.3	12	9.57	1.6	16	17
1997	9.24	3.8	42	5.79	1.5	25	5.87	0.7	11	26
1998	14.26	7.4	52	7.18	1.7	24	6.75	1.7	26	34
Overall	10.47	4.0	37	7.63	1.6	22	7.56	1.4	18	26

Note: The early-season is defined to include all peach sales before July 1, the mid-season includes all of July, and the late-season includes everything after July.
Prices are reported by the USDA's Market News Service.

Fresh-market peach prices during the five-year period are summarized in Table 2. For this study, prices of all ten sizes and grades of freestone peaches for each harvest season (early, mid and late) were averaged and used as the mean price growers received in each season. The average coefficient of variation of prices was 37 percent, 22 percent and 18 percent for the early-, mid- and late-seasons, respectively. The high-price variability of early-season cultivars occurs because peach prices are highest in the "early periods" of the early-season when supply is short, but they decline quickly as supplies increase. In mid- and late-seasons, however, price gradually stabilizes with peach supplies.

Peaches are perennial crops, so year-to-year variation in bearing acreage is low. Therefore, the major changes in production come primarily from yield variation. Cultivars that have high price and yield variability may generate relatively stable gross revenue because of negatively correlated prices and yields. For the 50 farmers surveyed, revenue per acre had a mean of $6,512, a standard deviation of $1,803 and a coefficient of variation of 28 percent. The range of those values, respectively, was $2,741 to $9,558, $274 to $1,927, and seven percent to 46 percent.

The Disaster Level

The minimum threshold for yield and revenue was determined by using the average responses of farmers to interview questions asking them to specify a level below which they could not meet their financial obligations. For each factor, the cut-off value identified was approximately ten percent on the normal distribution.

For yield, that translated into 412 boxes per acre. Thus, any cultivar yielding 412 boxes or fewer per acre is considered to have a disastrous result for growers.

The cut-off level for revenue disaster was calculated to be $4,204 per acre. If a grower obtained less than $4,204 per acre from all of his cultivars he would suffer what is called here a "100 percent disaster." He can also experience an intermediate level of disaster by getting less than $4,204 per acre from some of his cultivars.

Based on these calculations, 38 percent of the growers had some level of yield disaster and eight percent showed a 100 percent disaster level. On the other hand, 44 percent of growers had some revenue disaster because revenue from at least one cultivar was less than the minimum threshold. However, only two percent experienced a 100 percent revenue disaster. The percentage of growers with 100 percent disasters was lower for revenue than yield, indicating that revenue variance may be reduced by offsetting price and yield variation.

Correlation Among Cultivar Revenues

To reduce risk through diversification, farmers should choose cultivars with negative or low correlation between their revenues, because a potentially disastrous result from one cultivar can be offset by an adequate result from another. In this study, the average revenue correlation between all cultivars on individual farms ranged from -0.85 to 0.99, indicating good potential for risk reduction for some farms.

The offsetting effect of high price on low yield can be seen by comparing Tables 1 and 2. The average price of early cultivars was consistently higher than the prices of mid- and late-season cultivars, whereas average yield was lower for early cultivars than for mid- and late-season cultivars. Revenue per acre over

the 1994-98 period averaged $6,200 for the early-season, $7,090 for the mid-season and $7,480 for the late-season. The difference in revenue between early- and late-season cultivars is 20 percent, whereas the difference in yield between early- and late-season cultivars is 69 percent.

Variance Reduction Through Diversity

The 50 farms surveyed varied in diversity, ranging from two cultivars to 15 with an average of five. The within-farm variability of revenue observed with multiple cultivars was compared to the variability observed from a single cultivar for each farm. For 86 percent of the growers, revenue variability decreased as a result of cultivar diversity. Revenue variability was reduced by 21 percent on average.

Finally, the second form of benefits also shows positive results in that diversity reduces the probability of revenue falling below the disaster level. Eighty-eight percent of growers had revenues above the disaster level of $4,204 per acre. Also, the group of most diversified farms had a lower probability of disaster compared to the group of least diversified farms.

Concluding Comments

Growers face trade-offs when considering cultivar diversification versus specialization as a production strategy. Specialization may lead to economies of scale that lower per unit production costs, increasing the profitability of operations. However, diversification of all types has been found to reduce variance in returns. Therefore, the trade-off involves risk and returns. Interviews with peach farmers revealed that they are concerned about revenue variability and the probability of avoiding a financial disaster.

Like most farmers, peach growers are a heterogeneous group. The 50 growers interviewed ranged widely in size and they varied in their approaches to risk management. One common component of the risk management strategies being used by these farmers was diversification of at least two types. All of the growers were practicing cultivar diversification and crop diversification. It is possible that some growers' crop-diversification activities influenced their cultivar-diversification decisions. For example, a grower using a crop diversification strategy may be less concerned about variation in peach returns because he/she is diversified across other enterprises.

The results imply that planting combinations of early-, mid- and late-season cultivars may be less risky than relying on cultivars maturing during a single season.
Photo by Julie McNamara

The results of this study provide strong support for cultivar diversification as a risk management strategy. Compared to the results that surveyed farms would have generated as single-cultivar operations, cultivar diversity reduced yield variation in all cases, and 86 percent of farms had lower revenue variation with diverse cultivars. Most importantly, the results show that diversification significantly lowered the probability of disaster. This can be critical to the survival of farms in an industry like peaches where the probability of disaster increases rapidly with relatively small increases in cost per acre. Therefore, when a grower is unwilling to consider production systems that may have a financial result with some "risk of ruin," cultivar diversification is an alternative that provides a safer balance between risk and returns.

For Additional Information the Author Suggests the Following Reading:

Tadesse, D. and S. Blank, "Cultivar Diversity: A Neglected Risk Management Strategy," *Journal of Agricultural and Resource Economics* 28, 2 (2003): 217-232.

Steven C. Blank is an Extension Economist in the Department of Agricultural and Resource Economics at UC Davis. He can be contacted by phone at 530-752-0823 or by e-mail at sblank@primal.ucdavis.edu.