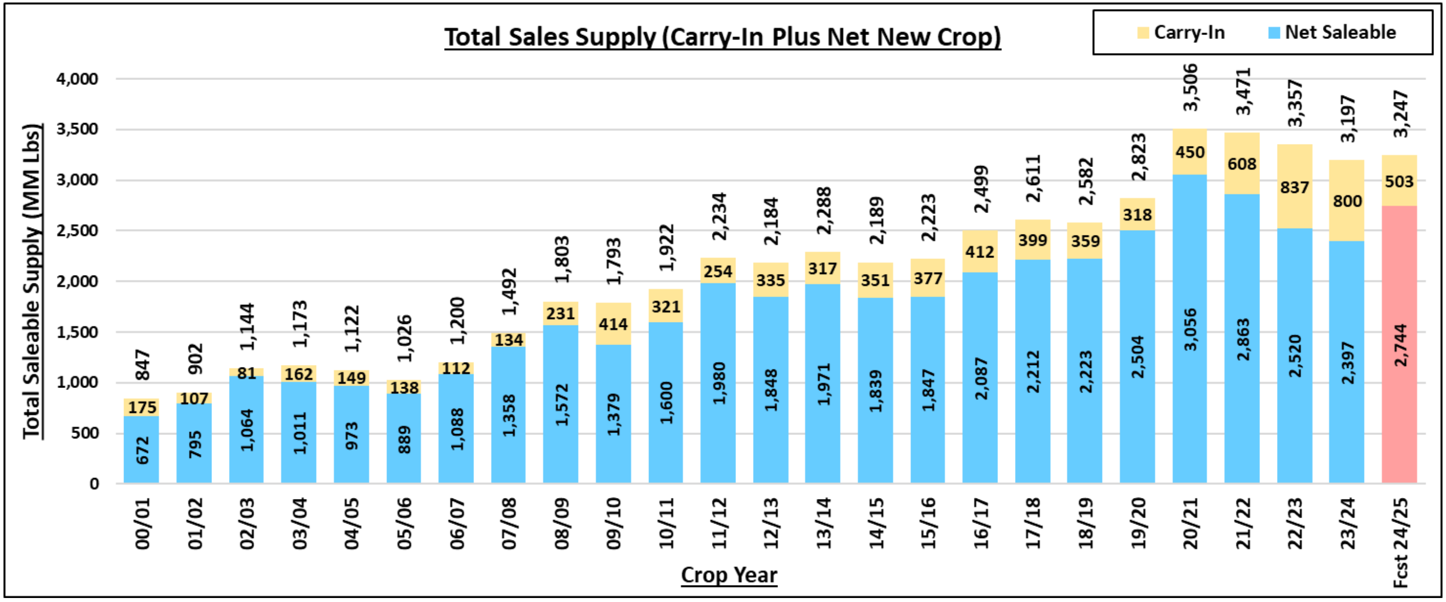
Almond Crops and 2024 Forecasted Volume

By Abran Padilla

According to the Almond Board of California (ABC), California accounted for 76% of the world's almonds in crop year 2023. Pre-COVID, the almond industry observed steady and continued growth from crop year 2000/01 to 2019/20. The industry supply peaked in 2020/21 (same year as COVID); however, post-pandemic volumes have steadily declined—see Figure 1.

Figure 1



Sources: Almond Board of California. Almond Almanacs published for crop years 2012, 2019, and 2023. Crop year 2024/25 carry-in and net new crop saleable volumes were sourced from the August 2024 Position Report.

There are many reasons cited for the decline in California saleable crop volumes; however, the most important is the "grower return" paid to almond farmers. According to Ian James of the LA Times, "For much of the last decade, almonds have been such a lucrative crop that growers and investment firms have poured money into planting new orchards across vast stretches of California farmland". However, James then points out that "now, the almond boom has fizzled and the industry has entered a slump. Prices have dropped over the last several years, and the state's total almond acreage has started to decrease as growers have begun to tear out orchards and plant other crops." (Mar 4, 2024). This is supported by the farm gate prices published in the USDA NASS's July 10, 2024 Objective Estimate relative to the 2019 estimated statewide and regional cost of farming (as calculated from the UC Davis Almond Cost Studies)—see Figure 2.

The 2019 Cost of Farming (By Region) and Corresponding Grower Returns

From crop years 2019 to 2023, the average yield per acre, as well as the UC Davis "Total Cash Costs Per Acre" by growing region is as follows (Sacramento Valley = *North* and San Joaquin North = *Central*):

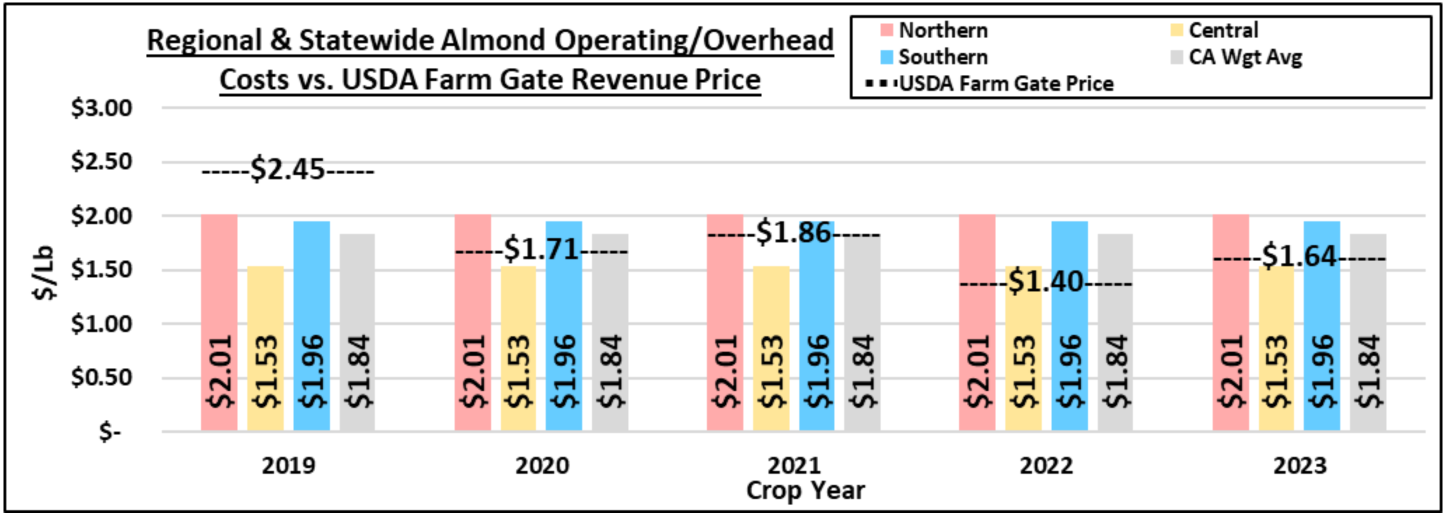
- **Northern = 1,582 Lbs/Acre ($3,184/Acre → $2.01/Lb)**
- **Central = 2,126 Lbs/Acre ($3,256/Acre → $1.53/Lb)**
- **Southern = 2,297 Lbs/Acre ($4,493/Acre → $1.96/Lb)**
- **Statewide = 2,120 Lbs/Acre ($3,895/Acre → $1.84/Lb)***

* Statewide weighted average cost per acre is based on the 2019 Bearing Acres (Northern = 18%, Central = 29%, and Southern = 53%)

Source: Almond Board of California Position Reports, July editions for all years from 2020 to 2024, along with the annual LandIQ "Standing Acreage – Final Estimate" reports from 2019 to 2023.

University of California, Davis 2019 Sample Costs to Establish an Orchard and Produce Almonds for: Sacramento Valley (p 19), San Joaquin Valley North (p 17), and San Joaquin Valley South (p 17).

Figure 2



Sources: UC Davis Agricultural & Resource Economics: Sample Costs to Establish an Orchard and Produce Almonds (Sacramento Valley, Northern San Joaquin, & Southern San Joaquin) 2019 Edition and the USDA NASS Objective Estimate (2024). **No inflation adjustments were applied to the costs**.

There are many reasons for the decline in grower returns, from demand-side pressures (such as an increase in tariffs from 10% to 60% into China in 2019--the third-largest importing country pre-2019) to supply-side pressures (such as increased production in countries such as Portugal, Spain, and Australia (to name a few) as well as environmental pressures (such as the reduction in chill hours in the Southern San Joaquin Valley, the increased cost of water, and upcoming water regulatory changes affecting groundwater supplies).

Rather than attempt to solve the supply, demand, and environmental factors associated with grower returns, this article will focus on simple "supply-side" analyses and also provide some models that can be used to "forecast" grower returns for upcoming crop years (using historical changes in supply and known grower returns). Three analyses will be presented. The first analysis will look at a factor which affects the market "sentiment" that can affect almond pricing. Then, the article will shift to provide two quantitative methods for estimating/forecasting upcoming grower returns.

Almond Carry-In and Saleable Supply

The almond crop year begins in August and runs to July of the following year. The saleable supply in any given year is the combination of the "Carry-In" from the prior year plus the net saleable new crop (which is 98% of the incoming crop—with the remaining 2% considered inedible, or "exempted", inventory)—see the Formula 1 below for a clear summary of the saleable supply calculation.

Formula 1

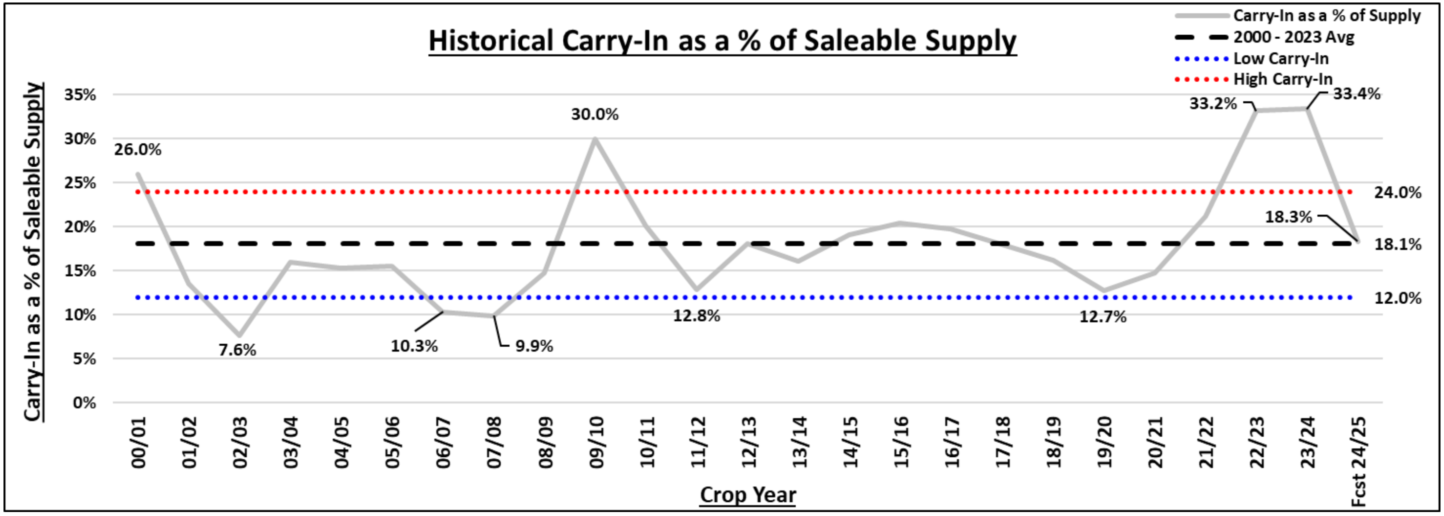
New Crop Saleable Supply = (Carry-In) + [(Incoming Crop) - (2% of the Incoming New Crop)]

Emotional Role of the "Carry-In" in Pricing

The "carry-in" is an important part of the saleable supply equation because it highlights the added volume supply being carried into the upcoming crop year (but customers consider it "old crop" and it usually sells at a discounted price relative to "new crop"). If the carry-in is "low" then there is a limited supply bridging the gap between one crop year to another (thus raising prices towards the end of one crop year, going into another). If the carry-in is "high" then the subsequent crop year "may" experience an "over-supply" problem (that could depress prices). The key question is "what is the historical 'optimal' level of 'carry-in' for the almond industry?"

To answer that question, it is best to compare the "carry-in" as a percentage of saleable supply from 2000 to 2023 to gauge the potential impact it could have on that crop year's grower return—see Figure 3.

Figure 3



Sources: Almond Board of California. Almond Almanacs published for crop years 2012, 2019, and 2023. Crop year 2024/25 carry-in and net new crop saleable volumes were sourced from the August 2024 Position Report.

According to Figure 3, the historical "carry-in as a percentage of saleable supply" is 18.1%. The significance of the "carry-in" for the crop is it shows if the upcoming year will be "over" or "under" supplied for the upcoming year's shipments. Since the almond industry typically ships between 83% to 87% (with an average of 85%) of its total saleable supply in any given crop year, the 18% carry-in number translates to approximately 2.5 months of supply. A number lower than 12% would suggest the industry only has 1.69 months of supply on-hand while a 24% carry-in suggests the industry has more than 3.39 months of supply. The implications on these carry-in percentages and the months of supply are summarized in the Table 1.

Table 1

Carry-In (as a % of Saleable Supply)	**Months of Supply**	**Processors Could be Shipping "Old Crop" to Date "X" for Shipments in the New Marketing Year**	**Classification Groups with Corresponding Crop Years** (and Potential Supply Signaling for the Early Months of the Upcoming Crop Year)				
			Low (Shortage)	**Preferred** (Slight Shortage to Stability)	**Acceptable** (Stability to Minor Surplus)	**High** (Surplus)	**Very High** (High Surplus)
			<=15%	15%-18%	18%-21%	21%-24%	>=24%
12%	1.69	21-Sep	01/02, 02/03, 06/07, 07/08, 08/09, 11/12, 19/20, & 20/21				
15%	2.12	4-Oct		03/04, 04/05, 05/06, 13/14, & 18/19			
18%	2.54	17-Oct			10/11, 12/13, 14/15, 15/16, 16/17, 17/18, & **(Fcst 24/25)**		
21%	2.96	30-Oct				21/22	
24%	3.39	12-Nov					00/01, 09/10, 22/23, & 23/24

Note: The crop year begins on August 1st of each year, so the "Months of Supply" show how long the industry can supply "carry-in" (i.e. "old crop") almonds for shipments in the marketing year. Furthermore, looking at the "Very-High" column, the crop years shown are associated with economic downturns (i.e. 00/01 and 09/10) or the latter half of the COVID years (22/23 and 23/24).

Recognizing the psychological effects of a "high" carry-in percentage would have in the market, one can see that the carry-in during and in the years after COVID were quite high—see Table 2.

Table 2

	Crop Year	Carry-In as a % of Saleable Supply	Months of Supply	Est Date Supplied to from "Old Crop"	
Pre-COVID	2019	12.7%	1.79	24-Sep	
COVID	2020	14.7%	2.08	3-Oct	
	2021	21.2%	3.00	31-Oct	<--The effect of CA port disruptions began to appear
	2022	33.2%	4.69	22-Dec	<--Due to holidays, "old crop" may have gone up to Jan.
	2023	33.4%	4.71	22-Dec	<--Due to holidays, "old crop" may have gone up to Jan.
Post-COVID	2024	18.3%	2.59	18-Oct	

The effect of the "over-supply" from the large-carry-ins can be seen in the low grower returns during the COVID related years from 2020 to 2023 in Figure 2. For Crop Year 2024, the carry-in returned back to a normal level of 18.3% (see Figure 3), due to the decreased new crop supply in crop year 2023—suggesting the COVID related surpluses are no longer present in the industry.

Forecasting Grower Returns Using Known Almond Elasticity

Over the last two decades, research suggests almonds are inelastic with demand elasticities ranging between 0.47 and 0.83 (with an average of 0.646). Table 3, summarizes the literature review on the elasticity of demand—along with a simple translation for what a 10% change in saleable supply would do to grower return.

Table 3

Group	Cited Elasticity	Translation (For every 10% change in Qty, the price will change by "X%" in the opposite direction)	Citation
Inelastic	0.47	Price Change = 21.3%	Babcock, B., Nemati, M., and Tran, D. (2021, July). *Estimation of Supply Elasticities for Non-Exchange Traded Commodities* (School of Public Policy, University of California, Riverside Working Paper No. 21-01), 1. https://spp.ucr.edu/sites/default/files/2021-07/%282%29%20Estimation%20of%20Supply%20Elasticities%20for%20Non-Exchange%20Traded%20Commodities%20.pdf
Inelastic	0.48	Price Change = 20.8%	Klonsky, K. (2011). *Economics of Almond Production*. [Webinar Slides presented by the Almond Board of California], slides 57-58. https://www.almonds.com/sites/default/files/content/attachments/economics_of_almond_production.pdf
Moderately Inelastic	0.70	Price Change = 14.3%	Crespi, J and Sexton, R. (2001). Almond advertising yields net benefits to growers. *California Agriculture*, 55(1), 20-25.
Moderately Inelastic	0.75	Price Change = 13.3%	Dharmasena, S., and Capps, O. Jr. (2017). "Consumer Demand for Nut Products in the United States: Application of Semi-parametric Estimation of Censored Quadratic Almost Ideal Demand System (C-QUAIDS) with Household-Level Micro Data." Paper presented at the annual meeting of the Southern Agricultural Economics, February 4–7, Mobile, Alabama.

Somewhat Inelastic	0.83	Price Change = 12.0%	Russo, C, Green, R., and Howitt, R. (2008). *Estimation of Supply and Demand Elasticities of California Commodities* (Department of Agricultural and Resource Economics, University of California, Davis Working Paper No. 08-001), 5. https://escholarship.org/content/qt3432z1pv/qt3432z1pv.pdf?t=krne0i

Despite the wide range of elasticities cited in the literature and by the Almond Board of California, the one consensus suggested across the articles cited is that almonds are “inelastic”. Given that the average of all of the elasticities is 0.646, the literature review suggests a 10% in quantity would result in a 15.5% change in price—see Formula 3.

For the first proposed grower return forecasting method, we will use the elasticity of demand for almonds and the percentage change in saleable quantities to forecast grower returns (i.e. prices). To do so, we must first show the formula for the elasticity of demand--see Formula 2:

Formula 2

$$e_d = \frac{\%\Delta Q}{\%\Delta P}$$

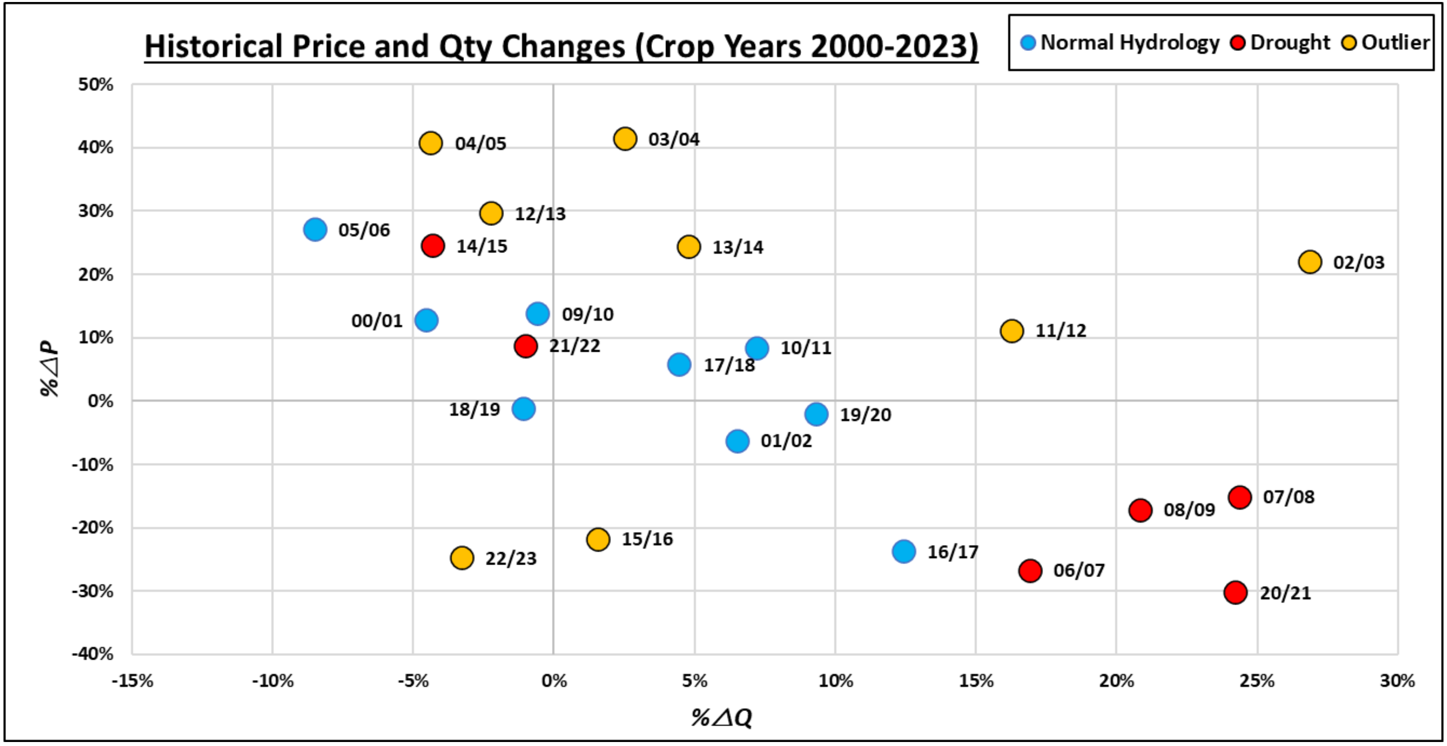
If we solve for the percentage change in price ($\%\Delta P$), then we end up with Formula 3, then just plug-in the values for “$\%\Delta Q$” and e_d. to calculate the $\%\Delta P$. (if $\%\Delta Q$ was 10%).

Formula 3

$$\left(\%\Delta P = \frac{\%\Delta Q}{e_d}\right) \rightarrow \left(\%\Delta P = \frac{10\%}{0.646}\right) \rightarrow \%\Delta P = 15.5\%$$

Using Formula 3, one can “estimate” the grower return based on the changes in saleable supply (carry-in plus net saleable new crop); however, we need to know what happens if quantity is “flat” (i.e. experiences “no change”). To do so, we need to see if there are any crop years with “minimal” changes in saleable supply and see how much farm gate prices changed in said given year. Figure 4 shows the historical percentage changes in saleable supply ($\%\Delta Q$) versus the USDA “farm gate prices” ($\%\Delta P$). Before digging into the data, it is important to note that periods where prices abnormally increase (or decrease) are considered “outliers” by industry analysts (see dots in orange). Ignoring the outliers, one can see the red dots are “drought years” while blue dots represent “normal hydrology” years from 2000 to 2023. Close inspection of the “non-outliers” suggests a combination of crop years 21/22 and 09/10 could work (and visually rounds to approximately 10%).

Figure 4



Sources: *Farm Gate Prices (i.e. Grower Returns)*: USDA NASS Almond Objective Estimate, July 10, 2024.
Saleable Supply: Almond Board of California. Almond Almanacs for crop years 2012, 2019, and 2023.

Testing the "Visual Model" to Forecast the 2023 Grower Return

A model is only "good" if it can help "predict" an outcome (within a reasonable error range). As such, if we wanted to predict the grower return for Crop Year 2023 (the most recent completed year), then we need to know the percentage change in saleable supply in crop year 2022 and crop year 2023 (to calculate the percentage change in supply)—see Formula 4 (**note**: crop volumes are shown in millions of lbs).

Formula 4

$$\%\Delta Q_{23} = \frac{(Q_{23} - Q_{22})}{Q_{22}} \rightarrow \%\Delta Q_{23} = \frac{(3{,}197.4 - 3{,}356.5)}{3{,}356.5} \rightarrow \%\Delta Q_{23} = \frac{(-159.1)}{3{,}356.5} \rightarrow \%\Delta Q_{23} = -4.74\%$$

Using the $\%\Delta Q_{23}$ of -4.74% and applying it to Formula 3, we can "estimate" the $\%\Delta P_{23}$—see Formula 5.

Formula 5

$$\left(\%\Delta P_{23} = \frac{\%\Delta Q_{23}}{e_d}\right) \rightarrow \left(\%\Delta P = \frac{-4.74\%}{-0.646}\right) \rightarrow \%\Delta P = +7.34\% \text{ (\textit{i.e. prices should rise by 7.34\%})}$$

Recognizing that we previously "visually" estimated the *%ΔP* was approximately 10% when the *%ΔQ* was zero, then we need to add the 10% with the added 7.34% (which was due to the saleable supply reduction of 4.74%). Formula 6 uses the "non-scientific" method to forecast Crop Year 2023's grower return.

Formula 6

$$\begin{aligned} Grower\ Return_{23} &= (Grower\ Return_{22}) * (1 + (10\% + 7.34\%)) \\ &= (\$1.40/Lb) * (1.1734) \\ &= (\$1.64/Lb) \end{aligned}$$

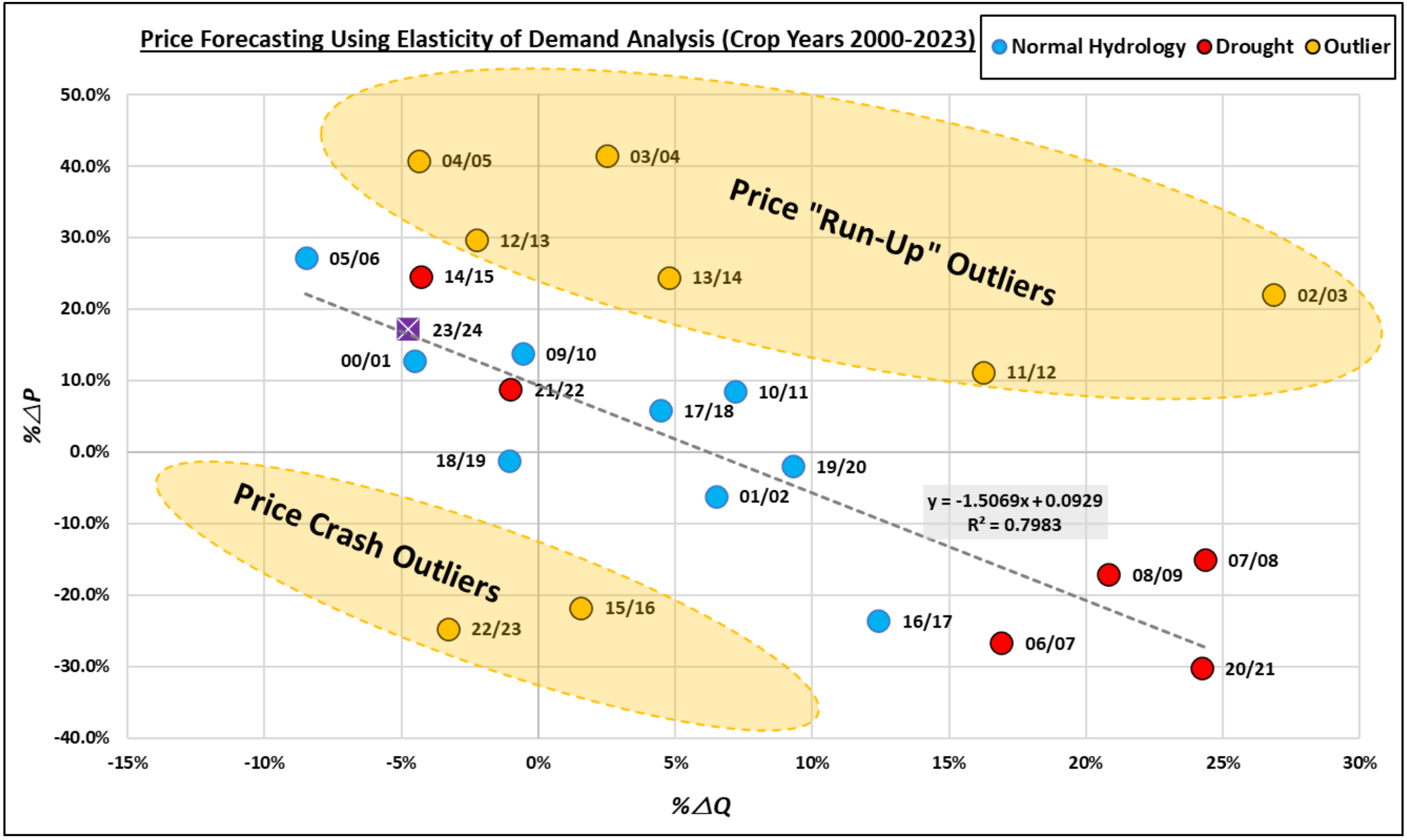
According to Formula 6, if the saleable supply was reduced by 4.74%, then the grower return should have increased by 17.34%. The effect of this change would result in grower returns increasing from $1.40 in CY22 to $1.64 in CY23.

According to the USDA NASS Objective Estimate on July 10, 2024, the crop year 2023 grower return was published to be $1.64/Lb (**exactly as the non-scientific "visual" model predicted**).

Regression-Based Forecasting Tool

Those with a background in statistics were probably seeing that the non-scientific "visual" model was actually a regression (without all of the calculations). However, to show the efficacy of the model and actually present a "mathematical" model for estimating grower returns, one can apply the same techniques of omitting the outlier years and calculating a regression based on the non-outlier "drought" and "normal hydrology" crop years—see Figure 5.

Figure 5



According to the calculated regression, the historical $\%\Delta Q$ can explain 79.83% of the variation in the historical $\%\Delta P$ (the definition of R^2). Formula 7 shows the proposed regression formula for calculating the grower return when market prices are "stable".

Formula 7

$$\%\Delta P = 0.0929 - (1.5069)*(\%\Delta Q)$$

Formula 8 calculates the grower return for crop year 2023 using Formula 7 (recognizing Formula 4 already calculated the $\%\Delta Q_{23}$ to be -4.74%).

Formula 8

$$\begin{aligned}\%\Delta P_{23} &= 0.0929 - (1.5069)*(-0.0474)\\ &= 0.0929 + 1.0714\\ &= 0.1643\\ &= 16.43\%\end{aligned}$$

Finally, Formula 9 applies the *%ΔP₂₃* to calculate the actual grower return.

Formula 9

$$\begin{aligned}Grower\ Return_{23} &= (Grower\ Return_{22}) * (1 + 0.1643)\\ &= (\$1.40/Lb) * (1.1643)\\ &= (\$1.63/Lb)\end{aligned}$$

The regression model was off by a "penny" compared to the actual 2023 farm gate price published in July 10, 2024 USDA NASS Objective estimate. For forecasting purposes, this estimate should be acceptable.

The two proposed models appear to have either "exactly" or very closely" forecasted the grower return; however, skeptics would say, "a single forecast is interesting but not proof the methodologies are valid." In fact, one of my early career bosses would say "even a broken clock is right twice a day." To provide a complete summary of how the models would perform under "non-outlier" crop years, Figures 6 and 7 show the predicted grower returns for each model versus the actual USDA "farm gate prices" from 2000 to 2023.

Figure 6

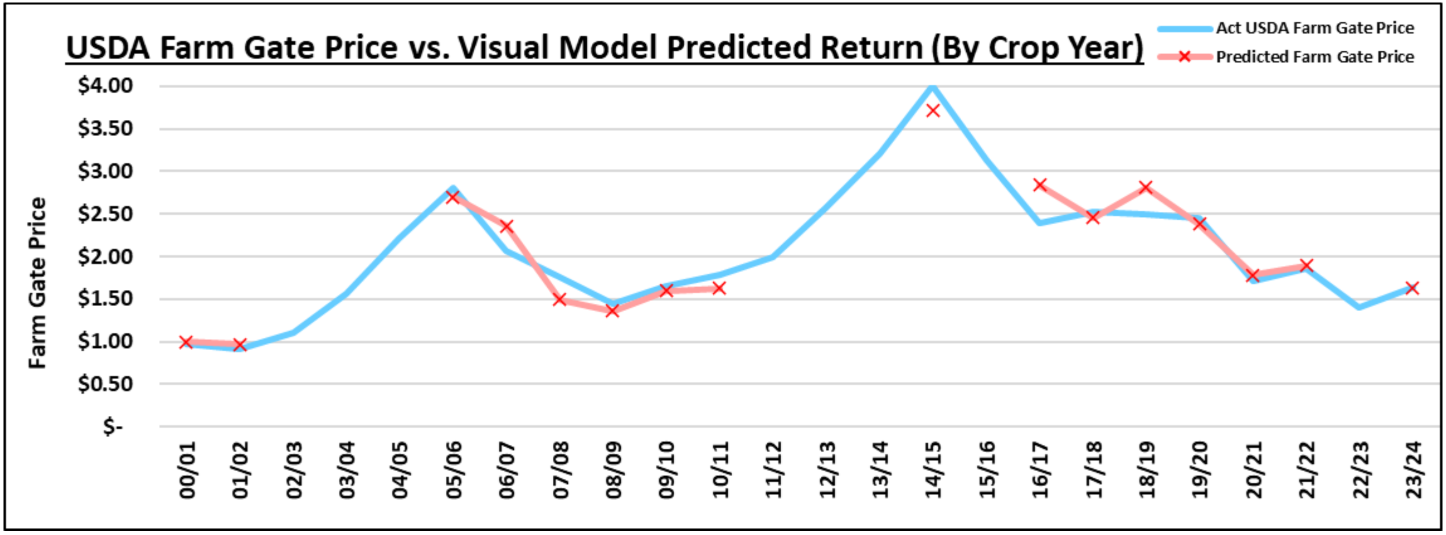
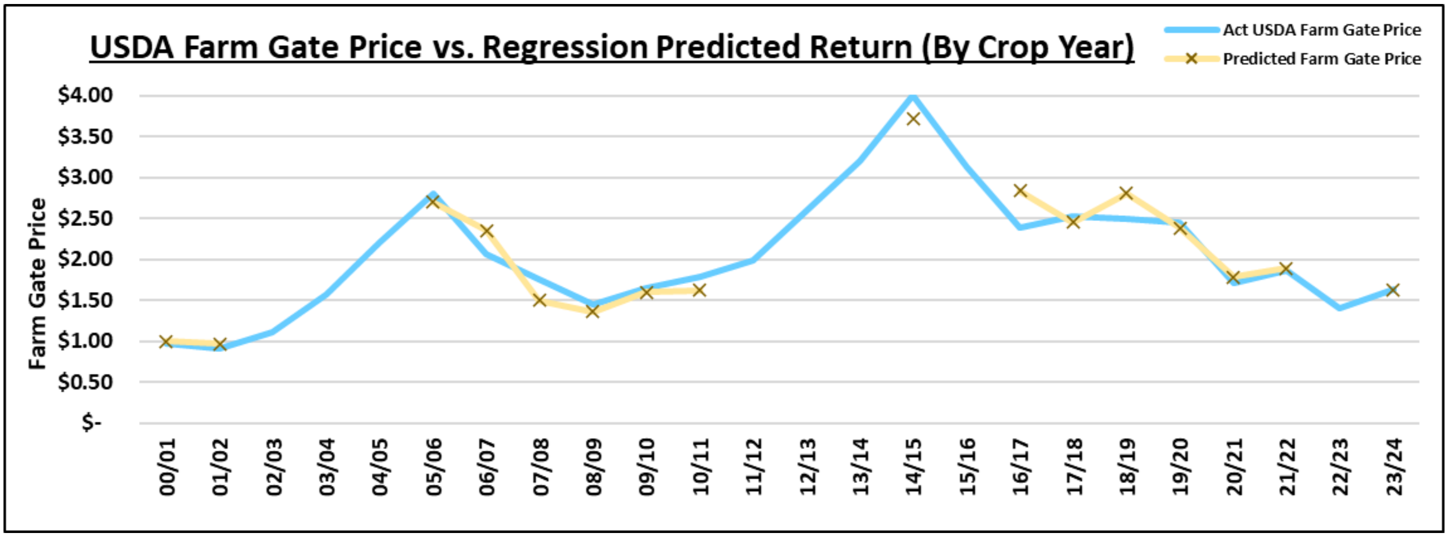


Figure 7



Figures 6 and 7 may "appear" to be identical, but each predicted return for the "visual" model and the "regression" model are uniquely shown in each chart. What the models actually show is that a person can "estimate" the grower return using either model and know the results will be relatively close to one another. To compare the calculated results between the two proposed models versus the USDA's farm gate price, the calculated results for the "non-outlier" crop years is provided on Table 4.

To answer the "which model is better at predicting the grower return" question, two diagnostic measures are presented: the Mean Absolute Deviation (i.e. in absolute value terms, on average, how far "off" is the model for the non-outlier years shown) and the Mean Absolute Percentage Deviation (the percentage error the model has versus the "actual" farm gate price—the lower the better)—see Table 4.

Table 4

Crop Year	USDA Farm Gate Price	Visual Model			Regression Model		
		Predicted Price	Error	Absolute Error	Predicted Price	Error	Absolute Error
00/01	$ 0.97	$ 1.01	$ 0.04	$ 0.04	$ 1.00	$ 0.03	$ 0.03
01/02	$ 0.91	$ 0.97	$ 0.06	$ 0.06	$ 0.97	$ 0.06	$ 0.06
05/06	$ 2.81	$ 2.72	$ (0.09)	$ 0.09	$ 2.70	$ (0.11)	$ 0.11
06/07	$ 2.06	$ 2.36	$ 0.30	$ 0.30	$ 2.35	$ 0.29	$ 0.29
07/08	$ 1.75	$ 1.49	$ (0.26)	$ 0.26	$ 1.50	$ (0.25)	$ 0.25
08/09	$ 1.45	$ 1.36	$ (0.09)	$ 0.09	$ 1.36	$ (0.09)	$ 0.09
09/10	$ 1.65	$ 1.61	$ (0.04)	$ 0.04	$ 1.60	$ (0.05)	$ 0.05
10/11	$ 1.79	$ 1.63	$ (0.16)	$ 0.16	$ 1.62	$ (0.17)	$ 0.17
14/15	$ 4.00	$ 3.75	$ (0.25)	$ 0.25	$ 3.72	$ (0.28)	$ 0.28
16/17	$ 2.39	$ 2.84	$ 0.45	$ 0.45	$ 2.83	$ 0.44	$ 0.44
17/18	$ 2.53	$ 2.46	$ (0.07)	$ 0.07	$ 2.45	$ (0.08)	$ 0.08
18/19	$ 2.50	$ 2.83	$ 0.33	$ 0.33	$ 2.81	$ 0.31	$ 0.31
19/20	$ 2.45	$ 2.39	$ (0.06)	$ 0.06	$ 2.38	$ (0.07)	$ 0.07
20/21	$ 1.71	$ 1.78	$ 0.07	$ 0.07	$ 1.78	$ 0.07	$ 0.07
21/22	$ 1.86	$ 1.91	$ 0.05	$ 0.05	$ 1.90	$ 0.04	$ 0.04
23/24	$ 1.64	$ 1.64	$ 0.00	$ 0.00	$ 1.63	$ (0.01)	$ 0.01

Mean Absolute Deviation-->	**$ 0.14**	**$ 0.15**
Mean Absolute Percentage Deviation-->	**7.1%**	**7.2%**

According to the diagnostic comparative metrics, the "visual" method is slightly better because the model is only 14-cents off "on-average" (versus the 15-cents for the regression model) and the average percentage error (MAPD) for the "visual" model was 0.1% lower than the "regression" model. Furthermore, both models have an error percentage of approximately 7% (which means they have an accuracy percentage of 93%). Although the difference between the two models is very minor, the take-away is that the "visual" model can provide a simple tool for analysts to forecast grower returns using the "visual" model and know the results will almost identical to a more scientific method (such as the "regression" model). For those with a "finance" background, it is similar to using the "Rule of 72" to estimate how long an investment will take to double in value at a given rate of return (versus using the compound interest formula for the "exact" number of years)—in the end, both will be relatively close to one another.

It should be noted that there are years with more than 25-cents of variation (see entries highlighted in yellow) that are not considered "outliers". The one does not consider the high variation years (i.e. the ones in yellow) into consideration, then the models would only have a variation of approximately 7-cents per pound.

Conclusion

After a decade of lucrative growth in the 2010s, almond farmers are struggling with low grower returns in the 2020s. The reasons for the low returns vary from demand reductions in key markets due to tariffs (such as China) to supply-side pressures due to high carry-ins during COVID. This article provided a qualitative overview of carry-ins and the potential signaling different levels can have on the almond market. Furthermore, the article then provided both an elasticity-based "non-scientific" method for forecasting grower returns as well as a "regression-based" method (both of which tied almost perfectly to the actual grower return in Crop Year 2023). Finally, when comparing the performance of the "visual" model and the "regression" model, the results were almost identical—with the "visual" model suggesting a very slight edge over the "regression" model.