Evaluation of Transportation Practices in the California Cut Flower Industry

Keywords: freight consolidation, cut flower

Abstract

In the past two decades, California's share of the national market for cut flowers has decreased from 64% to 20%. California flower farmers' largest competitors are South American farmers, particularly in Colombia and Ecuador, who have benefitted from the 1991 Andean Trade Preference Act. The law cut import tariffs from South American nations on a range of goods, resulting in Colombia capturing 75% of the U.S. flower market. This paper evaluates the California cut flower industry's current transportation practices and investigates the feasibility and cost of establishing a shipping consolidation center in Oxnard, California. The problem is formulated using a mixed-integer programming model. The model estimates a 34.8% shipping cost decrease, $20M, if all California farms participate in the consolidation center.

Introduction

California's unique climate is ideally suited for flower cultivation, and the cut flower industry is a significant contributor to the state's economy. In 2006, California led the country with $316 million in cut flower sales, representing 77 percent of the total U.S. production (U.S. Department of Agriculture 2007).

California flower farmers face fierce competition from South American growers. The flower business in Colombia began in 1969 with the founding of Floramérica. Earlier that decade, horticulturalist David Cheever suggested that the savannah near Bogotá, Colombia's capital, had an ideal climate to grow flowers all year round because the area had little temperature variation and consistent sun exposure. Founded by Cheever and three partners, the company put these theories into practice, and within five years of Floramérica's first planting in October 1969, at least ten more growers began planting in the area (McQuaid 2011). In 1991, the United States enacted the Andean Trade Preference Act (APTA), a business incentive that suspended import duties on flowers into the United States for countries such as Colombia and Ecuador. The purpose of this legislation was to promote production of legal crops and shift the dependence away from drug production and trafficking. The policy has been at least partially successful. Today, South America exports more than $1 billion in blooms, second only to the Netherlands, and controls approximately 70% of the United States market (Arbelaez, Melendez and Leon 2007). An imminent trade deal with Colombia passed by the U.S. Congress in October, 2011 will further facilitate the importation of South American blooms and their dominance of the market (Appelbaum and Steinhauer 2011).

An important factor in South American growers competing so effectively with U.S. growers and achieving such a substantial market share is the cross-docking and distribution system established in Miami and shared by South American growers. This point-of-entry for imports provides a single consolidation and pick-up location for South American growers to send their product before shipping out to the rest of the United States. The consolidation point in Florida allows South American growers to negotiate extremely favorable trucking delivery rates based on the magnitude of their volume and the need for trucking companies to transport their trucks out of Florida to other locations. A new framework for shipping flowers within and from California needs to be developed to offset this competitive advantage by the South American growers and enable California cut flower farmers to compete.

This paper evaluates the California cut flower industry's current transportation practices and investigates the feasibility and cost of shipping consolidation from one pick-up location, focusing specifically on firms represented by the California Cut Flower Commission (CCFC). The CCFC is a state government agency created by the state legislature to promote California-grown cut flowers and foliage. Established in 1990, CCFC represents approximately 250 cut flower and greens farms in the state of California (Williamson 2011). The CCFC proposes Oxnard, in southwestern Ventura county, as the site's location; Oxnard sits on the Pacific coast, approximately 35 miles southeast of Santa Barbara and 55 miles west of downtown Los Angeles. See Figure 1.

Currently, California's flower farms grow, sell and ship their products independently; there is no common pick-up location and a carrier must travel to all farm locations. Customers can be classified into two broad categories: Wholesale markets enter into long-term shipping arrangements with third-party carriers, and product bound for different wholesale purchasers can be accommodated on the same truck. Mass markets (e.g. supermarket chains) employ their own transportation network, and thus flowers purchased by different mass market customers travel in separate trucks.

The remainder of the paper is organized in the following manner. We summarize relevant literature on freight consolidation approaches in the next section. There are two phases to our approach: data collection and strategic/tactical modeling. The first phase is the collection of shipment data from the farms. The goal of data collection is to aggregate historical shipments to evaluate current shipping modes and rates. We perform a data analysis of current shipments on submitted CCFC data to evaluate current transportation practices. These results are included in

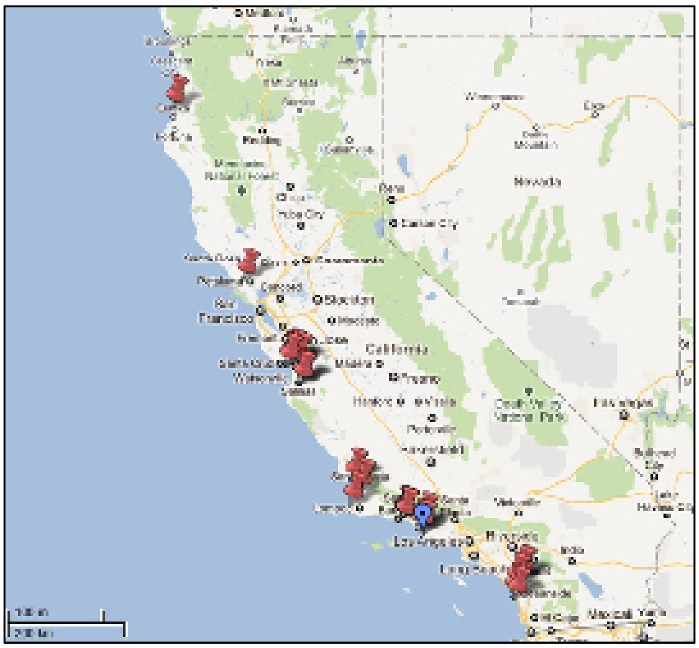

Figure 1. CCFC proposes establishing a consolidation center at Oxnard, CA(round place mark) to service its farmers (thumbtack place marks).

the *Data Analysis* section. The second phase of our approach is exercising a strategic concept model to evaluate various what-if scenarios and identify opportunities to lower costs and improve service levels. We explain the optimization methodology for shipping from a single consolidation center in the *Methodology* section. We present summary results and analysis in *Results*. Policy implications of the results are provided in the *Conclusions*.

Relevant Literature

Freight consolidation is the process of combining the transportation of different items produced or used at different locations; larger load sizes take advantage of lower transportation costs. This process can occur in inventory, in vehicles, and in terminals (Hall 1987). A survey of 53 U.S. firms reflects the importance of freight consolidation practices in terms of cost reductions. The majority of the cost reduction comes from taking advantage of economies of scale (Jackson 1985). There are three classifications of basic consolidation strategies: spatial, product and temporal (Min and Cooper 1990). This paper primarily focuses on a product consolidation strategy.

Shipment-release policies have been researched in various forms. Gupta and Bagchi (1987) develop a stochastic clearing model to calculate the minimum cost-effective lot size to be accumulated before release. Higginson and Bookbinder (1994) examine existing shipment-release policies used to determine how long shipments should be held and how much should be accumulated before shipping. A simulation model is designed to test and compare the different policies. Higginson (1995) focuses on both non-recurrent approaches and recurrent approaches. Non-recurrent approaches are predetermined criteria, such as a set target time or lot size, used to dispatch consolidated loads while recurrent approaches re-evaluate the decision to dispatch the consolidated load. The performance of two probabilistic recurrent decision models is compared with the non-recurrent policy. The model developed by Lee et al. (2003) computes the optimum replenishment value and determines shipment release schedules for a third party warehouse. The authors solve the model by combining a network approach and a polynomial algorithm.

Specific factors defined by the consolidation policy affect the system-level performance of a distribution network. Ha et al. (1988) design their study to determine the impact of the number of consolidation points and special delivery requirements (e.g. immediate delivery of an order without consolidation) on system performance values. The authors design a simulation model that uses market, transportation network and logistics data to build the distribution network and logistics system. A statistical analysis shows that the special delivery requirement level has a larger effect on system costs than the number of consolidation points in the network.

Cooper (1983) compares system costs and delivery times of different combinations of warehousing and consolidation strategies. A multivariate analysis of variance is used to analyze the results from a facility location and dynamic simulation model to determine relevant impacts. In a different paper, Cooper (1984) compares distribution costs and delivery times for six different distribution system designs. Two major methods are used: a branch and bound location algorithm to select consolidation points and an event-oriented Monte Carlo simulation to determine delivery times and distribution costs.

Pooley and Stenger (1992) employ a full factorial experimental design to assess factor effects of a single source shipment consolidation problem. An algorithm is developed to solve the problem, and the experiment tests the factors' effect on system performance while using a consolidation strategy. The methodology includes collecting empirical data for a dynamic simulation model and a mixed-integer mathematical programming network design model.

Distribution systems tend to be more complex than a system containing one consolidation center for a plant and its customers. A firm with multiple stages in the distribution network contains opportunities for consolidation across the system. Closs and Cook (1987) develop a dynamic simulation model that replicates complex operations in a multi-stage distribution network for use in real-world applications. The model determines the impact of stochastic transit times and order arrivals on system performance.

Popken (1994) considers a multi-attribute, multi-commodity problem solved by using an algorithm that consolidates inbound products through transshipment terminals. The results of multiple attribute commodities provide insight into reducing total transportation costs and inventory costs through routing strategies.

Tyan et al (2003) consider a system with shipments made between a distribution center and an airport. They focus on maximizing aircraft utilization under various consolidating policies for a global third party logistics firm. The authors develop a mathematical model that determines different shipment allocations to flights for each day.

Russell and Cooper (1992) examine a coordinated replenishment problem. They develop a multi-item model that incorporates quantity discounts and transport weight breaks on inbound shipments. Benchmark solutions from a mixed-integer linear programming model are used to determine the effectiveness of the developed heuristic and to provide insight on the relationship between the purchasing environment and the behavior of the inbound freight consolidation system.

Practical applications and case studies provide further insight on the behavior of real world scenarios to consolidation policies. Marcucci and Danielis (2008) perform a stated-preference study to investigate a firms' willingness to use and pay for an urban freight consolidation center (UFCC). Data was collected through face-to-face interviews with shop keepers, small businesses, and transport operators. Based on the sample data, UFCC service cost, delivery time, annual cost, and parking distance from the shop have a major influence on choosing between UFCC and private transport. The authors also simulate different policies to see how much and in what combinations these four variables influence UFCC or private vehicle choice.

Bookbinder and Barkhouse (1993) propose a logistics information system (LIS) to facilitate both inbound and outbound shipments at a consolidation center. A computer algorithm is developed to consolidate inbound and outbound shipments simultaneously. Their article describes the necessary requirements and modules, and capabilities of LIS in a real setting.

Bausch et al (1995) specifically examine the case of consolidating Mobil Oil Corporation's heavy petroleum products. They design a computer system that quickly solves an elastic set-partitioning model and selects a least-cost portfolio of schedules for each truck type. A dispatcher selects from the set of schedules and assigns a feasible route to a truck.

The Kellogg Company uses two versions of a planning system (KPS) to reduce costs, plan production and make distribution decisions. KPS is a large-scale multi-period linear programing system developed by Brown et al (2001). An operational version helps reduce its weekly production, inventory and distribution costs as well as where and how products should be produced and shipped. The tactical version of KPS is a linear programming model that plans budgets and makes capacity-expansion and consolidation decisions at a monthly level of detail. KPS estimates savings of $35 million per year from consolidating production (Brown et al. 2001).

Data Analysis

Of the 250 farms represented by CCFC, 70 have large production volumes. Sixteen of these 70 large cut flower producers participated in the transportation study. They submitted 2010 sales data including shipment origins, destinations, dates, box dimensions, and volume for each day of the year.

The collected data accounts for roughly 53% (in sales dollars) of the CCFC members' total production volume in 2010. In addition, four farmers participated in a previous study in 2008 but were unable to participate in the current study. To make use of all available data, we performed a statistical comparison between the two data sets and extrapolated the 2008 data based on the results. This section summarizes the data collection and analysis.

Data Summary

Scatterplots of 2008 and 2010 daily volumes, if available, were made for every farm. The scatterplots below are a sample of 2008 and 2010 data for four different farms. In general, the week before Valentine's Day and Mother's Day experience a significant increase in outgoing volume compared to the rest of the year; transportation schedules also change during Valentine's Day and Mother's Day to serve the larger than average holiday requests.

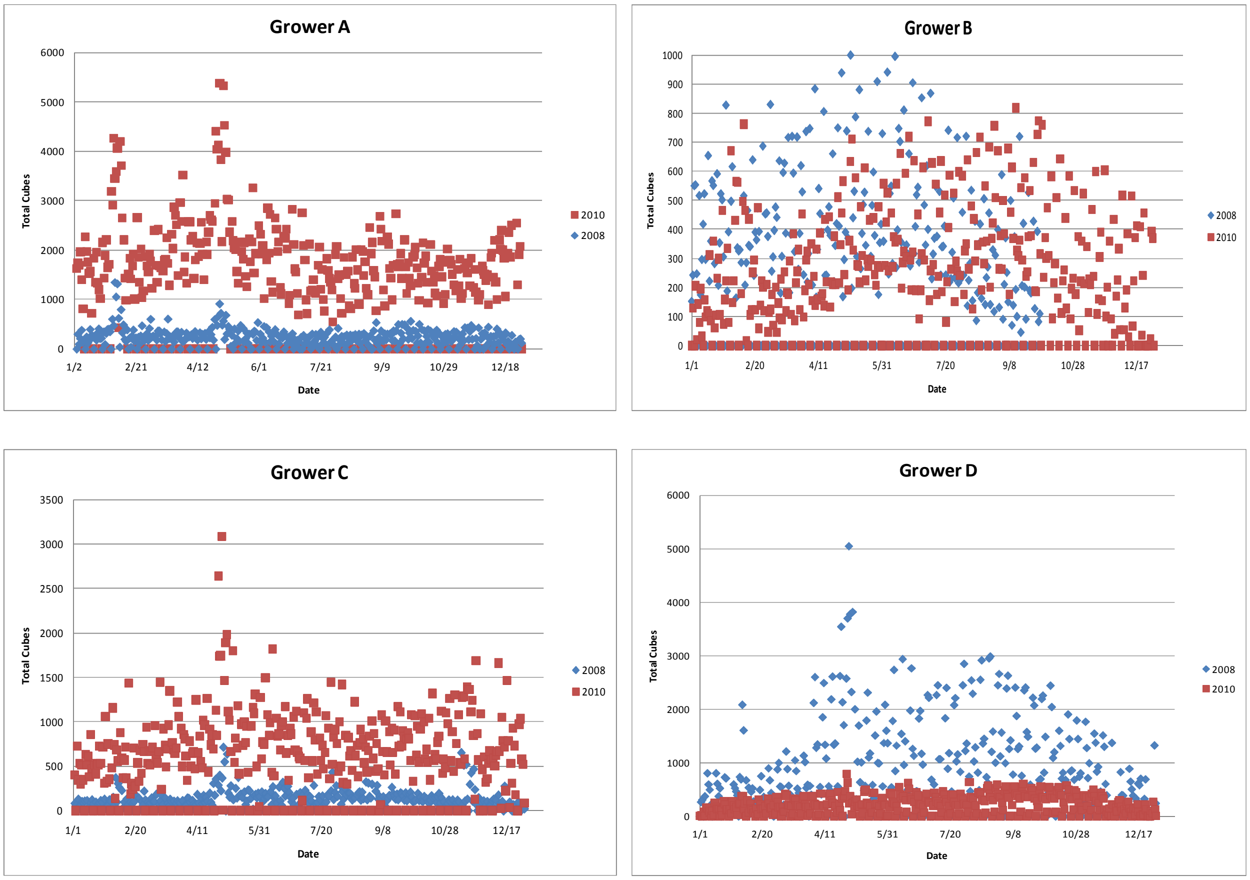

Figure 2. Volume sales can increase, decrease or stay the same from 2008 to 2010 as shown by these four farms.

Farm A and C's data illustrate an increase in sales from 2008 to 2010 while farm D experienced a decrease in sales. Farm B did not have a significant change in sales. Overall, most farms experienced an increase in sales similar to farms A and C.

Extrapolation from 2008 Data

We performed a Two-Sample t-test on each farm that submitted both 2008 and 2010 data to determine whether the 2008 data could be used directly or if an extrapolation should be applied.

The average and 95% Confidence Interval (CI) output from this test is based on the difference between 2008 and 2010. Table 1 displays average difference, CI lower and upper bounds, and a p-value for each farm under the null hypothesis that the 2008 and 2010 data came from the same population.

Table 1. The Two-Sample t-test results show that the 2008 and 2010 volume data are statistically significantly different.

		95% Confidence Interval		
Farm	Average Difference (2010-2008) (cubic feet)	Lower Bound (cubic feet)	Upper Bound (cubic feet)	T-Test of Difference, P-Value
A	1321.2	1219.9	1422.5	0.000
B	52.9	17.6	88.2	0.003
C	540.4	493.2	587.6	0.000
D	-665.1	-754.7	-575.6	0.000
E	64.1	51.8	76.39	0.000
F	-202.9	-282.3	-123.6	0.000
G	24.9	-9.5	59.4	0.156

Farms A, B, C, and E show an increase in sales from 2008 while farms D and F show a decrease in sales. The CIs for these farms do not contain 0, indicating that 2008 and 2010 data are statistically different. Therefore the 2008 data from the four farms who did not submit 2010 data could not be used directly. The average difference in production volume for the farms that submitted data for both 2008 and 2010 is 104.6%, and the data for the four farms that submitted data in 2008 but not for 2010 is linearly extrapolated by the same 104.6%. The data from the four farms provides an additional 10% in sales dollars. The four farms plus the sixteen 2010 data sets account for approximately 63% (in sales dollars) of the CCFC members' total production volume.

Methodology

We consider two models for this study: baseline and consolidation. The baseline model reflects the current transportation practices of the CCFC farms. The consolidation case assumes one pick-up location in Oxnard with all products consolidated prior to shipping to their respective customers. The optimization model formulation for the consolidation strategy is included in Appendix A. The following numerical parameters and assumptions were made for both models.

- Time frame: 365 days (Jan 1 - Dec 31)
- Maximum volume per trailer: 2,600 cubic feet
- Weight per cube: 7.2 lbs
- Less than Truckload (LTL) rates (provided by farms)
- Full Truckload (FTL) rates (provided by Supply Chain Coach, a consulting company)

Both models include the option to send products via full truckloads, LTL, or as small packages (FedEx/UPS). The transportation costs are assumed to be time-independent and the cheapest option is always chosen. FedEx/UPS rates depend on the weight of the shipment. LTL rates are dollars per cubic foot and full truckload rates are a fixed total cost that varies based on mileage between origin and destination. The rates in Figure 3 are chosen for illustrative purposes. Very small shipments can be sent at a cheaper rate with FedEx/UPS but as the volume increases, LTL shipments are cheaper. When volume gets much larger, sending a full truck is a less expensive option than an LTL truck.

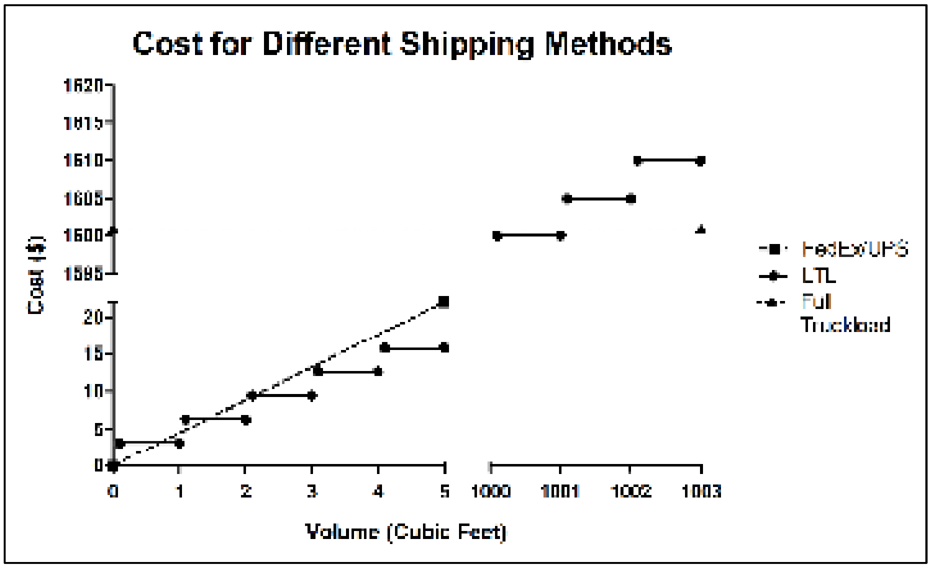

Figure 3. Extremely small shipments have cheaper FedEx/UPS cost while much larger volumes have cheaper full truckload rates.

The consolidation model also assumes that no consolidation takes place at individual farms; that is, the product is shipped to the consolidation point as soon as it is ready. To account for the product's vulnerability to spoilage, and based on CCFC grower feedback, we assume flowers are held at the consolidation point for no more than one day. In both models, wholesale and mass market products are shipped separately, and the products for different mass market customers are also shipped separately. Finally, the consolidation model does not consider a limited transportation fleet or a finite storage capacity at the consolidation center. Rather, the goal is to observe how the system would behave if these two policy variables are unconstrained, and then use this behavior to determine the required fleet size and facility capacity.

The consolidation model observes the following policy: on a given day, a truck departs for a specific destination only if the facility has some product that must be shipped there on that day. The truck is then filled as completely as possible with newer products heading to the same destination, with priority given to the product with the closest delivery date. Additional trucks are sent to the destination following the same rule. The model retains the option to send any truck using LTL or full truckload rates, depending on the volume. It can also send producs by small package carrier (FedEx/UPS) if the shipping cost is cheaper.

The consolidation model takes advantage of a single pick-up location for all the farms. This allows the farmers to send their flowers to one location to be packed onto a truck that, in the baseline model, would have to go to every farm to pick up the same products and would charge LTL rates to every farm individually.

Results

We evaluate the available data from the 20 farms (the 16 acquired for this study plus the four extrapolated from 2008 data) using both baseline and consolidation models. However, this data only accounts for 63% of CCFC's 2010 sales volume, thus ignoring possible additional economies of scale. A large share of the remaining volume associated with the CCFC membership is accounted for by the State's remaining 50 large growers. We therefore construct different extrapolation scenarios to account for the missing farms' volume.

Scenario Construction

The scenario set is constructed based on 2010 aggregate sales figures provided by CCFC. The 50 missing farms are sorted from largest to smallest, and the following scenarios are defined using this sorted list.

- Scenario 1: Do not extrapolate to include any of the remaining 50 large farms
- Scenario 2: Extrapolate to include the top 20% of the remaining 50 large farms
- Scenario 3: Extrapolate to include the top 40% of the remaining 50 large farms
- Scenario 4: Extrapolate to include the top 60% of the remaining 50 large farms
- Scenario 5: Extrapolate to include the top 80% of the remaining 50 large farms
- Scenario 6: Extrapolate to include the top 100% of the remaining 50 large farms

The baseline and consolidation models run these two sets of scenarios. The next section outlines the results of the scenario runs.

Analysis

Table 2 provides a detailed summary of the base case and consolidation models for Scenario 3, an intermediate volume case. The table includes the annual cost, volume sent by the three shipping options, and the cost difference or savings between the base case and consolidation strategies.

In Scenario 3, the LTL volume decreases from 57.37% to 4.29% of the total volume while the full truck volume increases from 36.85% to 95.70%. The total annual transportation cost decreases by approximately $17 million, or 37%. This difference illustrates the benefits of shipping consolidation.

Table 2. An extrapolation for 40% of the missing farms yields an estimated $17M in savings.

	Annual Cost	Volume Sent By: (cubic feet)			Total Volume (cubic feet)
		FedEx/UPS	Less Than Truckload	Full Truckload	
Base Case					
Mass Market	$ 5,124,687.27	59,841.93	1,601,729.53	701,605.17	2,363,176.63
Wholesale	$ 41,797,404.55	894,737.29	7,869,273.18	5,380,923.43	14,144,933.89
Total	$ 46,922,091.82	954,579.22	9,471,002.71	6,082,528.60	16,508,110.52
Consolidation					
Mass Market	$ 2,810,701.27	1,443.31	91,661.21	2,270,072.12	2,363,176.63
Wholesale	$ 26,917,723.84	1,028.24	616,449.66	13,527,456.00	14,144,933.89
Total	$ 29,728,425.11	2,471.54	708,110.86	15,797,528.12	16,508,110.52
Difference	$(17,193,666.71)	(952,107.68)	(8,762,891.84)	9,714,999.52	

Figure 4 shows the annual cost trend when extrapolating for the missing farms using sales as the extrapolation criteria. The cost difference between the base case and consolidation for each scenario grows as more missing farms are added to the simulation; that is, baseline costs grow more rapidly than consolidation costs, because the scope of the inefficiency in the baseline is larger.

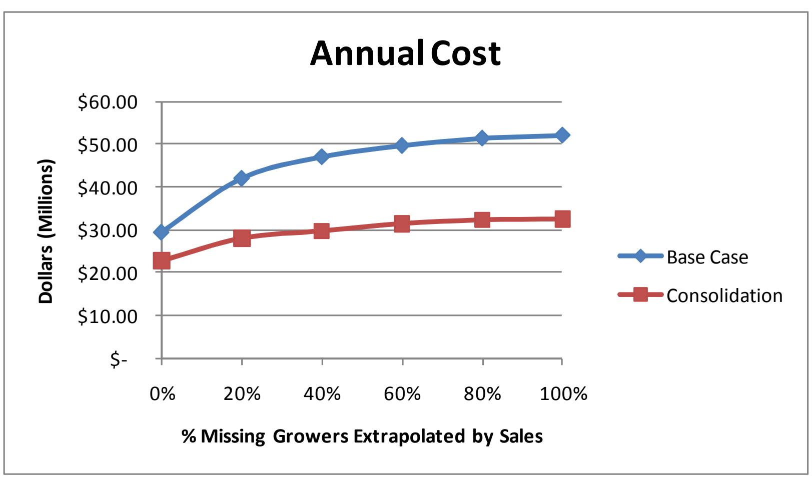

Figure 4. Transportation cost savings from the consolidation model increases as participation increases.

The difference between LTL volumes also grows as the scenarios include more missing farms, with the base case volume growing more rapidly than the consolidation case; see Figure 5. The opposite occurs for the full truck volumes in Figure 6. The full truck volume increases more rapidly for the consolidation case compared to the base case. These figures indicate that most farms do not have enough sales volume at specific destinations to send out a full truck, resulting in more costly LTL and FedEx/UPS shipments. Therefore, a consolidation within a cooperative model, as recommended, would greatly benefit these medium-sized farms.

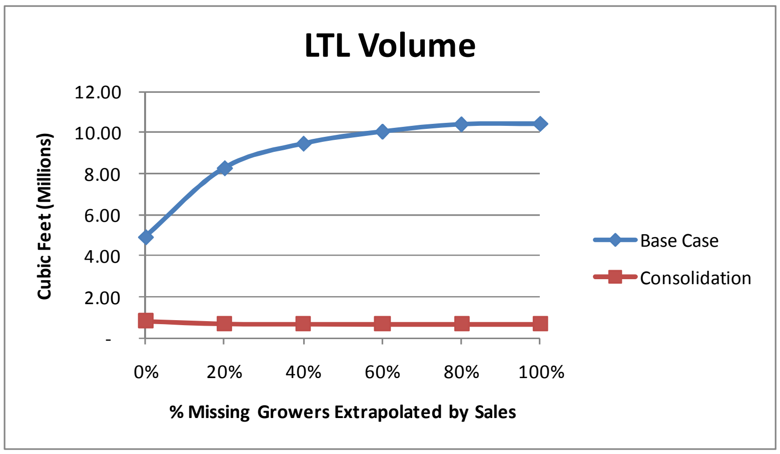

Figure 5. The LTL volume trend across the scenarios remains relatively the same.

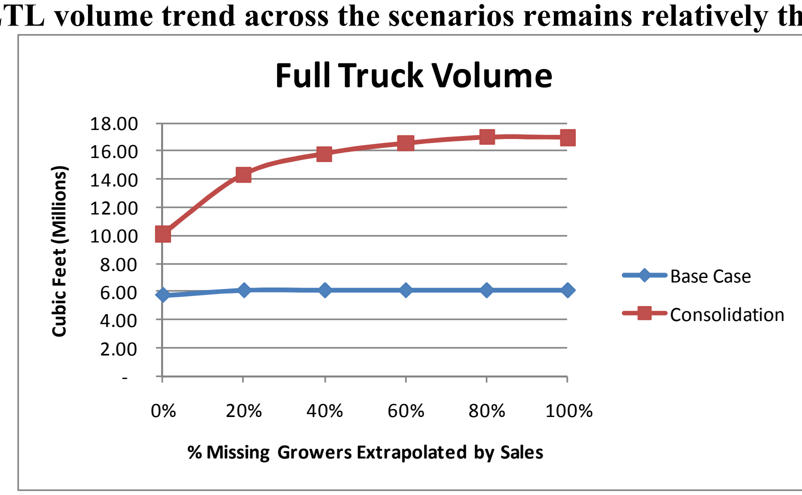

Figure 6. Consolidation takes advantage of the lower transportation costs for full trucks; the base case shows that only a few farmers have enough volume to send full trucks.

Overall, the benefits stem from the existence of a single location for the consolidation of shipments as well as the advantage to carriers of having one pick-up location. Appendix B includes the detailed results for each scenario.

Conclusions

The consolidation optimization model evaluates how CCFC growers could save on transportation costs by consolidating shipments. It uses a combination of 2010 sales data and extrapolated 2008 data to assess the potential savings from having one pick-up location for carriers to consolidate shipments. If the 20 growers that account for 63% of the volume shipped by CCFC members consolidate shipments, these farmers would experience approximately a 29.5% decrease in total annual transportation cost relative to the base case. For each scenario in which an increasing share of the largest remaining farms is added to the consolidation option, the model further demonstrates the opportunity for increased cost savings for those farms participating in the consolidation center and single pick-up location. The results provide a dollar value of potential cost savings to California's flower farms as a whole, assuming CCFC or a farm-managed organization, e.g. an agricultural co-operative, manages the consolidation center and the growers' transportation system.

Acknowledgement

The authors would like to thank Kasey Cronquist, CEO of CCFC, for his cooperation, and Tom French and Bob Mundell of Supply Chain Coach for their help in securing transportation figures necessary for the study.

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Appendix A: Optimization Model Formulation

A mixed-integer programming (MIP) optimization model was formulated to model the consolidation center. The following is a list of parameters, decision variables, and the mathematical formulation for the MIP.

Parameters

G: Set of Farms

D: Set of Destinations

t= 1..T : Time Index

α = Conversion factor: 7.2 lbs per cubic foot

d_{ijt} : Demand at destination j to be satisfied by farm i that must leave the consolidation center by time t, $\forall\ i\ \in G, j \in D, t = 1..T$

c_{jF}: Transportation cost for a full truck from consolidation center to destination j, $\forall\ j \in D$, ($/truck)

c_{jL}: Transportation cost for an LTL unit from consolidation center to destination j, $\forall\ j \in D$, ($/ft^3)

c_{jU}: Transportation cost for a small shipment (FedEx/UPS) from consolidation center to destination j, $\forall\ j \in D$, ($/lb)

θ : Maximum time shipments remain at consolidation center, =1

κ_F : Maximum capacity for a truck, in cubic feet

κ_L : LTL units in cubic feet, = 1

Decision variables

x_{jtF}: Number of Full trucks from consolidation center to destination *j* at time *t*, $\forall j \in D, t = 1..T$

x_{jtL}: Number of LTL units from consolidation center to destination *j* at time *t*, $\forall j \in D, t = 1..T$

y_{ijstF}: Amount of product sent by full truck from farm *i* for destination *j* sent on period *s* that needs to be sent by time period *t*, $\forall i \in G, j \in D, s = 1..T, t = s..\min\{s + \theta, T\}$

y_{ijstL}: Amount of product sent by LTL truck from farm *i* for destination *j* sent on period *s* that needs to be sent by time period *t*, $\forall i \in G, j \in D, s = 1..T, t = s..\min\{s + \theta, T\}$

y_{ijstU}: Amount of product sent by small shipments from farm *i* for destination *j* sent on period *s* that needs to be sent by time period *t*, $\forall i \in G, j \in D, s = 1..T, t = s..\min\{s + \theta, T\}$

Model

Minimize

$$\sum_{t=1}^{T}\sum_{j \in D}(c_{jF}x_{jtF} + c_{jL}x_{jtL}) + c_{jU}\alpha \sum_{i \in G}\sum_{s=1}^{T}\sum_{t=s}^{\min\{s+\theta,T\}} y_{ijstU} \tag{6}$$

Subject to

$$\sum_{i \in G}\sum_{t=s}^{\min\{s+\theta,T\}} y_{ijstF} \leq \kappa_F x_{jsF}, \qquad \forall j \in D, s = 1..T$$

$$\sum_{i \in G}\sum_{t=s}^{\min\{s+\theta,T\}} y_{ijstL} \leq \kappa_L x_{jsL}, \qquad \forall j \in D, s = 1..T \tag{7}$$

$$\sum_{s=\max\{1,t-\theta\}}^{t} y_{ijstF} + y_{ijstL} + y_{ijstU} = d_{ijt}, \quad \forall i \in G, j \in D, t = 1..T \tag{8}$$

$$
\begin{aligned}
&y_{ijstF} \geq 0, \quad \forall i \in G, j \in D, s = 1..T, t = 1..T \\
&y_{ijstL} \geq 0, \quad \forall i \in G, j \in D, s = 1..T, t = 1..T \\
&y_{ijstU} \geq 0, \quad \forall i \in G, j \in D, s = 1..T, t = 1..T \\
&x_{jtF} \geq 0, x_{jt} \in \mathbb{Z}, \qquad \forall j \in D, t = 1..T \\
&x_{jtL} \geq 0, x_{jt} \in \mathbb{Z}, \qquad \forall j \in D, t = 1..T
\end{aligned} \tag{9}
$$

Appendix B: Detailed Scenario Generation

This appendix contains the detailed information for each of the scenarios.

Extrapolation by Sorted 2010 Sales List

These scenarios were constructed from a sorted 2010 Sales list for all 70 farms (provided by CCFC). The farms who submitted data were removed and the remaining 50 farms were sorted by their sales.

- Scenario 1: Do not extrapolate to include any of the remaining 50 large farms
- Scenario 2: Extrapolate to include the top 20% of the remaining 50 large farms
- Scenario 3: Extrapolate to include the top 40% of the remaining 50 large farms
- Scenario 4: Extrapolate to include the top 60% of the remaining 50 large farms
- Scenario 5: Extrapolate to include the top 80% of the remaining 50 large farms
- Scenario 6: Extrapolate to include the top 100% of the remaining 50 large farms

The following tables give detailed results of each scenario. Each table contains the estimated annual cost, volume sent by FedEx/UPS, LTL and full truckload, and the breakdown for mass market and wholesale for the base case and the consolidation case.

Table 3. The estimated savings for no extrapolation of missing farms is approximately $7M USD.

	Annual Cost	Volume Sent By: (cubic feet) FedEx/UPS	Less Than Truckload	Full Truckload	Total Volume (cubic feet)
Base Case					
Mass Market	$ 1,675,919.10	7,396.44	415,331.81	621,139.49	1,043,867.75
Wholesale	$ 27,822,232.14	252,718.72	4,508,629.51	5,125,425.30	9,886,773.54
Total	$ 29,498,151.24	260,115.16	4,923,961.33	5,746,564.80	10,930,641.28
Consolidation					
Mass Market	$ 1,238,400.68	1,863.86	61,948.46	980,055.42	1,043,867.75
Wholesale	$ 1,537,451.40	1,425.36	784,127.74	9,101,220.44	9,886,773.54
Total	$ 22,775,852.08	3,289.22	846,076.20	10,081,275.86	10,930,641.28
Difference	$ (6,722,299.17)	(256,825.94)	(4,077,885.13)	4,334,711.06	

Table 4. Extrapolating for 20% of the top missing farms yields estimated savings of $14M USD.

	Annual Cost	Volume Sent By: (cubic feet) FedEx/UPS	Less Than Truckload	Full Truckload	Total Volume (cubic feet)
Base Case					
Mass Market	$ 4,189,472.76	42,451.64	1,273,200.79	701,605.17	2,017,257.60
Wholesale	$ 37,760,924.95	641,102.14	7,006,316.27	5,380,923.43	13,028,341.84
Total	$ 41,950,397.71	683,553.78	8,279,517.06	6,082,528.60	15,045,599.44
Consolidation					
Mass Market	$ 2,789,508.69	1,558.78	83,922.75	1,931,776.07	2,017,257.60
Wholesale	$ 25,241,621.85	1,012.34	639,728.61	12,387,600.89	13,028,341.84
Total	$ 28,031,130.55	2,571.12	723,651.36	14,319,376.96	15,045,599.44
Difference	$ (13,919,267.17)	(680,982.66)	(7,555,865.70)	8,236,848.36	

Table 5. The estimated savings for a scenario with 40% extrapolation of missing farms is approximately $17M USD.

	Annual Cost	Volume Sent By: (cubic feet) FedEx/UPS	Less Than Truck	Full Truckload	Total Volume (cubic feet)
Base Case					
Mass Market	$ 5,124,687.27	59,841.93	1,601,729.53	701,605.17	2,363,176.63
Wholesale	$ 41,797,404.55	894,737.29	7,869,273.18	5,380,923.43	14,144,933.89
Total	$ 46,922,091.82	954,579.22	9,471,002.71	6,082,528.60	16,508,110.52
Consolidation					
Mass Market	$ 2,810,701.27	1,443.31	91,661.21	2,270,072.12	2,363,176.63
Wholesale	$ 26,917,723.84	1,028.24	616,449.66	13,527,456.00	14,144,933.89
Total	$ 29,728,425.11	2,471.54	708,110.86	15,797,528.12	16,508,110.52
Difference	$ (17,193,666.71)	(952,107.68)	(8,762,891.84)	9,714,999.52	

Table 6. The estimated savings for a scenario with 60% extrapolation of missing farms is approximately $18M USD.

	Annual Cost	Volume Sent By: (cubic feet) FedEx/UPS	Less Than Truck	Full Truckload	Total Volume (cubic feet)
Base Case					
Mass Market	$ 5,614,389.05	71,258.16	1,763,161.70	701,605.17	2,536,025.03
Wholesale	$ 43,925,351.09	1,028,208.81	8,293,739.01	5,380,923.43	14,702,871.25
Total	$ 49,539,740.14	1,099,466.97	10,056,900.71	6,082,528.60	17,238,896.28
Consolidation					
Mass Market	$ 3,171,506.22	1,308.36	98,995.85	2,435,720.82	2,536,025.03
Wholesale	$ 28,248,466.73	1,022.69	603,173.42	14,098,675.14	14,702,871.25
Total	$ 31,419,972.95	2,331.05	702,169.27	16,534,395.96	17,238,896.28
Difference	$ (18,119,767.19)	(1,097,135.92)	(9,354,731.44)	10,451,867.36	

Table 7. The estimated savings for a scenario with 80% extrapolation of missing farms is approximately $19M USD.

	Annual Cost	Volume Sent By: (cubic feet) FedEx/UPS	Less than Truckload	Full Truckload	Total Volume (cubic feet)
Base Case					
Mass Market	$ 5,927,026.41	80,995.47	1,856,033.98	701,605.17	2,638,634.63
Wholesale	$ 45,321,244.38	1,094,864.74	8,558,296.62	5,380,923.43	15,034,084.78
Total	$ 51,248,270.78	1,175,860.21	10,414,330.60	6,082,528.60	17,672,719.41
Consolidation					
Mass Market	$ 3,364,901.31	1,361.29	96,635.87	2,540,637.46	2,638,634.63
Wholesale	$ 28,938,817.40	1,033.35	602,803.97	14,430,247.46	15,034,084.78
Total	$ 32,303,718.71	2,394.65	699,439.84	16,970,884.92	17,672,719.41
Difference	$ (18,944,552.07)	(1,173,465.56)	(9,714,890.76)	10,888,356.33	

Table 8. Participation of all 70 significant farms yields approximately $20M in savings.

	Annual Cost	Volume Sent By: (cubic feet) FedEx/UPS	Less Than Truckload	Full Truckload	Total Volume (cubic feet)
Base Case					
Mass Market	$ 6,020,728.03	81,514.44	1,860,960.69	701,605.17	2,644,080.30
Wholesale	$ 45,916,415.29	1,095,148.82	8,575,590.62	5,380,923.43	15,051,662.87
Total	$ 51,937,143.32	1,176,663.26	10,436,551.31	6,082,528.60	17,695,743.17
Consolidation					
Mass Market	$ 3,527,508.25	1,364.10	96,903.96	2,545,812.24	2,644,080.30
Wholesale	$ 28,974,705.56	996.61	602,546.85	14,448,119.40	15,051,662.87
Total	$ 32,502,213.81	4,005.28	699,450.81	16,956,741.59	17,695,743.17
Difference	$ (19,434,929.51)	(1,172,657.98)	(9,701,555.02)	10,874,212.99	