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Production Costs and Profitability for Select Greenhouse-Grown Annual Bedding Plants: Partial Enterprise Budgeting and Sensitivity Analysis[1]

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Introduction

The purpose of this study is to present practical enterprise budgets and help growers to determine how the particular crop they are growing influences profitability. If growers need to reduce costs and increase profitability, which cost component should they primarily focus on? Will switching to a different production practice be economically feasible? This information will help growers to determine which crops are relatively profitable to grow. Until now, such information has been so far neglected in enterprise budgeting analysis for ornamental production. By comparing and aggregating a set of crops similar to those in our study, growers can identify their operational efficiency. Further, sensitivity analysis provides applications to risk situations associated with price and input costs. Growers can make necessary modifications to reflect their own situations and determine if adoption of alternative pest management practices is economically feasible. With increasing environmental concerns related to pesticides and consumer demand for sustainable products, it is important for growers to be forward-looking and prepared to meet these challenges. It is also important for relevant stakeholders including Extension agents to understand the production cost structure and production decisions while developing educational programs with more relevant research recommendations.

Background

The United States is one of the world's largest producers of floriculture crops and nursery plants. According to the Floriculture Crops 2018 Summary report (USDA NASS2019), the total US wholesale value for all growers with $10,000 or more in sales was estimated to be $4.63 billion in 2018, with California and Florida being the two leading states account-ing for almost half of the value. The combined wholesale value of all bedding and garden plants was$2.16 billion, making it the largest plant category among all reported categories. The wholesale value for annual bedding plants and garden plants alone totaled $1.46 billion in 2018, up 13 percent from 2015 and representing 67 percent of the total bedding and garden wholesale value.

According to the National Green Industry Survey (2019), annual flowering bedding plants was the top-selling plant category accounting for 12.4 percent of the total industry sales (Khachatryan et al. 2020). Nonetheless, the industry has experienced continuously declining revenues in recent years due to considerable within-industry consolidation, increased price competition, and relatively weak

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consumer demand (Madigan 2018). It is thus important for floriculture crop growers to maintain low-cost, competitive production practices. While inquiring about the importance of various factors that affected competitiveness and performance, Khachatryan et al. (2020) reported that "cost of production" was the highest-rated factor with an average rating of 2.9 on a 4-point rating scale (4 representing "very important," 3 representing "important," 2 representing "minor importance," and 1 representing "not important.")

The total production area of greenhouse operations (including glass, rigid plastic, and film plastic greenhouses) was estimated in 2018 to be 423,013,000 sq. ft., accounting for almost half of the total area of covered production (USDA NASS 2019). This study focused on greenhouse production of annual crops not only because of its importance to the ornamental horticulture industry by providing out-of-season plant products, but also because of the high level of risks (e.g., large investment or uncertain yield or demand). Greenhouse production is more capital-intensive than producing the same crop in the open field.

To estimate the cost of greenhouse production for annual bedding plants and help growers to determine how the crop they are growing influences profitability, ten representative annual bedding plants (Table 1) were selected based on their sales values (USDA NASS 2014). Due to high levels of risks involved in greenhouse production, this enterprise budgeting incorporated sensitivity analysis to account for risk situations associated with price and input costs. Uncertainty in prices could be caused by supply or demand shock due to extreme weather conditions or outbreak of a pandemic disease. The uncertainty in input cost was represented by changes in pesticide and chemical costs and changes in labor costs, which could be caused by switching to alternative pest management practices or substitution between labor and intensive management of chemicals.

Methods

Partial Budgeting Analysis Assumptions

Partial budgeting is a commonly used economic tool to show the effect of changes in production operations and assess economic profitability of an alternative production practice. The supporting assumptions in this study were based on USDA survey data combined with knowledge and experience of agricultural economists, Extension horticulturalists, and ornamental plant producers. By the definition of partial budgeting analysis, upfront fixed investment costs that are unchanged (such as land lease/purchase or greenhouse construction costs) were suppressed.

This analysis considered a representative grower operating an existing greenhouse of 20,000 square feet (about 0.46 acre) designated to produce a single annual crop. To reflect the actual products available in retail outlets, we considered two finished plant sizes: 4-inch containers and 6-pack flats. Therefore, the representative grower was assumed to either start with 100,000 plants for a finished size of 4-inch containers, or 50,000 plants for a finished size of 6-pack flats (Table 1). Fisher et al. (2014) considered an example of 100,000 square feet to produce 250,000 one-gallon plants, but they did not specify whether the 250,000 one-gallon plants in their analysis were one single crop or multiple crops. The cost of growing media was calculated based on the finished container sizes (Fisher 2014). Growth period was then specified for each of the 10 crops to their corresponding finished sizes (Dole and Wilkins 1999). Growth period was used to calculate fertilizer and chemical usage and associated costs (Hinson et al. 2008). It is worth noting that due to variations in production practices within the green industry, individual growers may have different production schedules depending on whether they start from seed germination or different stages of propagation or transplants. Considering the shrinkage rate across all plant types was about 8 percent (Fisher et al. 2014), we assumed a 5-percent shrinkage rate for 4-inch containers and 10 percent for the 6-packs to account for the proportion of total production loss when calculating sales revenue. The shrinkage rate partially captures yield uncertainty, which is not explicitly modeled in this analysis. In sensitivity analysis, yield is held constant to indicate that any switch of pest management practices will need to produce the same amount of yield to be comparable.

Direct Costs

Eight detailed items were considered to capture the direct operating costs of a greenhouse operation. The cost categories included Seeds and Plants, Pots and Containers, Growth Media, Fertilizer, Insecticides, Fungicides, Other Chemical Controls, and Tags. Unit costs for materials were adopted from several published sources and individual interviews with growers. For example, unit prices for pots and containers and tags were adopted from a New Jersey greenhouse production analysis (Rutgers New Jersey Agricultural Experiment Station Farm Management 2008). The cost of growing media was assumed to be $2.00 per cubic foot (Fisher et al. 2014; Stathacos and White 1981; UMass Extension Greenhouse Crops & Floriculture Program 2003). The prices for insecticides and other chemicals were based on retail prices obtained from vendors, but individual growers may receive discounts depending on the size of their transaction/operation (i.e., bulk discounts). Details on calculating each cost component are presented in Table 2 using geraniums (4-inch containers) as an example. The total direct cost for the 10 selected plants was summarized in Table 3.

Labor Costs

Specialty crop production is labor intensive, and another large portion of production cost is associated with labor. Zahniser et al. (2012) estimated that labor expenses accounted for about 40% of the total variable costs for specialty crops production. According to the Bureau of Labor Statistics, the mean wage for green industry in Florida was $10.38 in 2016 (NASIS Classification Code 45-2092, Farmworkers and Laborers, Crop, Nursery, and Greenhouse). Hinson et al. (2008) utilized the wage rates of $9.60 and $15.30 to distinguish unskilled labor and skilled labor (e.g., tractor operators). In this analysis, labor costs were calculated based on three broad categories: unskilled labor, pest control labor, and skilled managerial labor with hourly wage rates set at $9.60, $12.00, and $15.00 respectively.

Overhead Costs

The third largest category in production costs is overhead costs. In this study, we broke overhead costs into two categories: Heating and Fuel, and Other Overhead Costs which include depreciation, interest, taxes, insurance, repair and maintenance, truck and equipment, and other cash expenses. Heating and fuel costs were considered to be sufficient to cover the production area of 20,000 square feet throughout the production period for each annual bedding plant and thus vary only across different growth periods. (Heating and fuel costs may vary depending on the location of the greenhouse. But the analysis of this variation is beyond the scope of this study.)

Economic Performance Indicators

The market prices used for calculating sales revenues for the 10 perennial plants were based on combined information of USDA NASS data and wholesale prices received by growers. Gross Margin, Net Income (Profit), and Profit Margin are calculated for a representative grower to provide baseline performance scenarios in the industry using the following formulas:

Gross Margin = (Total Sales – Total Direct Costs) / Total Sales, (1) Net Income = Total Sales – Total Costs, Profit Margin = Net Income / Total Sales, where Total Sales is given by unit price × the number of plants × (1 – the shrinkage rate).

Gross margin measures the percentage of revenue that exceeds daily operating costs. Therefore, as an indicator of profitability, the higher the gross margin is, the more efficient a given operation is in generating profit from operating costs involved in production. Based on definition, it is worth noting here that the gross margin indicator may slightly overestimate the profitability as labor costs are separated as a standalone category. In general, production labor (e.g., unskilled labor) is typically considered as a direct cost. In addition, increases in total sales and revenue do not necessarily translate into increased profitability. It is necessary to introduce net income (in absolute dollar amount) and profit margin to measure profitability.

Results

Cost Summary and Economic Performance

The total direct costs and per unit cost for the selected 10 annual bedding plants were summarized in Table 3. Geraniums and pentas had the lowest direct cost among the 10 annual bedding plants. Total direct costs of producing geraniums and pentas were $46,270 and $47,319, respectively (or equivalent to a direct cost of 50 cents per unit). On the high cost end, total direct costs of producing petunias, impatiens, and pansies were about $83,000 (or equivalent to a direct cost of 1.75 dollars per unit).

In terms of detailed cost categories, material costs, including seeds and plants, containers, and growing media, represented the largest portion of the total direct costs followed by tags and expenses on fertilizer. Material costs accounted for 50–80 percent of the total direct costs for the annual bedding plants (Table 3). Particularly, annual plants such as petunias, pansies, impatiens (other), marigold, zinnia, and sweet alyssum had relatively high material costs; more than 80% of the total direct costs went to materials for these plants. Agrichemical costs in general are small cost items. For example, insecticides alone only accounted for about 1% of the direct costs for annual bedding plants. Our calculations indicated that growers may face tradeoffs among material costs (e.g., seed costs and growing media) and fertilizer and chemical input costs depending on their decisions on the starting stages of plants. For instance, production from seed germination may significantly reduce cost on seeds compared with production from seedling plugs; however, this decision may inevitably increase costs on growing media as well as fertilizer and chemical control costs resulting from a longer growth period. As a rule of thumb, the growers are recommended to maintain a gross margin of 30–40 percent and a profit margin of 10–15 percent to be sustainable in the industry.

Detailed labor costs were summarized in Table 4. Among ten listed annual plants, geraniums (with a total labor cost of $12,397) had the lowest labor costs, while begonias (with a total labor cost of $33,058) had the highest labor costs. Expenses for unskilled labor (e.g., picking, cutting) accounted for more than 70 percent of the total labor cost. The combined expenses for semi-skilled (e.g., pest control) and skilled labor (e.g., managerial) account for 20 to 30 percent of the total labor costs.

As shown in Table 5, heating and fuel costs generally accounted for about 30 percent of the overhead costs. Other overhead costs—expenses related to depreciation, interest, taxes, insurance, repair and maintenance, truck and equipment, and other cash expenses—contribute 70 percent of the overhead costs. Given that heating and fuel usage and other overhead costs were allocated across square footage and growth periods, we typically observed that plants with longer grower periods had higher overhead costs.

Economic performance indicators were summarized in Table 6. All three economic indicators suggested that all annual bedding plants generated positive economic returns. By simply looking at gross margin, one may have an impression that the decision of which specific crop to grow may be not very important. However, high gross margins may not necessarily lead to high profit margins once labor costs are included as specialty crop production is labor-intensive. A cross comparison between gross margin and profit margin revealed more information on crop profitability. For example, among the top five annual plants (that have the largest sales values), geraniums were relatively low in both gross margin and profit margin. Begonia had high gross margin, but it was not as profitable as petunias and pansies. Even though gross margins for geraniums and pentas were similar, growing geraniums was much more profitable than growing pentas. Even though profit margins take into consideration all related production costs and are a more reliable predictor for economic performance and profitability, our analysis indicated that looking at multiple indicators is more informative for growers when making crop choice decisions. Profitability varies significantly across different plants. As a rule, growers are recommended to maintain a gross margin of 30–40 percent and a profit margin of 10–15 percent to be sustainable in the industry.

Sensitivity Analysis

Sensitivity analysis is one way to assess uncertainty when building enterprise budgets. Three uncertainty scenarios were considered in this study. The effect of price uncertainty was demonstrated in Table 7. The scenario was set to be unbalanced between -10 percent to +20 percent, as we anticipated a price premium due to consumer valuation for sustainable products or production practices (Khachatryan et al. 2017; Rihn et al. 2016). In response to increased attention to policies related to pollinator health (Gemmill-Herren 2016) and consumer valuation for pollinator-friendly labels (Khachatryan et al. 2017), we considered profit margin scenarios related to changes in production costs induced by alternative production practices, such as pesticide-free or neonicotinoid-free practices. Because previous research on comparison of production costs between organic and conventional production systems showed that production costs for organic products tend to be higher (Brumfield and Brennan 1996; Butler 2002; Takele et al. 2007) or at least similar to conventional products (Dalton et al. 2005, 2008), the scenario for changes in labor costs in Table 8 was also set to be unbalanced (-20 percent to +30 percent). Table 9 demonstrated the profit margins with percentage change in chemical controls ranging from -100 percent to +100 percent. This calculation simulated two possible production mechanisms that greenhouse growers could adopt: either switch to a completely chemical-free program or intensively substitute other chemical controls for neonicotinoid insecticides, depending on their risk perceptions, financial capabilities, equipment, and infrastructure.

A cross comparison of the three uncertainty scenarios indicated that price and labor are the two dominant factors affecting profit margin. A slight increase or decrease in price and labor could significantly affect greenhouse growers' profitability. Profit margins were not significantly affected by changes in agrichemical inputs due to their small share in total production costs. This finding was consistent with Fisher et al. (2014), who also indicated that lowering cost in pesticides or fertilizers alone has little impact on profitability. It is the combined effect of chemical and labor inputs induced by a switch of chemical use or pest management practices that had a more profound impact on growers' profitability and profit margins. We thus recommend growers emphasize labor item shifts and associated changes in costs when considering potential cost savings. In addition, some plants, such as pentas, were less resistant to potential risks and were sensitive to cost changes compared to other plants.

Conclusions

This report summarized a partial enterprise budget for 10 annual bedding plants. The budget represented a typical operation of a 20,000 square foot greenhouse and serves as an economic benchmark for growers with comparable size and operation characteristics. By knowing the costs in the production process, producers can focus on cost reduction in specific areas and maintain low-cost and competitive production practices (e.g., what is sometimes referred to as "lean processing"). While producing a set of ornamental crops rather than a single crop is more common in the green industry, enterprise budget estimates for each individual crop are still useful in identifying which crop(s) might be more profitable. Depending on the size of the operation, as well as the combination of crops produced, production costs might vary among growers.

Considering an average grower operating a greenhouse with production area of 100,000 square feet producing a crop mix of five perennial crops, a straightforward application of our analysis is to aggregate a few different combinations of crops from our list. Based on our analysis, a grower producing the top five most profitable crops (i.e., petunia, pansies, other impatiens, marigold, and sweet alyssum) would be much more profitable than a grower producing the combination of the five least profitable crops (geraniums, begonia, impatiens [New Guinea], zinnia, and pentas). This simple aggregation may have ignored some efficiency gains due to economies of scale. Nonetheless, adding up similar crops or crops with similar growth periods in our list may still provide some useful information to growers as a benchmark case. By providing estimates of revenue and expenses for each annual crop, this analysis can assist growers in reducing costs in specific areas and in selecting a combination of crops to maximize profits by increasing profitable crops and reducing unprofitable crops or less profitable crops. This method can be easily generalized to estimate the production costs of other annual bedding plants in different greenhouse sizes.

In addition, our sensitivity analysis of cost scenarios simulated different production regimes that greenhouse growers could adopt. With increasing environmental concerns related to pesticides and consumer demand for sustainable products, it is important for growers to be forward-looking and prepared to meet these challenges.

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Table 1. Fertilizer and chemicals used in selected greenhouse-grown annual plants.

Ranking	Annual Plant	Size	Growth Period (weeks)	Fertilizer (lb.)	Non-neonic	Neonic	Fungicides (gal)	Other Chemical (gal)
					Endeavor	Marathon 60WP		
					(2.5oz)	(0.7oz)		
1	Petunias	6-pack flat	9	2,939	16.6	6.7	6.4	4.26
2	Geraniums	4-inch	6	2,084	11	6.7	4.54	3
3	Pansies (violas)	6-pack flat	8	2,649	14.7	6.7	5.76	3.84
4	Begonia	4-inch	16	7,830	29	6.7	10.5	7
5	Other impatiens (*I. wallerana*)	6-pack flat	10	3,213	18.4	6.7	7	4.7
6	New Guinea impatiens	4-inch	8	2,649	14.7	6.7	5.76	3.84
7	Marigold	6-pack flat	10	3,213	18.4	6.7	7	4.7
12	Zinnia	6-pack flat	7	2,374	12.9	6.7	5.17	3.5
20	Sweet alyssum (Lobularia)	6-pack flat	10	3,213	18.4	6.7	7	4.7
25	Pentas	4-inch	8	2,649	14.7	6.7	5.76	3.84

Note: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Plant sales rankings are based on the 2014 USDA NASS Census Survey. 3. The usage of Marathon 60WP is based on the product label information. One packet (0.7oz) is used to account for 1,500 4-inch container treatments or 3,000 square feet for plants grown in flats. The usage of Endeavor is based on the product label information. Calculation is based on the maximum rate of 10 oz per acre per application every week assuming a 7-days-severe insect pressure.

Table 2. Cost structure for geraniums (4-inch): An example.

Item	Example Quantity	Unit	Example Unit Price	Total
DIRECT COSTS				
Seed and Plants	100,000	plant	$0.14	$14,000.00
Pots and Containers	100,000	plant	$0.09	$9,000.00
Growth Media	1700	cu. ft.	$2.00	$3,400.00
Fertilizer	2,084	lb.	$1.30	$2,709.72
Insecticides				$387.10
Endeavor	11	2.5oz	$28.33	$311.63
Marathon 60 WP	1.4	3.5oz	$53.91	$75.47
Fungicides	4.54	gal	$128.00	$581.12
Other Chemical Controls	3	gal	$64.00	$192.00
Tags	100,000	plant	$0.16	$16,000.00
TOTAL DIRECT COSTS				$46,269.94
LABOR				
Skilled managerial labor	165	hour	$15.00	$2,475.00
Unskilled labor	956	hour	$9.60	$9,177.60
Pest control labor	62	hour	$12.00	$744.00
TOTAL LABOR COSTS				$12,396.60
OVERHEAD COSTS				
Heating and fuel	2,079	gal	$2.50	$5,196.25
Other overhead costs	20,000-6	sq. ft-week	$0.11	$13,252.80
TOTAL OVERHEAD COSTS				$18,449.05
TOTAL COSTS				$77,115.59

Note: 1. A representative greenhouse operation of 20,000 square feet, starting with 100,000 plants was assumed.

Table 3. Total direct cost for selected greenhouse-grown annual plants.

Annual Plant	Seeds and Plants	Pots and Containers	Growing Media	Fertilizer	Insecticides	Fungicides	Other Chemical	Tags	Total Direct Cost	Direct Cost per unit
Petunias	$27,500	$36,500	$5,835	$3,820	$545	$819	$273	$8,000	$83,293	$1.75
	(33%)	(44%)	(7%)	(5%)	(1%)	(1%)	(0%)	(10%)	(100%)	
Geraniums	$14,000	$9,000	$3,400	$2,709	$387	$581	$192	$16,000	$46,270	$0.49
	(30%)	(19%)	(7%)	(6%)	(1%)	(1%)	(0%)	(35%)	(100%)	
Pansies (violas)	$27,500	$36,500	$5,835	$3,443	$492	$737	$246	$8,000	$82,754	
	(33%)	(44%)	(7%)	(4%)	(1%)	(1%)	(0%)	(10%)	(100%)	$1.74
Begonia	$14,000	$9,000	$3,400	$10,179	$897	$1,344	$448	$16,000	$55,268	
	(25%)	(16%)	(6%)	(18%)	(2%)	(2%)	(1%)	(29%)	(100%)	$0.58
Other Impatiens (*I. wallerana*)	$27,500	$36,500	$5,835	$4,177	$597	$896	$301	$8,000	$83,806	
	(33%)	(44%)	(7%)	(5%)	(1%)	(1%)	(0%)	(10%)	(100%)	$1.76
New Guinea impatiens	$36,000	$9,000	$3,400	$3,443	$492	$737	$246	$16,000	$69,319	
	(52%)	(13%)	(5%)	(5%)	(1%)	(1%)	(0%)	(23%)	(100%)	$0.73
Marigold	$17,500	$36,500	$5,835	$4,177	$597	$896	$301	$8,000	$73,806	
	(24%)	(49%)	(8%)	(6%)	(1%)	(1%)	(0%)	(11%)	(100%)	$1.55
Zinnia	$17,500	$36,500	$5,835	$3,086	$441	$662	$224	$8,000	$72,248	
	(24%)	(51%)	(8%)	(4%)	(1%)	(1%)	(0%)	(11%)	(100%)	$1.52
Sweet alyssum, (Lobularia)	$17,500	$36,500	$5,835	$4,177	$597	$896	$301	$8,000	$73,806	
	(24%)	(49%)	(8%)	(6%)	(1%)	(1%)	(0%)	(11%)	(100%)	$1.55
Pentas	$14,000	$9,000	$3,400	$3,443	$492	$737	$246	$16,000	$47,319	$0.50
	(30%)	(19%)	(7%)	(7%)	(1%)	(2%)	(1%)	(34%)	(100%)	

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative grower is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Growing media cost is calculated based on two finished sizes: 4-inch containers and flats. 3. Fertilizer and chemical usage are calculated based on and vary across growth periods only. 4. The percentage of each direct cost category out of the total direct cost is reported in parentheses.

Table 4. Labor cost for selected greenhouse-grown annual plants.

Annual Plant	Skilled Managerial Labor			Unskilled Labor			Pest Control Labor			Total Labor Costs	Labor cost per unit
	$/hour	Hours	Sub-Total	$/hour	Hours	Sub-Total	$/hour	Hours	Sub-Total		
Petunias	$15.00	247.5	$3,713	$9.60	1434	$13,766	$12.00	93	$1,116	$18,595	$0.39
Geraniums	$15.00	165	$2,475	$9.60	956	$9,178	$12.00	62	$744	$12,397	$0.13
Pansies (Violas)	$15.00	220	$3,300	$9.60	1275	$12,237	$12.00	82.7	$992	$16,529	$0.34
Begonia	$15.00	440	$6,600	$9.60	2549	$24,474	$12.00	165.3	$1,984	$33,058	$0.35
Other Impatiens *I. wallerana*)	$15.00	275	$4,125	$9.60	1593	$15,296	$12.00	103.3	$1,240	$20,660	$0.43
New Guinea impatiens	$15.00	220	$3,300	$9.60	1275	$12,237	$12.00	82.7	$992	$16,529	$0.17
Marigold	$15.00	275	$4,125	$9.60	1593	$15,296	$12.00	103.3	$1,240	$20,660	$0.43
Zinnia	$15.00	192.5	$2,888	$9.60	1115	$10,707	$12.00	72.3	$868	$14,462	$0.30
Sweet alyssum (Lobularia)	$15.00	275	$4,125	$9.60	1593	$15,296	$12.00	103.3	$1,240	$20,660	$0.43
Pentas	$15.00	220	$3,300	$9.60	1275	$12,237	$12.00	82.7	$992	$16,529	$0.17

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Labor hours are calculated based on and vary across growth periods only.

Table 5. Overhead costs associated with selected greenhouse-grown annual plants.

Annual Plant	Heating and Fuel			Other Overhead Costs			Total Overhead Costs	Overhead Costs per Unit
	$/Gallon	Gallon	Sub-Total	$/sq. ft-week	sq. ft-week	Sub-Total		
Petunias	$2.50	3,119	$7,796	$0.11	20,000×9	$19,879	$27,675	$0.58
Geraniums	$2.50	2,079	$5,196	$0.11	20,000×6	$13,253	$18,449	$0.20
Pansies (violas)	$2.50	2,772	$6,930	$0.11	20,000×8	$17,670	$24,600	$0.52
Begonia	$2.50	5,544	$13,860	$0.11	20,000×6	$35,341	$49,201	$0.52
Other Impatiens (*I. wallerana*)	$2.50	3,465	$8,663	$0.11	20,000×10	$22,088	$30,751	$0.65
New Guinea impatiens	$2.50	2,772	$6,930	$0.11	20,000×8	$17,670	$24,600	$0.26
Marigold	$2.50	3,465	$8,663	$0.11	20,000×10	$22,088	$30,751	$0.65
Zinnia	$2.50	2,426	$6,064	$0.11	20,000×7	$15,462	$21,525	$0.45
Sweet alyssum (Lobularia)	$2.50	3,465	$8,663	$0.11	20,000×10	$22,088	$30,751	$0.65
Pentas	$2.50	2,772	$6,930	$0.11	20,000×8	$17,670	$24,600	$0.26

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Heating and fuel usage are calculated based on growth periods only. Other overhead costs include depreciation, interest, taxes, insurance, repair and maintenance, truck and equipment, and other cash expenses.

Table 6. Economic performance indicators for selected annual plants.

Annual Plant	Size	Unit Price	Total Sales/ Returns[a]	Total Costs[b]	Economic Performance Indicator		
					Net Income[c]	Gross Margin[d] (%)	Profit Margin[e] (%)
Petunias	6-pack flat	$8.76	$394,200	$129,564	$264,637	79%	67%
Geraniums	4-inch	$1.20	$114,000	$77,116	$36,884	59%	32%
Pansies (violas)	6-pack flat	$8.91	$400,950	$123,877	$277,073	79%	69%
Begonia	4-inch	$2.75	$261,250	$137,526	$123,724	79%	47%
Other impatiens (*I. wallerana*)	6-pack flat	$8.75	$395,100	$135,217	$259,883	79%	66%
New Guinea impatiens	4-inch	$2.25	$213,750	$110,445	$103,305	68%	48%
Marigold	6-pack flat	$8.20	$369,000	$125,217	$243,783	80%	66%
Zinnia	6-pack flat	$4.00	$180,000	$108,236	$71,765	60%	40%
Sweet alyssum (Lobularia)	6-pack flat	$7.00	$315,000	$125,217	$189,783	77%	60%
Pentas	4-inch	$1.20	$114,000	$88,448	$25,552	58%	22%

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. A shrinkage rate of 5% is assumed for 4-inch containers and 10% for flats to cover the proportion of total production loss. 3. Unit price is the price per container for 4-inch container and price per flat for 6-pack flat.

[a] Total sales/returns = Unit price × No. of plants × (1 - shrinkage rate).

[b] Total costs sum up the direct costs, labor costs, and overhead costs.

[c] Net income = total sales - total costs.

[d] Gross margin = (total sales - direct costs) / total sales.

[e] Profit margin = net income / total sales.

Table 7. Profit margin scenarios with uncertainty in prices.

Annual Plant	Percentage Change in Price										
	-10%	-8%	-4%	-2%	0%	+2%	+4%	+8%	+12%	+16%	+20%
	Profit Margin (%)										
Petunias	63%	64%	66%	66%	67%	68%	68%	70%	71%	72%	73%
Geraniums	25%	26%	30%	31%	32%	34%	35%	37%	40%	42%	45%
Pansies (violas)	66%	66%	68%	68%	69%	70%	70%	71%	72%	73%	75%
Begonia	42%	43%	45%	46%	47%	48%	49%	51%	53%	55%	57%
Other Impatiens (*I. wallerana*)	62%	63%	64%	65%	66%	66%	67%	68%	69%	70%	72%
New Guinea impatiens	43%	44%	46%	47%	48%	49%	50%	52%	54%	55%	58%
Marigold	62%	63%	65%	65%	66%	67%	67%	69%	70%	71%	72%
Zinnia	33%	35%	37%	39%	40%	41%	42%	44%	46%	48%	51%
Sweet alyssum (Lobularia)	56%	57%	59%	59%	60%	61%	62%	63%	65%	66%	68%
Pentas	14%	16%	19%	21%	22%	24%	25%	28%	31%	33%	37%

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Profit margin = net income / total sales. 3. Sensitivity analysis is based on varying price within a range of -10% to +20% at an increment of 1%. Only selective results in increments of 2% or 4% are reported in this table. Other results are suppressed from the table.

Table 8. Profit margin scenarios with uncertainty in labor cost.

Annual Plant	Percentage Change in Labor Cost										
	-20%	-15%	-10%	-5%	0%	+5%	+10%	+15%	+20%	+25%	+30%
	Profit Margin (%)										
Petunias	68%	68%	68%	67%	67%	67%	67%	66%	66%	66%	66%
Geraniums	35%	34%	33%	33%	32%	32%	31%	31%	30%	30%	29%
Pansies (violas)	70%	70%	70%	69%	69%	69%	69%	68%	68%	68%	68%
Begonia	50%	49%	49%	48%	47%	47%	46%	45%	45%	44%	44%
Other impatiens (*I. wallerana*)	67%	67%	66%	66%	66%	66%	65%	65%	65%	64%	64%
New Guinea impatiens	50%	49%	49%	49%	48%	48%	48%	47%	47%	46%	46%
Marigold	67%	67%	67%	66%	66%	66%	66%	65%	65%	65%	65%
Zinnia	41%	41%	41%	40%	40%	39%	39%	39%	38%	38%	37%
Sweet alyssum (Lobularia)	62%	61%	61%	61%	60%	60%	60%	59%	59%	59%	58%
Pentas	25%	25%	24%	23%	22%	22%	21%	20%	20%	19%	18%

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Profit margin = net income / total sales. 3. Sensitivity analysis is based on varying labor costs within a range of -20% to +30% at an increment of 5%.

Table 9. Profit margin scenarios with uncertainty in agrichemical costs.

Annual Plant	Percentage Change in Agrichemical Costs										
	-100%	-75%	-50%	-25%	-10%	0%	10%	+25%	+50%	+75%	+100%
	Profit Margin (%)										
Petunias	68%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%
Geraniums	33%	33%	33%	33%	32%	32%	32%	32%	32%	32%	31%
Pansies (violas)	69%	69%	69%	69%	69%	69%	69%	69%	69%	69%	69%
Begonia	48%	48%	48%	48%	47%	47%	47%	47%	47%	47%	46%
Other impatiens (*I. wallerana*)	66%	66%	66%	66%	66%	66%	66%	66%	66%	65%	65%
New Guinea impatiens	49%	49%	49%	49%	48%	48%	48%	48%	48%	48%	48%
Marigold	67%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%
Zinnia	41%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Sweet alyssum (Lobularia)	61%	61%	61%	60%	60%	60%	60%	60%	60%	60%	60%
Pentas	24%	23%	23%	23%	23%	22%	22%	22%	21%	21%	21%

Notes: 1. A representative greenhouse operation of 20,000 square feet is assumed. Two types of finished sizes are considered. The representative producer is assumed to start with 100,000 plants for 4-inch containers and 50,000 6-pack flats. 2. Profit margin = net income / total sales. 3. Sensitivity analysis is based on varying chemical control costs within a range of -100% to +100% at an increment of 5%. Only selective results in increments of 10%, 15% or 25% are reported in this table. Other results are suppressed from the table.