The New Economics of Greenhouse Production

By Paul Fisher (pfisher@ufl.edu) and Alan Hodges (awhodges@ufl.edu), University of Florida,
Bill Swanekamp (wswanekamp@kubepak.com), Kube-Pak Corp., and
Charles Hall (c-hall@tamu.edu), Texas A&M University.

Adapted from a series published in OFA Bulletin and AmericanHort Connect 2012-14.

 

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Acknowledgements

We thank our industry partners in the Floriculture Research Alliance at the University of Florida (floriculturealliance.org) for helping fund this research. These partners include: AgriStarts, AMA Plastics, Blackmore Co., D.S Cole Growers, Dummen Group, Everris, Fine Americas, Four Star Greenhouses, Greencare Fertilizers, Heveco, Knox Nursery, Kube-Pak Corp., Lucas Greenhouse, Mast Young Plants, Pindstrup, Pleasant View Gardens, Premier Tech Horticulture, Quality Analytical Laboratories, Rockwell Farms, Speedling Inc., Spring Meadow Nursery, Sun Gro Horticulture, Welby Gardens, and Vivero Internacional.

1. Mine your income statement

Growing "quality" plants is now the easy part of managing a greenhouse business - a necessary but insufficient requirement for financial success. The greater challenge is to be profitable in a competitive industry with low margins. In this environment, it is increasingly important to analyze costs and profitability.

This series will report results from leading universities and growers in the Floriculture Research Alliance (floriculturealliance.org) who are working together to calculate costs of plugs, cuttings, liners, and finished plant production. Our goal is to provide tools that help you calculate where you are making or losing money, and what changes can make your business more profitable. This first chapter discusses the low hanging fruit, so to speak. There is a wealth of information that can be easily gleaned from your annual income statement to improve your business profitability. Future chapters will detail how to accurately track overhead costs, space, and enterprise budgets.

Benchmarking: Are you keeping up with the Joneses?
Companies can compare their performance against competitors, known as external or cross-sectional benchmarking, as well as compare their own company performance from year to year (internal or time series benchmarking) . This goes beyond knowing "did I make money at the end of the year?" and delves into specific costs such as labor as a percent of sales, and returns per square foot of production area, for similar types and sizes of businesses. However, benchmarking and cost analysis are still not common practices in the greenhouse industry. Based on responses at the OFA Short Course or other grower workshops, fewer than 10% of growers have calculated key parameters such as overhead cost per square foot-week.

The example data presented here represent the average of eight leading young plant growers from a survey of calendar year 2006 data by the Floriculture Research Alliance. To convert 2006 dollars to current (2012) dollars using the consumer price index, multiply figures reported here by 1.129. As far as we know, these are the only available published benchmarking figures for wholesale plug and liner growers, although we undertake ongoing analyses with the Floriculture Research Alliance partners.

The income statement
The obvious place to start analyzing costs and revenues is your annual income statement, because every business tracks income and costs for tax reporting. The most accurate way to compare annual data is on an accrual basis, which takes into account changes in inventory (such as value of stockpiled pots and media), rather than just cash revenue and costs that are received or paid during the year. However, both accrual and cash accounting provide useful data.

A first step in analyzing the income statement (Table 1.1) is to divide the information into broad sections that include

- Gross revenue (sales and other income)
- Direct input costs (pot, cutting, label, sleeve, etc.) that increase with every additional unit produced
- Labor costs (in this case, we have combined production, shipping, sales and management)
- Overhead costs such as marketing, insurance and utilities that are difficult to assign on a per unit basis
- Net income

Direct costs, labor costs, and overhead costs each contributed similar amounts to total costs (Table 1.1). You could compare this break down with your operation – for example, are you heavy on overhead or labor? Each of these categories can be further subdivided for detailed analysis (Tables 1.2 to 1.5). By adding additional information on space and labor use, factors such as overhead cost per square foot-week or sales per full time equivalent (FTE) worker can be calculated. **The biggest effort occurs in the first year to organize financial information into categories that make sense for grower decision-making, as opposed to tax reporting.** Once you have developed this first report, future years of data will be easier to prepare to allow comparisons.

Data in Table 1.1 are presented with several units:

- Total dollars ($): Contribution to total business income on an absolute basis.
- Percent of sales (%): Contribution to total business income as a proportion of total revenue.
- Dollars per square foot ($/ft^2): Annual income or cost per square foot (of covered space only).
- Dollars per square foot-week of combined covered and field space ($/sfw).

Table 1.1 Summary of the income statement data from eight leading U.S. young plant growers in 2006.

	$	% of sales	$/ft^2	$/sfw
Total Revenue (TR)	$10,292,795	100.0%	$24.37	$0.42
Direct Costs (DC)	$3,339,313	30.1%	$8.10	$0.14
Labor Costs (LC)	$3,099,638	31.9%	$7.65	$0.13
Overhead Costs (OC)	$3,282,926	30.8%	$7.69	$0.13
Total Costs (TC = DC+LC+OC)	$9,721,877	92.9%	$23.44	$0.40
Gross Margin (TR-DC)	$6,953,481	69.9%	$16.27	$0.28
Net Income (TR - TC)	$570,918	7.1%	$0.93	$0.02

Operations in the survey averaged 17.5 acres (range from 4 to 35 acres) of production area, with an average of 12.3 acres (75%) as covered area (rather than field production space). Space calculations excluded aisles, shipping area, and other space not used for production. All crops were grown in protected areas only, except potted finished plants which were grown both inside and outdoors.

To convert square foot calculations in Table 1.1, multiply by 43,560 for an acre basis, or by 10.76 to square meters of production area. For example, the average return per covered acre of productive area was $24.37 * 43,560 = $1,061,625 per acre.

Multiply the per acre figure by the space use efficiency (crop production area/total area) to get the values per total acres utilized – the total footprint of an operation. For example, if only 85% of the total area is used for crop production, with 15% as aisles and other non-productive areas, then the return per total area would be 85% * $1,061,625 = $902,381 per acre (total).

In greenhouse production, space (ft^2) and time (weeks) are both limiting resources during the peak production season. Square foot-weeks (sfw) can be used to compare revenue or costs for crops such as wholesale potted crops which tend to use a lot of space per unit for an extended period. For example, if a crop has 18 inches x 18 inches spacing for 16 weeks, then the sfw = 1.5 ft*1.5 ft*16 weeks equals 36 sfw. Compare this to a crop in plug trays that use a small area, approximately 1.5 ft^2 per 1020 tray, and for a short time (e.g., a 5 weeks), so then 1.5 ft^2*5 weeks equals 7.5 sfw.

The simple calculation for sfw used here is based on square feet for different types of indoor and outdoor production area, times the number of weeks that each type of space is in use. For example, if you have 40,000 square feet of covered production and use this space for 20 weeks, then 40,000 ft^2*20 weeks equals 800,000 sfw.

In the survey group, an average of 28,862,209 sfw were available for production, with 84% of this as covered space.

The advantage of calculating overhead cost per sfw is the ability to allocate overhead and labor to an individual crop in an enterprise budget. For example, if the direct costs for the cutting, pot, and media in a 4.5-inch specialty annual crop equals \$0.75, and the plant is spaced at 6 x 6-in (0.25 ft^2) for 5 weeks, the crop would use 1.25 sfw. If the overhead and labor cost per sfw equals (\$0.13+\$0.13=\$0.26), then 1.25*\$0.26 equals \$0.33 per plant, giving a total cost of \$0.75+\$0.33 = \$1.08.

Chapter 3 in the series on accurately tracking space use and its effects on profitability. The simple calculations reported here help us to get started down that path. However, a key factor we are not taking into account is that true calculation of space utilization must include the percent of available greenhouse space filled each week with crop plants. For example, if a greenhouse is used only 50% of the year, or is only 50% full all of the year, then the overhead costs per sfw are doubled. With this knowledge, a quick way to become more profitable is to reduce the time that greenhouse space lies empty.

Table 1.2 Average revenue from different sources

Annual Revenue Category	\$	% of sales	\$/ft^2
Wholesale unrooted cuttings	\$10,544	0.2%	\$0.07
Wholesale plugs and liners	\$4,913,578	58.5%	\$14.50
Wholesale potted crops	\$3,413,536	27.6%	\$4.46
Wholesale bedding plant flats and packs	\$812,338	6.5%	\$0.80
Retail sales of all crops and products	\$301,713	1.8%	\$0.39
Other income incl. interest and dividends	\$1,033,866	6.8%	\$1.59
Credits, sales refunds (reduces revenue)	-\$192,780	-1.5%	\$-0.26
Total Revenue (TR)	\$10,292,795	100%	\$21.55

Revenue

The breakdown of revenue sources (Table 1.2) characterizes our survey grower population, i.e. fairly large operations with an average 58.5% of income from young plant sales, and minor if any retail income. For your own operation, it may be useful to divide product categories in a different way, for example with detailed analysis of specific crops such as poinsettias, fall mums, geraniums, etc. By comparing income statements over a period of years, you can track increasing, stable, or falling revenue in absolute and percentage terms to project market trends of different crops.

Note that total revenue per square foot (\$/ft^2) differs slightly in Table 1.2 from Table 1.1. In Table 1.2, potted crops were calculated per ft^2 of combined covered and field space, whereas other crops were calculated per ft^2 of covered space only. All other figures reported per ft^2 in the chapter only include covered area.

Total revenues per ft^2 of production area among surveyed firms averaged \$24.37 and ranged from \$9.47 to \$38.69. This four-fold difference between these growers depended on the type of crops (annual, perennial, or foliage tissue culture, plugs and liners) and crop production times (from 4 weeks to nearly one year). The observed variability within "young plant growers" highlights how diverse our industry is, and the challenges of benchmarking across firms.

Direct Costs

Not surprisingly for young plant growers producing large volumes of small plugs and liners, seeds, plants, trays, and media contributed the majority of direct costs (Table 1.3). Note also which factors had little impact on total costs. For example, fertilizers, pesticides and plant growth regulators together cost less than $0.006 per sfw. To put this into perspective, for a 1020 tray of liners with a 6 week crop time, cost per tray (7.5 sfw) would only add $0.045 per tray. **Greater potential cost savings come from improved efficiencies with large cost items.** For example, trying to lower cost by reducing pesticide or fertilizer applications would have almost no impact on profitability, whereas losing even one cutting to disease could easily cost $0.20 or more in direct costs and labor to fix the tray, and an even greater opportunity cost (the sales price of that cutting). Of course it is important to negotiate a lower cost and to reduce waste for all purchased inputs, but the income statement provides a clear focus on the relative importance of different costs.

Table 1.3 Direct Costs

Direct Costs	$	% of sales	$/ft^2	$/sfw
Seeds and plants	$2,070,204	18.8%	$5.16	$0.085
Growing media, peat, bark, etc.	$299,111	3.1%	$0.90	$0.015
Trays and containers	$425,445	3.6%	$0.85	$0.014
Packaging, labels, sleeves, shipping materials	$147,829	1.3%	$0.44	$0.007
Hard goods/merchandise	$205,425	1.3%	$0.27	$0.006
Miscellaneous production supplies	$23,688	0.4%	$0.13	$0.002
Fertilizers	$33,415	0.3%	$0.08	$0.001
Pesticides and Growth Regulators	$134,197	1.2%	$0.27	$0.005
Total Direct Costs (DC)	$3,339,313	30.1%	$8.10	$0.136

Labor

Labor calculations from the income statement (Table 1.4) provide a first estimate for allocating labor in enterprise budgets. Office staff (managerial/secretarial/sales) is normally allocated as an overhead cost per sfw. Production labor increases directly in relation to the number of units. Therefore, production labor can either be simply considered on a cost per sfw basis, or as a direct cost per unit produced if the time required for tasks such as planting, moving plants to the greenhouse, pinching, irrigation, grading, etc. are quantified and multiplied by wage and benefit costs. The balance between production and management labor costs of 2:1 could be an interesting comparison with your company – the range was 4.2:1 to 0.7:1 in the survey group, which may have partly depended on the focus on either growing or marketing and also the category in which grower managers were entered.

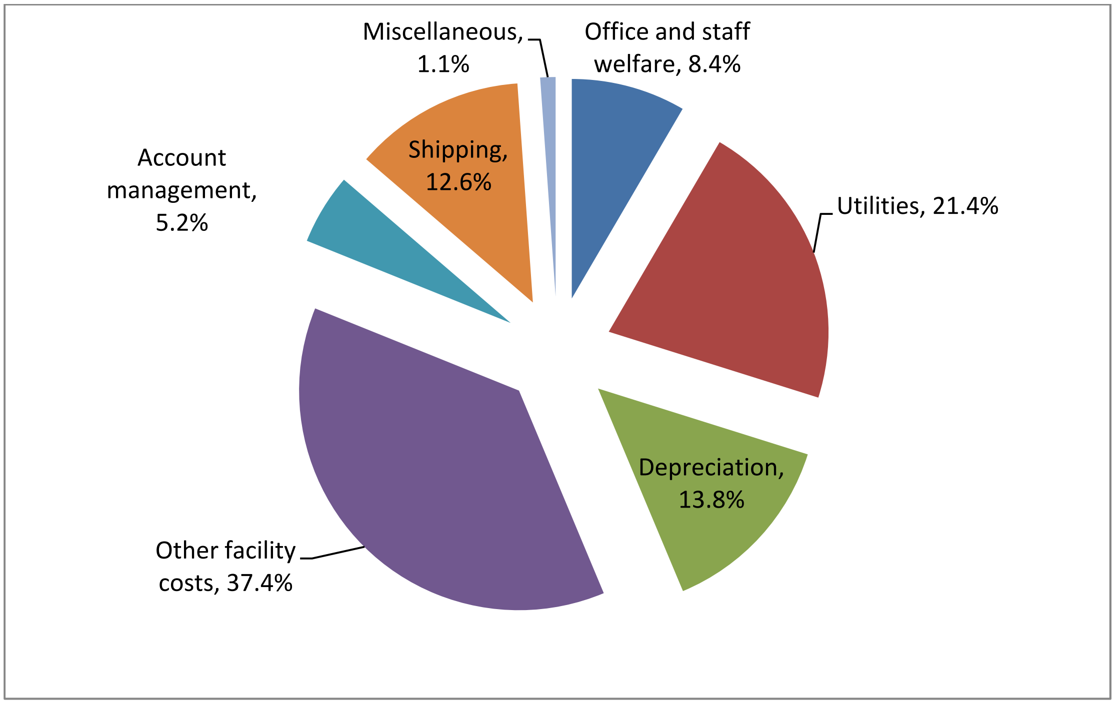
Table 1.4 Labor Costs

Labor Category (Wages + Benefits)	$	% of sales	$/ft^2	$/sfw
Production, maintenance, and shipping	$2,082,468	21.6%	$3.88	$0.093
Managerial/secretarial/sales labor and benefits	$1,017,170	10.3%	$1.62	$0.039
Total Labor Cost (LC)	$3,099,638	31.9%	$5.51	$0.133

Overhead Costs

The detailed analysis of overhead costs in Table 1.5 is summarized into broad categories in Figure 1.1. The facility costs (including depreciation) contributed more than 50% of the overhead, which is not surprising given the capital intensive nature of greenhouse production. The combined utilities and depreciation costs contributed around 35% of total overhead. When comparing greenhouse and field space, field space that is unheated and has minimal depreciation might cost around 65% of the overhead cost of greenhouse space. Shipping costs varied considerably between growers depending on whether these costs were passed on as a line item charged to customers (such as FedEx, in which case shipping cost was not included here), or were borne by the company.

Figure 1.1 Break down of overhead costs



In Conclusion

Your income statement is much more valuable than just an accounting or tax document – it can help identify opportunities to increase efficiency, to benchmark in comparison to other growers or between years, and is a first step to calculate costs per sfw to use in enterprise budgets. Hopefully, as you have read this chapter you thought to yourself "yes, but…", critiquing the simple analysis presented here. The devil really is in the details with greenhouse cost accounting, and the next chapters will discuss why we recommend a more detailed analysis.

Table 1.5 Overhead Costs

Overhead Cost Category	**$**	**% of sales**	**$/ft^2**	**$/sfw**
Office and staff	$276,162	2.6%	$0.68	$0.011
Professional fees, consultants, and contracted services	$96,671	0.9%	$0.27	$0.004
Office supplies, computer systems, postage	$54,217	0.7%	$0.13	$0.002
Education, training, dues, subscriptions, contributions	$23,236	0.3%	$0.05	$0.001
Employee welfare	$55,968	0.4%	$0.11	$0.002
Travel and entertainment	$46,070	0.4%	$0.12	$0.002
Utilities	$703,820	7.4%	$1.68	$0.029
Electricity	$129,245	1.3%	$0.31	$0.005
Heating Fuel	$456,754	4.1%	$1.06	$0.018
Gas/Diesel	$46,194	1.4%	$0.16	$0.003
Telephone	$41,836	0.4%	$0.10	$0.002
Water/Sewage/Garbage removal	$29,792	0.3%	$0.06	$0.001
Facilities	$1,682,720	16.3%	$4.12	$0.070
Depreciation	$454,292	5.2%	$1.17	$0.020
Interest	$252,476	2.3%	$0.56	$0.010
Insurance	$208,051	1.8%	$0.42	$0.007
Land rental	$270,466	2.5%	$0.86	$0.014
Property taxes	$61,533	0.5%	$0.14	$0.002
Greenhouse tools and other misc. supplies	$37,994	0.4%	$0.12	$0.002
Property maintenance, landscaping	$33,323	0.3%	$0.06	$0.001
Repairs and maintenance, excluding labor	$237,308	2.0%	$0.48	$0.008
Lease/rental of equipment, racks, vehicles	$127,277	1.3%	$0.31	$0.005
Account management	$170,605	1.6%	$0.37	$0.007
Bad debts	$9,931	0.1%	$0.01	$0.000
Bank charges	$42,782	0.3%	$0.08	$0.002
Advertising	$117,892	1.2%	$0.28	$0.005
Trucking/shipping (freight) excluding labor	$412,836	3.2%	$0.74	$0.013
Miscellaneous	$36,783	0.5%	$0.10	$0.002
Total overhead costs	$3,282,926	30.8%	$7.69	$0.132

2. Finetuning overhead calculations: Hanging baskets & field crops

When pricing out a bid, or deciding on your most profitable product mix, it is important to know how much it costs to grow each product. This is especially true when the main opportunity for new sales is to out-compete other businesses, and profit margins are tight.

Direct costs such as the container, growing media, and propagative material, which increase with each additional pot or tray produced, are straight forward to calculate. However, "overhead costs" are more difficult to allocate to individual products. Overhead items include costs such as the DIRTI 5 (depreciation, interest, repairs, taxes, and insurance) and other general overhead items that do not vary with each additional unit produced.

There is no one "best" way to allocate these overheads. In this chapter, we explain the traditional "Annual Overhead Cost per SFW" model, and then begin to address challenges with this overhead allocation method.

Our experience of cost accounting at Kube-Pak and working with other growers in the Floriculture Research Alliance (floriculturealliance.org) has identified several hurdles associated with using the annual model. These challenges include how to equitably allocate overhead to crops such as hanging baskets or field-grown mums that are not primarily grown on the greenhouse bench; the variability in overhead costs and income flows over the course of the year; miscalculation of production space actually used in production; and adjustments that need to be made to account for shrinkage.

Here we focus on hanging baskets and field crops. Chapter 3 will describe other features of a new approach to overhead cost allocation that we call the "Seasonal Cost Accounting Model".

The traditional "Annual Overhead Cost Per Square Foot-Week" model

The simplest enterprise budgets add up direct input costs such as the pot, media, label, and propagative material, and then substract these total direct costs from the sales price to give the "gross margin" (sales revenue minus direct costs). In the example in Table 2.1, the gross margin in row (A) would be $1.00 per pot from a 392-count plug tray or $0.89 from a 128-count plug tray. From that perspective, the smaller 392 plug appears to be most profitable.

However, gross margin does not account for the fact that some crops such as poinsettias take longer to grow and require more bench space compared with a quick-turn 4.5-inch petunia crop. The gross margin also ignores overhead costs such as depreciation and heating fuel cost for that space.

Overhead costs are allocated to an individual crop using a space * time (square foot-weeks, or sfw) calculation, whereby the square feet required per product is multiplied by the number of production weeks. Each sfw of greenhouse space is allocated a certain overhead cost (in this example, $0.30). Multiplying the sfw of a container plant by the overhead cost per sfw gives an overhead cost per pot.

For example, the 4.5-inch pot grown from a 392-count tray plug in Table 2.1 assumes pots are grown in a spacer tray with a 6-inch center. This would result in 0.25 square feet per pot, which over a 6-week production time results in 0.25 x 6 = 1.5 sfw per pot. Multiplying 1.5 sfw * $0.30/sfw gives an overhead cost allocation of $0.45 per pot. In contrast, a shorter crop time (4 weeks) using the 128-count tray plug would result in 0.25 x 4 = 1 sfw, and a lower overhead cost of $0.30 per pot.

The profitability of the larger 128-count tray plug now looks more attractive once overhead is taken into account (row C in Table 2.1). The higher profitability per sfw (row D in Table 2.1) is a useful measurement of profitability when production space and time are the key limiting resources.

Table 2.1 An example enterprise budget for a 4.5-inch Wave Petunia finished crop from two plug sizes.

Plug size	392-cell plug tray	128-cell plug tray
Plug cost	$0.15	$0.26
Media, pot, tag	$0.10	$0.10
Total direct cost	$0.25	$0.36
Sales price	$1.25	$1.25
(A) Gross margin/pot	$1.00	$0.89
Plant Spacing (sq.ft./pot)	0.25	0.25
Production time (Weeks)	6	4
Square foot-weeks (sfw)	1.5	1.0
Overhead cost/sfw	$0.30	$0.30
(B) Overhead cost	$0.45	$0.30
(C) Profit/pot	$0.55	$0.59
(D) Profit/sfw	$0.37 =$0.55/1.5	$0.59 =$0.59/1.0

How did we arrive at the overhead cost of $0.30 per sfw? Table 2.2 shows an example calculation. Costs from the annual income statement that do not increase with each additional unit produced are added together to calculate a total annual overhead cost, in this example $3,000,000. If the greenhouse bench space that is available for production (not including space such as aisles, shipping area, etc.) equals 200,000 square feet, and the greenhouse is used for 50 weeks per year, that combination of space and time would result in a total of 10,000,000 sfw. Dividing the $3,000,000 by the 10,000,000 sfw gives an overhead cost of $0.30 per sfw.

Table 2.2 Traditional model for calculating the overhead cost per squarefoot-week (sfw)

Factor	Amount
Annual overhead costs Salaried staff, fuel, electrical, water, depreciation, interest, insurance…	$3,000,000
Greenhouse bench space (square feet)	200,000
Weeks per year in production	50
Total square-foot weeks (=200,000 * 50)	10,000,000
Overhead cost $/square foot-week (=$3,000,000 / 10,000,000)	$0.30

Challenge #1 with the traditional annual model: Hanging baskets (HB), field crops (FC), and other products not grown on the greenhouse bench.

Calculating your annual overhead cost per sfw is a very good starting point for any grower serious about accurate costing. However, should you use this approach to allocate overhead to crops not grown on the greenhouse bench, but which are instead hung above the crop or grown outside? Although this is not the biggest issue with the traditional overhead cost approach, it is a detail that can tie cost accounting in knots.

Bill Swanekamp (Swanekamp, 2012) recently pointed out that (a) crops such as hanging baskets do incur overheads (their space and time are not "free"), and (b) that errors in allocating overheads to hanging baskets can make them appear either unrealistically profitable or costly to grow.

With hanging baskets, some growers will vary the assumed spacing "footprint" of the basket to be the diameter of the plastic pot, the diameter of the green plant, or the spacing along the drip line with some assumed crop width. They will vary this space assumption until the overhead cost allocation "looks about right" in terms of adding to the budgeted cost (to ensure that every crop carries some overhead) but not resulting in an unrealistically high cost (pricing the product out of the market). Indeed it is difficult to come up with the right footprint for plants grown in the air. A recent article (Swanekamp, 2012) recommended using the direct footprint of a 10-inch basket including foliage as about 1 square foot, multiplying by the cost/sfw (in that case $0.40) resulting in an overhead cost of $4.40 to $5.20 for an 11 to 13-week crop.

Similar problems occur when deciding a reasonable overhead cost and sfw calculation for field-grown crops such as fall mums. Infrastructure for field space is typically not as expensive as heated greenhouse space. Based on a survey of young plant growers (see Chapter 1) electricity, heating, and depreciation costs represented 10.5% of sales, whereas total overhead costs (not including any labor) equaled 31% of sales. Assuming field production did not use any electric or heating (questionable because of irrigation pumps, etc.) and had no depreciation (also questionable because of irrigation lines, landscape fabric, etc.) then it would be possible to "discount" the sfw cost of field space to 2/3 the value of greenhouse space. In other words, a mum crop grown with 4 ft^2 for 12 weeks would still have = 48 (4 x 12) sfw, but the cost factor would be $0.20 ($0.30 x 2/3) per sfw, and the overhead cost would be $9.60 (48 x $0.20). A detailed analysis of actual utility and depreciation for field versus greenhouse space would improve accuracy. However, sales price for an 8-inch mum is often less than $4. Any approach that allocates more overhead than the gross margin per pot at a typical market price is unrealistically high.

Alternative approaches to allocating overhead

Companies that have multiple profit centers (such as car parts, new vehicles, and car repair at an automobile dealer) use a variety of alternative approaches for allocating overhead. For a discussion of these approaches, we recommend the article by Putra (2008). http://accounting-financial-tax.com/2008/08/overhead-allocation/, which describes how companies allocate overhead to different profit centers based on the percentage of sales, percentage of gross margin (sales minus direct costs), percentage of labor, or calculating overhead specific to each profit center, in addition to square footage. Other industries choose between several overhead allocation models because all have pros and cons.

We can also learn from how landscape and nursery companies allocate overheads. Landscape companies typically allocate overhead based on how much revenue (sales) or gross margin (sales minus direct costs) comes from different profit centers such as plant sales or landscape maintenance. Profit centers that generate more income are allocated more overhead.

Field plant nurseries add up all the units (pots) produced annually, and divide annual overhead costs by the number of units. To account for different pot sizes and production times, container nurseries can convert units into “1-gallon equivalents”. For example, each 1-gallon pot would be a single “1-gallon equivalent”, but 7-gallon pot may be assigned 5.5 “1-gallon equivalents” (or some other value) based on space and time compared with 1-gallon pots. In other words, a 7-gallon pot would be allocated 5.5 times the overhead compared with a 1-gallon pot.

How can we apply these concepts to hanging baskets and fall mums? One solution is shown in Table 2.3. First, calculate the revenue and direct costs for the entire business (the Annual column). Next, complete the same calculations for HB and FC. The remainder (Annual – HB -FC) is calculated for bench-grown crops (Bench Crops, BC).   Now calculate the number of units sold for each profit center (HB, FC, and BC). This is most important for HB and FC, but for completeness this is included for bench crops. The Annual number of units produced equals the sum of the units from each profit center.

Enter the Annual overhead ($8,000,000 in the example in Table 2.3). By subtracting direct costs from revenue for each profit center, we know how much gross margin is available for HB, FC, and BC. Table 2.3 shows the percentage contribution of revenue, direct costs, or gross margin for each profit center. In this case, we allocated overhead to each profit center based on their percent contribution to Annual gross margin, because you can think of the gross margin from any product as its ability to pay down overhead. However, you could alternatively allocate based on revenue or some other factor. With our example in Table 2.3, 7.2% of an Annual overhead of $8,000,000 gives us $577,778 allocated to HB.

Now we can divide the overhead allocated to hanging baskets by the number of units. This equals $5.78 per pot ($577.778/100,000). How about different hanging basket pot sizes? You might like to use “10-inch basket equivalents (BE)”, and figure out the number of units that way – perhaps you would assign a 12-inch basket to have 1.5 BE based on needing 1.5 the number of sfw compared with a 10-inch basket. That would result in less overhead being allocated to the smaller items.

An example of how this overhead cost per unit figure can be used in an HB enterprise budget is shown in Table 2.4. An advantage of the per unit overhead based on gross margin is that overhead is allocated to HB based on their ability to pay, rather than having to guess at the sfw calculation until it is about right.

It is not necessary to calculate an overhead cost/sfw using this approach. However, if you really want to, here is the method: Divide the per unit overhead cost ($5.78 per basket) by an average cost per sfw you previously calculated using the annual model (for example, $0.30). Now you can calculate the number of square foot-weeks to assign to the basket ($5.78/$0.30 = 19 sfw in this case). Further dividing the 19 sfw by 13 weeks gives 1.5 square feet per basket.

In Conclusion

There are overhead costs in every crop we grow. We have presented alternative approaches to overhead allocation for hanging baskets and field crops such as mums. You can choose an approach (sfw, percent gross margin, or some other method) to allocate to these profit centers that works best for your business.

This approach emphasizes that HB and FC help improve profitability of the overall business by paying down overhead costs. Allocating costs based on the percentage of gross margin ensures that the maximum overhead applied to HB and FC equals the sales minus direct costs – there isn’t any more money there to allocate!

We highlighted that cost per sfw may not be the best way to allocate overhead costs for HB or FC, unless you make adjustments in how sfw are calculated. In Chapter 3 we will discuss how to account for seasonality, space use, and shrinkage in cost analysis.

Table 2.3 Allocation of annual overhead costs between different profit centers based on gross margin, including hanging baskets and field crops that are not primarily grown on the greenhouse bench. Subtracting the overhead costs allocated to hanging baskets and field-grown crops from the total Annual overhead allows calculation of how much overhead should be allocated to greenhouse-grown Bench Crops. Cells in red and bold need to be entered, and the other cells are calculated.

Code	**Profit Center:**	**Annual**	**Hanging Baskets (HB)**	**Field Crops (FC)**	**Bench Crops BC**
	Description:	Total business revenue and costs	Hanging baskets grown primarily in the air	Crops grown outside or in low-cost cold frames	Remainder allocated to greenhouse bench crops
R	Total Revenue	**$12,000,000**	**$1,000,000**	**$500,000**	$10,500,000
D	Direct costs (or cost of goods sold for retail)	**$3,000,000**	**$350,000**	**$200,000**	$2,450,000
U	Number of units produced	1,250,000	**100,000**	**150,000**	**1,000,000**
O	Total overhead per year	**$8,000,000**			
G	Gross margin (R-D)	$9,000,000	$650,000	$300,000	$8,050,000
R%	Percent of annual sales (R)	100%	8.3%	4.2%	87.5%
D%	Percent of direct costs (D)	100%	11.7%	6.7%	81.7%
G%	Percent of gross margin (G/Gannual)	100%	7.2%	3.3%	89.4%
O	Overhead allocated based on gross margin (G% * Oannual)	$8,000,000	$577,778	$266,667	$7,155,556
	Sales price per unit (R/U)	$9.60	$10.00	$3.33	$10.50
	Direct cost per unit (D/U)	$2.40	$3.50	$1.33	$2.45
	Overhead allocation per unit (O/U)	$6.40	$5.78	$1.78	$7.16
	Profit per unit ((R-D-O)/U)	$0.80	$0.72	$0.22	$0.89
	Overhead allocation as a percent of sales (O/R)	66.7%	57.8%	53.3%	68.1%
	Profit margin as a % of sales ((R-D-O)/R)	8.3%	7.2%	6.7%	8.5%

Table 2.4 An example of overhead cost allocation per unit in an enterprise budget for a 10-inch hanging basket grown with New Guinea Impatiens liners.

Crop Time (weeks)	**13**	
Number Plants/Basket	4	
Cost Per Plant	$0.35	
Total Cost of Plants per HB	$1.40	
Cost of Pot, Media, Label and Basket	$1.10	
Labor Costs Associated With Basket Planting and Maintenance	$1.00	
Total Direct Costs	$3.50	
Overhead Cost Allocation per Unit	$5.78	Based on calculations in Table 2.3
Selling Price	$10.00	
Profit per Basket	$0.72	Selling price minus direct costs minus overhead costs
Profit as a % of Sales	7.2%	Profit/selling price

Literature Cited

Putra, L. 2008. Overhead allocation. Accounting, financial and tax web resources, available at http://accounting-financial-tax.com/2008/08/overhead-allocation, accessed Aug. 9, 2012.

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3. Seasons, space, and shrinkage affect production costs

Three key factors affecting the cost of greenhouse production are seasonality (because costs vary over the course of the year), space use (greenhouse space is rarely completely full), and shrinkage (we do not sell all products that are planted). In order to accurately calculate the cost to produce an individual pot or tray, these factors need to be considered.

Let's recap the traditional cost accounting approach, which we call the "Annual Overhead Cost per Square Foot-Week". Overhead items include costs such as the DIRTI 5 (depreciation, interest, repairs, taxes, and insurance) and other general overhead items that do not directly vary with each additional unit produced. These overhead costs are added together over the entire year (for example, $3,000,000). Square foot-weeks (SFW) are calculated from an estimate of productive space (for example, 200,000 ft^2, which does not including aisles or shipping areas) multiplied by the weeks per year in production (for example, 50 weeks). Annual overhead cost divided by SFW gives a cost per SFW (for example, $3,000,000/(200,000 * 50) = $0.30/SFW, which can be allocated to individual plants based on production time and space requirements.

In Chapter 2, we discussed how certain crops do not fit easily into this approach. Hanging baskets, which are grown mainly in the air rather than taking up bench space, and field-grown crops grown in low-cost production areas. With those crops, we showed alternative approaches to overhead cost allocation, for example on a per unit (basket or pot) basis. Here we show how seasonality, space use, and shrinkage can be handled when calculating the remaining overhead costs that are allocated to greenhouse bench or floor-grown crops.

The Seasonality Challenge: Overhead costs are not uniform during the year.

Certain costs vary between growing seasons. For example, fuel costs are usually higher during the winter and marketing costs increase during spring sales promotions. Certain labor categories that are often considered as overhead may also vary through the year. For example, extra sales staff may be brought on during the peak.

Revenue also varies between seasons. In typical greenhouse businesses, winter-spring is the peak sales time when most revenue is generated. Winter-spring can be described as a space race, when available production area and time limit the amount of product that can be grown (Figure 3.1). Many of the products selected are trays, flats, and small containers that turn quickly, thus allowing more than one crop cycle in the same space. Because seasons differ in revenue, the ability to pay down overhead costs also varies at different times of the year.

In contrast, during the summer-fall season, growers search for products to fill greenhouse space, provide cash flow, retain employees, and pay down overhead. Unused greenhouse sections may be closed down, and plants may be given more space. Crops such as poinsettias are grown that have a low gross margin (sales minus direct costs) per SFW (Figure 3.2) but are grown anyway because they make some minimum contribution to overhead. For many growers, therefore, revenue during the summer-fall is primarily market-limited, rather than limited by space and time.

However, not all growers share this pattern of seasonality in costs and revenue. For example, indoor foliage growers may have more uniform space use and annual revenue compared with a grower producing spring bedding plants. Timing of production seasons for cut flower growers may also differ, with florist-related sales peaking for Valentine's Day.

Given these realities, is it realistic to assume that overhead cost per SFW is constant throughout the year? Obviously, for most growers, that is not the case.

Figure 3.1 Spring time is the peak season when space is limiting, characterized by higher production costs such as staffing (left, at Mast Young Plants, MI) and short term, space-efficient crops such as young plants (right, Four Star Greenhouses, MI).

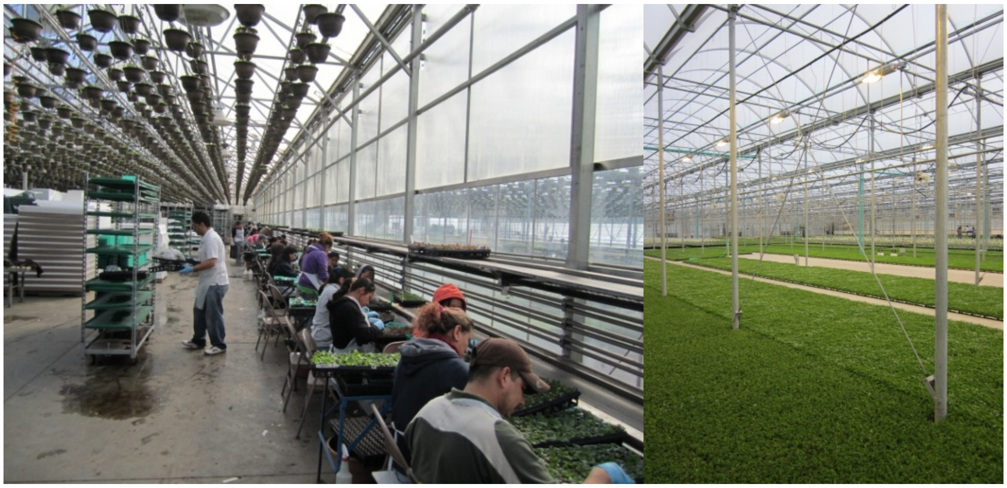


Figure 3.2 Summer and fall is characterized by lower heating costs, more open greenhouse space, outdoor production for fall mums and pansies, and is limited more by market demand than space and time. Many crops such as poinsettias (right, Knox Nursery, FL) use more space-time than spring crops.

Poinsettia crops illustrate why it is useful to calculate a different overhead cost per SFW during the summer-fall compared with the winter-spring. Consider a 7-inch poinsettia grown on an 18-inch centers over 16 weeks (equals 2.25 ft^2 * 16 weeks = 36 SFW). If the overhead cost (from the earlier example) was $0.30/SFW, then the overhead allocation would be 36 * $0.30 = $10.80 using the Annual Overhead per SFW model.

However, a grower may find that the maximum price they are able to receive for a 7-inch poinsettia is $5.00, and direct costs including the pot, direct-stuck cutting, growing media, and sleeve equal $1.40. Using the traditional approach, profitability (sales price minus direct costs minus overhead costs) would equal $5.00 - $1.40 - $10.80 = -$7.20 (in this case, a loss). Based on that analysis, the grower may decide not to produce the crop. But is the crop really losing money and is that the correct decision?

Consider that sales minus direct costs results in a gross margin of $3.60 per pot. This $3.60 per pot is money the business would not otherwise receive if the greenhouse was left empty. That would negatively affect cash flow and annual net income. In addition, the $3.60 per pot would no longer be available to pay down overhead. The overhead would still be borne by the business and needs to be paid down by other revenues. If the only other revenue stream is spring crops, the downstream effect would be a higher overhead cost per SFW for products grown in the winter-spring, thereby reducing the profitability of those plants and the business overall.

The maximum overhead the poinsettia crop could pay would be $3.60/36 SFW = $0.10 per SFW. This is considerably lower than the annual average of $0.30 in our example. However, allocating overhead cost to less space-time efficient crops is still helpful to the business so long as they have a positive gross margin (sales price exceeds direct costs). An article by Putra (2008), not specific to greenhouse production, discusses the decision on whether to drop a product (such as poinsettia) based on its overhead. Putra suggests that a product should not be dropped so long as price exceeds direct costs of production, there is available production capacity, the product does not negatively impact more profitable alternatives, and return on investment meets corporate goals.

How can we ramp up this concept of seasonality in overhead costs to a whole business level? Our recommended approach is to first allocate a proportion of annual revenue, direct costs, and overhead to the hanging baskets and field crops profit centers, as described in Chapter 2. The remaining revenue, direct costs, and overhead, which we will focus on here, are then allocated to bench-grown crops. These revenue and cost figures can then be divided into two (or more) accounting seasons for bench-grown crops, for example Jan to May, and June to Dec (Table 3.1).

It may seem most intuitive to assign seasonal overhead costs based on monthly billing – you would assign overhead costs such as the marketing budget during the months that these bills fall due. However, there are two problems with that approach. Some bills (such as advance payments for fuel, container, or growing media) may fall at different times of the year than when these resources are mostly used. Bonuses and pension contributions are often paid out at the end of the calendar year. Maintenance costs are typically incurred during the summer and fall months when production is low. Yet most assets are used for spring production. Adjustments are therefore required to move overhead expenses to the months that are most profitable. Second, there is no mathematical guarantee that there is enough gross margin (remember the poinsettia example) available during a particular season to pay all of the overhead costs that occur during that season.

An alternative approach is to divide overhead costs between seasons based on percent of gross margin from each season. That ensures that no more cost is allocated to crops within a season than their seasonal average ability to pay down that overhead. Annual revenue and direct costs allocated to bench-grown crops are therefore entered (Table 3.1), to allow calculation of gross margin on a $ and percentage basis for each season.

The Space Use Challenge: How much greenhouse space is filled with crops?

This brings us to the challenge of accurately calculating SFW. If a grower overestimates how much space is used, they will divide the business overhead cost by an excessively high SFW, and underestimate the overhead cost for each product (Swanekamp, 2012). In our experience, it is easy to overestimate how much space is being used to grow crops at any point in time, even during the peak. Moving plants out of the greenhouse for shipping, cleaning between crops, and planting new product means there is inevitably open space. As noted earlier, during the summer-fall there may not be sufficient market to justify filling the greenhouse, and space is no longer limiting.

With all methods of space estimation, the first step is to calculate the available productive area based on footprint and subtracting non-productive areas such as aisles. “Available” space varies during the year depending on level of protection and weather. For example, field space is not “available” for anything other than overwintering in much of the U.S.

Growers employ one of four main approaches to estimate SFW.

1. The traditional cost accounting approach is to estimate a percentage of available space in use (as shown in Table 3.2). This is a good starting point, but is the least accurate method.
2. A physical walk-through on a weekly basis to check the space used in each bay. At Kube-Pak, each bay has a known area, and the approximate percent full is entered for each bay into a simple spreadsheet tool, as shown in Table 3.3. This method is accurate but has the highest labor cost.
3. A current inventory model, which is used by companies that have inventory management software that calculates the number of units of each type currently in inventory on a weekly basis, along with their space requirement. For example, 10,000 trays being grown that each take up 21” x 11” (1.6 square foot) represents 16,000 SFW for that week.
4. A sales model, which is identical to method 3 but is based on units sold during a year or season. This method is simplest for companies that have a limited number of product sizes and production times. For example, consider a grower who only produces liner trays that each take up 1.6 ft^2. Over the year, the grower sells 100,000 trays which require 4 weeks and 50,000 trays that require 6 weeks. That would equal 100,000 * 4 * 1.6 + 50,000 * 6 * 1.6 = 640,000 + 480,000 = 1,120,000 SFW.

Based on real walk-through data from Kube Pak, only around 50% of space is utilized on average through the year. That means that if we estimated that overhead cost/SFW was $0.30 assuming all space was filled, we would actually have to assign $0.30/50% = $0.60 per SFW to any crop being grown. An advantage of methods 2 and 3 above is that space use efficiency can be tracked on a weekly basis to identify opportunities where more plant products can be grown in empty space. An advantage of method 4 is that shrinkage (other than perhaps credits on product sold) is already taken into account when calculating SFW.

Figure 3.3 Even during peak winter-spring production in efficient operations, greenhouse bays are rarely 100% full (photo of Lucas Greenhouses in NJ).

The Shrinkage Challenge: Not all crops planted lead to a successful sale

By dividing the overhead cost by the SFW in each season, we obtain an accurate overhead allocation for crops planted. However, there is a final source of error – shrinkage, which is the difference between crops planted and crops sold. We recommend a recent article (Healy, 2012) that details different types of shrinkage.

In our work with Floriculture Research Alliance growers (floriculturealliance.org), we divide shrinkage into three broad categories:

1. Internal production losses: The crop is planted, but never becomes saleable because of poor rooting, disease, too tall, etc.

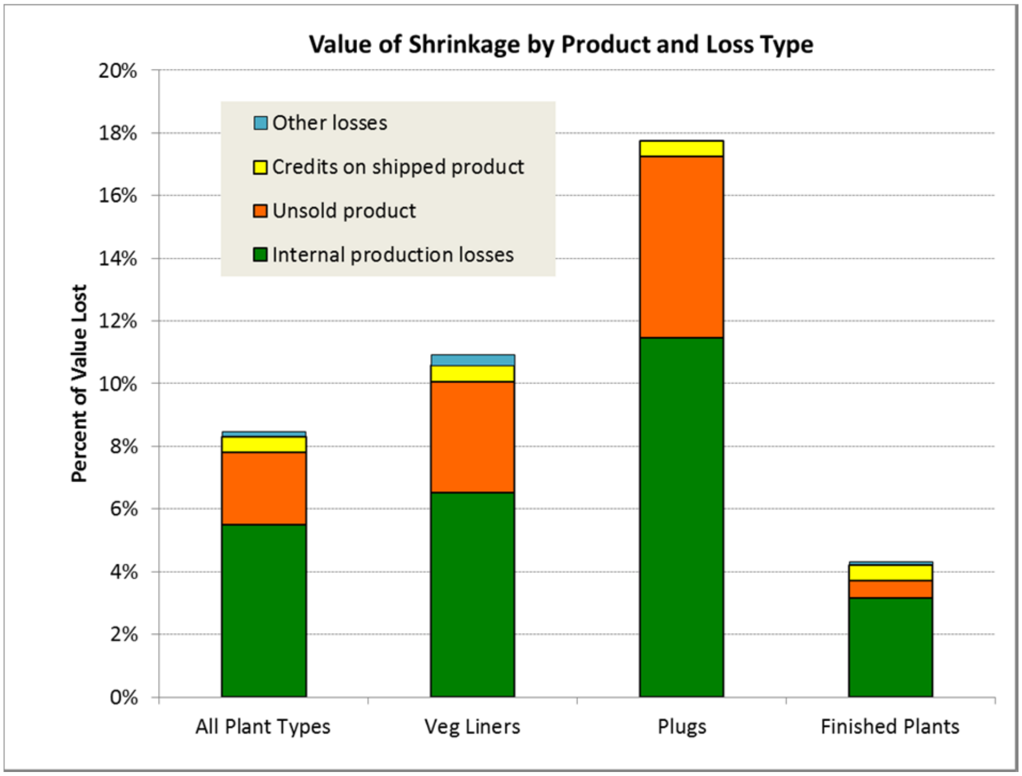
2. Unsold product: Primarily speculation losses as well as buffer (extra plants grown to cover possible production losses), where the product is grown and is saleable quality, but is never sold.

3. Credits on shipped product: Product is sold, but a credit is requested because of shipping issues such as cold or heat, the wrong cultivar is sent, or plant quality may not meet specifications due to insufficient growth, wrong color, pest damage, lack of flowers, etc.

Figure 3.4 summarizes shrinkage, as an average of 9 growers in the Floriculture Research Alliance. Note the higher loss rate for young plants compared with finished containers, as well as the relative importance of production, speculation, and credit losses. In our survey, we noted widely varying levels of shrinkage between firms, and in their distribution between shrinkage categories, depending on the type of crops grown and marketing structure of businesses (data not shown).

More detailed subcategories can certainly be applied when monitoring shrinkage (for example, losses caused by stressed cuttings, disease, pests, poor rooting, etc.). However, loss codes can be so detailed that usability of data suffers. Growers such as Mast Young Plants who successfully manage shrinkage have grower, marketing, and management meetings to review causes of loss, and to identify target shrinkage levels and solutions for the coming season (for example, improving cool storage and handling of unrooted cuttings). We strongly encourage growers to monitor shrinkage, at least within these three broad categories, in order to identify areas to focus on for improved efficiency.

Figure 3.4 Average levels of three categories of shrinkage during 2010 as a percent of crops planted .



Source: survey of 9 leading growers in the Floriculture Research Alliance.

Table 3.1 shows how shrinkage percentages can be built into the overhead estimates per SFW, in order to calculate overhead on the basis of crops sold, rather than crops planted. The figure that incorporates shrinkage is more useful and valid when calculating total production cost and therefore appropriate pricing to ensure you are achieving a desired profit margin, particularly with crops prone to rooting or germination losses or with a new and untried market.

In Conclusion

By taking into account seasonality, space use, and shrinkage, the overhead cost to produce greenhouse crops can be more accurately estimated. In our next chapter, we will use overhead and direct costs to calculate enterprise budgets for different crop types.

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Swanekamp, W. 2012. Use It or Lose It! GrowerTalks. March 2012, 75(11):68.

Table 3.1 Steps to allocate annual overheads across two accounting seasons.

Code	Calculation Step	Annual	Season 1 (S1)	Season 2 (S2)
	Decide on accounting seasons	Jan 1 to Dec 31	Jan 1 to May 31 (young plants to spring peak)	June 1 to Dec 31 (summer/fall)
R	Total revenue from greenhouse bench crops from income statement	$10,500,000	$8,000,000	$2,500,000
D	Total direct costs for greenhouse bench crops from income statement	$2,450,000	$2,000,000	$450,000
G	Calculate gross margin (R-D)	$8,050,000	$6,000,000	$2,050,000
G%	Calculate % of gross margin per season (G_{Season}/G_{Annual})	100%	75%	25%
O	Allocate overheads to each season based on gross margin (G% * O_{Annual})	$7,155,556 from income statement	$5,333,333	$1,822,222
SFW	Square foot weeks per season (Calculated using one of four methods in this article)	16,059,643	10,354,286	5,705,357
OP	Overhead cost/square foot week for CROPS PLANTED (O / SFW)	$0.45	$0.52	$0.32
L	Average shrink percentage per season (= % ($ planted-$ sold)/$ planted) from monitoring losses	11%	14%	4%
OS	Calculate cost/square foot week for CROPS SOLD (OP*(1/(1-L)))	$0.50	$0.60	$0.33
O/R	Overhead costs as a percent of sales for CROPS SOLD (O/R)	68%	67%	73%

Table 3.2 Estimation of SFW based on an estimate of available space used in each season (method 1).

Code	Calculation Step	Annual	Season 1 (S1)	Season 2 (S2)
	Accounting seasons	Jan 1 to Dec 31	Jan 1 to May 31 (young plants to spring peak)	June 1 to Dec 31 (summer/fall)
SA	Average space available (square feet)		600,000	750,000
SU	Average % of available space utilized		80%	25%
W	Number of weeks per season	52	22	30
SFW	Calculated SFW per season (= SA * SU * W). Annual SFW is calculated by adding SFW for each season.	16,059,643	10,354,286	5,705,357

Table 3.3 Estimation of SFW based on a physical walk-through (method 2). In this example, there are three greenhouse zones called G1, G2, and G3, which each have 20,000 to 40,000 square feet in bench area. During weeks 1 to 3, the greenhouses are between 25% and 100% full. Multiplying bench area * percent full gives SFW for each zone per week. Over the 3 week period, crops used a total of 220,000 SFW. In this example, only three weeks are shown. In practice, however, the space monitoring process would continue throughout the year.

Greenhouse zone	Productive bench area (ft^2)	Percent of space filled with plants				Square foot weeks (Bench area * % full)			
		Week 1	Week 2	Week 3	Average wk 1 to 3	Week 1	Week 2	Week 3	Total wk 1 to 3
G1	40,000	25%	75%	100%	67%	10,000	30,000	40,000	80,000
G2	20,000	100%	100%	50%	83%	20,000	20,000	10,000	50,000
G3	40,000	75%	75%	75%	75%	30,000	30,000	30,000	90,000
Total or Average:	100,000	67%	83%	75%	75%	60,000	80,000	80,000	**220,000**

4. Using enterprise budgets to calculate costs and profit

You don't need us to tell you that the floriculture industry life cycle is at a mature stage (Figure 4.1). Mature or declining markets are characterized by consolidation (think big growers and box stores), with producers as price takers rather than price setters. Growth of an individual business in a hyper-competitive climate is only possible by taking market share from other producers or by developing a completely new market with innovative products.

In the last 10 years, USDA (2012) reports floriculture sales averaged $4.11 billion (B) annually from growers wholesaling more than $10,000 in the top 15 production states. During the period 2003-12, revenue was fairly flat, with sales ranging from $3.95B (in 2003) to a peak of $4.32B (in 2007). Since 2007, the number of growers has declined by 26% from 7,387 to 5,419, reflecting the attrition and consolidation that has occurred in the industry.

Given the market climate, how do you decide whether it is profitable to grow a particular crop? Rather than throw your hands up in the air, it is even more important to know your production costs and profit margins. If you decide to gain market share by pricing product below the market price, which requires deep pockets and economies of scale, then are you still making money? If you want to reduce costs, which expenses should you focus on to increase efficiency? Should you grow a particular crop yourself or contract with another grower? In this article, we discuss how to develop enterprise budgets that accurately estimate costs and profitability and aid in answering these types of questions.

Figure 4.1 General industry life cycle

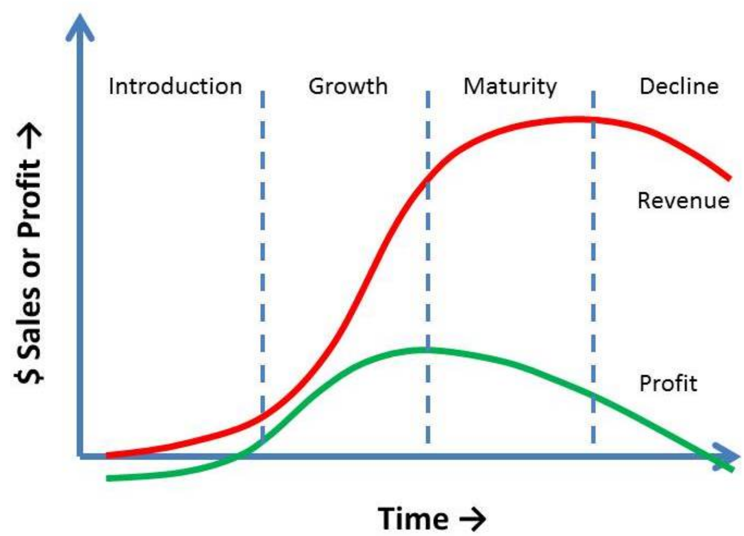


Table 4.1 An example budget for a 4-inch potted petunia grown from two seedling plug sizes

	Item	392 cell tray	128 cell tray
A	Plant cost	$0.15	$0.26
B	Container, growing substrate, label	$0.10	$0.10
C	Total direct cost	$0.25	$0.36
D	Sales price	$1.25	$1.25
E	Gross margin/container (D - C)	$1.00	$0.89
F	Spacing between container (in)	6	6
G	Area per container (ft^2) (in^2/144)	0.25	0.25
H	Weeks	6	4
J	Square-foot weeks (sfw) (G * H)	1.5	1.0
K	Overhead cost per sfw	$0.30	$0.30
L	Overhead cost (J * K)	$0.45	$0.30
M	Total cost (direct + overhead) before shrinkage (C + L)	$0.70	$0.66
N	Shrinkage (production losses & unsold product, %)	4%	2%
O	Cost of shrinkage (N / (1 - N) * M)	$0.029	$0.013
P	Total cost including shrinkage (M + O)	$0.73	$0.67
Q	Net margin/pot (D – P)	$0.52	$0.58
R	Net margin % of sales (D – P) / D	42%	46%
S	Net mark up (D / P - 1)	71%	86%
T	Net margin/sfw	$0.35	$0.58
U	Net margin/ft^2	$2.08	$2.31

Direct costs

The example enterprise budget in Table 4.1 provides a starting point to discuss cost and profitability. Lines A to E only consider sales price versus direct costs. Direct costs [also called variable costs or cost of goods sold (COGS)] are expenses that are directly linked to the level of production, such as labor, equipment operating costs, and material costs (in this case seed, container, growing substrate, and label). For plant costs, include royalties unless these are passed through to the customer as a separate line item over and above the sales price, in which case it is not a direct cost borne by your business.

Many businesses go no further in analyzing profitability at the product level than gross margin per container (Line E). Profitability in these terms looks great: $1.00 per pot for a 392 plug, or $0.89 for a 128 plug. Based on that analysis, the grower may decide to purchase the cheaper 392 plugs.

Overhead costs

However, we also need to consider overhead costs, which include expenses such as depreciation, interest, rent, office expenses, and administration that do not directly increase with each additional unit produced. In previous articles in this series, we discussed how to allocate overheads to individual products, with two main approaches: (a) the production area and time (square-foot weeks or sfw) per container or (b) by the number of units produced (container unit equivalents).

In Table 4.1, we show calculations for allocating overhead costs using square-foot weeks (Lines F to M). To obtain the value \$0.30 in Line K, you need to go through calculations covered in previous Chapters that add up all the overhead costs (in this case including labor) and then divide by the number of square feet of production space filled with crops each week of the year.

The overhead cost allocated to the 6-week crop grown from 392 cell tray plugs is more (\$0.45, Line L) than the faster turn 4-week crop grown from 128 plugs (\$0.30). Adding in direct costs, this makes the total production cost (Line M) lower with the 128 plugs (\$0.66 compared with \$0.70 for 392 plugs). The potential to lower overhead costs by providing a faster crop time is one reason why larger plug sizes are increasingly popular despite their higher purchase cost.

There are several keys to ensuring this overhead calculation is accurate:

- Care is needed to calculate actual space use, by a weekly physical greenhouse walk-through or by multiplying inventory by space use per unit each week.
- If your business is highly seasonal in costs and sales, calculate a separate overhead cost for different production seasons. Overhead costs are typically higher during the peak sales period, and lower during the off season. Use the seasonal accounting approach described in Chapter 3.
- If crops are re-spaced, more calculations are needed in the enterprise budget. Add up the square-foot weeks during the first period (for example, 4 weeks pot tight) plus the sfw at final spacing.

Shrinkage

Shrinkage in this case refers to the number of crop units sold divided by the number of crop units planted. In Chapter 3, we discussed three broad categories of shrinkage.

1. Internal production loss: The crop is planted, but cannot be sold because of disease, etc.
2. Unsold product: Speculation losses and extra plants grown to cover possible production losses, where the product is grown and is saleable quality, but is never sold.
3. Credits on shipped product: Product is sold, but a credit is requested because of shipping or quality issues. This also applies to unsold pay-by-scan product returned from the retail outlet.

Shrinkage of each category applies to any costs incurred up to the point in production when the loss occurs. For example, internal production loss and unsold product shrinkage increase all the production costs before sale.

In this simple budget example, we left out post-production costs such as shipping, tags, or sleeves. If those post-production costs are not passed through to the customer, they should be added after Line P in Table 1. If there are credits on shipped product, that shrinkage cost would be incurred on the total of Line P plus post-production costs.

Shrinkage costs are higher than they may seem. In greenhouse production, a plant that dies or for some other reason can't be sold usually has similar input costs as a plant you grow and successfully sell. Let's take an extreme example of a crop of woody ornamental cuttings where 80% of cuttings do not root (four die for every one that can be sold), and the cost to plant and care for each cutting is \$0.10. That means that the cost of losses would not just be 80% (\$0.08) more. Rather, you would have to plant five units (costing \$0.50) for every one unit sold. Therefore if the percent shrinkage is represented by *N*, the cost of shrinkage is $N / (1 - N)$ * production cost.

For example, if *N* is 80%, then the extra cost of shrinkage is 80% / (1 - 80%) = 4 times the production cost (in this case an additional $0.40).

In Table 1, we entered 4% shrinkage for crops grown from 392 plugs, and 2% from 128 plugs. Our intention is to highlight that the smaller the starting plant material, the higher the production losses (seed or rooted cutting > small plug > large-plug > pre-finished > selling through finished product). We observe that trend in higher shrinkage rates for young plant production (which averaged 18% in a survey we conducted) compared with finished plant production (4%). Minimizing risk is another reason our industry is moving to large plugs and purchasing young plants from specialized growers.

Labor

The biggest difference between simple and complex enterprise budgets relates to labor – will you handle labor as direct or overhead cost, or both? Managerial, sales, and staff labor are normally considered overhead. Salaried grower and crop maintenance staff who are assigned to a particular greenhouse zone can also be added to the overhead cost per sfw.

However, in the case of producing trays of rooted cuttings the following tasks should be considered on a per hour per worker basis:

- Number of trays stuck and dispatched to bench
- If liners are pinched, number of trays pinched
- Liner trays graded and fixed
- Liner trays pulled and boxed/prepared for shipping

Although labor for these production tasks can be added into overhead, a more accurate costing requires tracking labor. Many growers have gone through that process as part of lean flow analysis. You can run a time and motion study by observing workers and timing their activities with a stopwatch, or recording video with an on-screen timer displayed. Alternatively, you can divide the number of units processed (for example, trays dispatched to the greenhouse in a day) by the number of workers involved during that time period. The advantage of the second method is that it captures down time, and avoids biased performance when workers are being timed.

You do not have to spend time doing time and motion analysis on every single crop in your operation. Once you have gone through detailed labor tracking with one crop, similar crops may vary in only one or two tasks. For example, the main difference in labor between young plant crops is in sticking time, which is higher for double-stuck crops like bacopa, but lower for single-stuck petunia.

Profit

There are many different ways to look at profit. Following are some of the different levels of profit analysis used for individual products.

<u>Business level (annual income statement).</u>

At the end of the year, are you still in business, and did total income exceeded total costs? This is obviously important , but provides no information about which individual crops are making or losing money.

<u>Gross margin (sales minus direct costs including shrinkage) either per unit or as a percentage of sales.</u>

This approach only considers direct costs and is easy to calculate. If gross margin is negative, either do not grow the crop or recognize you are growing the crop as a charitable act for your customers. Sometimes buyers demand that you provide certain crops in order to get the business on other crops. These “profit-challenged” crops may be good candidates for being contract grown instead of using up your vital greenhouse space on such less-than-optimal crops.

Net margin (sales minus (direct and overhead costs including shrinkage)) either per unit, as a percentage of sales, or as a mark-up above costs.

Direct, overhead and shrinkage costs represent the true production cost. If net margin is positive, this is where your company is making money. However, if net margin is negative (total cost exceeds sales price) but gross margin is positive, it can still be worth growing the crop. This is because otherwise you lose the gross margin which pays down overhead for the entire business. For example, growing poinsettias in the fall may not be profitable in terms of net margin, but does bring in gross margin, cash flow, makes a contribution to overhead, and allows you to retain staff.

If you then decide to grow the product, adjust your budget because the maximum overhead that can be allocated to any crop equals the gross margin (net margin is set to zero). If overhead allocation exceeds the gross margin (leading to a negative net margin), that means you will underestimate the overhead on other crops. This is a key reason why we advocate accounting "seasons" based on gross margin with a different overhead cost per sfw at different times of year, and where overhead is matched to crops based on their ability to pay.

Gross or net margin per area or area week

Greenhouse production is characterized by high overhead (capital investment). Profitability is therefore driven by maximizing gross margin for every square foot of greenhouse space over the year. For greenhouses producing multiple crop turns, a key parameter is gross or net margin per square foot week during the peak season. This is where line T in Table 4.1 represents the strongest reason to use a larger plug size.

However, gross or net margin per square foot week are less important in cases where growing a fast turn crop does not provide an opportunity to turn the space again. This may occur if there is only one crop turn in a given space over the course of a year, such as with long-term crops or a single turn, small-scale retail business. It can also occur if space is not limiting, for example, with poinsettias grown in the fall when much of the greenhouse is empty. In those cases, gross and net margin per unit can be more appropriate measures of profitability.

Sensitivity analysis

Varying the assumptions in an enterprise budget helps you focus on which factors will increase profitability. Of course, the greater the percent of total cost from a particular input, the bigger its impact. Results in Table 4.2 and Figure 4.2 emphasize the importance of overhead cost on profitability for this particular crop, as well as sales price. It is imperative to recognize here that even if you negotiated hard with suppliers for a reduced cost of the plant, the container and substrate, that alone would have minimal effect on profitability. Reducing overhead costs would, however, have a large impact. In contrast, if you were growing young plants, then plant cost has a much larger contribution to total cost than overhead, because of the large number of plants per tray, small footprint, and quick crop time.

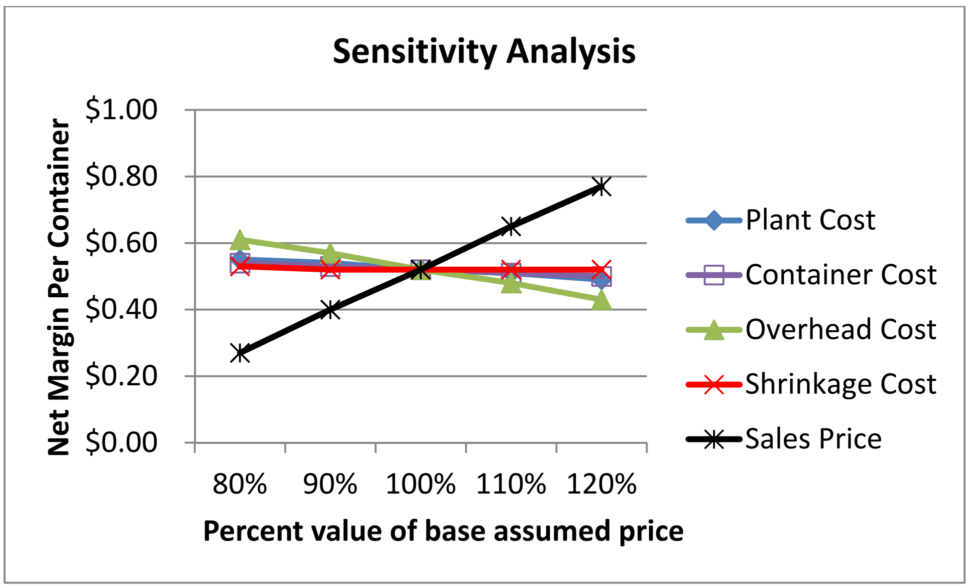
All of this analysis should help you come to the conclusions which crops are profitable to grow and which are not. But as an industry, our goal should be to price our products in a way that accurately reflects the cost of production, which includes overhead, and ultimately should leads to higher prices and more profit. There is no single way to calculate an enterprise budget, but we hope you find these guidelines helpful as you strive for efficiency in a challenging marketplace.

Table 4.2 Change in costs or sales price above or below base price.

Factor varied	Effect on Price of Individual Factors				
	80%	90%	100%	110%	120%
Plant Cost	$0.12	$0.14	$0.15	$0.17	$0.18
Container, Substrate and Label Cost	$0.08	$0.09	$0.10	$0.11	$0.12
Overhead Cost	$0.36	$0.41	$0.45	$0.50	$0.54
Shrinkage Cost	$0.02	$0.03	$0.03	$0.03	$0.04
Sales Price	$1.00	$1.13	$1.25	$1.38	$1.50

Varying assumptions for 392 plugs from Table 1 by 80% to 120% of each level, one factor at a time. 100% represents the value in the base assumption in Table 1. The range in the shrinkage assumption is therefore from 3.2 to 4.8%.

Figure 4.2 Sensitivity analysis for net margin in relation to varying costs and sales price.



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5. Evaluating Grower Productivity

Introduction

Achieving good productivity is the foundation of any profitable business venture, and plant growing is no exception. Productivity reflects the efficiency in use of resources such as space (land), labor and capital, to produce an acceptable crop. Productivity in a nursery or greenhouse business may change over time as assets become aged and worn out, as the quality of the workforce changes, or as the mix of crops and production systems changes.

Assessing business productivity is one of the key responsibilities of management. Managers should develop and monitor productivity metrics for their specific business practices. Measurement of productivity involves using information from the income statement and balance sheet, together with certain production records.

Common Productivity Measures

To help understand the calculation of productivity indicators, consider the example information given in Table 5.1 for a small greenhouse operation. The information on greenhouse area comes from measurements taken; annual worker hours is taken from payroll records; annual plant sales is from the company income statement; and plant and supply inventory information are from the balance sheet.

Space Productivity. In the nursery and greenhouse industry, the value of production per square foot or acre is probably the most commonly considered productivity indicator. Production can be measured either in physical quantities, such as number of units produced, or in dollar value terms. The quantity or value of production should consider not only the products sold and shipped, but also product that contributes to inventory growth or shrinkage, since this reflects the output of the firm. If inventory increases from one accounting period to the next, this means that production exceeded sales, while if inventory decreases, then sales were being supported by product from inventory produced in a previous period.

Figure 5.1 Greenhouse and outdoor space use can be tracked to estimate space productivity (dollars per unit area). Only count the productive area (not aisles or driveways). Photo of Costa Nursery, Homestead, FL.

Table 5.1 Greenhouse productivity calculation example.

Gross greenhouse area (square feet)	100,000
Net usable production space, 80% utilization (square feet) (A)	80,000
Annual worker hours	20,000
Number of fulltime equivalent employees (FTE) (C)	9.63
Number of plant units produced annually (one gallon plants)	250,000
Annual plant sales (D)	$500,000
Value of product retained in inventory	$50,000
Annual value of plant production (B)	$550,000
Plant inventory value--Year beginning	$350,000
Year end	$400,000
Yearly average (E)	$375,000
Supply inventory value (average)	$50,000
Total plant and supply inventory average (F)	$425,000
Cash and other current assets	$50,000
Fixed assets: land, buildings and equipment (net of depreciation)	$350,000
Total assets (G)	$825,000
Space productivity: value of production (B) / net usable area ($/sq. ft.) (A)	$6.88
Labor productivity: value of production (B) / number workers ($/FTE) (C)	$57,113
Plant inventory turnover: annual sales (D) / average plant inventory value (E)	1.33
Plant &supply inventory turnover: annual sales (D) / plant and supply inventory value (F)	1.18
Asset turnover: total income (B) / total assets (G)	0.67

The production area used in this analysis should reflect only the space actually used for plant production, in growing beds or greenhouse benches (Figure 5.1). Areas used for office space, storage, parking, shipping, etc., while essential for operation of the business, do not directly contribute to plant production, and if included in the assessment of space productivity would result in an erroneous value. In addition, the aisleways between plant beds or benches should be netted-out of the gross production area. Typically, about 80 percent of a greenhouse or outdoor plant block is utilized for plant production. For a field nursery, the share of area used for plant production may be either higher or lower, depending upon the size of trees or shrubs and the spacing between plant rows needed for equipment access.

The physical productivity would be calculated as: 250,000 plants / 80,000 square feet = 3.125 plants per square foot per year. For value productivity, remember that we need to account for change in plant inventory, as well as sales, so in this case it would be $500,000 sales plus $50,000 inventory growth, or $550,000 total value produced. The space value productivity then would be calculated as: $550,000 / 80,000 sq. ft. = $6.875 per square foot. This type of calculation should be done frequently to assess possible changes in the space productivity of your operation, and help detect production problems before they become major failures.

<u>Labor Productivity</u>. Labor is usually the largest expense for most nursery/greenhouse operations, typically representing 30 to 50 percent of total costs. Efficient use of the workforce and labor productivity is obviously an important business performance indicator (Figure 5.2). Because some employees may work a different number of hours in a workweek, it is necessary to use a standardized measure of worker effort. A common unit of work effort is the fulltime equivalent employee or FTE, which represents 40 hours per week times 52 weeks per year, or 2080 payroll hours annually. Note that vacation or sick leave are <u>not</u> considered in this measure. You can easily determine the number of FTEs in your business based on your payroll records. For example, if you had a total of 20,000 payroll hours annually, then dividing by 2080 hours/FTE gives 9.62 fulltime equivalent employees (Table 5.1).

To calculate labor productivity, simply divide the value of production by the number of FTEs. For example, again using an annual plant production value of $550,000 ($500,000 in sales and $50,000 in inventory growth), and dividing by 9.62 FTE workers, gives a labor productivity of $57,173 per FTE. The labor productivity calculation may be made separately for production labor and for all nursery labor, including office and management workers. Let’s say that this business has two fulltime persons for management and sales/clerical functions, so the production workforce is 7.62 FTE (9.62 – 2.0). The production labor productivity then would be $550,000 / 7.62 = $72,178 per FTE.

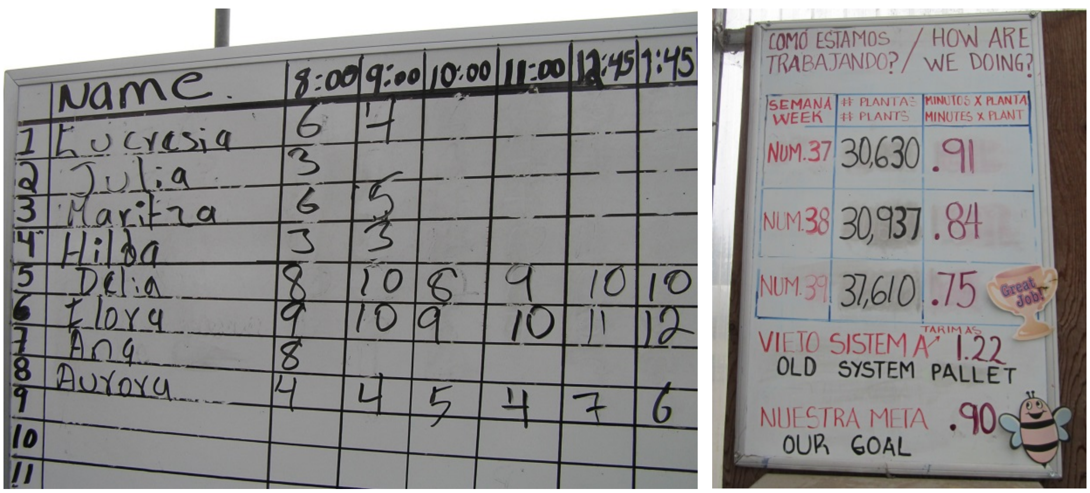

Figure 5.2 Tracking output of individual workers (left) and total output (right) is a key step to identify and communicate the potential for improved efficiency. Photos of Kerry’s Bromeliads, FL and T&L Nursery, WA.

<u>Inventory Turnover</u>. Another measure of productivity is inventory turnover, which represents the ratio of annual sales to average inventory value. It is an indicator of the rate at which inventory is converted into sales, and for a plant nursery it is a measure of plant growth rates. Inventory turnover is a nice measure of productivity because it removes the effect of plant prices, and provides a complement to physical production per square foot as a measure of space productivity. To calculate plant inventory turnover, it is necessary to have a representative annual average inventory value, which can be taken as an average of the year beginning and year end quantities or values. For our example nursery operation, we had a beginning plant inventory of $350,000 and an ending value of $400,000, or an average of $375,000 (Table 5.1). Then to calculate plant inventory turnover, divide the annual sales ($500,000) by the average plant inventory value ($375,000), giving 1.33. Plant inventory turnover can be interpreted as a measure of the average number of crops “turns” each year. Notice that plant inventory turnover always uses sales in the numerator rather than production value (sales plus inventory change) because it is intended to measure the rate at which inventory is sold.

Figure 5.3 Plant inventory turnover reflects the number of crop turns per year, which varies greatly depending on the type of plant product grown. Photo of Spring Meadow Nursery, MI.

Plant inventory turnover can also be expressed as an average production time: divide 52 weeks per year by 1.33 to give 39 weeks as the average time to produce the one-gallon product in this case. Of course, if the nursery facility is seasonally idle for part of the year, then the calculation must be adjusted to reflect the smaller number of weeks. Plant inventory turnover, like production per square foot, varies widely across different types of nursery operations. Greenhouse operations with relatively small plants and short production times generally have much higher turnover rates than woody ornamental container or field production operations. For example, a bedding plant producer that is producing a new crop every 10 weeks would have a turnover rate of 5.2 (52 weeks/10 weeks), while a woody container nursery producing crops with an average production time of 14 months would have a turnover rate of .86 (12 months/14 months).

There are numerous ways to value plant inventories in a nursery. A recommended approach is to use a percentage of completion method of accounting, which assigns values based on the wholesale price of the finished plant, together with discounts for unfinished plants in relation to their stage of growth. For example, if a crop normally takes 10 months to produce, and at the end of the accounting period it has been in production for five months, we would say this crop is 50 percent completed, and would be valued at one-half of its eventual market value. Calculation of inventory turnover may also consider supply inventories, such as fertilizers, chemicals, pots, packaging materials, etc., as well as plants, to give a more comprehensive measure of working capital utilization. For example, if the firm has an average supply inventory of $50,000, then the overall inventory turnover would be 1.18, calculated as $500,000 in sales divided by $425,000 in inventory.

Asset Turnover. The concept of turnover can be further extended to all assets involved in the business, including cash, accounts receivable and other currents assets, fixed assets in land, machinery and equipment, in addition to inventories. For example, if the nursery/greenhouse had $400,000 in other assets in addition to the $425,000 in inventories, the total asset turnover rate would be 0.61, calculated as $500,000 in sales, divided by $825,000 in total assets. Obviously, the more asset categories are included in the calculation, the lower the resulting turnover rate for a given level of sales.

It is interesting to note that asset turnover can be mathematically related to rate of return on investment (ROI), representing the ratio of net income to total assets. If you take the net profit margin as the ratio of net income to total income, then multiplying by the asset turnover rate (total income / total assets) gives the same expression as

ROI. The shows clearly how the asset turnover rate is a key component of profitability in the DuPont Total Profitability Model (see other OFA Bulletin articles by Hodges and Hall for a fuller discussion of this model).

Figure 5.4 Ornamental plant production is a capital-intensive business, and asset productivity can be measured using benchmarks such as asset turnover rate and return on investment. Photo of Rockwell Farms, NC.

Using Productivity Measures for Internal Benchmarking

One of the primary uses of productivity measures for a business is to evaluate changes over time, i.e. comparing the current year with past years, to determine whether there may be emerging problems that could potentially affect profitability. This process is known as internal (or time-series) benchmarking. Industry surveys indicate that a majority of companies globally use some kind of internal benchmarking to track business performance.

As an example of internal benchmarking, consider the information for a small nursery over a three year period given in Table 5.2. The nursery production area remained the same, but employment increased from 10 to 15 FTE, annual sales increased from $500,000 to $700,000, and plant inventory value increased from $300,000 to $400,000, however, fixed assets decreased slightly due to depreciation. Because the amount of production space is fixed while total income (value of production) increased, space productivity increased from $5.50 to $7.50 per square foot. However, the increase in value of production did not increase enough to offset the increased labor effort, so labor productivity fell slightly from $55,000 to $50,000 per FTE. Sales increased at a greater rate than plant inventory, so inventory turnover increased from 1.43 to 1.75. Total assets actually decreased due to depreciation on fixed assets, so asset turnover increased by a proportionally larger amount from 0.52 to 0.75. The example shows that productivity measures may not always show consistent trends over time, but are nevertheless revealing about changes in the structure of the business.

Table 5.2 Example data for three years of operations for internal benchmarking.

	Year 1	Year 2	Year 3	% Change Year 1 to 3
Greenhouse space, net usable area (square feet)	100,000	100,000	100,000	0.0%
Number of fulltime equivalent employees (FTE)	10	13	15	50.0%
Annual Plant Sales	$500,000	$600,000	$700,000	40.0%
Total Income (value of production)	$550,000	$650,000	$750,000	36.4%
Plant inventory value (average)	$350,000	$400,000	$400,000	14.3%
Fixed assets: land, buildings and equipment (book value)	$500,000	$450,000	$400,000	-20.0%
Total assets	$1,050,000	$1,050,000	$1,000,000	-4.8%
Space productivity ($/sq.ft.)	$5.50	$6.50	$7.50	36.4%
Labor productivity ($/FTE)	$55,000	$50,000	$50,000	-9.1%
Inventory turnover	1.43	1.50	1.75	22.5%
Asset turnover	0.52	0.62	0.75	43.2%

Using Productivity Measures for External Benchmarking

Another way that productivity measures are used is to compare one firm to another, or to industry averages or standards. Consider the data shown in Table 5.3 for two different firms. Firm A is a small, established nursery grower with relatively small investment in fixed assets, while firm B is a medium sized firm, with annual sales of $1.2m, and significantly greater investment in buildings and equipment. Because firm B has greater investment in labor-saving equipment, it is able to support greater production with the same labor force (10 FTE), so labor productivity is substantially higher ($125,000/FTE vs $55,000). Space productivity is also higher ($6.25/sq.ft. vs. $5.50/sq.ft.). Inventory turnover for firm B is higher as well (2.0 vs. 1.43). However, because of the greater capital investment in firm B, its asset turnover is actually lower (0.45 vs. 0.52).

Table 5.3 Example information for external benchmarking

	Firm A	Firm B
Greenhouse space, net usable area (square feet)	100,000	200,000
Number of fulltime equivalent employees (FTE)	10	10
Annual plant sales	$500,000	$1,200,000
Total income (value of production)	$550,000	$1,250,000
Plant inventory value (average)	$350,000	$600,000
Fixed assets: land, buildings and equipment (book value)	$500,000	$2,000,000
Total assets	$1,050,000	$2,800,000
Space productivity ($/sq.ft.)	$5.50	$6.25
Labor productivity ($/FTE)	$55,000	$125,000
Inventory turnover	1.43	2.00
Asset turnover	0.52	0.45

Industry Productivity Benchmark Information

Data on nursery industry productivity benchmarks are available from the *Horticultural Business Analysis System* maintained by the University of Florida (https://hortbusiness.ifas.ufl.edu/analysis/). The system contains historic information on wholesale nursery operations for a variety of different plant production systems, including containerized and field grown woody ornamentals, flowering plants, greenhouse and shadehouse production of tropical foliage plants, and cut foliage.

The system consists of data entry forms, an historical database of business records, a report generator and a security encrypted website user interface. The benchmark measures and calculations used in this system closely follow the longstanding *Nursery Business Analysis Program* at the University of Florida. The database was developed from financial statements and production records collected from wholesale grower firms in Florida between 1990 and 1998, and augmented with new data submitted to the internet-based system since 2004. Benchmark information in the system is deflated to present in current dollar terms.

Users of this expanded system can choose from a series of menus to create reports that summarize benchmark information in the database for selected nursery commodities or production systems, firm sizes, profitability levels, locations (state, county) and years. Within each commodity, information is also available for subgroups of large, small, and highly profitable firms. Large firms are defined as those having annual sales of $2 million or greater, while small firms had sales of less than $250,000. Highly profitable firms had a rate of return on assets of 15% or greater. Users can also view time series information for any industry group in three separate periods (years). The system requires a minimum of five (5) valid records in the database to view averages for a selected combination of attributes (commodity/production system, firm size, profitability, location, year), in order to protect the confidentiality of user records. If the user does not specify any of these selection conditions, the system automatically defaults to all records available.

Users may also create an account to enter their own financial data for customized analysis of their company in comparison to industry benchmarks. Creating an account requires entering general company information (name, address, telephone, email, etc.) and selecting a username and password to enable access to the system. Security encryption prevents unauthorized access to confidential information. You can view reports for up to three years of your own company -- or any combination of industry average benchmarks.

Reports generated by the system consist of a series of tables and charts that present information for comparison of up to three industry groups or individual firm records (years). Graphical bar charts are also available for selected key indicators to help visualize critical differences. The following information is provided:

- Scope of Business Operations: Annual plant sales, value of production (sales plus plant inventory change); gross nursery area and net usable production area; workforce (number of fulltime equivalent employees); and, value of owned and leased capital.
- Income Statement: Nursery sales, miscellaneous income, total income; expenses for six major categories (labor, supplies, equipment/facilities, overhead, capital, management) and 32 detailed items; and, gross and net income.
- Monthly Sales as a percentage of total annual sales (charted).
- Statement of Financial Position: Current and long term assets; current and long term liabilities; and, net worth.
- Productivity and Efficiency Indicators: Sales and value produced per square foot and per acre growing space; sales and value produced per full-time equivalent employee; and, capital managed per acre and per employee.
- Financial Ratios: Profitability (gross and net margins, return on assets, return on equity); turnover (inventory, asset, managed capital); liquidity (cash on hand/current liabilities, current ratio, quick ratio, accounts receivable / sales, average collection period); and, solvency (assets/liabilities, leverage, current value /original cost of long term assets).
- Cost Analysis: Costs per square foot, costs per unit sales, and costs per unit value produced in major expense categories (labor, supplies, facility & equipment, overhead, capital, management).

An example of the information available from the *Horticultural Business Analysis System* is shown in Table 5.4 for three industry groups: container grown woody ornamentals, greenhouse tropical foliage, and flowering plants. Value of annual production per square foot of growing space ranged from $1.02 for woody container firms to over $5.00 for greenhouse tropical foliage production, while production per FTE person was more consistent, ranging from $87 to $101 thousand. Plant inventory turnover ranged from 76 percent for container woody ornamental growers to 244 percent for greenhouse tropical foliage, to 460 percent for flowering plants. Clearly, there are dramatic differences in productivity benchmarks for different kinds of nursery operations, so it is important to use benchmarks for your specific type of operation.

Table 5.4 Productivity benchmark information available from the *Horticultural Business Analysis System*

Indicator	Container Grown Woody Ornamentals	Greenhouse Tropical Foliage	Flowering Plants
Sales Per Square Foot Growing Space	$0.88	$5.04	$4.29
Production Per Square Foot Growing Space	$1.02	$5.02	$4.37
Sales Per Acre Growing Space	$38,269	$219,381	$186,719
Production Per Acre Growing Space	$44,320	$218,696	$190,509
Sales Per Person (FTE)	$86,967	$90,791	$85,392
Production Per Person	$100,720	$90,508	$87,126
Growing Area Per Person (sq.ft.)	98,990	18,027	19,921
Persons Per Acre Growing (FTE)	0.44	2.42	2.19
Capital Managed Per Person	$206,843	$92,735	$60,817
Capital Managed Per Acre	$91,019	$224,078	$132,984
Managed Capital Turnover (total sales/managed capital)	42.0%	97.9%	140.4%
Asset Turnover (total sales/total assets)	46.4%	110.4%	169.1%
Plant Inventory Turnover (total sales/plant inventory value)	76.3%	243.6%	460.4%

Source: University of Florida, Food & Resource Economics Department.

Conclusions

This chapter showed how productivity measures can be used to evaluate business performance in the nursery and green ouse industry, both within a firm (internal benchmarking), and to make comparisons between firms (external benchmarking). The measures of space productivity, labor productivity, inventory turnover and asset turnover each provide a different type of information for managers. These measures reflect the specific nature of nursery production practices, and are distinct from the standard financial ratios that apply to any type of business. Internal and external financial benchmark analysis is a proven tool for improving management and performance of nursery enterprises. An internet-based system for financial benchmark analysis provides access to industry benchmark information and enables users to compare their performance with peer industry firms.

Have you checked the productivity in your firm recently?

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