DETERMINING CONTAINER PRODUCTION COSTS ON A PER PLANT BASIS

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Nurserymen are businessmen. Like all businessmen our main objective must be to make money, a profit over and above our expenses. No business can survive without making a profit.

There are several ways of accessing the profitability of a business. Some monitor bank accounts; others produce periodic income and expense statements. Johnson Nursery is concerned about the profitability of every plant. It is the sale of plants that produces income for this business. If the nursery is going to be profitable, the plants we sell must be profitable. To determine this degree of profitability we have developed a method of cost allocation in which all expenses incurred in the nursery are allocated to all plants.

Before discussing the cost allocation procedure, examine Table 1; this is the end result. The table lists the various container sizes we grow, separates the containers according to the size plant from which they were potted, and shows the cumulative expense allocated to each size over 18 months. For example, a three-gallon plant grown from a one quart liner (3G-QT) that has been in production for nine months, has cost the nursery $3.17. In like manner, other production costs can be determined for the other sizes at various ages.

The remainder of this paper provides explanation of how figures in Table 1 were developed.

The first step in allocating expenses is to determine the expenses. Table 2 is the expense portion of an income statement for the month of July. These expenses, except freight sales, are allocated to all plants in the nursery. Although Johnson Nursery delivers about 90% of its sales, freight is a service to our customer and not a means of making money. Therefore, freight expense is

Table 1. Cost Per Plant Analysis,[1] July, 1986.

	CONTAINER SIZE								
Months	QT-BR	1G-BR	1G-QT	2G-QT	2G-1G	3G-QT	3G-1G	7G-2G	7G-3G
1	0.28	0.50	0.81	1.03	1.82	1.31	2.05	4.16	4.78
2	0.31	0.58	0.94	1.14	1.83	1.47	2.20	4.47	5.09
3	0.37	0.68	1.05	1.30	2.00	1.75	2.48	4.88	5.50
4	0.41	0.78	1.15	1.45	2.14	1.99	2.72	5.30	5.92
5	0.45	0.86	1.23	1.58	2.27	2.20	2.93	5.66	6.28
6	0.49	0.95	1.32	1.71	2.40	2.42	3.15	6.03	6.65
7	0.53	1.04	1.41	1.85	2.54	2.65	3.38	6.43	7.05
8	0.59	1.25	1.62	2.05	2.74	2.99	3.72	7.02	7.64
9	0.62	1.32	1.69	2.16	2.85	3.17	3.90	7.32	7.94
10	0.67	1.42	1.79	2.31	3.01	3.42	4.15	7.76	8.38
11	0.72	1.51	1.88	2.45	3.14	3.64	4.37	8.14	8.76
12	1.02	1.86	2.23	2.71	3.40	4.11	4.84	8.50	9.12
13	1.05	1.93	2.30	2.82	3.51	4.29	5.02	8.81	9.43
14	1.08	2.02	2.38	2.95	3.64	4.50	5.23	9.17	9.79
15	1.13	2.11	2.48	3.09	3.79	4.74	5.48	9.59	10.21
16	1.17	2.21	2.58	3.24	3.93	4.98	5.71	10.00	10.62
17	1.22	2.32	2.69	3.41	4.10	5.27	6.00	10.50	11.12
18	1.27	2.40	2.77	3.53	4.22	5.46	6.19	10.83	11.45

[1] Months represent the length of time the plant has been in production. The top of the columns gives the size container and the size container from which it was grown. For example 3G-QT represents a three-gallon grown from a quart. The table lists the expense that has been allocated to the various size plants at different stages of production. For example, a two gallon grown from a quart (2G-QT) that has been in production for nine months has an expense of $2.16.

Table 2. Expense statement for July, 1986.

Operating Expenses:

Salaries	$ 6,543	General supplies	0
F.I.C.A.	487	Tools	25
Nursery Supplies	10,048	Rep. & main.	785
Interest	2,343	Lic. & taxes	0
Depreciation	1,800	Membership dues	0
Attorney	0	Literature	0
Accountant	0	N.C. sales taxes	64
Insurance	502	Travel	0
Telephone	245	Advertisement	54
Utility	252	Service charge	0
Office supplies	79	Postage	69
Freight, purchase	485	Entertainment	10
Freight, sales	1,262	Miscellaneous	0
		Total Operating Expense:	$25,052

offset by freight income and is not allocated to the cost of plant production. All other expenses are allocated.

In producing plants, as much as one-third of the expense is incurred during the first day of production. These expenses are classified as initial production costs. Space will not permit a lengthy discussion of how initial production costs are determined; how-

ever, a summary of these expenses are found in Table 3. These expenses will not change with an increase in production on a per plant basis. For example, to grow 1000 additional three-gallon plants requires 1000 additional pots at $0.2730 per pot.

Table 3. Initial production costs.

	QT-BR	1G-BR	1G-QT	2G-QT	2G-1G	3G-QT	3G-1G	7G-2G	7G-3G
Liner	0.1500	0.2500	0.5500	0.5500	1.3400	0.5500	1.3400	2.4900	3.1900
Container	0.0400	0.0800	0.0800	0.1850	0.1850	0.2730	0.2730	0.7900	0.7400
Labor	0.0431	0.0606	0.0750	0.1031	0.1500	0.1337	0.1500	0.2750	0.3850
Potting media	0.0188	0.0496	0.0435	0.0950	0.0496	0.1982	0.1333	0.3304	0.1900
Total	0.2519	0.4402	0.7485	0.9331	1.7246	1.1549	1.8963	3.8854	4.5050

Unfortunately the investment does not stop here. A plant remains in production until sold. Each month we pay for chemicals, fertilizer, supplies, telephone, utilities, insurance, repairs and other overhead items. These expenses, referred to as "monthly recurring expenses", are independent of the inventory. Our phone bill is not directly proportional to the inventory, neither is the attorney's fee, nor interest expense. Nevertheless, it is the sale of plants that will pay for these expenses. If our plants are profitable, we must sell them at a price that exceeds that incurred from these expenses.

We must have a list of these expenses in order to allocate amounts. This requires excellent record keeping. First, labor allocation will be discussed (Table 4). The activities of each employee are recorded each day, and at the end of each month these daily labor sheets are compiled into a labor allocation table. Some of these expenses (potting labor, propagation labor, and soil mixing) are part of initial production costs and are allocated to either potting labor, liner or potting media expense. Management and secretary expense are allocated directly as monthly recurring expenses. The remainder of these labor expenses are allocated as recurring production costs. These include all other labor expenses such as pruning, spraying, fertilizing, and even such expenses as vacation pay.

Table 4. Labor allocation.

Manager	$1,664
Office	340
Recurring production costs	1,921
Initial production costs	2,618
Total	6,543

The next category of expenses is nursery supplies, which totaled $10,048 for July, 1986 (Table 2). Many of these expenses, such as containers, potting media, and liners went into the plants

the first day of production. These expenses are classified as initial production costs. Recurring production costs are incurred while the plants are in production. These expenses, such as fertilizers, insecticides, and herbicides are used in the plants' growth, maintenance, and production. Table 5 separates the initial production costs and recurring production costs for nursery supply expense.

Table 5. Nursery supply allocation.

Initial production costs	$ 8,843
Recurring production costs	1,205
Total	10,048

Most major expenses in Table 2 are allocated as shown (interest and depreciation) or have previously been discussed (salaries and nursery supplies). Operating expenses, such as insurance, phone, and utilities are aggregated into general overhead.

Table 6 summarizes all of the expenses that are to be allocated as monthly recurring expenses. These are to be allocated to all plants in the nursery. Although some accountants argue that it is incorrect to allocate interest and overhead to production costs, we disagree. The only way Johnson Nursery can pay our bills is through plant sales. If our sales price per plant is not high enough to cover all expenses, the business will not realize a profit.

Table 6. Monthly recurring expenses.[1]

Labor expenses	
Management	$1.664
Office	340
Production	1,828
Interest	2,343
General overhead	3,057
Nursery supplies	1,205
Depreciation	1,800

[1]These are the expenses that will be allocated to the plants for the month of July.

We must have an accurate inventory of the number of plants in the nursery in order to allocate monthly expenses in this way. Keeping accurate inventory records in any nursery is difficult, at best. To overcome this problem, we maintain daily records of the number potted and monthly records of the number sold or thrown away. This inventory count is periodically checked against the number of plants actually in the nursery. Table 7 lists the inventory as of July 1, 1986.

The next step is to allocate expenses over items that do not have the same market value. It would be inaccurate to allocate the same amount of interest expense to both quart and 7-gallon containers. Therefore, a standard allocation unit (AU) was derived to compare different sizes according to their ease of handling and the growing

Table 7. Inventory, July 31, 1986.

No. of quarts	37367
No. of gallons	61190
No. of 2 gallons	20076
No. of 3 gallons	32557
No. of 7 gallons	564

area they require (Table 8). These values are used to allocate the recurring expenses to the various container sizes. For example, a quart is given a value of 1(AU), while a one gallon is 2.3(AU). This means that a one-gallon will be allocated 2.3 times more expense than a quart. A three-gallon will receive 5.8 times more of a given expense than a quart and about 2.5 times more expense than a one-gallon. The following example may help explain this concept. If $22.60 of expenses were to be allocated over five containers, one of each size, it would be allocated in the following manner: Quarts = $1.00, one gallons = $2.30, two gallons = $3.50, three gallons = $5.80, seven gallons = $10.00. If $22.60 of expense were to be allocated over 10 containers, two of each size, the above costs per would be cut in half. For example, quarts would be allocated $0.50 expense.

Table 8. Allocation values.

Allocation units	
Quart =	1.0 (AU)
1 gal =	2.3 (AU)
2 gal =	3.5 (AU)
3 gal =	5.8 (AU)
7 gal =	10.0 (AU)

With this system a quart receives one unit (1AU) of allocation value. Johnson Nursery has 7,367 quarts in inventory; therefore, quarts have a total value of 37,367 allocation units (37,367 × 1). In like manner the allocation value of two-, three- or seven-gallons can be determined from Table 9.

Table 9. Allocation units (AU).

37,367	qts ×	1.0 (AU per qt)	=	37,367 (AU)
61,190	1 gal ×	2.3 (AU per 1 gal)	=	140,737 (AU)
20,067	2 gal ×	3.5 (AU per 2 gal)	=	70,266 (AU)
32,557	3 gal ×	5.8 (AU per 3 gal)	=	188,830 (AU)
564	7 gal ×	10.0 (AU per 7 gal)	=	5,640 (AU)
		Total allocation units	=	442,840 (AU)

The inventory, as seen in Table 9, has a total value of 442,840 allocation units. Interest is allocated to the inventory by dividing interest expense ($2,343) by total allocation units (442,840). This reveals that one allocation unit has an interest allocation value of $0.0053. In like manner, the value of one allocation unit for each

recurring expense is computed in Table 10.

Table 10. Allocation unit expense.

	Monthly expense		Value of one allocation unit (AU)
Management	$1,664	divided by 442,840 =	0.0038
Office	340	divided by 442,840 =	0.0008
Production	1,828	divided by 442,840 =	0.0041
Interest	2,343	divided by 442,840 =	0.0053
General overhead	3,057	divided by 442,840 =	0.0069
Nursery supplies	1,205	divided by 442,840 =	0.0027
Depreciation	1,800	divided by 442,840 =	0.0041

It is now possible to allocate the recurring monthly expenses to all plants. A quart has an allocation value of 1(AU). Table 10 shows that 1(AU) of interest expense is valued at $0.0053; therefore a quart receives $0.0053 of interest expense (0.0053 × 1). A gallon has an allocation value of 2.3 (AU) so it has an interest expense value of $0.0122 (2.3 × 0.0053). In like manner, the interest expense allocation for two-, three- and seven-gallons can be determined, and is found in Table 11.

The results of allocating all of the monthly expenses to all of the plants and the total allocation to each plant is seen in Table 11. Each month will vary due to changes in inventory and expense.

Table 11. Allocation of monthly recurring expenses for July.[1]

	Manage. Cost/plt	Office Cost/plt	Produc. Cost/plt	Interest Cost/plt	Overhead Cost/plt	Nur. supp Cost/plt	Deprec. Cost/plt
Quart = 1.0 (AU) =	0.0038	0.0008	0.0041	0.0053	0.0069	0.0027	0.0041
1 Gal = 2.3 (AU) =	0.0086	0.0018	0.0095	0.0122	0.0159	0.0063	0.0093
2 Gal = 3.5 (AU) =	0.0131	0.0027	0.0144	0.0185	0.0242	0.0095	0.0142
3 Gal = 5.8 (AU) =	0.0218	0.0045	0.0239	0.0307	0.0400	0.0158	0.0236
7 Gal = 10. (AU) =	0.0376	0.0077	0.0413	0.0529	0.0690	0.0272	0.0406

[1]This table lists the allocation expense for each size container with regard to each category of expense.

Now back to the beginning, Table 1. The expenses allocated to plants potted in July can be found on the first line (month 1). Two-gallon containers potted from quarts have an expense of $1.03. This results from adding the initial production cost for July ($0.9331 from Table 3) plus monthly recurring expense for July ($0.0967 from Table 11). Two-gallon containers that have been in inventory for 10 months have a total expense of $2.31 (initial production cost for September, 1985 plus all recurring expenses from September through July, 1986). In like manner, all other expenses for different sizes and ages can be determined.

The relevance of the costs presented in this study to other nurseries is questionable. Size of inventory, efficiency of operation, degree of indebtedness, among other things, would affect the overall cost per plant. However, a similar procedure could be developed to fit any nursery. The information this ongoing study gives Johnson Nursery is significant. We know our time limitations for growing plants. Discounts can easily be decided upon with regard to profitability. This study will also reveal production efficiency increases and decreases.

ROOT STRESS IN CONTAINERS

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Plants that are container-grown in artificial media are subjected to many stresses different from those encountered by a plant grown in soil. Containerized root systems are confined to a limited volume; thus, they rely on supplemental irrigation, supplemental nutrition, and are not buffered against temperature changes. Containers are left above ground during the winter, exposing the roots to temperature extremes. Roots are not as hardy as shoots; therefore, roots may be injured at temperatures lower than those that injure shoots (15). Summer container-media temperatures, in contrast, can easily exceed temperatures considered optimum for good root growth (14).

Container plant production of woody ornamentals has expanded rapidly in recent years and now represents more than 50 percent of all landscape plants sold in the United States (15). Technological advances have, and are, revolutionizing the nursery industry. However, as growers are keenly aware, temperature extremes and devastating winter freezes can destroy a crop unless some protection is provided. The objectives of this paper are to discuss high and low temperature stress of roots in containers and describe the physiology of root temperature stress.

LOW TEMPERATURE ROOT STRESS

Cold hardiness varies among species and often varies among cultivars and ecotypes (10). Marked differences are also observed among tissues on the same plant (15). Reproductive buds are less

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