

Pacific Plug & Liner Crop Shrinkage Evaluation

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Jillian Balli

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## **Abstract**

Crop Shrinkage has a major impact on a company's bottom line. There are many ways to combat shrinkage. This report focuses on shrinkage reduction by adjusting buffer planting numbers to reflect the actual number of plants lost in production. Inaccurate buffer can cause the cost of production to be inaccurate as well. This report evaluates crop shrinkage of a greenhouse located in Watsonville, CA called Pacific Plug & Liner.

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## **Introduction and Literature Review**

Pacific Plug & Liner (PP&L) is a wholesale greenhouse that specializes in growing young plants (“Discover Pacific Plug & Liner”). The company is located in Watsonville, CA. It is equipped with rolling benches, irrigation booms, Argus environmental controls, high-pressure fog system, and hydronic bottom heating (“Discover Pacific Plug & Liner”). The Picas software system is used to manage orders and inventory (“Discover Pacific Plug & Liner”).

The Picas software controls all aspects of young plant production. There are three main aspects to the Picas system; crop scheduling, material requirements, and activity requirements. Crop scheduling manages sowing, sticking, and transplant dates (“Picas Information”). Material requirements allow companies to know how many hard goods to purchase such as plastics, tags, cuttings, seed, substrates, etc. (“Picas Information”). Activity requirements allow growers to set up schedules for pinching, patching, spraying, spacing, and moving (“Picas Information”). Handheld portable devices are used to gather information in the greenhouse saving hours of entering information from handwritten notes (“Picas Information”).

Although Pacific Plug and Liner has the proper technology to manage inventory accurately and efficiently, correct inputs into the system such as crop plans and proper use of the scanning technology are necessary to maintain accuracy and maximize profits. Having accurate inventory history can help companies calculate how much product is planted versus how much product is sold; the difference is the crop shrinkage (Mattson et al., 2009). Shrinkage is the gradual loss of plants over time, which can occur from germination failure, disease and pests, poor quality, or the inability to sell product (Mattson, et al., 2009). Shrinkage can affect a greenhouse in two ways, by increasing the

cost of production and by decreasing the number of saleable plants (Mattson, et al., 2009). High shrinkage indicates that changes should be made in plant selection or the crop requirements. Crop shrinkage dictates the pricing of a product because it affects the cost of production, so minimizing shrinkage can allow companies to lower their prices while maintaining their profit margin. This report will focus on the two main influences of the cost of production, overstart and crop time. The goal of this project is to suggest possible ways to reduce crop shrinkage by analyzing and evaluating Pacific Plug & Liner's crop inputs and methods of production.

The cost of production can be broken down into three parts; materials, labor, and overhead (Ingels 451-455). The price of a product is the cost of production plus the anticipated profit margin (Ingels 451-455). The materials component consists of perishable and nonperishable items (Ingels 451-452). Perishable items would be plant material like cuttings, seeds, and tissue culture (Ingels 451-452). Nonperishable items would be trays, containers, fertilizer, etc (Ingels 451-452). Labor costs consist of wages and benefits of the employees (Ingels 452). Overhead is the cost that is not directly related to materials or labor (Ingels 452). This can include administrative salaries, utility costs, rent, maintenance costs, etc. (Ingels 452). When calculation of the cost of production is inaccurate, the price of the product is unfair to either the business or the customer (Ingels 451-455). Overestimating the cost of production is unfair to the customer because the company is taking away a higher profit margin than they intended. Underestimating the cost of production is unfair to the company because they are not receiving the profit margin that they anticipated and it could be to the extent that the company is breaking even or worse, losing money.

When growing plants, especially young plants, losses are going to occur. In a

survey organized by Ball Horticultural Co., shrink losses were 20% during propagation, 11% during production, and 9% at retail for a total of 40% shrinkage (Mattson, et al., 2009). Since PP&L specializes in propagation, shrink should be carefully managed to try to overcome such heavy losses and produce plants with less than the average amount of losses. Pacific Plug & Liner uses the term “overstart” to describe the expected percentage of loss. For example, if a customer orders 100 trays of a certain crop and Pacific Plug and Liner’s overstart for that specific crop is 10%, then 110 trays of material will be started with the expectation to end up with 100 saleable trays. The overstart serves as a buffer so that enough products are produced to fulfill orders. The overstart is accounted for in the cost of production, so if the overstart does not reflect actual losses then the price will not match the intended profit margin (Healy, 2012). Keeping the buffer cost to a minimum is essential for shrink management, but eliminating buffers altogether will cause order fulfillment to suffer (Healy, 2012).

Inaccurate crop schedules can cause the cost of production to be inaccurate as well. Providing extra time to ensure the crop will finish by the ship date will cause the cost of production to be higher and poses a risk to the quality of the plants (Mattson, et al., 2009). If the crop finishes a couple weeks before its intended ship date, there is a risk that the plants will be overgrown or become root bound. The price of the product may also be too high because the cost of production is being overestimated. On the other hand, underestimating a crop time will cause the price to be too low. The cost of production does not account for the extra time and resources that are required to finish the crop.

Orders will need to be pushed back if the crop does not finish in the expected amount of time. Changing ship dates can create conflicts with the customer’s planting schedule and potentially cause them to move their orders back as well. In some cases,

customers cannot afford to rearrange their schedules or push back orders and need to cancel any material that cannot be shipped on time. In this circumstance, the company will need to sell their product to a new customer or dump the unsold plants. Dumping unsold product contributes to shrink and it is money wasted on goods and labor.

## **Materials and Methods**

There are five major categories that need to be researched and analyzed when assessing the crop shrinkage of a specific company. The five categories are growing facilities, product offerings, customer orders, cost of production, and pricing. In order to understand how to manage crop shrinkage, these five aspects should be known.

### **Growing Facilities**

The first category, growing facilities, is extremely important because it gives insight on the company's growing capabilities and capacity. Collect information about how the plants are grown. Are they grown in a greenhouse or outdoors? Are they grown in the ground, in containers, or in trays? Are the containers and trays on the floor or on benches? Growing equipment and technology is extremely important to know the capabilities of the growing facility. What type of irrigation system is used? Is there a heating or cooling system? Is the environment being monitored by a highly controlled software system? Are there any mechanized systems for planting, pinching, moving, etc.? Are there any cold storage areas or germination chambers?

### **Product Offerings**

The next category, product offerings, is an overview of what types of products are offered to customers. There are many different types of growers that specialize in a few products or can grow a large variety of products. For this category, it is important to determine the types of plants grown and the sizes that are being offered. Some growers focus on propagation and would only sell trays with small plugs and liners. Other growers focus finished products that are ready for the final consumers and the size of the containers and plants can vary greatly depending on what is grown. Knowing the products will allow evaluation of seasonality and market demands. Not every product is

suitable for growing during every season of the year. Some products are only in demand during certain seasons, so growing them outside of the demand window can lead to dumping unsold product.

### **Customers and Orders**

The third category, customers and orders, gives insight on how well the company organizes its growing choices and times. A company can grow product for specific orders or grow with speculation that customers will buy the product that they are growing. Growing product for specific orders requires customers to place orders in advance to give the grower time to order the material and grow the product by the customers desired ship date. Growing on speculation does not require customers to order in advance for product. Speculation depends on predicting what products customers will buy without entering an order in advance. Growing material on speculation can be risky because it poses a risk of having unsold product that will need to be dumped. Speculation can also be very profitable to a company if accurate predictions of demand are made and the entire product is sold. Another thing to keep in mind is whom the product is being sold to. Is the product going to another grower or to a store for the final buyer?

### **Cost of Production**

As mentioned earlier, the cost of production is comprised of three components; materials, labor, overhead. Find out the cost of each component. How does the company calculate the cost of production? Are there inefficiencies in labor that can be fixed to decrease labor costs? Can the company buy the same materials from another supplier for a lower price? Are the costs of utilities high due to wasteful behavior?

### **Pricing**

The last category, pricing, determines whether or not a company will make a

profit. Determine how the company generates their prices. Are they pricing their products based on the competitor's price or do they have an organized pricing system? What is the anticipated profit margin?

## **Results and Discussion**

### **Growing Facilities**

Pacific Plug & Liner has an exceptional growing facility for growing young plants. PP&L has indoor and outdoor growing space. The greenhouses are separated into different zones that offer different environmental controls for growing an assortment of products at different growth stages. One of the zones is equipped with a high-pressure fog system. The entire greenhouse uses the Argus software system, which allows strict environmental control of all the zones. The entire greenhouse production area is equipped with irrigation booms that have adjustable irrigation options and a hydronic heating system. The outdoor growing space is used specifically for hardening off the young plants. The outdoor area is irrigated by a sprinkler system or occasionally by hand.

All of the plants grown at Pacific Plug & Liner are grown in trays that sit on rolling benches. The benches have the capability to be manually moved to any area of the greenhouse and outdoor growing space. They have two germination chambers that offer warm and cool germination environments. The facility is equipped with two storage coolers. One of the coolers is used for storing cuttings and the other is used for seed storage. There is a mechanical seeding machine, a conveyor belt in the sticking area, a trimming machine, and Ellepot machine.

The greenhouse has approximately 40 rows of production area. Each row can hold 36 benches and each bench can carry 66 trays. The greenhouse has the potential to carry approximately 95,040 trays. This does not include outdoor space.

### **Product Offerings**

Pacific Plug & Liner offers over 100 different genera of plants grown from seed, vegetative cuttings, and tissue culture. The plant offerings are organized into six different

categories; shrubs, herbs, vegetative annuals, specialty, perennials, and grasses. See Tables 1-6 for a complete list of offerings by category; the lists do not include specific cultivars, just plant genera.

PP&L does not grow a finished product. The products are all young plants that merely start the growing process for other growers. The plants are grown in four different tray sizes- 288's, 162's, 102's, and 72's. The 288's are for used for seeded items. The 162's and 102's are used for both seeds and cuttings, depending on the variety. The 72's are used for cuttings only. Each tray is approximately 1.7 squared feet; the only difference is the number and the size of the cells. Not all tray sizes are offered for each variety. In fact, each variety generally only offers two different tray sizes depending on the size of the propagules, the ease of growing, and cost effectiveness.

Each crop has its own crop plan, which designates overstart and crop time. The crop time can vary depending on the time of the year. The grower determines products that do not grow well during a specific season and can make the product unavailable during that season for upcoming years. The grower also determines which tray sizes or seed types are unsuitable for growing. Using the grower's input allows Pacific Plug & Liner to prevent future shrinkage because growing issues can lead to unsaleable product that will end up being dumped.

### **Customers and Orders**

Pacific Plug & Liner sells its products to other growers who will then grow a finished product. All orders must be placed through brokers. See Figure 1 for the list of brokers that PP&L works with. There are two different ways customers can order products. The first way is to place an order in advance, so that PP&L will have time to purchase the growing material and grow the crop by the date specified by the customer.

PP&L calls these orders “grow to” orders. The second way customers can order products are through availability orders. Available trays come from extra trays from unused overstart and from speculation. Pacific Plug & Liner grows most of their tissue culture items as speculation. Tissue culture items have limited availability, so it is difficult to accept “grow to” orders for this type of material. It does not seem as though Pacific Plug & Liner has a problem with extra material from unsold speculation.

**Table 1 Specialty offerings**

Specialty
Agave
Aloe
Anigozanthos - Kangaroo Paw
Astelia
Beschorneria - False Red Yucca
Colocasia - Taro
Cordyline
Dianella - Flax Lily
Echeveria
Ferns - Perennial
Ferns - Tropical
Phormium - New Zealand Flax
Yucca

**Table 2 Shrub offerings**

Shrubs
Abelia
Callistemon - Bottlebrush
Ceanothus - California Lilac
Hardenbergia
Nandina - Heavenly Bamboo
Tibouchina - Princess Flower
Westringia - Coast Rosemary

**Table 3 Herb offerings**

Herbs
Artemesia - Tarragon

Ocimum - Basil
Helichrysum - Curry
Mentha - Mint
Origanum - Oregano
Rosmarinus - Rosemary
Salvia - Sage
Satureja - Yerba Buena
Stevia
Thymus - Thyme
Fragaria - Strawberry

**Table 4 Grass offerings**

Grasses
Baloskion - Tassel Cord Rush
Calamagrostis - Feather Reed Grass
Carex - Sedge
Cortaderia selloana
Corynephorus - Clubawn Grass
Deschampsia - Tufted Hair Grass
Festuca - Blue Fescue
Juncus - Rush
Koleria - Blue Hair Grass
Lomandra - Matt Rush
Luzula - Wood Rush
Ophiopogon - Black Mondo Grass
Pennisetum - Fountain Grass
Stipa - Needle Grass

**Table 5 Vegetative Annual offerings**

Vegetative Annuals	
Abutilon - Flowering Maple	Helichrysum
Acalypha	Heliotrope
Alternanthera - Alligator Weed	Impatiens - New Guinea

Angelonia - Summer Snapdragon	Ipomea - Bindweed
Antirrhinum majus - Snapdragon	Lantana
Arctotis - African Daisy	Lobelia
Argyranthemum - Margeruite Daisy	Lobularia - Sweet Alyssum
Bacopa - Water Hyssop	Lotus - Parrot's Beak
Begonia	Lysimachia
Bidens	Nemesia
Bracteantha - Outback Paper Daisy	Nierembergia - Cup Flower
Calibrachoa -Trailing Petunia	Osteospermum - Cape Daisy
Calocephalus - Cushion Bush	Oxalis
Coleus	Pericallis
Coreopsis - Tickseed	Petunia
Cuphea - Mexican Heather	Portulaca - Moss Rose
Dahlia	Salvia
Dianthus - Pot Carnation	Sanvitalia - Creeping Zinnia
Diascia - Twinspur	Scaevola - Fanflower
Euphorbia	Setcreasea
Fuchsia	Strobilanthes
Gazania -Treasure Flower	Thunbergia - Black Eyed Susan
Geranium - Interspecific	Trixi - Multi-Stick Liners
Geranium - Ivy	Torenia -Wishbone Flower
Geranium - Zonal	Verbena - Vervain

**Table 6 Perennial offerings**

Perennials		
Achillea - Yarrow	Erodium - Cranesbill	Monarda - Bee Balm
Agastache - Hummingbird Mint	Erysimum - Wallflower	Nepeta - Catmint
Ajuga - Bugleweed	Eupatorium - Joe Pye weed	Oenothera - Evening Primrose
Anemone - Windflower	Euphorbia - Spurge	Papaver - Iceland Poppy
Aquilegia - Columbine	Gaillardia - Blanket Flower	Penstemon - Beardtounge

Arabis - Rockcress	Gaura - Wandflower	Phlox
Arenaria- Mountain Sandwort	Gerbera - Hardy Garden Daisy	Phygelius - Cape Fuschia
Armeria - Common Thrift	Geranium - Crane's Bill	Polemonium - Jacob's Ladder
Artemisia - Wormwood	Gysophila - Baby's Breath	Primula - Primrose
Asclepias - Butterfly Weed	Helianthus - Hardy Sunflower	Ptilotis
Aubrieta	Heliopsis	Rudbeckia - Black-eyed Susan
Bellis -English Daisy	Helleborus - Lenten Rose	Salvia - Sage
Buddleia - Butterfly Bush	Heuchera - Coral Bells	Santolina - Lavender Cotton
Campanula - Bellflower	Iberis - Candytuft	Saxifraga
Caryopteris - Bluebeard	Kniphofia - Red Hot Poker	Scabiosa - Pincushion Flower
Cerastostigma - Plumbago	Lamium - Dead Nettle	Scaevola - Fan Flower
Coreopsis - Tickseed	Lavandula - Lavender	Sedum - Stonecrop
Cosmos - Chocolate	Lavatera - Rose Mallow	Silene - Catchfly
Delosperma - Hardy Ice Plant	Leucanthemum - Shasta Daisy	Solidago - Goldenrod
Delphinium	Ligularia - Leopard Plant	Stachys - Lamb's Ears
Dianthus - Pinks	Lithodora	Stokesia - Stoke's Aster
Digitalis - Foxglove	Lobelia - Cardinal Flower	Tecoma - Yellow Bells
Doronicum- Leopard's Bane	Lupinus	Veronica - Speedwell
Echinacea - Coneflower	Lysimachia - Loosestrife	Vinca - Periwinkle
Erigeron - Fleebane	Mimulus - Monkey Flower	Viola - Sweet Violet

Figure 1 List of Brokers

## Brokers

### Abbott-Ipco, Inc.

PO Box 551329, Dallas, TX 75355-1329  
 Ph. 1(800)525-1379(800)525-1379 Fax. 1(214)341-7873  
[www.abbott-ipco.com](http://www.abbott-ipco.com)



### Eason Horticultural Resources

939 Helen Ruth Drive, Ft. Wright, KY 41017  
 Ph. 1(800)214-2221 Fax. 1(859)578-2266  
[www.ehrnet.com](http://www.ehrnet.com)

### Fleurizon

#### Fleurizon LLC

1602 Grace Court, Camarillo, CA 93010  
 Ph. 1(805)389-8980 Fax. 1(805)823-2723  
[www.fleurizon.com](http://www.fleurizon.com)



### Fred C. Gloeckner & Co. Inc.

600 Mamaroneck Ave., Harrison, NY 10528  
 Ph. 1(800)345-3787 Fax. 1(914)698-0848  
[www.fredgloeckner.com](http://www.fredgloeckner.com)

### Ball

#### Ball Horticulture

622 Town Road, West Chicago, IL 60185  
 Ph. 1(800)879-BALL Fax. 1(630)293-2542  
[www.ballhort.com](http://www.ballhort.com)

#### EXPRESS SEED COMPANY

#### Express Seed

51051 US Highway 20, Oberlin, OH 44074  
 Ph. 1(800)221-3838 Fax. 1(440)774-2728  
[www.expressseed.com](http://www.expressseed.com)



#### Florasource Ltd.

PO Box 758, San Clemente, CA 92674  
 Ph. 1(949)498-1131 Fax. 1(949)498-1196  
[www.florasourceltd.com](http://www.florasourceltd.com)

#### JVK

1894 Seventh Street, St. Catharines, ON L2R 6Z4



**M&M Plants**

410 Spring Grove Road, Hollister, CA 95023  
Ph. 1(831)801-6049 Fax. 1(831)637-3338  
[www.mmplants.com](http://www.mmplants.com)



**McHutchison**

64 Mountain View Blvd., Wayne, NJ 07470  
Ph. 1(800)943-2230 Fax. 1(866)234-8884  
[www.mchutchison.com](http://www.mchutchison.com)



**Messick Company LLC**

142 North Central Ave., Campbell, CA 95008  
Ph. 1(408)871-9816 Fax. 1(408)871-9839  
[www.messickco.com](http://www.messickco.com)



**Michells**

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Ph. 1(800)442-4678 Fax. 1(610)265-4208  
[www.michells.com](http://www.michells.com)

**Raymond Perri**

8 Winding Trail Road, Pine Bush, NY 12566  
Ph. 1(845)744-6801



**SHS Griffin**

4343 Commerce Ct. Suite 500, Lisle, IL 60532  
Ph. 1(800)454-8159 Fax. 1(800)454-8160  
[www.shsgriffin.com](http://www.shsgriffin.com)



**Vis Seed**

PO Box 661953, Arcadia, CA 91066  
Ph. 1(626)445-1233 Fax. 1(626)445-3779  
[www.visseed.com](http://www.visseed.com)

**Vaughan's Horticulture**

40 Shuman Boulevard, Suite 175, Naperville, IL 60563  
Ph. 1(885)864-3300 Fax. 1(885)864-5970  
[www.vaughans.com](http://www.vaughans.com)

**Cost of Production**

The cost of production is split up into different sections; labor, material cost, and overhead.

**I. Labor**

Labor cost is separated into three categories; seed, vegetative, and tissue culture. The cost for sowing one tray is \$0.50, the cost for sticking one cell is \$0.03, and the cost for planting one cell for tissue culture is \$0.05. See Table 7 for the total cost per tray organized by tray size. Based on the table, trays with more cells have the highest labor cost. This makes sense because it would take longer to stick 162 cuttings than it would to stick 72 cuttings. Seeded items are the least expensive in terms of labor, which can be explained by the use of a mechanical seeder. The vegetative cuttings and tissue culture cost the most in terms of labor because the material is planted by hand.

PP&L is constantly upgrading and maintaining its current machinery to keep labor costs low. Mechanization is a great way to keep labor costs low, but manual activities also need to be efficient. There is a long process in the receiving department that serves no purpose. When seed is received and entered into Picas, all the information about the seed is entered by hand. This information includes lot numbers, germination rates, seed weight, and supplier. When the seed is used, it is manually removed from a specific lot for a specific batch of trays. The problem with this process is none of the information is used to benefit PP&L. The information is basically entered in the system for no reason. In order to enhance receiving efficiency, PP&L needs to eliminate the process of entering the information by hand or use the information to make the labor more cost effective.

**Table 7 Cost of Labor Per Tray Size**

<b>Labor Cost Per Tray</b>			
	<b>Seed</b>	<b>Vegetative</b>	<b>Tissue culture</b>
<b>72</b>	NA	\$2.16	\$3.60
<b>102</b>	NA	\$3.06	\$5.10
<b>162</b>	\$0.50	\$4.86	\$8.10
<b>288</b>	\$0.50	NA	NA

## **II. Material Cost**

Material cost of nonperishable items is mostly fixed. See Table 8 for a breakdown of the material costs by tray size. In this case, trays with larger cells are more expensive in terms of material cost. The larger cells require more depth in order to support a larger root system and also require more soil, which explains the price difference among the tray sizes.

Material cost for perishable items is completely dependent upon the type of plant being grown and the type of propagule being used. Seed, cutting, and tissue culture costs

vary significantly. The amount of overstart for these items also varies. Generally the overstart for seed is higher because germination is not 100% and there may be quality losses after germination. The amount of overstart needed for seed may vary depending on the germination rate on the seed package. Currently, PP&L does not adjust overstart based on the germination rate listed on the seed package. Vegetative cuttings generally have lower overstarts than seed because rooting is fairly uniform and losses are marginal. Tissue culture should have the least amount of losses because the material is expensive and the plants should establish quite easily in the right environment.

Pacific Plug & Liner sets the overstart for all the varieties in increments of 5. This allows for inconsistencies between the overstart and the actual amount lost during production. For example, if the overstart is consistently 12%, then the overstart will be set to 10% or 15%.

The Purchasing Coordinator determines whether or not the cost of material is feasible for the price that is quoted for the customers. If the cost of material from a supplier is too high, the purchasing coordinator looks for another source to buy the material. If another source cannot be found, a decision has to be made about whether or not PP&L will accept the customer's order.

**Table 8 Material cost by tray size**

<b>MATERIAL COST TOTALS</b>					
<b>Tray Size</b>	<b>Box Cost</b>	<b>Tray Cost</b>	<b>Soil Cost</b>	<b>Tag Cost</b>	<b>Total Cost</b>
<b>72</b>	\$1.21	\$0.68	\$0.45	\$0.01	<b>\$2.35</b>
<b>102</b>	\$0.88	\$0.68	\$0.54	\$0.01	<b>\$2.11</b>
<b>162</b>	\$0.88	\$0.61	\$0.10	\$0.01	<b>\$1.60</b>
<b>288</b>	\$0.89	\$0.53	\$0.12	\$0.01	<b>\$1.55</b>

### **III. Overhead**

Overhead is \$0.70 per square foot per week, so \$1.19 per tray per week. If a crop

time were 8 weeks, the overhead cost would be \$9.52 per tray.

## **Pricing**

A pricing model developed by the company's Financial Analyst determines all the prices for the products. The model determines the cost of production for each individual product and sets a profit margin to determine the selling price. The profit margin at PP&L has a huge range between 6% and 50%. The profit margin is adjusted based on competitor prices. When competitor pricing forces the price so low that there is no profit margin, the crop is taken off the list of offerings. The prices are determined per cell and multiplied by the number of cells in the tray. In most cases, overpack is included with these trays. The 288's are sold as 280 plants, 162's sold as 160 plants, and 102's sold as 100 plants. The 72-tray size does not include a buffer and guarantees 72 plants to the customer. For tissue culture items, there is no buffer so the entire tray is included in the price because tissue culture is more expensive and availability is incredibly limited.

## **Analysis**

Determining how many seeds should be sown per cell is a big decision that can greatly affect the cost or production and shrinkage. If more seeds are sown per cell, there is a less likely hood of empty cells in the tray. When there are few empty cells, fewer trays will need to be sown, but the cost of sowing multiple seeds per cell increases the value going into each cell. Sowing one seed per cell will reduce the cost per cell, but increase the labor cost because laborers will need to replace empty cells by hand. These are the types of decisions that need careful consideration in order to keep shrink to a minimum. It would make little sense to sow two seeds per cell for a crop that has excellent germination because it would cost less to produce the same amount of product by sowing one seed per cell. On the contrary, a crop that has poor germination would

benefit from having multiple seeds per cell because the amount of money it would save on bench space and labor would outweigh the cost of sowing extra seeds. PP&L uses trials to determine what methods of production are more cost effective. The Production Planning Manager manages these trials.

## **Recommendations and Conclusion**

Pacific Plug & Liner should use the germination rates on the seed packages to determine a more accurate overstart. Currently, overstart is determined by using a base germination percentage, which is applied to all seed grown from a specific variety. The base germination percentage is generally lower than the germination percentage of the actual seeds used in order to avoid shortages. For example, the base germination percentage could be 75% for a specific variety, but Pacific Plug & Liner could receive high performing seed with a germination percentage of 95%. That is a 20% difference in expected germination, which would cause extra trays that would need to be sold.

It would be more useful to have an overstart that represents losses after the germination percentage. Since the germination percentage accounts for the seeds that do not germinate, the overstart would only represent the losses that occur when seedlings are not of saleable value. The new overstart would most likely be very small for most varieties since it should only be accounting for expected quality issues with the germinated seedlings.

Applying this information to the sowing schedule should not take too much effort since the information is already in the system. If the information that is being recorded in the system is not put to use, it is basically an extra step in the receiving process that provides no benefit. Pacific Plug and Liner can use this information to their advantage by setting their software system to constantly adjust the overstart to correspond with the germination rates of the seed packages. By applying the germination rates, PP&L would greatly improve the overstart accuracy, which would save a tremendous amount of money and growing space.

Another way overstart can be improved is by not limiting the percentage. By only setting the overstart in increments of 5%, PP&L allows for inconsistencies of 1-4%. Table 9 compares the current overstart versus the actual percentage of loss of the crop. The crops from Table 9 were chosen based on the number of units started; the top twenty were taken for this representation. The main thing to notice here is that these actual percentages of loss are not consistently in multiples of five. The red values under % Loss Avg are the percentages that do not follow the 5% increments that PP&L has set. Only three out of the twenty crops followed this “rule.” It does not make very much of a difference for small orders, but looking at the big picture, it can increase order fulfillment or save a lot of greenhouse space and money.

**Table 9 Current overstart vs. Actual percent loss**

<b>Crop</b>	<b>Units Started</b>	<b>% Loss Avg</b>	<b>Current Overstart</b>	<b>Difference</b>
Salvia Reddy Bright Red	433	21%	20%	-1%
Cosmos Sonata Carmine	495	26%	25%	-1%
Festuca Boulder Blue	511	1%	10%	9%
Lotus berthelotii Parrot's Beak	511	3%	15%	12%
Lobelia Rvra Blue Eyes	530	6%	5%	-1%
Rudbeckia Little Goldstar	554	7%	10%	3%
Bidens Bidy Gonzales+	588	4%	15%	11%
Delphinium Guardian Mix	618	27%	30%	3%
Viola Penny All Season Mixture	685	18%	0%	-18%
Viola Sorbet XP Ipd Mix	686	14%	20%	6%
Petunia Easy Wave Plum Vein	741	13%	20%	7%
Salvia Amistad	747	2%	10%	8%
Lobelia Rvra White	763	5%	5%	0%
Calib Aloha Canary Yellow+	867	5%	10%	5%
Arenaria Montana Avalanche	887	10%	15%	5%
Lavandula Sentivia Blue	901	14%	15%	1%
Marigold Bonanza Orange	952	12%	20%	8%
Petunia Dreams Rose Picotee	964	29%	20%	-9%
Snap Spdy Snnt Crimson	986	23%	25%	2%
Snap Spdy Snnt Yellow	1,166	22%	25%	3%

By making these simple changes, Pacific Plug & Liner can help minimize their shrink. There are plenty of more ways to combat shrinkage, but managing the technical

aspect of shrink is one of the easiest ways to control unnecessary losses. Adjusting a small component such as overstart can make a significant difference in production efficiency and profits.

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