

## Transplanting cuttings by hand and robotics



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**UF IFAS**  
UNIVERSITY of FLORIDA

Thanks to our industry partners

Floriculture Research Alliance

### Growers

- Dummen Orange
- Four Star (MI)
- Knox Horticulture (FL)
- Kube-Pak (NJ)
- Lucas (NJ)
- Mast Young Plants/Neal Mast (MI)
- Pleasant View Gardens (NH)
- Rockwell Farms (NC)
- Speedling (FL, CA)
- Spring Meadow (MI)
- Vivero Internacional (Mexico)
- Walters Gardens (MI)

### Allied

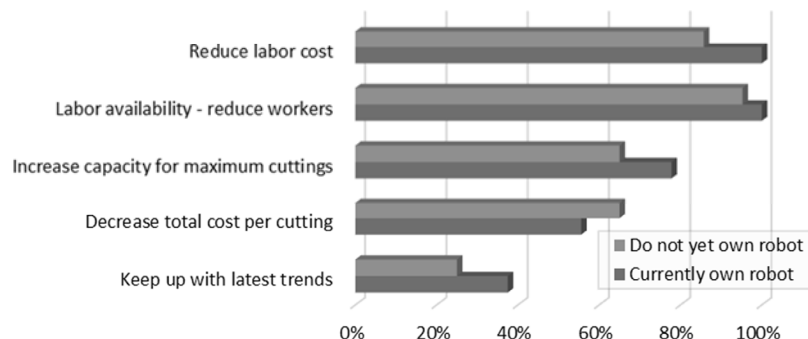
- AMA Horticulture
- Blackmore Co.
- Fine Americas
- Greencare Fertilizers
- Griffin Greenhouse Supplies
- Klasmann-Deilmann
- Pindstrup
- Premier Tech Horticulture
- Quality Analytical Labs
- Sun Gro Horticulture



Floriculture and Nursery Research Initiative

## Grower online survey on cutting transplant robots 2018

### Very or Extremely Important Factors Affecting Adoption of Cutting Robots (30 growers)

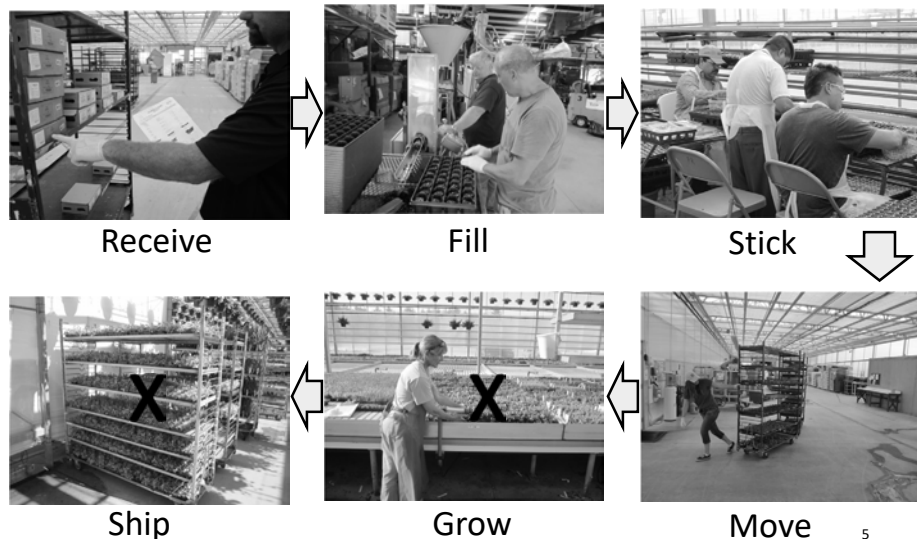


## Key questions from 25 potential adopters

- What companies have already invested in this technology? Successes & challenges?
- Technical
  - Actual number of cuttings per hour?
  - Efficiently transplants small runs?
  - Adjusts to cutting variability?
  - Unrooted cutting (URC) specs?
  - What percent of our varieties will run?
  - Easy to implement into existing systems?
  - How reliable (uptime) and accurate sticking achieved?
  - Will URC dry out prior to sticking?
- Economic
  - Machine purchase cost?
  - Maintenance cost, issues, technical assistance, and access to parts?
  - Return on investment (ROI)?
- Anything better coming down the pipeline?

## Labor Efficiency of Manual Transplanting

Ulrich Adegbola



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## Survey methodology

- 14 large young plant operations in the U.S. surveyed
- Each company had at least \$1M in annual sales, transplanting 200,000 to 3M cuttings in their peak week of 2016



## How do you figure out labor efficiency?



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## Labor analysis of peak week in one location

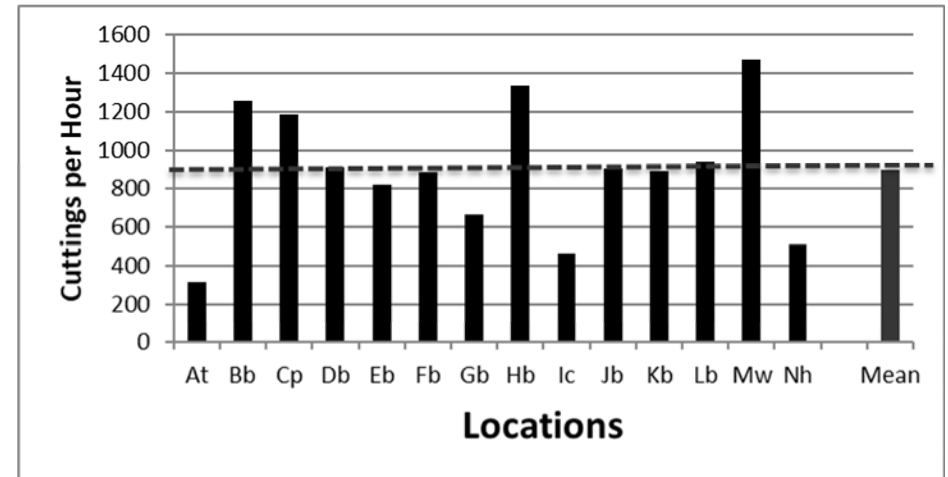
2,974,713 cuttings during peak week	Workers hours per week	Hourly Labor Cost	Labor Cost Per Week	Cuttings/worker hour
Receive, organize and deliver cuttings to transplant Line	495	\$11.47	\$5,678	6010
Fill trays with substrate	270	\$11.47	\$3,097	11017
Supervise transplant of cuttings	315	\$16.80	\$5,292	9444
Transplant cuttings into trays	3375	\$12.34	\$41,648	881
Move trays to greenhouse	495	\$11.47	\$5,678	6010
Total process	4950	-	\$61,392	601
Transplanting and transplanting supervising	3690	-	\$46,940	806
Other processes (Not transplanting)	1260	-	\$14,452	2361

## Time and labor cost per cutting in one location

Labor Type	Seconds/Cutting	Cost/ cutting	% of Cost/cutting
Receive, Organize and Deliver Cuttings To transplant Line	0.6	\$0.0019	10%
Fill Trays with Substrate	0.3	\$0.0010	5%
Supervise Transplant of Cuttings	0.4	\$0.0018	9%
Transplant Cuttings Into Trays	4.1	\$0.0140	70%
Move Trays to Greenhouse	0.6	\$0.0019	10%
Total process	6	\$0.0200	100%
Transplanting and Transplanting supervising	75%	79%	79%
Other processes (Not transplanting)	25%	21%	21%

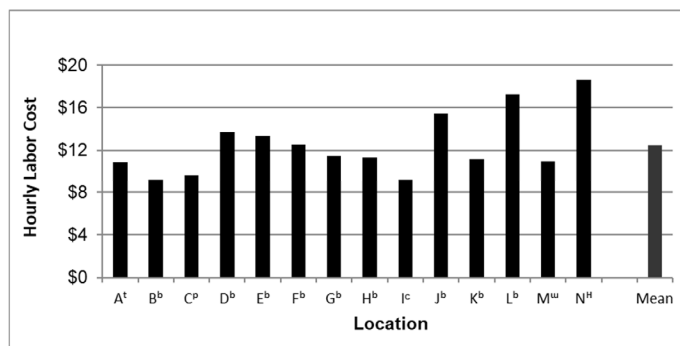
## Manual cuttings transplanted per hour

- Mean 897 (317 to 1473) cuttings/hour for the sticking task
- Mean 560 cuttings/hour for overall process



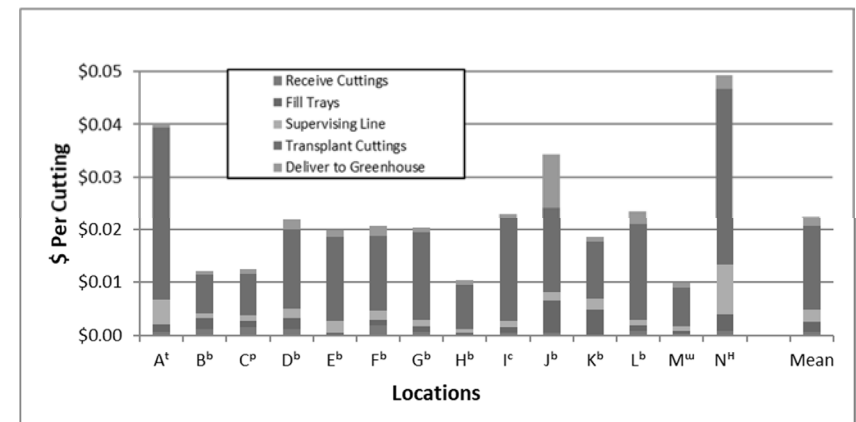
## Labor hourly wage

- Mean hourly cost to business (wages, insurance, taxes, benefits): \$12.49
- Average hourly wage for seasonal workers: \$11.55 (range \$9.00 to \$13.53)
- Wage comparisons (2016) affects labor availability!
  - Workers without high school completion national average: \$13.51
  - Farmworker average in these areas: \$10.38 to \$13.75
  - Adverse wage (immigrant labor): \$10.70 to \$12.02



## Labor cost per cutting for different tasks

- Mean: \$0.023 per cutting to receive cuttings through to place in greenhouse
- Labor cost break down:
  - Transplanting cutting into tray 70% (\$0.0161)



Are these conditions you would like to work in?

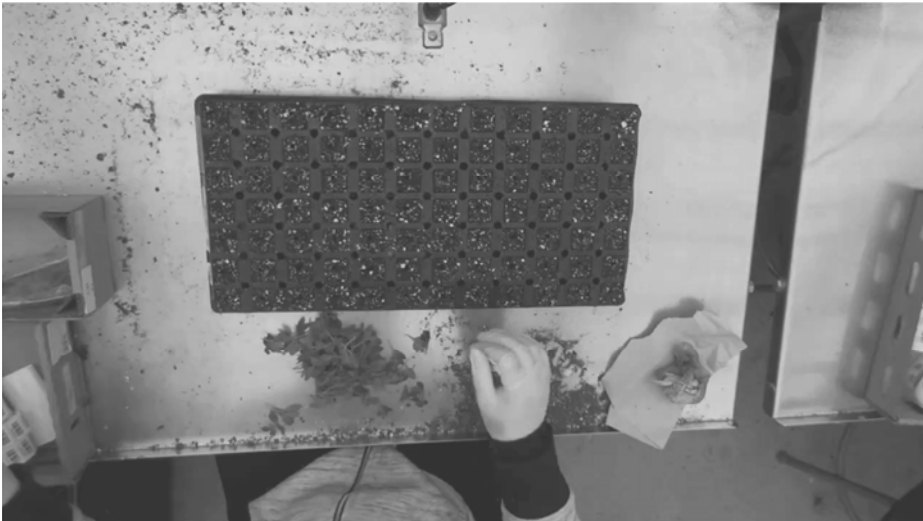


Efficient work station



## Optimize manual labor efficiency

- Let's not forget manual transplanting
- Wide range of productivity between companies & individuals
- Is this good technique?



Can we identify the best method, standardize, and provide training?



# What can you do?

1. Optimize your manual process
  - Track individuals or teams (quantity & quality)
  - Get a lean consultant in to evaluate the process
  - Provide training
  - Develop standards and provide incentives
2. Evaluate labor cost of your manual process
3. Provide pay and conditions to attract & retain staff
4. Work with recruitment agencies...



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## Return on investment in robotics



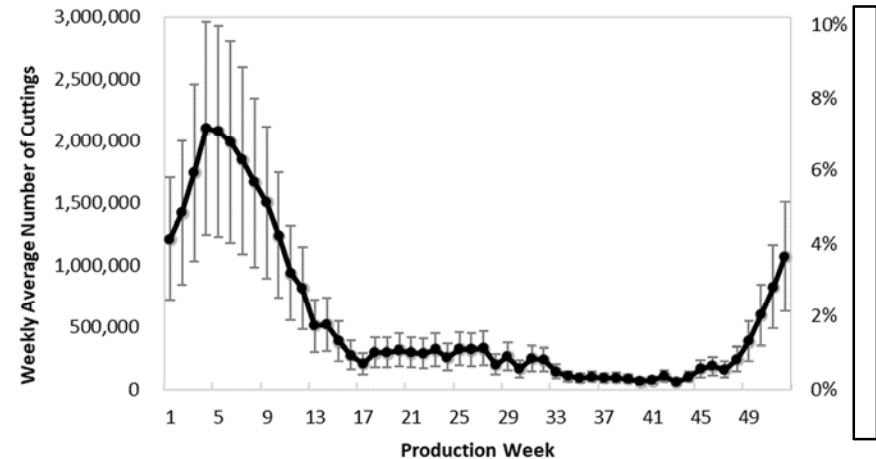
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## Transplant Process: Automated Transplanting



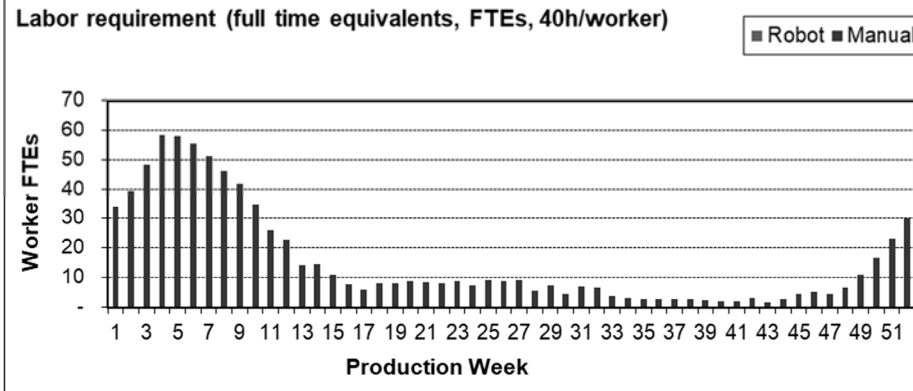
## Baseline scenario: cuttings transplanted per week

- 29.3M cuttings transplanted over 1 year
- Average of 6 growers, peak 2.1M cuttings per week



## Baseline scenario with all manual transplanting

- 29.3 Million (29.3 M) cuttings transplanted
- Peak week: 59 FTE transplant 2.1M cuttings, planting 897 cuttings/hour
- Hourly wage: \$12.49
- Labor cost: \$408,377
- Cost per cutting: \$0.014

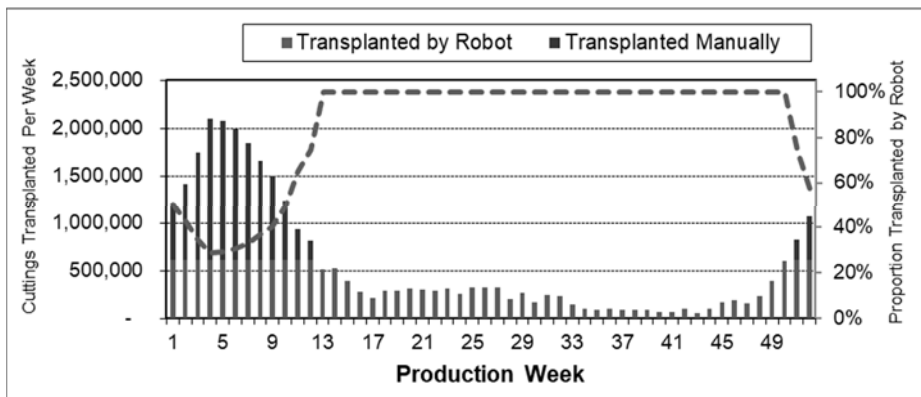


## Example assumptions for return on investment (ROI) model with four robots

Parameter	Assumption
Number of robots	4
Cost including installation & equipment	4 x \$125K = \$500K
Cuttings per hour per robot	2,000
Workers per robot	0.8
Maximum hours robot operated per week	76 (2 shifts)
Labor cost/hour for robot operator	\$17.80
Labor cost/hour for manual worker	\$12.49
Discount rate	5%
Useful life for equipment (years)	10

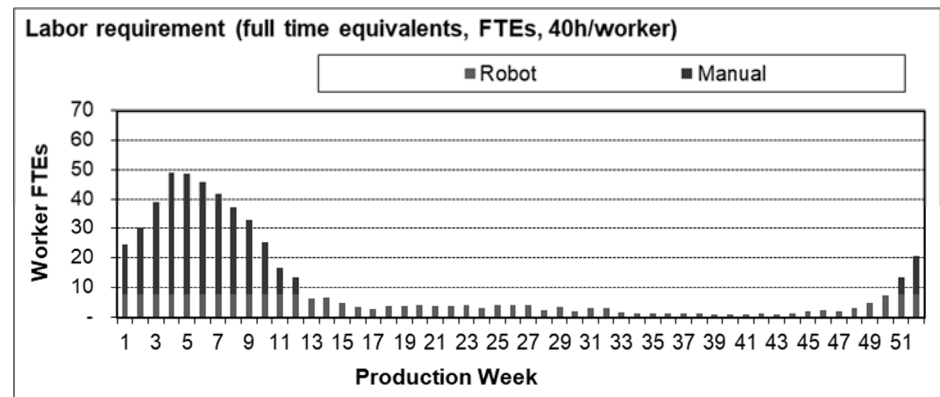
## ROI model with four robots

- Robot: 17.4 M cuttings transplanted per year (59% of total)
- Manual: 11.9 M cuttings transplanted per year
- Peak week robot cuttings: 0.6 M (29% of total peak week cuttings)
- Peak week manual cuttings: 1.5 M



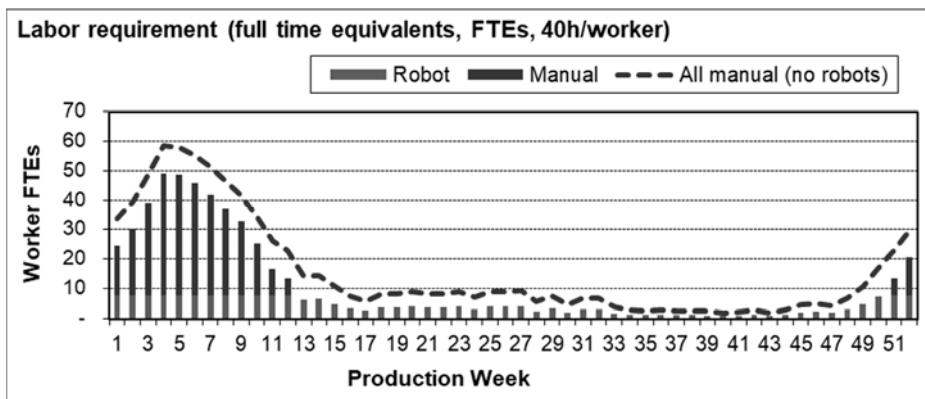
## Impacts on labor and total cost

- Peak week: 50 FTE



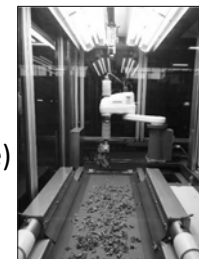
## Impacts on labor and total cost

- Peak week: 50 FTE (saving 9 workers or \$87,488)
- Labor + machine cost per year with 4 robots: \$345,890 (saving \$62,488)
- Cost per cutting: robot \$0.010, less than the manual cost of \$0.014



## Summary on ROI

- Discounted payback 3 years with these assumptions
- Factors that favor automation of transplanting plant cuttings:
  - Limited labor availability
  - Manual process is slow or uneven
  - High hourly wage
  - Long runs of few items (less change over time)
  - Transplanting throughout the year
  - Multiple shifts during peak
- **A customized analysis is needed for each company**



## For more information...

- [hort.ifas.ufl.edu/training/](http://hort.ifas.ufl.edu/training/) for online extension courses
  - “Costing & Profitability” begins September 2
  - Use “CULTIVATE19” code for 20% discount



## Manual Sticking of Woody Cuttings



## Manual Sticking Continuous Improvement (32 cell tray)

	2008	2009	2010	2011-12	2013-18	Total Gain
		Lean training		3 person team	Indexed sticking line	
Cuttings/man hour (32 cell tray)	768	864	960	1056	1248	<b>63%-15 trays</b>

\*Expected rate currently is 1248; incentives paid over this rate

## ISO Group Machines

2016 - 1 machine trialed; soon had 4

Max rate 2200

2018 average rate for 32 cell trays =1571;  
expected rate = 1664

Line is run with 4-5 people (18 cell, 32, 72):

- Flat filler
- Operator
- 2 fixers/lay down
- +1 for 18 cell
- <https://springmeadownursery.com/innovation/production-innovation/>



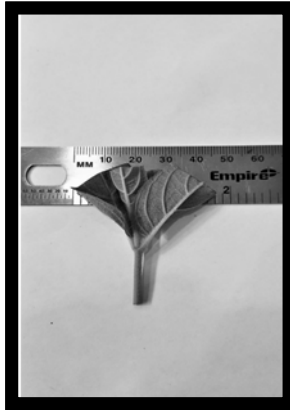
## Robotic Sticking of Cuttings

All cuttings are taken in house

Size parameters are critical

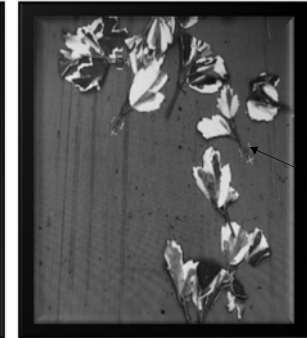


50-75mm  
tall



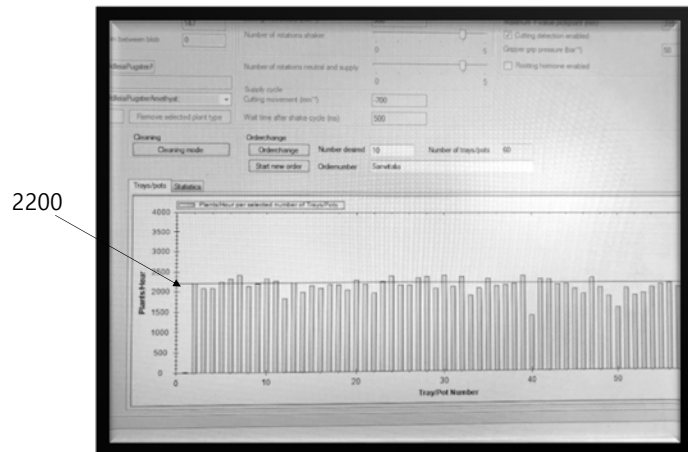
>55mm  
wide

## Training the Computer



Pick point

## Hourly Output



1 bar = 1 min

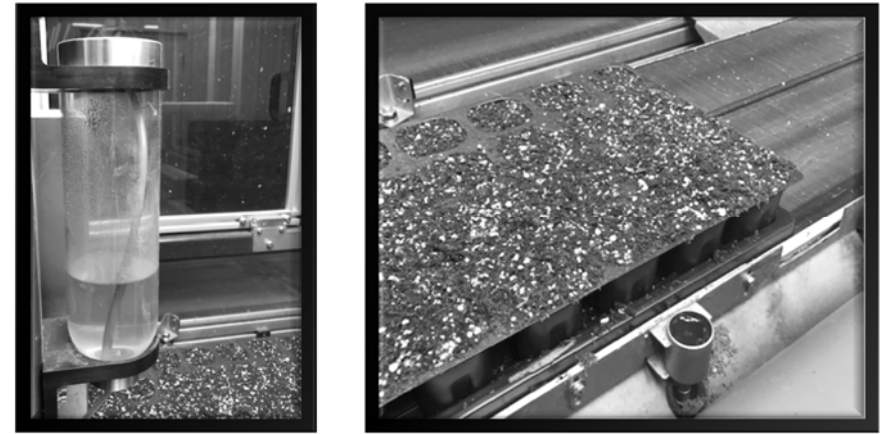
## Productivity Killer: Fixing



## Reducing Fixing

- Make cuttings to precise specifications; properly train up to 20 people cutting
- Grow plants with precise internode length 😊
- Update files with current pictures
- Moist media

## Improvements/Changes



Liquid hormone dip dispenser used infrequently ↓ 20% rate.  
SOP foliar hormone post stick.

## Two Robot Arms



Softwood head



2  
part  
grab

Evergreen head-

↓ 20%

## Bottom Line

- ISO average rate 2019 = 1536 stems
- Manual average rate 2019 = 1312 stems
- Average 224 (17%) more w/ISO.
- New facility in 2020
  - Longer infeed/outfeed to avoid flat "starving"
  - Pre-stick watering to keep cuttings upright
  - Sound deadening/cleaner environment

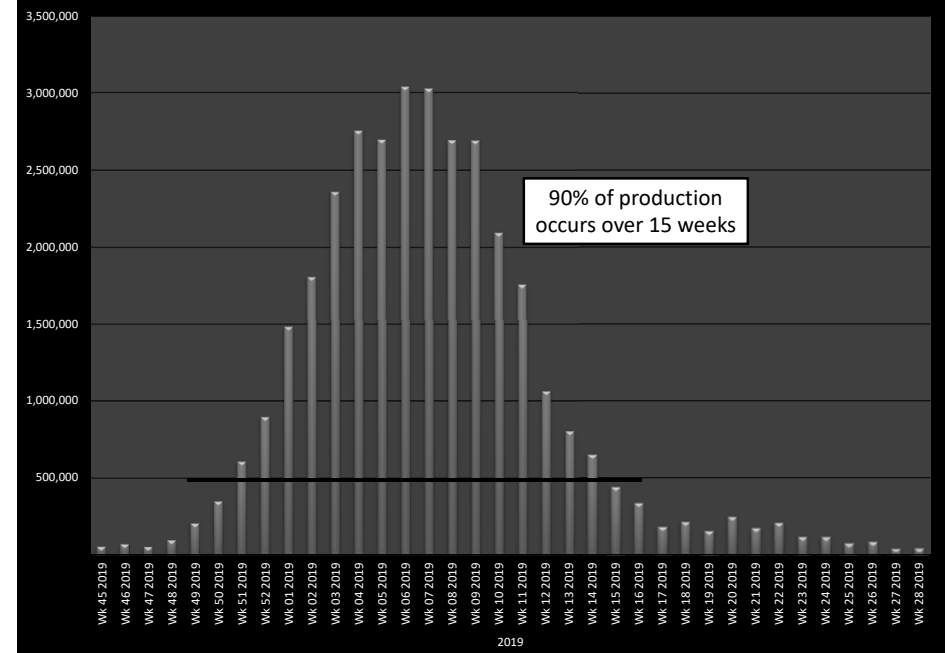
## Transplanting Cuttings by Hand & Robot

### Mike Goyette, Pleasant View Gardens

- Over 35 million cuttings per year
  - Annuals
  - Perennials
  - Herbs
  - Shrubs
- 90% transplanted by hand
- 10% by ISO robot
- We run 2 shifts over a 12-15 week period at each facility in order to get the work done
- We employ over 60 people to stick cuttings during peak production weeks.
- Hourly rates jumped 20% this year and most likely will rise another 10% next year! Ouch!



Cuttings Transplanted



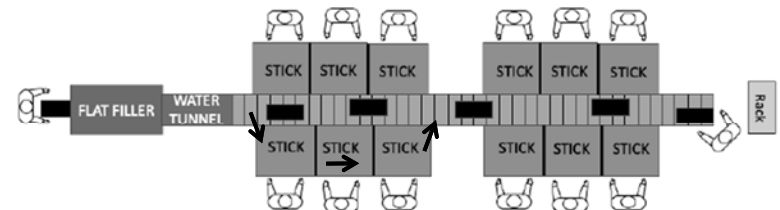
## Single Station



- Trays move to "sticker"
- Sticker applies labels and sticks
- Cuttings are brought to each station by line leaders
- Stickers do not move from their stations
- 800-1,000 cuttings per hour



## Progressive Sticking

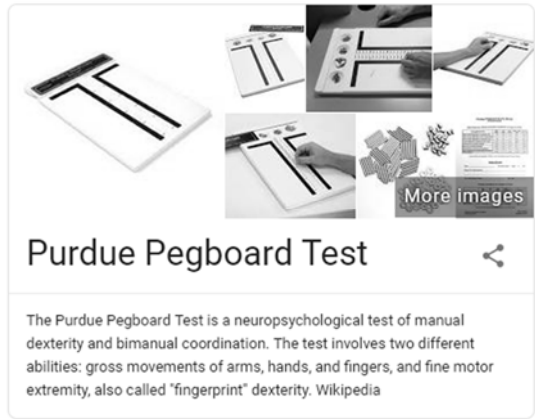


- Smooth cadence of work makes for better consistency throughout the work day
- Place your fastest "sticker" at the beginning of each cell to set the pace

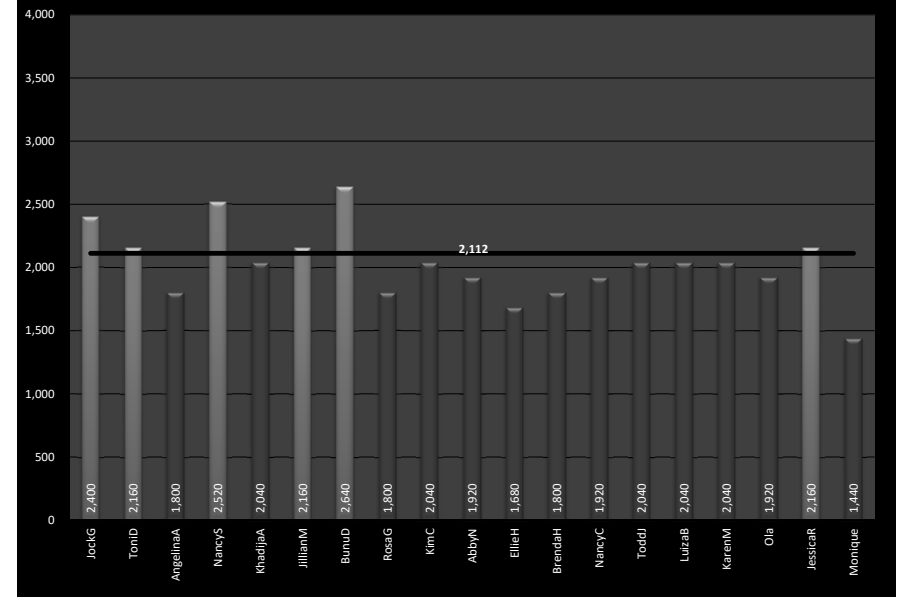


## Purdue Pegboard Test

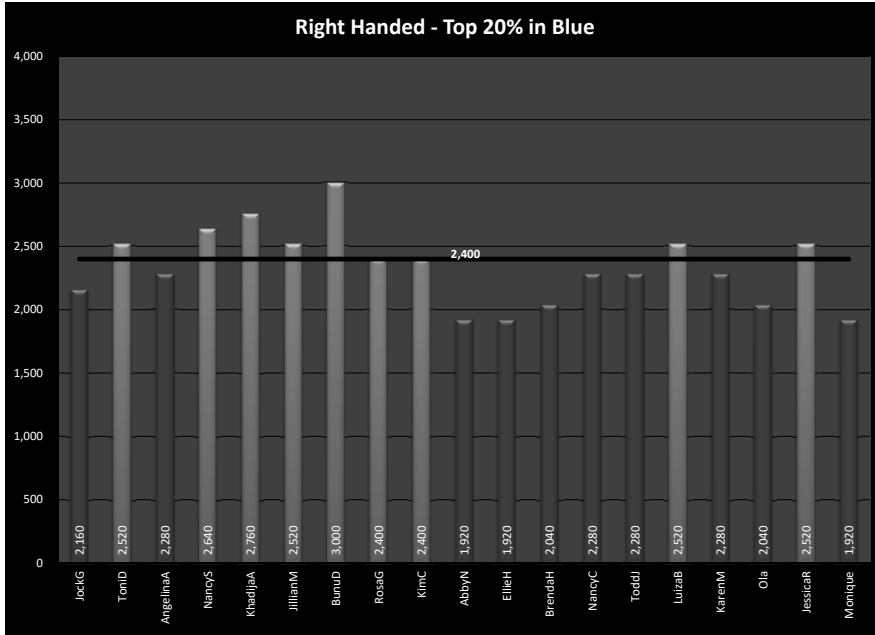
- Tool to help make decisions about potential sticking performance



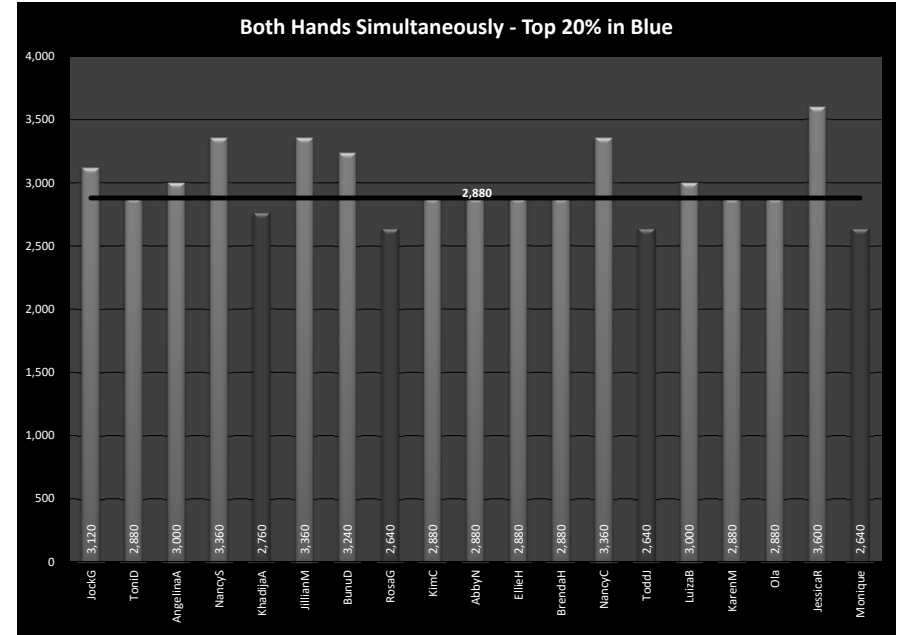
Left Handed - Top 20% in Blue



Right Handed - Top 20% in Blue



Both Hands Simultaneously - Top 20% in Blue



## Transplanting Cuttings by Hand

### Tips & Suggestions

1. High volumes per variety.
2. Plan what will be stuck each day. Give easy to stick plants to your faster people.
3. Phase out multiple cuttings per cell whenever possible.
4. Returning personnel – do what you can to keep productive seasonal workers coming back year after year.
5. Form relationships - good people know other good people.
6. Job shadowing – place new people alongside quality veterans.
7. Always keep “stickers” in motion – bring work to them.
8. Track output by person or team, move ineffective workers to other jobs where they might be more productive.
9. Pay people what they’re worth or pay them a bonus based on output. Fast stickers are driving down your costs, can you share the win with them and help retention?
10. Provide sufficient lighting and a comfortable environment – Hawthorne effect.



## ISO Robot - Transplanting Cuttings by Robot



- Up to 2,200 per hour per machine
- Learn what works well
- Calibrachoa
- Sutera
- Verbena
- Bidens
- Angelonia
- Browalia
- Lobelia
- Nemesia



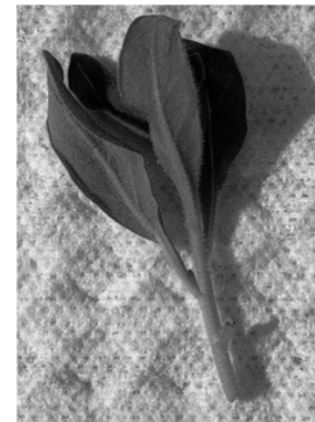
## ISO Robot - Transplanting Cuttings by Robot



- Spread cuttings out on the belt – toss like confetti
- Belt shakes when the cameras are having trouble identifying the cuttings
- The more the belt vibrates the slower the robot goes



## ISO Robot - Transplanting Cuttings by Robot

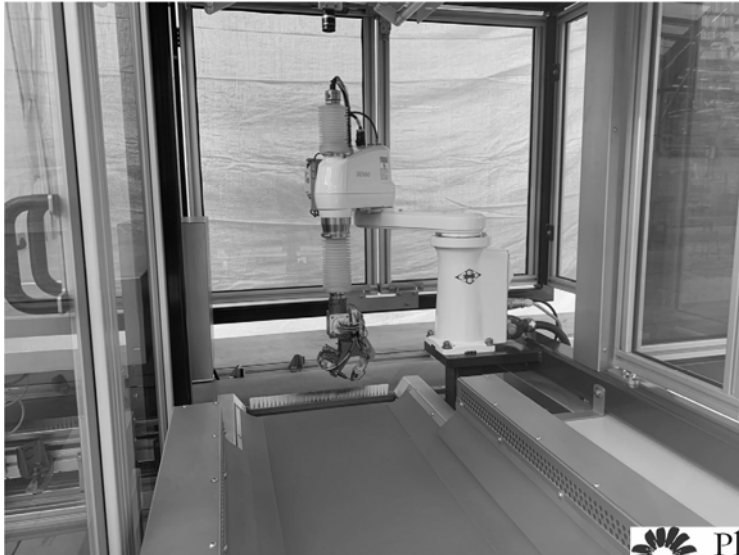


### ISO Cuttings Spec

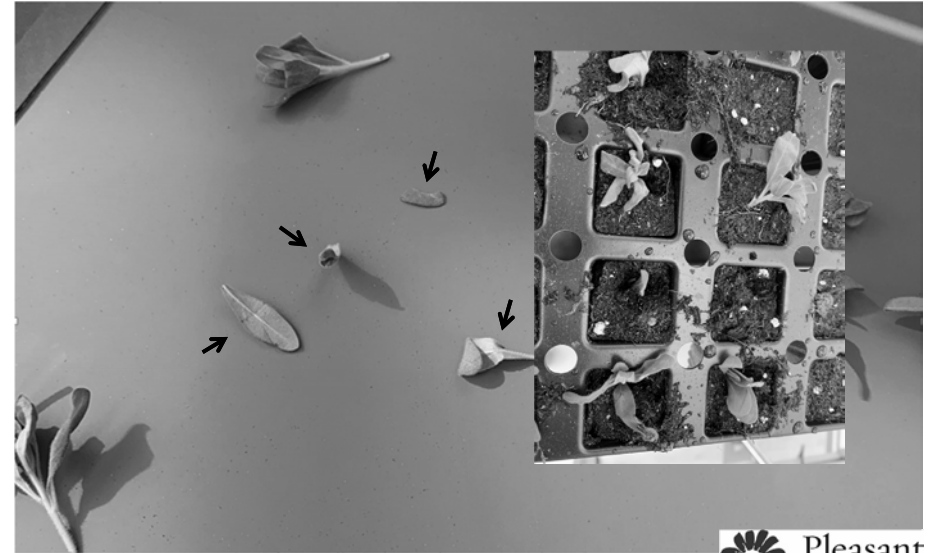
- ¼" bare stem
- Large leaves removed
- Not wet



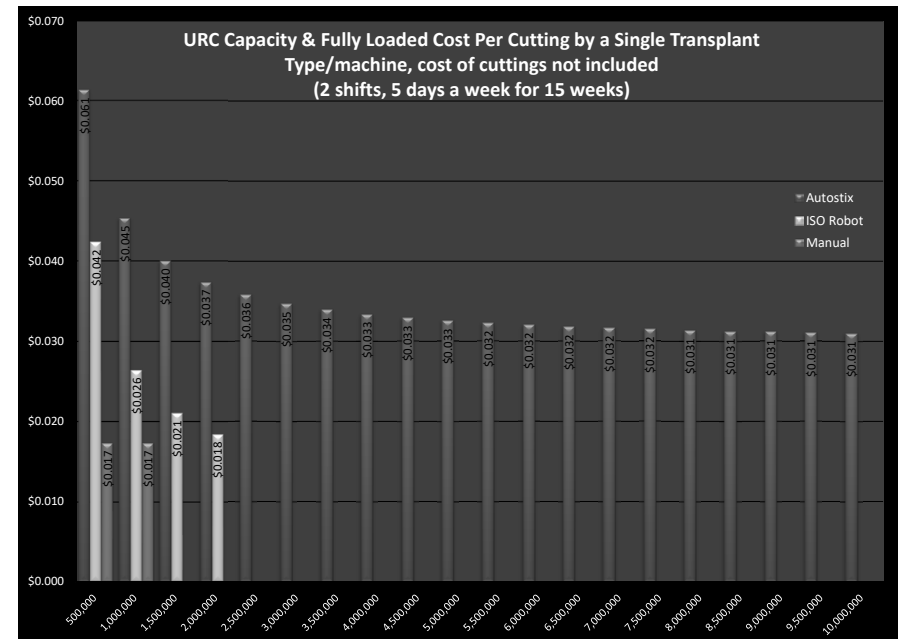
## ISO Robot - Transplanting Cuttings by Robot



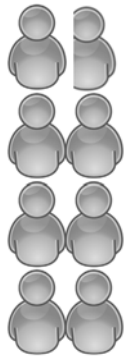
## ISO Robot - Transplanting Cuttings by Robot



## ISO Robot - Transplanting Cuttings by Robot



## Transplanting Cuttings – Displacing Labor



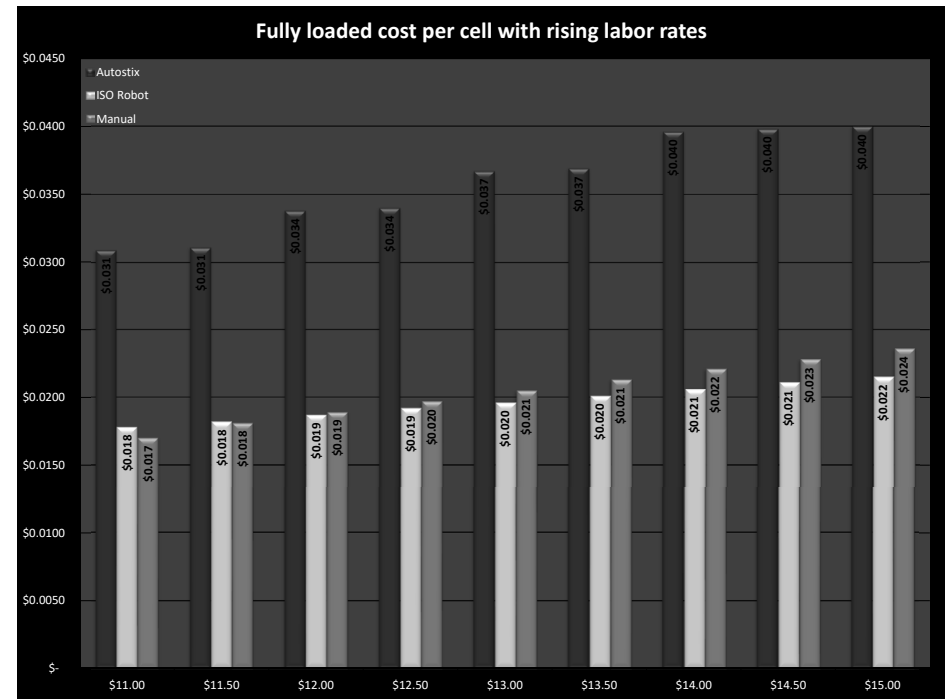
Autostix

7.8



ISO Robot

0.75



## Transplanting Cuttings by ISO Robot

### Tips & Suggestions

1. Plant selection – select plants that the robot can stick much faster than humans and plants that have enough volume to keep the robot at capacity.
2. Know your current manual sticking rates to make good choices.
3. Work with your cuttings suppliers to create ISO spec cuttings.
4. Utilize the ISO robot for as many hours and shifts as you can. In this model machine breaks even around 2.3 million cuttings.
5. As employee hourly rates rise the ISO robot breaks even sooner.
6. Having more than 1 robot can improve ROI by reducing robot ratio of 1:1.5.



## Transplanting Cuttings by Hand & Robot



**Thank You!**

Mike Goyette  
Operations Manager  
Pleasant View Gardens



## Advantages of AutoStix

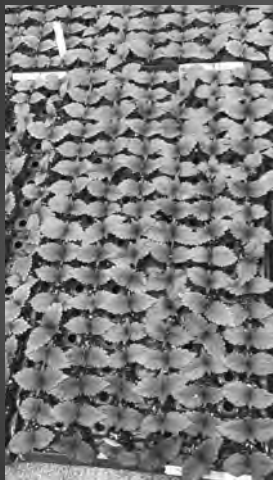
- ▶ Uniformity
- ▶ Solves labor shortages
- ▶ Improves production processes
- ▶ More predictable productivity
- ▶ Improved counts and quality control
- ▶ Lowers sanitation risks



Transplanting Cuttings by Hand  
and Robotics

Bob Dickman, Dickman Farms

## Crop Uniformity



700 per person/hour



9,500 per/hr with 3 people

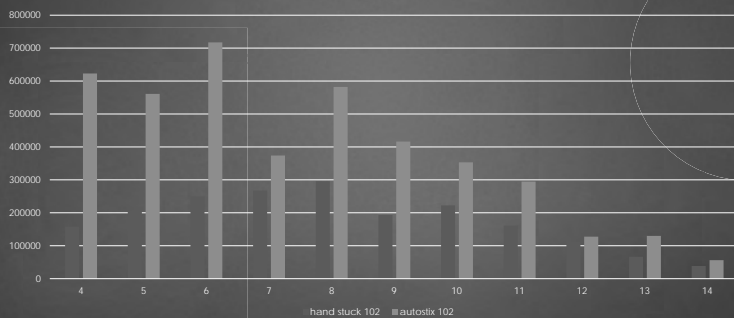


[illegible]

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- ▶ More interesting/exciting to run an Autostix machine than stick cuttings

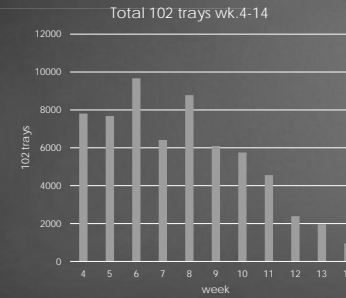


- ▶ Uniform planting depth
- ▶ Dibble not needed
- ▶ Strips are already tagged
- ▶ Watering in after sticking is more effective....soil stem contact
- ▶ Less cuttings falling out in transit to greenhouse
- ▶ Loading machine is easier than passing out cuttings
- ▶ Production runs always together

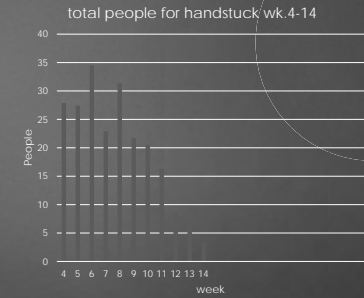


# If Dickman did not have Autostix: Labor and trays

Total amount of trays



Total amount of people to handstick



## Why Dickman's chose AutoStix

- 28.86% increase in Minimum wage over 4 years.

General Minimum Wage Rate Schedule						
Location	12/31/16	12/31/17	12/31/18	12/31/19	12/31/20	2021*
NYC - Large Employers (of 11 or more)	\$11.00	\$13.00	\$15.00			
NYC - Small Employers (10 or less)	\$10.50	\$12.00	\$13.50	\$15.00		
Long Island & Westchester	\$10.00	\$11.00	\$12.00	\$13.00	\$14.00	\$15.00
Remainder of New York State	\$9.70	\$10.40	\$11.10	\$11.80	\$12.50	*

- Available quality dependable seasonal labor
- AEW rate \$13.82 NYS H2A program
- Current local temp agency rate \$18.00 plus time and ½ over 40 hrs \$27.00
- Production peaks and valleys
- Simplicity of machine and Product











Know your costs to produce



Decide what is important  
Quality/Quantity



Good trained Operators



Mechanical support



There is no perfect machine-Patience



THANK YOU