An Overview of Field Evaluation of Robotic Weed Control

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Salinas Valley Weed School, Nov. 13, 2012

Cost & Return budgets: Romaine hearts

Operation	Conventional
Cultural costs	$2,629
Thinning	$137
Hand weed	$80
Herbicide	$90
Harvest costs	$4,739
Overhead	$1,718
Cost /Acre	$8,614

Smith, Klonsky & De Moura 2009

We need to keep our perspective: we are not the “big guy”

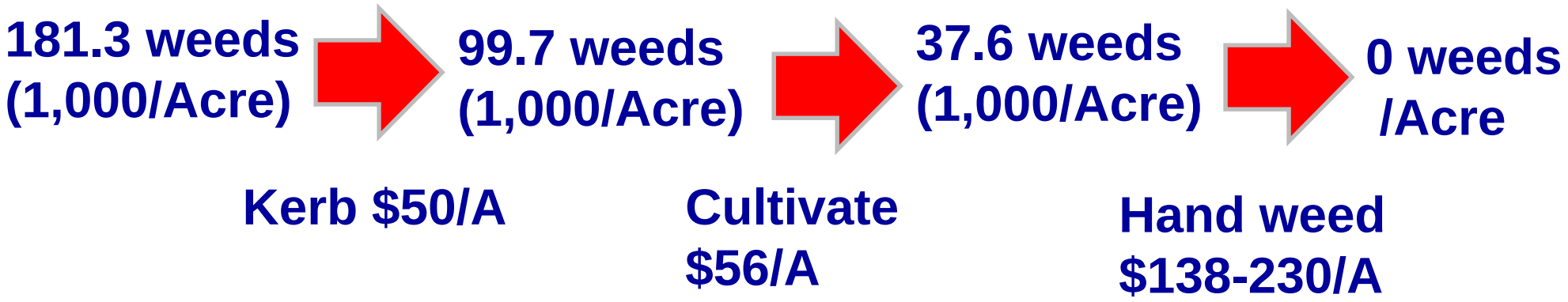
Robotic lettuce thinning & weeding

- Thinning
  - mechanical
  - Sprayer
- Weeding
  - mechanical
  - sprayer

Integrated weed management in vegetables

- Strategies and tactics for IPM
  - Prevention
  - Sanitation
  - Field selection
  - Physical weed management
  - Cultural weed management
  - Chemical weed control

Integrated Weed Management in Lettuce



Tourte & Smith 2010
Fennimore unpublished 2011

Cultivation

A traditional inter-row cultivator does not reach into the seedline

An intra-row cultivator weeds around and in the row

Cultivation in the field

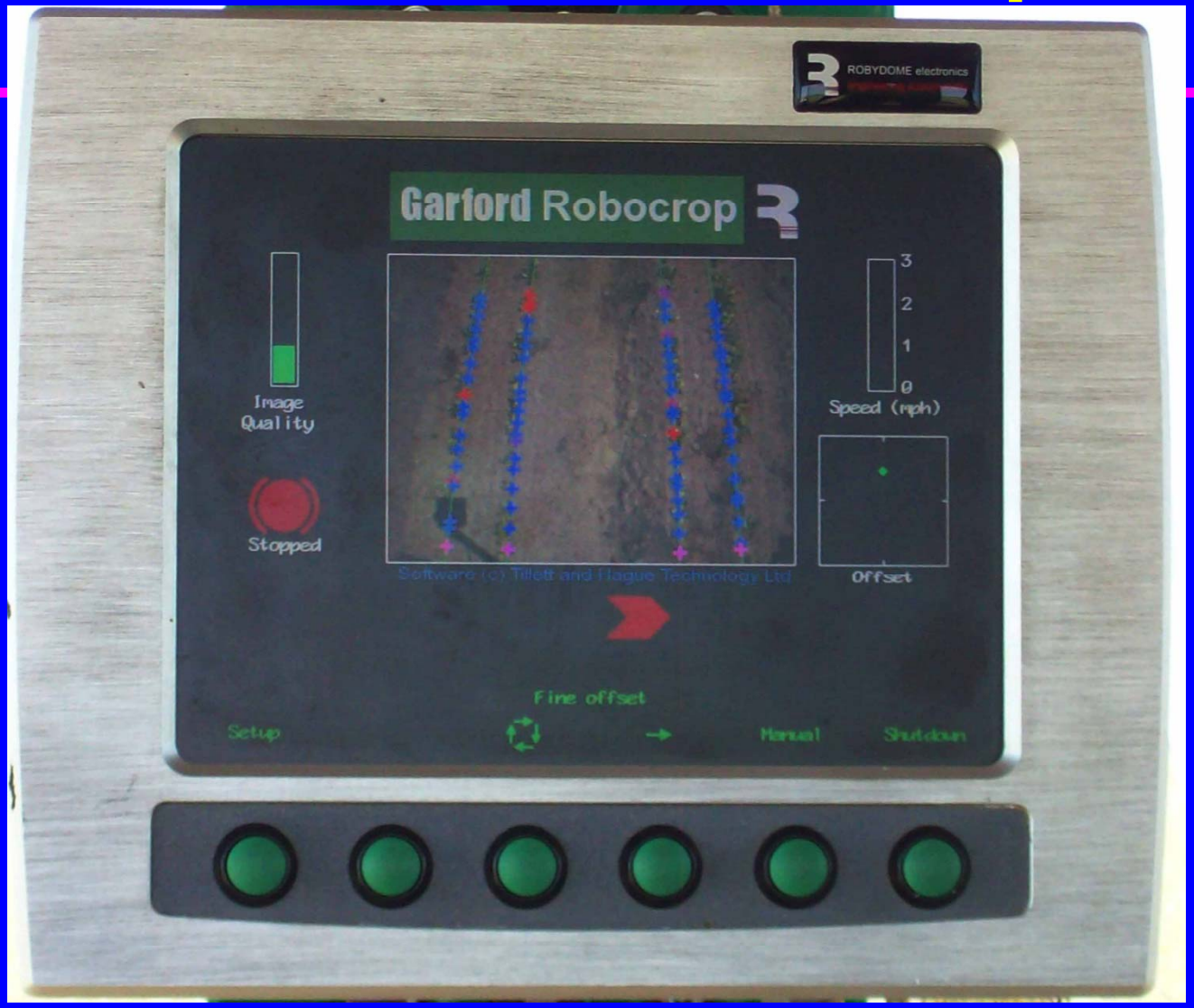
Inter-row cultivation

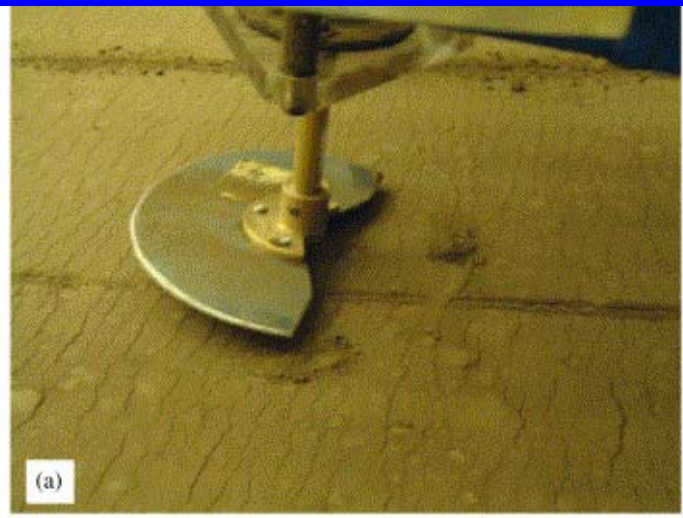
Intra-row cultivation

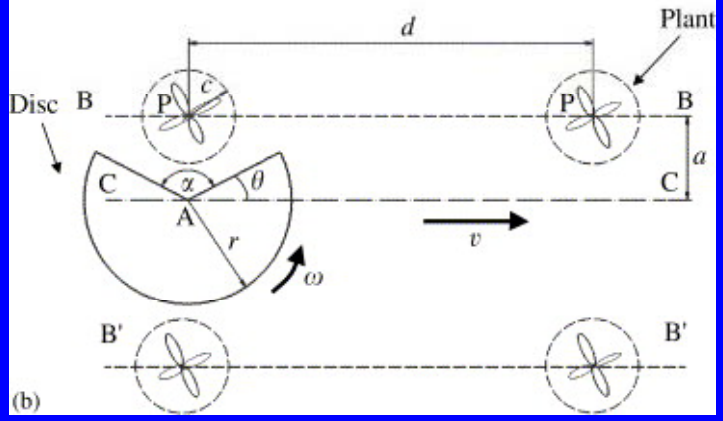
Robotic thinning/weeding objectives

- Determine if we can thin and weed lettuce with the rotating cultivator
- Determine if the need for hand weeding and thinning can be reduced with the rotating cultivator
- Measure rotating cultivator effects on lettuce yields

Garford Robocrop cultivator







http://www.thtechnology.co.uk/index.html

Garford rotating cultivator

Lettuce thinning with the rotating cultivator

Before thinning

After thinning

Weed control data

- Weed densities were measured before & after cultivation; thinning and weeding times were also measured.

Post cultivation weed densities in seeded lettuce

Cultivator	2009.03	2010.01	2010.05
	Number 1,000/Acre		
Rotating	66 b	39 b	45 b
Standard	140 a	63 a	65 a
P value	<0.0001	0.0038	0.0013

Thinning times in seeded lettuce

Cultivator	2009.03	2010.01	2010.05
		Hours /Acre	
Rotating	14.4 b	10.5 b	9.1 b
Standard	20.1 a	12.5 a	14.1 a
P value	0.0003	0.0058	<0.0001

Number of marketable heads seeded lettuce

Cultivator	2009.03	2010.01	2010.05
	Marketable heads lbs. / Acre		
Rotating	7,470 b	5,250 b	7,843
Standard	8,998 a	7,021 a	7,064
P value	0.0026	0.0012	0.67

Robotic thinning studies - conclusions

- The Garford rotating cultivator is able to thin direct seeded lettuce.
- The rotating cultivator reduces hand thinning time.
- The rotating cultivator reduced lettuce yields 2 out of 3 trials.

University of Arizona/Blue River thinning project 2012

Machine lettuce thinning results

Treatments	Pre thin	Post thin	Hand thin	Hand weed	Total time
	No./A	No./A	Hr./A	Hr./A	Hr./A
Grower std	167,129	30,253	4.6	2.8 *	7.4
Machine	169,272	34,343	0	5.7	5.7

2012 Fennel Ranch, Salinas

Thinning trial yield

- Standard grower yield 27.08 tons/A
- Machine thinned yield 25.08 tons/A which was significant
- Grower hand thinning costs were $92/A
- Machine thinning costs were $140/A for 0.6 mph and $107/A for 1.5 mph.
- Net returns for grower standard $11,877 vs $10,968 for machine thinned

Lettuce thinning

- Need much faster operating speeds for lettuce thinner >1.5 mph.
- Optimize seed spacing at planting to take advantage of the technology
- Need to optimize use of labor – eg. Reduce number of hoe crew passes through the field from two to one.

Other thinners

- Ramsay Highlander
- Blue River
- University of Arizona
- Ag Mechtronix

IN ROW WEEDING

In row weeding in transplanted lettuce

- Conducted at the Salinas USDA station in 2009 & 2010.
- Plots were 2 X 40-inch wide beds wide by about 80 ft long. RCBD with 4 reps
- Treatments were the rotating cultivator and the standard cultivator and Kerb at 0 and 1.2 lb ai/A.
- Weed control is based on the difference between pre and post cultivation counts.

Weed densities & weeding times in transplanted lettuce

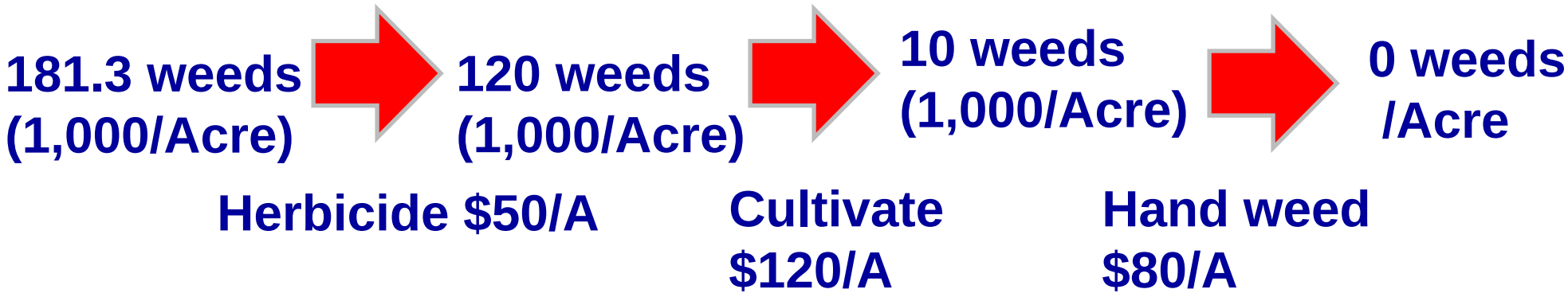
Cultivator	2009.04	2010.10	2009.04	2010.10
	Weeds 1,000/Acre		Hours / Acre	
Rotating	1.5 b	48.0 b	5.4 b	10.8
Standard	11.1 a	84.1 a	6.1 a	11.3
P value	<0.0001	0.0016	0.0369	0.67

Machine costs

- The rotating cultivator cost is about $15-20K per plant line.
- An 8 plant line unit able to cultivate 4 lettuce beds would be $120-160K.

Standard vs alternative Lettuce Weed Management Strategies

Total weed cost = $244 to $336



Total weed cost = $250


www.krishitea.com
IC Cultivator

Robotic lettuce thinning & weeding

- Thinning
  - Mechanical – the Garford machine did not work well
  - Sprayer – this method has promise
- Weeding
  - Mechanical – could be made to work
  - Sprayer – where we propose new work.

Summary I

- The rotating cultivator can weed seeded & transplanted lettuce.
- The rotating cultivator controls more weeds than a standard cultivator.
- Transplanted lettuce has better future prospects for improved weed control options than seeded lettuce.

Summary II

- Lettuce machine thinning looks promising, but improvements are needed to reduce labor costs and increase efficiency.
- Development of weed control technology looks a lot more promising in the area of robotics than it does for herbicides.

Acknowledgments

- California Leafy Greens Research Board
- David Fountain, Solex
- Blue River
- Univ. of Arizona
- California Department of Food & Agriculture Specialty Crop Block Grants