

Auto-guidance and Boom Control: Does it Pay?

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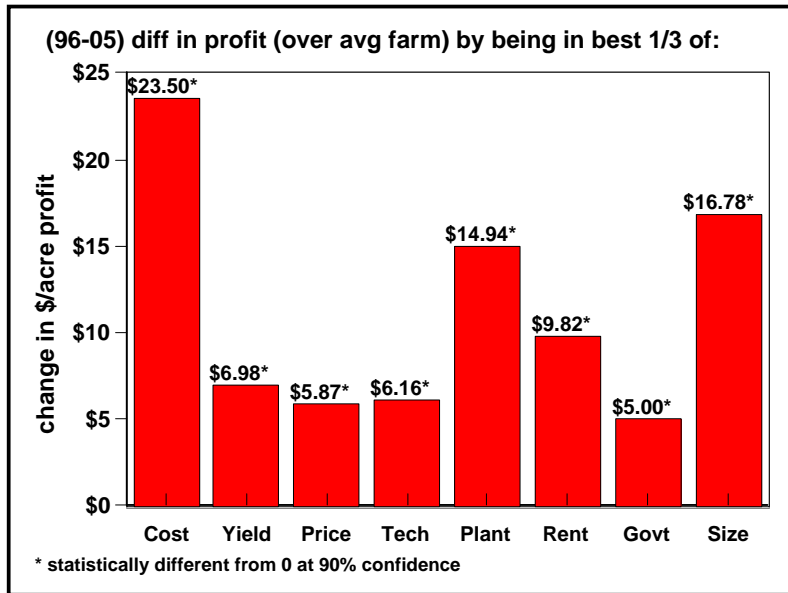


Machinery cost categories

- Repair and maintenance
- Labor
- Depreciation (market, not tax depreciation)
- Interest (opportunity interest)
- Fuel and lubrication
- Taxes, insurance, and shelter

- Custom hire – an excellent proxy for average machinery cost

Cost differences drive profit differences across farms



Machinery large part of costs, but other stuff matters too

How important are farm machinery costs for Kansas farmers?

Kansas Farm Management Association Enterprise Analysis						
Nonirrigated Crops – State Averages, 2002-2004						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	109	37	171	307	168	50
Average Acres	356	481	325	587	321	49
Costs, \$ per Acre						
Seed	\$27.45	\$45.16	\$9.42	\$6.38	\$23.61	\$6.68
Fertilizer	34.53	46.42	22.07	18.81	4.17	8.96
Herb-Ins	23.41	41.38	20.21	4.95	16.60	10.53
Crop Ins	6.60	11.59	4.17	3.86	5.20	0.24
Machinery	70.26	107.65	56.10	59.19	63.16	80.79
Other	18.70	100.03	16.26	16.00	18.17	21.92
Land	35.90	53.82	19.30	22.68	30.16	44.59
Interest	17.21	32.59	12.58	11.95	14.39	15.49
Total Cost	\$234.04	\$438.64	\$160.12	\$143.81	\$175.45	\$189.20
Machinery, %	30.0%	24.5%	35.0%	41.2%	36.0%	42.7%

Machinery costs are highly variable across farms ...

Kansas Farm Management Association Enterprise Analysis Nonirrigated Crops -- State Averages, 2002-2004						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	109	37	171	307	168	50
Average Acres						
High profit farms	512	552	446	742	452	87
Mid profit farms	325	525	321	633	329	192
Low profit farms	231	362	207	386	183	79
Machinery Costs, \$/acre						
High profit farms	\$52.07	\$88.51	\$44.16	\$48.57	\$50.73	\$64.04
Mid profit farms	\$64.46	\$105.36	\$54.26	\$53.51	\$61.04	\$80.62
Low profit farms	\$94.40	\$129.28	\$69.88	\$75.55	\$77.71	\$97.68
High less low, \$	-\$42.34	-\$40.77	-\$25.72	-\$26.98	-\$26.98	-\$33.64
High less low, %	-44.8%	-31.5%	-36.8%	-35.7%	-34.7%	-34.4%

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Machinery costs are important in explaining profitability differences across farms ...

Kansas Farm Management Association Enterprise Analysis Nonirrigated Crops -- State Averages, 2002-2004						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	109	37	171	307	168	50
Machinery Costs, \$/acre						
High profit farms	\$52.07	\$88.51	\$44.16	\$48.57	\$50.73	\$64.04
Mid profit farms	\$64.46	\$105.36	\$54.26	\$53.51	\$61.04	\$80.62
Low profit farms	\$94.40	\$129.28	\$69.88	\$75.55	\$77.71	\$97.68
High less low, \$	-\$42.34	-\$40.77	-\$25.72	-\$26.98	-\$26.98	-\$33.64
High less low, %	-44.8%	-31.5%	-36.8%	-35.7%	-34.7%	-34.4%
Differences between high profit farms and low profit farms in ...						
Net returns	\$108.15	\$158.42	\$79.78	\$80.72	\$79.16	\$141.93
Total costs	-\$101.95	-\$106.81	-\$65.97	-\$52.86	-\$58.78	-\$78.16
Cost/net returns	94.3%	67.4%	82.7%	65.5%	74.3%	55.1%
Mach/total costs	41.5%	38.2%	39.0%	51.0%	45.9%	43.0%
Mach/net returns	39.1%	25.7%	32.2%	33.4%	34.1%	23.7%

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- **Adopting new machinery technologies is an important way that farm managers lower their machinery costs to distinguish themselves from others for the purpose of increasing profit.**

- Using GPS to assist machinery operations is an especially important new technology.

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General machinery overlap issues

- **Extra machine operation**
 - Increases machinery costs since overlap areas are covered more than once, so more acres have to be farmed than which are in the field
- **May affect applied input usage**
 - Increases crop input cost since overlap areas are covered more than once and thus get more seed, fertilizer, herbicide, etc.
- **These are *cost* issues**

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Field headland issues (where the action is)

- **Headlands cause economic problems:**
 - Increase cost of machine operations
 - Doubling up of machine operations
 - Machines need to slow down for turnaround
 - Increase crop input costs due to doubling up
 - Double-planting, -applying, -tilling, and extra compaction can reduce crop yield, thus revenue
- **Portion of field covered by headlands:**
 - Affects *costs* and *revenues*
 - Greatly affected by **field size and shape**
 - Especially affected by width of machine

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Large (wide) machine issues

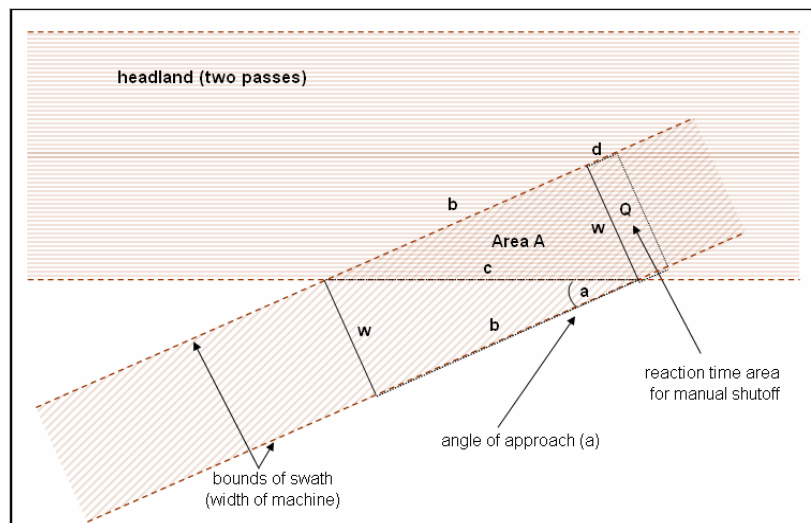
- **Need large turnaround area, increasing headland size**
- **Can we make the larger machines behave as though they were smaller, at least in terms of the portion of a headland affected by input doubling-up?**
 - boom or section shut-offs

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- **Regardless, all situations are quite site- and machine-specific**
 - Hard to make general rules of thumb across farms
 - Requires individual-situation analysis
 - So, we developed a decision tool (an Excel spreadsheet) to aid such decisions, called
 - **KSU-GPSguidance.xls** (at www.agmanager.info)
- **To get some understanding, we will report some economic results for one particular farm (the Kastens farm)**

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Field headland



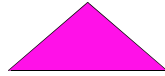
Areas A and Q and turnaround counterparts will have a) doubling-up of inputs and b) possible yield losses due to this doubling-up. After the turnaround there will be overlap along b, also accounted for.

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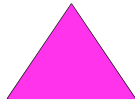
Various field shapes of interest (farm left to right)



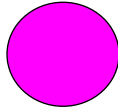
Square; hit ends at 90 degree angles
5,280 feet of headlands in 160 acre field



Isosceles right triangle; hit ends at 60 degree angles
7,467 feet of headlands in 160 acre field



Equilateral triangle; hit ends at 45 degree angles
8,024 feet of headlands in 160 acre field



Circle; hit ends at angles varying from 0 to 90 degrees
(avg. 40 degrees) 9,359 feet of headlands in 160 acre field

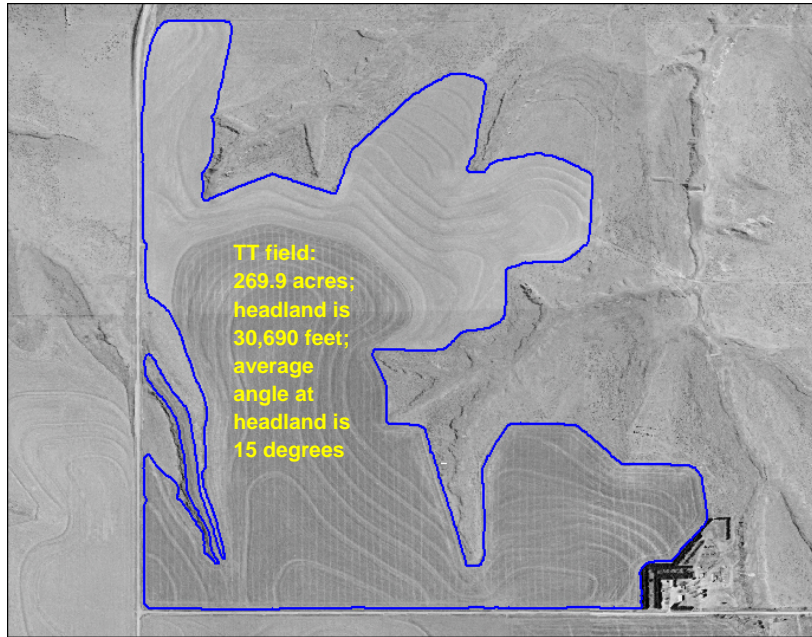
Kastens fields average hitting headlands at around 24 degrees

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A Kastens field that is much less efficient than squares, triangles, or circles

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Another extremely inefficient Kastens field

Microsoft Excel - newKSU-GPSguidance(Dec2006).xls

Spreadsheet has an Intro page – check version date

A1

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38

KSU-GPSguidance.xls -- A spreadsheet program to analyze the economics of machine guidance and section control investment.

Version -- 12.05.06

Print information

BACKGROUND INFORMATION

This spreadsheet examines:

- 1) machine operation cost relative to field size and shape
- 2) economics of guidance technology in the context of overlap, which impacts:
 - a) machine usage per land acre (i.e., overlapping of machine operations)
 - b) crop input usage per land acre (i.e., overlap of inputs applied), which impacts:
 - i) cost of crop inputs
 - ii) reduced yield revenue associated with crop input overlap on headlands
- 3) economics of boom/machine section control

Typical uses would involve crop spraying, planting, tillage, etc. Dollar-valued calculations generally are on a per "applied" acre basis. A 3000 acre field sprayed three times in a year results in 9000 applied acres for the year. Per-applied acre values are brought back to an implied investment per applied acre via simple amortization (no salvage value of technology is considered). To derive how much you can invest in a given technology you will need to consider applied acres per year. But, if you use the same technology for different machine operations, you might also need to add results from multiple runs of this spreadsheet, where a separate machine operation is associated with a separate spreadsheet run. Finally, notice that a "covered" acre is something different than an applied acre. In particular, an acre that is doubled-up on for inputs or machine coverage results in 2 covered acres; but, it would still be only 1 applied acre.

The user inputs information for a field of interest, which is compared to four stylized fields. One of the five fields (user field and four stylized fields) must be used as the custom rate benchmark. All four stylized fields have the same acreage and can be made the same acreage as the user-defined field if user desires.

INPUTS vs CALCULATED VALUES

In the *Analysis* sheet all blue numbers are inputs and all other numbers are calculated from these inputs. The spreadsheet automatically recalculates every time an additional input is entered. Thus, it is important to wait until all data have been entered and reviewed before interpreting any of the calculated results (i.e., black numbers).

DESCRIPTION OF INPUTS

Several of the input cells (i.e., blue numbers) and calculated values have a red diamond in the upper right hand corner of the cell (if the comments do not appear go to View / Comments on the Excel menu -- you may need to click and then again).

Intro / Analysis / Results / Notes / Amortization

Draw AutoShapes

Ready

Microsoft Excel - newKSU-GPSguidance(Dec2006).xls

Spreadsheet has a user-input section for field information

Field shape and headland economics analysis

Print Information

four stylized fields, assume farm north to south

user-defined field userfield square isos R trian equal triang equal sized circle odd1 odd2

Section A: Input and field characteristics section

	units	userfield	square	isos R trian	equal triang	circle	odd1	odd2
8 Size of field	acres	75	40	40	40	40	167.4	269.9
9 Size of field	square feet	3,267,000	1,742,400	1,742,400	1,742,400	1,742,400	7,291,944	11,756,844
10 Maximum width of field, perpendicular to direction of swaths (passes)	feet	2,000	1,320	1,320	1,737	1,489	3,960	5,502
11 Running distance of headlands to cover for field	feet	5,250	2,640	3,734	4,012	4,679	16,700	30,690
12 Number of swaths (passes) needed to cover headlands	count	2	2	2	2	2	2	2
13 Turnaround speed is this portion of field speed	percent	75%	75%	75%	75%	75%	75%	75%
14 Width of machine	feet	40	40	40	40	40	40	40
15 Typical swath overlap in percent of machine width (selected below)	percent	1.75%	1.75%	1.75%	1.75%	1.75%	1.75%	1.75%
16 Number of machine or boom sections to be controlled (for Section D)	count	16	16	16	16	16	16	16
17 Reaction distance (overlap) on manual shutoff of boom	feet	6	6	6	6	6	6	6
18 Effective width of equipment allowing for overlap	feet	39.3	39.3	39.3	39.3	39.3	39.3	39.3
19 Number of passes in field	count	50.89	33.59	33.59	44.20	37.90	100.76	140.00
20 Width of headland	feet	79.30	79.30	79.30	79.30	79.30	79.30	79.30
21 Area in headlands	acres	9.56	4.81	6.80	7.30	8.52	30.40	55.87
22 Area in field proper (i.e., non-headlands)	acres	65.44	35.19	33.20	32.70	31.48	137.00	214.03
23 Implied perimeter distance for each pass (i.e., the 2 ends)	feet	103.16	78.60	111.16	90.76	123.46	165.73	219.21
24 Avg length of a pass (distance before must turnaround)	feet	1425.34	1161.40	1095.71	819.85	920.69	1506.98	1694.50
25 Running distance of headland per acre	feet	70.00	66.00	93.34	100.30	116.90	99.76	113.71
26 Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	28.31	21.01
27 Machine efficiency								
28 Excess area covered due to machine overlap	acres	1.25	0.67	0.65	0.65	0.64	2.71	4.31
29 Total area covered by machine	acres	95.91	45.48	47.45	47.95	49.15	200.51	330.00
30 Machine efficiency (acres in field / area covered)	percent	87.40%	87.96%	94.30%	93.42%	81.38%	83.49%	81.77%
31 Total "area equivalent" covered by machine w/ speed adjustment	acres	88.99	47.08	49.71	50.39	51.99	210.64	348.70
32 Machine efficiency (acres in field / "area equivalent" covered)	percent	84.28%	84.97%	80.48%	79.39%	76.93%	79.47%	77.40%
33 Crop input efficiency assuming manual control of whole boom or machine								
34 Excess area for crop inputs at turnarounds due to angle and reaction time	acres	2.15	0.37	1.60	1.42	2.10	7.98	14.93
35 Doubling-up of inputs on headlands field efficiency	percent	97.21%	99.08%	96.15%	96.56%	95.00%	95.45%	94.78%
36 Total area to which crop inputs are applied	acres	78.40	41.04	42.26	42.07	42.74	178.09	289.14
37 Crop input efficiency (acres in field / area applied)	percent	95.66%	97.47%	94.66%	95.08%	93.59%	94.00%	93.35%

Microsoft Excel - newKSU-GPSguidance(Dec2006).xls

Spreadsheet has a user-input section for costs and other information

Section B: Economic factors and overlap amounts input section

41 Custom rate of machine operation, \$/ application acre		\$12.50
42 Cost of input (fertilizer, herbicide, etc.), \$/application acre		\$22.50
43 Lost yield revenue for doubling up, \$/doubled-up acre		\$25.00
44 Interest rate for investment analysis, percent		8.00%
45 Number of years for amortization		10
46	overlap %	cost \$/acre
47 Maximum overlap to consider	7.0%	\$0.00
48 Minimum overlap to consider	0.0%	\$0.20

Section C: Value of overlap

1 for overlap %

	userfield	square	isos R trian	equal triang	circle	odd1	odd2
54	0	0	1	0	0		
55 Machinery efficiencies for custom rates:							
56 incl. turnaround slowdown	80.46%						
57 crop input efficiency	94.66%						
58 doubling-up input efficiency	96.15%						
59 Custom rate and input cost were assigned to:							
60 isos R trian field with 1.75% overlap	0						
61	overlap %						
62	7.0%	90.85%	92.55%	89.98%	90.42%	89.07%	89.39%
63	5.3%	92.48%	94.19%	91.56%	91.98%	90.58%	90.34%
64	3.5%	94.06%	95.83%	93.11%	93.53%	92.09%	92.47%
65	1.8%	95.66%	97.47%	94.66%	95.08%	93.59%	94.00%
66	0.0%	97.26%	99.10%	96.21%	96.82%	95.09%	95.53%
67	overlap %						
68	7.0%	97.06%	99.03%	95.94%	96.37%	94.74%	95.20%
69	5.3%	97.11%	99.05%	96.01%	96.44%	94.83%	95.29%
70	3.5%	97.16%	99.07%	96.08%	96.50%	94.92%	95.37%
71	1.8%	97.21%	99.08%	96.15%	96.56%	95.00%	95.45%
72	0.0%	97.26%	99.10%	96.21%	96.82%	95.09%	95.53%

Sub-section C1: Machine operations

	overlap %	Custom rate for machine operations equivalent (uses turnaround slowdown), \$/applied acre
74	7.0%	\$12.43
75	5.3%	\$12.26
76	3.5%	\$12.08

A word about amortization...

Amortization factors		Interest Rate			
Years	6.00%	7.00%	8.00%	9.00%	
1	1.0600	1.0700	1.0800	1.0900	
2	0.5454	0.5531	0.5608	0.5685	
3	0.3741	0.3811	0.3880	0.3951	
4	0.2886	0.2952	0.3019	0.3087	
5	0.2374	0.2439	0.2505	0.2571	
6	0.2034	0.2098	0.2163	0.2229	
7	0.1791	0.1856	0.1921	0.1987	
8	0.1610	0.1675	0.1740	0.1807	
9	0.1470	0.1535	0.1601	0.1668	
10	0.1359	0.1424	0.1490	0.1558	

payment factor>	$\text{int}[1-(1+\text{int})^{-N}]$
interest rate>	8.00%
number of years>	7
payment factor>	0.1921
investment>	\$13,000
annual payment>	\$2,496.94
acres used on annually>	15,000
investment per acre>	\$0.8667
annual cost per acre>	\$0.1665

At 8.00% and 7 years could invest about 5x the annual amount per acre

Microsoft Excel - newKSU-GPSguidance(Dec2006).xls

Spreadsheet summarizes economic results in a Results tab

Field shape and headland economics analysis

four stylized fields; assume farm north to south

	units	user-defined field userfield	square	equal sized isos R trian	equal sized equal trian	circle	odd1	odd2
7 Section A: Input and field characteristics section								
8 Size of field	acres	75	40	40	40	40	167.4	269.9
9 Number of swaths (passes) needed to cover headlands	count	2	2	2	2	2	2	2
10 Width of machine	feet	40	40	40	40	40	40	40
11 Area in headlands	acres	3.56	4.81	6.80	7.30	8.52	30.40	55.87
12 Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	28.31	21.01
13 Number of machine or boom sections to be controlled (for Section D)	count	16	16	16	16	16	16	16
16 Sub-section C5: Summed net benefits to overlap-reducing technology	overlap %	Sum of net annual benefits, \$/applied acre (relative to topmost row)						
17 Percent of category to include in net benefits total	7.0%	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
18 Machine costs	5.3%	\$0.5435	\$0.5291	\$0.5355	\$0.5269	\$0.5282	\$0.5373	\$0.5332
19 Input costs	3.5%	\$1.0650	\$1.0367	\$1.0490	\$1.0302	\$1.0344	\$1.0524	\$1.0443
20 Yield revenue	1.8%	\$1.5655	\$1.5240	\$1.5417	\$1.5140	\$1.5200	\$1.5467	\$1.5346
21 Non-ownership costs	0.0%	\$2.0463	\$1.9919	\$2.0147	\$1.9783	\$1.9859	\$2.0212	\$2.0051
22	overlap %	Investment supported by above annual cost savings (relative to topmost row), \$/applied acre						
23	7.0%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
24	5.3%	\$3.65	\$3.55	\$3.59	\$3.53	\$3.54	\$3.61	\$3.58
25	3.5%	\$7.15	\$6.96	\$7.04	\$6.91	\$6.94	\$7.06	\$7.01
26	1.8%	\$10.50	\$10.23	\$10.34	\$10.16	\$10.20	\$10.38	\$10.30
27	0.0%	\$13.73	\$13.37	\$13.52	\$13.27	\$13.33	\$13.56	\$13.45
30 Section D: Boom-nozzle-machine section shutoff on headlands analysis (affects applied input amounts and yield loss only, not machine operation costs) (based on 1.8% overlap)								
31 insert a 1 here to consider input cost savings >	1							
32 insert a 1 here to consider reductions in yield losses >	1							
33 input cost and yield revenue savings relative to manual whole boom control, expressed as \$/applied acre in whole field and associated with:	\$/acre	\$0.3552	\$0.4395	\$0.4395	\$0.5794	\$0.4959	\$0.3151	\$0.2715
34 automatic control of whole boom	\$/acre	\$0.9435	\$0.0000	\$1.3735	\$1.0436	\$1.8774	\$1.8277	\$2.2090
35 manual control of boom sections	\$/acre	\$1.2987	\$0.4395	\$1.8130	\$1.6220	\$2.3733	\$2.1428	\$2.4805
37 investment supported by annual input savings for:								
38 automatic control of whole boom	\$/acre	\$2.3831	\$2.9491	\$2.9491	\$3.8813	\$3.3278	\$2.1141	\$1.8218
39 manual control of boom sections	\$/acre	\$6.3309	\$0.0000	\$9.2161	\$7.0027	\$12.5972	\$12.2642	\$14.8223
40 automatic control of boom sections	\$/acre	\$8.7141	\$2.9491	\$12.1652	\$10.8840	\$15.9250	\$14.3782	\$16.6441

Benefit to reducing overlap is similar across field shapes (given assumed benefits)

Results (Notes Amortization /)

Reporting a few results from Kastens farm

- “Typical field” is 92.26 acres
 - 1874 feet distance perpendicular to line of travel
 - Same-sized square field 2005 feet
 - 9216 feet running distance of headlands
 - Same-sized square field 4009 feet
 - Headland angle 24 degrees
 - Same-sized square field 90 degrees
 - Much like the Ranch field (odd1), only smaller
- Other universal assumptions:
 - Base custom rate is for typical Kastens field
 - Other fields would have lower base costs
 - amortization of 8.00% interest over 7 years
 - Manual reaction distance (machine up) 5 feet
 - Turnaround speed 75% of down-row speed
 - GPS subscription fee (or hassle factor) cost \$0.20/acre at 0% overlap to \$0.00/acre at top overlap considered

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- Undercutter or field cultivator example
 - 40 foot wide
 - 2 passes to cover headland
 - \$6.50/acre custom rate
 - Assume lost yield revenue on doubled-up headland acres is \$35/acre for the year on wheat
 - Say 10 bu/acre at \$3.50/bu
 - But, use machine 5 times prior to planting, so yield revenue lost per application on doubled-up acres is \$7/acre

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Using tractor on a 40-ft undercutter or field cultivator

Field shape and headland economics analysis

[Print Information](#)

four stylized fields; assume farm north to south

	units	user-defined field userfield	square	equal sized isos R trian	equal sized equil triang	equal sized circle	Kastens Ktypical	
Section A: Input and field characteristics section								
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26	
Number of swaths (passes) needed to cover headlands	count	2	2	2	2	2	2	
Width of machine	feet	40	40	40	40	40	40	
Area in headlands	acres	9.30	7.11	10.05	10.80	12.59	16.33	
Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	23.99	
Number of machine or boom sections to be controlled (for Section D)	count	1	1	1	1	1	1	
Sub-section C5: Summed net benefits to overlap-reducing technology								
Percent of category to include in net benefits total	overlap %		Sum of net annual benefits, \$/applied acre (relative to topmost row)					
Machine costs	7.0%	1	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Input costs	5.3%	0	\$0.0877	\$0.0904	\$0.0888	\$0.0859	\$0.0837	\$0.0792
Yield revenue	3.5%	0	\$0.1720	\$0.1773	\$0.1702	\$0.1684	\$0.1641	\$0.1552
Non-ownership costs	1.8%	0	\$0.2531	\$0.2610	\$0.2505	\$0.2478	\$0.2414	\$0.2280
	0.0%	0	\$0.3312	\$0.3415	\$0.3277	\$0.3241	\$0.3156	\$0.2980
	overlap %		Investment supported by above annual cost savings (relative to topmost row), \$/ap					
	7.0%		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	5.3%		\$0.46	\$0.47	\$0.45	\$0.45	\$0.44	\$0.41
	3.5%		\$0.90	\$0.92	\$0.89	\$0.88	\$0.85	\$0.81
	1.8%		\$1.32	\$1.36	\$1.30	\$1.29	\$1.26	\$1.19
	0.0%		\$1.72	\$1.78	\$1.71	\$1.69	\$1.64	\$1.55

Ignoring everything else, save \$0.2280/acre taking overlap from typical no-marker value of 7% to say, 1.8% with a reasonable autoguidance setup. This would allow an investment of \$1.19/acre or \$11,900 on 10,000 acres (i.e., 2,000 acres of summerfallow wheat, farmed 5 times in preparation for planting).

Notice that more complex field shapes induce LESS benefit to overlap reduction rather than more – such fields have more of their machines' field time spent on intrinsic inefficiencies related to headlands that are not impacted by reduced overlap.

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Using tractor on a 40-ft undercutter or field cultivator

Field shape and headland economics analysis

[Print Information](#)

four stylized fields; assume farm north to south

	units	user-defined field userfield	square	equal sized isos R trian	equal sized equil triang	equal sized circle	Kastens Ktypical	
Section A: Input and field characteristics section								
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26	
Number of swaths (passes) needed to cover headlands	count	2	2	2	2	2	2	
Width of machine	feet	40	40	40	40	40	40	
Area in headlands	acres	9.30	7.11	10.05	10.80	12.59	16.33	
Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	23.99	
Number of machine or boom sections to be controlled (for Section D)	count	1	1	1	1	1	1	
Sub-section C5: Summed net benefits to overlap-reducing technology								
Percent of category to include in net benefits total	overlap %		Sum of net annual benefits, \$/applied acre (relative to topmost row)					
Machine costs	7.0%	1	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Input costs	5.3%	0	\$0.0377	\$0.0404	\$0.0368	\$0.0359	\$0.0337	\$0.0292
Yield revenue	3.5%	0	\$0.0720	\$0.0773	\$0.0702	\$0.0684	\$0.0641	\$0.0562
Non-ownership costs	1.8%	1	\$0.1031	\$0.1110	\$0.1005	\$0.0978	\$0.0914	\$0.0780
	0.0%		\$0.1312	\$0.1415	\$0.1277	\$0.1241	\$0.1156	\$0.0980
	overlap %		Investment supported by above annual cost savings (relative to topmost row), \$/ap					
	7.0%		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	5.3%		\$0.20	\$0.21	\$0.19	\$0.19	\$0.18	\$0.15
	3.5%		\$0.38	\$0.40	\$0.37	\$0.36	\$0.33	\$0.29
	1.8%		\$0.54	\$0.58	\$0.52	\$0.51	\$0.48	\$0.41
	0.0%		\$0.68	\$0.74	\$0.66	\$0.65	\$0.60	\$0.51

Bringing in the assumed \$0.15/acre (\$1,500 on 10,000 acres) annual GPS subscription fee or hassle factor, reduces the investment that could be made to get to 1.8% overlap to \$4,100 on 10,000 acres (i.e., \$0.41/acre).

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Using tractor on a 40-ft undercutter or field cultivator

Field shape and headland economics analysis

[Print information](#)

four stylized fields; assume farm north to south

	units	user-defined field userfield	square	equal sized isos R trian	equal sized equil triang	equal sized circle	Kastens Ktypical
Section A: Input and field characteristics section							
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26
Number of swaths (passes) needed to cover headlands	count	2	2	2	2	2	2
Width of machine	feet	40	40	40	40	40	40
Area in headlands	acres	9.30	7.11	10.05	10.80	12.59	16.33
Average angle of approach to headland in degrees (0.90)	degrees	49.63	90.00	45.00	60.00	39.54	23.99
Number of machine or boom sections to be controlled (for Section D)	count	1	1	1	1	1	1
Sub section C5: Summed net benefits to overlap-reducing technology							
Percent of category to include in net benefits total	overlap %	7.0%	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Machine costs	<input type="checkbox"/>	5.3%	\$0.0408	\$0.0411	\$0.0403	\$0.0389	\$0.0383
Input costs	<input checked="" type="checkbox"/>	3.5%	\$0.0780	\$0.0787	\$0.0771	\$0.0744	\$0.0731
Yield revenue	<input checked="" type="checkbox"/>	1.8%	\$0.1119	\$0.1130	\$0.1105	\$0.1065	\$0.1046
Non-ownership costs	<input checked="" type="checkbox"/>	0.0%	\$0.1427	\$0.1442	\$0.1408	\$0.1366	\$0.1330
	overlap %	7.0%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	5.3%	\$0.21	\$0.21	\$0.21	\$0.20	\$0.20	\$0.19
	3.5%	\$0.41	\$0.41	\$0.40	\$0.39	\$0.38	\$0.35
	1.8%	\$0.69	\$0.69	\$0.68	\$0.65	\$0.64	\$0.60
	0.0%	\$0.74	\$0.75	\$0.73	\$0.71	\$0.69	\$0.64

Bringing in also the \$7/acre/operation lost yield revenue on doubled-up headland acres supports an investment of \$5,000 in this 2000 acres of annual summerfallow wheat situation.

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- **Sprayer example**
 - 90 foot wide
 - 1 pass to cover headland
 - \$4.25/acre custom rate
 - \$10.00/acre/application of chemical used
 - Assume lost yield revenue on doubled-up headland acres is \$30/acre/year on corn (12 bu/acre at \$2.50)
 - Assign loss half to spraying excess chemicals and half to double-planting with planter, so \$15 for sprayer/yr.
 - But, apply 3 times prior to planting (say twice after wheat harvest, once in spring), so yield revenue lost per application on doubled-up acres is \$5/acre.

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90-ft sprayer example

Field shape and headland economics analysis

[Print Information](#)

four stylized fields; assume farm north to south

	units	user defined field userfield	square	equal sized isos R trian	equal sized equil triang	equal sized circle	Kastens Typical
Section A: Input and field characteristics section							
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26
Number of swaths (passes) needed to cover headlands	count	1	1	1	1	1	1
Width of machine	feet	90	90	90	90	90	90
Area in headlands	acres	10.85	8.28	11.72	12.59	14.68	19.04
Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	23.99
Number of machine or boom sections to be controlled (for Section D)	count	5	5	5	5	5	5
Sub-section C5: Summed net benefits to overlap-reducing technology							
Percent of category to include in net benefits total	overlap %		Sum of net annual benefits, \$/applied acre (relative to topmost row)				
Machine costs	7.0%	1	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Input costs	5.3%	0	\$0.0558	\$0.0576	\$0.0552	\$0.0546	\$0.0532
Yield revenue	3.5%	0	\$0.1096	\$0.1130	\$0.1084	\$0.1072	\$0.1044
Non-ownership costs	1.8%	0	\$0.1614	\$0.1665	\$0.1587	\$0.1580	\$0.1538
	0.0%	0	\$0.2115	\$0.2181	\$0.2092	\$0.2069	\$0.2015
	overlap %		Investment supported by above annual cost savings (relative to topmost row, \$/ap				
	7.0%		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	5.3%		\$0.29	\$0.30	\$0.29	\$0.28	\$0.26
	3.5%		\$0.57	\$0.59	\$0.56	\$0.55	\$0.51
	1.8%		\$0.84	\$0.87	\$0.83	\$0.82	\$0.76
	0.0%		\$1.10	\$1.14	\$1.09	\$1.08	\$1.05

Ignoring everything else, save \$0.1452/acre taking overlap from typical foam-marker value of 7% to say, 1.8% with a reasonable autoguidance setup. This would allow an investment of \$0.76/acre, or \$11,400 on 15,000 acres of annual sprayings.

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90-ft sprayer example

Field shape and headland economics analysis

[Print Information](#)

four stylized fields; assume farm north to south

	units	user defined field userfield	square	equal sized isos R trian	equal sized equil triang	equal sized circle	Kastens Typical
Section A: Input and field characteristics section							
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26
Number of swaths (passes) needed to cover headlands	count	1	1	1	1	1	1
Width of machine	feet	90	90	90	90	90	90
Area in headlands	acres	10.85	8.28	11.72	12.59	14.68	19.04
Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	23.99
Number of machine or boom sections to be controlled (for Section D)	count	5	5	5	5	5	5
Sub-section C5: Summed net benefits to overlap-reducing technology							
Percent of category to include in net benefits total	overlap %		Sum of net annual benefits, \$/applied acre (relative to topmost row)				
Machine costs	7.0%	1	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Input costs	5.3%	1	\$0.2134	\$0.2134	\$0.2124	\$0.2086	\$0.2022
Yield revenue	3.5%	0	\$0.4191	\$0.4191	\$0.4170	\$0.4096	\$0.3970
Non-ownership costs	1.8%	0	\$0.6174	\$0.6174	\$0.6144	\$0.6035	\$0.5849
	0.0%	0	\$0.8088	\$0.8088	\$0.8049	\$0.7905	\$0.7663
	overlap %		Investment supported by above annual cost savings (relative to topmost row, \$/ap				
	7.0%		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	5.3%		\$1.11	\$1.11	\$1.11	\$1.09	\$1.05
	3.5%		\$2.18	\$2.18	\$2.17	\$2.13	\$2.07
	1.8%		\$3.21	\$3.21	\$3.20	\$3.14	\$3.05
	0.0%		\$4.21	\$4.21	\$4.19	\$4.12	\$3.99

Bringing in the input cost savings increases the investment that could be made to support going from 7% to 1.8% overlap to \$3.05/acre (over \$45,000 on 15,000 acres/yr sprayed).

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90-ft sprayer example

Field shape and headland economics analysis

[Print information](#)

four stylized fields; assume farm north to south

	units	user-defined field userfield	square	equal sized isos R trian	equal sized equi triang	equal sized circle	Kastens Ktypical
Section A: Input and field characteristics section							
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26
Number of swaths (passes) needed to cover headlands	count	1	1	1	1	1	1
Width of machine	feet	90	90	90	90	90	90
Area in headlands	acres	10.85	8.28	11.72	12.59	14.68	19.04
Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	45.00	60.00	39.54	23.99
Number of machine or boom sections to be controlled (for Section D)	count	5	5	5	5	5	5
Sub section C5: Summed net benefits to overlap-reducing technology							
Percent of category to include in net benefits total	overlap %	7.0%	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Machine costs	5.3%	\$0.1677	\$0.1639	\$0.1673	\$0.1626	\$0.1644	\$0.1620
Input costs	3.5%	\$0.3275	\$0.3201	\$0.3260	\$0.3176	\$0.3211	\$0.3163
Yield revenue	1.8%	\$0.4798	\$0.4689	\$0.4788	\$0.4652	\$0.4704	\$0.4634
Non-ownership costs	0.0%	\$0.6260	\$0.6107	\$0.6232	\$0.6069	\$0.6127	\$0.6036
	overlap %	7.0%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	5.3%	\$0.87	\$0.85	\$0.87	\$0.85	\$0.86	\$0.84
	3.5%	\$1.70	\$1.67	\$1.70	\$1.65	\$1.67	\$1.65
	1.8%	\$2.60	\$2.44	\$2.49	\$2.42	\$2.45	\$2.41
	0.0%	\$3.25	\$3.18	\$3.25	\$3.15	\$3.19	\$3.14

Bringing in everything we consider changes the investment that could be made to support going from 7% to 1.8% overlap to \$2.41/acre (\$36,150 on 15,000 acres/yr sprayed).

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Moving from guidance to section control...

- **Sprayer example – boom shutoff**
 - We now consider the benefits for automatic boom section shutoff at the headlands
 - We start with the assumption of a default overlap percentage of 1.8% as the one determining custom rates, and then consider:
 - Automatic (GPS) control of whole boom
 - Manual control of each of 5 boom sections independently (you'd better be fast acting)
 - Automatic (GPS) control of 5 boom sections





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90-ft sprayer example – boom shutoff control, 5 sections

Field shape and headland economics analysis

Print Information

four stylized fields; assume farm north to south

user-defined field  equal sized isos R trian  equal sized equi triang  equal sized circle  Kastens Ktypical

units userfield square

Section D: Boom/nozzle/machine section shutoff on headlands analysis (affects applied input amounts and yield loss only, not machine operation cost):

Insert a 1 here to consider input cost savings >

Insert a 1 here to consider reductions in yield losses >

Input cost and yield revenue savings relative to manual whole boom control, expressed as \$/applied acre in whole field and associated with:

	\$/acre	\$/acre	\$/acre	\$/acre	\$/acre	\$/acre
automatic control of whole boom	\$0.0760	\$0.0762	\$0.0762	\$0.1002	\$0.0859	\$0.0712
manual control of boom sections	\$0.4660	\$0.0000	\$0.5483	\$0.4166	\$0.7496	\$1.1516
automatic control of boom sections	\$0.5410	\$0.0762	\$0.6245	\$0.5169	\$0.8364	\$1.2228
Investment supported by annual input savings for:						
automatic control of whole boom	\$0.3956	\$0.3965	\$0.3965	\$0.5210	\$0.4474	\$0.3706
manual control of boom sections	\$2.4211	\$0.0000	\$2.8548	\$2.1692	\$3.9022	\$5.9955
automatic control of boom sections	\$2.8167	\$0.3965	\$3.2513	\$2.6910	\$4.3496	\$6.3661

Going to automatic boom shutoff control saves \$1.2228/acre per year, and thus supports an investment of \$95,000+ in this 15,000 acres/year scenario. Note, that the GPS component of this technology may not have to be “covered” by savings here if it is already justified via the autoguidance investment. This is obviously the place to focus GPS investments for Kastens.

Even if yield loss component is ignored, the justified investment is \$63,000+.

Notice the huge benefits to this technology for more irregular fields (compare Ktypical with square field).

Keep in mind that most of this “gain” could come from manual control of the 5 sections, which typically the sprayer already comes with. But, can you really manually control 5 sections effectively? If not, then the investment noted above is merited.

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• Planter example

- 40 foot wide (16 rows 30 inches)
- 2 passes to cover headland
- \$12.50/acre custom rate
- \$25.00/acre seed cost
- Assume lost yield revenue on doubled-up headland acres is \$30/acre for the year on corn (12 bu at \$2.50)
 - Assigned half to sprayer operations
 - So, \$15/acre for planter

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Planter example – guidance only

Field shape and headland economics analysis

[Print information](#)

four stylized fields; assume farm north to south

	units	user-defined userfield	square	equal sized isos R trian	equal sized equil trian	equal sized circle	Kastens Ktypical
Section A: Input and field characteristics section							
Size of field	acres	92.26	92.26	92.26	92.26	92.26	92.26
Number of swaths (passes) needed to cover headlands	count	2	2	2	2	2	2
Width of machine	feet	40	40	40	40	40	40
Area in headlands	acres	9.55	7.29	10.31	11.08	12.92	16.76
Average angle of approach to headland in degrees (0-90)	degrees	49.63	90.00	46.00	60.00	39.54	23.99
Number of machine or boom sections to be controlled (for Section D)	count	2	2	2	2	2	2
Sub section C5: Summed net benefits to overlap-reducing technology							
Percent of category to include in net benefits total	overlap %	2.0%	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
Machine costs		1	\$0.1147	\$0.1143	\$0.1143	\$0.1127	\$0.1126
Input costs		1	\$0.2277	\$0.2269	\$0.2269	\$0.2236	\$0.2233
Yield revenue		1	\$0.3390	\$0.3378	\$0.3379	\$0.3330	\$0.3324
Non-ownership costs		1	\$0.4487	\$0.4471	\$0.4472	\$0.4407	\$0.4399
	Sum of net annual benefits, \$/applied acre (relative to topmost row)		\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$0.0000
	Investment supported by above annual cost savings (relative to topmost row), \$/ap		\$0.00	\$0.60	\$0.60	\$0.59	\$0.59
			\$1.19	\$1.18	\$1.18	\$1.16	\$1.16
			\$1.77	\$1.76	\$1.76	\$1.73	\$1.73
			\$2.34	\$2.33	\$2.33	\$2.29	\$2.29

Bringing in everything we consider, going from a 2.0% overlap (e.g., marker-based guidance) to 0.5% guidance (fairly good GPS guidance), saves \$0.3255/acre, which supports an investment of \$1.69/acre, or \$5,070 if the planter plants 3,000 acres of corn per year.

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- planter example – section shutoff
 - We now consider the benefits for automatic section shutoff at the headlands
 - We start with the assumption of a default overlap percentage of 1.0% as the one determining custom rates, and then consider controlling:
 - 2 sections (8 rows each)
 - 4 sections (4 rows each)
 - 8 sections (2 rows each)
 - 16 sections (i.e., individual row shutoff)
 - In our investment analysis, we'll assume the operator already effectively controls 2 sections manually

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Planter example – section shutoff control, 2 sections

Field shape and headland economics analysis

Print Information

four stylized fields; assume farm north to south

user-defined field units: square, equal sized isos R trian, equal sized equi triang, equal sized circle, Kastens Ktypical

Section D: Boom/nozzle/machine section shutoff on headlands analysis (affects applied input amounts and yield loss only, not machine operation cost):

Insert a 1 here to consider input cost savings >

Insert a 1 here to consider reductions in yield losses >

Input cost and yield revenue savings relative to manual whole boom control, expressed as \$/applied acre in whole field and associated with:

	\$/acre	\$0.2011	\$0.2015	\$0.2015	\$0.2652	\$0.2274	\$0.1884
automatic control of whole boom	\$/acre	\$0.3419	\$0.0000	\$0.4031	\$0.3063	\$0.6510	\$0.8466
manual control of boom sections	\$/acre	\$0.5429	\$0.2015	\$0.6046	\$0.5715	\$0.7784	\$1.0349
automatic control of boom sections	\$/acre	\$1.0469	\$1.0493	\$1.0493	\$1.3010	\$1.1040	\$0.9007
investment supported by annual input savings for:							
automatic control of whole boom	\$/acre	\$1.7799	\$0.0000	\$2.0986	\$1.5946	\$2.8686	\$4.4075
manual control of boom sections	\$/acre	\$2.8267	\$1.0493	\$3.1480	\$2.9756	\$4.0526	\$5.3882

Going from manual to automatic section control of planter (2 sections; 8-rows controlled together) saves \$0.1884/acre/year (from \$1.0349-\$0.8466), which happens to be the same thing as the auto-control of whole boom number, supporting an investment of \$2,942 on 3000 acres (\$0.9807/acre). Comparable numbers (tables not shown) for more sensitive control (relative to manual 8-row control) are:

- 4-row control, \$0.6117/acre/yr savings, \$ 9,553 investment supported
- 2-row control, \$0.8233/acre/yr savings, \$12,859 investment supported
- 1-row control, \$0.9291/acre/yr savings, \$14,512 investment supported

If all headland yield loss assigned to planter rather than half to sprayer:

- 1-row control, \$1.2775/acre/yr savings, \$19,954 investment supported

Like the sprayer, big benefits to section control for irregular fields

Why is this not yet an option on planters?

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Additional thoughts/considerations

- In the planter example, assume:
 - 1% overlap (so assume autoguidance)
 - \$1.78/acre/year benefit to individual row control over manual whole-planter control (the \$1.78 here compares with the \$0.9291 number on previous slide)
- (1) No section control of planter
 - Typical (acres-weighted) machine cost or custom rate is \$12.50/acre; rates range from \$11.65/acre to \$17.95/acre across the 75 fields, with a standard deviation of \$1.41.
- With 16-section (each row) control & sunk investment
 - (2) For owner-operator (gets input benefits)
 - Typical “cost” is now \$10.72/acre (i.e., \$12.50-\$1.78)
 - Appropriate “machine” costs (brings in input and yield loss savings) across the 75 fields range from \$10.52/acre to \$12.35/acre, with a std dev of \$0.38/acre.

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Planter section control, cont'd

- With 16-section (each row) control & sunk investment
 - (3) If custom operator can extract a producer's benefits (but not the added cost of farming irregular fields):
 - Typical charge is \$14.28/acre (i.e., \$12.50+\$1.78); ranges from \$13.63 to \$18.35, with a std dev of \$1.03/acre.
 - Either scenario 2 or 3 reduces variability and increases profit relative to no section control of planter.
 - (4) If custom operator can extract a producer's benefits and appropriately charge for the differences in machinery cost across irregular fields:
 - Typical charge is still \$14.28/acre, but charges now range from \$12.78 to \$23.78, with a std dev of \$2.44/acre.
 - Increases profit and increases variability relative to no section control
 - Think about how you would sell the "service"

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Summary

- Lowering machinery costs is where the action is.
- Keep in mind that a tractor is multi-purpose, so GPS benefits can be additive.
- Think carefully about expected yield losses on doubled-up headland acres.
- Field size and shape doesn't much impact benefits to GPS autoguidance,
 - but really impacts benefits to section shutoff.
 - Autoguidance and section control share GPS items.
- GPS technologies should help to differentiate custom rates and ultimately land rental rates by field size and shape.
 - Section control may help stabilize these numbers.
- We didn't account for reduced operator fatigue.

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Govt Payments and Non-Ag Returns Impact on Land Values
 September 7, 2006 by Terry Haskins and Kevin Chuyvalter

CRP Decision Tool, Excel spreadsheet to evaluate expiring CRP contracts
 September 6, 2006 by Rodney Jones and Kevin Harber

Questions?
 www.agmanager.info

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