Economics of Adopting Technology

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Technology

- Definition: The application of science to industrial or commercial objectives
- Broadly, agricultural technologies are those processes or machines that impact production agriculture, typically by
  - lowering cost, or
  - increasing revenue
- Requires an investment
  - so, the natural question is will it pay?

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Technology: Will it pay?

1. How much is the investment?
2. What is the expected return on investment? (How fast is the payback)
3. How confident am I that this will happen?

Answering these three questions will often go a long ways in explaining why a technology is, or is not, adopted (and how fast it is adopted).

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If a profit materializes…

- I'd like to apply the technology to more units of production (often, acres)
- So, I bid up rent or land values
  - Just a bit if I'm the only one using the technology
  - A whole bunch if many are using the technology
- It takes only a few viable adopters in an area to dramatically drive up rents

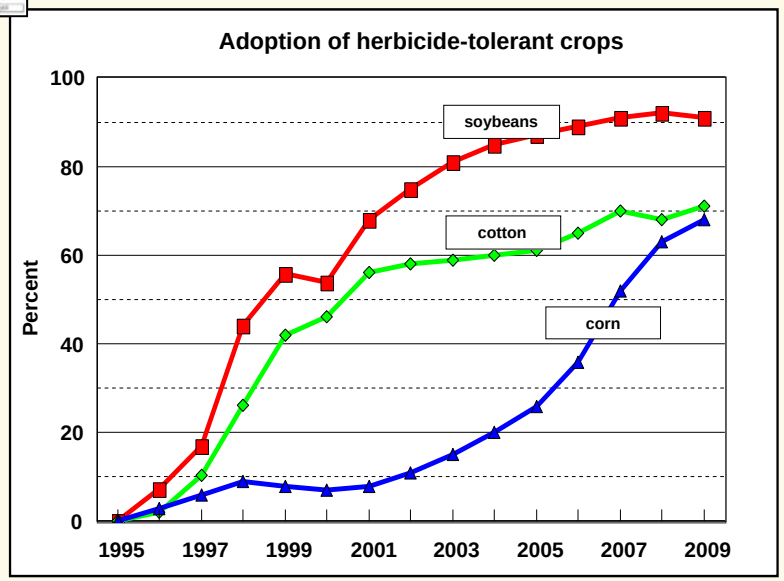
Early vs. late adopters…

- **Early adopters**
  - Adopt to become more profitable
  - See the technology as a great opportunity
  - Bid up rents and land values
- **Later adopters**
  - Adopt just to survive
  - Often wish things would go back to the way they were
  - Sometimes recognize the potential but are too small to justify the investment
  - Higher rents mean higher costs, and late adopters find themselves going broke in the face of rents they perceive as "too high"

Technology: speed of adoption

- Big and obvious gains probably non-existent
- Small but obvious gains, along with small investment, implies fast adoption
  - "belly-button" or "duh" technologies
  - Think of Roundup-Ready soybeans

Some technologies are fairly obvious…



Source: USDA/ERS

Other "duh" technologies (most farms)

- **Lightbars (GPS guidance)**
  - Gains against overlap and marker alternatives are easily perceived (i.e., quantifiable)
  - Do take a little more investment so less adopted by small farms until recently
- **Tractor cabs**
  - Hard to measure gain in $ but know it's there
- **GPS-assisted steering**
  - Larger investment than lightbars but still easy to perceive the advantage
  - Aspects like tractor cabs (reduces stress)
- **Section controllers**

(will come back to economics of GPS-assisted steering and section controllers)

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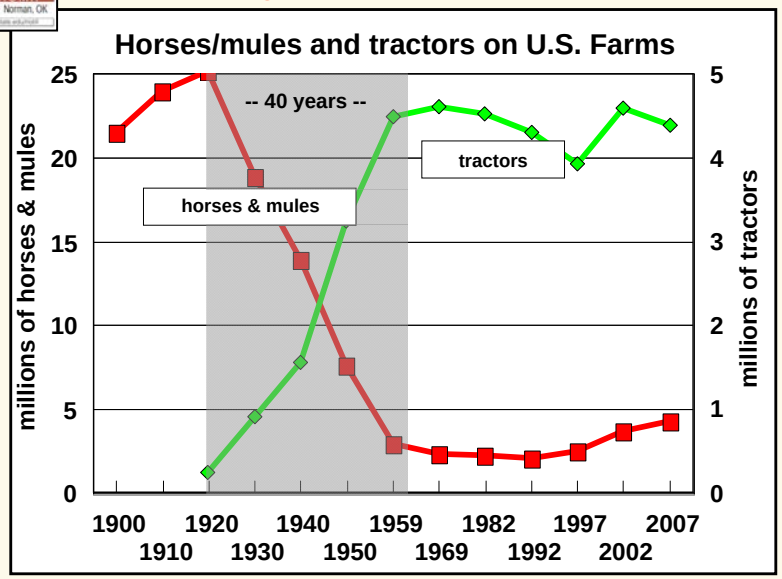
Some technologies aren't so obvious…



Source: U.S. Census of Agriculture

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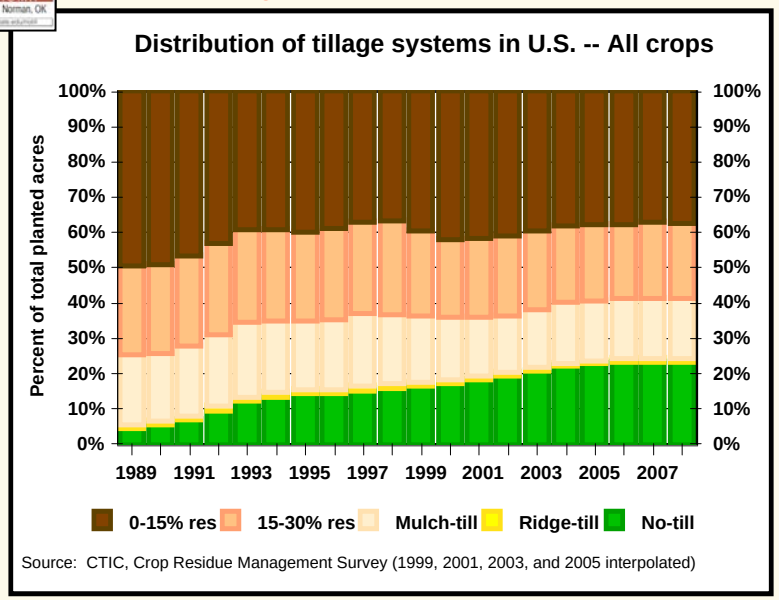

Source: CTIC, Crop Residue Management Survey (1999, 2001, 2003, and 2005 interpolated)

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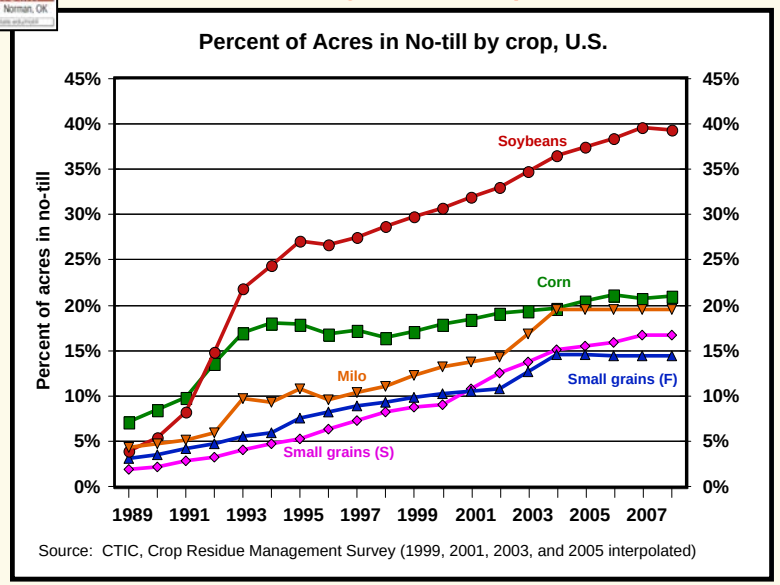
No-till acres increasing on most crops…



Source: CTIC, Crop Residue Management Survey (1999, 2001, 2003, and 2005 interpolated)

… but, more prevalent with corn and soybeans than wheat.

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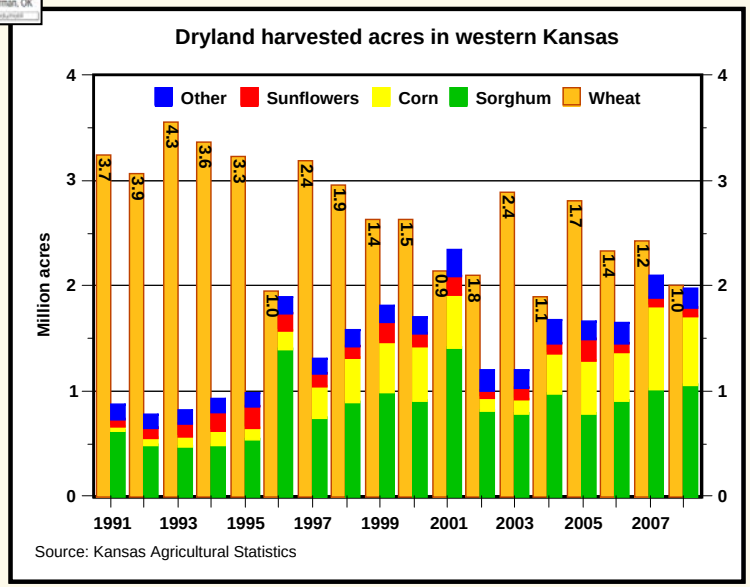
Unexpected factors drive technology adoption…



Source: Kansas Agricultural Statistics

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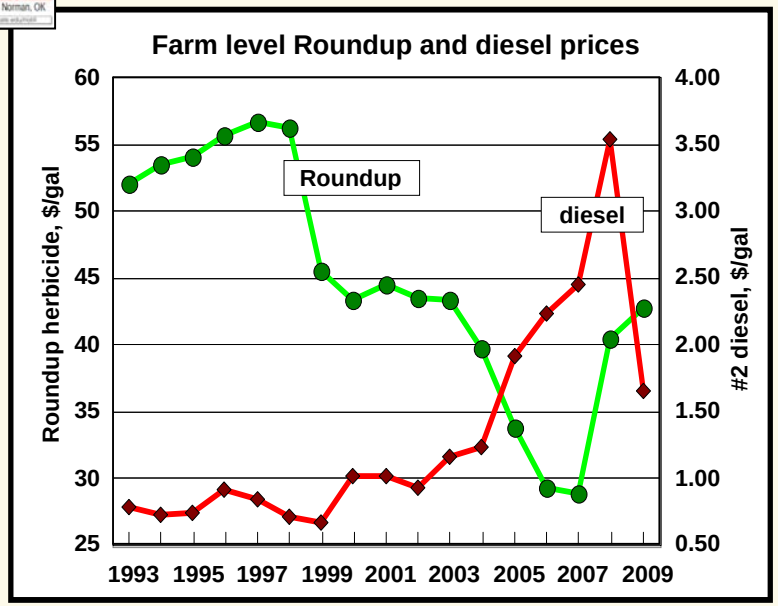
Did falling relative herbicide costs hasten adoption?



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Technology and farm size

- Large farms adopt technology more quickly
  - Because of investment (economies of size)
- If technologies come out ever faster, then farms will get larger ever faster
- Rapid growth in farm size may become the norm
- End result (intended or not): consolidation

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Scale-neutral Technologies?

- Roundup-ready soybeans?
- Robotic milkers
  - A robot station is rated at 60 cows
  - Will I get a discount if I buy multiple robots?
  - Can't one person check the "attention list" of more than one robot?
  - New semi-robots coming out for large dairies
- Farm machinery
  - Maxes out at some size so is it scale neutral beyond that point?
    - Multi-unit discounts?
    - Multi-unit tracking and servicing?

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Technology: how to get an edge

- Invest in the "duh" technologies quickly
  - You don't have a choice
- Invest in the slow moving technologies
  - The profits will last for years
- Invest in technologies that DO NOT save labor
  - Most people do not; hence the gains last for years

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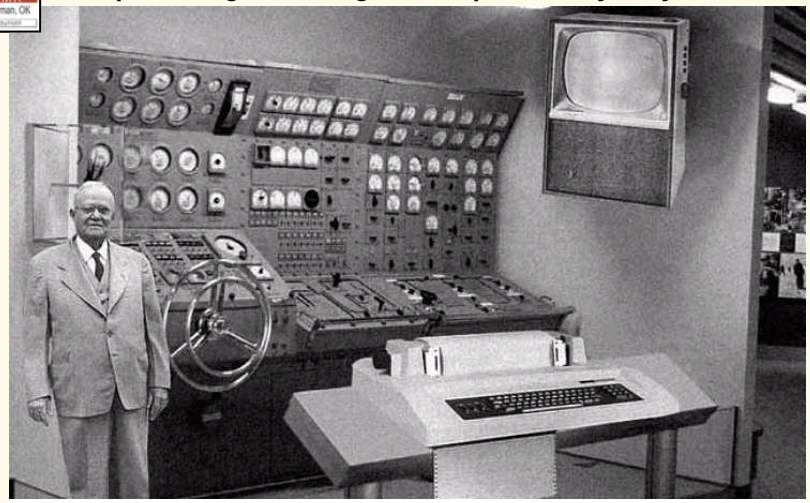
But, predicting technologies isn't particularly easy…



Scientists from the RAND Corporation have created this model to illustrate how a "home computer" could look in the year 2004. However the needed technology will not be economically feasible for the average home. Also the scientists readily admit that the computer will require not yet invented technology to actually work, but 50 years from now scientific progress is expected to solve these problems. With teletype interface and the Fortran language, the computer will be easy to use.

Popular Science, 1954

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But how do I know?

- Think SCIENCE
  - No magic
  - Stay away from foo-foo dust
- Think MARKETS
  - If the returns sound too good to be true they probably are
- Think ENGINEERING
  - What will the technology actually do?
  - What is a technology's potential (opportunity)?
    - After all, costs often fall

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Land Grant Institutions

- Provide a nice check
  - Kept many from using the myriad silage/hay preservatives in the 1970s
    - But, don't carry that mantra too far. After all, some preservatives actually worked!
- Sometimes too slow
  - Focus on high confidence in their statistical tests
  - Business decisions often made at much lower confidence levels
- But, their science is good, so ask them about the science behind a technology you're considering

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"Precision ag" related technologies…

Early Precision Ag "Movement"

- GPS signal availability early 1990s
  - Yield monitors
  - Grid soil sampling and VRA
- Dreams
  - Salvation for the little guy (free GPS)
  - Salvation for the big guy (can manage like the little guy)
  - No more excessive environmental pollution
  - Higher yields on less inputs (more efficient production)
  - More profit

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Early Precision Ag "Movement"

- Engineers give us all the cool electronic stuff to work with the GPS signals
- Agronomists help us use the cool electronic stuff to make better crop input decisions
  - Here's where the money was supposed to have been made!

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Whipker & Akridge CropLife/Purdue Survey

- 1996: what were the greatest opportunities for PA?
  - Better agronomic understanding
  - Improved dealer profit due to offering new services
  - Improved crop yields
- Did it happen? In a 2006 survey all rankings averaged between 3.7 and 4.5 where 1 meant no impact and 7 meant large impact – so sort of ho hum
- Very few (<10%) of dealers believe that PA (essentially VRA) improved crop input efficiency (2006)
  - Apparently, that dream never materialized!

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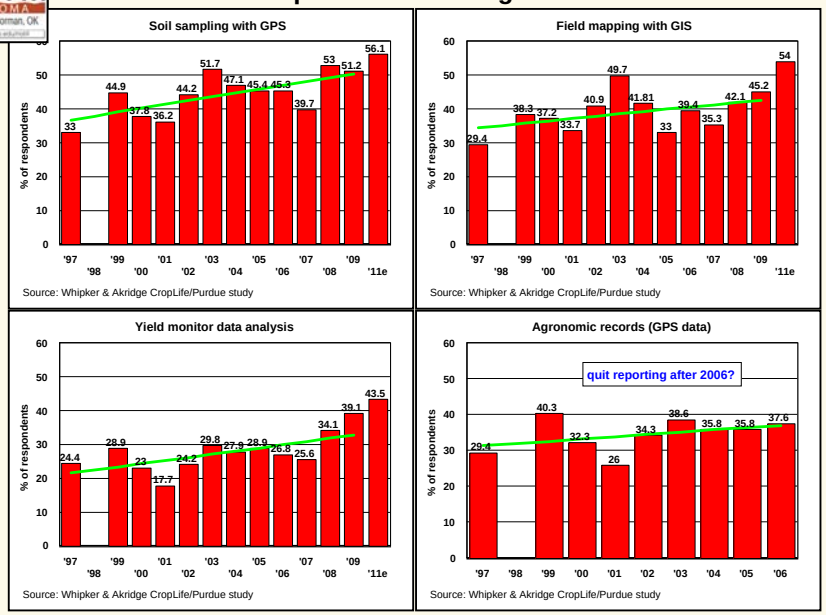
Percent of service providers offering services



a typical slow-moving technology . . . some things even go away enroute

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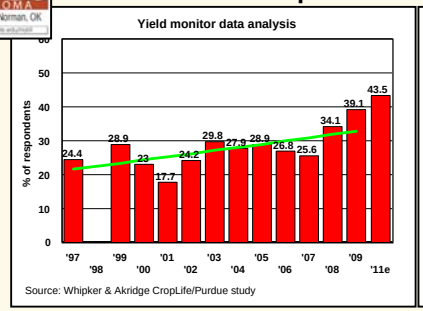
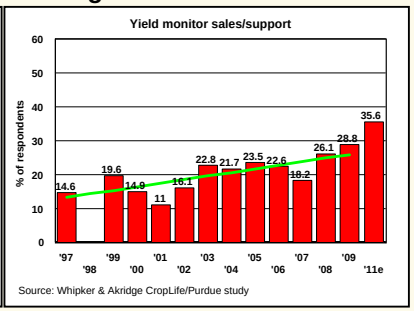


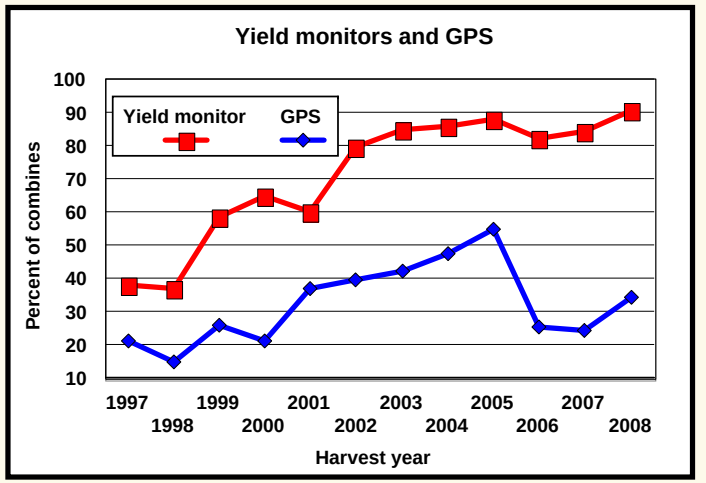
Source: Whipker & Akridge CropLife/Purdue study



Source: Whipker & Akridge CropLife/Purdue study

PA started with collecting and analyzing data from yield monitors 15 years ago, but such activities have been somewhat slow in adoption

From 151 combines operated by CHAMP members



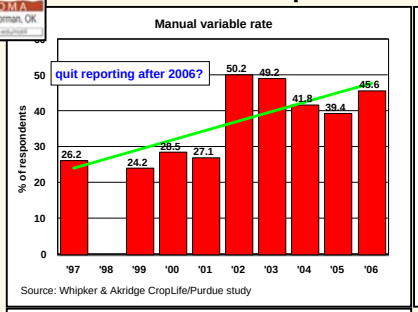
In 2008, 22.2% of CHAMP members providing yield maps
Of those providing, yield maps were provided for 20.1% of customers

Yield monitoring is a fast moving technology
Yield mapping is a slow-moving technology

A few thoughts on VRA and yield monitors

- **Input efficiency improvement not that great**
  - **Hence acres treated with VRA are still low**
  - **i.e., users don't know how (why?) to do VRA**
- **Yield mapping slow to be adopted**
  - **Folks don't know how to analyze the data**
  - **May be uncomfortable with task of making maps or managing the reams of data that arise**
- **Yield monitors fast to adopt**
  - **Require no formal analysis**
  - **Provide useful subjective & objective information:**
    - **Grain moisture information is especially valuable**
    - **Real-time combine performance information, especially along with grain loss monitors**
    - **Causes operator to think about reasons for yield differences**

Percent of service providers offering services



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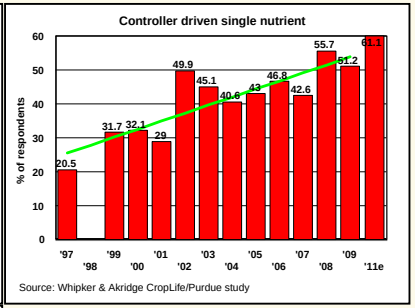

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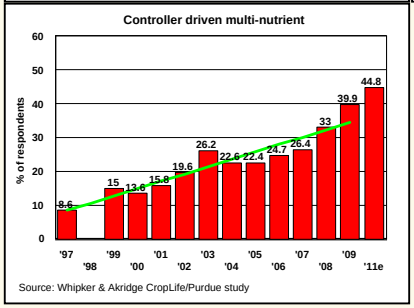


Source: Whipker & Akridge CropLife/Purdue study

VRA is NOT dead!

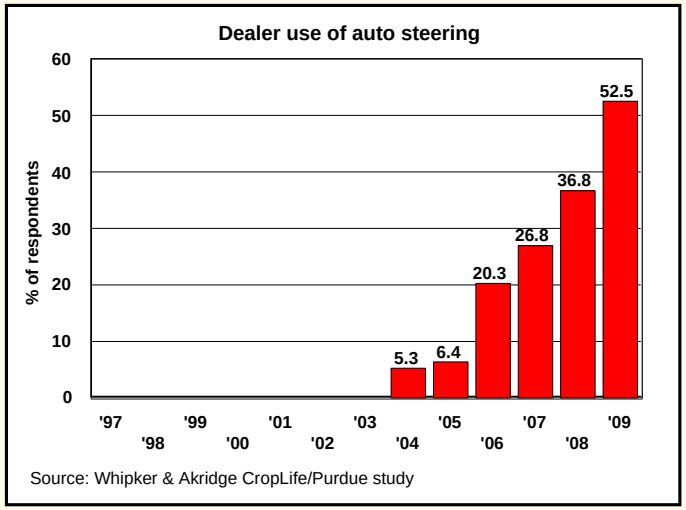
Though, it is slow moving . . .

Manual rate control disappeared?

In part, it may be an issue of costs of the capability having fallen, i.e., still may not be that many acres being treated with VRA.

VRA continues to grow in adoption

- Likely, users are gradually developing
  - subjective rules from map-based information, or
  - objective rules from area data information
- Likely, rules vary considerably from user to user and year to year – still much experimentation to do
- A very typical slow technology
  - Some figure it out and others do not
  - No clear large benefit to users on average
  - Yet, probably a nice opportunity for long-term profit for those who continue to experiment and learn



a very fast moving technology – improved accuracy of driving and reduced operator pressure likely make it obvious

More recent machinery enhancements…

- Boom and section shutoff of
  - Sprayers
  - Fertilizer applicators
  - Planters and seeders
- KSU-GPSguidance.xls
  - Available at ***www.agmanager.info***
  - An updated version, sponsored by PrecisionAg Institute, will soon be available at its website
  - Shows high return on investment in these machine control add-ons
    - If you don't believe it, use the spreadsheet and you'll see that boom and section shutoff controls are no-brainers for many

Examples of the economics of autoguidance and boom/section control…

Sprayer -- returns to guidance system and section controller

Planter -- returns to individual row controllers

- Vary acres "covered" per year
- Vary cost of input (i.e., herbicide and seed)
- Field size/shape held constant

(results presented here for sprayer only, planter results in pdf of slides)

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**

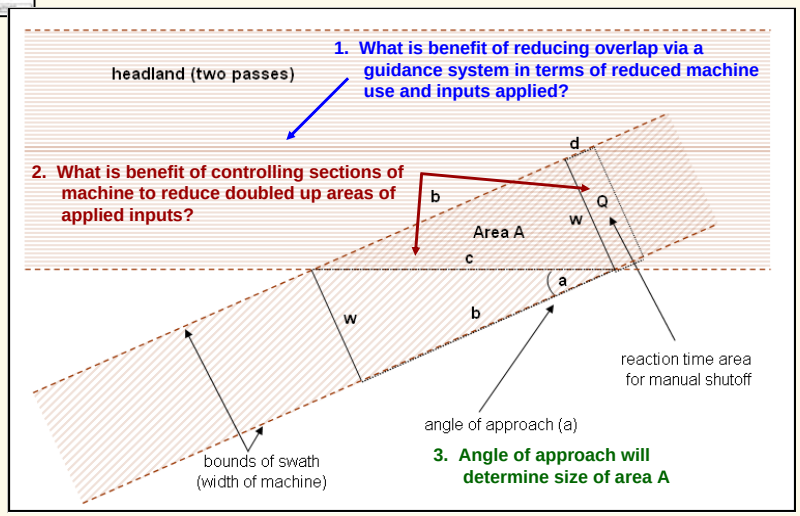
Field headland issues (where the action is)

- **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

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

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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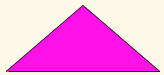
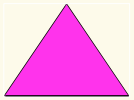
Stylized field shapes (farm left to right)

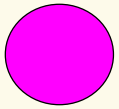
Square; hit ends at 90 degree angles
5,280 feet of headlands in 160 acre field



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

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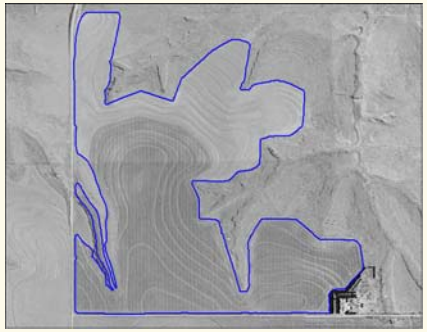
Kastens fields –
less efficient than squares, triangles, or circles…



Ranch field (Odd 1):
167.4 acres;
headland is 16,700 feet;
average angle at headland is 28 degrees
90' pass = 20% of field

TT field: (Odd 2)
269.9 acres;
headland is 30,690 feet;
average angle at headland is 21 degrees
90' pass = 23% of field

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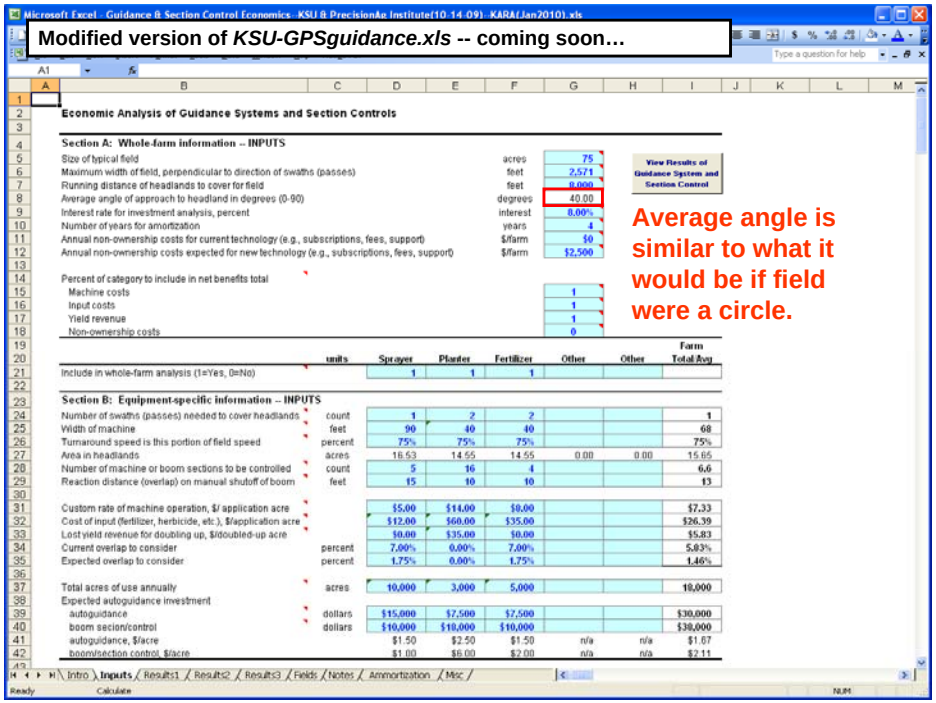
Modified version of *KSU-GPSguidance.xls* -- coming soon…



Economic Analysis of Guidance Systems and Section Controls

Section A: Whole-farm information -- INPUTS

Size of typical field	acres	75
Maximum width of field, perpendicular to direction of swaths (passes)	feet	2,571
Running distance of headlands to cover for field	feet	9,000
Average angle of approach to headland in degrees (0-90)	degrees	40.00
Interest rate for investment analysis, percent	interest	8.00%
Number of years for amortization	years	4
Annual non-ownership costs for current technology (e.g., subscriptions, fees, support)	$/farm	$0
Annual non-ownership costs expected for new technology (e.g., subscriptions, fees, support)	$/farm	$2,500

View Results of Guidance System and Section Control

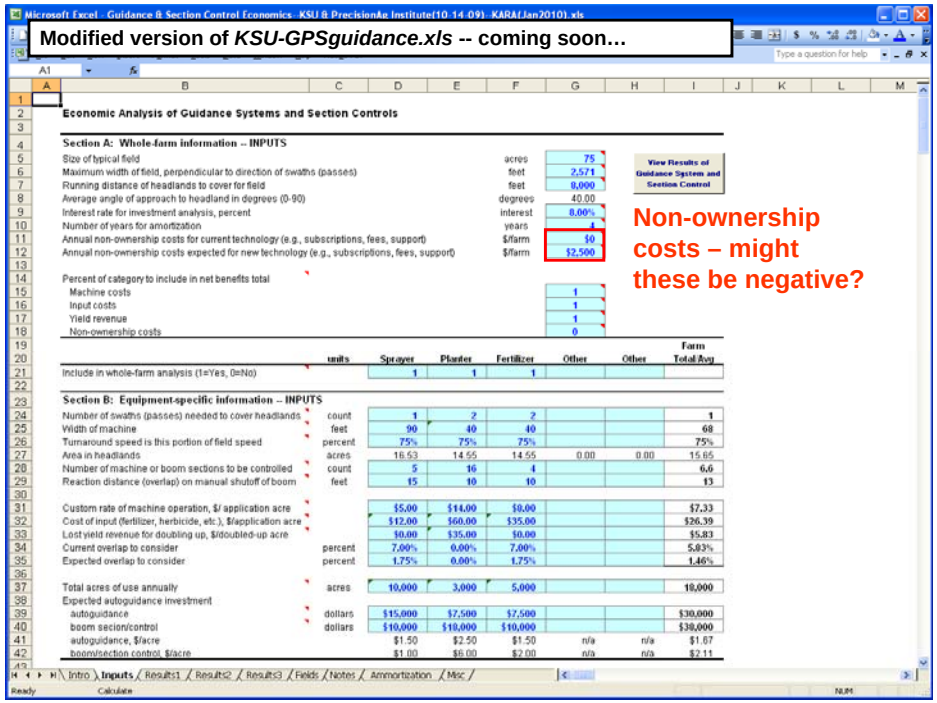
Percent of category to include in net benefits total

Machine costs	1
Input costs	1
Yield revenue	1
Non-ownership costs	0

	units	Sprayer	Planter	Fertilizer	Other	Other	Farm Total/Avg
Include in whole-farm analysis (1=Yes, 0=No)		1	1	1			
Section B: Equipment-specific information -- INPUTS							
Number of swaths (passes) needed to cover headlands	count	1	2	2			1
Width of machine	feet	90	40	40			68
Turnaround speed is this portion of field speed	percent	75%	75%	75%			75%
Area in headlands	acres	16.53	14.55	14.55	0.00	0.00	15.65
Number of machine or boom sections to be controlled	count	5	16	4			6.6
Reaction distance (overlap) on manual shutoff of boom	feet	15	10	10			13
Custom rate of machine operation, $/ application acre		$5.00	$14.00	$8.00			$7.33
Cost of input (fertilizer, herbicide, etc.), $/application acre		$12.00	$60.00	$35.00			$26.39
Lost yield revenue for doubling up, $/doubled-up acre		$0.00	$35.00	$0.00			$5.83
Current overlap to consider	percent	7.00%	0.00%	7.00%			5.83%
Expected overlap to consider	percent	1.75%	0.00%	1.75%			1.46%
Total acres of use annually	acres	10,000	3,000	5,000			18,000
Expected autoguidance investment							
autoguidance	dollars	$15,000	$7,500	$7,500			$30,000
boom section/control	dollars	$10,000	$18,000	$10,000			$38,000
autoguidance, $/acre		$1.50	$2.50	$1.50	n/a	n/a	$1.67
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

Average angle is similar to what it would be if field were a circle.

Modified version of *KSU-GPSguidance.xls* -- coming soon…



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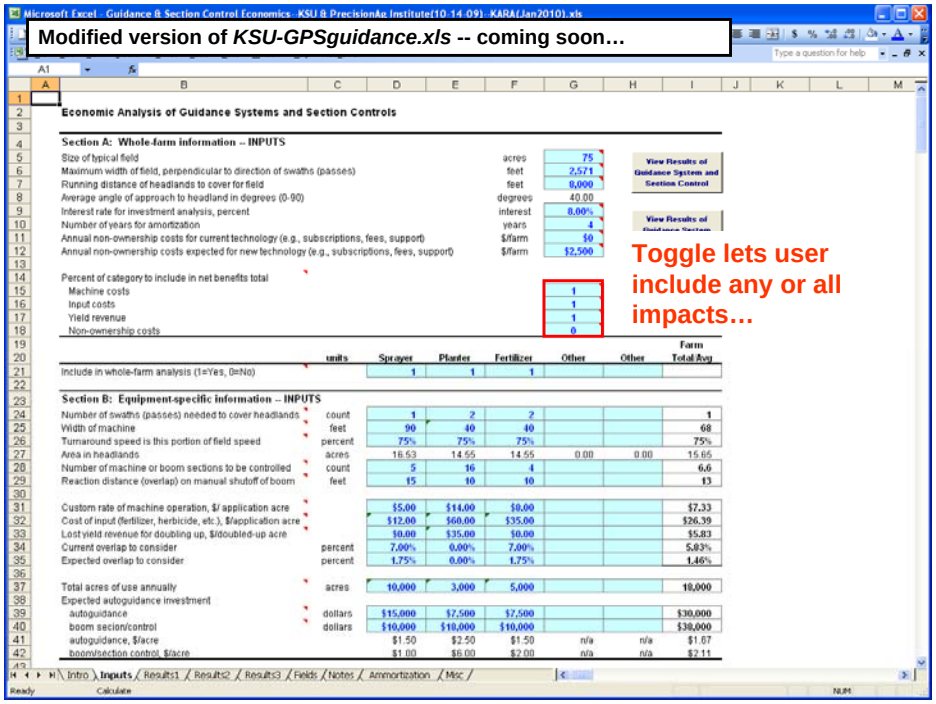
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

Non-ownership costs – might these be negative?

Modified version of *KSU-GPSguidance.xls* -- coming soon…



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View Results of Guidance System and Section Control | View Results of Guidance System

Percent of category to include in net benefits total

Machine costs	1
Input costs	1
Yield revenue	1
Non-ownership costs	0

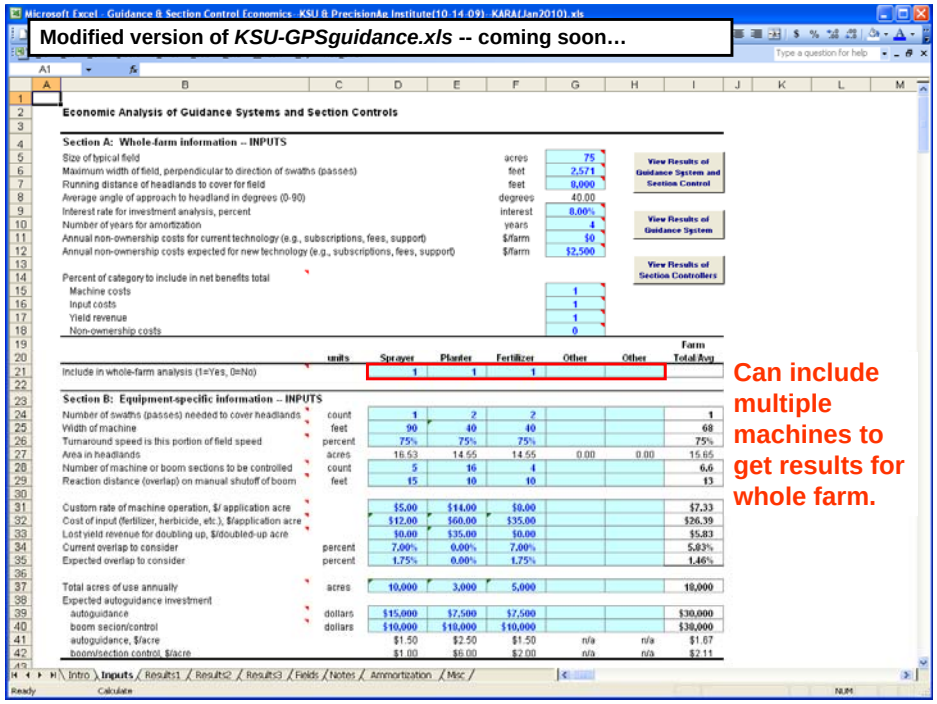
Toggle lets user include any or all impacts…

	units	Sprayer	Planter	Fertilizer	Other	Other	Farm Total/Avg
Include in whole-farm analysis (1=Yes, 0=No)		1	1	1			
Section B: Equipment-specific information -- INPUTS							
Number of swaths (passes) needed to cover headlands	count	1	2	2			1
Width of machine	feet	90	40	40			68
Turnaround speed is this portion of field speed	percent	75%	75%	75%			75%
Area in headlands	acres	16.53	14.55	14.55	0.00	0.00	15.65
Number of machine or boom sections to be controlled	count	5	16	4			6.6
Reaction distance (overlap) on manual shutoff of boom	feet	15	10	10			13
Custom rate of machine operation, $/ application acre		$5.00	$14.00	$0.00			$7.33
Cost of input (fertilizer, herbicide, etc.), $/application acre		$12.00	$60.00	$35.00			$26.39
Lost yield revenue for doubling up, $/doubled-up acre		$0.00	$35.00	$0.00			$5.83
Current overlap to consider	percent	7.00%	0.00%	7.00%			5.03%
Expected overlap to consider	percent	1.75%	0.00%	1.75%			1.46%
Total acres of use annually	acres	10,000	3,000	5,000			18,000
Expected autoguidance investment							
autoguidance	dollars	$15,000	$7,500	$7,500			$30,000
boom section/control	dollars	$10,000	$10,000	$10,000			$30,000
autoguidance, $/acre		$1.50	$2.50	$1.50	n/a	n/a	$1.67
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

Intro | Inputs | Results1 | Results2 | Results3 | Fields | Notes | Ammortization | Misc

Ready | Calculate | NUM

Modified version of *KSU-GPSguidance.xls* -- coming soon…



Economic Analysis of Guidance Systems and Section Controls

Section A: Whole-farm information -- INPUTS

Size of typical field	acres	75
Maximum width of field, perpendicular to direction of swaths (passes)	feet	2,571
Running distance of headlands to cover for field	feet	9,000
Average angle of approach to headland in degrees (0-90)	degrees	40.00
Interest rate for investment analysis, percent	interest	8.00%
Number of years for amortization	years	4
Annual non-ownership costs for current technology (e.g., subscriptions, fees, support)	$/farm	$0
Annual non-ownership costs expected for new technology (e.g., subscriptions, fees, support)	$/farm	$2,500

View Results of Guidance System and Section Control | View Results of Guidance System | View Results of Section Controllers

Percent of category to include in net benefits total

Machine costs	1
Input costs	1
Yield revenue	1
Non-ownership costs	0

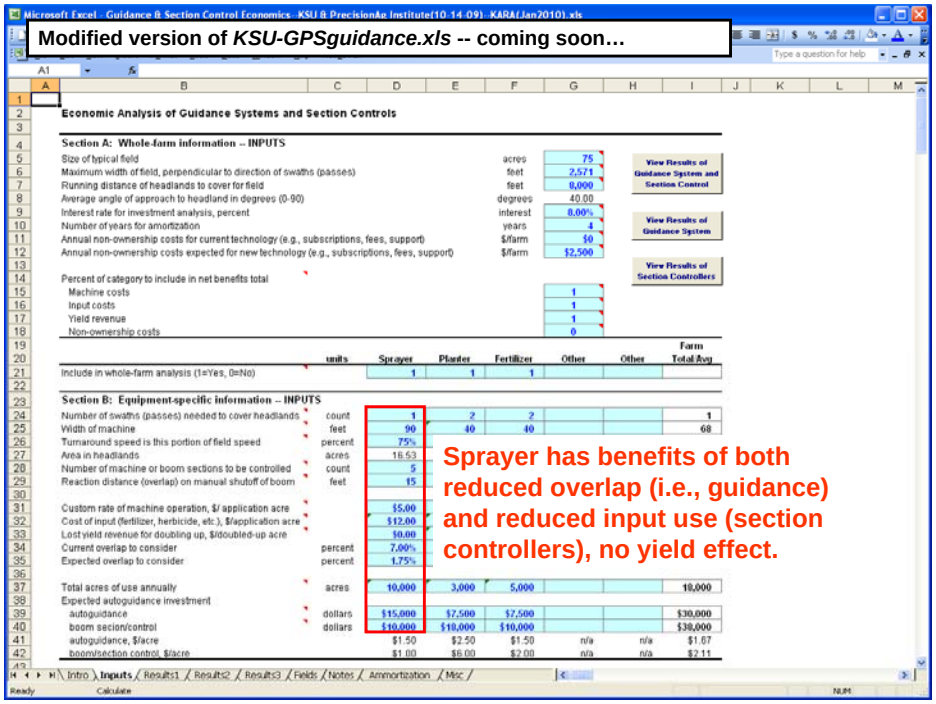
	units	Sprayer	Planter	Fertilizer	Other	Other	Farm Total/Avg
Include in whole-farm analysis (1=Yes, 0=No)		1	1	1			
Section B: Equipment-specific information -- INPUTS							
Number of swaths (passes) needed to cover headlands	count	1	2	2			1
Width of machine	feet	90	40	40			68
Turnaround speed is this portion of field speed	percent	75%	75%	75%			75%
Area in headlands	acres	16.53	14.55	14.55	0.00	0.00	15.65
Number of machine or boom sections to be controlled	count	5	16	4			6.6
Reaction distance (overlap) on manual shutoff of boom	feet	15	10	10			13
Custom rate of machine operation, $/ application acre		$5.00	$14.00	$0.00			$7.33
Cost of input (fertilizer, herbicide, etc.), $/application acre		$12.00	$60.00	$35.00			$26.39
Lost yield revenue for doubling up, $/doubled-up acre		$0.00	$35.00	$0.00			$5.83
Current overlap to consider	percent	7.00%	0.00%	7.00%			5.03%
Expected overlap to consider	percent	1.75%	0.00%	1.75%			1.46%
Total acres of use annually	acres	10,000	3,000	5,000			18,000
Expected autoguidance investment							
autoguidance	dollars	$15,000	$7,500	$7,500			$30,000
boom section/control	dollars	$10,000	$10,000	$10,000			$30,000
autoguidance, $/acre		$1.50	$2.50	$1.50	n/a	n/a	$1.67
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

Can include multiple machines to get results for whole farm.

Intro | Inputs | Results1 | Results2 | Results3 | Fields | Notes | Ammortization | Misc

Ready | Calculate | NUM

Modified version of *KSU-GPSguidance.xls* -- coming soon…



Economic Analysis of Guidance Systems and Section Controls

Section A: Whole-farm information -- INPUTS

Size of typical field	acres	75
Maximum width of field, perpendicular to direction of swaths (passes)	feet	2,571
Running distance of headlands to cover for field	feet	9,000
Average angle of approach to headland in degrees (0-90)	degrees	40.00
Interest rate for investment analysis, percent	interest	8.00%
Number of years for amortization	years	4
Annual non-ownership costs for current technology (e.g., subscriptions, fees, support)	$/farm	$0
Annual non-ownership costs expected for new technology (e.g., subscriptions, fees, support)	$/farm	$2,500

View Results of Guidance System and Section Control | View Results of Guidance System | View Results of Section Controllers

Percent of category to include in net benefits total

Machine costs	1
Input costs	1
Yield revenue	1
Non-ownership costs	0

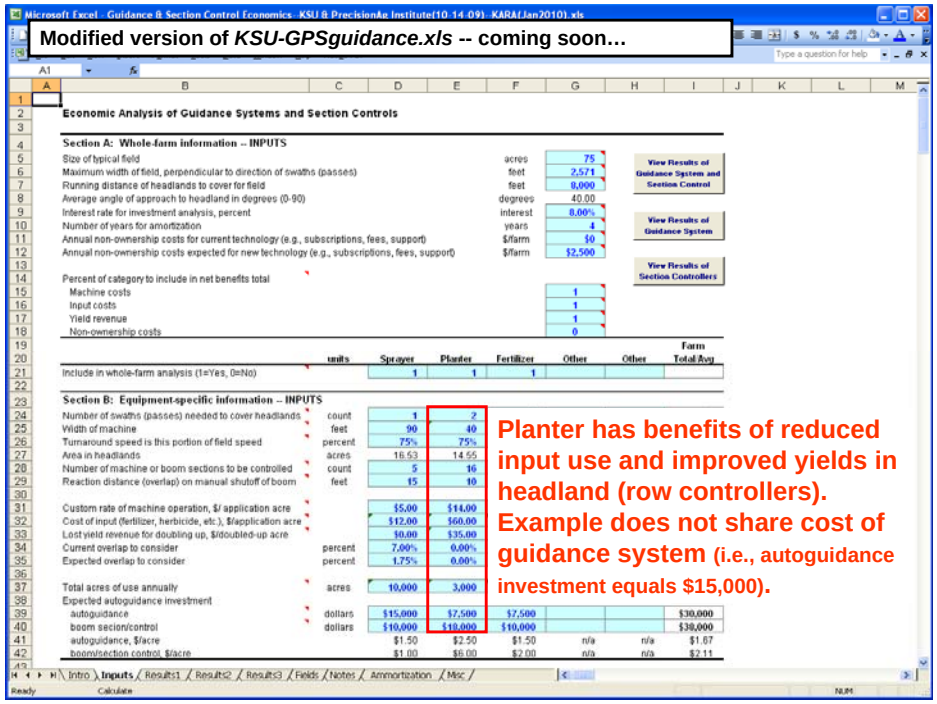
	units	Sprayer	Planter	Fertilizer	Other	Other	Farm Total/Avg
Include in whole-farm analysis (1=Yes, 0=No)		1	1	1			
Section B: Equipment-specific information -- INPUTS							
Number of swaths (passes) needed to cover headlands	count	1	2	2			1
Width of machine	feet	90	40	40			68
Turnaround speed is this portion of field speed	percent	75%					
Area in headlands	acres	16.53					
Number of machine or boom sections to be controlled	count	5					
Reaction distance (overlap) on manual shutoff of boom	feet	15					
Custom rate of machine operation, $/ application acre		$5.00					
Cost of input (fertilizer, herbicide, etc.), $/application acre		$12.00					
Lost yield revenue for doubling up, $/doubled-up acre		$0.00					
Current overlap to consider	percent	7.00%					
Expected overlap to consider	percent	1.75%					
Total acres of use annually	acres	10,000	3,000	5,000			18,000
Expected autoguidance investment							
autoguidance	dollars	$15,000	$7,500	$7,500			$30,000
boom section/control	dollars	$10,000	$10,000	$10,000			$30,000
autoguidance, $/acre		$1.50	$2.50	$1.50	n/a	n/a	$1.67
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

Sprayer has benefits of both reduced overlap (i.e., guidance) and reduced input use (section controllers), no yield effect.

Intro | Inputs | Results1 | Results2 | Results3 | Fields | Notes | Ammortization | Misc

Ready | Calculate | NUM

Modified version of *KSU-GPSguidance.xls* -- coming soon…



Economic Analysis of Guidance Systems and Section Controls

Section A: Whole-farm information -- INPUTS

Size of typical field	acres	75
Maximum width of field, perpendicular to direction of swaths (passes)	feet	2,571
Running distance of headlands to cover for field	feet	9,000
Average angle of approach to headland in degrees (0-90)	degrees	40.00
Interest rate for investment analysis, percent	interest	8.00%
Number of years for amortization	years	4
Annual non-ownership costs for current technology (e.g., subscriptions, fees, support)	$/farm	$0
Annual non-ownership costs expected for new technology (e.g., subscriptions, fees, support)	$/farm	$2,500

View Results of Guidance System and Section Control | View Results of Guidance System | View Results of Section Controllers

Percent of category to include in net benefits total

Machine costs	1
Input costs	1
Yield revenue	1
Non-ownership costs	0

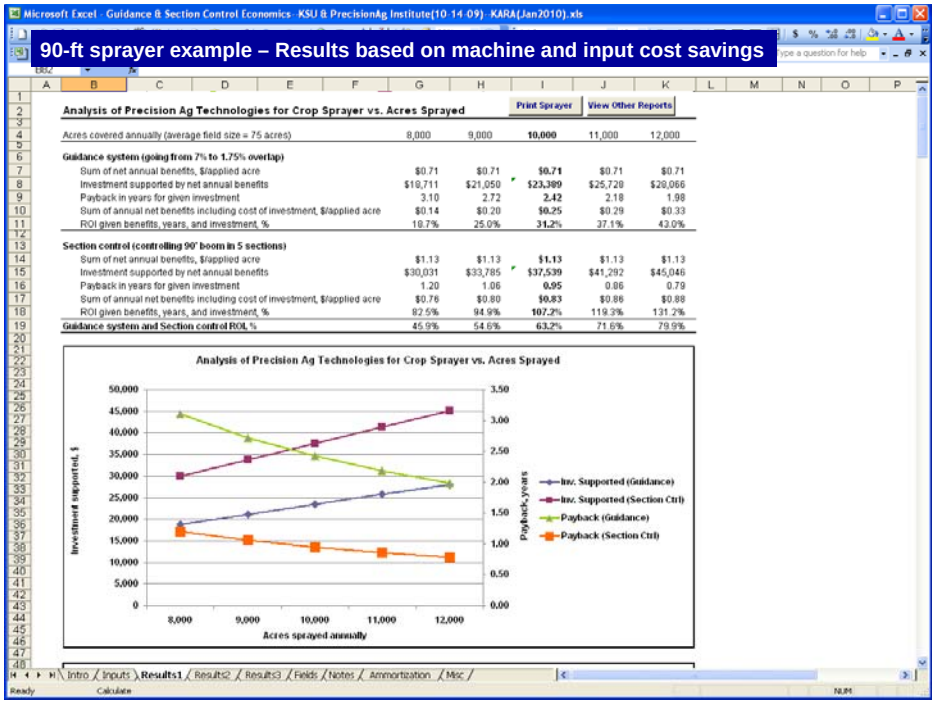
	units	Sprayer	Planter	Fertilizer	Other	Other	Farm Total/Avg
Include in whole-farm analysis (1=Yes, 0=No)		1	1	1			
Section B: Equipment-specific information -- INPUTS							
Number of swaths (passes) needed to cover headlands	count	1	2				
Width of machine	feet	90	40				
Turnaround speed is this portion of field speed	percent	75%	75%				
Area in headlands	acres	16.53	14.55				
Number of machine or boom sections to be controlled	count	5	16				
Reaction distance (overlap) on manual shutoff of boom	feet	15	10				
Custom rate of machine operation, $/ application acre		$5.00	$14.00				
Cost of input (fertilizer, herbicide, etc.), $/application acre		$12.00	$60.00				
Lost yield revenue for doubling up, $/doubled-up acre		$0.00	$35.00				
Current overlap to consider	percent	7.00%	0.00%				
Expected overlap to consider	percent	1.75%	0.00%				
Total acres of use annually	acres	10,000	3,000				
Expected autoguidance investment							
autoguidance	dollars	$15,000	$7,500	$7,500			$30,000
boom section/control	dollars	$10,000	$10,000	$10,000			$30,000
autoguidance, $/acre		$1.50	$2.50	$1.50	n/a	n/a	$1.67
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

Planter has benefits of reduced input use and improved yields in headland (row controllers). Example does not share cost of guidance system (i.e., autoguidance investment equals $15,000).

Intro | Inputs | Results1 | Results2 | Results3 | Fields | Notes | Ammortization | Misc

Ready | Calculate | NUM

90-ft sprayer example – Results based on machine and input cost savings



90-ft sprayer example –
results based on machine and input cost savings

Impact of Acres Covered on Economics of Guidance System[1]

Annual acres	Investment supported[2]	Return on investment[2,3]	Payback years[3]
14,000	$32,744	54.3%	1.7
12,000	$28,066	43.0%	2.0
10,000	$23,389	31.2%	2.4
8,000	$18,711	18.7%	3.1
6,000	$14,033	5.1%	4.3
4,000	$9,355	-10.4%	7.2
2,000	$4,678	-30.2%	24.6

[1] Machine and input cost savings reducing overlap from 7.0% to 1.75%
[2] Based on four-year ammortization
[3] Given $15,000 investment

Impact of Acres Covered on Economics of Section Control[1]

Annual acres	Investment supported[2]	Return on investment[2,3]	Payback years[3]
14,000	$52,554	154.9%	0.7
12,000	$45,046	131.2%	0.8
10,000	$37,539	107.2%	1.0
8,000	$30,031	82.5%	1.2
6,000	$22,523	56.7%	1.6
4,000	$15,015	28.9%	2.5
2,000	$7,508	-3.8%	5.7

[1] Automatic control of 5 boom sections, input cost savings (guidance exists)
[2] Based on four-year ammortization
[3] Given $10,000 investment

As with most all technologies, the returns to investing in guidance systems and section controls is not scale neutral…

Given the assumptions for this example, the returns to investing in section controls are much higher than guidance systems (but you need the guidance system to realize these benefits)

90-ft sprayer example –
results based on machine and input cost savings

Impact of Acres Covered and Input Cost on Guidance System ROI[1]

Annual	Average cost of input, $/application acre				
acres	$4.00	$8.00	$12.00	$16.00	$20.00
14,000	11.4%	33.9%	54.3%	73.5%	92.0%
12,000	4.5%	24.8%	43.0%	60.0%	76.3%
10,000	-2.9%	15.2%	31.2%	46.0%	60.1%
8,000	-10.9%	4.9%	18.7%	31.3%	43.3%
6,000	-19.9%	-6.5%	5.1%	15.5%	25.3%
4,000	-30.5%	-19.6%	-10.4%	-2.3%	5.3%
2,000	-44.6%	-36.7%	-30.2%	-24.5%	-19.4%

[1] Machine and input cost savings reducing overlap from 7.0% to 1.75%
Based on four-year ammortization
Given $15,000 investment

Impact of Acres Covered and Input Cost on Section Control ROI[1]

Annual	Average cost of input, $/application acre				
acres	$4.00	$8.00	$12.00	$16.00	$20.00
14,000	38.5%	99.0%	154.9%	209.2%	262.9%
12,000	28.9%	82.5%	131.2%	178.3%	224.6%
10,000	18.8%	65.5%	107.2%	147.1%	186.1%
8,000	8.0%	47.8%	82.5%	115.3%	147.1%
6,000	-3.8%	28.9%	56.7%	82.5%	107.2%
4,000	-17.5%	8.0%	28.9%	47.8%	65.5%
2,000	-35.1%	-17.5%	-3.8%	8.0%	18.8%

[1] Automatic control of 5 boom sections, input cost savings (guidance exists)
Based on four-year ammortization
Given $10,000 investment

… but, as input costs increase, these technologies will pay for smaller operations as well (additionally, investment required likely will fall over time).

As a reminder,
results for section control depend heavily on field shape…

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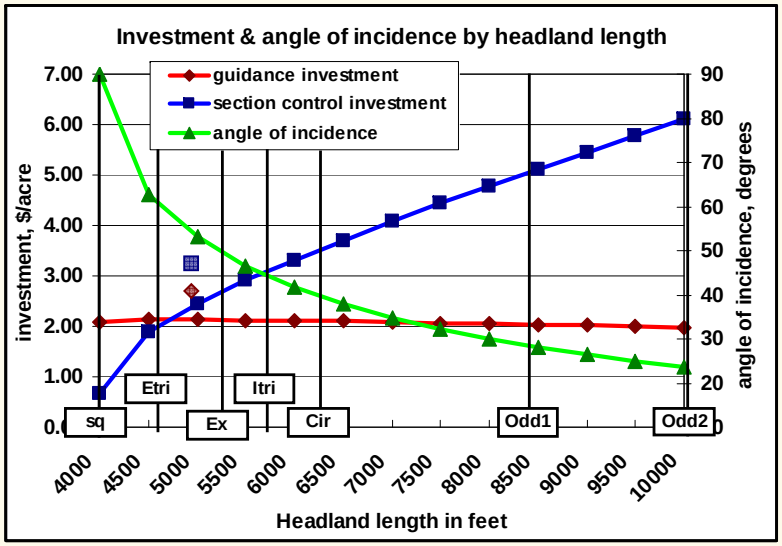
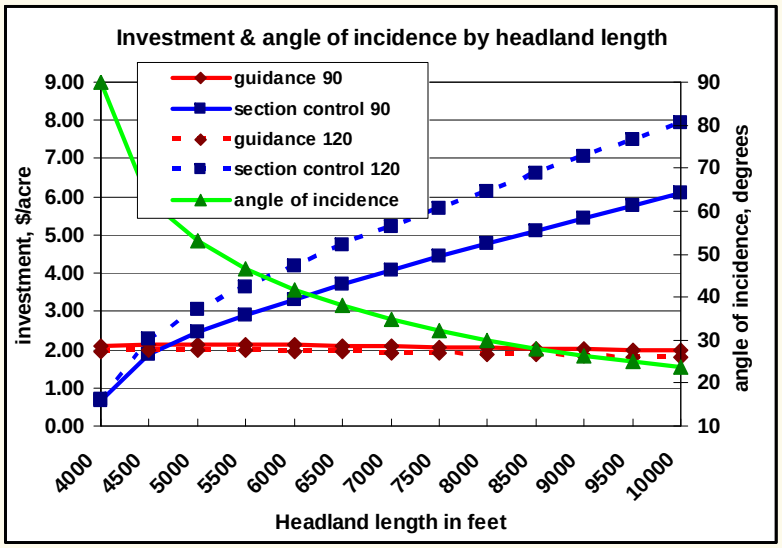


As a reminder,
results depend on field shape and equipment size…



Comparing a 120-foot sprayer with the 90-foot one

16-row planter example –
results based on input savings and yield improvement

Impact of Acres Covered on Economics of Section Control[1]

Annual acres	Investment supported[2]	Return on investment[2,3]	Payback years[3]
4,000	$65,387	103.2%	1.0
3,500	$57,213	88.3%	1.1
3,000	$49,040	73.1%	1.3
2,500	$40,867	57.4%	1.6
2,000	$32,693	40.9%	2.1
1,500	$24,520	23.4%	2.8
1,000	$16,347	3.8%	4.5

[1] Automatic control of individual rows, input cost savings and yield benefit
[2] Based on four-year ammortization
[3] Given $18,000 investment -- guidance already exists

Impact of Acres Covered on Economics of Section Control[1]

Annual acres	Investment supported[2]	Return on investment[2,3]	Payback years[3]
4,000	$65,387	47.0%	1.9
3,500	$57,213	37.8%	2.2
3,000	$49,040	28.3%	2.6
2,500	$40,867	18.3%	3.1
2,000	$32,693	7.6%	4.0
1,500	$24,520	-4.2%	5.7
1,000	$16,347	-17.8%	-17.8

[1] Automatic control of individual rows, input cost savings and yield benefit
[2] Based on four-year ammortization
[3] Given $33,000 investment -- guidance investment included

Investing in individual row controllers is pretty much a "no brainer" for operations with sufficient acres, especially if auto-guidance system already exists…

16-row planter example –
results based on input savings and yield improvement

Impact of Acres Covered and Input Cost on Section Control ROI[1]

Annual acres	Average cost of input, $/application acre				
	$30.00	$45.00	$60.00	$75.00	$90.00
4,000	64.9%	84.4%	103.2%	121.7%	140.0%
3,500	54.0%	71.5%	88.3%	104.8%	121.0%
3,000	42.7%	58.2%	73.1%	87.5%	101.7%
2,500	31.0%	44.5%	57.4%	69.8%	82.0%
2,000	18.5%	30.0%	40.9%	51.4%	61.6%
1,500	4.9%	14.4%	23.4%	31.9%	40.0%
1,000	-10.6%	-3.1%	3.8%	10.3%	16.5%

[1] No machine and input cost savings associated with overlap reduction
Automatic control of invidual rows, input cost savings and yield benefit
Based on four-year ammortization
Given $18,000 investment -- guidance already exists

Guidance System and Section Control ROI[1]

Annual acres	Average cost of input, $/application acre				
	$30.00	$45.00	$60.00	$75.00	$90.00
4,000	23.1%	35.4%	47.0%	58.2%	69.1%
3,500	16.1%	27.3%	37.8%	48.0%	57.8%
3,000	8.8%	18.8%	28.3%	37.4%	46.1%
2,500	0.0%	9.9%	18.3%	26.3%	33.9%
2,000	-7.6%	0.0%	7.6%	14.4%	21.0%
1,500	-17.0%	-10.3%	-4.2%	1.5%	7.0%
1,000	-28.1%	-22.7%	-17.8%	-13.2%	-8.9%

[1] No machine and input cost savings associated with overlap reduction
Automatic control of invidual rows, input cost savings and yield benefit
Based on four-year ammortization
Given $33,000 investment -- guidance investment included

… and as input costs increase, these technologies will pay for smaller operations as well (additionally, investment required likely will fall over time).

Many things to consider for an analysis…

- Base machine operation cost or custom rate
- Machine size
- Which machines, which operations?
- Machines share investment components?
- Accuracy of GPS wish to consider
- Crop input cost
- Field size
- Field shape
- Farm/operation size (mostly a fixed cost investment)
- How do you value personal comfort?

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Factors affecting technology adoption…

- Size of the expected profit
- Confidence in the outcome
- Investment amount required
- Keep in mind . . .
  - Late adopters adopt for survival
  - Early adopters adopt for profit
  - Speed of adoption is important only relative to your neighbors

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Questions ???

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