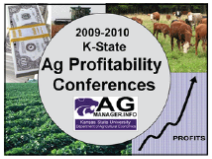
2010
Kansas State University

AG PROFITABILITY CONFERENCE

February 11, 2010

Fisher Community Center
201 E. Iowa Street
Hiawatha, Kansas



Kansas State University
Department of Agricultural Economics

Machinery Economics

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Machinery costs are important

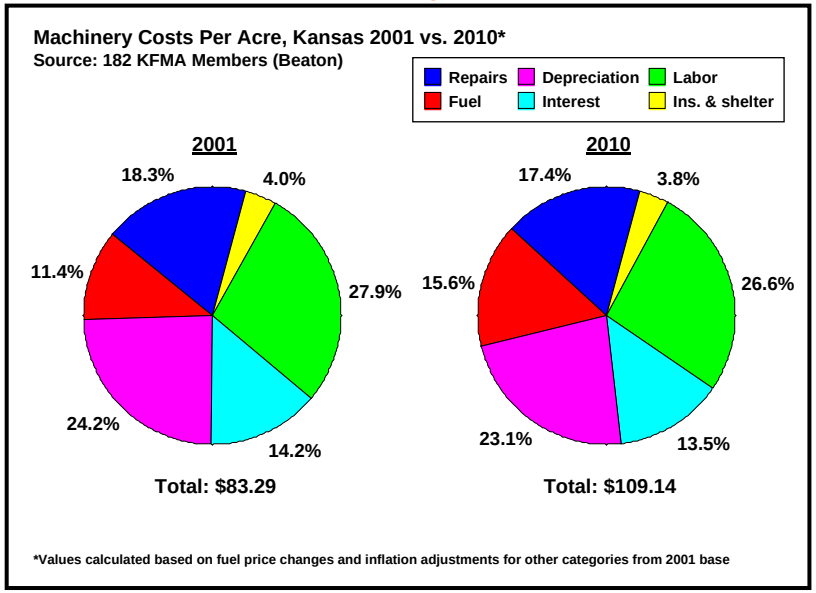
Why producers need to know

- Selecting Profit-maximizing Crop Mix
  - must prorate to crops
- Dealing with Technological Change (no-till)
  - alternative systems use machinery less intensively
- Benchmarking
- Banking (tracking market value & deprec.)
- Minimizing Costs of Production
  - owning vs. leasing vs. custom hire
  - optimal trade decisions

Machinery cost categories

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

Breakdown of total machinery costs…



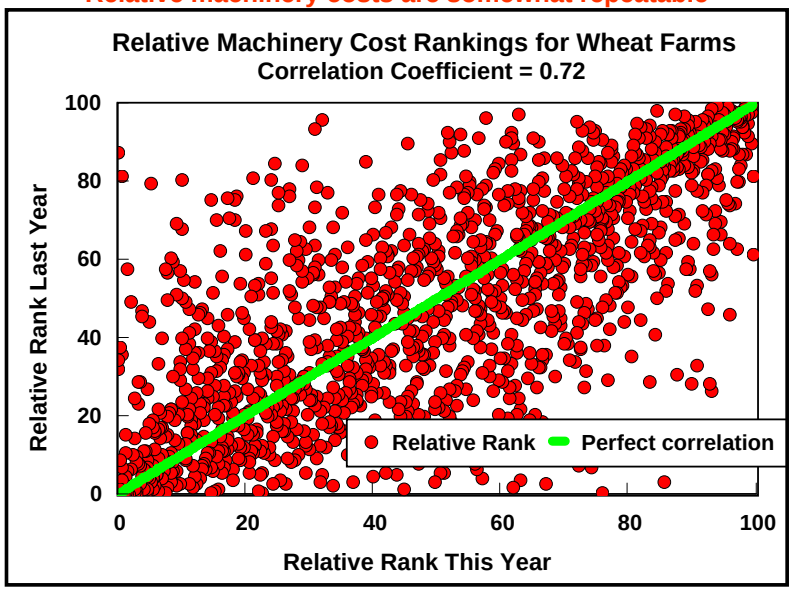
Custom hire cost has been allocated to individual categories

Machinery costs are especially important!

Kansas Farm Management Association Crop Enterprises Analysis State Averages, 2006-2008	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	98	45	132	225	120	49
Average Acres	436	547	340	668	308	71
Costs, $ per Acre						
Seed	$36.27	$54.16	$13.74	$10.55	$30.36	$9.00
Fertilizer	52.88	80.90	39.62	35.94	7.90	10.01
Herb-Ins	28.15	42.06	28.96	8.59	19.35	11.21
Crop Ins	14.08	20.00	9.07	7.34	10.91	0.50
Machinery	91.03	123.56	77.68	80.06	81.41	106.49
Other	22.99	109.29	20.29	21.34	21.91	24.95
Land	51.93	97.96	36.24	31.84	45.76	54.00
Interest	23.80	38.02	16.78	16.24	17.82	19.91
Total Cost	$321.12	$565.95	$242.39	$211.89	$235.41	$236.06
Machinery, %	28.3%	21.8%	32.0%	37.8%	34.6%	45.1%

Note: A portion of interest cost should also be allocated to machinery costs
Costs reflect operator's costs on owned and rented land

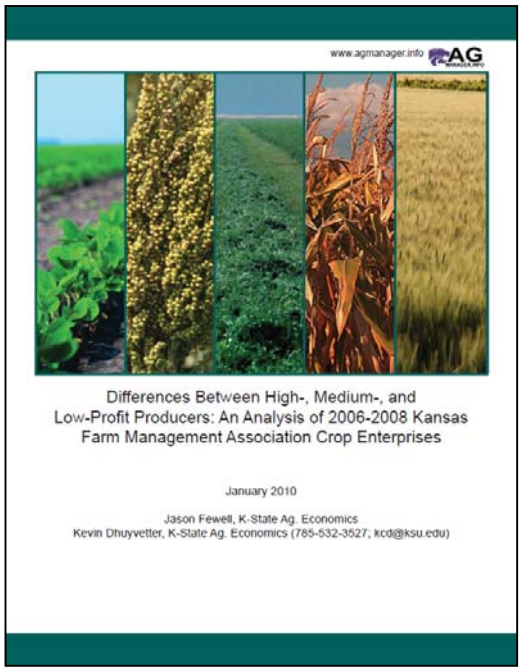
Relative machinery costs are somewhat repeatable



Machinery cost management is more important than traits like marketing

Machinery costs are important in explaining profitability differences across farms …

Kansas Farm Management Association Crop Enterprises Analysis State Averages, 2006-2008	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	98	45	132	225	120	49
Machinery Costs, $/acre						
High profit farms	$78.94	$115.99	$65.12	$68.02	$67.40	$94.62
Mid profit farms	$82.09	$116.33	$73.19	$71.32	$79.06	$96.01
Low profit farms	$111.78	$138.34	$94.73	$100.84	$97.76	$129.50
High less low, $	-$32.83	-$22.35	-$29.62	-$32.82	-$30.36	-$34.88
High less low, %	-29.4%	-16.2%	-31.3%	-32.5%	-31.1%	-26.9%
Differences between high profit farms and low profit farms in …						
Net returns	$149.77	$251.77	$125.44	$119.56	$129.62	$166.02
Total costs	-$88.75	-$231.10	-$48.01	-$79.72	-$57.41	-$82.24
Cost/net returns	59.3%	91.8%	38.3%	66.7%	44.3%	49.5%
Mach/total costs	37.0%	9.7%	61.7%	41.2%	52.9%	42.4%
Mach/net returns	21.9%	8.9%	23.6%	27.5%	23.4%	21.0%



Study examining profitability differences between crop producers for different enterprises. Costs are quite important in explaining differences and machinery costs represent a relatively large portion of costs.*

Paper is available on www.agmanager.info

*** In this study, income plays a larger part in explaining profit differences than earlier analyses have found, which is attributed to the years analyzed (i.e., 2006-08).**

Low- vs High-Profit Groups in Illinois

(Six-year ('95-'00) average return – Source: University of Illinois)

Trait/category	Low-profit group		High-profit group	
Total acres	672		1,007	
Owned	171	(25.4%)	74	(7.3%)
Share rent	311	(46.3%)	789	(78.4%)
Cash rent	190	(28.3%)	144	(14.3%)
Total costs ($/A)	$430		$340	
Land	133	(30.9%)	98	(28.8%)
Power	71	(16.5%)	55	(16.2%)
Buildings	23	(5.3%)	19	(5.6%)
Labor	50	(11.6%)	30	(8.8%)
Variable inputs	99	(23.0%)	92	(27.1%)
Other	54	(12.6%)	46	(13.5%)
Power, bldgs, & labor	144	(33.5%)	104	(30.6%)

$90/acre difference in costs, of which $40 is machinery (44.4% of total).

Are machinery costs a strength or weakness of your operation?

Expected costs …

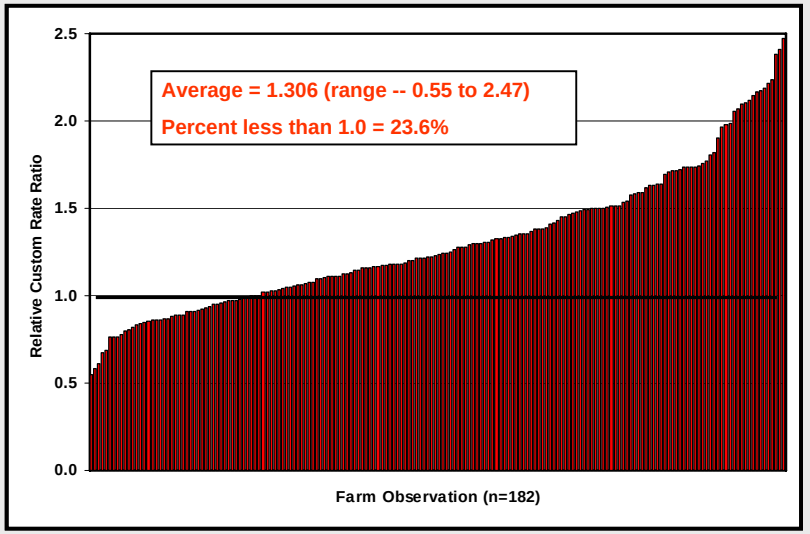
- **Benchmarking means to compare actual costs with what they are expected to be.**
- **Given that most producers' machinery cost data are whole-farm costs, across farm comparisons are not appropriate. Thus, what costs do we benchmark against?**
- **Where do "expectations" come from?**

Farm costs vs. custom rates

Expected crop machinery cost based on custom rates…

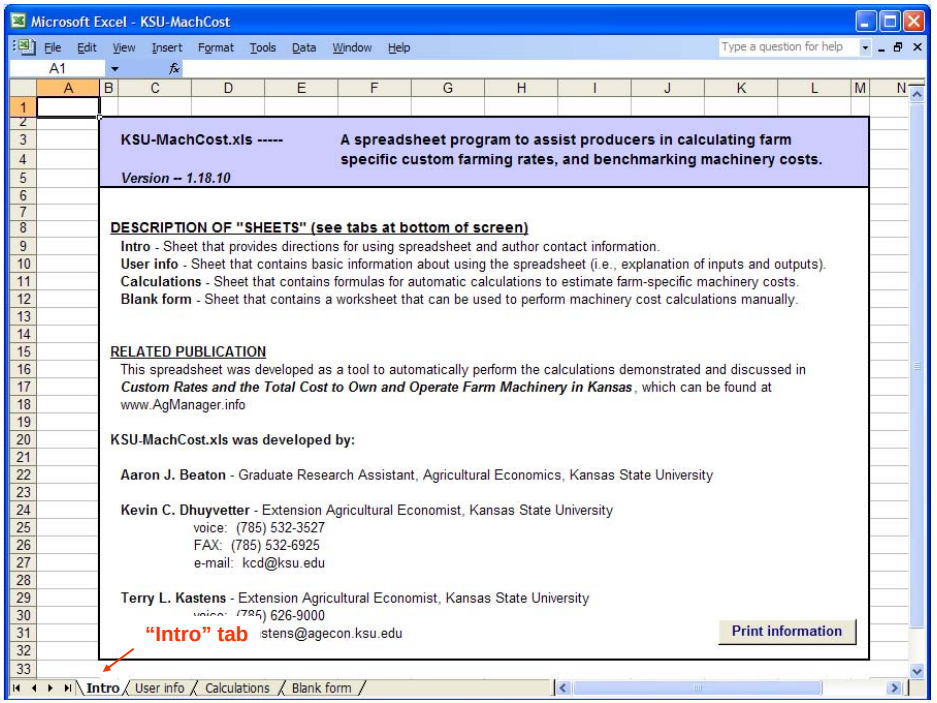
- Sum of all operations performed on the farm multiplied by their respective custom rates
- Relative custom rate ratio developed
  - If > 1, then per unit costs are greater than custom rates
  - If = 1, then per unit costs are equal to custom rates
  - If < 1, then per unit costs are less than custom rates

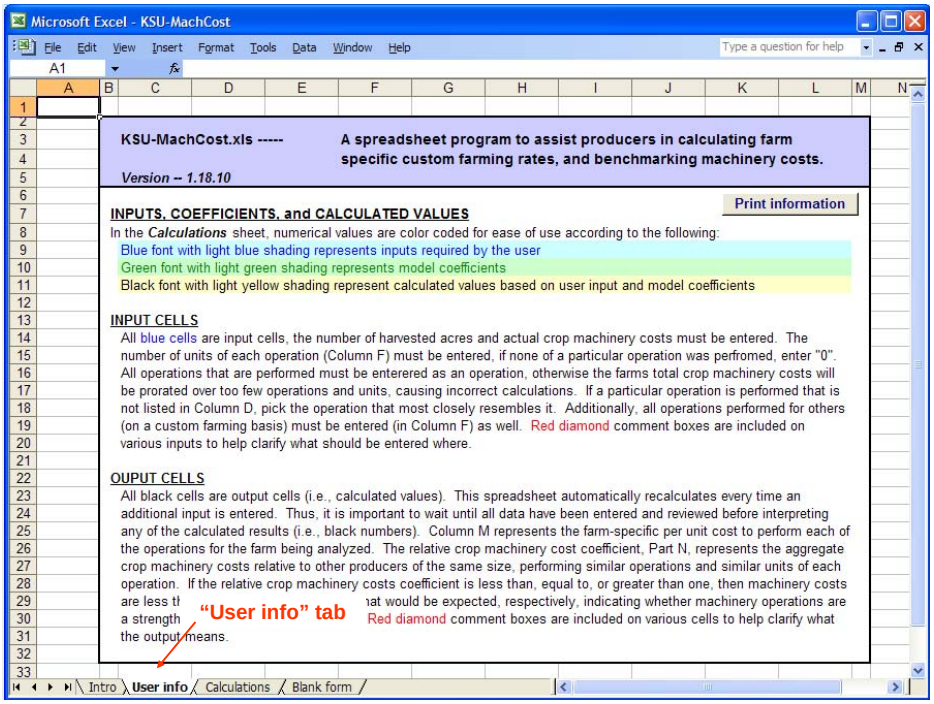
Relative custom rate ratio

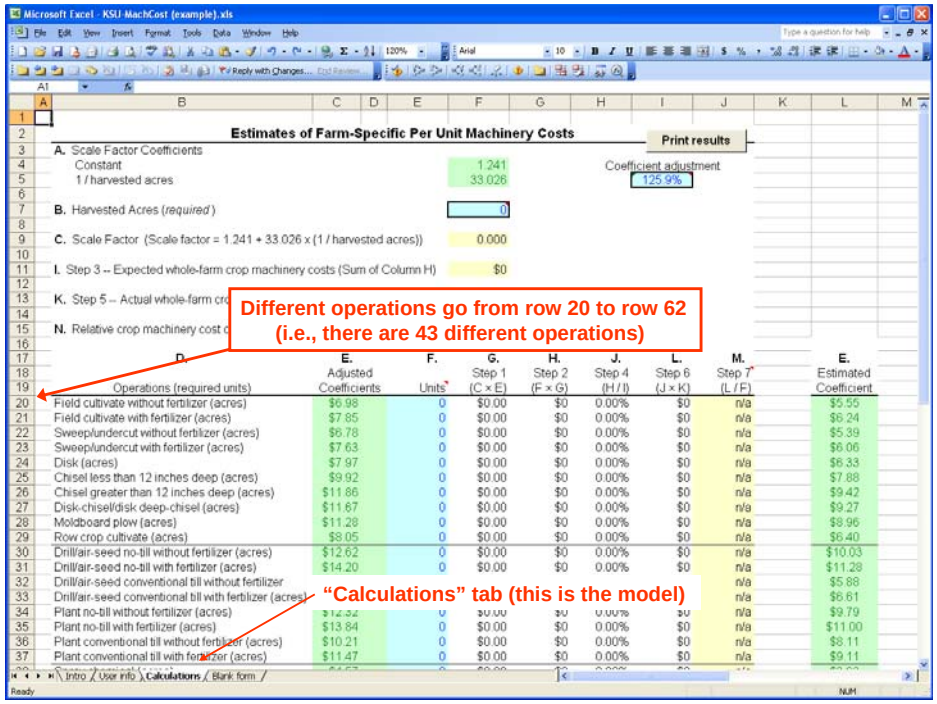


Conclusions

- Published custom rates need to be increased by approximately 25%, on average, but tremendous variability exists across producers
- Economies of size exist (i.e., scale factor adjustment decreases as farm size increases)
- Procedure developed to find farm-specific, per unit machinery costs
- Results are useful for benchmarking costs and have been incorporated into *KSU-MachCost.xls* (available on agmanager.info also see MF-2583 -- *Custom Rates and the Total Cost To Own and Operate Farm Machinery In Kansas*)




Microsoft Excel - KSU-MachCost
KSU-MachCost.xls -----
A spreadsheet program to assist producers in calculating farm specific custom farming rates, and benchmarking machinery costs.
Version -- 1.18.10
Print information
INPUTS, COEFFICIENTS, and CALCULATED VALUES
In the Calculations sheet, numerical values are color coded for ease of use according to the following:
Blue font with light blue shading represents inputs required by the user
Green font with light green shading represents model coefficients
Black font with light yellow shading represent calculated values based on user input and model coefficients
INPUT CELLS
All blue cells are input cells, the number of harvested acres and actual crop machinery costs must be entered. The number of units of each operation (Column F) must be entered, if none of a particular operation was perfromed, enter "0". All operations that are performed must be enterered as an operation, otherwise the farms total crop machinery costs will be prorated over too few operations and units, causing incorrect calculations. If a particular operation is performed that is not listed in Column D, pick the operation that most closely resembles it. Additionally, all operations performed for others (on a custom farming basis) must be entered (in Column F) as well. Red diamond comment boxes are included on various inputs to help clarify what should be entered where.
OUPUT CELLS
All black cells are output cells (i.e., calculated values). This 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). Column M represents the farm-specific per unit cost to perform each of the operations for the farm being analyzed. The relative crop machinery cost coefficient, Part N, represents the aggregate crop machinery costs relative to other producers of the same size, performing similar operations and similar units of each operation. If the relative crop machinery costs coefficient is less than, equal to, or greater than one, then machinery costs are less th
at would be expected, respectively, indicating whether machinery operations are a strength
Red diamond comment boxes are included on various cells to help clarify what the output means.
"User info" tab
Intro
User info
Calculations
Blank form


Estimates of Farm-Specific Per Unit Machinery Costs
Print results
A. Scale Factor Coefficients
Constant 1.241
1 / harvested acres 33.026
Coefficient adjustment 125.9%
B. Harvested Acres (required) 0
C. Scale Factor (Scale factor = 1.241 + 33.026 x (1 / harvested acres)) 0.000
I. Step 3 -- Expected whole-farm crop machinery costs (Sum of Column H) $0
Different operations go from row 20 to row 62
(i.e., there are 43 different operations)
"Calculations" tab (this is the model)
Operations (required units)
Adjusted Coefficients
Units
Step 1 (C x E)
Step 2 (F x G)
Step 4 (H / I)
Step 6 (J x K)
Step 7 (L / F)
Estimated Coefficient
Field cultivate without fertilizer (acres) $6.98 0 $0.00 $0 0.00% $0 n/a $5.55
Field cultivate with fertilizer (acres) $7.85 0 $0.00 $0 0.00% $0 n/a $6.24
Sweep/undercut without fertilizer (acres) $6.78 0 $0.00 $0 0.00% $0 n/a $5.39
Sweep/undercut with fertilizer (acres) $7.63 0 $0.00 $0 0.00% $0 n/a $6.06
Disk (acres) $7.97 0 $0.00 $0 0.00% $0 n/a $6.33
Chisel less than 12 inches deep (acres) $9.92 0 $0.00 $0 0.00% $0 n/a $7.88
Chisel greater than 12 inches deep (acres) $11.86 0 $0.00 $0 0.00% $0 n/a $9.42
Disk-chisel/disk deep-chisel (acres) $11.67 0 $0.00 $0 0.00% $0 n/a $9.27
Moldboard plow (acres) $11.28 0 $0.00 $0 0.00% $0 n/a $8.96
Row crop cultivate (acres) $8.05 0 $0.00 $0 0.00% $0 n/a $6.40
Drill/air-seed no-till without fertilizer (acres) $12.62 0 $0.00 $0 0.00% $0 n/a $10.03
Drill/air-seed no-till with fertilizer (acres) $14.20 0 $0.00 $0 0.00% $0 n/a $11.28
Drill/air-seed conventional till without fertilizer n/a $5.88
Drill/air-seed conventional till with fertilizer (acres) n/a $6.61
Plant no-till without fertilizer (acres) n/a $9.79
Plant no-till with fertilizer (acres) $13.84 0 $0.00 $0 0.00% $0 n/a $11.00
Plant conventional till without fertilizer (acres) $10.21 0 $0.00 $0 0.00% $0 n/a $8.11
Plant conventional till with fertilizer (acres) $11.47 0 $0.00 $0 0.00% $0 n/a $9.11
Intro
User info
Calculations
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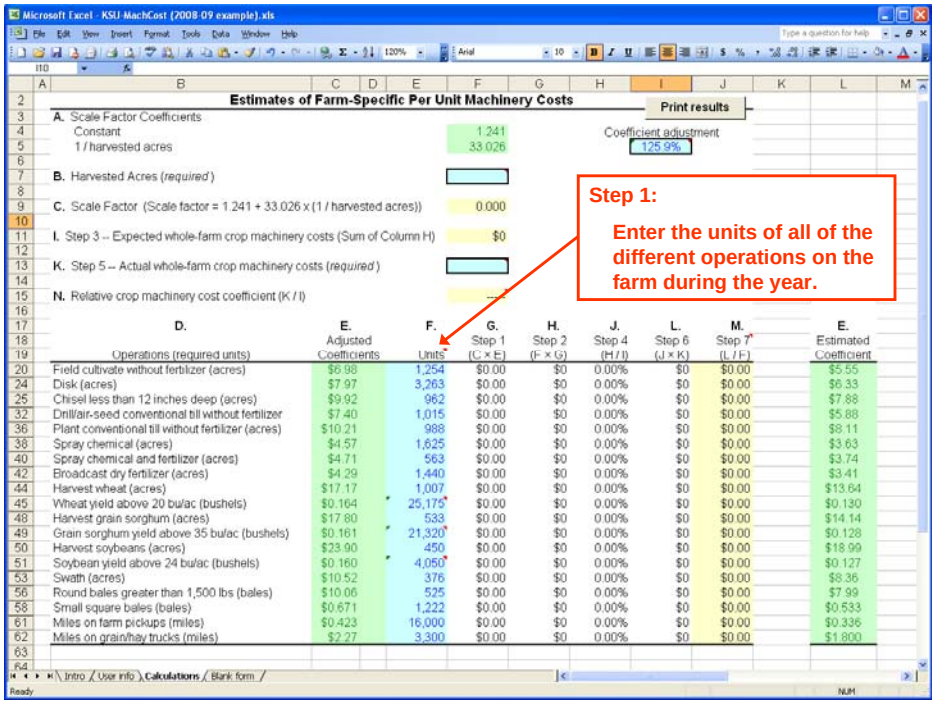
Estimates of Farm-Specific Per Unit Machinery Costs
Print results
A. Scale Factor Coefficients
Constant 1.241
1 / harvested acres 33.026
Coefficient adjustment 125.9%
B. Harvested Acres (required)
C. Scale Factor (Scale factor = 1.241 + 33.026 x (1 / harvested acres)) 0.000
I. Step 3 -- Expected whole-farm crop machinery costs (Sum of Column H) $0
K. Step 5 -- Actual whole-farm crop machinery costs (required)
N. Relative crop machinery cost coefficient (K / I)
Step 1:
Enter the units of all of the different operations on the farm during the year.
Operations (required units)
Adjusted Coefficients
Units
Step 1 (C x E)
Step 2 (F x G)
Step 4 (H / I)
Step 6 (J x K)
Step 7 (L / F)
Estimated Coefficient
Field cultivate without fertilizer (acres) $6.98 1,254 $0.00 $0 0.00% $0 $0.00 $5.55
Disk (acres) $7.97 3,263 $0.00 $0 0.00% $0 $0.00 $6.33
Chisel less than 12 inches deep (acres) $9.92 962 $0.00 $0 0.00% $0 $0.00 $7.88
Drill/air-seed conventional till without fertilizer $7.40 1,015 $0.00 $0 0.00% $0 $0.00 $5.88
Plant conventional till without fertilizer (acres) $10.21 988 $0.00 $0 0.00% $0 $0.00 $8.11
Spray chemical (acres) $4.57 1,625 $0.00 $0 0.00% $0 $0.00 $3.63
Spray chemical and fertilizer (acres) $4.71 563 $0.00 $0 0.00% $0 $0.00 $3.74
Broadcast dry fertilizer (acres) $4.29 1,440 $0.00 $0 0.00% $0 $0.00 $3.41
Harvest wheat (acres) $17.17 1,007 $0.00 $0 0.00% $0 $0.00 $13.64
Wheat yield above 20 bu/ac (bushels) $0.164 25,175 $0.00 $0 0.00% $0 $0.00 $0.130
Harvest grain sorghum (acres) $17.80 533 $0.00 $0 0.00% $0 $0.00 $14.14
Grain sorghum yield above 35 bu/ac (bushels) $0.161 21,320 $0.00 $0 0.00% $0 $0.00 $0.128
Harvest soybeans (acres) $23.90 450 $0.00 $0 0.00% $0 $0.00 $18.99
Soybean yield above 24 bu/ac (bushels) $0.160 4,050 $0.00 $0 0.00% $0 $0.00 $0.127
Swath (acres) $10.52 376 $0.00 $0 0.00% $0 $0.00 $8.36
Round bales greater than 1,500 lbs (bales) $10.06 525 $0.00 $0 0.00% $0 $0.00 $7.99
Small square bales (bales) $0.671 1,222 $0.00 $0 0.00% $0 $0.00 $0.533
Miles on farm pickups (miles) $0.423 16,000 $0.00 $0 0.00% $0 $0.00 $0.336
Miles on grain/hay trucks (miles) $2.27 3,300 $0.00 $0 0.00% $0 $0.00 $1.800
Intro
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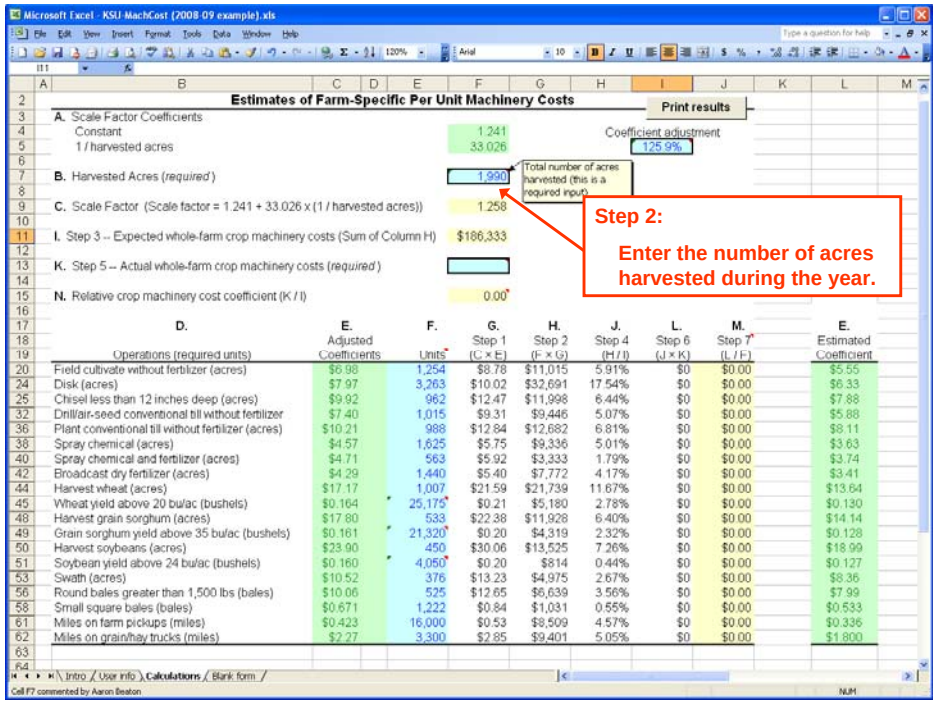
Estimates of Farm-Specific Per Unit Machinery Costs
Print results
A. Scale Factor Coefficients
Constant 1.241
1 / harvested acres 33.026
Coefficient adjustment 125.9%
B. Harvested Acres (required) 1,990
Total number of acres harvested (this is a required input)
C. Scale Factor (Scale factor = 1.241 + 33.026 x (1 / harvested acres)) 1.258
I. Step 3 -- Expected whole-farm crop machinery costs (Sum of Column H) $186,333
K. Step 5 -- Actual whole-farm crop machinery costs (required)
N. Relative crop machinery cost coefficient (K / I) 0.00
Step 2:
Enter the number of acres harvested during the year.
Operations (required units)
Adjusted Coefficients
Units
Step 1 (C x E)
Step 2 (F x G)
Step 4 (H / I)
Step 6 (J x K)
Step 7 (L / F)
Estimated Coefficient
Field cultivate without fertilizer (acres) $6.98 1,254 $8.78 $11,015 5.91% $0 $0.00 $5.55
Disk (acres) $7.97 3,263 $10.02 $32,691 17.54% $0 $0.00 $6.33
Chisel less than 12 inches deep (acres) $9.92 962 $12.47 $11,998 6.44% $0 $0.00 $7.88
Drill/air-seed conventional till without fertilizer $7.40 1,015 $9.31 $9,446 5.07% $0 $0.00 $5.88
Plant conventional till without fertilizer (acres) $10.21 988 $12.84 $12,682 6.81% $0 $0.00 $8.11
Spray chemical (acres) $4.57 1,625 $5.75 $9,336 5.01% $0 $0.00 $3.63
Spray chemical and fertilizer (acres) $4.71 563 $5.92 $3,333 1.79% $0 $0.00 $3.74
Broadcast dry fertilizer (acres) $4.29 1,440 $5.40 $7,772 4.17% $0 $0.00 $3.41
Harvest wheat (acres) $17.17 1,007 $21.59 $21,739 11.67% $0 $0.00 $13.64
Wheat yield above 20 bu/ac (bushels) $0.164 25,175 $0.21 $5,180 2.78% $0 $0.00 $0.130
Harvest grain sorghum (acres) $17.80 533 $22.38 $11,928 6.40% $0 $0.00 $14.14
Grain sorghum yield above 35 bu/ac (bushels) $0.161 21,320 $0.20 $4,319 2.32% $0 $0.00 $0.128
Harvest soybeans (acres) $23.90 450 $30.06 $13,525 7.26% $0 $0.00 $18.99
Soybean yield above 24 bu/ac (bushels) $0.160 4,050 $0.20 $814 0.44% $0 $0.00 $0.127
Swath (acres) $10.52 376 $13.23 $4,975 2.67% $0 $0.00 $8.36
Round bales greater than 1,500 lbs (bales) $10.06 525 $12.65 $6,639 3.56% $0 $0.00 $7.99
Small square bales (bales) $0.671 1,222 $0.84 $1,031 0.55% $0 $0.00 $0.533
Miles on farm pickups (miles) $0.423 16,000 $0.53 $9,509 4.57% $0 $0.00 $0.336
Miles on grain/hay trucks (miles) $2.27 3,300 $2.85 $9,401 5.05% $0 $0.00 $1.800
Intro
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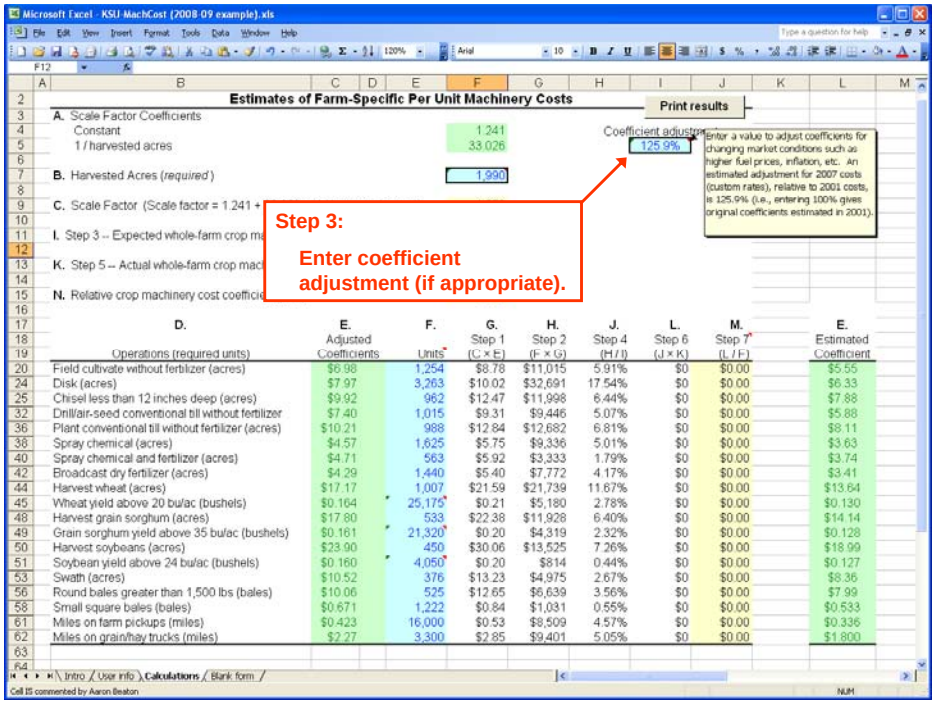
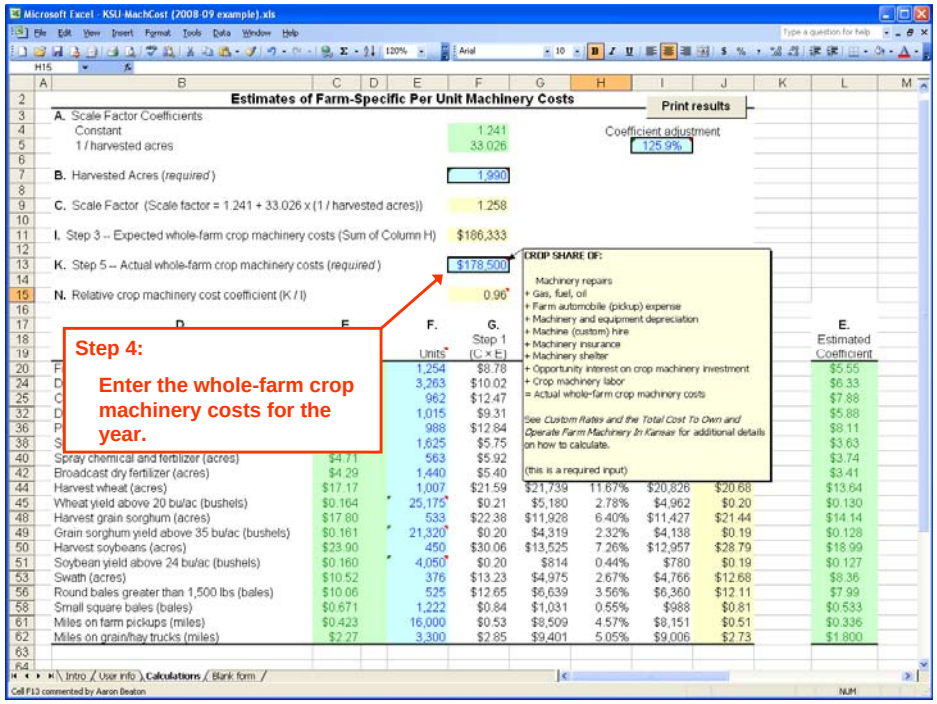
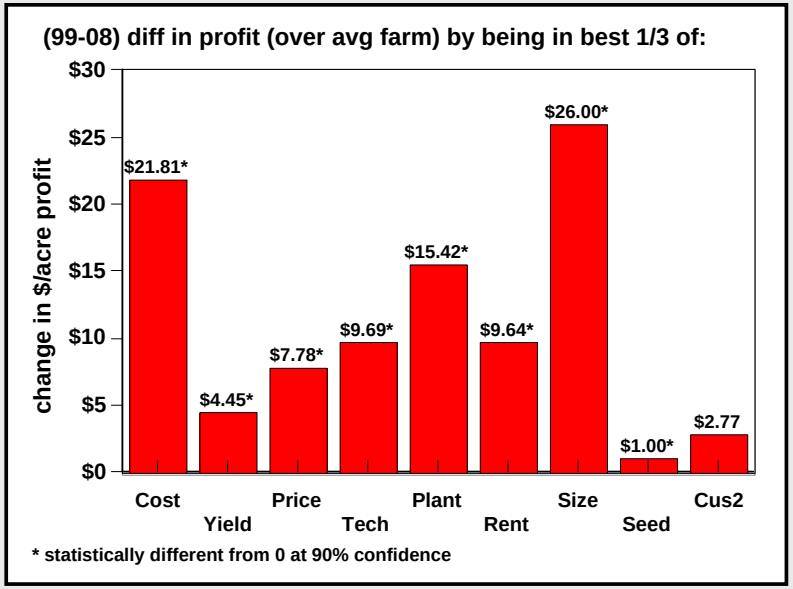


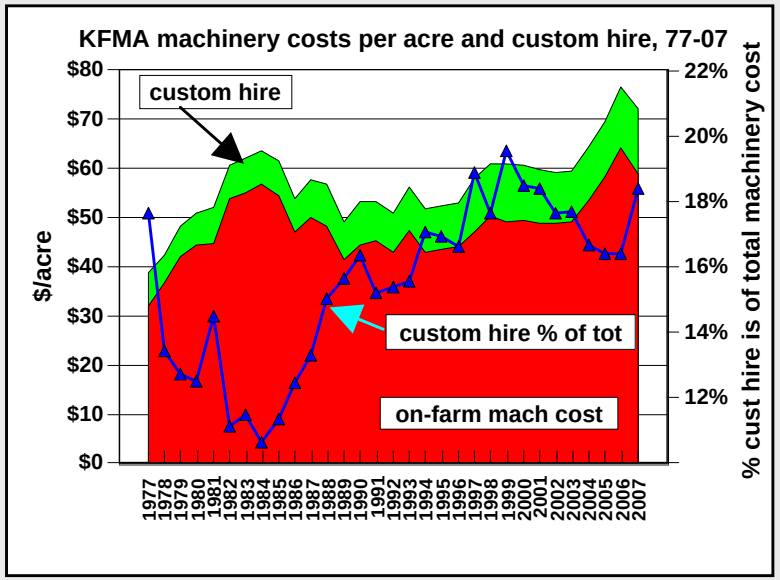


Implications of this research?

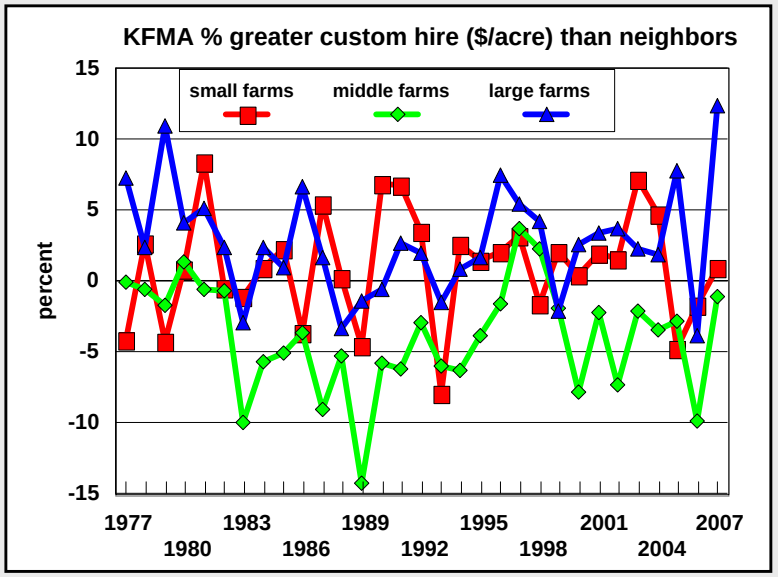
- It appears many farms would be better off hiring farming operations rather than doing them in house
  - Is that really true?
- Are farms using more custom work today?
  - i.e., is the overall demand increasing?
- Are bigger or smaller farms hiring custom work?
  - Where is the best market segment?



Cus2 is relative custom hire intensity (custom hire / total crop expense).
Custom hire tends to make one more profitable, but not stat significant.



Maybe a slight temporal increase in demand for custom hire . . .



Small and large farms tend to spend more $/acre in custom hire than avg size.

What about benchmarking machinery investment?

Crop Machinery Investment, Kansas, 2007, $/a

2007	as is /cropland	as is /crop	"if don't hire custom work" /cropland	/crop	$custom-to-mkt investment factor
NW	$124	$137	$154	$171	2.1
SW	$96	$149	$127	$198	2.1
NC	$129	$124	$145	$139	2.0
SC	$145	$144	$170	$169	2.8
NE	$177	$176	$205	$204	2.6
SE	$176	$157	$194	$173	2.3
KS	$146	$147	$169	$171	2.2

For benchmarking, multiply the factor times the $/year of custom machine work you hire (NET of what you do for others) to estimate the additional machinery investment you might have if you did the work in house. Don't forget machine hire embedded in bundled charges (e.g., herbicide application).

External benchmarking will become harder over time …

- Some farms do more custom hire
- Some farms rent machines
- Some farms do less tillage
- Some farms raise specialty crops

… external benchmarking may need to be done on broader categories (internal benchmarking will still be important but it is also affected by these factors)

Economies of size

An important driving force in agriculture: Economies of size

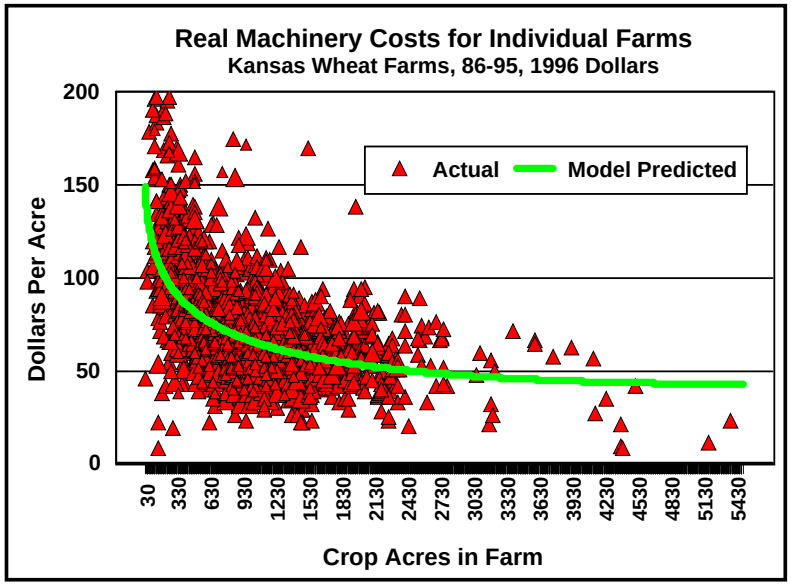
- Per-unit costs fall as a firm gets bigger
  - Essentially about spreading fixed costs
  - Sometimes means higher prices as well

Why are large farms more profitable?

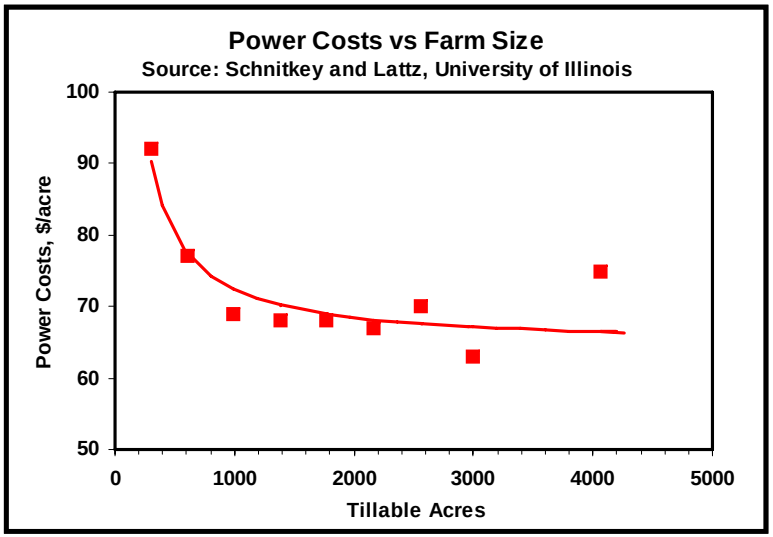
- Lower cost is the obvious benefit, but other benefits arise from the research
- Larger farms:
  - Have much lower costs
  - Get somewhat higher yields
  - Get slightly higher prices
  - Farm more intensively
  - Are much faster adopters of technology, for example, less-tillage

Changing EOS features across farm size

- Labor first
  - Labor is fixed and it pays to be fully employed
- Machinery second
  - Bigger machines are less expensive per unit of capacity



Machinery cost economies of size …

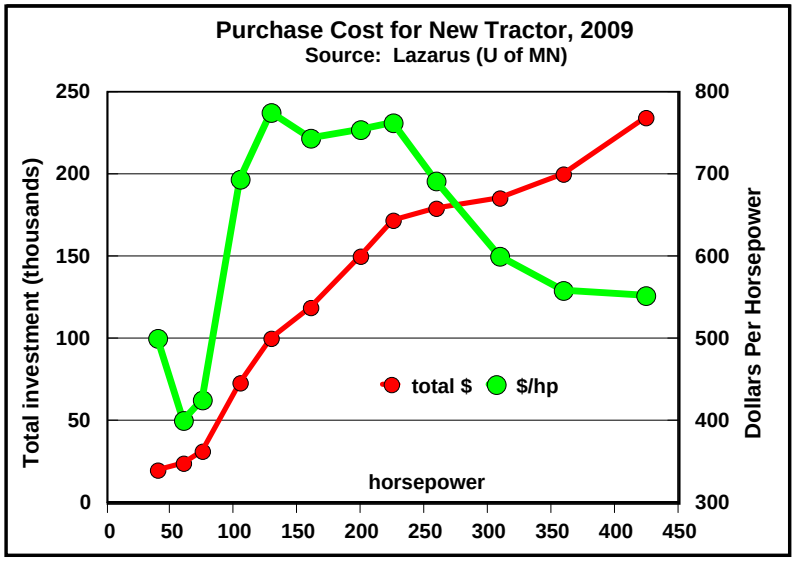


Hard to beat machinery size as a cost reducer… at least historically

Machinery size issues

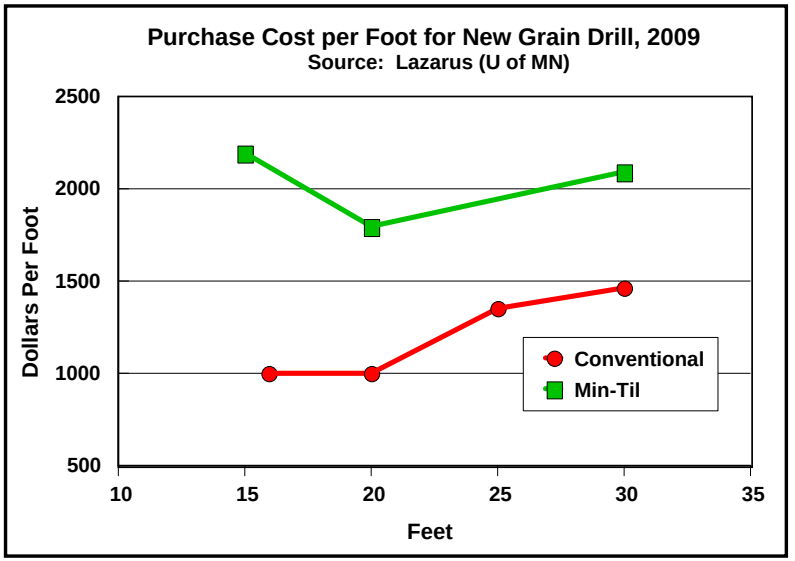
- Large equipment requires major investment
  - investment is not the same as cost
  - ability to use capacity is critical
- *Per acre*, larger machines require
  - similar or a bit lower investment
  - much lower labor costs (the big driver)

Big equipment requires larger investment …

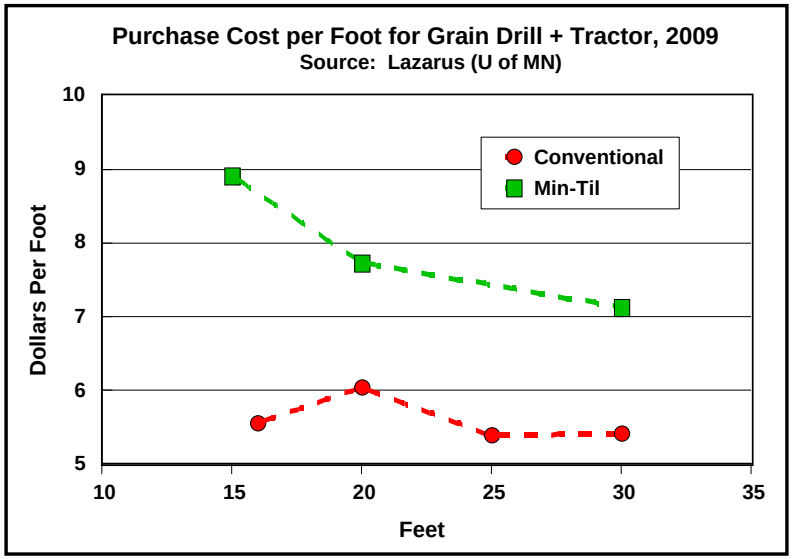


… but investment per hp falls with larger equipment.

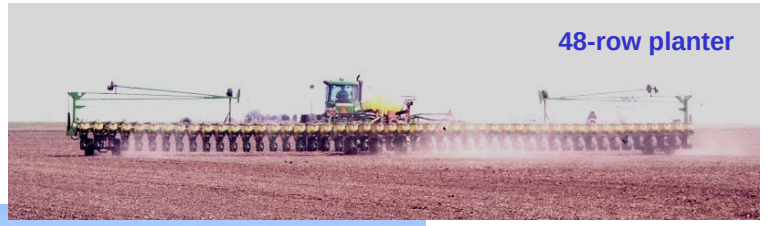
Investment for implements does not necessarily fall with size …



But, when including tractor cost it still might …



Purchase cost per unit of machinery does not always fall with larger equipment, but other factors also come into play in the machinery size decision…

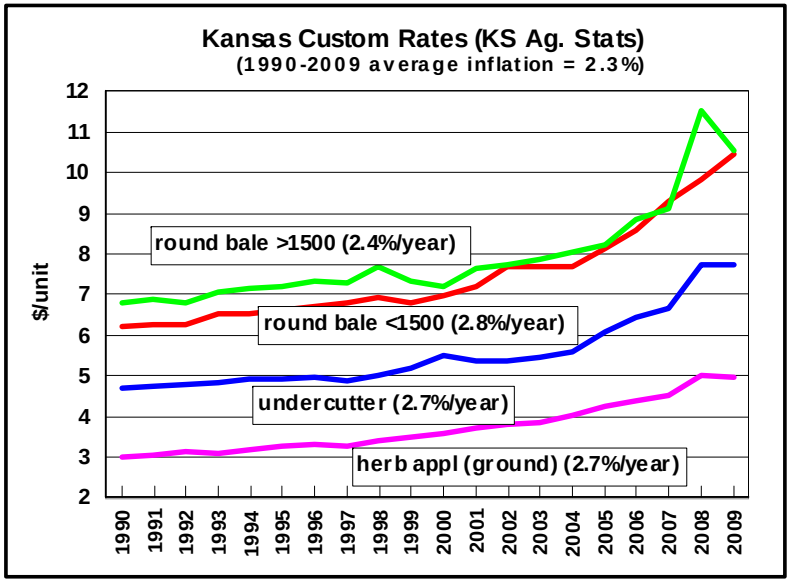


… timeliness needs to be factored in to the decision.

Machinery cost categories

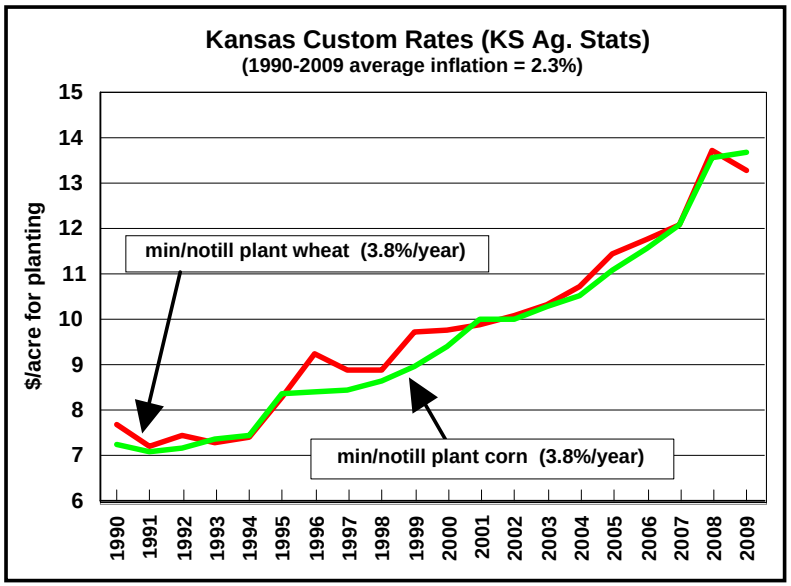
- Repair and maintenance
- Labor
- Depreciation (market, not tax depreciation)
- Interest (opportunity interest)
- Fuel and lubrication
- Taxes insurance and shelter
- **Custom hire**
  - Leads to published and "accepted" custom rates
  - Proxy for how costs are changing over time?

Growth rates in custom rates similar to inflation…



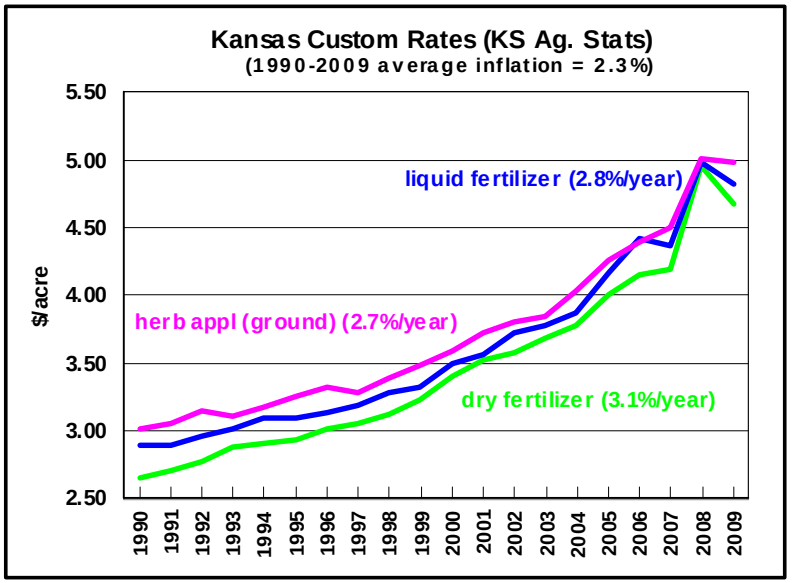
Source: Kansas Agricultural Statistics, Custom Rates

Growth rates in custom rates have outpaced inflation…



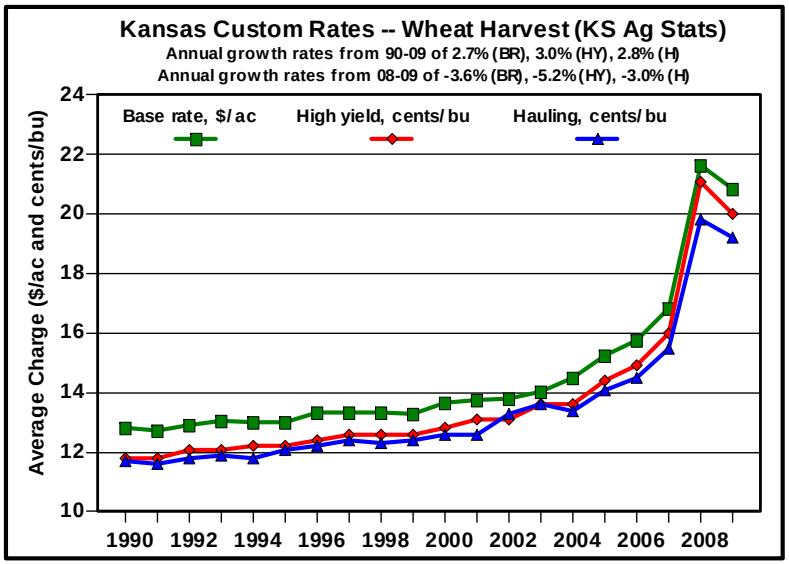
Source: Kansas Agricultural Statistics, Custom Rates

Growth rates in custom rates similar to inflation…



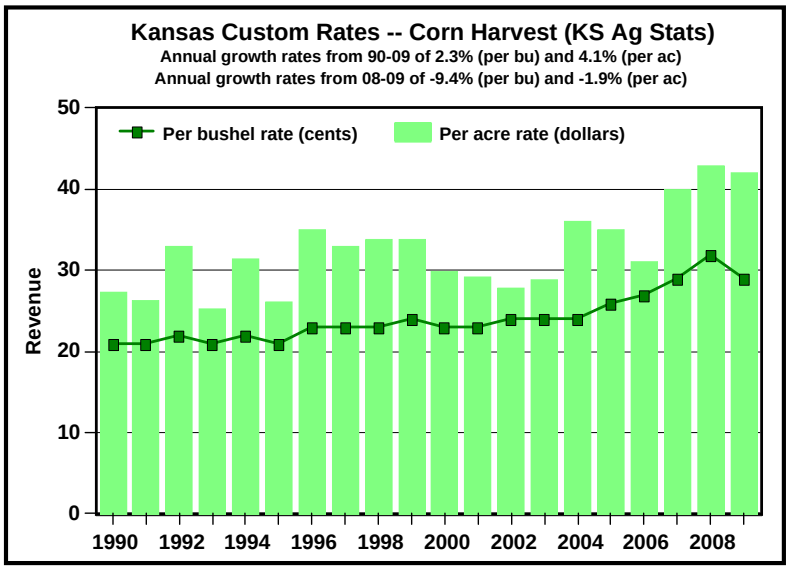
Source: Kansas Agricultural Statistics, Custom Rates

Growth rates in custom rates similar to inflation (2.3%)…



Harvest rates some of the best reported custom rates in Kansas

Growth rates in custom rates similar to inflation (2.3%)…



Harvest rates some of the best reported custom rates in Kansas

Bottom line –

Big equipment requires a large investment, and as machines keep getting bigger and more technologically advanced, the investment required will continue increasing…

But, this does not necessarily equate to higher costs if machines are used efficiently…

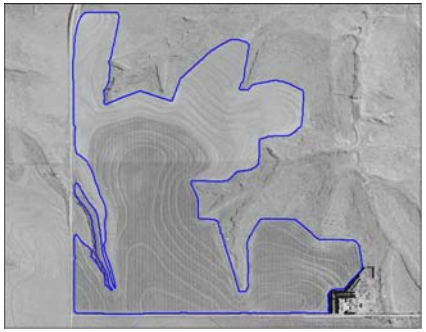
Machinery size issues

- ***Per acre*, larger machines require**
  - **similar or a bit lower investment**
  - **much lower labor costs (the big driver)**
- **But, since field size has not kept up with machine size, per acre, larger machines:**
  - **require more road time (reduces efficiency)**
  - **have more headland overlap (reduces efficiency)**

Typical Kastens fields –

Big-machine input inefficiency can negate labor savings in fields shaped like these…

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

Some machinery technologies can be especially good investments (use *KSU-GPSguidance.xls*)

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**

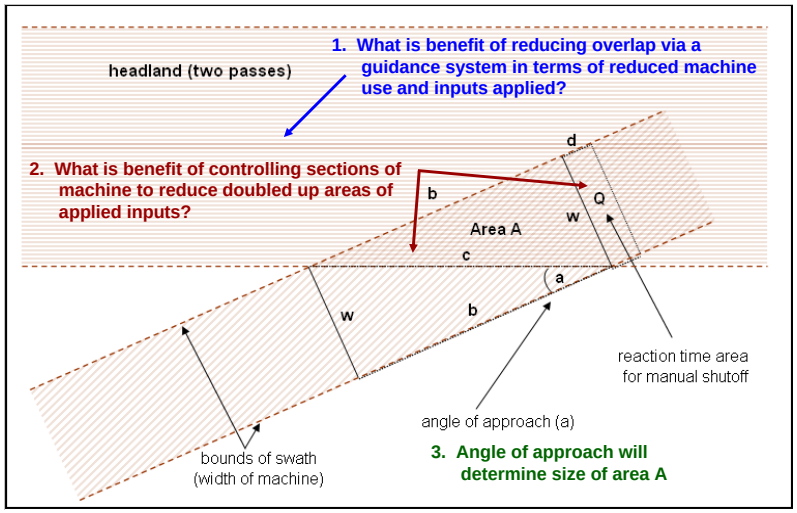
Field headland issues (where the action is)

- 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

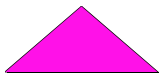
Field headland



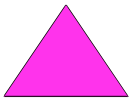
Areas A and Q and turnaround counterparts will have a) doubling-up of inputs and b) possible yield losses due to this doubling-up. After the turnaround there will be overlap along b, also accounted for.

Stylized field shapes (farm left to right)

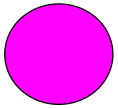
Square; hit ends at 90 degree angles
5,280 feet of headlands in 160 acre field



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



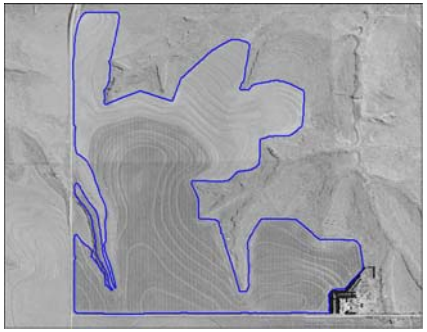
Equilateral triangle; hit ends at 45 degree angles
8,024 feet of headlands in 160 acre field



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

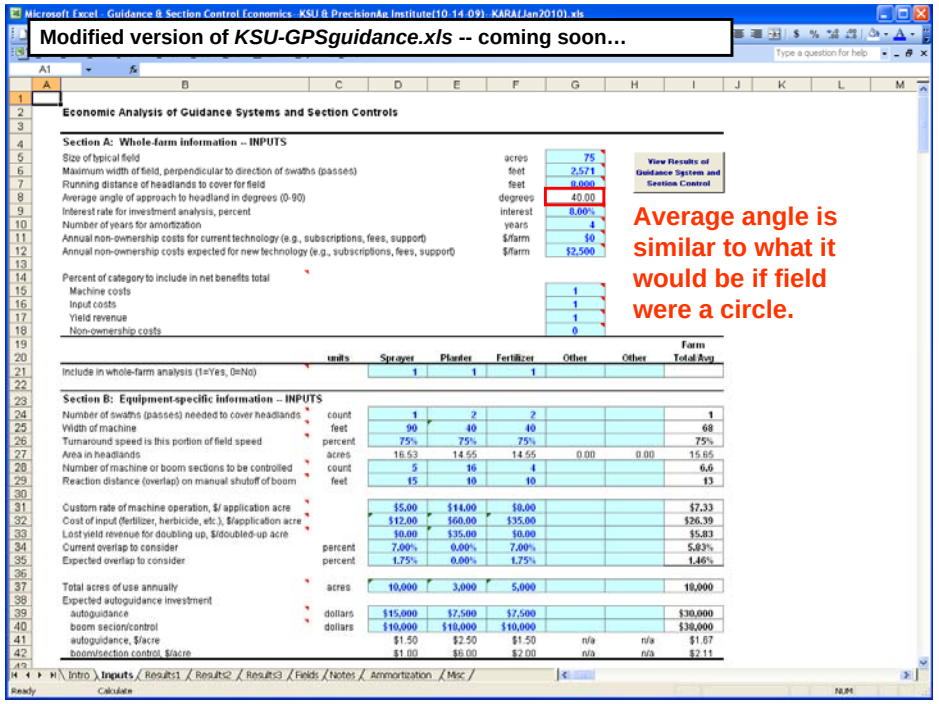
Kastens fields –
less efficient than squares, triangles, or circles…

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

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			

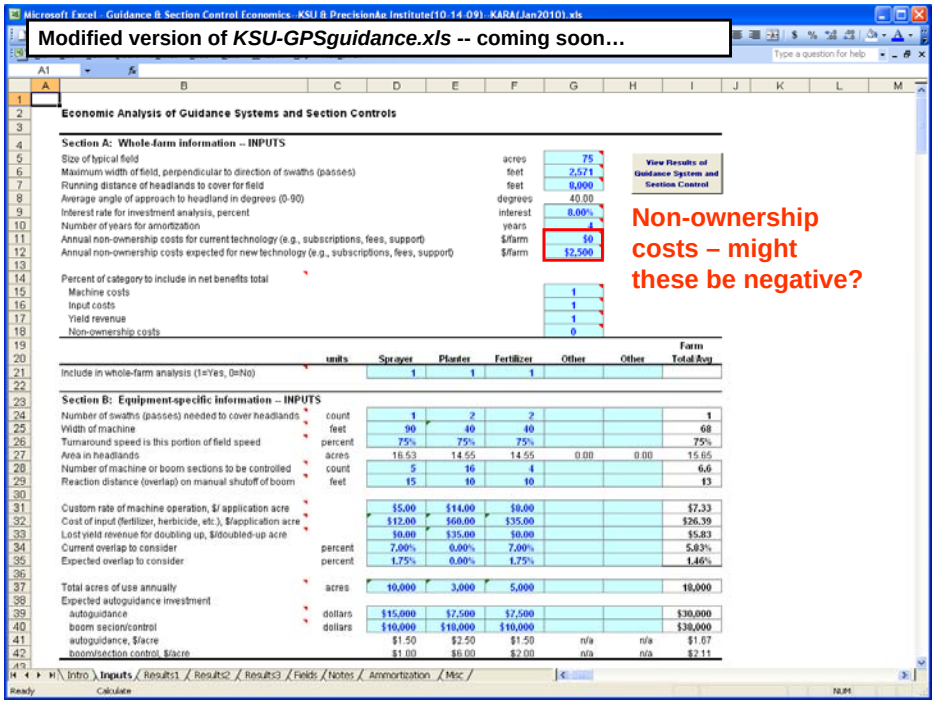
Section B: Equipment-specific information -- INPUTS

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%			5.03%
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

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

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



Economic Analysis of Guidance Systems and Section Controls

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View Results of Guidance System and Section Control

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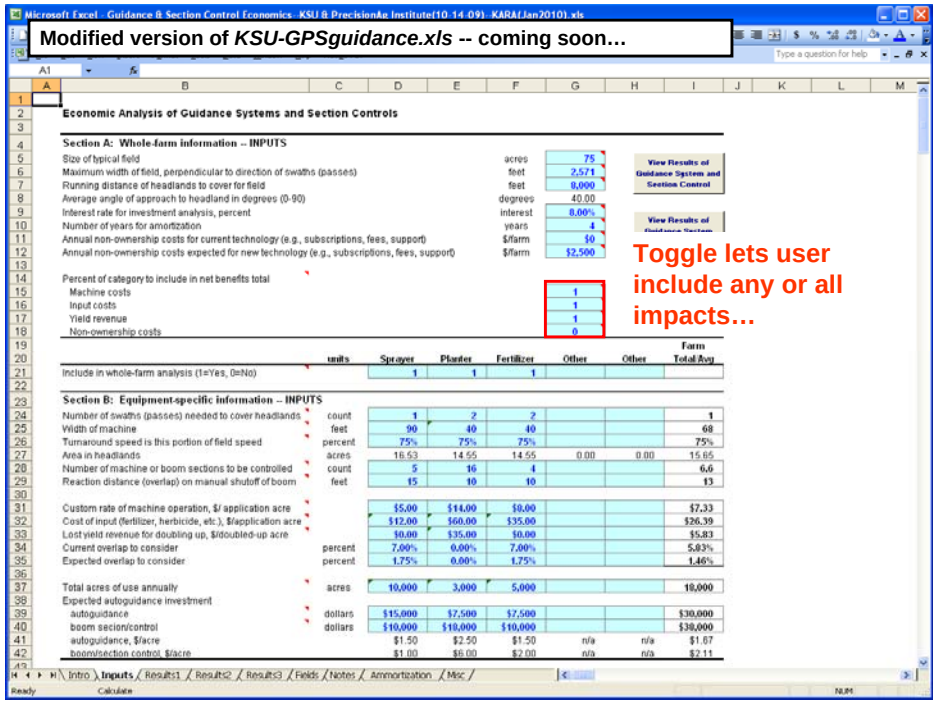
Intro / Inputs / Results1 / Results2 / Results3 / Fields / Notes / Ammortization / Misc

Non-ownership costs – might these be negative?

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



Economic Analysis of Guidance Systems and Section Controls

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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

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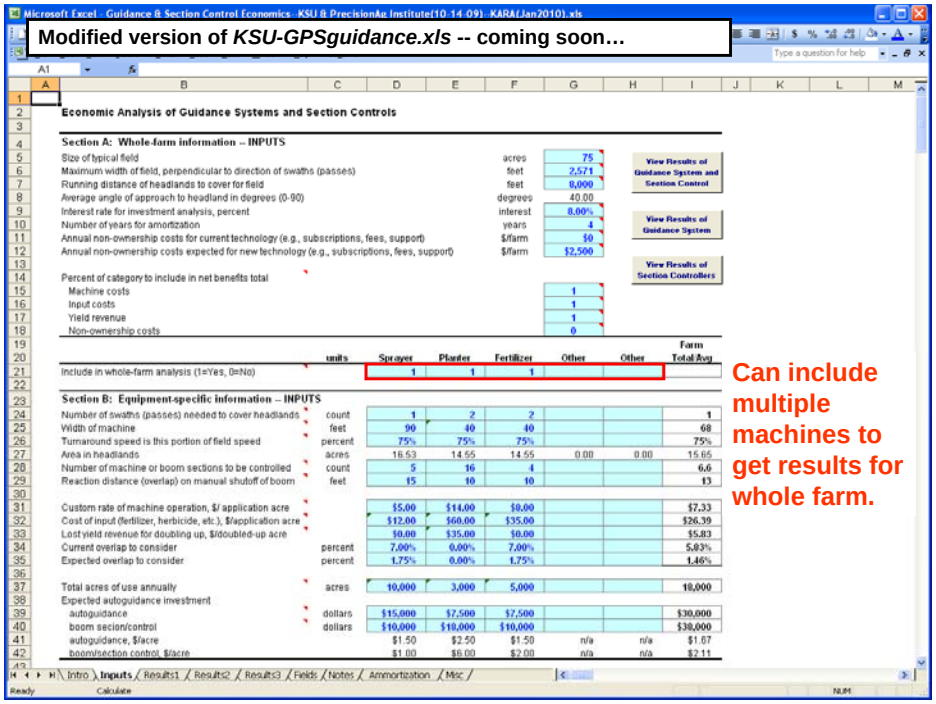
Intro / Inputs / Results1 / Results2 / Results3 / Fields / Notes / Ammortization / Misc

Toggle lets user include any or all impacts…

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 | View Results of Section Controllers

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	units	Sprayer	Planter	Fertilizer	Other	Other	Farm Total Avg
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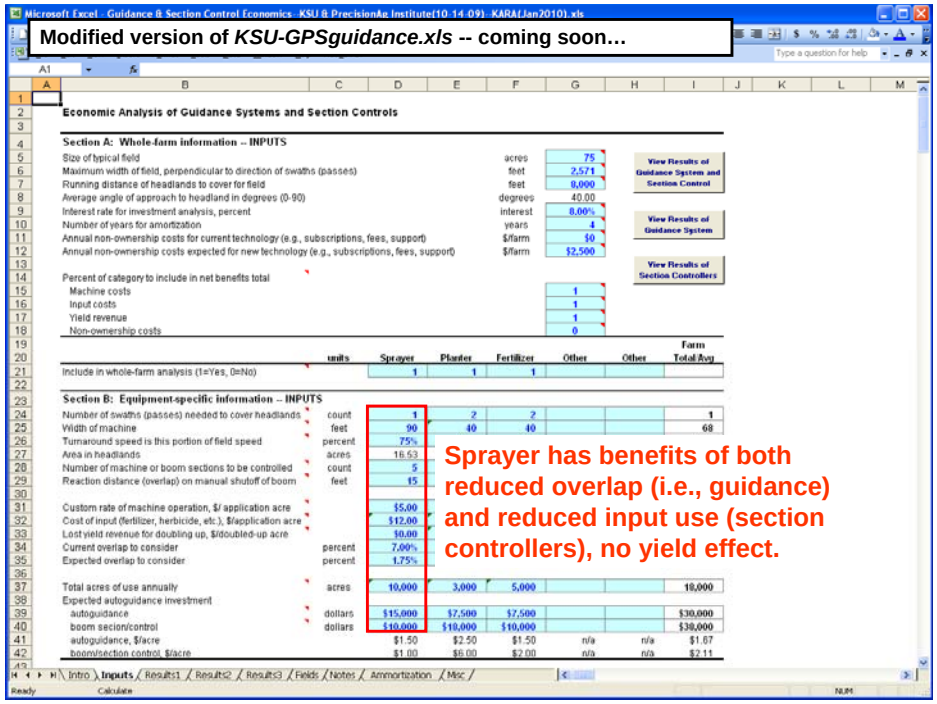
Intro | Inputs | Results1 | Results2 | Results3 | Fields | Notes | Ammortization | Misc

Can include multiple machines to get results for whole farm.

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



Economic Analysis of Guidance Systems and Section Controls

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

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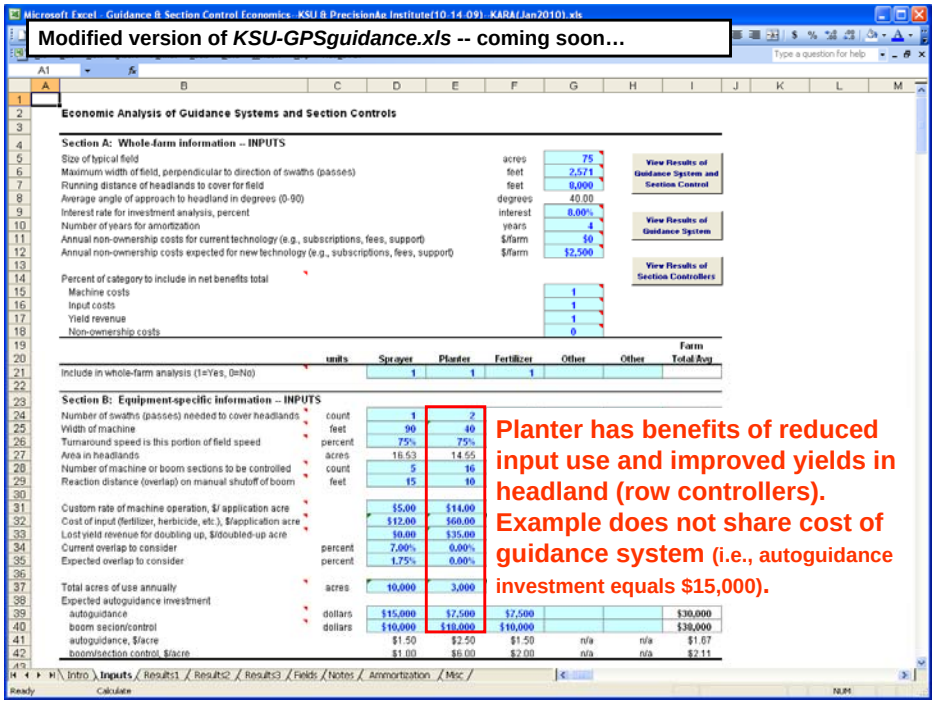
boom section/control	dollars	$10,000	$10,000	$10,000			$30,000
autoguidance, $/acre		$1.50	$2.50	$1.50	n/a	n/a	$1.67
boom/section control, $/acre		$1.00	$6.00	$2.00	n/a	n/a	$2.11

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

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

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

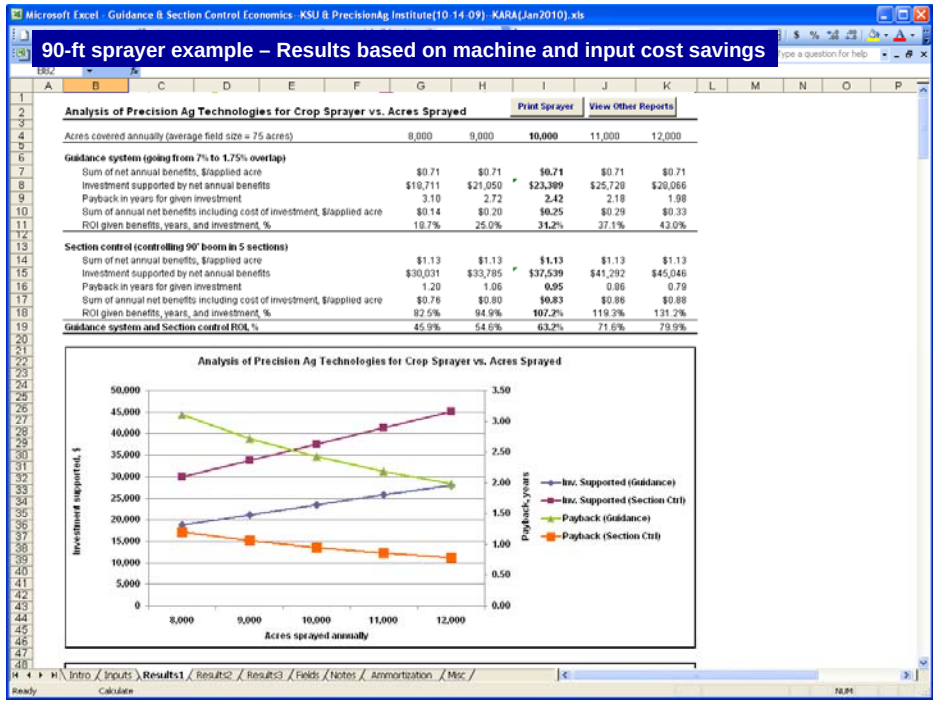
Machine costs	1
Input costs	1
Yield revenue	1
Non-ownership costs	0

	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

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

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).

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



Analysis of Precision Ag Technologies for Crop Sprayer vs. Acres Sprayed

Print Sprayer | View Other Reports

Acres covered annually (average field size = 75 acres)	8,000	9,000	10,000	11,000	12,000
Guidance system (going from 7% to 1.75% overlap)					
Sum of net annual benefits, $/applied acre	$0.71	$0.71	$0.71	$0.71	$0.71
Investment supported by net annual benefits	$19,711	$21,050	$23,389	$25,728	$28,066
Payback in years for given investment	3.10	2.72	2.42	2.18	1.98
Sum of annual net benefits including cost of investment, $/applied acre	$0.14	$0.20	$0.25	$0.29	$0.33
ROI given benefits, years, and investment, %	19.7%	25.0%	31.2%	37.1%	43.0%
Section control (controlling 90' boom in 5 sections)					
Sum of net annual benefits, $/applied acre	$1.13	$1.13	$1.13	$1.13	$1.13
Investment supported by net annual benefits	$30,031	$33,785	$37,539	$41,292	$45,046
Payback in years for given investment	1.20	1.06	0.95	0.86	0.79
Sum of annual net benefits including cost of investment, $/applied acre	$0.76	$0.80	$0.83	$0.86	$0.88
ROI given benefits, years, and investment, %	82.5%	94.9%	107.2%	119.3%	131.2%
Guidance system and Section control ROI, %	45.9%	54.6%	63.2%	71.6%	79.9%

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

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

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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

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Impact of Acres Covered and Input Cost on Guidance System ROI[1]					
Annual acres	Average cost of input, $/application acre				
	$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 acres	Average cost of input, $/application acre				
	$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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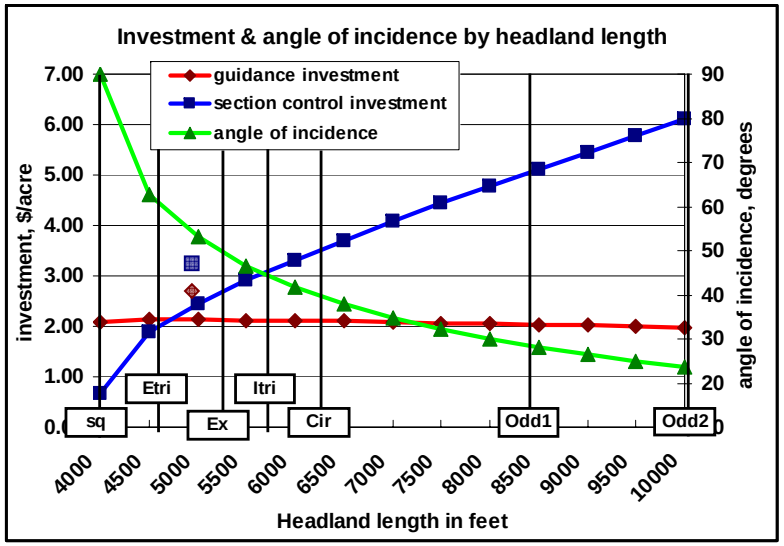

As a reminder, results depend on field shape and equipment size…

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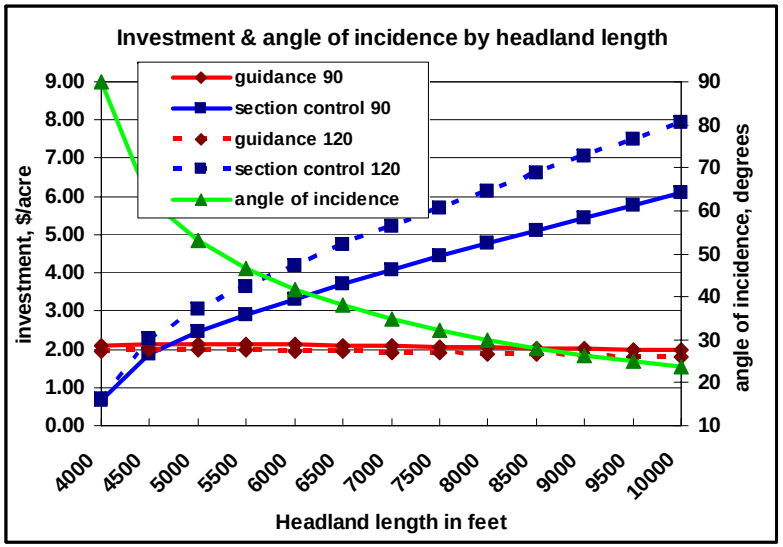

Comparing a 120-foot sprayer with the 90-foot one

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

www.agmanager.info

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
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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

www.agmanager.info

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?

Some nuts and bolts (computational) tools . . .

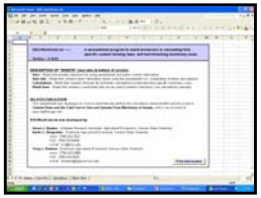
Machinery Decision Tools at www.agmanager.info

OwnCombine.xls

KSU-GPSguidance.xls

OwnBaler.xls

OwnSprayer.xls

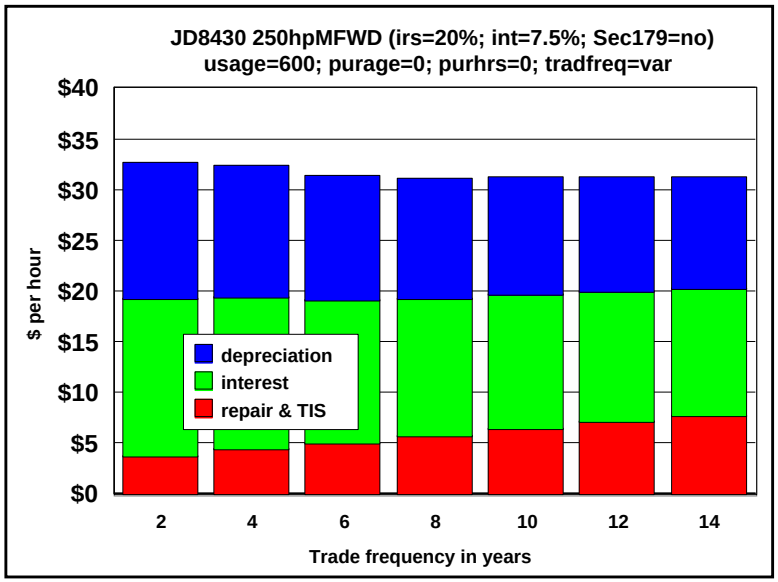


KSU-MachCost.xls

OwnTractor.xls

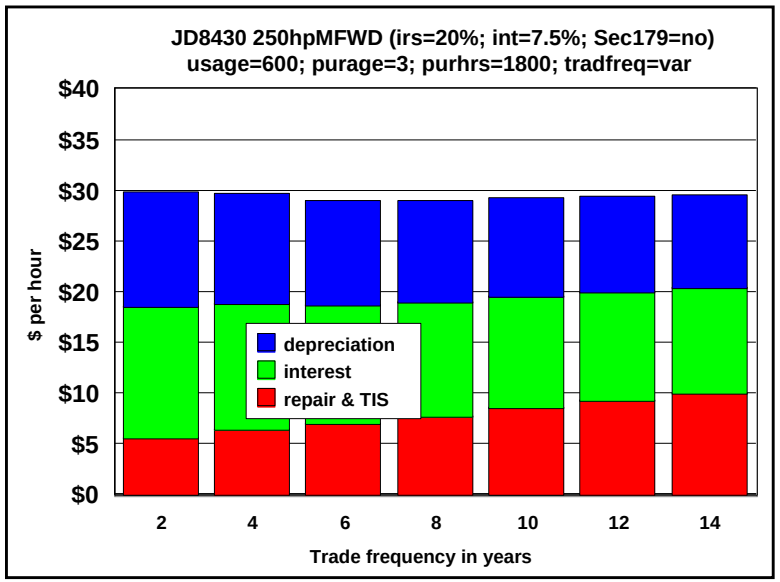
Optimal machinery trading: no universal recommendations

Results from *OwnTractor.xls*



The market is fairly efficient when buy NEW and with a variable holding period

Results from *OwnTractor.xls*



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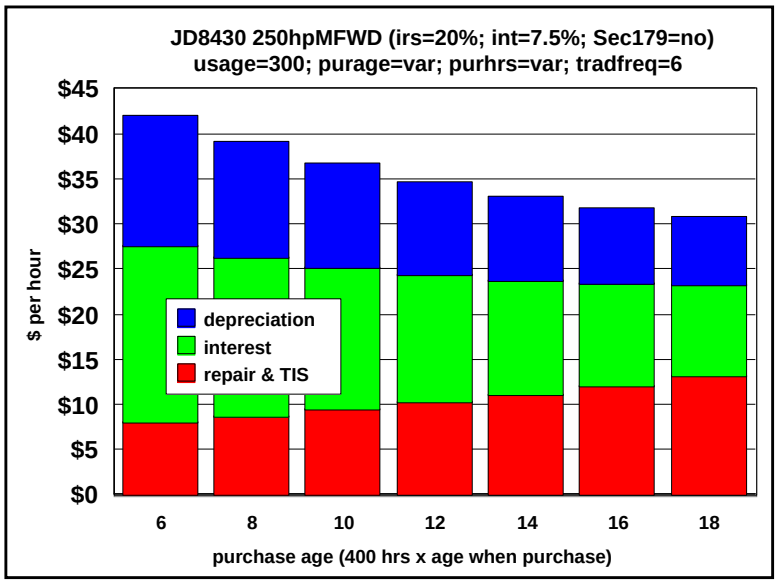
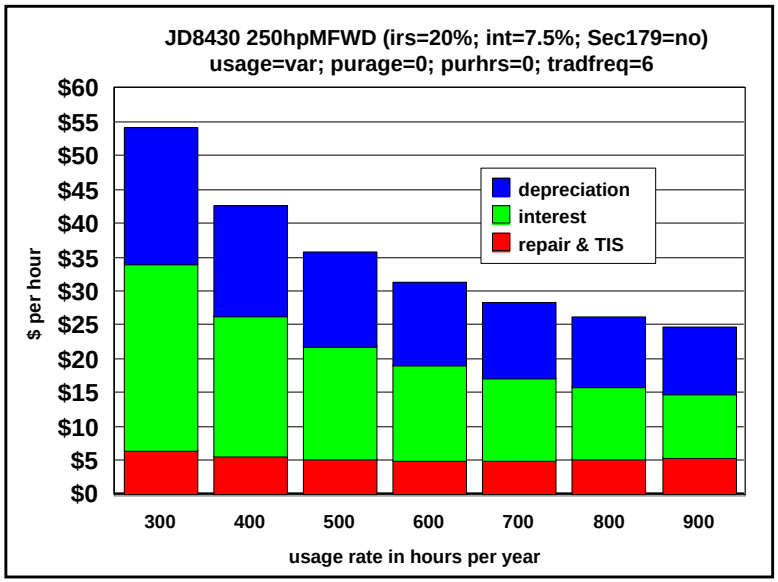


Less intensive users can hold down costs by buying older tractors,
but must be able to handle high repairs and do without newer technologies

Hard to beat intensity of use as a cost reducer…

Results from *OwnTractor.xls*

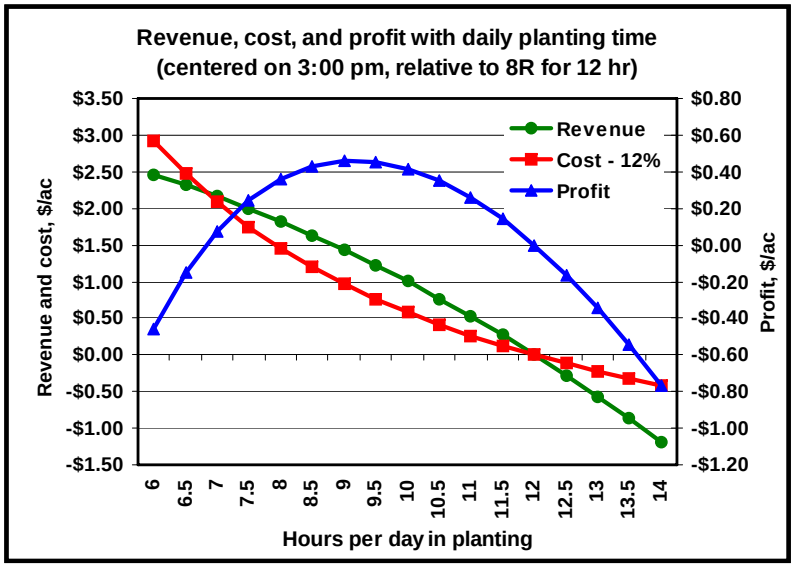


Not a trading strategy, but putting more hours on per year really pays off

Intensity of use considerations

- GPS-based steering and machine control promotes long hours and night-time activity
- Be sure you're ready (machinery good repair)
- Do the agronomics support night work?

Do the agronomics support night-time operations?



Intensity of use considerations

- GPS-based steering and machine control promotes long hours and night-time activity
- Be sure you're ready (machinery good repair)
- Do the agronomics support night work?
- Is night work supported by auxiliary businesses, e.g., elevators, repair shops?
- How safe is night travel with machinery?
- Will employees and family members support night work?
- Think tradeoff between short- and long-run profit.

Machinery strategies to control costs

- Get big machines . . . but
  - think about ease of road travel
  - get the technologies that enhance field efficiency
- Use machinery intensively. . . but remember
  - agronomics
  - safety
  - quality of life of operators
- Don't forget auxiliary equipment & services
  - Poor labor and equipment matchups (e.g., grain carts, tendering vehicles, pickups) can negate machinery size and intensity benefits

Summary…

- Machinery costs are an important factor in explaining producer profitability differences
- Machinery costs are fairly persistent – important to know if they are a strength or weakness of your operation
- Economies of scale generally exist such that larger operations have lower machinery costs
- High investment for large equipment does not necessarily equate to high costs
- Numerous tools exist (on agmanager.info) that can be used to help analyze machinery costs