

## Machinery Costs – What are drivers of variability between producers?



Kevin C. Dhuyvetter  
Extension Ag Economist  
Kansas State University  
785-532-3527 -- kcd@ksu.edu

**Presented at:**  
Citizens State Bank Producer Meeting  
AGCO Communications Center  
Hesston, KS. February 10, 2011

www.agmanager.info **AG** Manager

Differences Between High-, Medium-, and Low-Profit Producers: An Analysis of 2007-2009 Kansas Farm Management Association Crop Enterprises

August 2010

Kevin Dhuyvetter, K-State Ag. Economics (785-532-3527; kcd@ksu.edu)  
| Craig Smith, K-State Ag. Economics

**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](http://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., 2007-09).

### DIFFERENCE between the High 1/3 and Low 1/3 farms ranked on return to management Kansas Farm Management Association Enterprise Analysis, State Averages 2007-09

	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of farms	115	50	128	221	139	46
<b>INCOME (\$/acre)</b>						
Yield per acre, bu	17.8	16.6	23.2	7.6	7.8	1.2
Price per unit	\$0.25	\$0.28	\$0.12	\$0.29	\$0.40	\$13.12
Crop income	\$97.17	\$51.95	\$72.78	\$45.16	\$91.51	\$167.91
Government payment	-0.04	-5.09	-1.64	1.10	-0.20	-1.61
Gross income	\$97.64	\$45.16	\$68.63	\$50.69	\$94.12	\$166.63
<b>COSTS (\$/acre)<sup>1</sup></b>						
Seed	-\$3.83	-\$27.93	-\$2.53	-\$2.14	-\$2.30	\$1.42
Fertilizer	-7.42	-26.14	-3.81	-15.32	-0.92	2.67
Herbicide-insecticide	-6.10	-17.85	-7.77	-3.42	-2.67	-3.10
Crop insurance	0.72	-15.37	0.24	0.04	0.64	-0.40
Machinery	-19.70	-22.91	-27.75	-30.52	-32.71	-17.79
Other	-5.41	-49.21	-8.76	-11.06	-10.23	-5.83
Land	3.11	-36.25	-3.49	-7.41	6.15	11.26
Interest	-4.46	-16.16	-4.11	-4.75	-5.02	-4.36
Total Cost	-\$43.08	-\$211.82	-\$57.97	-\$74.59	-\$47.06	-\$16.12
<b>Net Return to Management</b>	<b>\$140.72</b>	<b>\$256.98</b>	<b>\$126.60</b>	<b>\$125.28</b>	<b>\$141.18</b>	<b>\$182.75</b>
Enterprise acres	184	-99	201	606	150	-28
Operator percentage	4.2%	-7.3%	-0.6%	-1.6%	3.0%	6.5%
Yield effect	43.5%	16.8%	47.5%	33.1%	50.3%	56.6%
Price effect	21.3%	13.6%	7.4%	9.5%	13.0%	33.3%
Cost effect	35.2%	69.6%	45.1%	57.4%	36.7%	10.1%

<sup>1</sup> Based on the operator's share of production, and thus includes only production expenses paid by the operator.

## How important are machinery costs for KS farmers?

Kansas Farm Management Association Crop Enterprises Analysis State Averages, 2007-2009						
	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	115	50	128	221	139	46
Average Acres	409	568	364	725	297	73
<b>Costs, \$ per Acre</b>						
Seed	\$42.44	\$61.97	\$13.45	\$12.65	\$35.53	\$12.01
Fertilizer	61.63	93.02	44.99	44.96	9.02	12.39
Herb-Ins	30.94	47.44	33.92	11.11	24.01	11.36
Crop Ins	16.66	24.65	11.50	11.28	13.01	0.15
<b>Machinery</b>	<b>97.49</b>	<b>126.23</b>	<b>83.73</b>	<b>86.92</b>	<b>92.22</b>	<b>120.18</b>
Other	25.39	106.55	22.22	23.00	24.71	29.47
Land	60.65	95.40	38.10	34.41	55.69	61.27
Interest	24.80	39.99	17.44	17.26	18.99	20.81
Total Cost	\$360.00	\$595.26	\$265.36	\$241.59	\$273.16	\$267.64
<b>Machinery, %</b>	<b>27.1%</b>	<b>21.2%</b>	<b>31.6%</b>	<b>36.0%</b>	<b>33.8%</b>	<b>44.9%</b>

## High profit farms have lower machinery costs...

Kansas Farm Management Association Crop Enterprises Analysis  
State Averages, 2007-2009

	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	115	50	128	221	139	46
Average Acres						
High profit farms	506	568	473	1002	358	79
Mid profit farms	400	464	348	777	324	108
Low profit farms	322	667	271	396	208	107
Machinery Costs, \$/acre						
High profit farms	\$90.29	\$118.35	\$70.77	\$75.48	\$77.90	\$109.44
Mid profit farms	\$92.33	\$118.64	\$81.88	\$79.18	\$88.24	\$123.63
Low profit farms	\$109.99	\$141.26	\$98.52	\$106.00	\$110.61	\$127.23
High less low, \$	-\$19.70	-\$22.91	-\$27.75	-\$30.52	-\$32.71	-\$17.79
High less low, %	-17.9%	-16.2%	-28.2%	-28.8%	-29.6%	-14.0%

## High profit farms have lower machinery costs...

Kansas Farm Management Association Crop Enterprises Analysis  
State Averages, 2007-2009

	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of Farms	115	50	128	221	139	46
Average Acres	409	568	364	725	297	73
Differences in Machinery Costs, \$/acre (high profit vs. low profit)						
Repairs	-\$4.84	-\$9.57	-\$4.02	-\$7.43	-\$7.02	-\$7.48
Machine Hire	-3.93	2.11	-5.03	-3.41	-5.35	3.29
Fuel and Oil	-2.44	4.18	-2.96	-2.94	-2.97	-4.41
Depreciation	-3.55	-6.34	-1.87	-2.02	-6.74	-2.58
Labor	-4.94	-13.28	-13.87	-14.71	-10.64	-6.61
Total	-\$19.70	-\$22.91	-\$27.75	-\$30.52	-\$32.71	-\$17.79

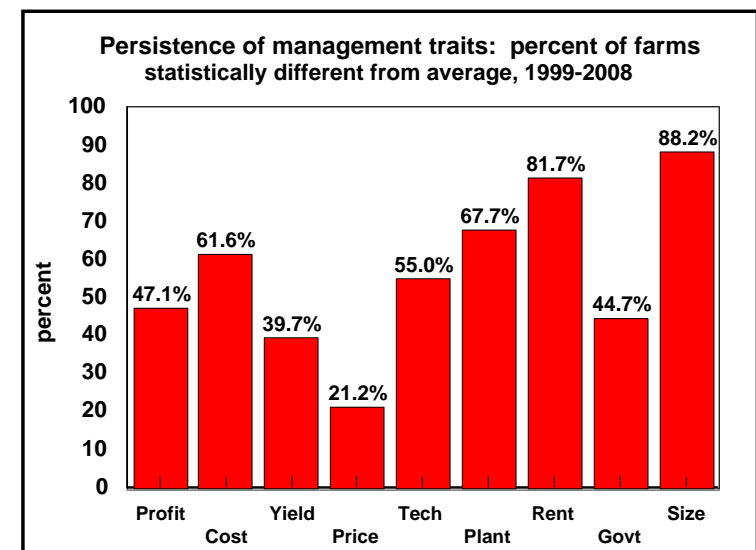


Department of Agricultural Economics

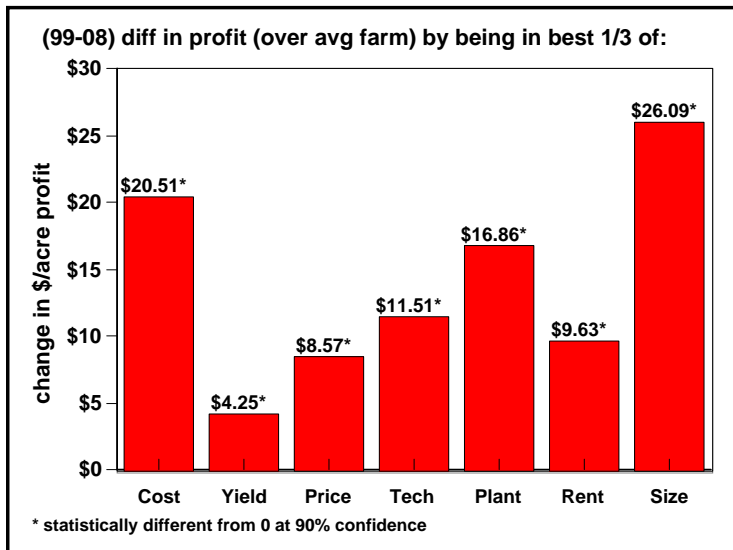
## Persistence --

Something is said to be persistent if it is consistently different (better or worse) than average. Thus, the less persistent something is, the more random it is.

## Persistence of management traits...



## Factors impacting profitability differences...



## Key drivers of profitability differences among producers...

- Costs
- Technology adoption
- Farm size

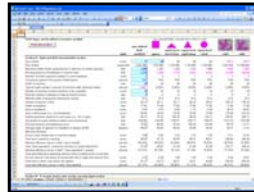
... machinery investment and costs are directly related to these three factors.

## Machinery decision-tools available from KSU...

www.agmanager.info



OwnCombine.xls



KSU-GPSguidance.xls



OwnBaler.xls



OwnSprayer.xls



KSU-MachCost.xls



OwnTractor.xls

### Guidance & Section Control Profit Calculator

Welcome | Instructions | Whole Farm Data | Sprayer | Planter | Fertilizer | Other | Whole Farm Results

To Get Started, Click the Instructions Tab

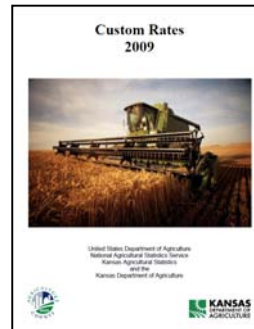
welcome to the  
**Guidance & Section Control Profit Calculator**

<p>Sponsored by</p> <p><b>PRECISIONAG</b> INSTITUTE</p> <p>37733 Euclid Avenue Willoughby, Ohio 44094 440-942-2000 www.precisionagworks.com</p>	<p>Developers</p> <p>Kavin C. Dhuyvetter Extension Agricultural Economist Kansas State University (785) 532-3527 kod@ksu.edu</p> <p>Terry L. Kastens Professor Emeritus Kansas State University (785) 626-9000 terrykastens@agecon.ksu.edu</p>	<p>Developed by</p> <p><b>AG</b> MANAGER.INFO</p> <p>Department of Ag Economics Kansas State University Manhattan, KS 66506 www.agmanager.info</p>
---	--	--

Version 2.26.2010

## Machinery cost categories...

- Repair and maintenance
- Labor
- Depreciation (market, not tax depreciation)
- Interest (opportunity interest)
- Fuel and lubrication
- Taxes, insurance, and shelter
- Custom hire – a reasonable proxy for average machinery cost



## An aside, related to custom rates...

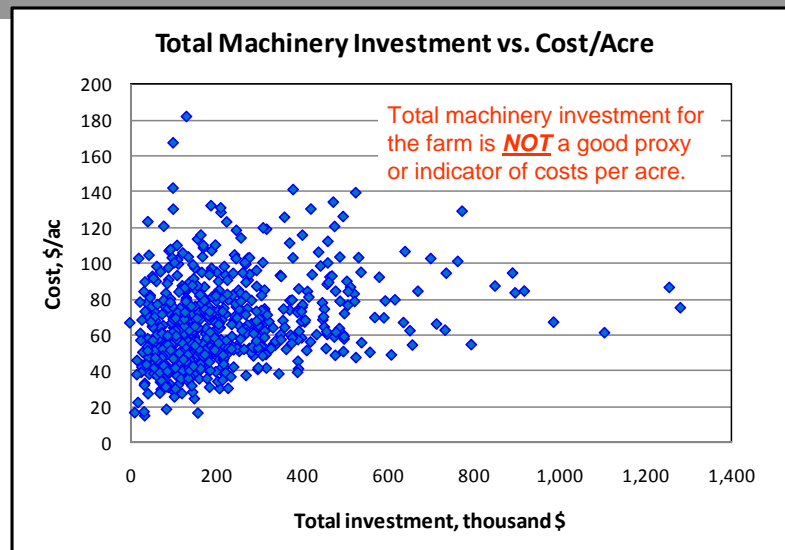
Kansas Ag Statistics discontinued their survey of custom rates in 2010. Projected state averages for most all operations have been projected based on inflation and fuel prices and are reported in KSU paper available on [www.agmanager.info](http://www.agmanager.info)

Operation	2007	2008	2009	Projections		2011 versus 2010		R <sup>2</sup>
				2010	2011	\$/acre chg	% chg	
Regular-Till	\$9.54	\$11.09	\$11.14	\$11.09	\$11.89	\$0.80	7.2%	0.961
Small grains	\$10.65	\$12.30	\$12.61	\$12.45	\$13.24	\$0.79	6.4%	0.959
Corn	\$10.91	\$12.51	\$12.02	\$12.45	\$13.06	\$0.61	4.9%	0.976
Soybeans	\$10.94	\$12.87	\$12.58	\$12.65	\$13.31	\$0.66	5.2%	0.977
Grass	\$12.60	\$14.65	\$14.02	\$14.11	\$14.85	\$0.74	5.3%	0.962
Alfalfa	\$11.35	\$13.75	\$12.68	\$13.23	\$13.89	\$0.66	5.0%	0.948
Minimum-Till or No-Till								
Small grains	\$12.10	\$13.73	\$13.01	\$13.49	\$13.94	\$0.55	2.6%	0.964
Sorghum	\$12.04	\$13.49	\$13.03	\$13.54	\$13.99	\$0.45	3.3%	0.970
Corn	\$12.09	\$13.57	\$13.70	\$13.63	\$14.05	\$0.42	3.1%	0.977
Soybeans	\$12.34	\$14.07	\$13.68	\$13.90	\$14.26	\$0.33	2.4%	0.974

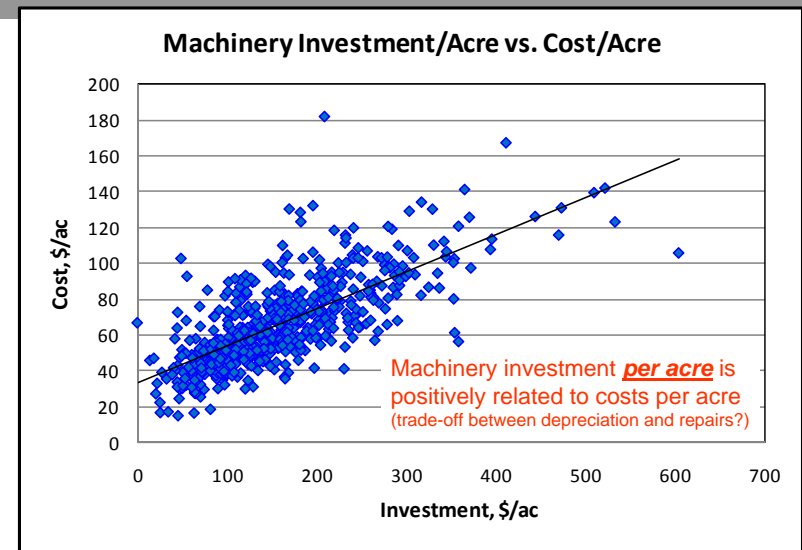
Operation	2007	2008	2009	Projections		2011 versus 2010		R <sup>2</sup>
				2010	2011	\$/acre chg	% chg	
Row crop cathate w/ fertilizer	\$6.33	\$8.41	\$8.00	\$8.04	\$8.24	\$0.20	2.5%	0.805
Row crop cathate w/o fertilizer	\$6.32	\$8.46	\$7.24	\$8.03	\$8.35	\$0.32	4.0%	0.868
Dry fertilizer application	\$4.20	\$4.96	\$4.68	\$4.80	\$4.99	\$0.19	3.9%	0.963
Liquid fertilizer application	\$4.37	\$4.98	\$4.62	\$4.87	\$5.05	\$0.18	3.7%	0.963
Anhydrous ammonia application	\$8.46	\$10.20	\$10.05	\$10.25	\$11.12	\$0.88	8.6%	0.919
Aerial herbicide application	\$5.19	\$6.20	\$6.00	\$6.43	\$6.95	\$0.52	8.1%	0.762
Ground herbicide application	\$4.50	\$5.01	\$4.98	\$4.96	\$5.13	\$0.17	3.5%	0.979
Aerial insecticide application	\$5.48	\$6.20	\$6.60	\$6.39	\$6.82	\$0.43	6.7%	0.865
Ground herbicide application	\$4.49	\$5.07	\$4.95	\$4.97	\$5.13	\$0.16	3.2%	0.980

## Machinery investment is not the same as machinery cost



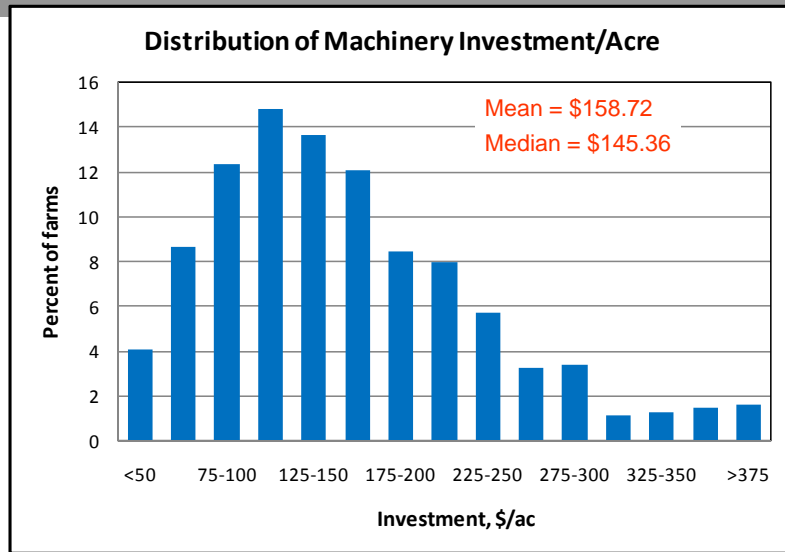
Source: KFMA non-irrigated crop farms having continuous data from 2005-2009 (minimum of 160 acres and machinery cost/acre > \$10/ac; costs do not include labor – total of 614 farms)

## It is important to use assets efficiently...



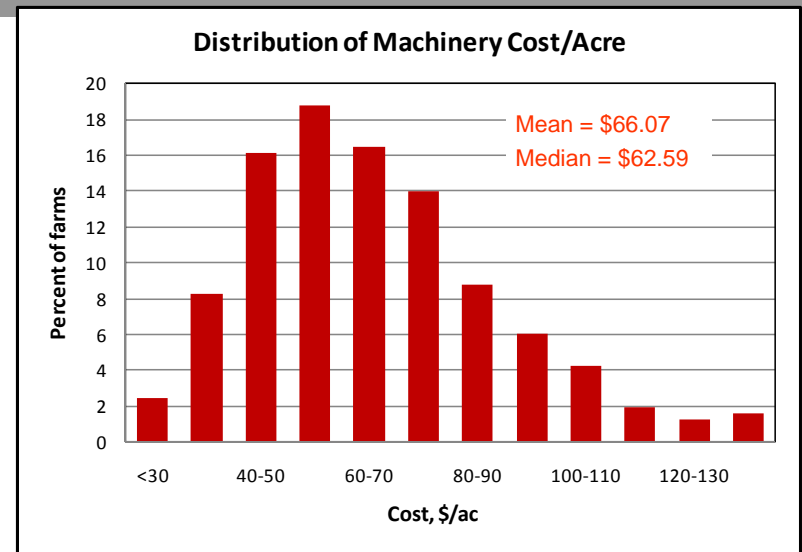
Source: KFMA non-irrigated crop farms having continuous data from 2005-2009 (minimum of 160 acres and machinery cost/acre > \$10/ac; costs do not include labor – total of 614 farms)

## Machinery investment/acre varies across producers...



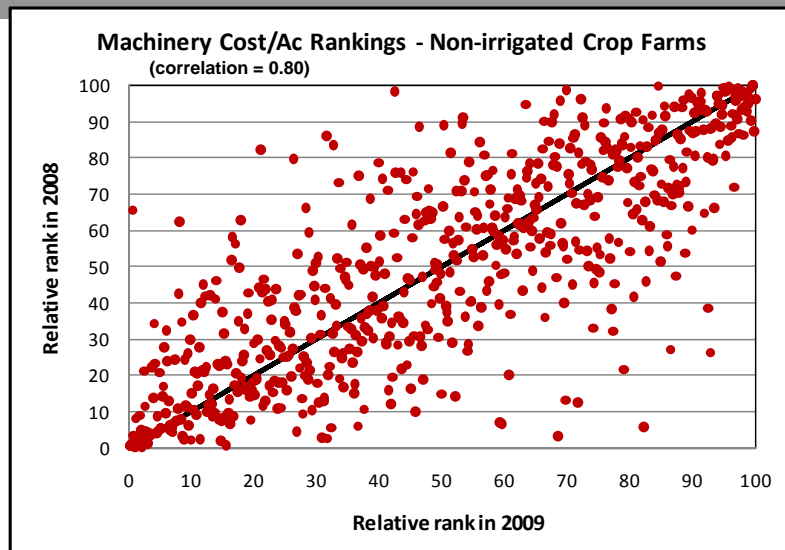
Source: KFMA non-irrigated crop farms having continuous data from 2005-2009 (minimum of 160 acres and machinery cost/acre > \$10/ac; costs do not include labor – total of 614 farms)

## Hence, machinery cost varies across producers...



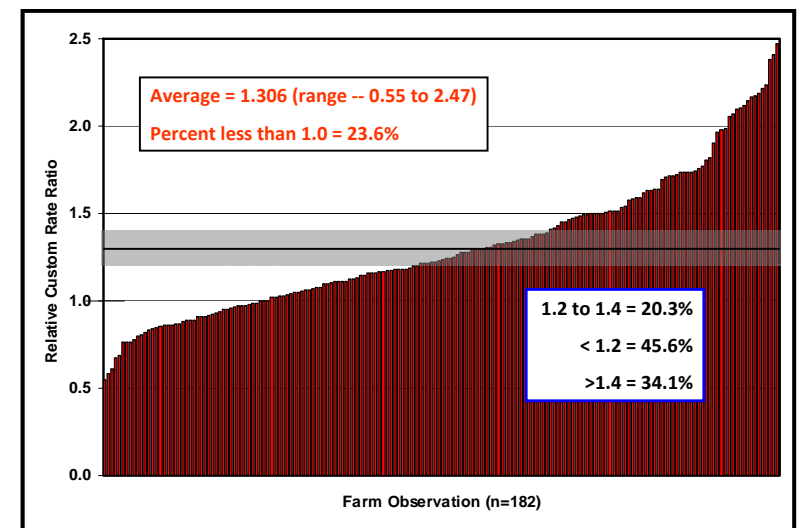
Source: KFMA non-irrigated crop farms having continuous data from 2005-2009 (minimum of 160 acres and machinery cost/acre > \$10/ac; costs do not include labor – total of 614 farms)

## Machinery costs per acre are fairly persistent...



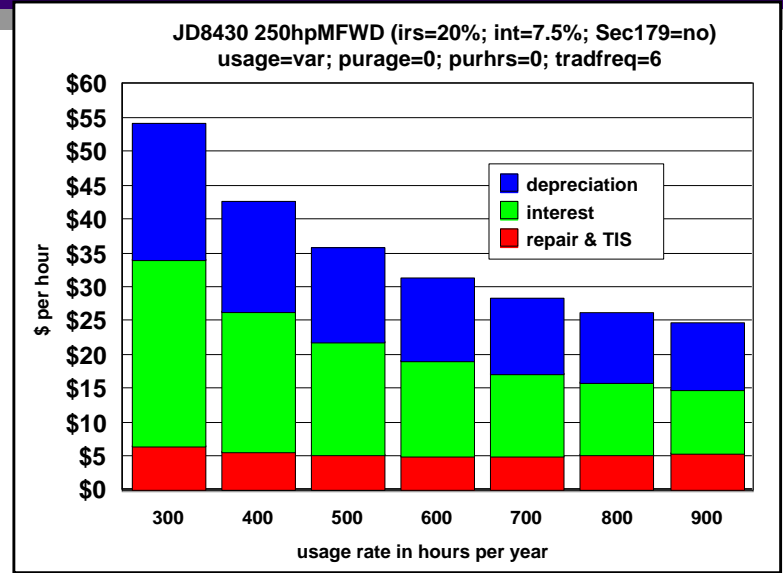
Source: KFMA non-irrigated crop farms having continuous data from 2005-2009 (minimum of 160 acres and machinery cost/acre > \$10/ac – total of 614 farms)

## Very few individuals are “average”...



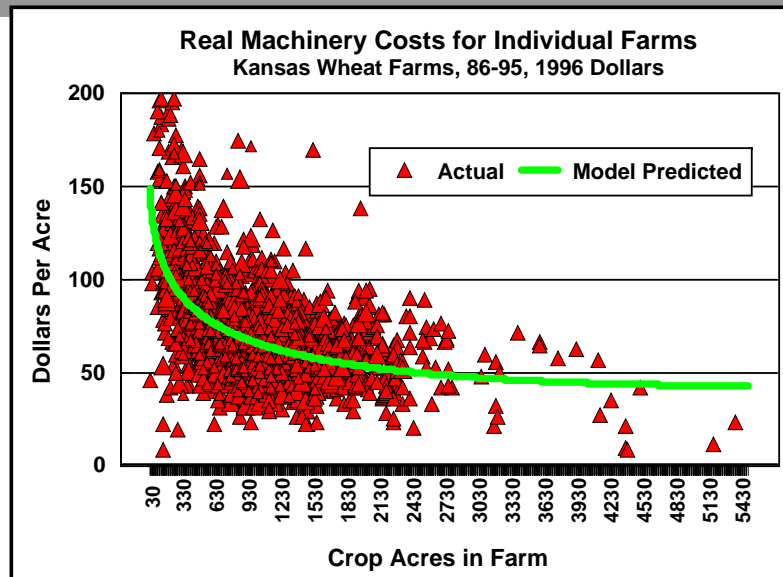
Source: Beaton MS thesis, 2003 (data from 2001)

Hard to beat intensity of use as a cost reducer...



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

Machinery costs fall as more acres are farmed...



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)
- **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)

## Impact of field size on machinery and input costs

Analysis based on *KSU-GPSguidance.xls*

(similar values could be derived from *GuidanceSectionControlProfitCalculator.xls*)

## Field size & shape are basically headland issues

- **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

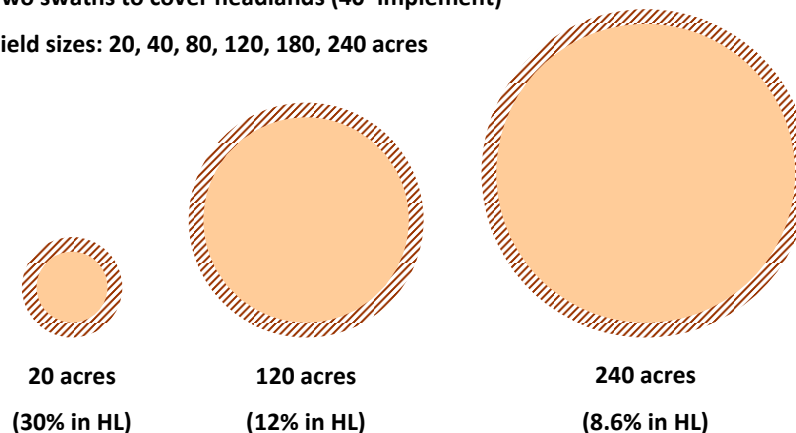
## Larger fields have less area in headlands...

### Assumptions for this example:

All fields have average angle of approach to headland of 39.5

Two swaths to cover headlands (40' implement)

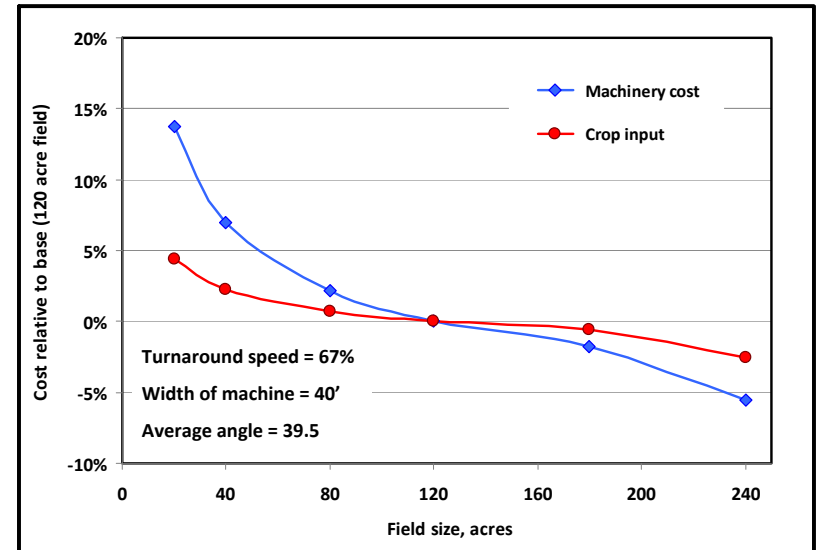
Field sizes: 20, 40, 80, 120, 180, 240 acres



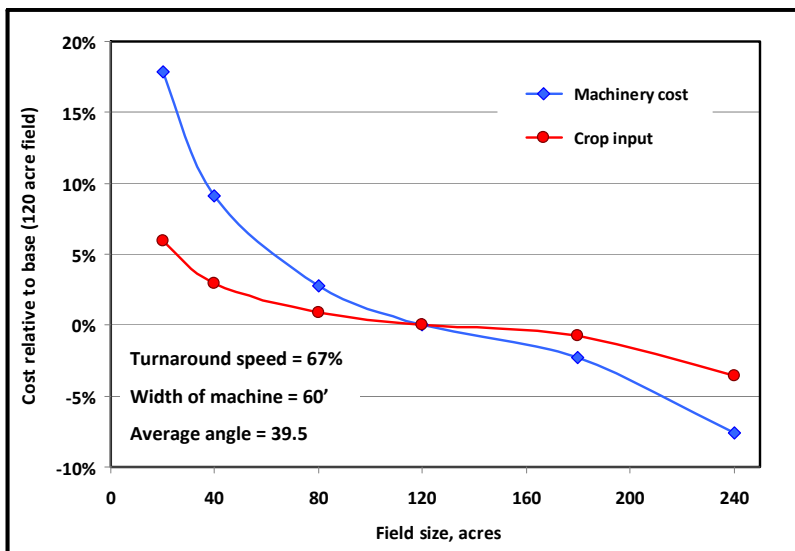
## Impact of field size on costs...

- **Machinery costs**
  - percent machinery costs vary relative to base field (120 acres)
  - vary due to “covering” acres more than once (i.e., overlap and area in headlands)
  - slowing down to turn increases costs
- **Crop inputs**
  - percent crop inputs (e.g., seed, fertilizer, chemicals) vary relative to base field
  - vary due to “doubling up” on overlap acres and areas in headlands

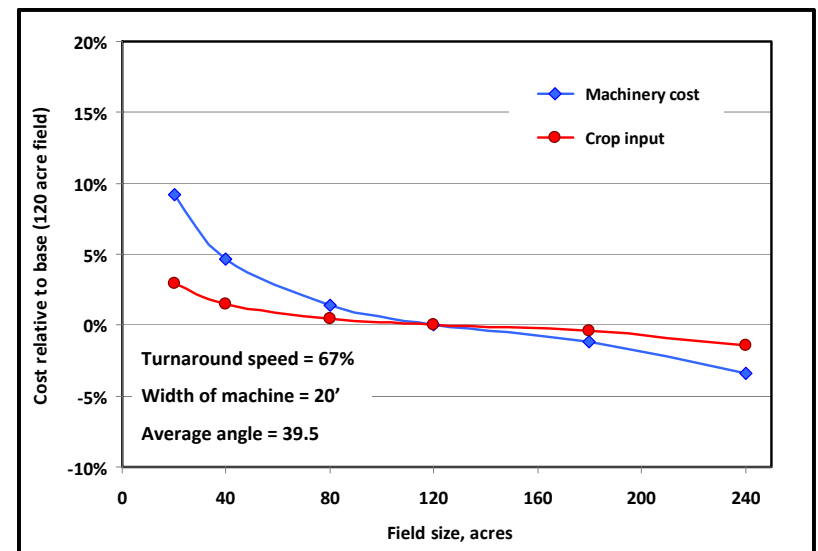
## Machinery and input costs as field size varies



## Machinery and input costs as field size varies



## Machinery and input costs as field size varies



## Impact of field shape on machinery and input costs

Analysis based on *KSU-GPSguidance.xls*

(similar values could be derived from *GuidanceSectionControlProfitCalculator.xls*)

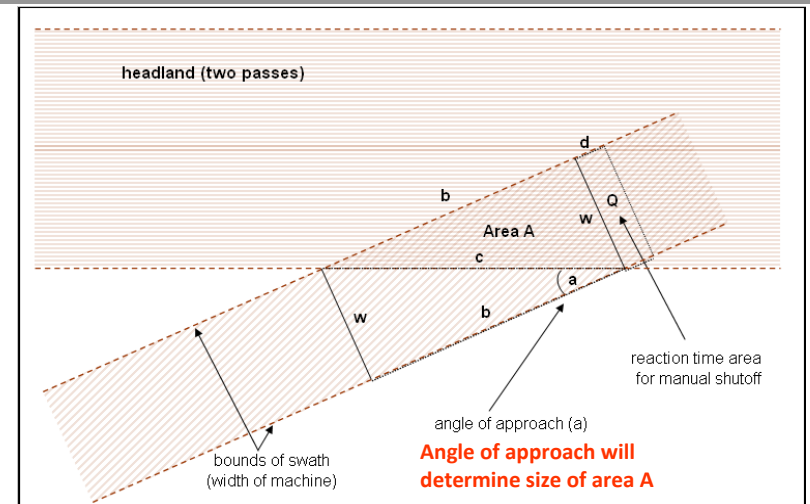
## Large (wide) machine issues

- Need large turnaround area, increasing headland size (problem is compounded with small fields)
- By using section controllers we can make larger machines behave as though they were smaller, at least in terms of the portion of a headland affected by input doubling-up (but we still “cover the acres” with the machine)

## Technology reduces the “over applied input” problem...



## Overlap and headlands geometry



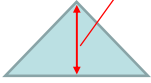
Areas A and Q and turnaround counterparts will have a) doubling-up of inputs and b) possible yield losses due to this doubling-up. After the turnaround there will be overlap along b, also accounted for.

## Stylized field shapes (farm left to right)

Maximum width of field, perpendicular to direction of swaths (passes) = 2,640 feet



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



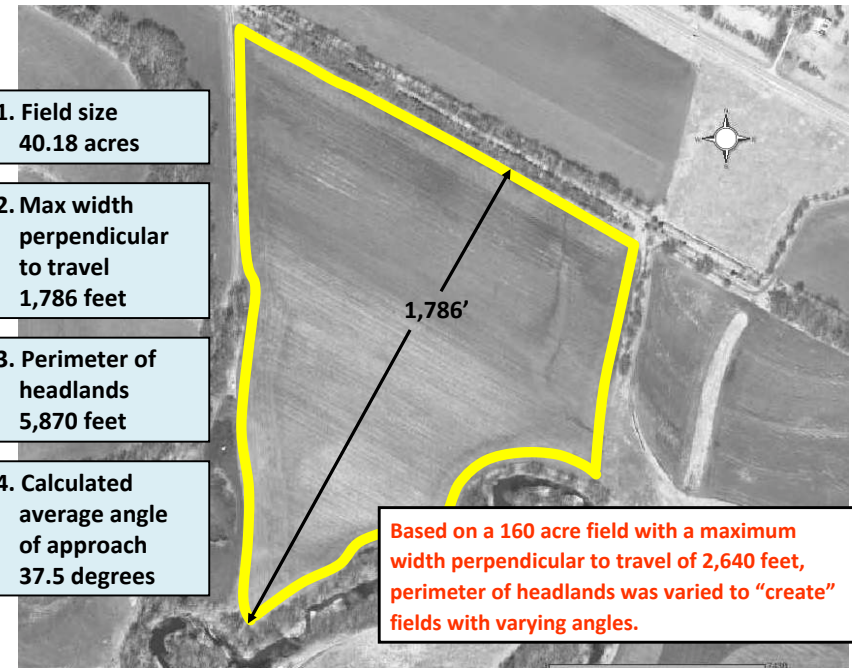
Isosceles right triangle; hit ends at 60 degree angles, 7,467 feet of headlands in 160 acre field



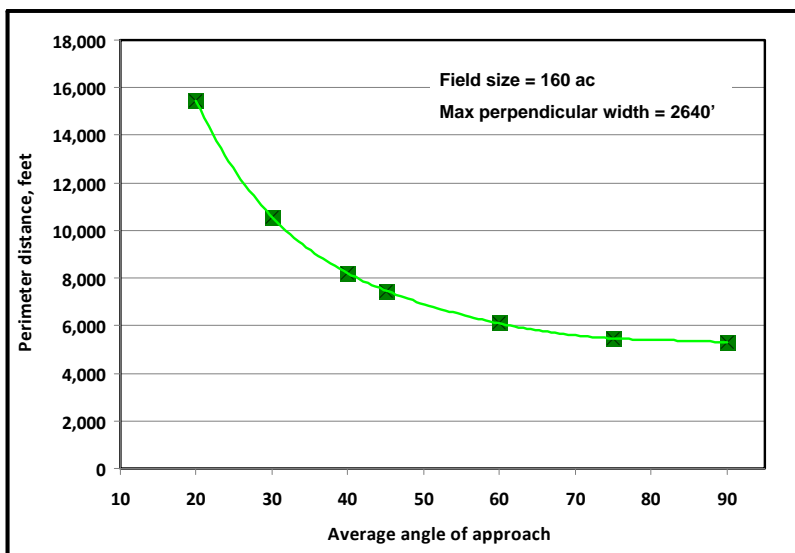
Equilateral triangle; hit ends at 45 degree angles, 8,024 feet of headlands in 160 acre field



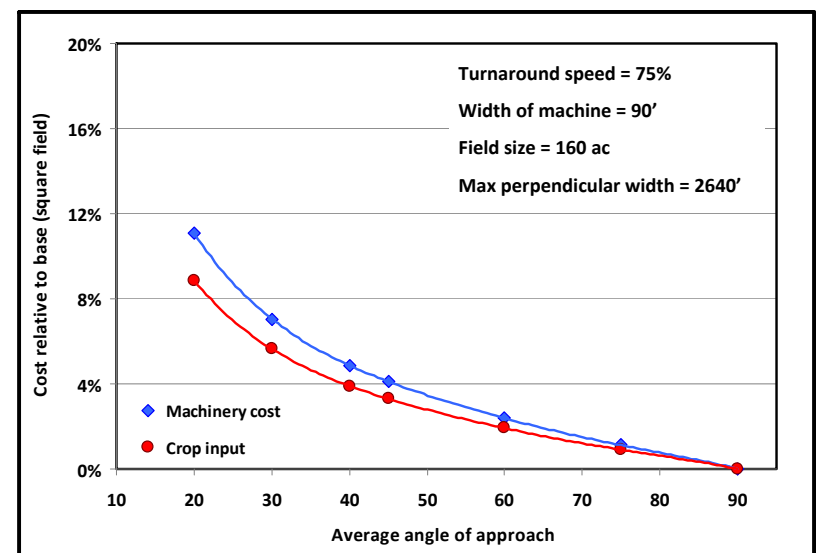
Circle; hit ends at angles varying from 0 to 90 degrees (avg. 40 degrees) 9,359 feet of headlands in 160 acre field



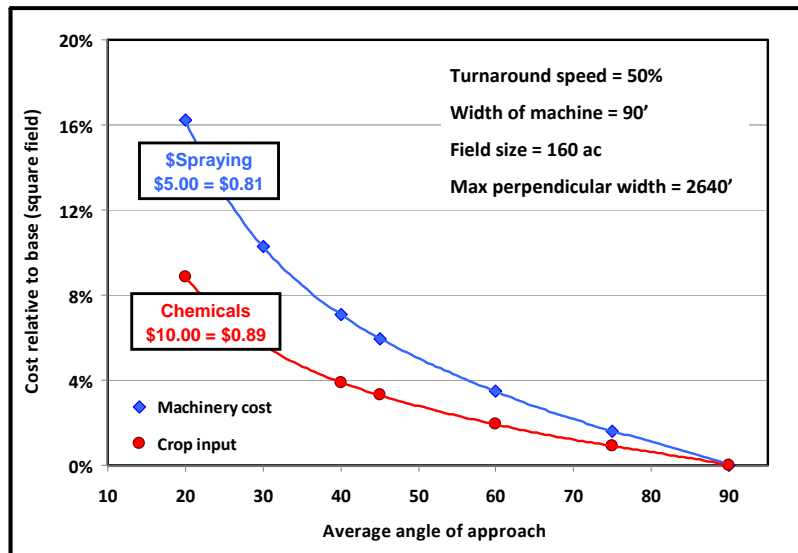
## Headland distance as field shape varies



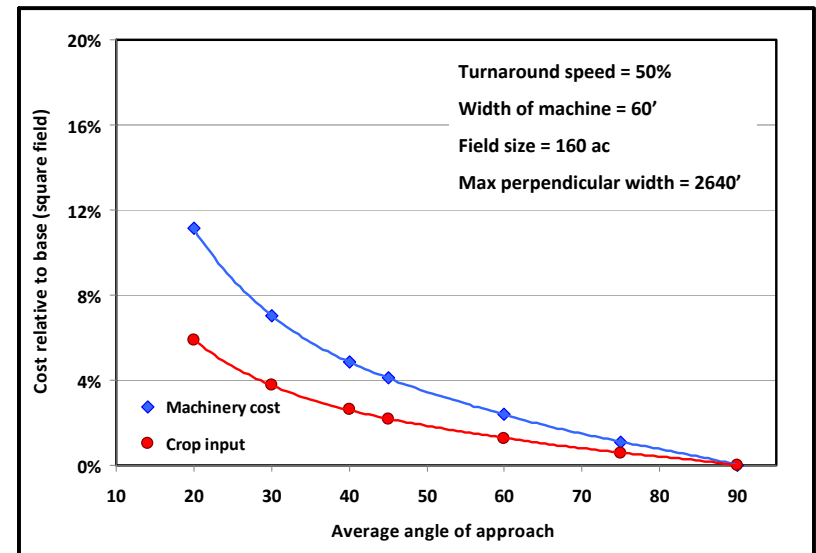
## Machinery and input costs as field shape varies



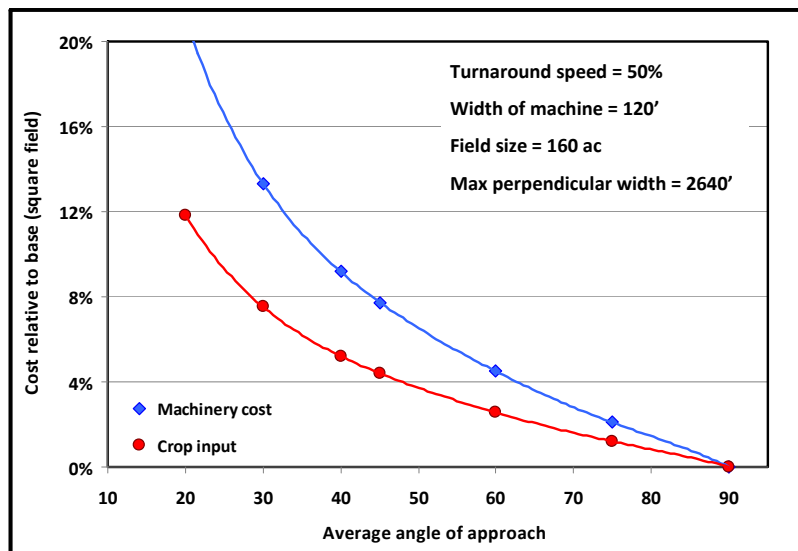
## Machinery and input costs as field shape varies



## Machinery and input costs as field shape varies



## Machinery and input costs as field shape varies



## Field shape significantly impacts costs...

- Section controller technology can help significantly with regard to crop input usage
- All else equal, reducing machine size will lower machinery cost associated with irregular shaped fields (for same reason as with small fields)
- While you may not be able to do a lot about the impact of field shape on machinery costs, it is still important to be aware of this issue for other management decisions

## ***Impact of distance from headquarters on costs***

Analysis based on *KSU-DistanceToFields.xls*

### **Motivation --**

As operations continue to expand and consolidate, producers will routinely be looking at land farther away from their home base. While this is a complex issue, quantifying as many factors as possible will help ensure producers make good management decisions (e.g., how much they can bid for varying land acquisition opportunities).



### Field distance increases travel costs...

#### Travel costs are a function of:

- Crop acres and rotation
- Distance from headquarters
- Distance from elevator/input source
- Labor costs per hour
- Vehicle speed (pickup, semi, and machines)
- Vehicle cost per mile
- Field operations and machine capacity
- Use of pickup for travelling back and forth
- Input levels required and yield (trips with semi)

## Base assumptions...

- Acres – 150, 300, 600, and 1200
- Crop rotation -- corn/soybean/wheat  
(plant each crop each year and rotate by year (300 acres or less))
- Distance from HQ – 5, 10, 20, 35, 50 (current fields 2.5)
- Distance from elevator/input source – 15 miles
- Labor costs per hour – \$15
- Vehicle speed – pickup=55, semi=40, machines=17-26
- Vehicle cost per mile – pickup=\$0.50, semi=\$2.00
- Field operations and machine capacity – no-till
- Use pickup for all operations except spraying

## Example of model developed (only one crop shown)...

### Analysis of Farming Additional Acres a Given Distance from Farm Headquarters

Crop name	Corn	Wheat	Soybean	Other	Total
Average annual acres	200	200	200	0	600
Distance from headquarters in miles (dist1)	30				
Distance from elevator/field source in miles (dist2)	15				
Labor cost per hour	\$15.00				
Vehicle travel costs					
Pickup			Speed, mph	Cost, \$/mi	Total \$/mi
Semi			55	\$0.50	\$0.77
			40	\$2.00	\$2.38
Breakpoint for where days are "rounded down" (percent of day)					10.0%

Blue values are inputs  
Black values are calculated

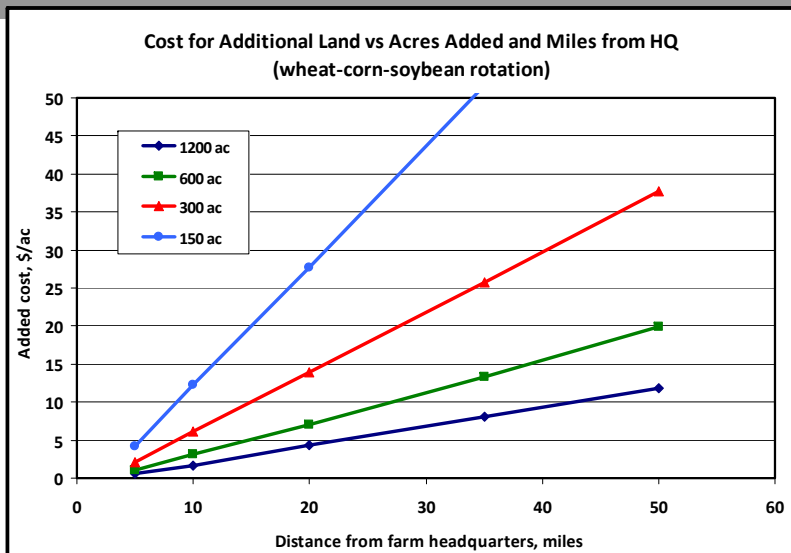
  

Crop	number machines	number operations	haul to field	use a pickup	avg ac/day /machine	in these "field" hrs	required days	hours of travel first & last day	hours of travel other days	number semis	semi units per acre	semi units per semi	average machine road speed	non-labor machine cost \$/hr	machine road cost \$/mi
<b>Corn</b>															
Spraying	1	2	1	0	400	8	2	1.50	1.50	1	5	3,000	26	\$0	\$0.58
Disking	1	0	0	1	175	10	0	0.00	0.00	0	0	0	18	\$62	\$4.28
Field cultivate	1	0	0	1	350	10	0	0.00	0.00	0	0	0	18	\$62	\$4.28
Planting	1	1	0	1	240	10	1	2.12	1.09	1	25	4,200	19	\$62	\$4.05
Fertilizing	1	1	0	1	240	10	1	2.05	1.09	1	25	4,200	20	\$62	\$3.85
Harvest	2	1	0	1	100	10	2	2.31	1.09	3	100	1,050	17	\$80	\$5.59
Scouting	1	8	0	0	1200	10	8	1.09	1.09	0	0	0	85	\$28	\$0.77
<b>Total</b>		<b>13</b>							<b>14</b>						
<b>Total for all crops</b>		<b>31</b>							<b>34</b>						

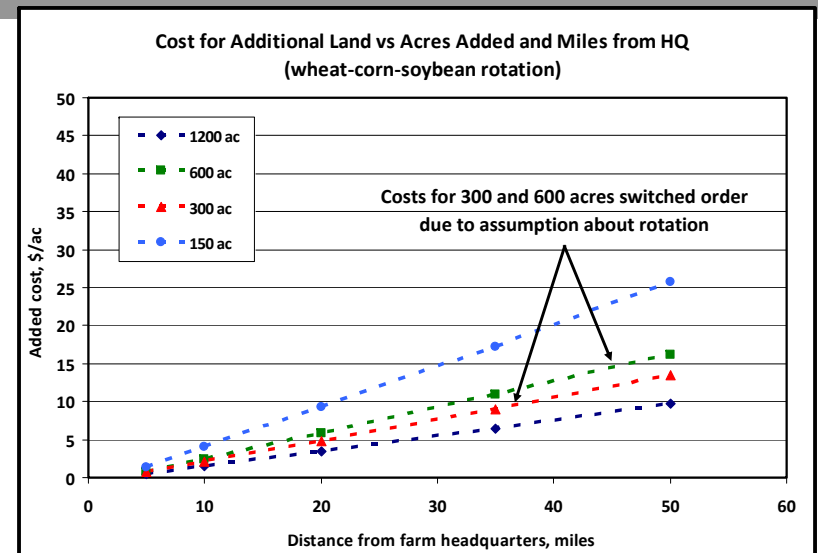
Crop	# pickup dist	Number of trips (roundtrip) # semi dist	# semi dist2	# machine dist	Total number of miles # semi dist1	# semi dist2	# machine dist1	Travel-related costs pickup dist1	semi dist1	semi dist2	machine dist1	total cost
<b>Corn</b>												
Spraying	0	2	0	2	0	120	0	\$0.00	\$285.00	\$0.00	\$0.00	\$285.00
Disking	0	0	0	0	0	0	0	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Field cultivate	0	0	0	0	0	0	0	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Planting	1	1	1	1	60	60	30	\$46.36	\$142.50	\$71.25	\$243.16	\$503.27
Fertilizing	1	1	1	1	60	60	30	\$46.36	\$142.50	\$71.25	\$231.00	\$491.11
Harvest	2	3	18	2	120	180	100	\$92.73	\$427.50	\$1,353.75	\$876.58	\$2,544.57
Scouting	0	0	0	8	0	0	480	\$0.00	\$0.00	\$0.00	\$370.91	\$370.91
<b>Total</b>	<b>4</b>	<b>7</b>	<b>21</b>	<b>14</b>	<b>240</b>	<b>420</b>	<b>630</b>	<b>\$185</b>	<b>\$998</b>	<b>\$1,496</b>	<b>\$1,516</b>	<b>\$4,185</b>
<b>Total for all crops</b>	<b>11</b>	<b>20</b>	<b>39</b>	<b>34</b>	<b>660</b>	<b>1200</b>	<b>1170</b>	<b>\$510</b>	<b>\$2,850</b>	<b>\$2,779</b>	<b>\$3,945</b>	<b>\$10,084</b>
<b>Total per acre</b>	<b>0.02</b>	<b>0.03</b>	<b>0.07</b>	<b>0.06</b>	<b>1.10</b>	<b>2.00</b>	<b>1.95</b>	<b>\$0.85</b>	<b>\$4.75</b>	<b>\$4.63</b>	<b>\$6.58</b>	<b>\$16.81</b>

## Adding small acreage very far away is costly...



Assumes each crop is planted each year with no overlap of operations.

## How rotation is managed has large impact on costs...



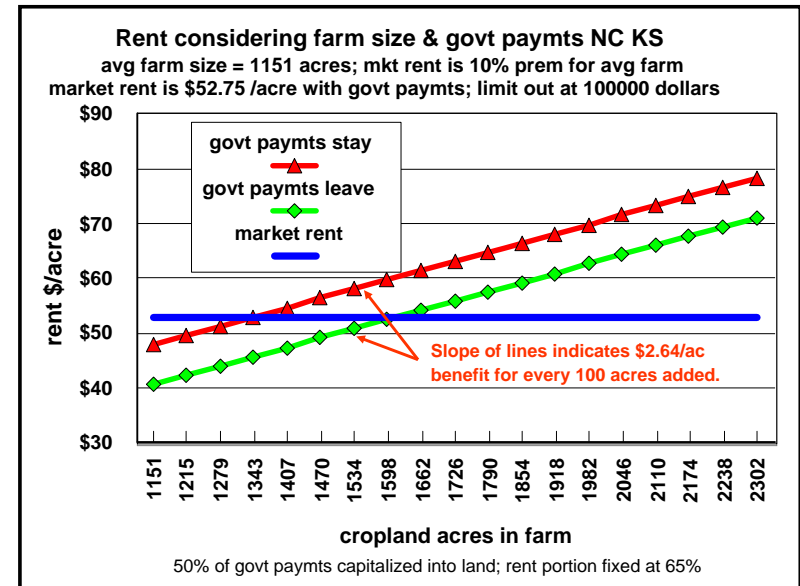
Assumes entire farm is planted to one crop per year for 300 acres or less, with larger acres, corn and soybean operations overlap (reducing the number of trips required).

### Factors not accounted for (there are many)...

- Impact on overall costs (i.e., EOS benefit)



### Economies of size analysis for typical NC KS farm in 2008



### Factors not accounted for (there are many)...

- Impact on overall costs (i.e., EOS benefit)
- Geographical diversification
  - Spread weather risk over larger area
  - More visibility (double-edged sword)
- Manage less intensively at greater distance?
  - Weed escapes, replant acres, repairs, etc.
- Hire some operations, stay overnight, separate line of equipment (costs might not be linear)?
- Costs decrease as you “fill in the gap”
- Other?



### Summary...

- Given economies of size that exist, a growth strategy makes sense for long-term sustainability
- Adding acres that are (1) in small fields, (2) irregular shaped fields, and (3) far away can increase costs potentially offsetting EOS benefits
- Machinery technologies available can help reduce some of the negative effects of small and odd-shaped fields (e.g., section controllers, auto-steer)
- The economics of expansion opportunities is complex, but producers should quantify the benefits and costs where they can



