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Department of Agricultural Economics

Crop Production Economics

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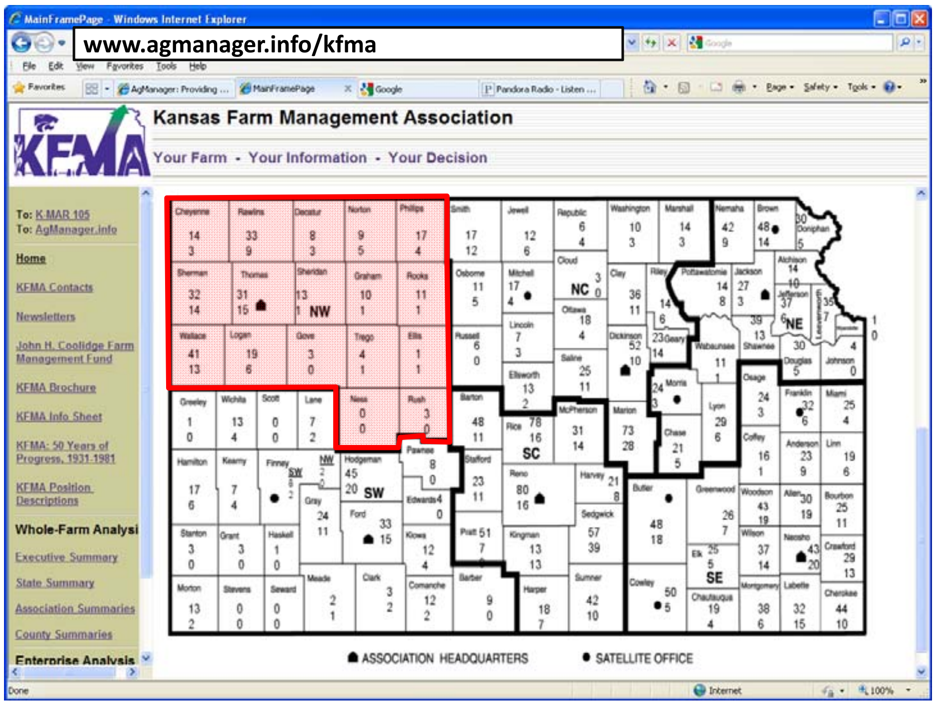
What we're going to talk about …

- **Historical returns from KFMA enterprise reports**
- **Variability between producers / machinery costs**
- **Economics of travel logistics**



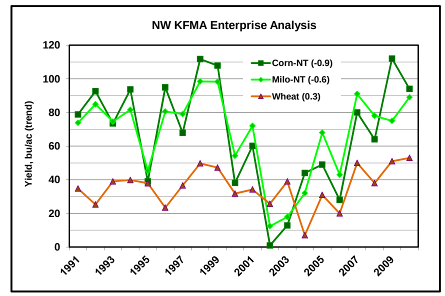
Hay has the least variable yields, corn has the most…

Economic comparison of crops for Northwest Kansas
Source: NW Farm Management Association - Enterprise Analysis

Yield						1991-2010*			
	2006	2007	2008	2009	2010	Avg.	Range	Std Dev	CV
Corn-NT	28.0	80.0	64.0	112.0	94.0	67.1	111.1	32.7	48.6%
Milo-NT	43.0	91.0	78.0	75.0	89.0	67.5	86.0	25.2	37.3%
Wheat	20.0	50.0	38.0	51.0	53.0	35.7	46.0	11.7	32.7%
Cane hay	2.07	3.51	3.38	3.14	2.90	2.97	3.03	0.82	27.5%
Alfalfa	2.75	3.27	3.41	3.58	4.12	3.41	2.65	0.64	18.7%

* CV is coefficient of variation (standard deviation / average).

5-year average yields	
Corn-NT	75.6
Milo-NT	75.2
Wheat	42.4
Cane hay	3.00
Alfalfa	3.43



KFMA Source: KFMA Enterprise Analysis Report

Alfalfa has highest return over VC…

(other crops are similar, but corn and milo are considerably more variable than wheat)

Economic comparison of crops for Northwest Kansas
Source: NW Farm Management Association - Enterprise Analysis

Return over Variable Costs, $/acre						1991-2010*		
	2006	2007	2008	2009	2010	Avg.	Range	Std Dev
Corn-NT	20.16	124.96	71.92	160.88	191.63	53.98	188.94	51.62
Milo-NT	42.14	159.91	75.29	47.40	204.91	53.82	187.72	46.65
Wheat	32.31	143.01	99.38	67.64	95.59	55.88	113.33	28.48
Cane hay	55.38	111.71	109.63	86.34	48.47	49.59	110.50	29.51
Alfalfa	140.04	151.83	178.17	125.71	156.61	105.09	129.35	37.44

* Std Dev is standard deviation over 1991-2010 time period.

Last five years considerably better than long-term average

5-year average returns	
Corn-NT	$113.91
Milo-NT	$105.93
Wheat	$87.59
Cane hay	$82.31
Alfalfa	$150.47

Source: KFMA Enterprise Analysis Report

Alfalfa and corn have considerably higher costs…

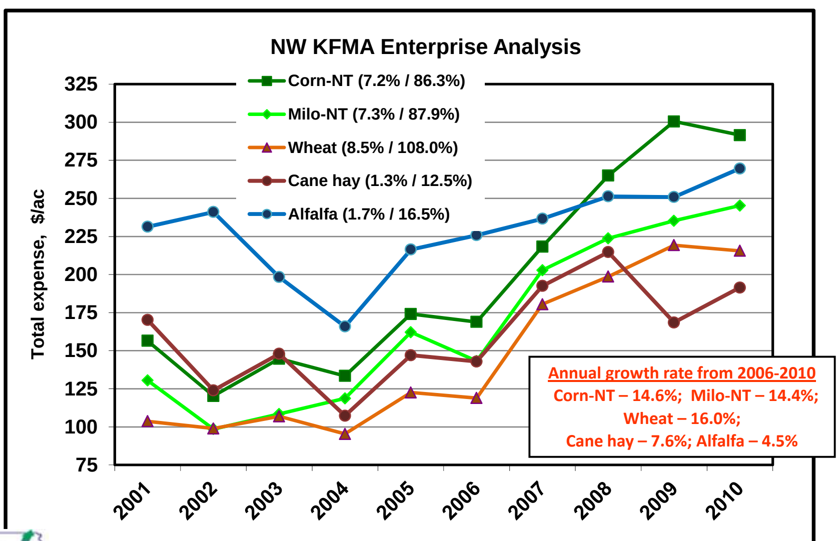
Economic comparison of crops for Northwest Kansas
Source: NW Farm Management Association - Enterprise Analysis

Total Expense						2001-2010*		
	2006	2007	2008	2009	2010	Avg.	Range	Std Dev
Corn-NT	168.90	218.36	265.02	300.48	291.52	197.34	180.22	66.95
Milo-NT	143.21	202.87	223.75	235.32	245.28	166.87	146.72	55.45
Wheat	118.95	180.50	198.67	219.26	215.62	146.04	123.93	51.17
Cane hay	142.94	192.55	214.74	168.52	191.49	160.68	107.41	33.16
Alfalfa	225.87	236.69	251.30	250.91	269.61	228.75	103.71	29.67

* Std Dev is standard deviation over 2001-2010 time period.

Source: KFMA Enterprise Analysis Report

Costs for grain crops growing much faster than hay…



Source: KFMA Enterprise Analysis Report

With FC included, long-run returns are about as expected…

Economic comparison of crops for Northwest Kansas
Source: NW Farm Management Association - Enterprise Analysis

Net Return to Management (return over total costs), $/acre						1991-2010*		
	2006	2007	2008	2009	2010	Avg.	Range	Std Dev
Corn-NT	-15.96	59.63	16.50	82.06	108.99	4.62	156.74	40.32
Milo-NT	11.56	98.89	20.75	-11.24	131.01	9.61	150.00	37.90
Wheat	-4.13	70.74	36.71	1.61	26.61	12.82	78.90	18.13
Cane hay	-6.27	22.44	19.91	-0.18	-34.10	-24.51	81.19	23.95
Alfalfa	29.54	24.55	61.41	10.04	42.08	-10.53	156.80	38.42

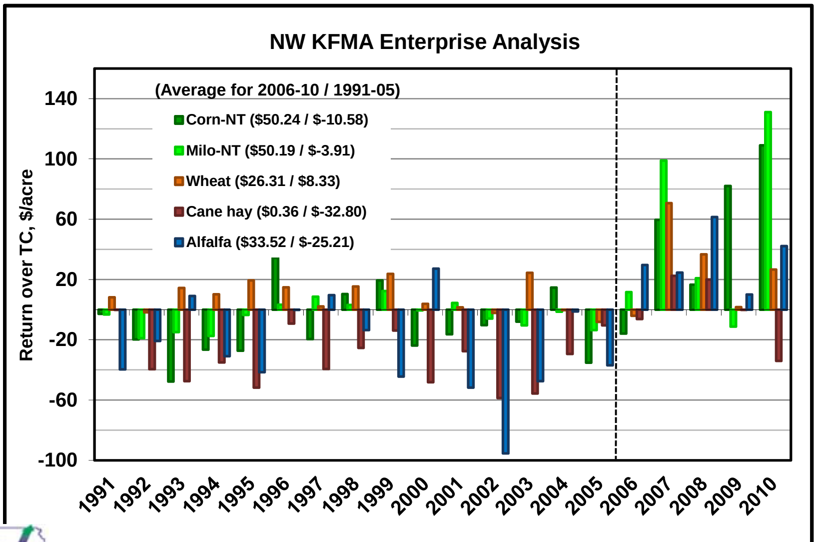
* Std Dev is standard deviation over 1991-2010 time period.

In recent years things have been quite good suggesting an adjustment may be coming…

5-year average returns	
Corn-NT	$50.24
Milo-NT	$50.19
Wheat	$26.31
Cane hay	$0.36
Alfalfa	$33.52

Source: KFMA Enterprise Analysis Report

On average, we seldom cover total costs. Why?



Source: KFMA Enterprise Analysis Report

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Returns look pretty good for the last several years…

… does this mean that all crop farmers are making lots of money?

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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

* 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).

Average returns over TC quite good for most crops…

Average Income, Total Costs, and 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
INCOME ($/acre)						
Yield per acre, bu	113.3	187.1	92.4	39.3	41.2	3.6
Price per unit	$3.78	$3.91	$3.43	$5.83	$9.36	$95.01
Crop income[1]	$370.20	$640.02	$263.45	$193.22	$332.27	$328.99
Government payment	$13.95	$24.93	$14.42	$15.75	$12.58	$8.72
Gross income	$397.03	$694.53	$287.94	$233.50	$353.63	$340.66
COSTS ($/acre)[2]						
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
Herbicide-insecticide	30.94	47.44	33.92	11.11	24.01	11.36
Crop insurance	16.66	24.65	11.50	11.28	13.01	0.15
Machinery	97.49	126.23	83.73	86.92	92.22	120.18
Other	25.39	42.88	22.20	22.99	24.70	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
Net Return to Management	$37.03	$99.27	$22.58	-$8.09	$80.47	$73.02

[1] Does not equal yield x price because landowner's share of production is excluded from crop income.
[2] Based on the operator's share of production, and thus includes only production expenses paid by the operator.

Not everybody is making money though…

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
INCOME ($/acre)						
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	$166.63
COSTS ($/acre)[1]						
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
Net Return to Management	$140.72	$256.98	$126.60	$125.28	$141.18	$182.75
Enterprise acres	184	-99	201	606	150	-28
Operator percentage	4.2%	-7.3%	-0.6%	-1.6%	3.0%	6.5%
Yield effect	37.9%	19.9%	48.1%	34.3%	45.7%	49.3%
Price effect	18.5%	16.2%	7.5%	9.9%	11.8%	29.0%
Operator % effect	13.0%	-18.5%	-1.4%	-3.8%	9.1%	12.9%
Cost effect	30.6%	82.4%	45.8%	59.5%	33.3%	8.8%

[1] Based on the operator's share of production, and thus includes only production expenses paid by the operator.

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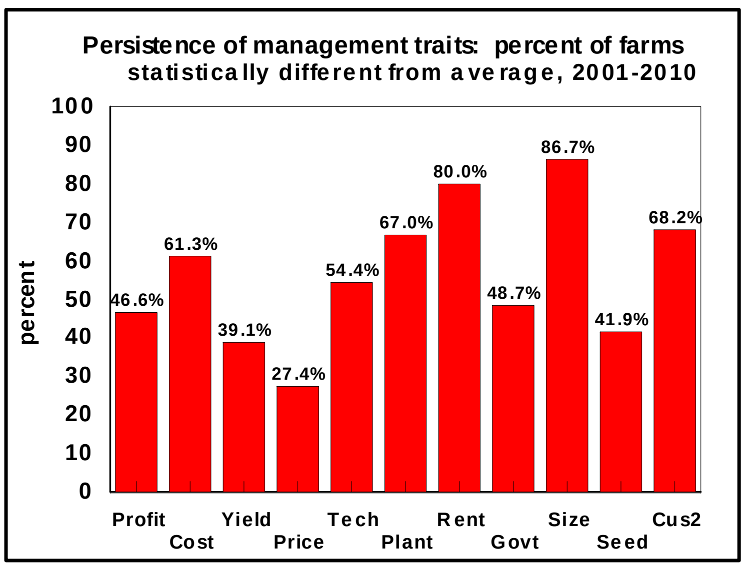
Persistence --

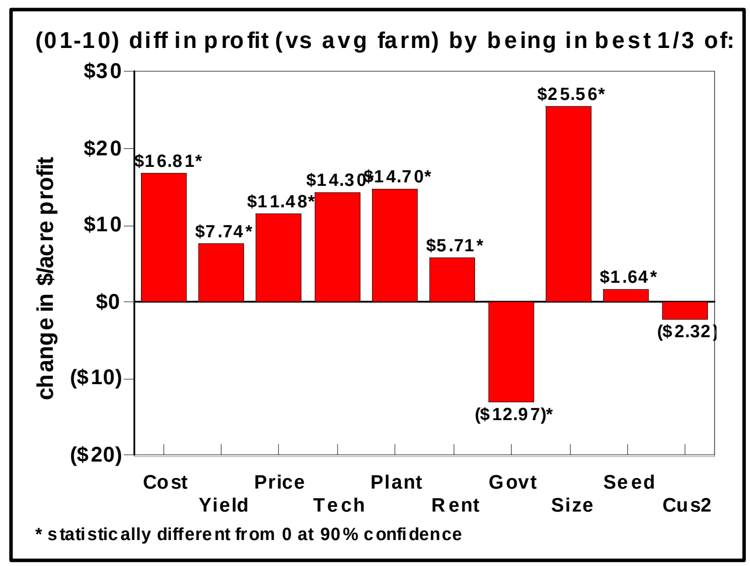
Something is said to be persistent if it is consistently different (better or worse) than average. Thus, the less persistent something is, the more random it is.

What does this mean in terms of where we should spend our management efforts?

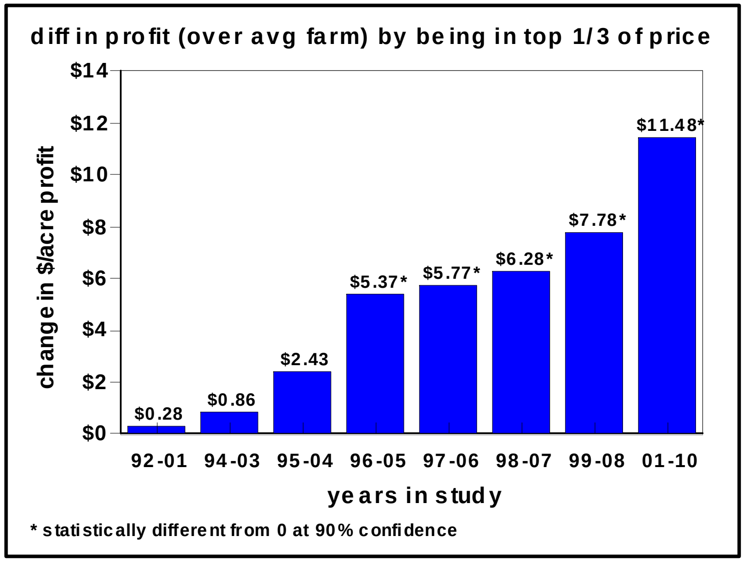
Persistence of management traits…



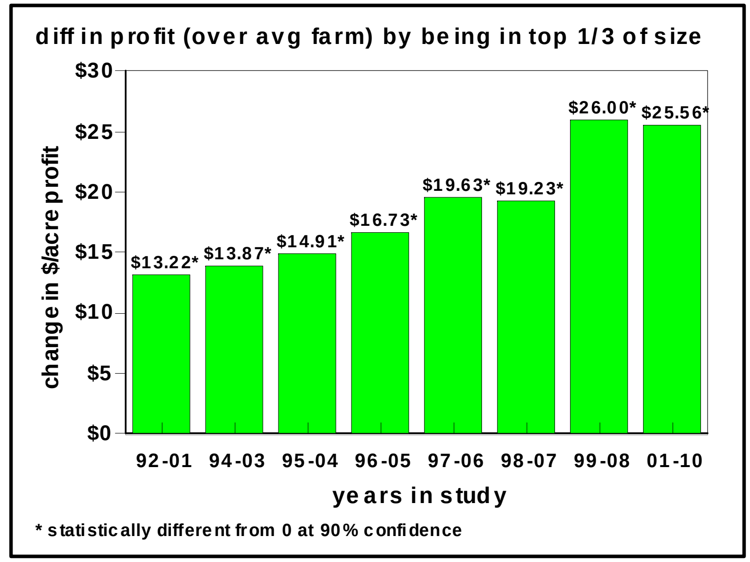
Factors impacting profitability differences…



Price is becoming more important over time…



The benefit of being larger than average is also increasing…

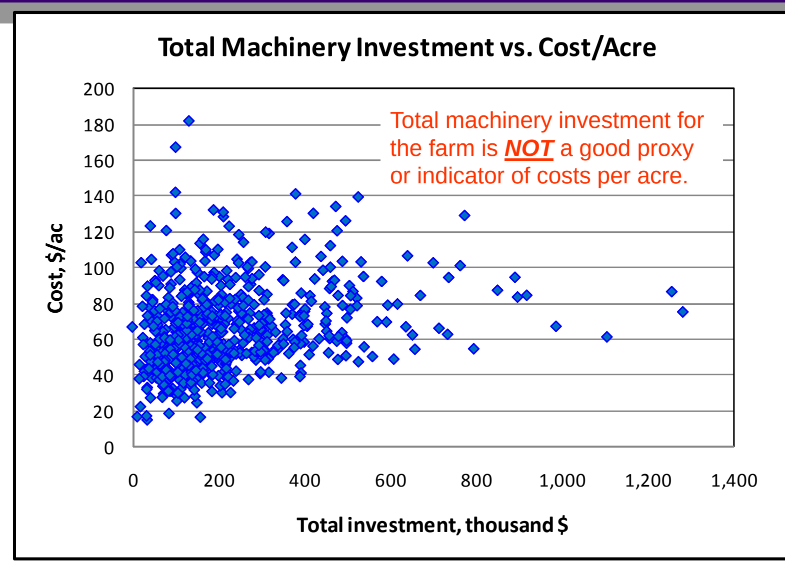


Key drivers of profitability differences among producers…

- Costs
- Technology adoption
- Farm size

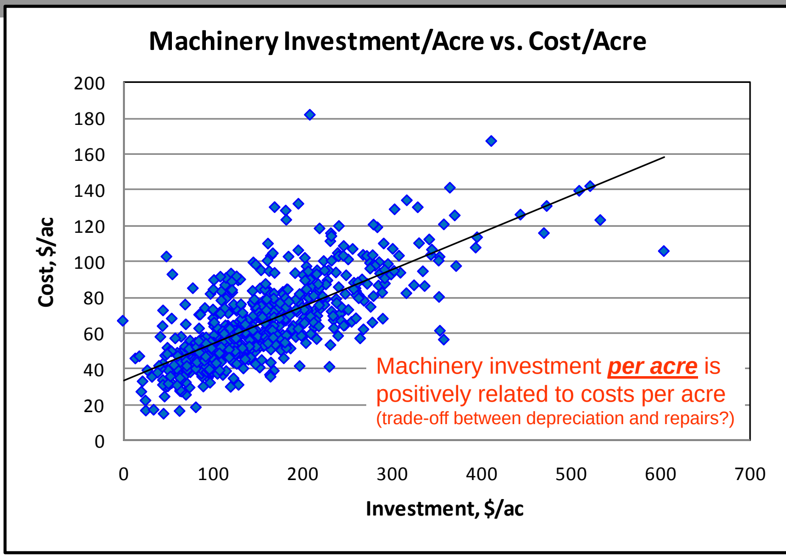
…machinery investment and costs are directly related to these three factors.

Machinery investment is not the same as machinery cost



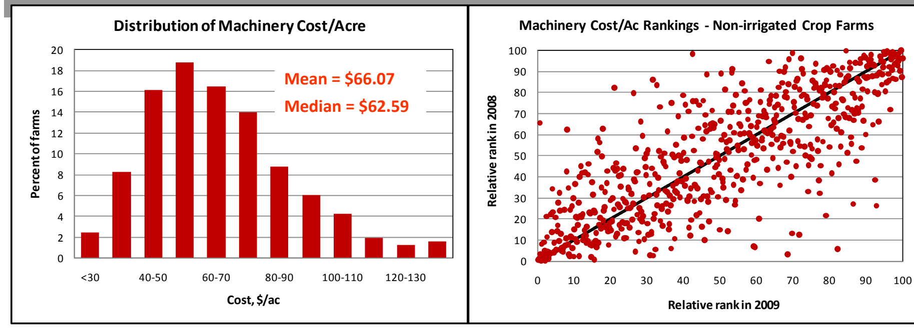
Source: KFMA non-irrigated crop farms having continuous data from 2005-2009
(minimum of 160 acres and machinery cost/acre > $10/ac; costs do not include labor – total of 614 farms)

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)

Information presented at 2010 R&P Conference…



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)

Tremendous variability in machinery costs across producers and costs are quite persistent from year to year…

What drives this variability?

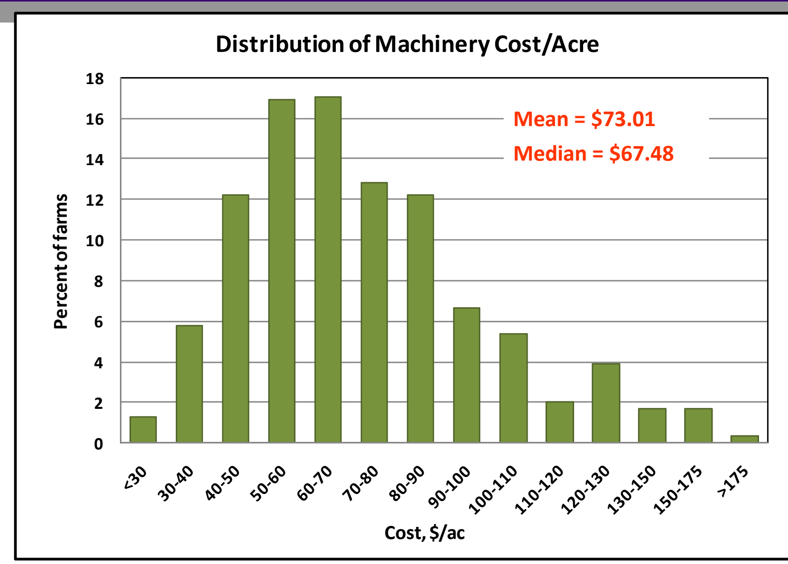
What leads to some producers having lower costs?

1) **Hard to beat intensity of use as a cost reducer**

2) **Hard to beat machinery size as a cost reducer**

(at least historically)

Different sample of farms, but similar variability…



Source: KFMA farms having continuous data from 2006-2010 and crop labor percentage ≥ 75%
(minimum of 160 acres and machinery cost/acre > $10/ac; costs do not include labor – total of 539 farms)

KFMA machinery costs definition…

- **Total Crop Machinery Cost (TCMC)**
  - Equal to the crop share of machinery repairs, gas-fuel-oil, auto expense, motor vehicle depreciation, listed property depreciation, and machinery and equipment depreciation plus crop machine hire expense plus an opportunity interest charge on crop machinery investment minus machine work income.*

- **Machinery cost/acre = TCMC/total crop acres**

* Note – labor associated with operating and servicing machinery is not included in total crop machinery cost.

Can we explain variability in machinery costs?

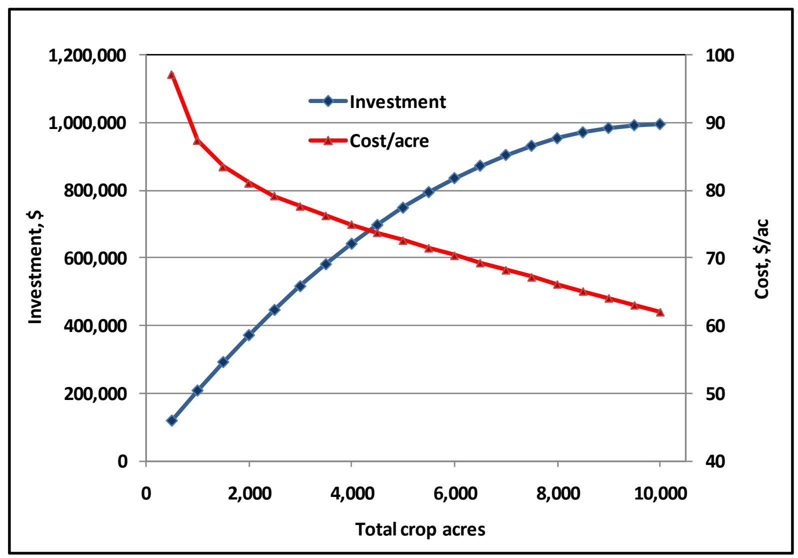
- **Cost/ac was estimated as a function of…**
  - investment/acre
  - crop acres
  - region (SE is default)
  - % acres irrigated
  - % acres corn
  - % acres other row crop
  - % acres hay
  - no-till (when available)
  - custom income as % of value of production

Machinery cost model results…

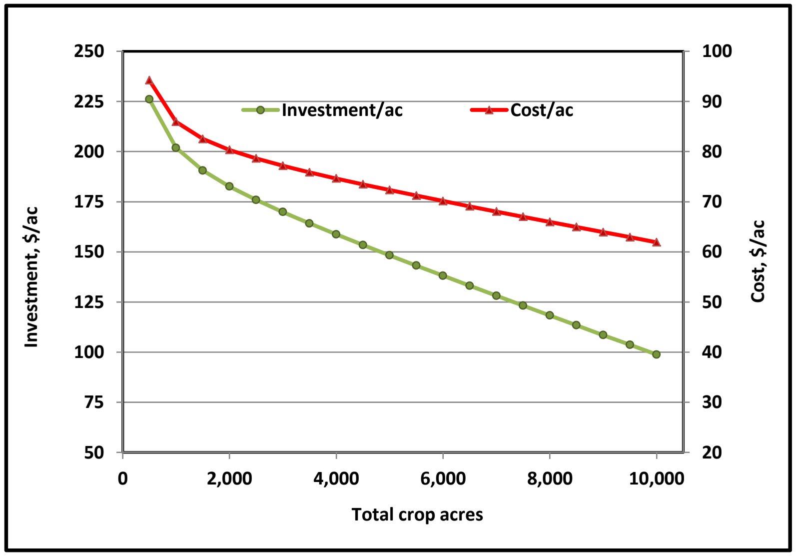
Model of Machinery Cost/Acre (2006-2010 data)

Variable	Estimate	p-value
Intercept	22.61	<.0001
MachInvAcX	0.20	<.0001
TCAinv	3352.19	0.0005
NW	-0.21	0.9663
SW	0.28	0.9468
NC	9.91	0.0022
SC	10.18	0.0008
NE	-5.12	0.0810
IrrAcPctX	7.13	0.2240
CrnAcPctX	33.34	<.0001
OthAcPctX	3.18	0.6101
HayAcPctX	29.61	<.0001
NCntX	-8.79	0.0268
SCntX	-16.88	<.0001
NEntX	-3.56	0.3778
NWntX	-6.67	0.2246
MachHirePctX	-68.51	0.0034
Adjusted R-square	0.62	
RMSE	17.09	
Number of observations	539	

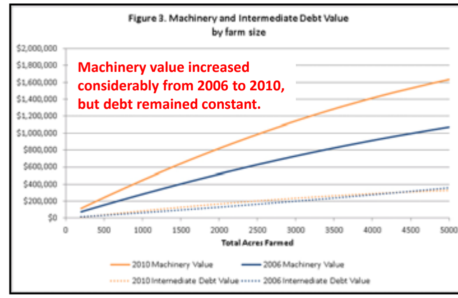
Machinery investment and cost/acre vs. farm size…

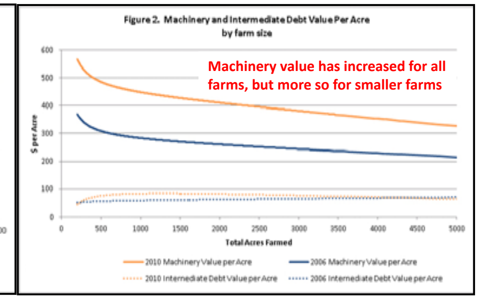


Investment/ac falls faster than cost/ac with farm size…



Machinery investment and debt vs. farm size…





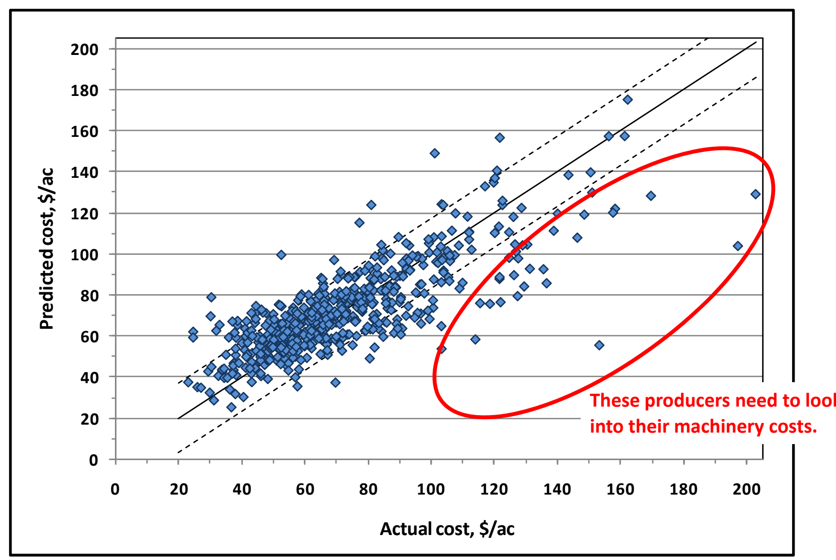
Previous results are not unique to KS, while absolute value vary considerably, similar patterns hold in the Corn Belt…

Source: Illinois FBFM (grain farms only)

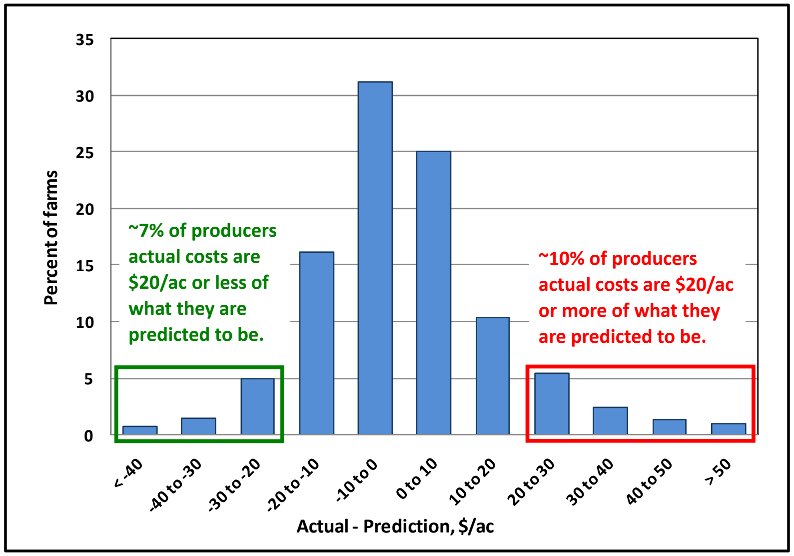
Model can be used to calculate "expected" costs…

- **Actual costs (KFMA value)**
- **Expected costs (i.e., model-predicted costs)**
  (KFMA "x-variables" multiplied by model coefficients)
- **Error (difference between actual and predicted values)**
  - **Actual – Predicted (absolute measure)**
    ➔ positive values are "bad" and negative values are "good"

Actual costs versus model-predicted costs…



Actual costs versus model-predicted costs…



Summary of machinery cost model results…

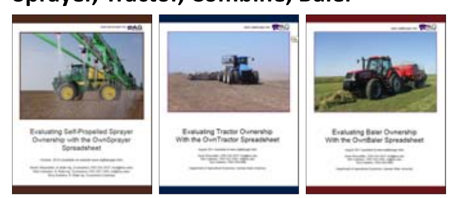
- **Higher investment/acre leads to higher cost**
- **Larger farms have lower cost**
  (primarily the result of having lower investment/acre)
- **NC/SC farms have higher costs and NE farms have lower costs relative to SE region (other regions are similar to SE)**
- **Irrigated farms have slightly higher costs**
  (only marginally statistically significant)
- **Farms with higher proportion of acres in corn and hay have higher costs**
- **No-till farms (in 2010) in NC/SC regions had lower costs**
  (similar for NE/NW farms but not statistically significant)
- **Higher custom work income leads to lower cost**

Summary of machinery cost model results…

- **Considerable variability in machinery costs across producers**
- **Characteristics of operation can explain much of that variability, but not all of it (i.e., "other stuff matters")**
- **Investment per acre is an important variable in explaining differences**
- **Producers are encouraged to use available tools to help them make machinery investment decisions that best fit their operations**

Machinery decision-tools available from KSU…

- **OwnSeries (Excel spreadsheets)**
  -- Sprayer, Tractor, Combine, Baler



Sprayer, Tractor, and Baler models recently updated. Combine model to be updated in near future. Models estimate the cost of owning and operating equipment given user input for annual usage, age, purchase price, tax rates, etc.

- **Guidance and section controller calculators**
  -- Excel spreadsheets and web dashboard
- **Excel spreadsheets for trucks and buildings**
- **KSU-MachCost – benchmarking spreadsheet**
- **Custom rate projections (web dashboard)**

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Impact of distance from headquarters on costs – economics of travel logistics

Analysis based on
KSU-DistanceToFields.xls

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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…

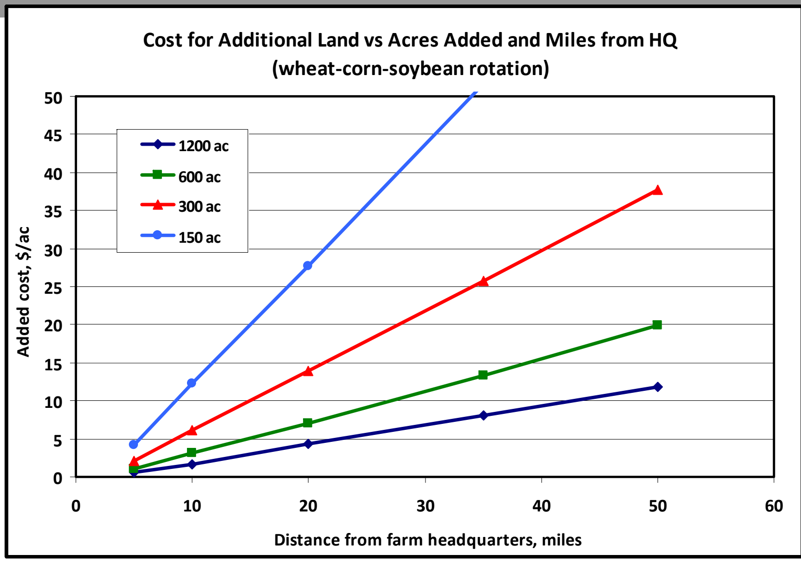
Travel costs are a function of:

- Crop acres and rotation
- Distance from headquarters/nearest field
- 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 for simple example…

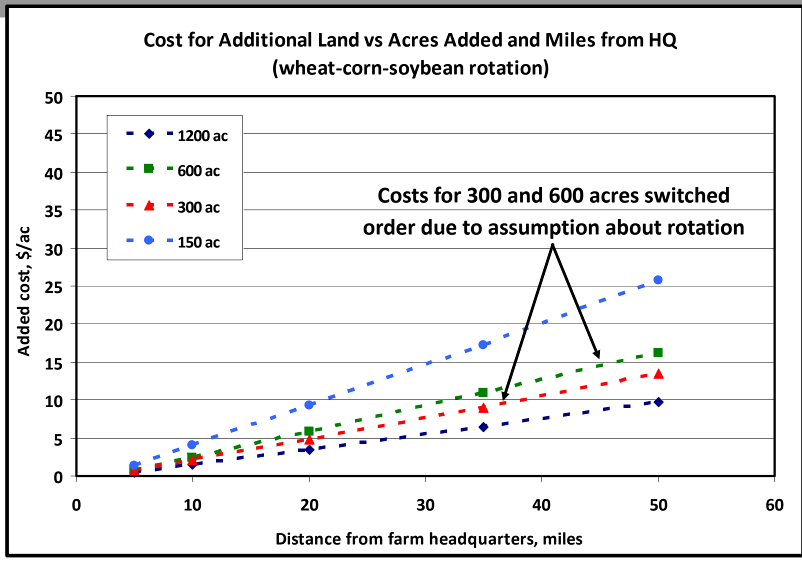
- **Acres –** 150, 300, 600, and 1200
- **Crop rotation –** corn/soybean/wheat
  (plant each crop each year and rotate by year (300 acres or less))
- **Distance from HQ –** 5, 10, 20, 35, 50 (current fields 2.5)
- **Distance from elevator/input source –** 15 miles
- **Labor costs per hour –** $15
- **Vehicle 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**

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).

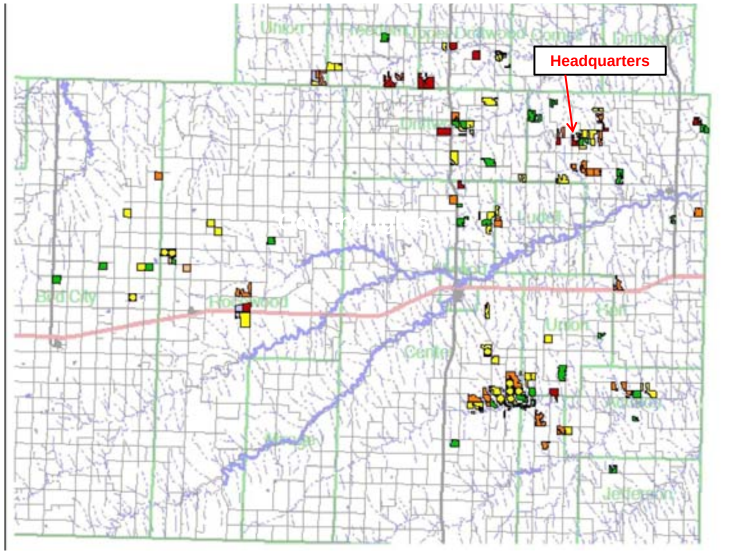
Thoughts about travel distance…

- **Road distance is the distance of choice**
  - **Can use GIS distance times a factor as an estimation**
  - **Kastens uses a factor of 1.34**
- **With larger farms and larger equipment the during-day distance from field to field can matter**
  - **If go to a random field to start the day:**
    - **Best during-day field-to-field distance is optimized traveling-salesman problem, using average whole-farm nearest-field distance**
    - **Worst is probably average whole-farm field-to-field distance**
  - **Work with a weighted avg of these two numbers, by field operation**
- **Intuition not a good guide (eventually will have data)**

Different ways to view a new parcel in the analysis

- **Standalone parcel in terms of acres:**
  - **Use distance from HQ**
  - **Use distance from nearest existing field**
- **Incorporate new farm into existing operation**
  - **Start with all operation acres and acres-weighted distance**
  - **Compute total travel cost for whole farm (original operation)**
  - **Add in new acres and new acres-weighted distance**
  - **Compute total travel cost for whole farm (with new parcel)**
  - **Subtract original travel cost from new farm travel cost**
  - **Divide by number of acres in added parcel**

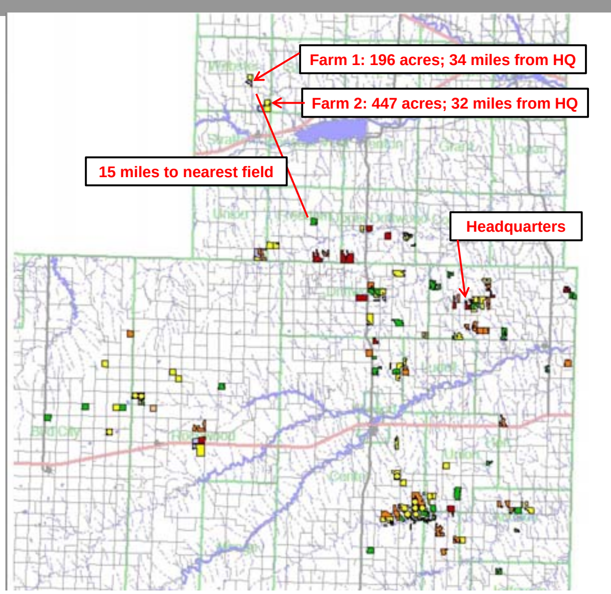
Example from Kastens Farm



A few base assumptions for Kastens Farm

- **Crop rotation – wheat/corn/milo/peas (each crop each year)**
  - **Wheat & corn – plant, spray, scout, harvest**
  - **Milo & peas – plant, spray, scout (harvest custom done)**
- **Existing operation:**
  - **Acres-weighted average distance from HQ = 21.29 mi**
  - **To get at during-day field-to-field travel weight these:**
    - **Avg nearest field distance = 2.03 mi**
    - **Random field-to-field distance = 20.60 mi**
    - **Our weights imply these during-day field-to-field miles:**
    - **Spraying 4, planting 8, harvest 8, scouting 4**
  - **Average travel cost = $2.59/a**

Several farms to possibly add…



Farm 1 or Farm 1&2, standalone, from HQ

- **Farm 1 (196 ac), distance from HQ = 34 mi (between fields=0)**
  - **Travel cost If plant 4 crops each year = $41.54/a**
  - **Travel cost If plant 1 crop each year = $11.96/a**
- **Farm 1&2 (643 ac), distance from HQ = 33 mi (between fields=1)**
  - **Travel cost If plant 4 crops each year = $14.33/a**
  - **Travel cost If plant 1 crop each year = $5.34/a**
- **Size of tract can matter a lot**
- **Overstates cost because wouldn't stage from HQ**

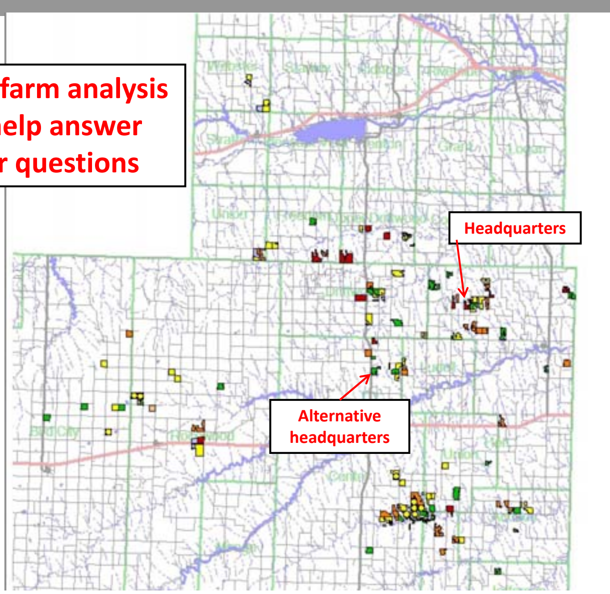
Farm 1 or Farm 1&2, standalone, from nearest field

- **Farm 1 (196 ac), distance from NF = 16 mi** (between fields=0)
  - Travel cost If plant 4 crops each year = $19.55/a
  - Travel cost If plant 1 crop each year = $5.63/a
- **Farm 1&2 (643 ac), distance from NF = 15 mi** (between fields=1)
  - Travel cost If plant 4 crops each year = $8.23/a
  - Travel cost If plant 1 crop each year = $2.67/a

Whole farm analysis of bringing in Farm 1&2

- **Acres-weighted average distance from HQ:**
  - Goes from 21.29 miles to 21.97 miles
- **Avg nearest field distance:**
  - Goes from 2.03 miles to 2.28 miles
- **Avg random field-to-field distance:**
  - Goes from 20.60 miles to 21.80 miles
- **Avg whole-farm travel cost:**
  - Goes from $2.59/a to $2.65/a
  - Assign increase to only Farm 1&2 implies $4.26/a (4 crops)

Whole farm analysis can help answer other questions



Changing location for farm headquarters

- **Acres-weighted average distance from headquarters:**
  - Goes from 21.97 miles to 15.98 miles
- **Avg nearest field distance stays about the same**
- **Avg random field-to-field distance about the same**
- **Avg whole-farm travel cost:**
  - Goes from $2.65/a to $2.22/a (small incentive to move)
- **Many other things matter to a move of headquarters**
  - Employee travel, closer to town, good roads, grain storage at new site – so no future building investment at old site
- **Bottom line: annual benefit around $32,000**
  - Would that support the required investment?????

What analytical method should I use?

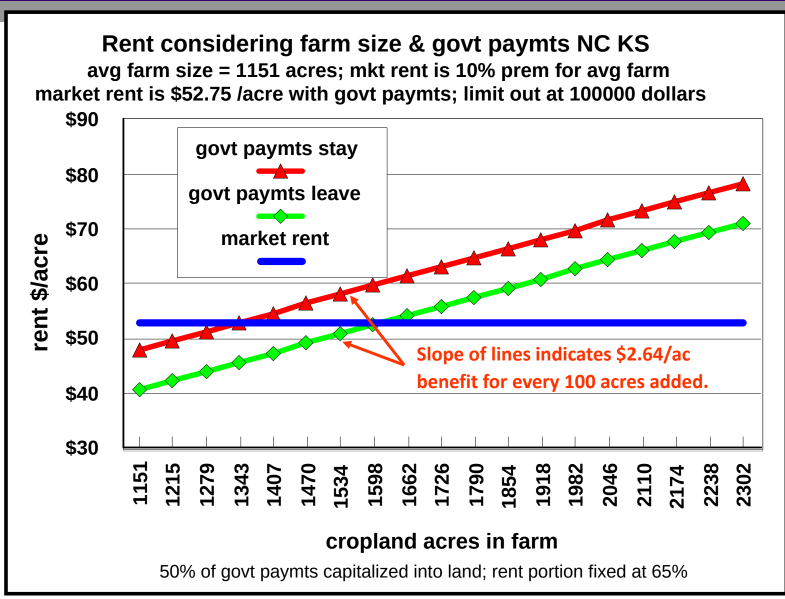
- **Use standalone method from nearest field for:**
  - **most small-acreage additions (e.g., a land purchase)**
  - **Requires least information and easy to do**
  - **Likely the most accurate for such situations**

- **Use whole-farm analysis for:**
  - **potential additions of scattered tracts as a group (e.g., renting all land currently being operated by a retiring farmer)**
  - **Broader decisions like moving headquarters**
  - **Requires more information**
  - **Likely the most accurate for such situations**

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



Some simple math behind EOS benefits of adding land

Base operation	**1,500 ac**	
Average rent	**$55/ac**	
Additional ground	**200 ac**	
EOS benefit	**$2.64/ac**	**(i.e., could pay $57.64/ac)**
Total rent "could pay"	**$97,988**	**(1,700 x $57.64/ac)**
Rent on base operation	**$82,500**	**(1,500 x $55.00)**
Difference	**$15,488**	**($15,488/200 = $77.44/ac)**
Premium on new land	**$22.44/ac**	

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