Kansas State UNIVERSITY

Department of Agricultural Economics

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How Far to the Field?

The Economics of Travel Logistics

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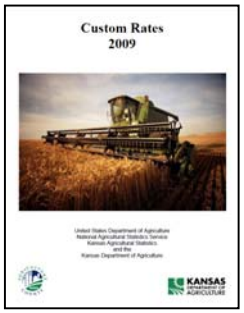
Motivation

- 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).

But, first some background information as to why this is important…

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 proxy for average machinery cost



Custom rates background…

- **Custom rates for machinery operations in Kansas have historically been reported by Kansas Agricultural Statistics based upon annual surveys***

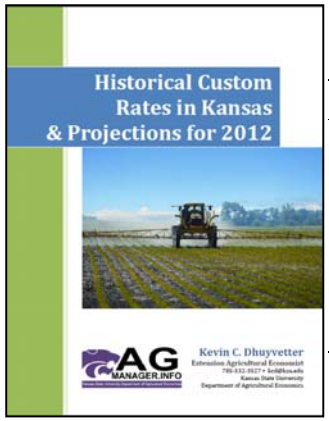
Discontinued in 2010 due to budget constraints!

* Survey is sent to farmers, ranchers, custom operators, co-ops and elevators and reported in Jan of the following year. Format of report has varied over time, but information reported has been relatively consistent. Historical publications for years 1973 through 2009 were obtained with the exception of 1986 when there was no report due to budget cuts.

Historical and predicted rates published in paper…

Predicted values in report were based on diesel price forecasts available at that point in time (as well as forecast for PCE).

Problem → If fuel prices change significantly, forecasts need to be updated.



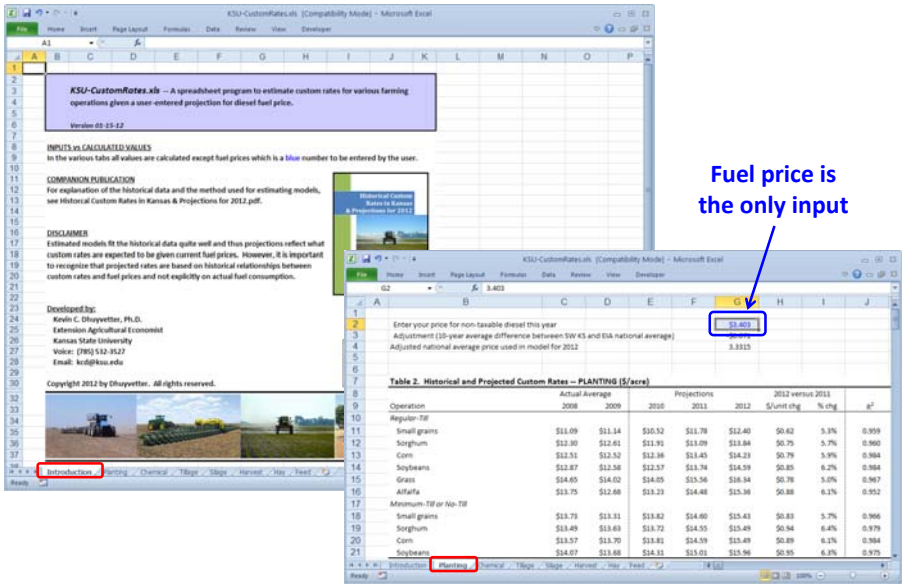
Actual rates **Predicted rates (absolute vs. relative)**

Table 2. Historical and Projected Custom Rates -- PLANTING ($/acre)

Operation	Actual Average 2008	Actual Average 2009	Projections 2010	Projections 2011	Projections 2012	2012 versus 2011 $/unit chg	2012 versus 2011 % chg	R^2
Regular-Till								
Small grains	$11.09	$11.14	$10.52	$11.78	$12.40	$0.62	5.3%	0.959
Sorghum	$12.30	$12.61	$11.91	$13.09	$13.84	$0.75	5.7%	0.960
Corn	$12.51	$12.52	$12.36	$13.45	$14.23	$0.79	5.9%	0.984
Soybeans	$12.87	$12.58	$12.57	$13.74	$14.59	$0.85	6.2%	0.984
Grass	$14.65	$14.02	$14.05	$15.56	$16.34	$0.78	5.0%	0.967
Alfalfa	$13.75	$12.68	$13.23	$14.48	$15.36	$0.88	6.1%	0.952
Minimum-Till or No-Till								
Small grains	$13.73	$13.31	$13.82	$14.60	$15.43	$0.83	5.7%	0.966
Sorghum	$13.49	$13.63	$13.72	$14.55	$15.49	$0.94	6.4%	0.979
Corn	$13.57	$13.70	$13.81	$14.59	$15.49	$0.89	6.1%	0.984
Soybeans	$14.07	$13.68	$14.31	$15.01	$15.96	$0.95	6.3%	0.975

Goodness of Fit

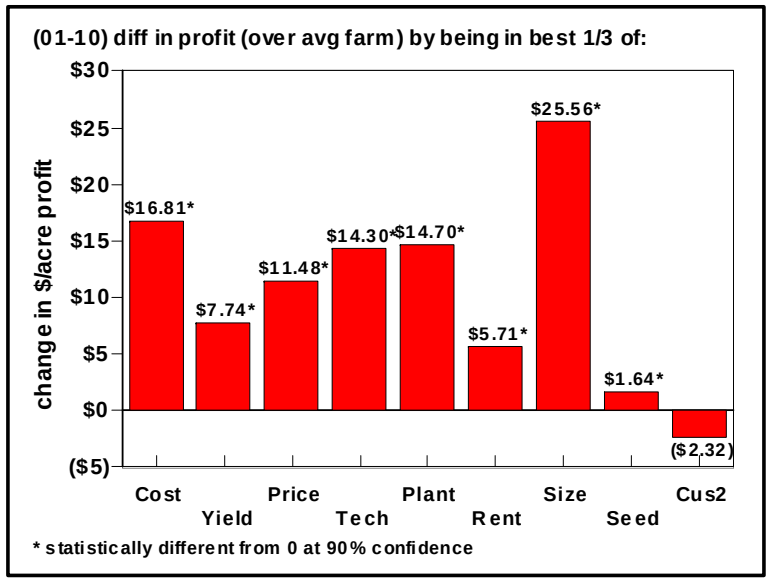
Spreadsheet that allows user to change fuel price…



Key drivers of profitability differences among producers…

- **Costs**
- **Technology adoption**
- **Farm size**

Factors impacting profitability differences…

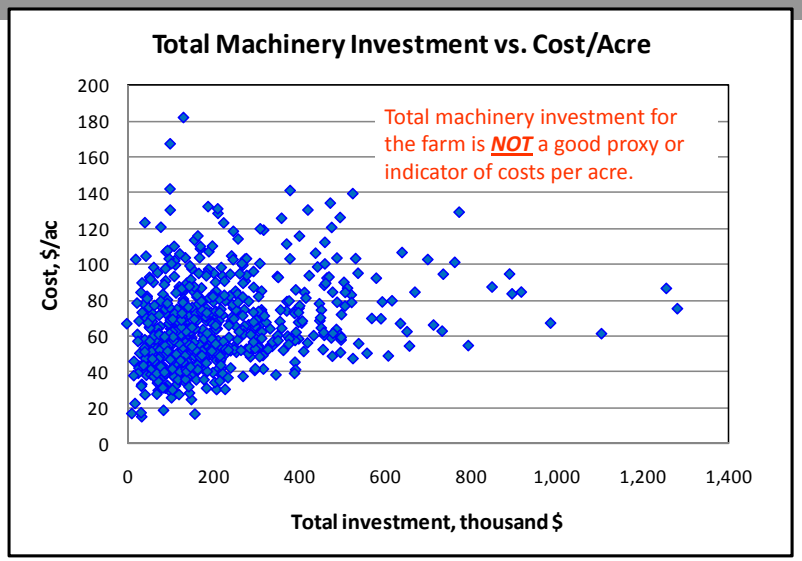


Key drivers of profitability differences among producers…

- **Costs**
- **Technology adoption**
- **Farm size**

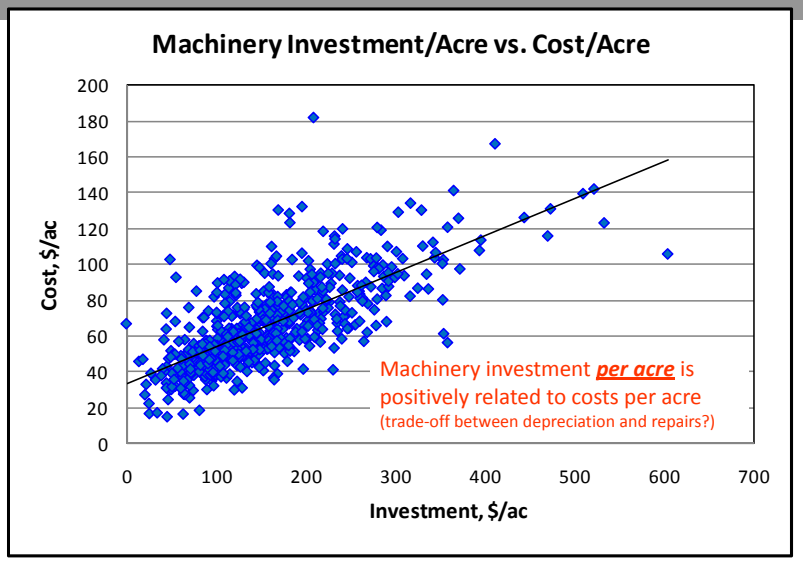
…machinery investment and costs are directly related to these three factors.

Machinery 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
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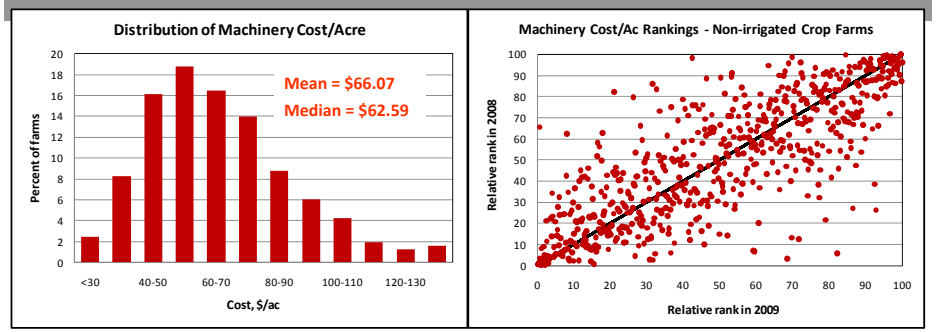
Information presented at 2010 R&P Conference…

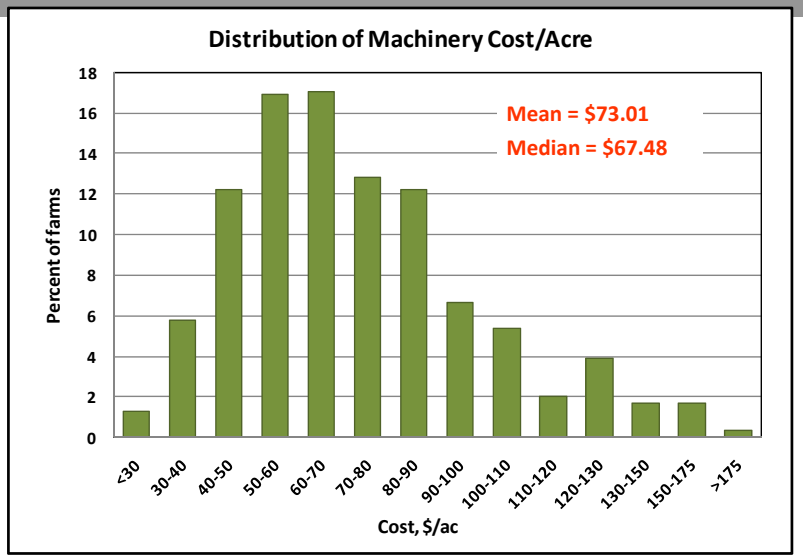


Source: KFMA non-irrigated crop farms having continuous data from 2005-2009
(minimum of 160 acres and machinery cost/acre > $10/ac; costs do not include labor – total of 614 farms)

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

What drives this variability?

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**

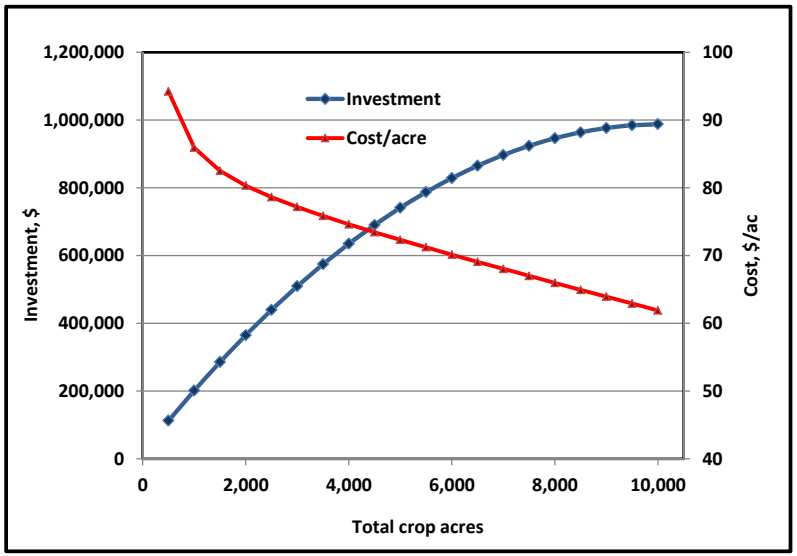
*** Valentin and Wood (2002 Risk & Profit) estimated total machinery costs as a function of acres of various crops and machine work income.**

Machinery cost model results…

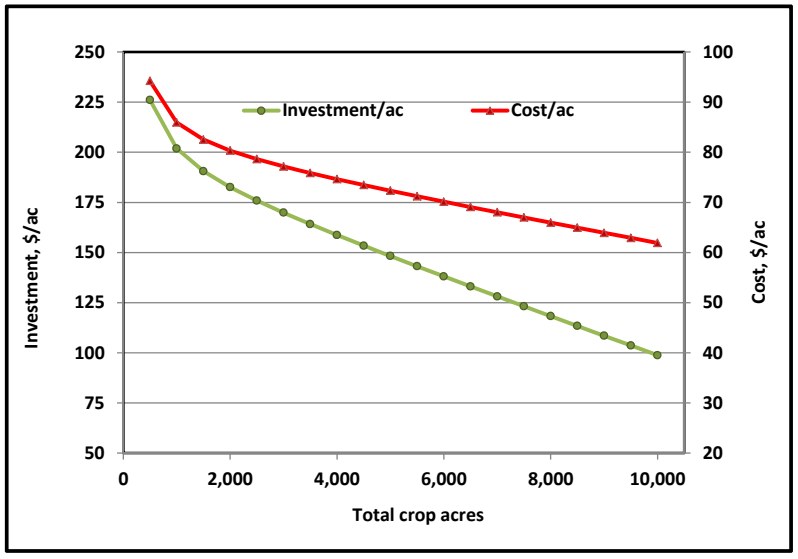
Model of Machinery Cost/Acre (2006-2010 data)

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	

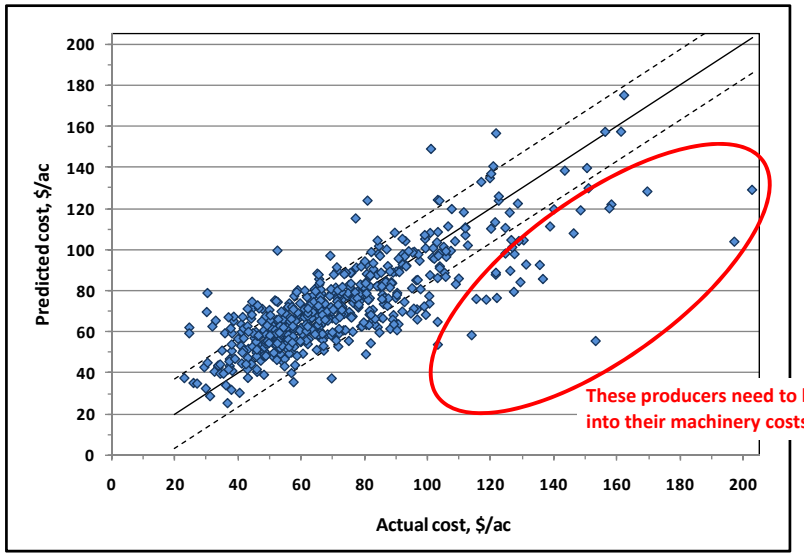
Machinery investment and cost/acre vs. farm size…



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

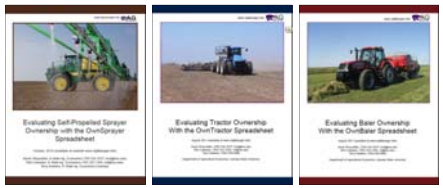


Actual costs versus model-predicted costs…



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)**

Impact of distance from headquarters on costs

Analysis based on
KSU-DistanceToFields.xls

Field distance increases travel costs…

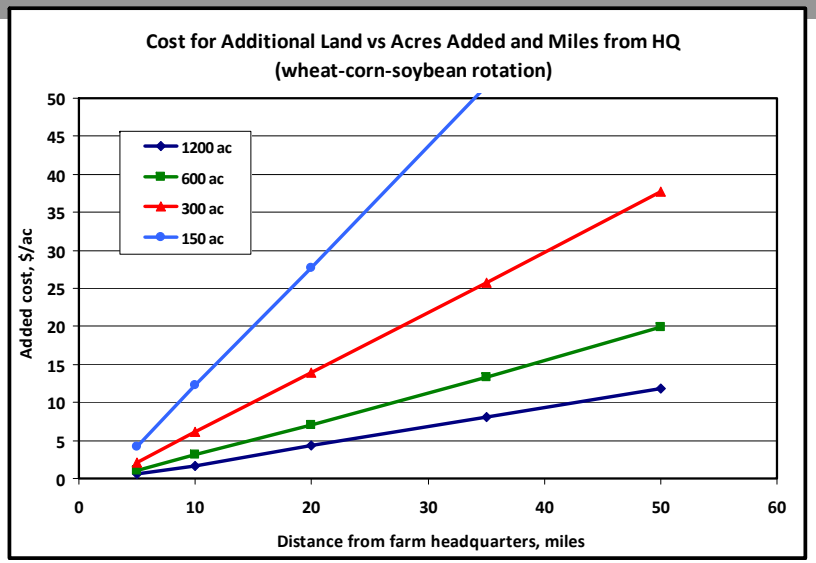
Travel costs are a function of:

- **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…

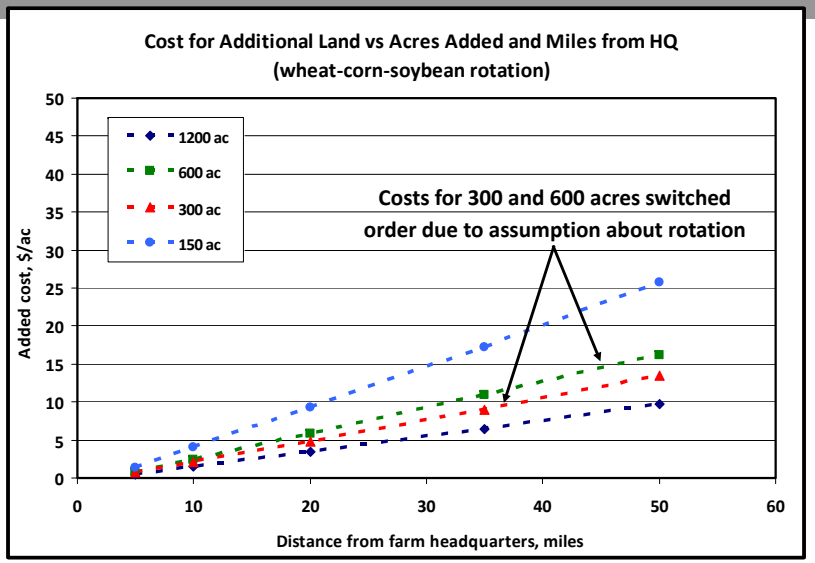
- **Acres – 150, 300, 600, and 1200**
- **Crop rotation -- corn/soybean/wheat**
  (plant each crop each year and rotate by year (300 acres or less))
- **Distance from HQ – 5, 10, 20, 35, 50 (current fields 2.5)**
- **Distance from elevator/input source – 15 miles**
- **Labor costs per hour – $15**
-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

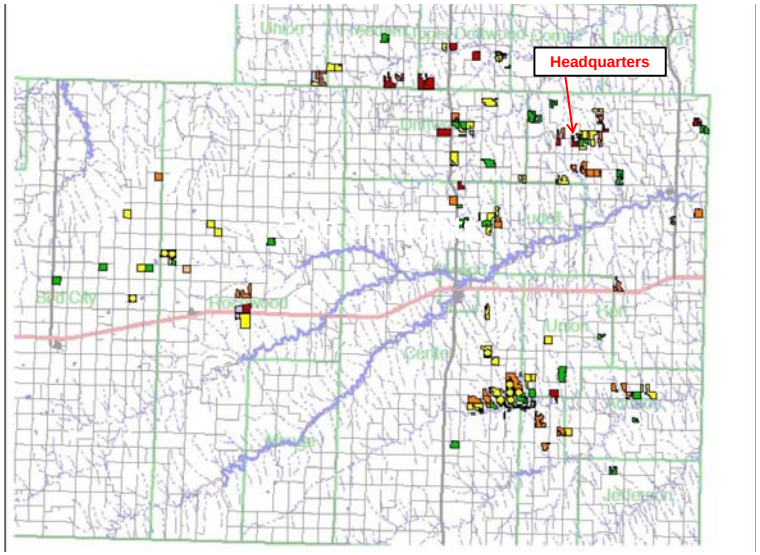
Thoughts about travel distance…

- **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**

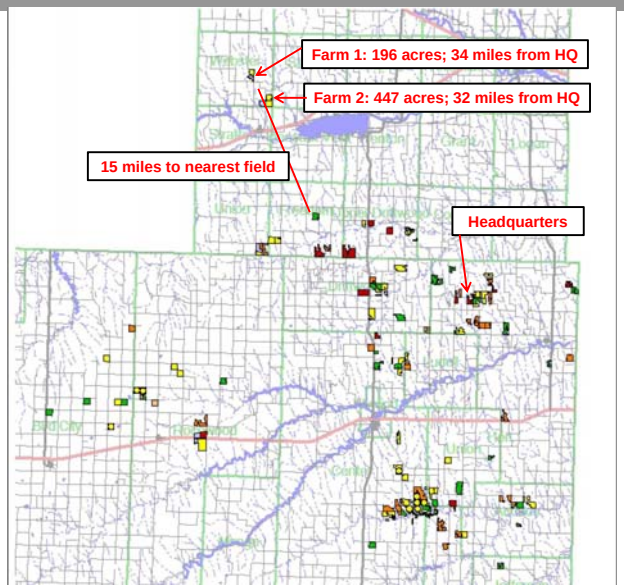
Example from Kastens Farm



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**

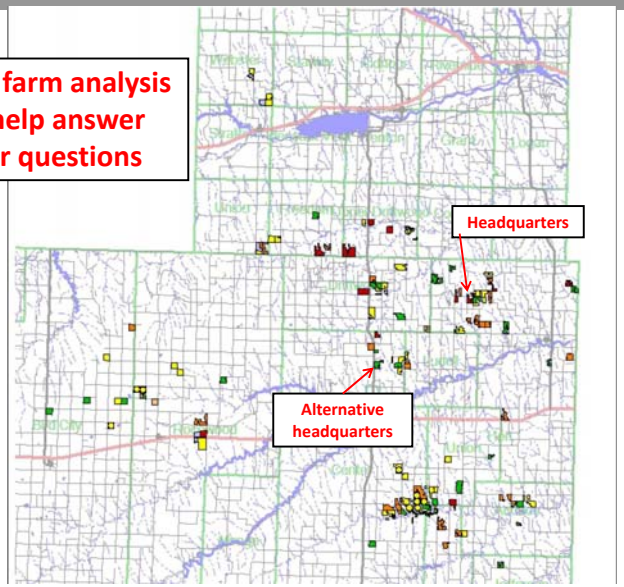
Farm 1 or Farm 1&2, standalone, from nearest field

- **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?

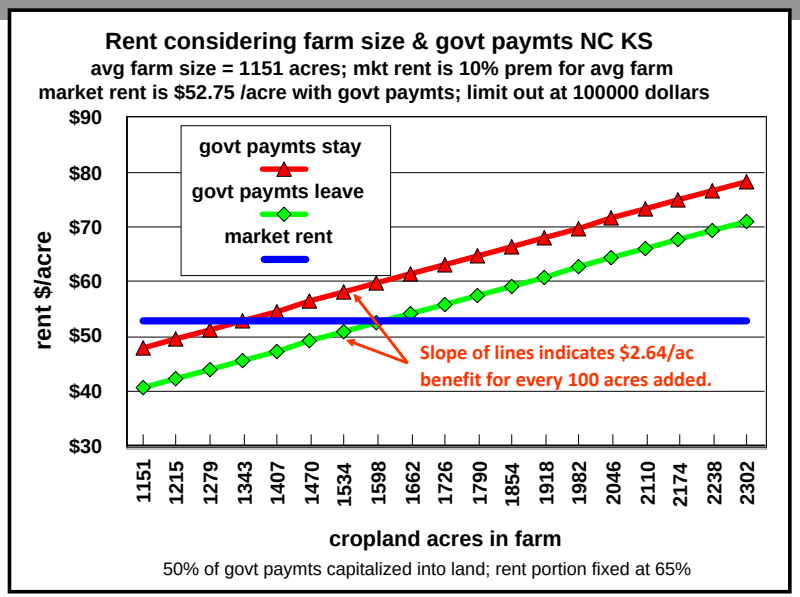
- **Use standalone method from nearest field for:**
  - most small-acreage additions (e.g., a land purchase)
  - Requires least information and easy to do
  - Likely the most accurate for such situations

- **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**

For more information and decision tools related to farm management, marketing, and risk management go to www.AgManager.info

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