Louisiana Agricultural Technology and Management Conference - LACA
Paragon Casino and Resort
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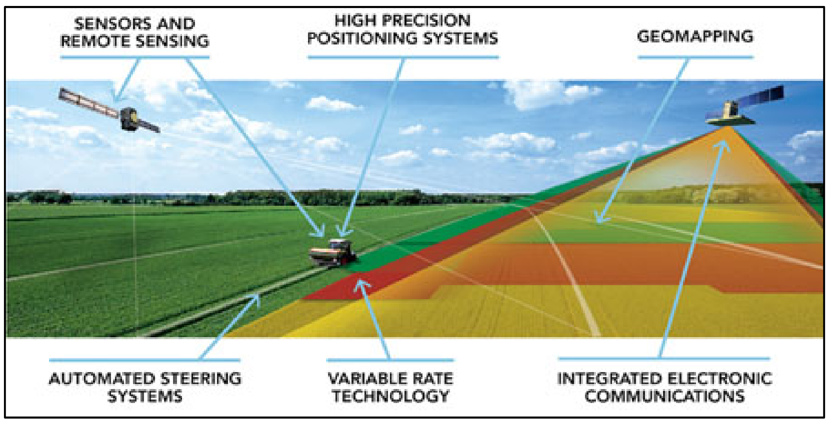
Economic Motivation Behind PA Adoption



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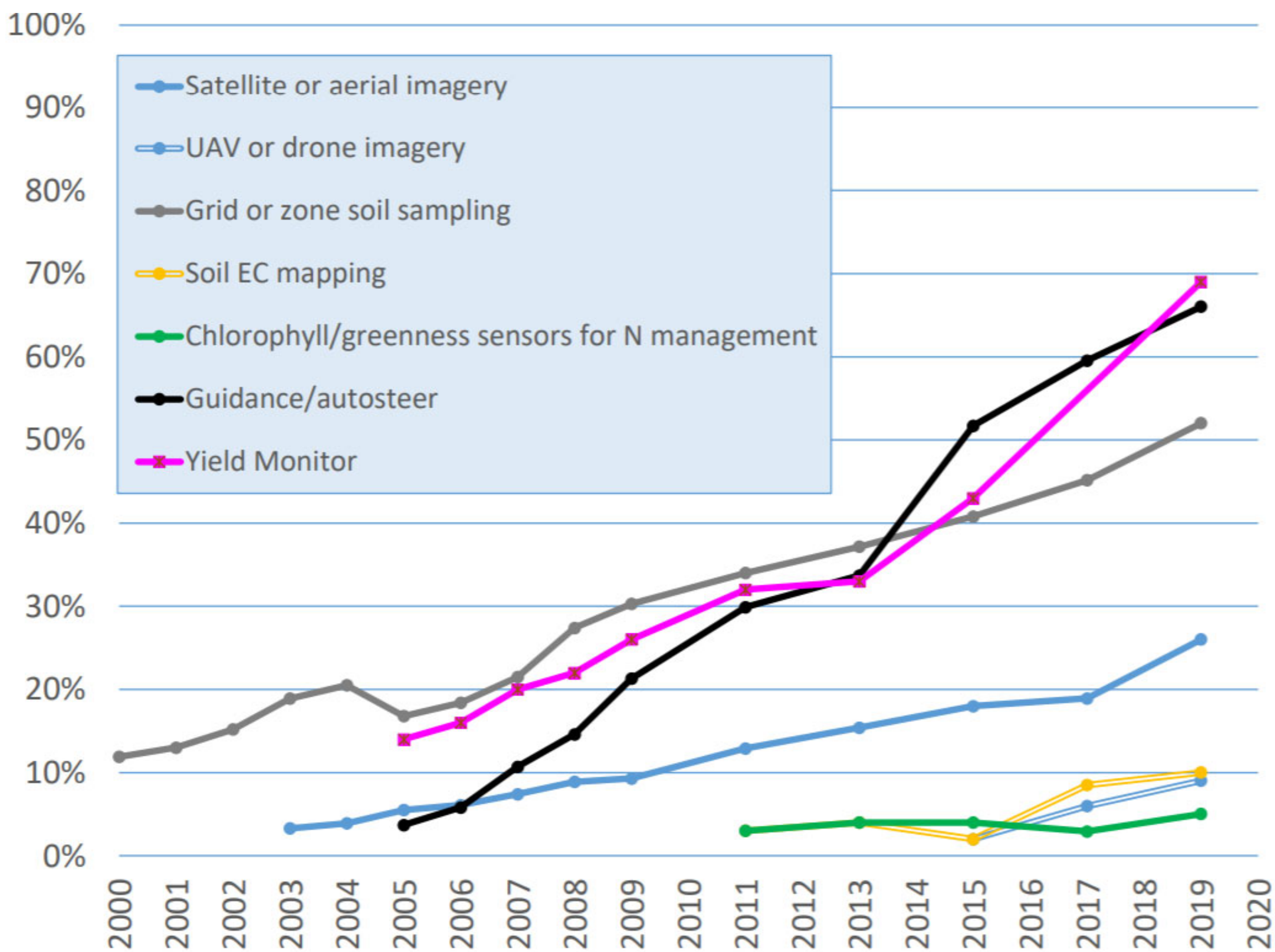
Estimating Producer Adoption of PA Technologies

The percent of acres in the retailer's market



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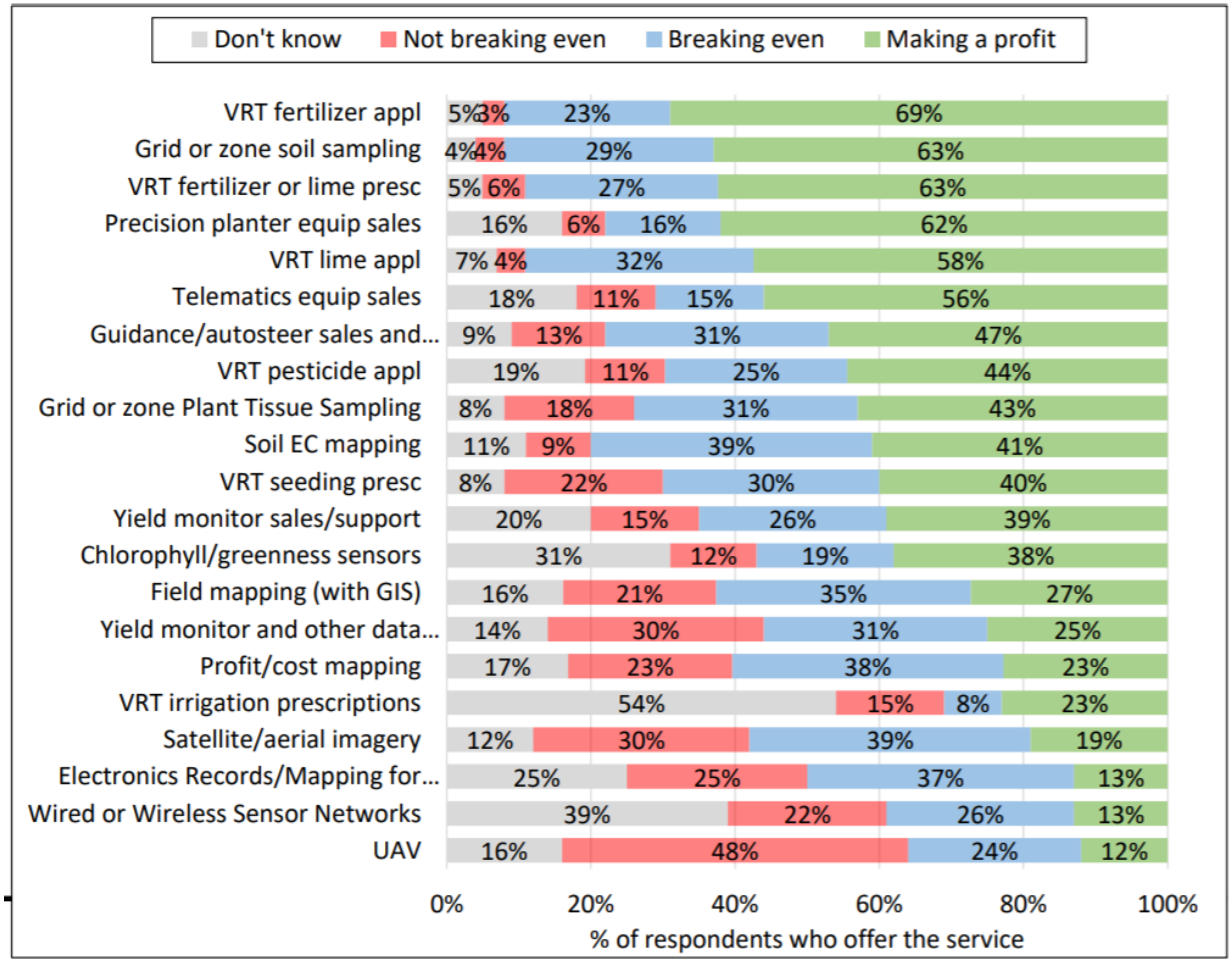
Retailer Use of Precision Ag Technology in 2019

GPS guidance, satellite and aerial imagery see biggest increases

Precision Ag Technology	2017	2019
GPS guidance systems with automatic control (autosteer) for fertilizer/chemical application	78%	86
Auto sprayer boom section or nozzle control	73%	72
GPS guidance systems with manual control (light bar) for fertilizer/chemical application	55%	56
Satellite/aerial imagery for internal dealership purposes	52%	65
Smart scouting using an app on a mobile device to record field situations and locations	44%	44
Field mapping with GIS to document work for billing/insurance/legal purposes	43%	46
UAV or drone for internal dealership purposes	34%	38
GPS to manage vehicle logistics, tracking locations of vehicles, and guiding vehicles to the next site	34%	36
Telematics to exchange information among applicators or to/from office locations	24%	30
Sprayer turn compensation	22%	22
Y drops on fertilizer applicators	19%	25
Other soil sensors for mapping, mounted on a pickup, applicator or tractor (example: pH sensor)	9%	9
Chlorophyll/greenness sensors mounted on a pickup, applicator or tractor (CropSpec, GreenSeeker, OptRx, etc.)	9%	7

Profitability of Technology Offerings

Percent of retailers indicate VRT as profitable, sensing services less profitable



Precision Agriculture: The Economic Analysis

Deriving the cost/benefit analysis

- Understanding:
  - The capital costs associated with technology acquisition
  - Annual operating costs associated with that technology
  - That technology's impact on labor demand
- Potential benefits derived from technology:
  - Increases in yield s
  - Increases in grain quality
  - Cost savings
  - Allows targeted input applications for improved results
  - Overcoming a constraint
  - Enhancing operator performance or implementation

Source: Grains Research and Development Corporation. Australian Government. February 2017.

Precision Agriculture: The Economic Analysis

Collecting data and information

- Economic costs:
  - Initial investment
  - Annual subscription fees
  - Repair and maintenance
  - Operating costs
  - Ownership costs
- Economic benefits:
  - Input savings
  - Yield/quality increases
  - Value of improve management decisions/strategies

Source: Shockley, J., 2016.

Precision Agriculture: Economic Rationale

Understanding Cost/Benefit Structures

- Is Economic Benefit>Economic Cost
  - Economic cost is not accounting cost
    - Accounting costs are explicit cost, money out of pocket
    - Economic costs are both accounting and implicit costs
      - Implicit costs are the opportunity costs of that investment, it considers the next best alternative of those resources and compares alternatives
  - Economic Benefit considers both near and long term results of a decision (in this case, PA adoption)

Source: Shockley, J., 2016.

Example #1: Investment Analysis

Purchasing land-leveling equipment – calculating the payback period (years)

	TRACTOR[1/] large 4 wd 300 hp		SCRAPER[2/] 18cu. yd.		LASER EQUIPMENT[3/]		LABOR		TOTAL COSTS	
Purchase Price ($)	**$**	**282,000**	**$**	**98,880**	**$**	**30,000**			--	
Expected Life (years)		**8**		**15**		**10**			--	
Salvage Value ($)	$	98,700	$	9,888	$	3,000			--	
[Percent of Purchase Price]		35%		10%		10%			--	
Annual Use (Hours)		**1200**		417		417			--	
Land Leveling (Hours)		417		417		417		417	--	
Repair Cost (% of Purchase Price)		**96.0%**		**66.0%**		**20.0%**			--	
Fuel Consumption (gals per hr)		**15.4418**							--	
OPERATING COSTS PER HOUR										
Fuel Costs ($)	$	28.57							$	28.57
Repair Cost ($)	$	28.20	$	10.44	$	1.44			$	40.08
Labor Costs ($15.30 per hour)								15.30	$	15.30
Total Operating Costs per Hour	$	56.77	$	10.44	$	1.44	$	15.30	$	83.95
FIXED COSTS PER HOUR										
Depreciation	$	19.09	$	14.24	$	6.48			$	39.81
Interest on Investment	$	7.53	$	6.20	$	1.88			$	15.62
Total Fixed Costs per Hour	$	26.63	$	20.44	$	8.36			$	55.43
TOTAL COSTS PER HOUR	$	83.40	$	30.88	$	9.80	$	15.30	$	139.38

Cycles per Hour				**8**						
Cubic Yards per Cycle				**18**						
Cubic Yards per Hour				**144**						
Cubic Yards per Acre				**300**						
Hours per Acre				**2.1**						
Acres Leveled per Year				**200**						
Annual Land Leveling Hours				**417**						
COSTS PER ACRE										
Operating Costs	**$**	**116.27**	**$**	**21.76**	**$**	**3.00**	**$**	**31.88**	**$**	**174.89**
Fixed Costs	**$**	**66.46**	**$**	**42.68**	**$**	**17.42**	**$**	**-**	**$**	**116.47**
Total Costs	**$**	**173.74**	**$**	**64.33**	**$**	**20.42**	**$**	**31.88**	**$**	**290.37**

Source: Deliberto and Hilbun, 2017.

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Example #1: Investment Analysis

Purchasing land-leveling equipment – calculating the payback period (years)

Example assumes a 61% GRW share of sugar production.

- *Payback period* is the number of years it would take an investment to return its original cost through the additional annual cash revenue it generates
  - ✓ "the sum of the benefit equals the investment"

$$\frac{Initial\ Costs\ of\ the\ Investment}{Expected\ Annual\ Cash\ Revenue} = \text{Payback Period in years}$$

$$\frac{\$290.37\ investment\ cost}{\$0.24\ sugar\ price * 213.5\ pounds\ of\ suagr} = 5.66\ \text{years}$$

Source: Deliberto and Hilbun, 2017.

Example #1: Investment Analysis

Purchasing land-leveling equipment – payback period (years)

Raw Sugar Price ($/lb)	Total Precision Investment Cost per Acre				
	$250	$275	$300	$325	$350
$0.22	5.3	5.9	6.4	6.9	7.5
$0.24	4.9	5.4	5.9	6.3	6.8
$0.26	4.5	5.0	5.4	5.9	6.3
$0.28	4.2	4.6	5.0	5.4	5.9
$0.30	3.9	4.3	4.7	5.1	5.5

Grower decides to perform the work on their farm. This analysis assumes a ***+ 5% increase in productivity*** *with a base yield of 7,000 pounds per acre. Note: Raw sugar price varies with a grower's share of production (set at 61%).*

Source: Deliberto and Hilbun, 2017.

Partial Budgeting

Evaluating Variable Rate Technology (VRT) for fertilizer application: two soil types

- Evaluating the economics of VRA of nitrogen (*N*) fertilizer
  - Soils can be tested for up to fourteen nutrients
  - Some VRA systems can apply up to seven nutrients in one pass
  - For study purposes only one nutrient is evaluated so as to analyze/explain the evaluation process

- Field that has two distinct types of soils (High/Low Yield).
  - High/Low Yield soil can produce a maximum of 200/150 bushels of corn per acre, respectively
  - Low Yield field can manage up to 200 pounds of *N* per acre
    - Applying more than 200 pounds will not affect the yield, up to some point.
  - The High Yield field can utilize up to 250 pounds of *N* per acre.
    - Applying more *N* will not affect the yield, up to some point, but applying less lowers the yield. The field is approximately *50/50* High/Low Yield soils.

- Partial Budgets used to evaluate four different scenarios.

Sources: Cal Poly; precisionag.org.

Example #2: Partial Budgeting

Evaluating VRT for fertilizer application: two soil types

1

Soil Type	Yield Potential	Fert. Required	Fert. Applied	Actual Yield	Yield "Lost"	Fertilizer "Lost"
Low	150	200	**200**	**150**	0	0
High	200	250	**200**	**150**	50	0

2

Soil Type	Yield Potential	Fert. Required	Fert. Applied	Actual Yield	Yield "Lost"	Fertilizer "Lost"
Low	150	200	**250**	**150**	0	50
High	200	250	**250**	**200**	0	0

3

Soil Type	Yield Potential	Fert. Required	Fert. Applied	Actual Yield	Yield "Lost"	Fertilizer "Lost"
Low	150	200	**225**	**150**	0	25
High	200	250	**225**	**175**	25	0

4

Soil Type	Yield Potential	Fert. Required	Fert. Applied	Actual Yield	Yield "Lost"	Fertilizer "Lost"
Low	150	200	**200**	**150**	0	0
High	200	250	**250**	**200**	0	0

Sources: Cal Poly; precisionag.org.

Example #2: Partial Budgeting

Evaluating VRT for fertilizer application: two soil types

- If only maximizing yields, Scenario 4 is preferable. Only enough soil samples to determine the optimum amount of fertilizer for each area of your field would be taken and then apply that optimal amount.

- **However, you are more likely concerned with maximizing profits. You then want to determine if the added returns from more soil samples and VRT are greater than their costs.**

Sources: Cal Poly; precisionag.org.

Example #2: Partial Budgeting

Evaluating VRT for fertilizer application: two soil types

	Cost	Annualized Cost
Price of corn	$3.00/bu	--
Price of Nitrogen	$0.25/lb	--
Price to soil sample	$18.00/ac (1-ac grid)	$7.24/ac
	$6.00/ac (5-ac grid)	$2.41/ac
VRT System		
GPS system	$1,500 - $3,000	$600 - $1,200
Variable rate applicator	$3,000 - $5,000	$1,200 - $2,010
Operating costs	$7.50/ac	

Annualized cost assumes: soil sample is valid for three years; VRT system-3 year useful life; a discount rate of 10%.
Annualized Cost Formula: Cost*{10%/[1-(1.10)$^{-3}$]}

Sources: Cal Poly; precisionag.org.

Example #2: Partial Budgeting

Evaluating VRT for fertilizer application: two soil types

Partial Budget Format: Scenario #1 to #4	
Additional Costs: $12.50 fertilizer $2.41 sampling $2.51 VRT ownership $7.50 VRT operating	Additional Revenue: $150 (50 bu/ac sold at $3.00/bu)
Reduced Revenue: $0	Reduced Costs: $0
A. *Total additional costs and reduced revenue….. $24.92*	B. *Total additional revenue and reduced costs ….. $150*
GRW net change in profit (B-A) …………………………….…. $125.08 Net Benefit : Cost Ratio ………………………………………………. 6.02	

Example #2: Partial Budgeting

Evaluating VRT for fertilizer application: two soil types

Partial Budget Format: Scenario #2 to #4	
Additional Costs: $2.41 sampling $2.51 VRT ownership $7.50 VRT operating	Additional Revenue: $0
Reduced Revenue: $0	Reduced Costs: $12.50 (50 lbs at $0.25/lb)
A. *Total additional costs and reduced revenue….. $12.42*	B. *Total additional revenue and reduced costs ….. $12.50*
GRW net change in profit (B-A) ……………………………….…. $0.08 Net Benefit : Cost Ratio ………………………………………………. 1.001	

Example #2: Partial Budgeting

Evaluating VRT for fertilizer application: two soil types

Partial Budget Format: Scenario #3 to #4	
Additional Costs: $2.41 sampling $2.51 VRT ownership $7.50 VRT operating	Additional Revenue: $75.00 (25 bu at $3.00/bu)
Reduced Revenue: $0	Reduced Costs: $6.25 (25 lbs at $0.25/lb)
A. *Total additional costs and reduced revenue….. $12.42*	B. *Total additional revenue and reduced costs ….. $81.25*
GRW net change in profit (B-A) ……………………………….…. $68.83 Net Benefit : Cost Ratio ……………………………………………. 6.541	

Example #3: Partial Budget Framework in Cotton

Evaluating the benefits (change in net returns per acre) of VRT on sprayers

- Evaluate VRT investment in sprayers
  - Identify capital ownership/information gathering costs
  - Develop a partial budget framework to estimate change in net returns
  - Apply methodology to three assumptions of input savings (10%, 15%, and 20%)

Source: Mooney, et al., 2009.

Example #3: Partial Budget Framework in Cotton

Evaluating the benefits (change in net returns per acre) of VRT on sprayers

Parameter	Value
VRT Controller	$6,000
GPS Receiver	$5,000
GIS Software	$1,450
Installation	$500
Spatial NDVI System	$15,000-$60,000
Useful Life	10 years
Taxes, Ins., Housing	2% Purchase Price
Farm Acreage	1,900 acres Cotton:900, Other:1,000

Source: Mooney, et al., 2009.

Example #3: Partial Budget Framework in Cotton

Evaluating the benefits (change in net returns per acre) of VRT on sprayers

$$\Delta Net\ Returns = [(Price * \Delta Yield) - (Input\ Price * \Delta Qty\ Input\ Used)] - \Delta AOC - \Delta SOC - \Delta INFO$$

$$where\ AOC = No.of\ Sprayers * \frac{VRT\ Ownership\ Cost}{Acreage}$$

$$where\ SOC = \frac{Labor\ Cost + Fuel\ Cost + R\&M\ Cost}{Change\ in\ Sprayer\ Field\ Performance}$$

$$where\ \text{Srayer Field Performamce} = \frac{BW * (1 - BOURT) * \Delta FS * FE}{8.25} - \frac{BW\ (1 - \Delta BO) * FSURT * FE}{8.25}$$

Traditionally, ΔSFP is modeled as a function of boom width (BW), field speed (FS), and field efficiency (FE). ΔSFP is modeled as a function of field speed and boom overlap (BO).

Source: Mooney, et al., 2009.

Example #3: Partial Budget Framework in Cotton

Evaluating the benefits (change in net returns per acre) of VRT on sprayers

Equipment and Information Costs	Cost per acre
VRT Controller	$0.73
GPS Receiver	$0.61
GIS Software	$0.18
Installation	$0.04
Spatial NDVI System	$1.82-$7.28
NDVI Aerial Subscription	$7.20
GPS Subscription	$0.71
GIS Software Maintenance	$0.22
Mapping	$0.80
Analysis and Training	$0.62
VRT Labor Costs	$0.08

Source: Mooney, et al., 2009.

Example #3: Partial Budget Framework in Cotton

Evaluating the benefits (change in net returns per acre) of VRT on sprayers

Info. Gathering Method	10% Input Savings	15% Input Savings	20% Input Savings
	High Resolution		
All Inputs	-$0.95	$4.21	$9.36
Herbicide Only	-$5.02	-$1.90	$1.22
	Low Resolution		
All Inputs	$4.51	$9.67	$14.82
Herbicide Only	$0.44	$3.56	$6.68

Results indicated that a 10% level of input savings would not be sufficient to cover VRT system costs for the high resolution NDVI system. Investment and inputs costs would be covered at savings greater than 18% for high resolution and 15% for low resolution system.

Source: Mooney, et al., 2009.

Partial Budget Framework in Cotton

Evaluating the benefits (change in net returns per acre) of VRT on sprayers

- Sensor-based VRT systems
  - *high ownership costs*
  - *low recurring annual costs*
- Map-based VRT systems
  - *lower ownership costs*
  - *higher annual information costs*
- Increased cotton area/equipment life allows allocate these fixed costs over more acres.

Source: Mooney, et al., 2009.

Serendipities of Precision Agriculture

Unexpected Benefits from PA

- There are going to be some *unexpected* benefits/challenges with PA adoption
  - Engineers will have one idea in mind, enterprising farmers will use these technologies in much better ways
    - Grain and Tomato famers in California have used Yield Monitors to aid in loading trucks (to the pound), virtually eliminating probability of being stopped for being overloaded

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