Resource Allocation For Crop Production

Bryon J Parman, Ph.D.

Department of Ag. Business and Applied Economics

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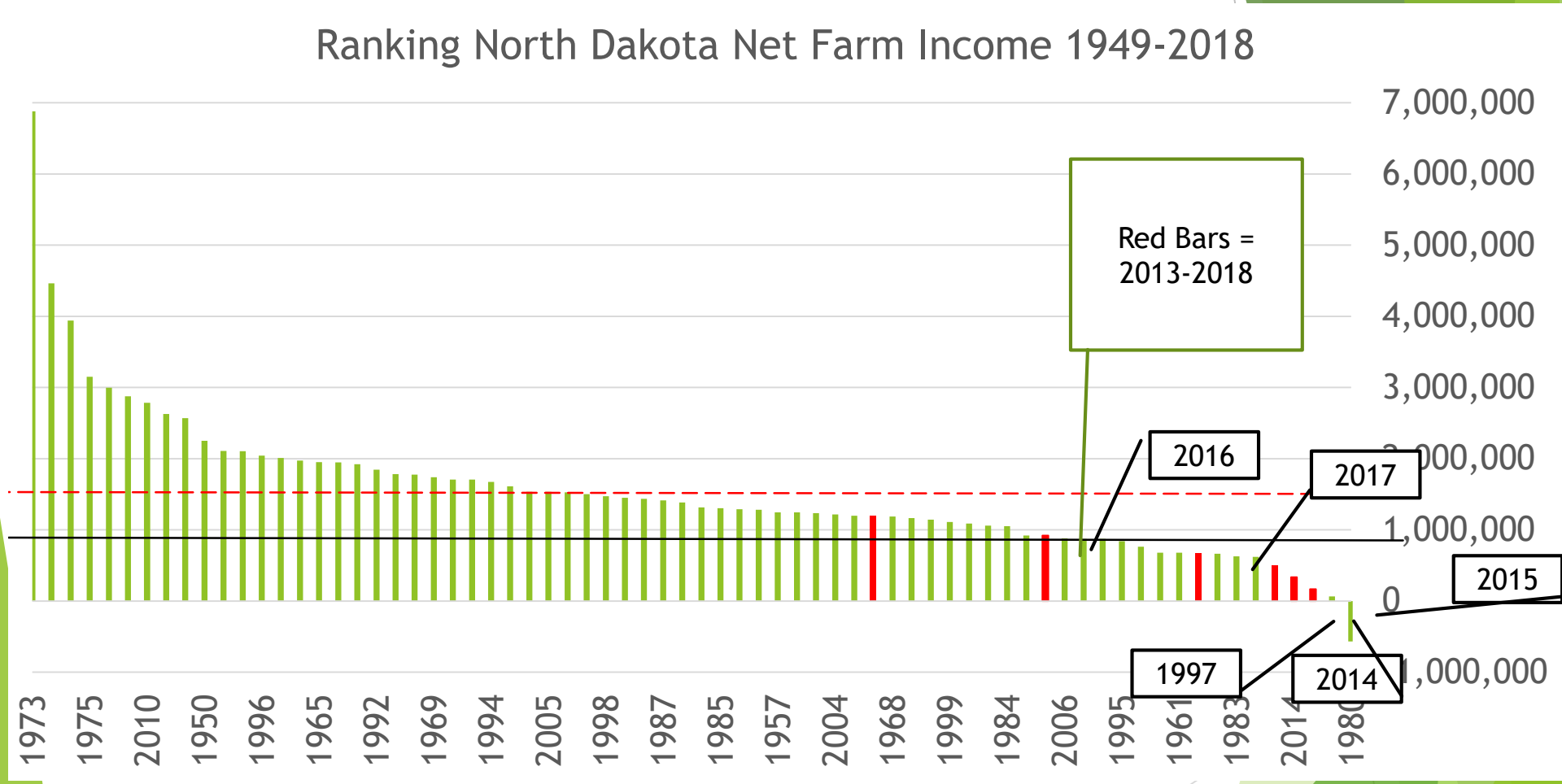

Ranking North Dakota Net Farm Income 1949-2018
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
1,000,000
0
Red Bars = 2013-2018
2016
2017
2015
1997
2014
1973
1975
2010
1950
1996
1965
1992
1969
1994
2005
1998
1987
1985
1957
2004
1968
1999
1984
2006
1995
1961
1983
1980

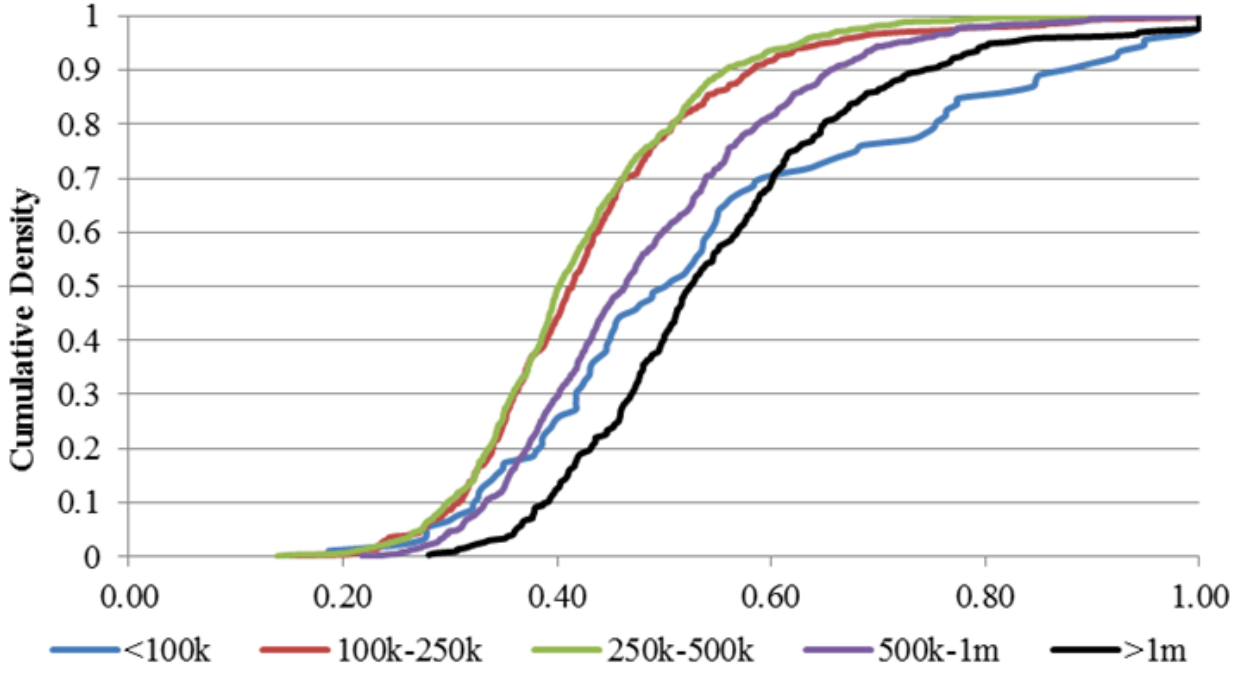
Efficiency

- What is Economic Efficiency?
  - Economic efficiency is when all goods and factors of production in an economy are distributed or allocated to their most **valuable** uses and **waste is eliminated or minimized**.

Essentially two ways to evaluate Production efficiency

- 1: We hold inputs constant and evaluate the output quantities
  - Could more be produced using the same inputs if they were allocated differently
  - For instance: with the same equipment compliment, could we farm more acres. With the same amount of land/equipment
- 2: We hold output quantities constant and evaluate inputs
  - Do we have equipment sitting idle for long periods of time
  - Do we have portions of the year where our labor is not fully utilized

Getting Bigger Vs. Getting Better: Cost Efficiency by Gross Revenue

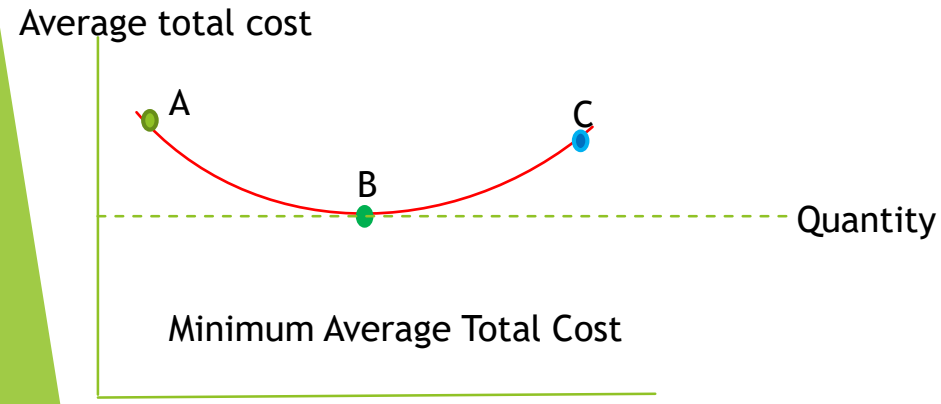


Concepts

- Economies of Scale
  - Spreading certain fixed/operating costs out over a larger portion of outputs
- Economies of Scope
  - Utilizing existing capacity (and additional resources) to produce joint outputs more cost effectively
- Diminishing Marginal Returns
  - It takes a continuously increasing amount of inputs to produce diminishing levels of output

Cost per Unit-Cost Minimization

- Returns to Scale
  - Measures the proportional change in output resulting from a unit proportional change in all inputs.
  - Directly related to economies of scale.
- Figure depicting returns to scale on long run average cost curve…..Firm A is at increasing returns to scale (economies of scale): Firm B is at constant returns to scale: Firm C is at diseconomies of scale/decreasing returns to scale:



Spring Wheat and Soybean Enterprise Budgets

INDIRECT (FIXED) COSTS	North RR Valley HRSW	North RR Valley Soybeans	South RR Valley HRSW	South RR Valley Soybeans
-Misc. Overhead	9.09	8.43	9.15	8.53
-Machinery Depreciation	25.05	23.21	25.21	23.48
-Machinery Investment	14.82	13.51	14.90	13.65
-Land Charge	90.00	90.00	125.00	125.00
SUM OF LISTED INDIRECT COSTS	138.96	135.15	174.26	170.66

Multi-product Economies of Scale by Gross Revenue Class

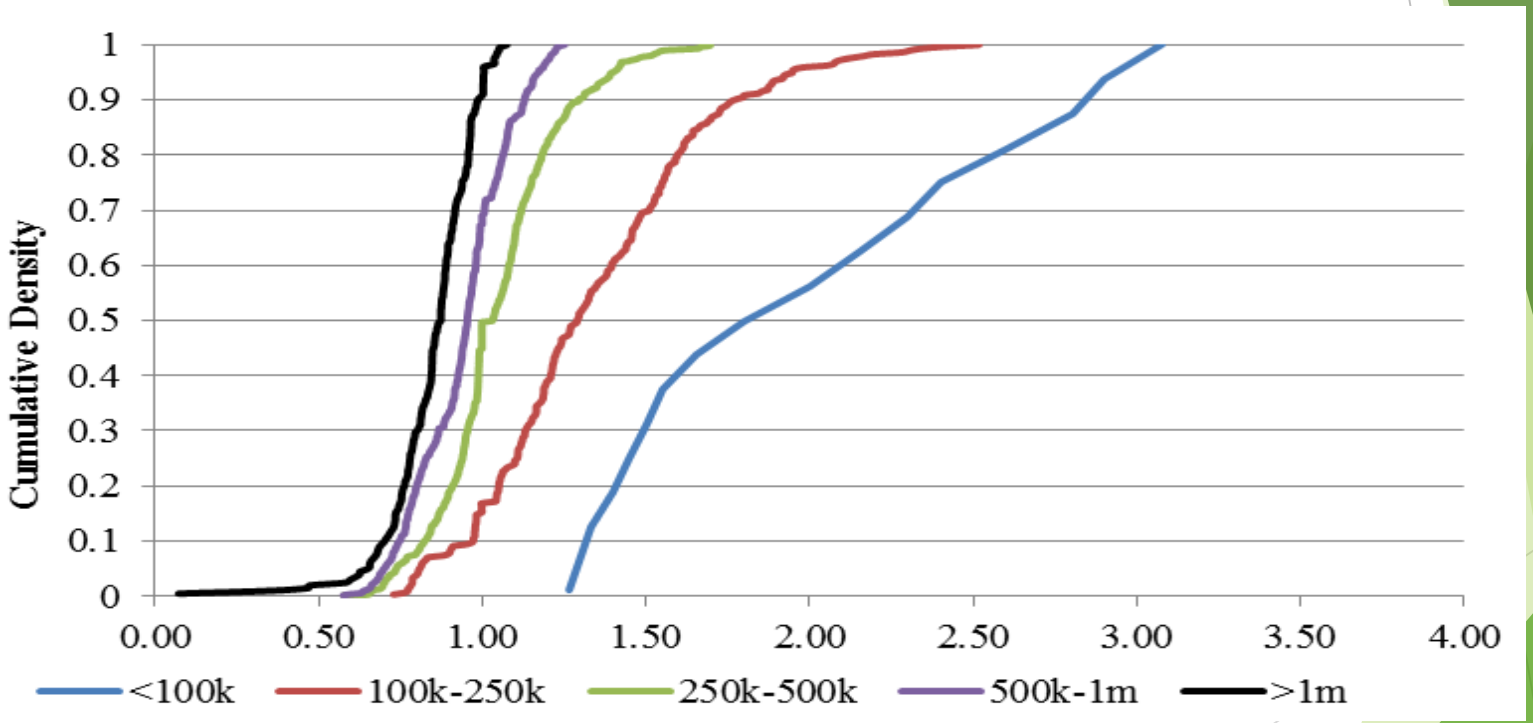


Table Error! No text of specified style in document.**.1** Overall summary statistics for estimated cost measures for Kansas Farm Management Farms estimated from a single frontier and annually.

	N	Average	Standard Deviation	Minimum	Maximum
		----- *Single Frontier*------			
Cost Efficiency	2410	0.462	0.136	0.138	1.000
Multi-product Economies of Scale	1571	1.142	0.407	0.588	4.210
Economies of Scope	1571	0.175	0.093	0.003	0.553
Crop-specific Economies of Scale	2363	0.768	0.167	0.023	1.000
Livestock-specific Economies of Scale	1649	0.830	0.190	0.010	1.000

Indicates that when increasing one output only, per-unit production costs Increase. However, a proportionate increase In both outputs yields a DECREASE in Per unit production costs.

Diseconomies of Scale & Inflexibility

- Diseconomies of scale
  - Where getting bigger increases cost per unit. This can occur if management is stretched too thin and yields suffer, or costs increase dramatically.

- Inflexibility
  - If you are sufficiently large, then it becomes difficult to adjust to different cost/market conditions.
  - I.e. Cash rents go up to very high levels, but you have to continue farming the expensive rented ground to spread equipment costs over more acres

Cost Minimization (per unit) – Economies of Scope

- **Economies of Scope**

  Economies of scope are the reduction in per-unit production costs by employing under utilized assets to produce outputs.

  Example: A farmer using existing equipment, land, grain storage etc. to produce corn and cattle

  - It would cost more per bushel and more per pound of beef produced to produce one or the other by itself.

  - This also would apply to someone who has 3,000 acres of soybeans only vs someone who has 1,000 acres of soybeans, 1,000 acres of barley, and 1,000 acres of corn.

Diversification

- Diversification Examples:
  - Crop and livestock enterprises
  - Geographic diversification
  - Off-farm employment
- Constraints to diversification:
  - Management skill and time
  - Compatibility of activities with resources available
  - Product specific economies of scale
  - Economies of Scope Leverage

Weather Variability and Time Management Mitigation through Crop Diversity

- Some crops may react differently to growing season conditions,
  - I.e. a cool semi-wet early summer followed by a hotter dry August may produce an excellent wheat yield, but be very detrimental to soybean yields.
  - A warm wet summer may cause problems for wheat but would be optimal for corn/soybeans

North Dakota Corn, Wheat, and Soybean Yield Correlation Matrix 1990-2019

	corn	wheat	soybeans
corn	1		
wheat	0.52	1	
soybeans	0.82	0.25	1

It's unlikely to find a negative correlation between crop yields since they still need GDD's, water, fertilizer, etc. But the weak positive Correlation shows wheat can do better yield-wise on a given year than corn Or soybeans while corn and soybeans will typically both be impacted similarly by growing conditions

Full Utilization of the Growing Season

- Many of North Dakota's crops have different planting dates and harvest dates
  - Growing a variety of crops allows for the full utilization of a relatively short growing season.
  - Harvest windows and planting windows in ND may create bottlenecks on labor and equipment when growing large amounts of acres of 1 crop

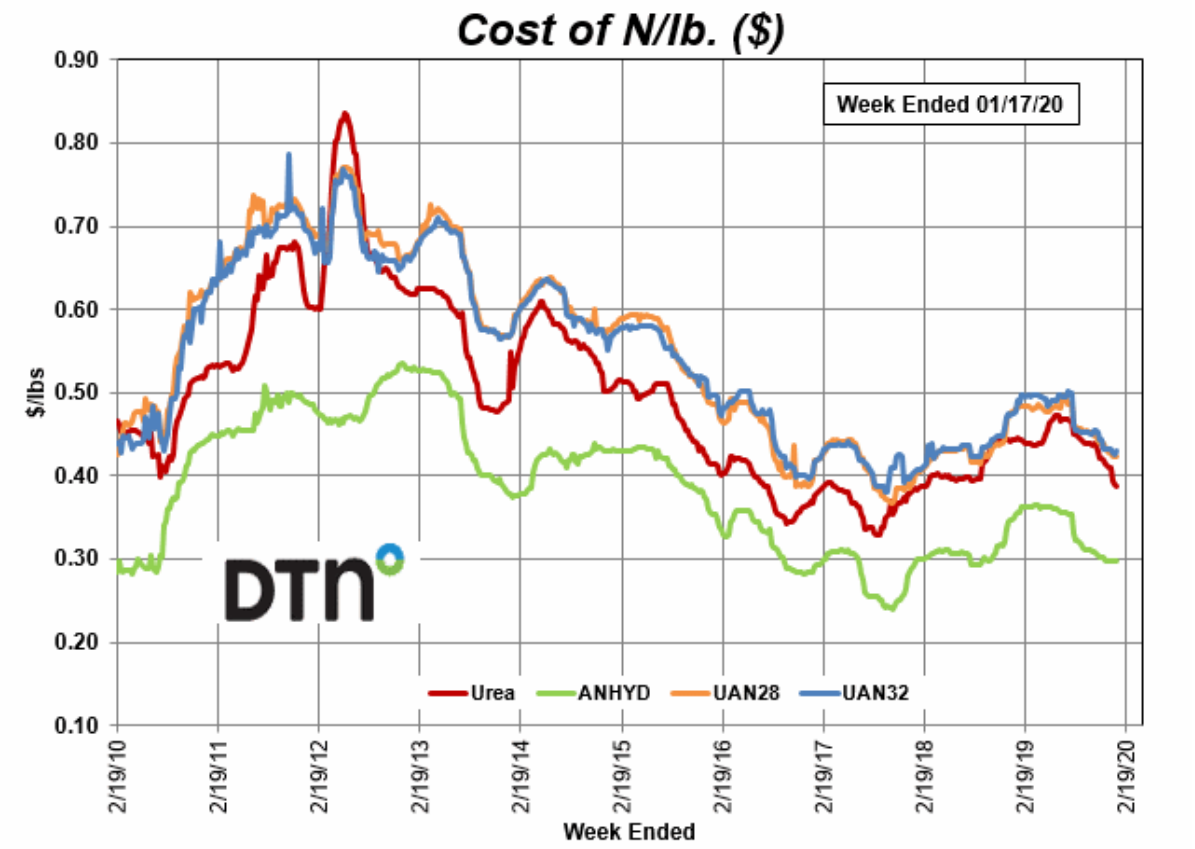
Final Planting Dates, Richland County ND 2018

- Wheat, Barley, Corn, Sugar Beets 5/31
- Soybeans, Sunflowers, Flax, and Dry Beans 6/10
- Canola, Peas 5/20

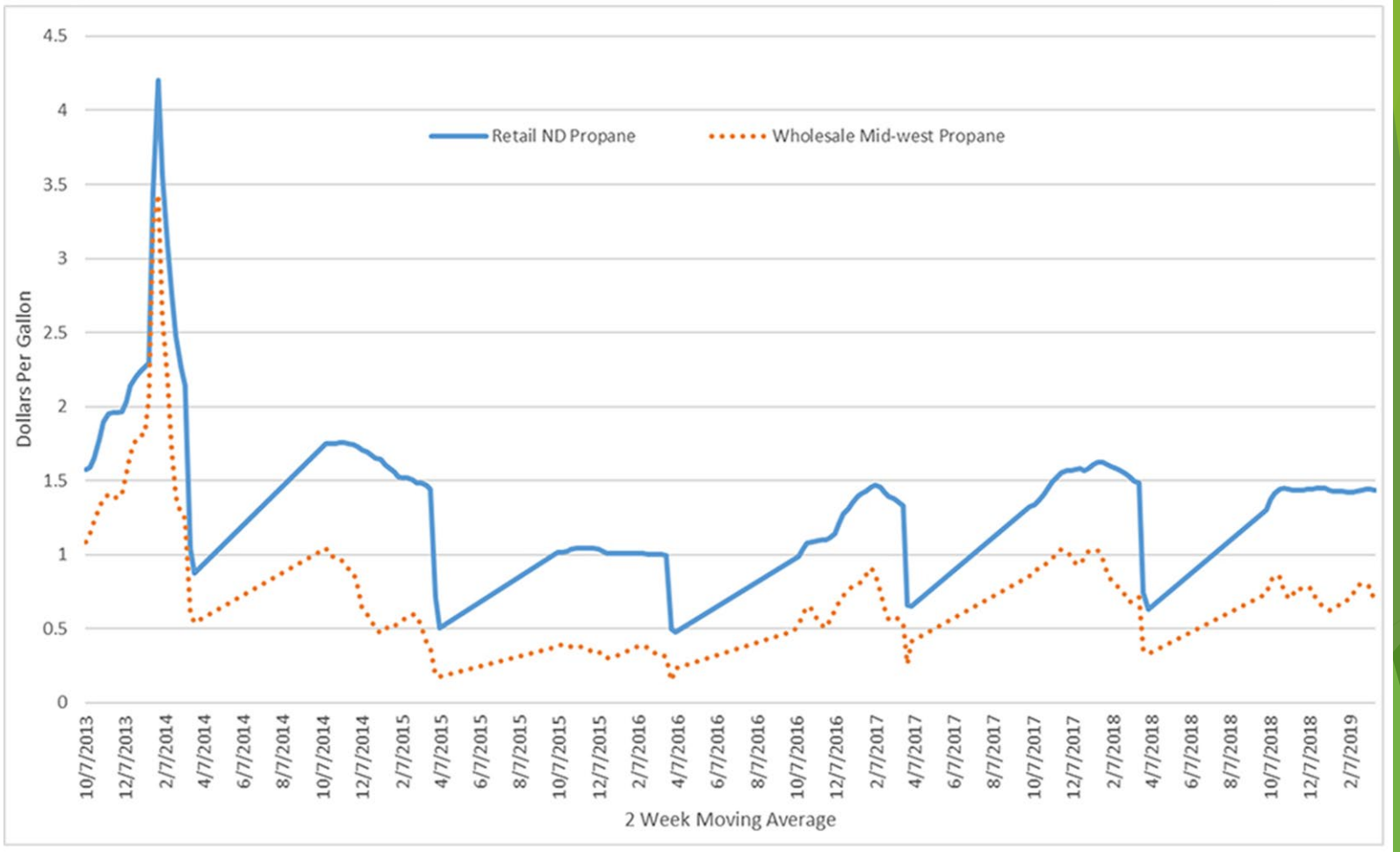
Some Amount of Input Cost Variability Mitigation

- Certain crops use more nitrogen than others i.e. corn/wheat vs. Soybeans
- Some crops are harvested later and at greater risk of being to wet for storage resulting drying costs

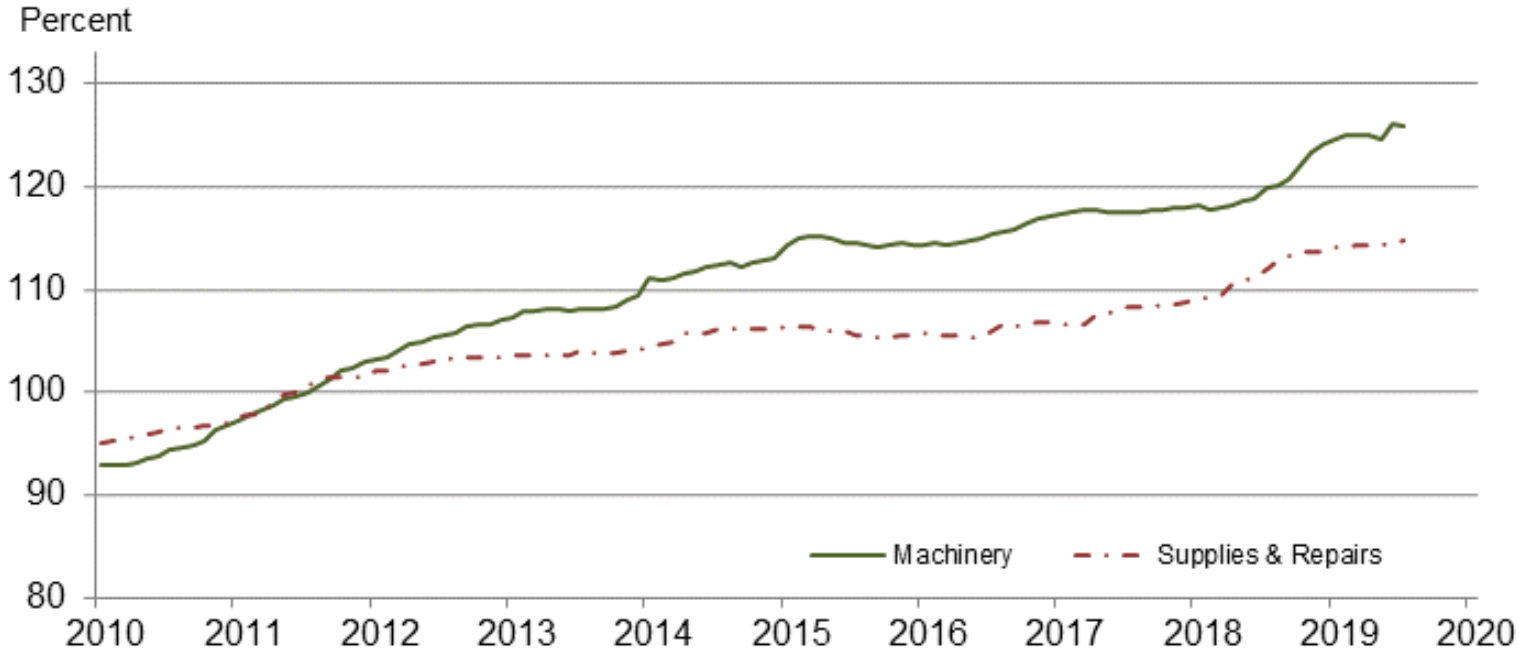
Production Cost Risk – Nitrogen Fertilizer



Six Year Price of Propane for N.D. and Midwest

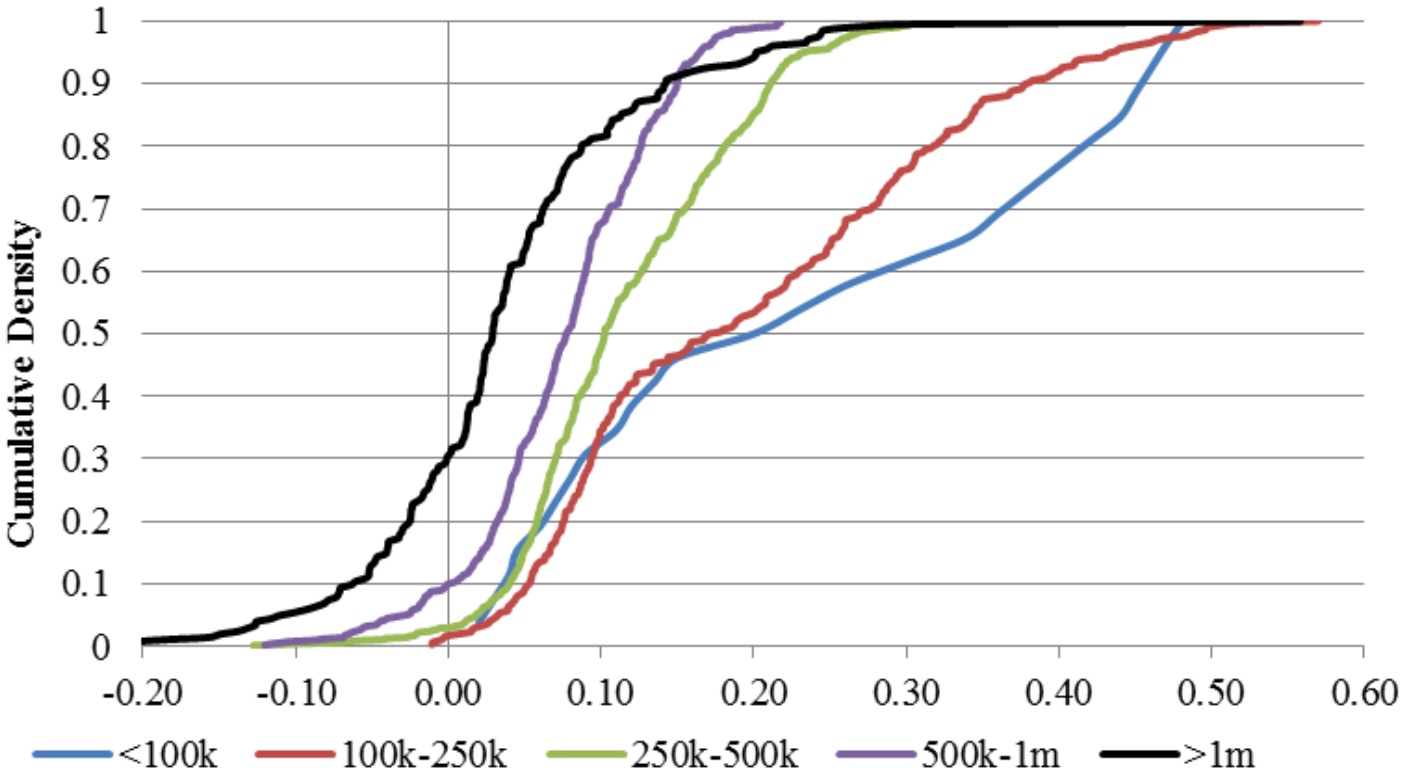


Paid Indexes by Non-farm Origin and Month, Machinery and Supplies & Repairs – United States: 2011=100



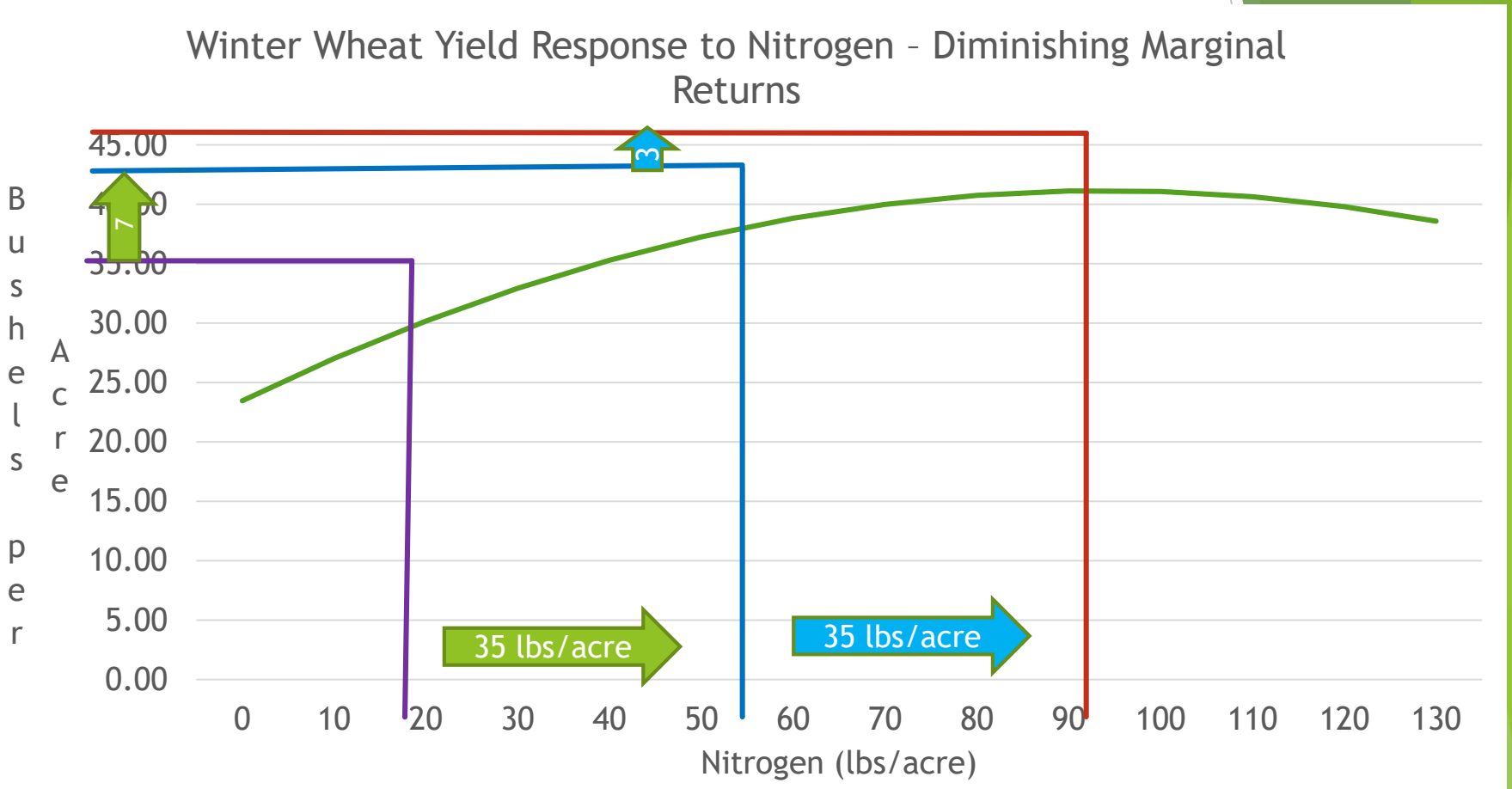
USDA – NASS
08/30/2019

Economies of Scope for Multi-Product Farms 2002 – 2013 by Gross Revenue Class



Diminishing Marginal Returns

- Marginal Returns
  - The amount of inputs it takes for an additional unit of outputs
- Diminishing Marginal Returns
  - Where it takes proportionately more inputs for a given increase in output
  - i.e. it takes more feed per day to put 2 lbs per day of weight on a 1,250 lb steer than a 550 lb steer
  - A student has to study more hours to go from a “B” to an “A” than from a “C” to a “B”


Winter Wheat Yield Response to Nitrogen – Diminishing Marginal Returns
Bushels per Acre
45.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Nitrogen (lbs/acre)
7
3
35 lbs/acre
35 lbs/acre

How Does the Market Value Affect This?

- Are we yield maximizers? Or Profit Maximizers?
- If the price of wheat is $20/bushel and the price of Nitrogen is $0.40/lb do we fertilize for max yield ?
- What if the price of wheat is $5.50 per bushel and fertilizer is $1.00 per pound of Nitrogen

NDSU Crop Compare

Select reference crop		S. Wht
Enter the	S. Wht futures price	$5.60
Enter expected local basis (cash-futures)		-$0.45
Expected	S. Wht local cash price	$5.15

	S. Wht	Barley	Corn	Soybean	Drybeans	Oil Snflr	Conf Snflr	Oats	W.Wht
Yield	65	84	161	41	2050	2130	1740	100	60
Relative Price	$5.15	$3.70	$2.98	$7.22	$0.191	$0.157	$0.207	$2.85	$5.17
Income	$335	$311	$480	$296	$392	$335	$361	$285	$310

	S. Wht	S.Wheat 2	Corn	Soybean	S. Wheat 3	Oil Snflr	Conf Snflr	Oats	W.Wht
Yield	65	60	161	41	70	2130	1740	100	60
Relative Price	$5.15	$5.58	$2.98	$7.22	$4.782	$0.157	$0.207	$2.85	$5.17
Income	$335	$335	$480	$296	$335	$335	$361	$285	$310

	S. Wht	S.Wheat 2	Corn	Soybean	S. Wheat 3	Oil Snflr	Conf Snflr	Oats	W.Wht
Yield	65	60	161	41	70	2130	1740	100	60
Relative Price	$5.15	$5.58	$2.98	$7.22	$4.782	$0.157	$0.207	$2.85	$5.17
Income	$335	$335	$480	$296	$335	$335	$361	$285	$310
Variable costs:									
Seed	$20.50	$20.50	$100.50	$65.80	$20.50	$37.20	$55.00	$12.50	$11.70
Herbicide	21.00	21.00	28.00	35.00	21.00	27.70	29.90	5.40	24.50
Fungicide	17.00	17.00	0.00	0.00	17.00	0.00	0.00	0.00	9.00
Insecticide	0.00	0.00	0.00	4.00	0.00	5.00	10.00	0.00	0.00
Fertilizer	76.53	76.53	97.83	2.77	76.53	47.04	36.53	60.30	69.84
Crop Insurance	5.00	5.00	11.00	6.00	5.00	10.00	15.00	9.50	5.00
Fuel & Lube	18.08	18.08	25.46	14.92	18.08	17.54	16.88	20.90	16.11
Repairs	21.57	21.57	29.31	19.86	21.57	20.61	20.25	23.04	19.86
Drying	0.00	0.00	28.98	0.00	0.00	6.39	5.22	0.00	0.00
Misc.	8.00	8.00	8.00	1.50	8.00	16.00	24.00	8.00	8.00
Operating Int.	5.07	5.07	8.89	4.05	5.07	5.06	5.75	3.77	4.43
Total Var.Costs	$193	$193	$338	$154	$193	$193	$219	$143	$168
Return Over	$142	$142	$142	$142	$142	$142	$142	$142	$142

Sensitivity Analysis under 3 Different Wheat Scenarios

Select reference crop		S. Wht
Enter the S. Wht futures price		$5.60
Enter expected local basis (cash-futures)		-$0.45
Expected S. Wht local cash price		$5.15

	S. Wht	S.Wheat 2	Corn	Soybean	S. Wheat 3	Oil Snflr	Conf Snflr	Oats	W.Wht
Yield	65	60	161	41	70	2130	1740	100	60
Relative Price	$5.15	$5.13	$2.98	$7.22	$5.493	$0.157	$0.207	$2.85	$5.17
Income	$335	$308	$480	$296	$385	$335	$361	$285	$310
Variable costs:									
Seed	$20.50	$20.50	$100.50	$65.80	$20.50	$37.20	$55.00	$12.50	$11.70
Herbicide	21.00	21.00	28.00	35.00	21.00	27.70	29.90	5.40	24.50
Fungicide	17.00	17.00	0.00	0.00	17.00	0.00	0.00	0.00	9.00
Insecticide	0.00	0.00	0.00	4.00	0.00	5.00	10.00	0.00	0.00
Fertilizer	76.53	50.00	97.83	2.77	125.00	47.04	36.53	60.30	69.84
Crop Insurance	5.00	5.00	11.00	6.00	5.00	10.00	15.00	9.50	5.00
Fuel & Lube	18.08	18.08	25.46	14.92	18.08	17.54	16.88	20.90	16.11
Repairs	21.57	21.57	29.31	19.86	21.57	20.61	20.25	23.04	19.86
Drying	0.00	0.00	28.98	0.00	0.00	6.39	5.22	0.00	0.00
Misc.	8.00	8.00	8.00	1.50	8.00	16.00	24.00	8.00	8.00
Operating Int.	5.07	4.35	8.89	4.05	6.38	5.06	5.75	3.77	4.43
Total Var.Costs	$193	$166	$338	$154	$243	$193	$219	$143	$168
Return Over	$142	$142	$142	$142	$142	$142	$142	$142	$142

Adjusting Fertilizer Quantities for Different Yields

Select reference crop		S. Wht
Enter the	S. Wht futures price	$5.60
Enter expected local basis (cash-futures)		-$0.45
Expected	S. Wht local cash price	$5.15

	S. Wht	S.Wheat 2	Corn	Soybean	S. Wheat 3	Oil Snflr	Conf Snflr	Oats	W.Wht
Yield	65	60	161	41	75	2130	1740	100	60
Relative Price	$5.15	$5.13	$2.98	$7.22	$5.127	$0.157	$0.207	$2.85	$5.17
Income	$335	$308	$480	$296	$385	$335	$361	$285	$310
Variable costs:									
Seed	$20.50	$20.50	$100.50	$65.80	$20.50	$37.20	$55.00	$12.50	$11.70
Herbicide	21.00	21.00	28.00	35.00	21.00	27.70	29.90	5.40	24.50
Fungicide	17.00	17.00	0.00	0.00	17.00	0.00	0.00	0.00	9.00
Insecticide	0.00	0.00	0.00	4.00	0.00	5.00	10.00	0.00	0.00
Fertilizer	76.53	50.00	97.83	2.77	125.00	47.04	36.53	60.30	69.84
Crop Insurance	5.00	5.00	11.00	6.00	5.00	10.00	15.00	9.50	5.00
Fuel & Lube	18.08	18.08	25.46	14.92	18.08	17.54	16.88	20.90	16.11
Repairs	21.57	21.57	29.31	19.86	21.57	20.61	20.25	23.04	19.86
Drying	0.00	0.00	28.98	0.00	0.00	6.39	5.22	0.00	0.00
Misc.	8.00	8.00	8.00	1.50	8.00	16.00	24.00	8.00	8.00
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Total Var.Costs	$193	$166	$338	$154	$243	$193	$219	$143	$168
Return Over	$142	$142	$142	$142	$142	$142	$142	$142	$142

What if they do not return a definitive net return answer?

Final Comments

- Leveraging economies of scale will help lower average costs per bushel – but only to a point.
  - Eventually getting bigger can cause production efficiency issues and limit flexibility
- Diversification can help lower costs per unit and risk through economies of scope.
  - To be effective, it generally has to utilize existing infrastructure like land/labor/equipment that you would have needed to employ anyway
- Diminishing Marginal Returns and changing input prices vs. output prices may require us to conduct yearly re-evaluations on production decisions

Thank You

Bryon J. Parman, Ph.D
Agricultural Financial Specialist
North Dakota State University Extension
701-231-8248
bryon.parman@ndsu.edu

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