

Crop Fertilization Issues with High Energy Costs

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Natural Gas Use in Fertilizer Production

- ❖ **Proportion of fertilizer production cost from natural gas**
- ❖ **Nitrogen**
 - 75 to 90%
- ❖ **Phosphorus**
 - 15 to 30%
- ❖ **Potassium**
 - 15%

Fertilizer Issues

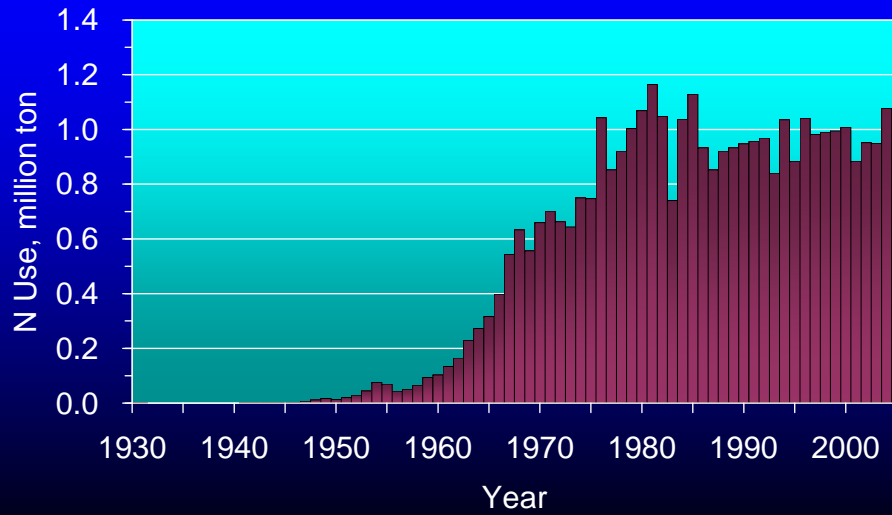
❖ High Nitrogen Prices

- High natural gas price
- High crude oil price
- Shutdown of U.S. ammonia production
- Nitrogen producers finances
- Product supply “just-in-time”
- Imports

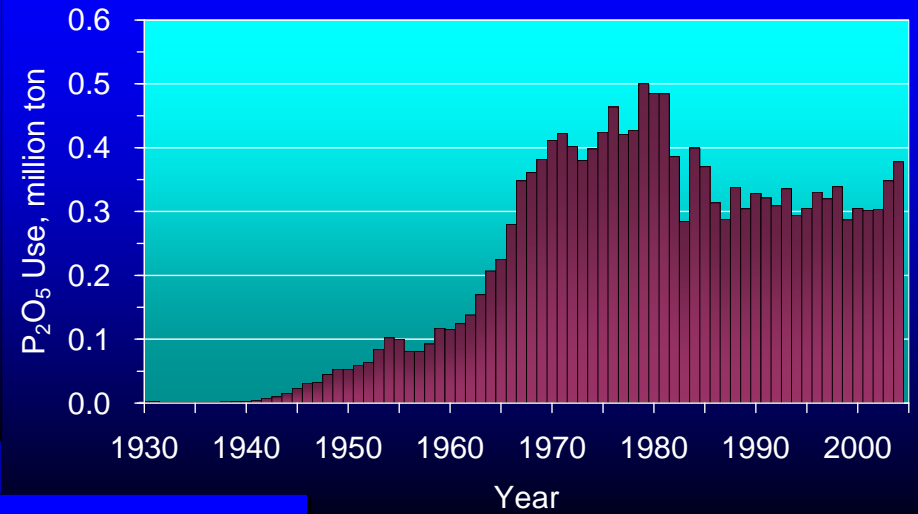
❖ High Phosphorus and Potassium Prices

- High energy price
- World demand

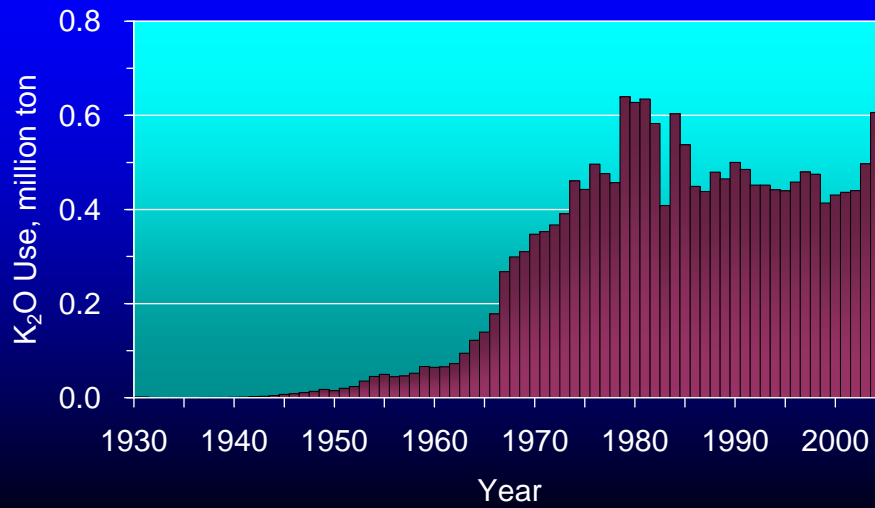
Annual Nitrogen Usage In Iowa



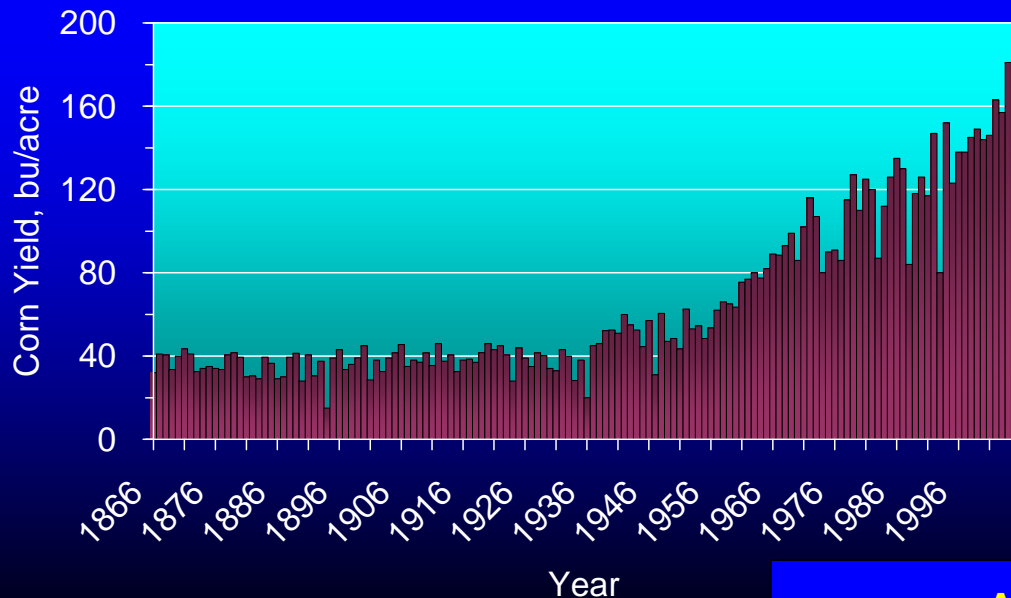
Annual Phosphorus Usage In Iowa



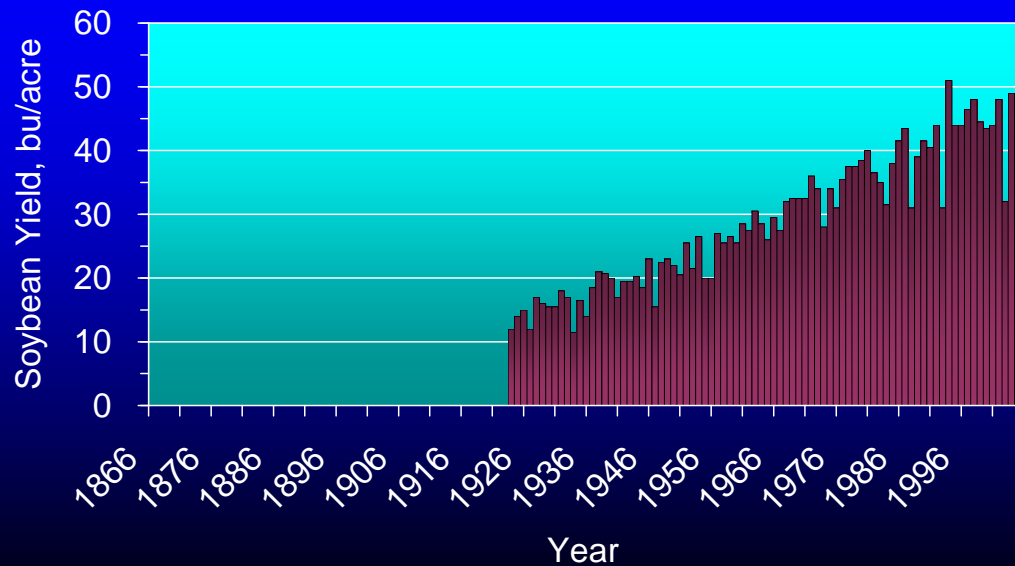
Annual Potassium Usage In Iowa



Annual Corn Yield In Iowa



Annual Soybean Yield In Iowa



Anhydrous Ammonia Synthesis

Haber - Bosch Process

- ❖ **Natural Gas**

 - **Source of energy and H₂**

- ❖ **Atmosphere**

 - **Source of N₂ (33,000 tons N₂ in air over every acre)**



Energy – Producing Nitrogen Fertilizer

- ❖ **For each ton of ammonia production**
 - **38,130 cu ft natural gas**
 - **22,220 cu ft for H₂ source**
 - **15,910 cu ft for heat**
 - **Total energy requirement is 10.24 million kcals per ton = 6,250 kcals per lb N**
- ❖ **Conversion of ammonia to other N products requires additional energy**
 - **Urea = 8,120 kcals per lb N**
 - **Ammonium Nitrate = 8,485 kcals per lb N**

Energy -- Using Nitrogen Fertilizer

❖	<u>Transportation</u>	<u>Application</u>
	--- kcals/lb N ---	
Ammonia	277	254
Urea	505	70
Am. Nitrate	669	104

❖ Total per 100 lb N/acre (diesel fuel equivalent)

- **Ammonia** **20 gal**
- **Urea** **25 gal**
- **Am. Nitrate** **27 gal**

Energy Balance from Use of Nitrogen Fertilizer

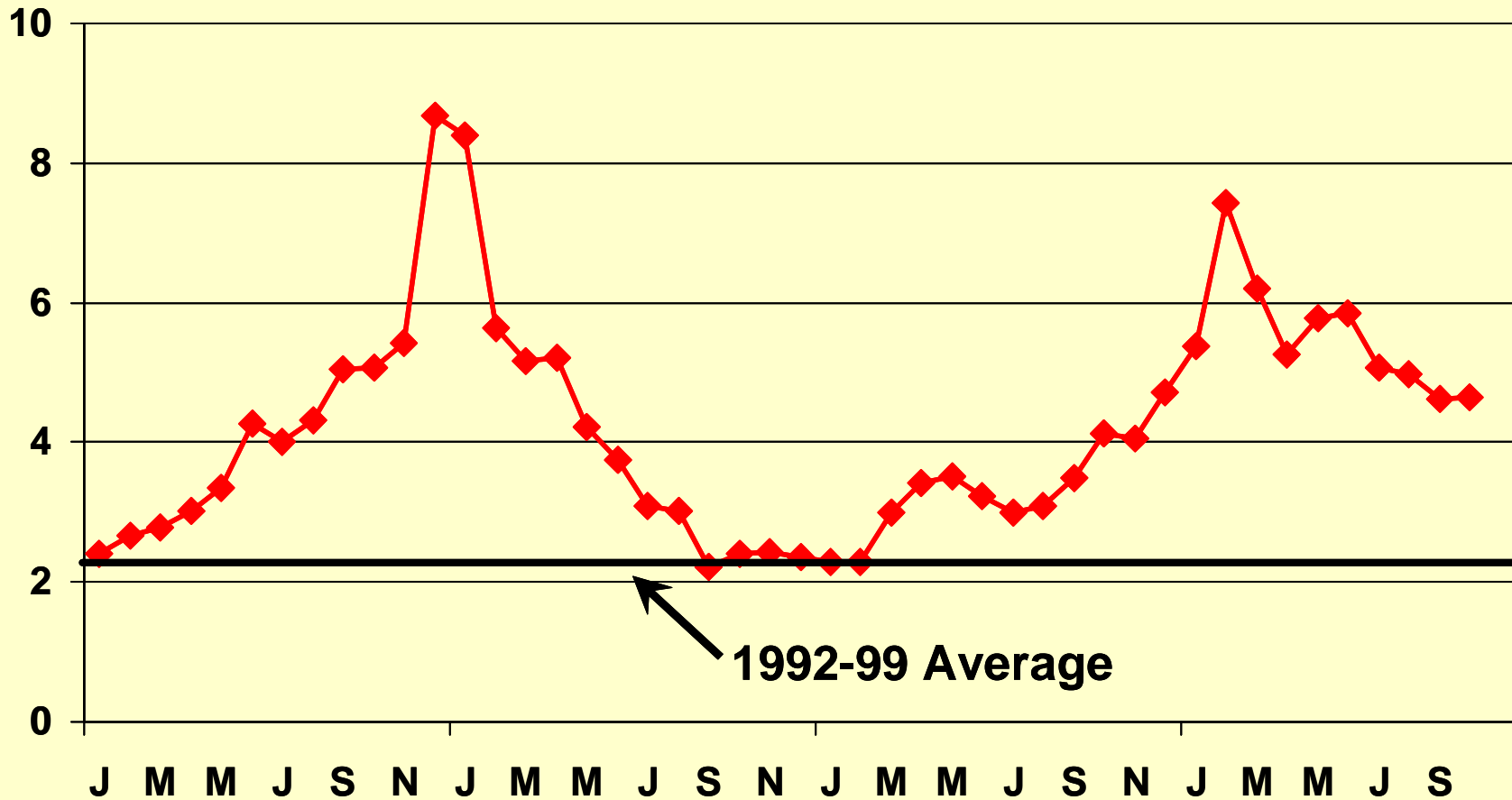
❖ Energy return from producing corn grain

- With 95,000 kcals/bu corn
- At 100 lb N/acre application rate
- Corn yield increase from N application needed to obtain equivalent energy
 - Ammonia 7.2 bu
 - Urea 9.2 bu
 - Am. Nitrate 9.7 bu

U.S. Natural Gas Prices

\$ Per MMBtu

Henry Hub Average Daily Price



January 2000 – October 2003

Natural Gas Spot Henry Hub

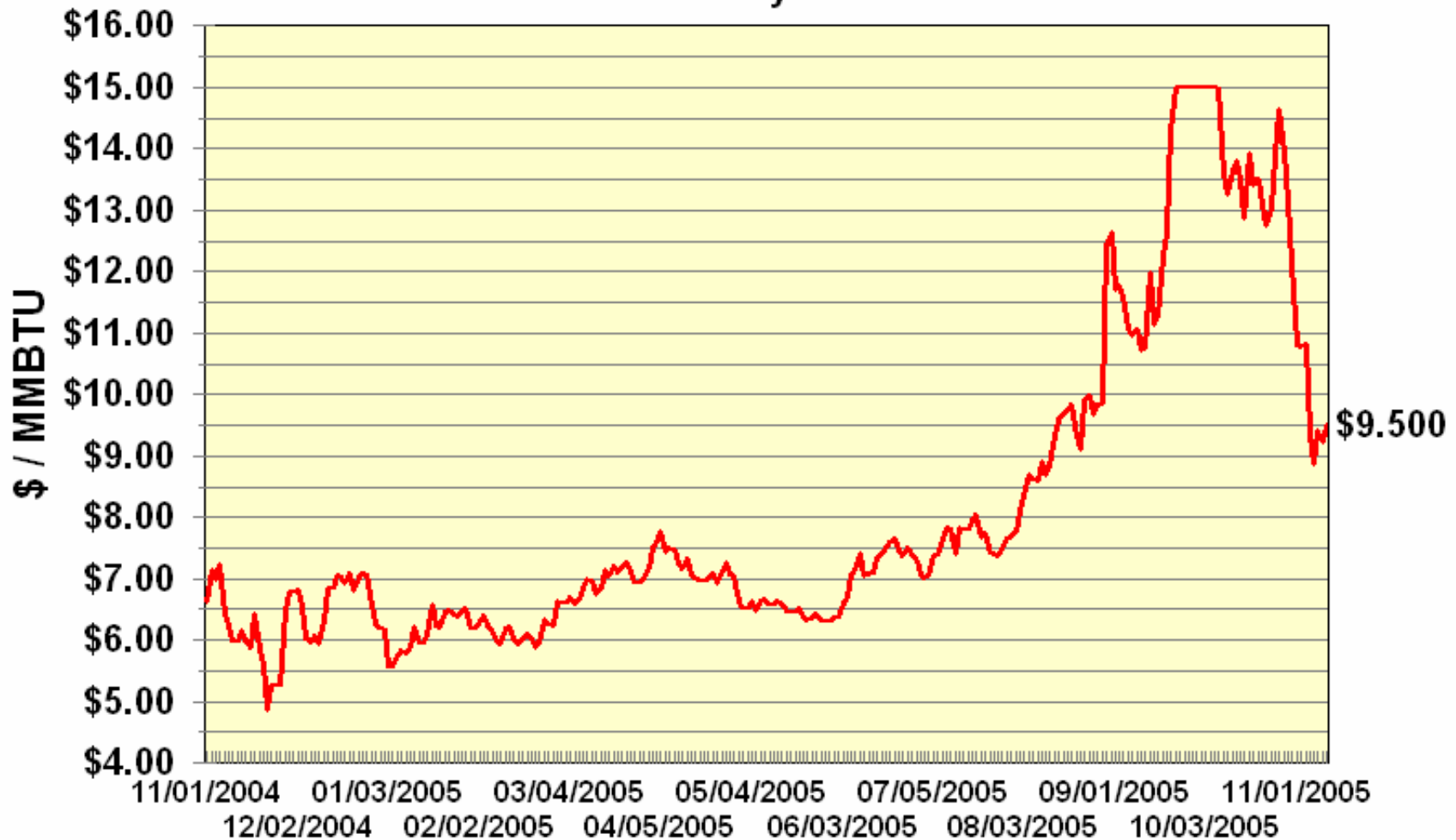


Nov 3, 2003 - Nov 23, 2004

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Natural Gas Spot Henry Hub

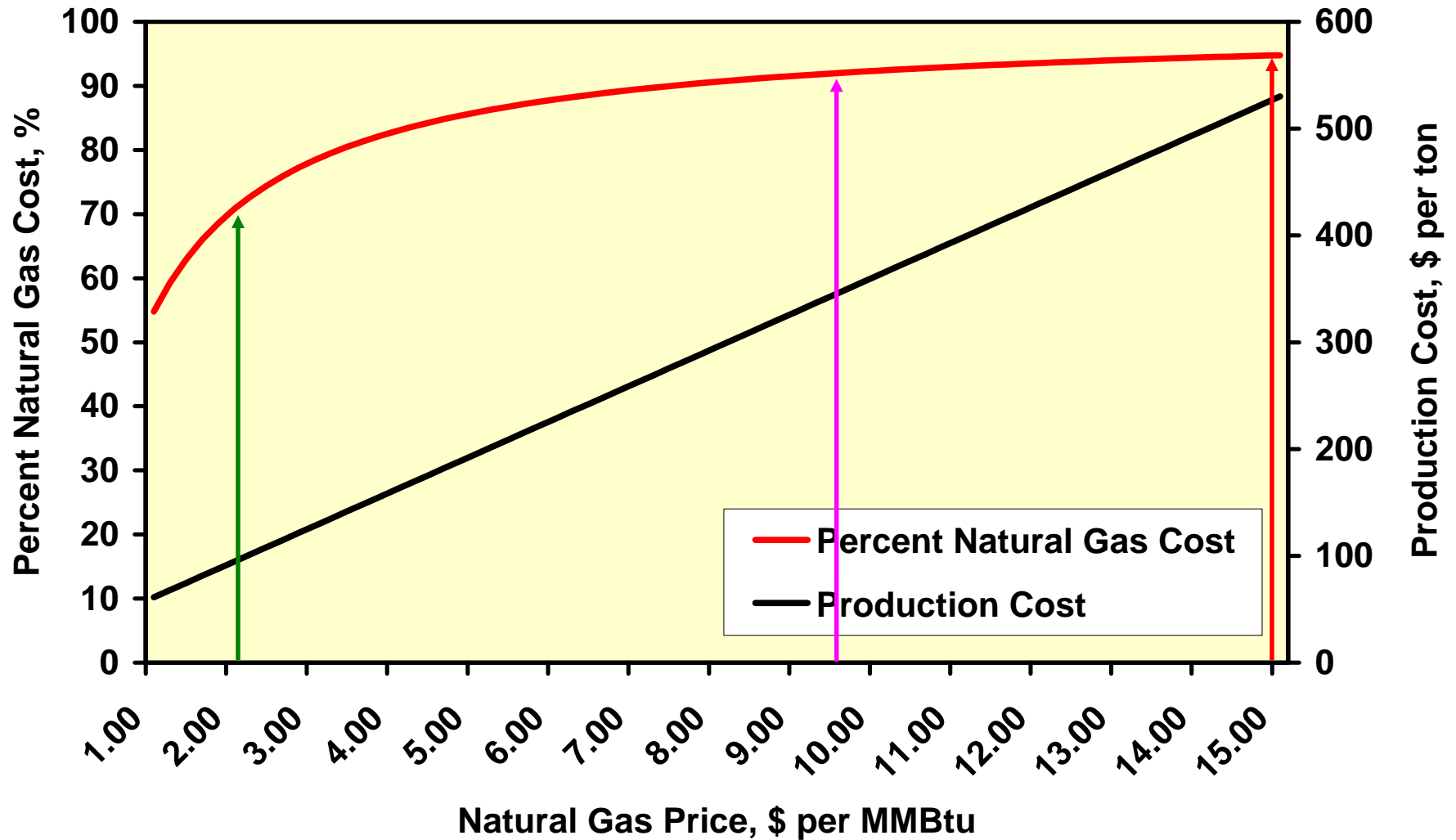


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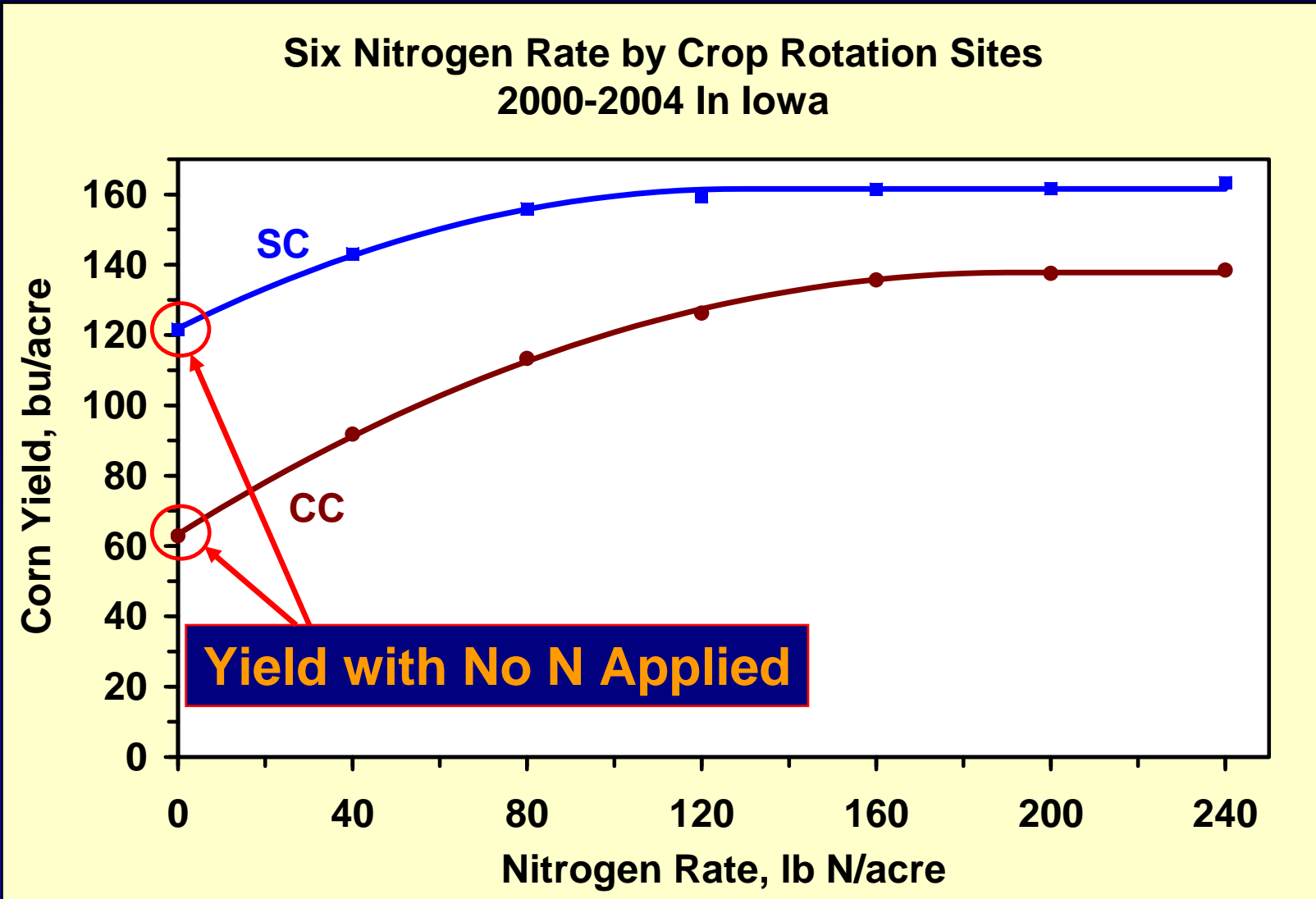
Ammonia Production Cost 1999 Base Year Cost: Adapted from TFI



Why Apply Nitrogen to Corn?

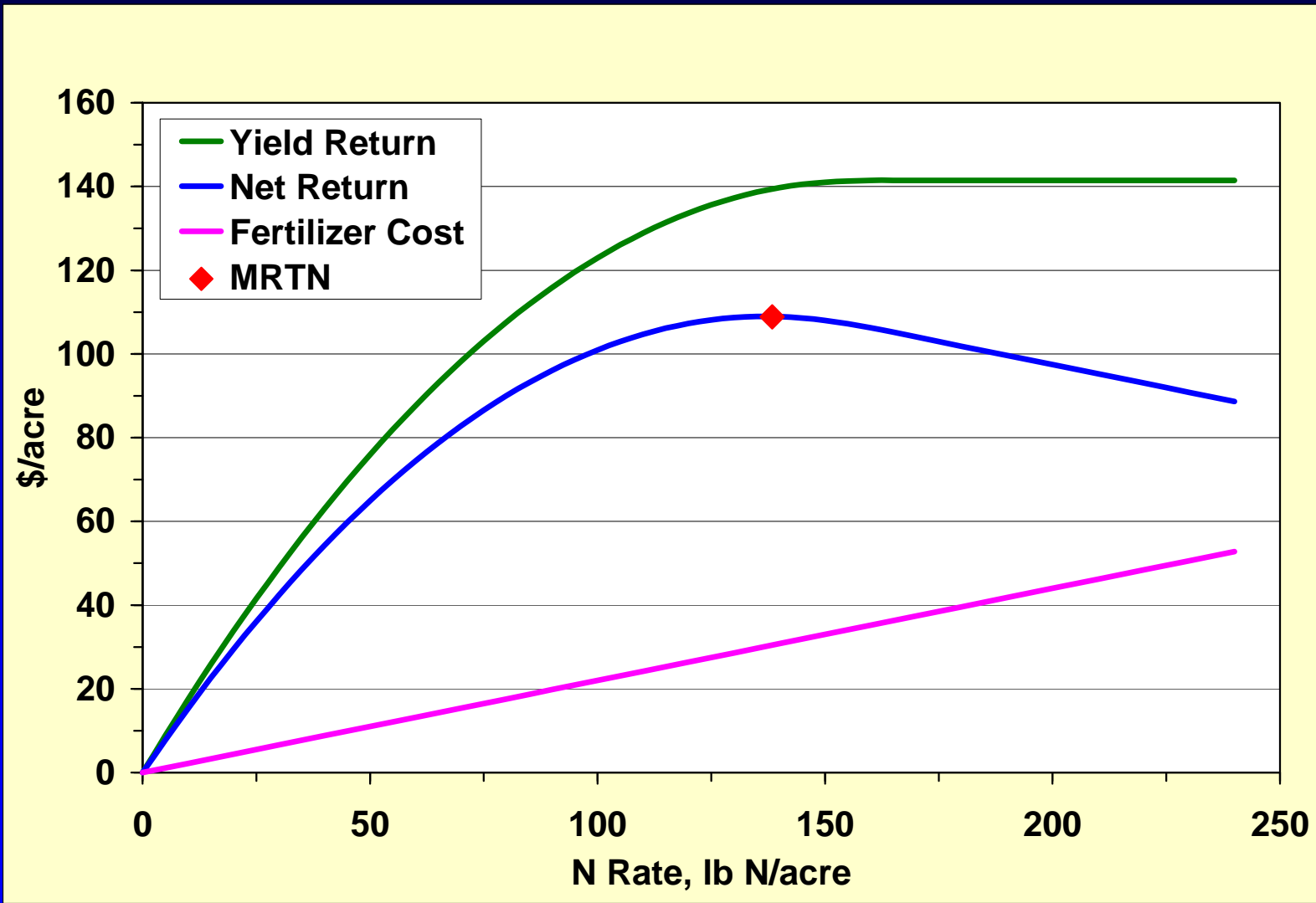
- ❖ **What is the economic optimum N application rate for corn production?**
- ❖ **Effect of nitrogen and corn prices?**
 - **N:Corn price ratio (\$/lb N:\$/bu corn grain)**

Why Apply Nitrogen to Corn?



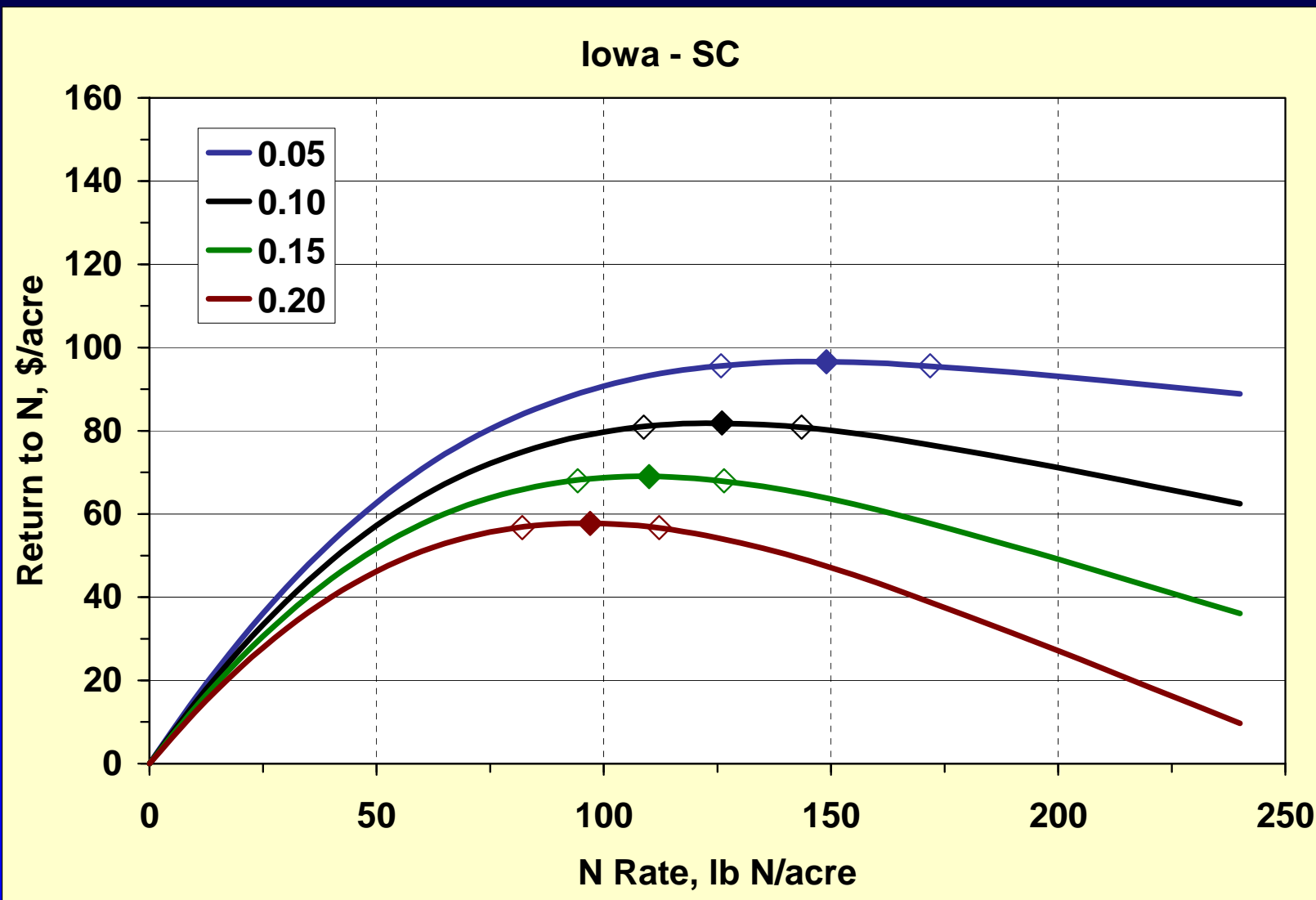
Why Apply Nitrogen to Corn?

Maximum Return To N (MRTN)



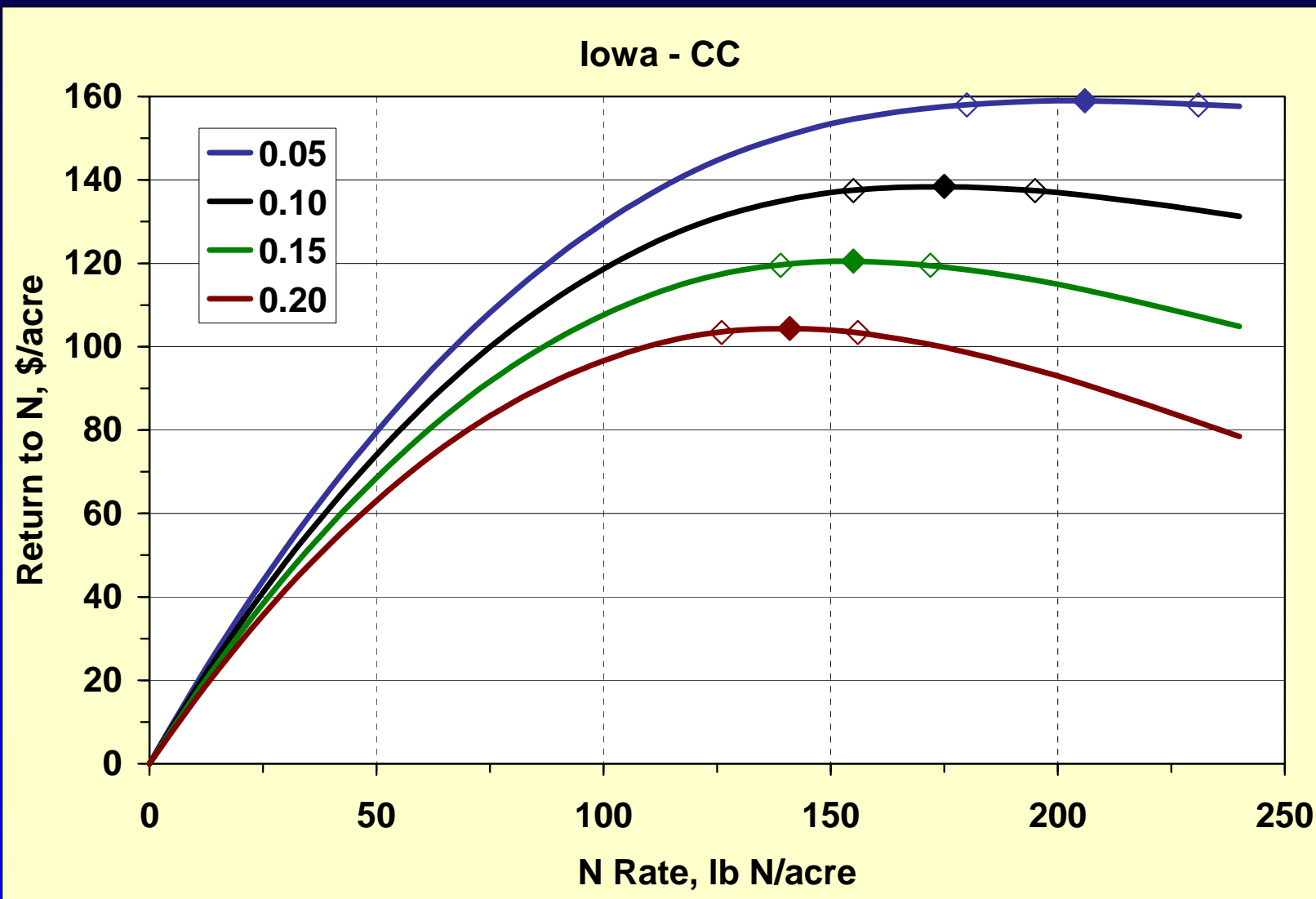
Profitable Nitrogen Application

Maximum Return To N (MRTN)



Profitable Nitrogen Application

Maximum Return To N (MRTN)



Nitrogen Fertilizer Guidelines for Corn In Iowa

Preplant N Applications

Crop Category	N Rate
	lb N/acre
Recently manured soils	0 to 90
After established alfalfa	0 to 30
2 nd - year after alfalfa	0 to 60
Corn after corn	150 to 200
Corn after soybean (no manure)	100 to 150

Pm-1714 Nitrogen Fertilizer Recommendations for Corn in Iowa, 1997

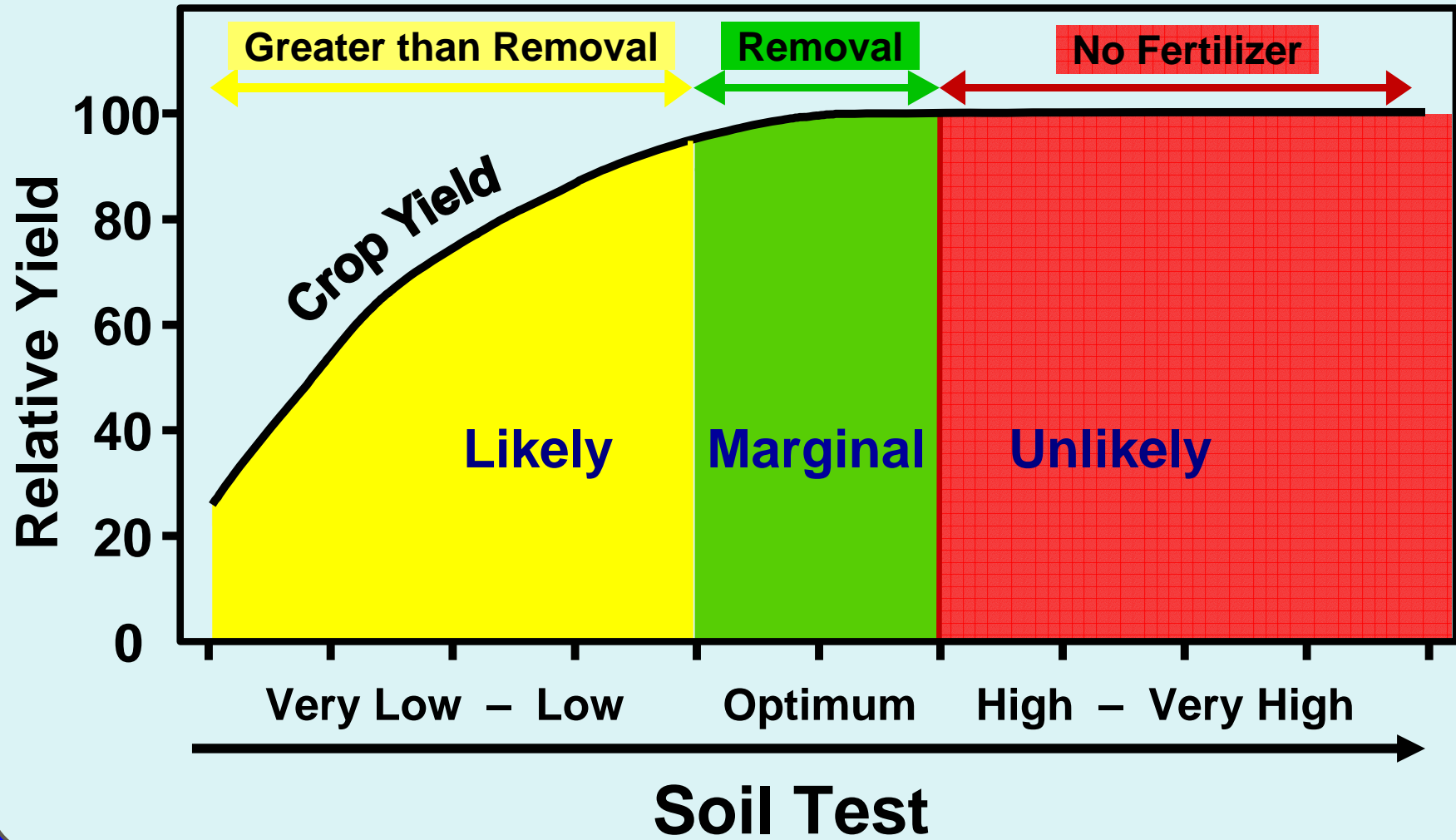
Pm-905 Crop Rotations, Effect on Yields and Response to Nitrogen, 1979

Soil Testing Determines Phosphorus and Potassium Fertilization Needs

- ❖ **Soil test categories give relative nutrient supply from soil**
- ❖ **Very Low and Low**
 - **Soil nutrient supply deficient for crop production**
- ❖ **Optimum**
 - **Soil nutrient supply marginal**
 - **Most profitable category to maintain**
- ❖ **High and Very High**
 - **Soil supply sufficient for crop production**

Crop Yield Response Curve

Soil Test to Interpretation



Phosphorus Recommendations - Corn

	Phosphorus Soil Test (ppm)				
Soil Test Category:	Very Low	Low	Optimum*	High	Very High
Bray P₁ and Mehlich-3 P:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
Mehlich-3 ICP:					
Low Subsoil P	0-15	16-25	26-35	36-45	46+
High Subsoil P	0-10	11-20	21-30	31-40	41+
	P₂O₅ to apply (lb/acre)				
	100	75	55	0	0
Diesel Equivalent gal/acre:	5.4	4.1	3.0	0	0

Potassium Recommendations - Corn

	Potassium Soil Test (ppm)				
Soil Test Category:	Very Low	Low	Optimum*	High	Very High
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0-90	91-130	131-170	171-200	201+
High Subsoil K	0-70	71-110	111-150	151-180	181+
	K₂O to apply (lb/acre)				
Fine Textured	130	90	45	0	0
Sandy Textured	110	70	45	0	0
Diesel Equivalent gal/acre:	5.5	3.8	1.9	0	0

Summary

- ❖ **Fertilizer manufacture, distribution, delivery, application is energy intensive**
- ❖ **Fertilizer use is a major expense in crop production**
- ❖ **Fertilizer use is needed for long-term production of high and economical crop yields**
- ❖ **Adjustments can be made in fertilizer use as energy costs (fertilizer prices) increase**
- ❖ **High energy costs (fertilizer prices) reduce crop production profitability**



Iowa State University Agronomy Extension
Soil Fertility Web Site

<http://extension.agron.iastate.edu/soilfertility>