



Exposure of the Upper Midwest to Invasive & Noxious Weeds Fueled by Renewable Energy Mandates

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Applied Economics

Monday, November 22, 2010

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Integrative Graduate Education and Research Traineeship (IGERT)
Risk Analysis for Introduced Species & Genotypes



PhD Dissertation
Willingness of Farmers to Supply Biomass and
Ecosystem Services through Perennial Crop Production

Lowering the Cost of Bio-energy Feedstocks while Providing Environmental Services – A Win-Win Opportunity



Renewable Development Fund



Research Idea

- Tribal Renewable Energy Research Workshop
May, 2010 at the University of Washington
- Yakama Nation Natural Resource Manager
 - Russian Olive Management as biomass source
 - High Yields per acre
- Forestry Industry



Economics in Risk Assessment

- Assessment Endpoint
 - economic impact of invasive species
- Exposure & Effects
 - Economic analysis to determine exposure & non-economic effects
 - Recreational Boater Behavior
 - (IGERT Symposium February Spring 2011)
 - **Agricultural**
 - Horticulture

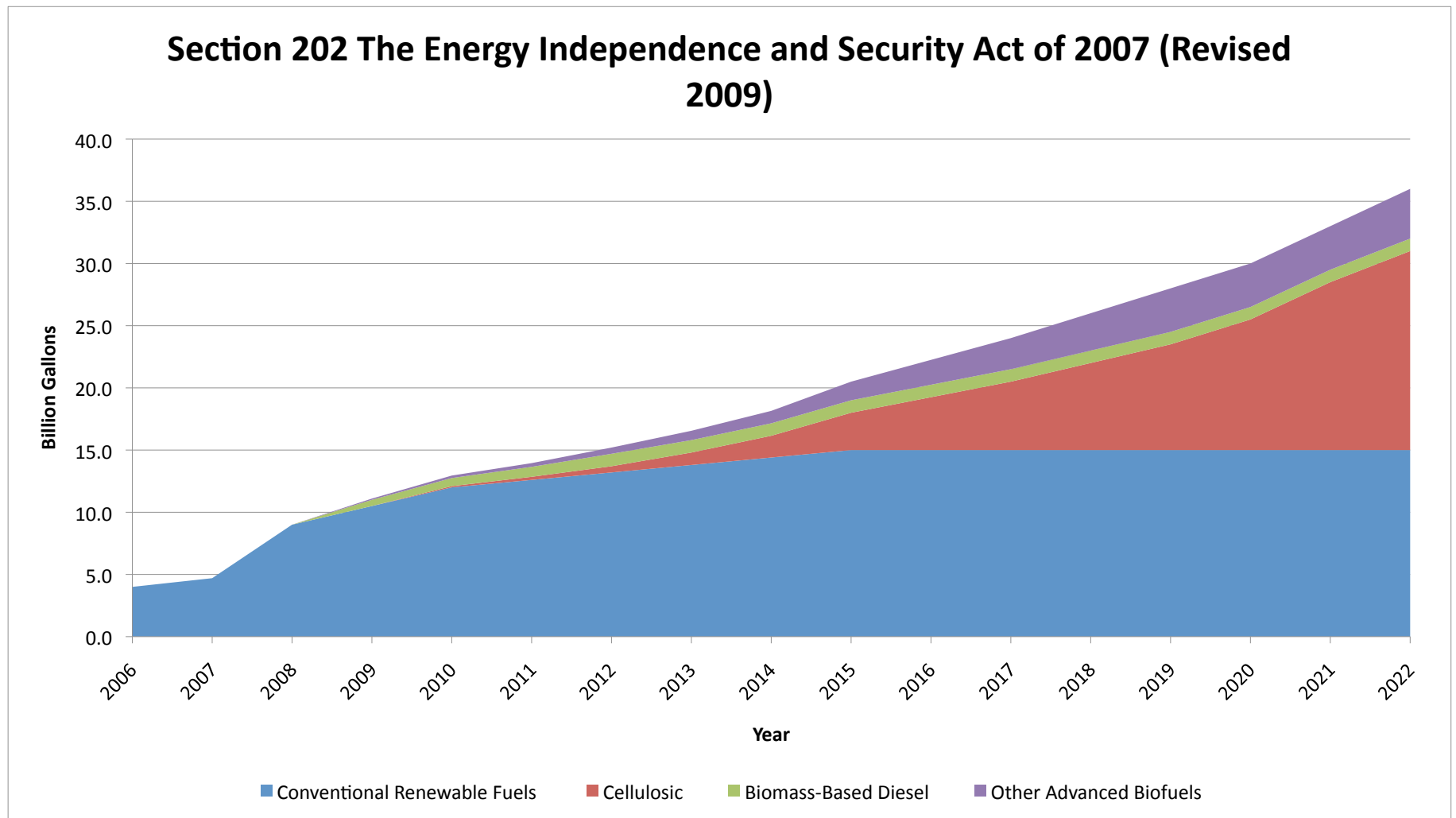
Exposure Risk of Invasive and Noxious Weeds from Perennial Bioenergy Production

- Renewable Energy Mandates
- Exposure Assessment
 - Climate
 - History of Invasion
- Regulation
- Economics

Renewable Energy Mandates

- Cellulosic Ethanol
 - The Energy Independence and Security Act of 2007
- Biopower & Bioheat
 - State Renewable Portfolio Standards (RPS)
 - Minnesota Renewable Portfolio Standard (25% by 2025), Xcel (30% by 2020)
 - Wisconsin Energy Efficiency and Renewable Act (10% by 2015)

Cellulosic Ethanol Mandates



Bioheat & Biopower Examples



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A Few Biomass Sources

- Conventional Crop Residuals (Corn Stover)
- Perennials
 - Trees
 - Forestry
 - Short Rotation Woody Crops
 - Grasses



Why are we concerned about perennial bioenergy crops?

Conventional Row Crops

- Annuals
- Dependent on Agronomic Inputs
- Varieties which maximize Grain production

Biomass Crops

- Perennials
- Not Dependent on Agronomic Inputs
- Similar to natural varieties
- Maximizing cellulosic material

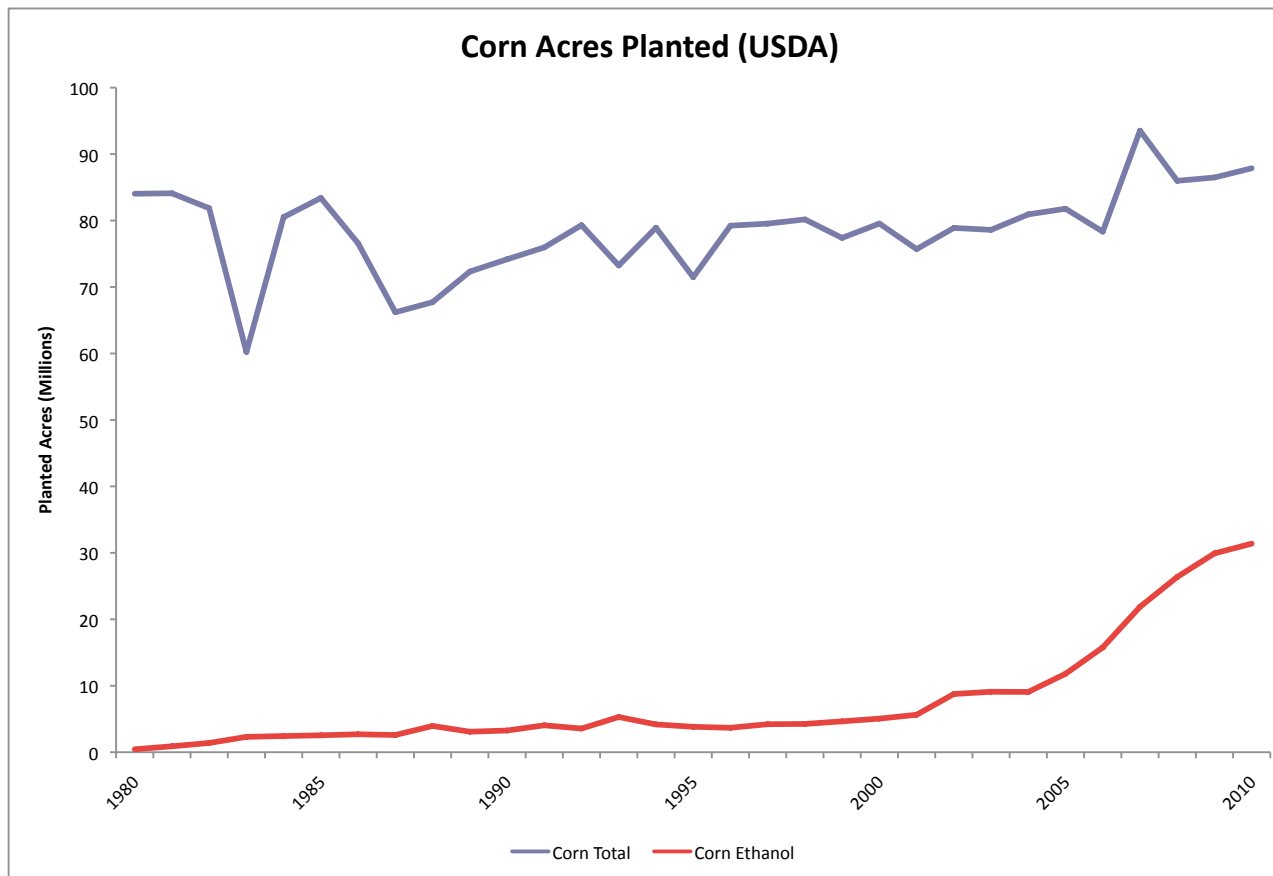
Agronomic/invasive characteristics (Barney 2008)

- Life History
 - Perennial
 - High yielding (aboveground biomass)
 - Grows at high densities
 - Rapid growth rate
- Physiology
 - Drought tolerant
 - High water-use efficiency
 - Tolerates soil disturbance
 - C4 Photosynthesis (Grasses)
- Hosts few pests/diseases
- Reallocates nutrients to perennating structures

Land Used for Production

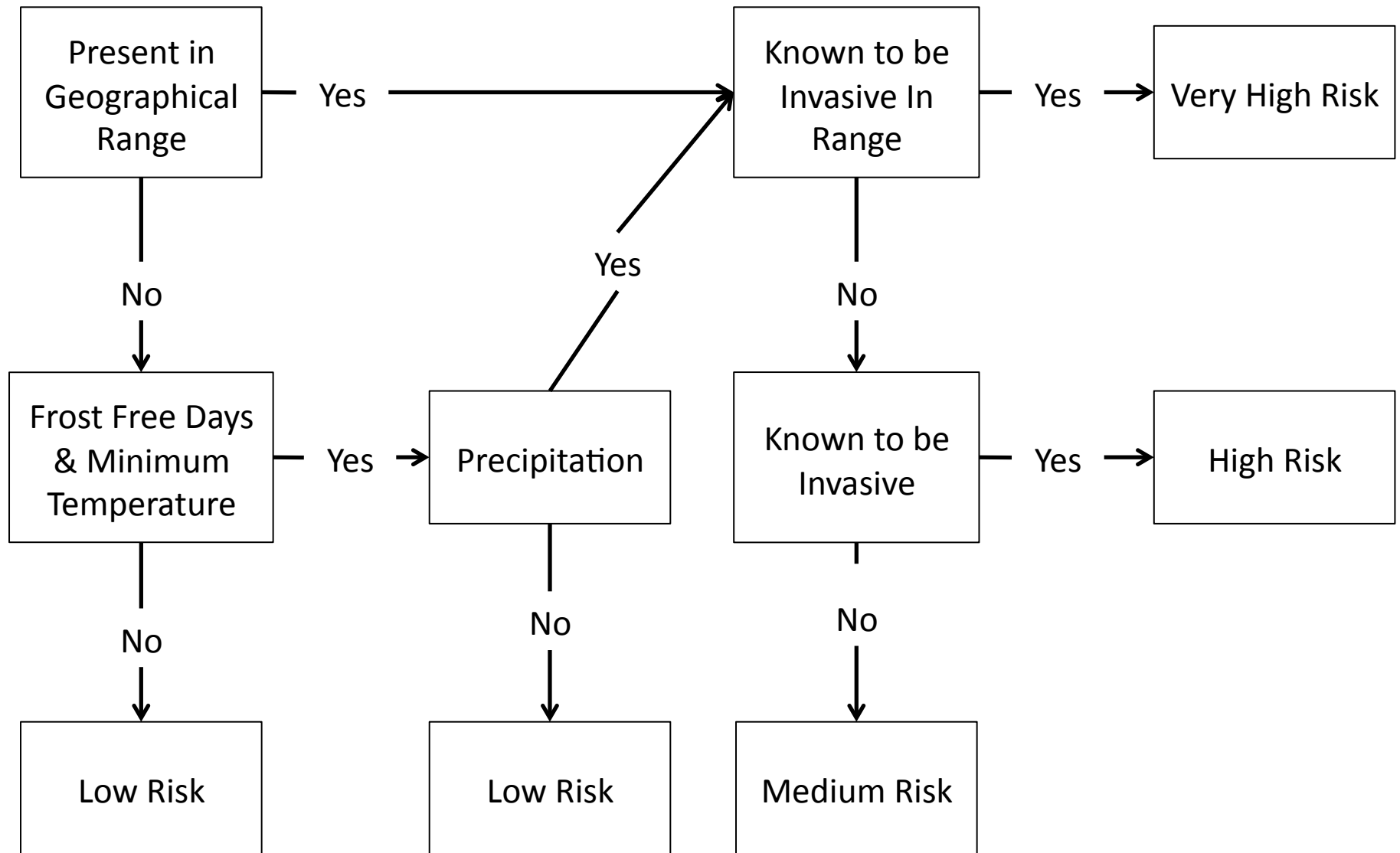
10 Billion Gallons Ethanol = 30 Million Acres of Corn (30%)

16 Billion Gallons of Cellulosic Ethanol by 2025 = ?



Initial List

- Global Invasive Species Program Watch List
- Journal Articles
- State Invasive Species Lists
 - MN, WI
 - Grasses, Short Rotation Woody Crops
- DATA
 - USDA Plants Database



Planting Potential

Medium or High Drought Tolerance

Moderate or Rapid After Harvest Growth Rate

Rapid Growth Rate

Medium or Low Moisture Use

C4 Photosynthesis

State Laws: MN



- Minnesota Noxious Weed Laws
 - PROHIBITED 1505.0730
 - RESTRICTED 1505.0732
 - Glossy buckthorn (*Frangula alnus*)
 - Common Buckthorn (*Rhamnus cathartica*)
 - SECONDARY 1505.0740

State Laws: WI



- Wisconsin's Invasive Species Identification, Classification and Control Rule (Chapter NR 40)
 - Prohibited (P)
 - **Princess tree** (*Paulownia tomentosa*)
 - **Sawtooth oak** (*Quercus acutissima*)
 - **Japanese stilt grass** (*Microstegium vimineum*)
 - **Tall or Reed manna grass** (*Glyceria maxima*)
 - **Lyme grass or Sand ryegrass** (*Leymus arenarius*)
 - Restricted (R)
 - **Russian olive** (*Elaeagnus angustifolia*)
 - **Autumn olive** (*Elaeagnus umbellata*)
 - **Glossy buckthorn** (*Frangula alnus*)
 - **Common Buckthorn** (*Rhamnus cathartica*)
 - **Common Reed** (*Phragmites australis*)
 - **Narrow-leaved cattail** (*Typha angustifolia*)
 - **Hybrid cattail** (*Typha x glauca*)
 - Caution (C)

Example Invasive Perennial Crop

- Miscanthus
 - Rapid Growth
 - High Yield



Profit Maximizing Farm

$$\text{Max}(\pi_1(p_1, c_1, \text{CPI}), \pi_2(p_2, c_2, \text{CPI}), \dots, \pi_c(p_c, c_c, \text{CPI}))$$

$$\pi_c = p_c y_c - c_c$$

$$\pi_c = \text{Profit} \quad p_c = \text{Price}$$

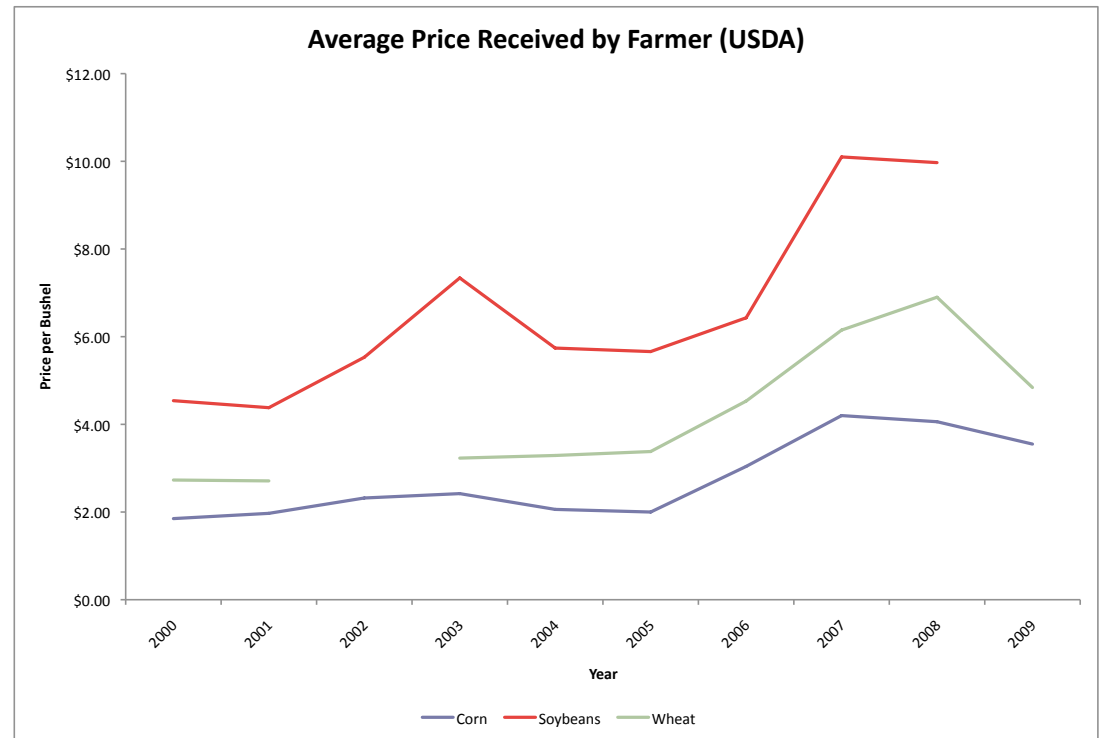
$$y_c = \text{Yield} \quad c_c = \text{Cost}$$

$$y_c = a_c + b_c \text{CPI}$$

CPI=Crop Productivity Index

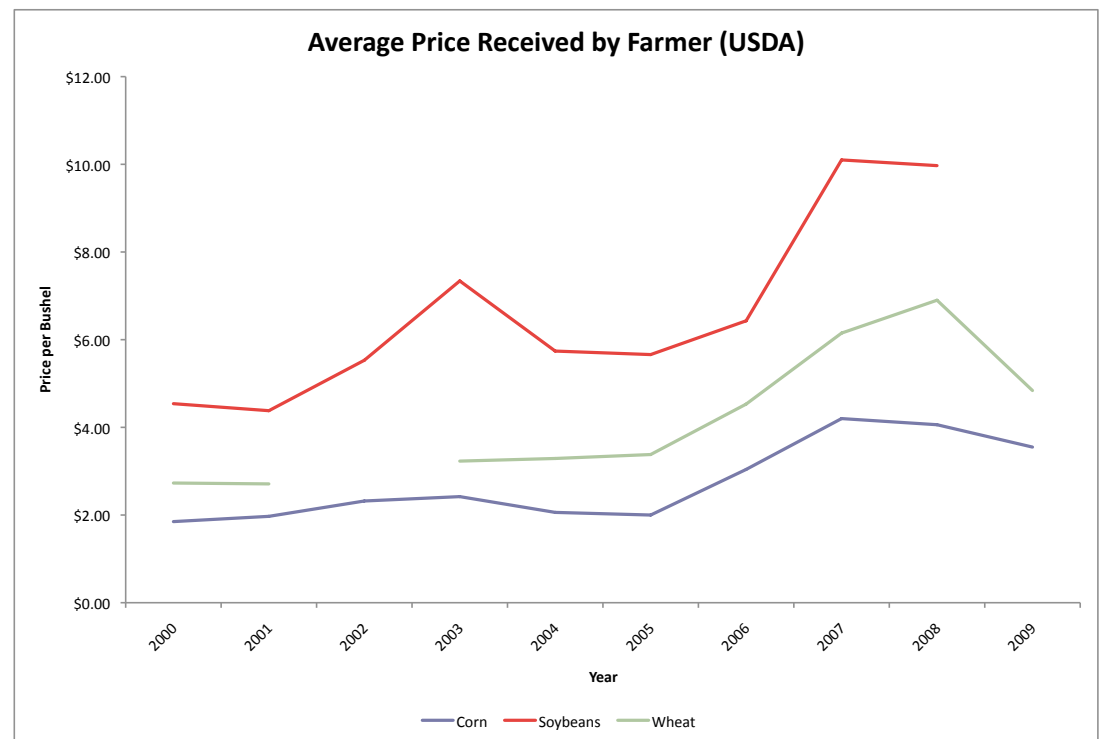
Economic Determinants

- Prices
 - Agricultural Commodities
 - Corn
 - Soybeans
 - Wheat
 - Biomass
 - Inputs
 - Oil
 - Capital
 - Seed
 - Chemicals
 - Rent
 - Environmental Services
- Land Productivity (CPI)
- Government Policies
 - Subsidies
 - CRP

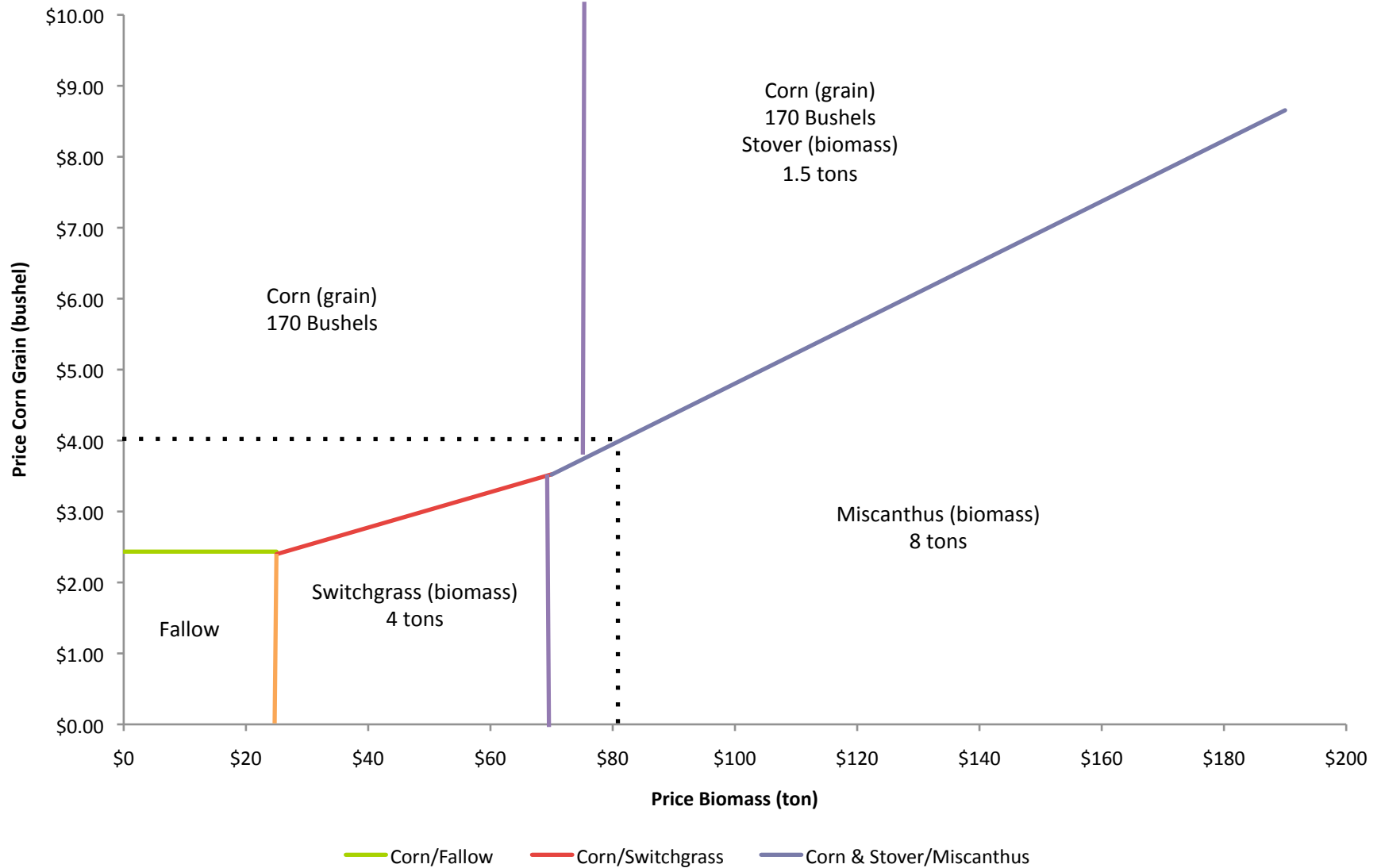


Economic Determinants

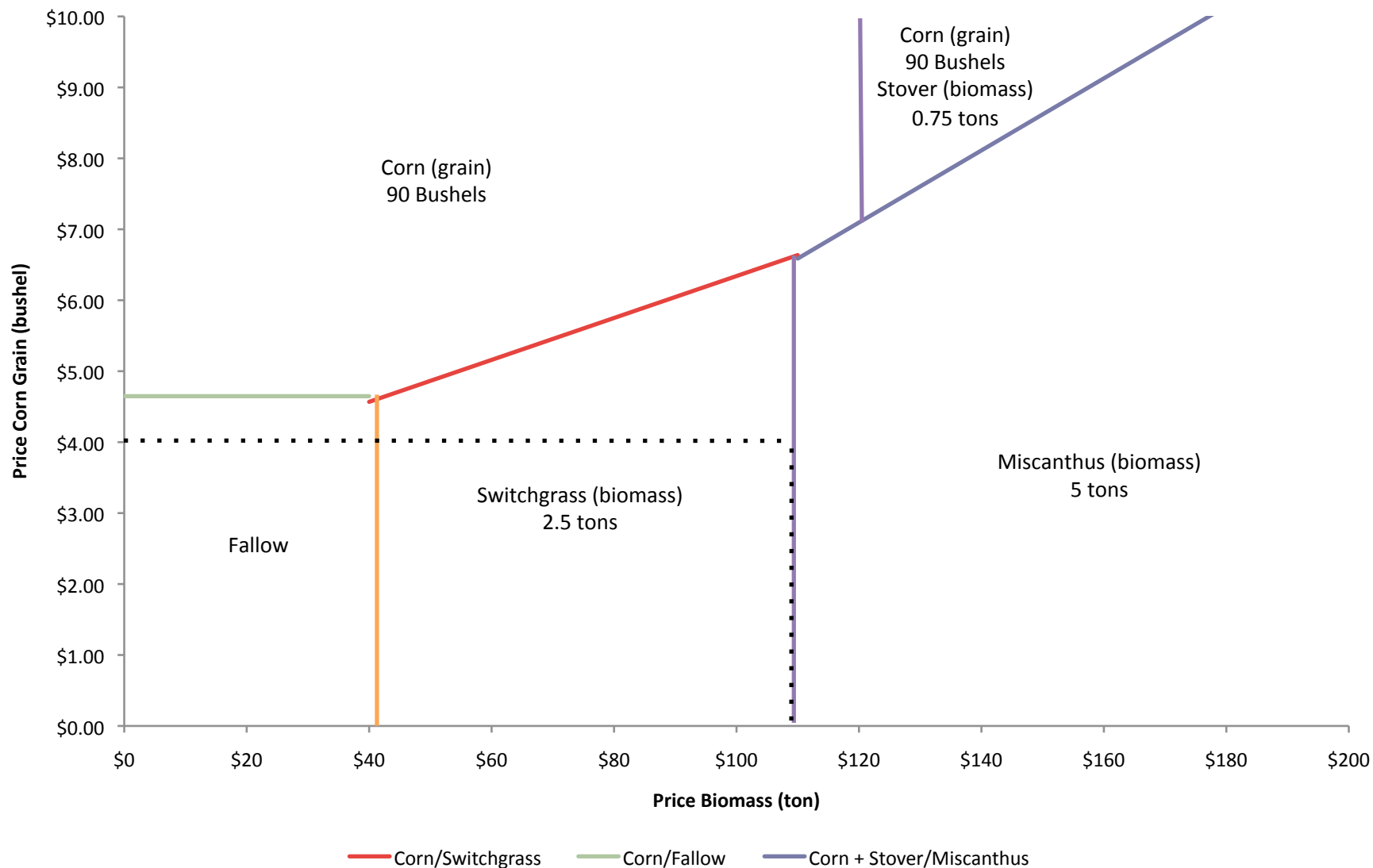
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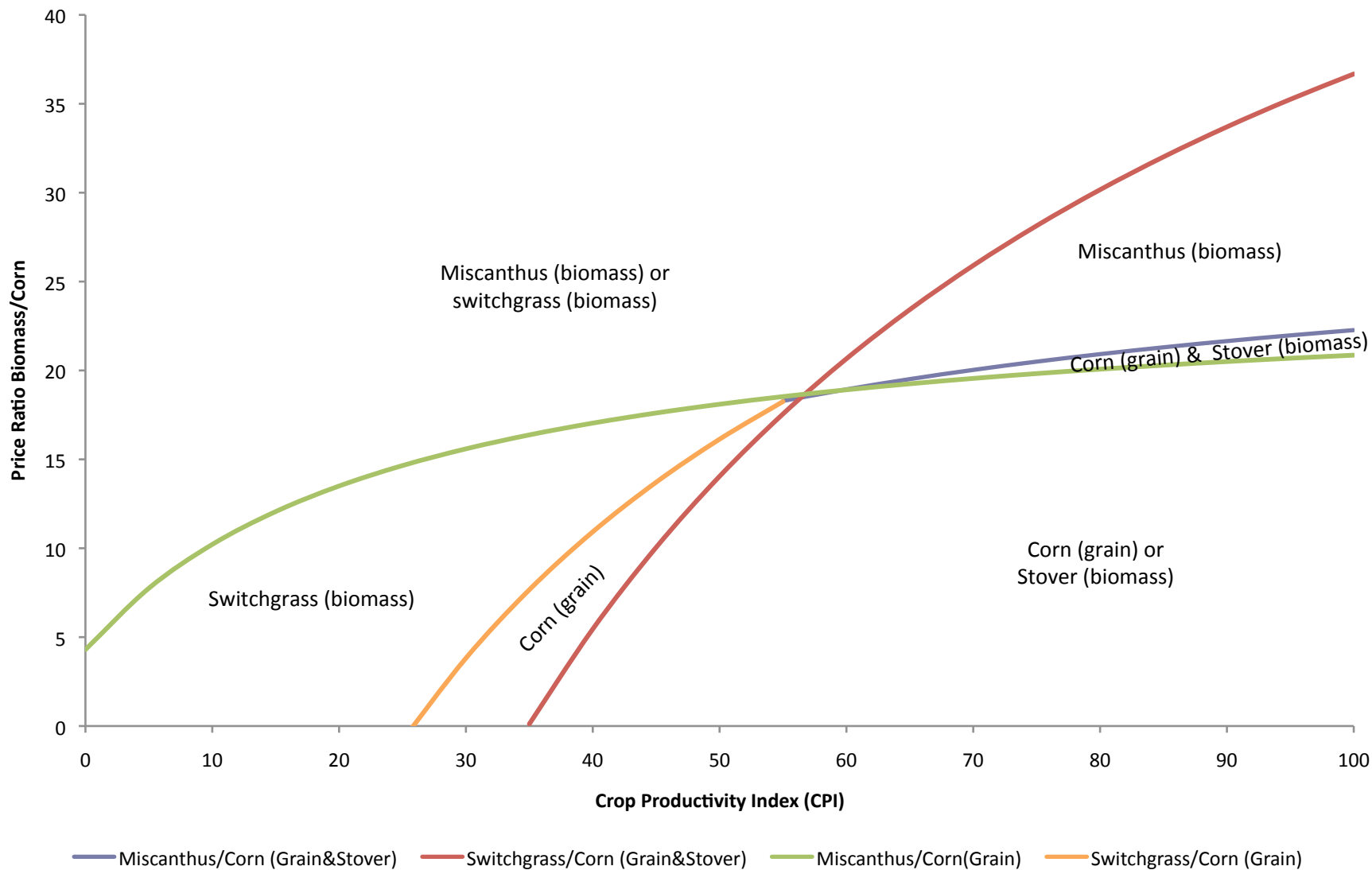
Crop Choice Southern MN Crop Productivity Index (CPI 80)



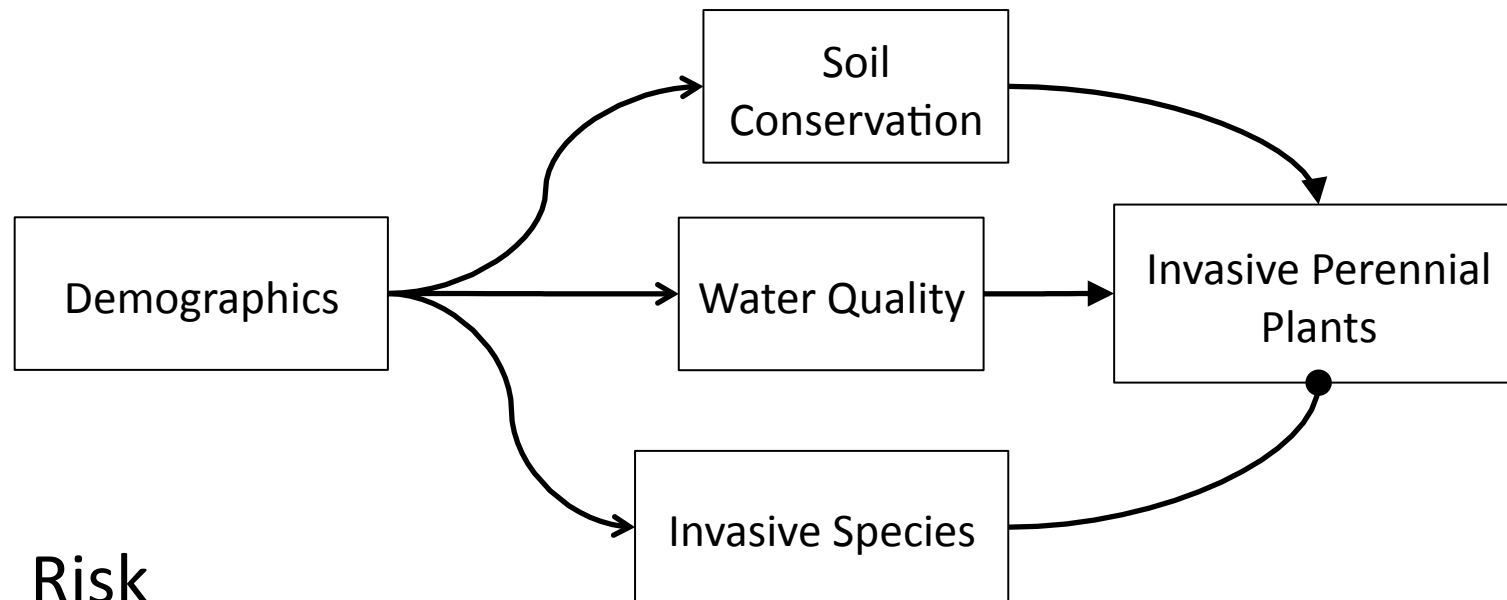
Crop Choice Southern MN Crop Productivity Index (CPI 40)



Crop Choice Southern MN



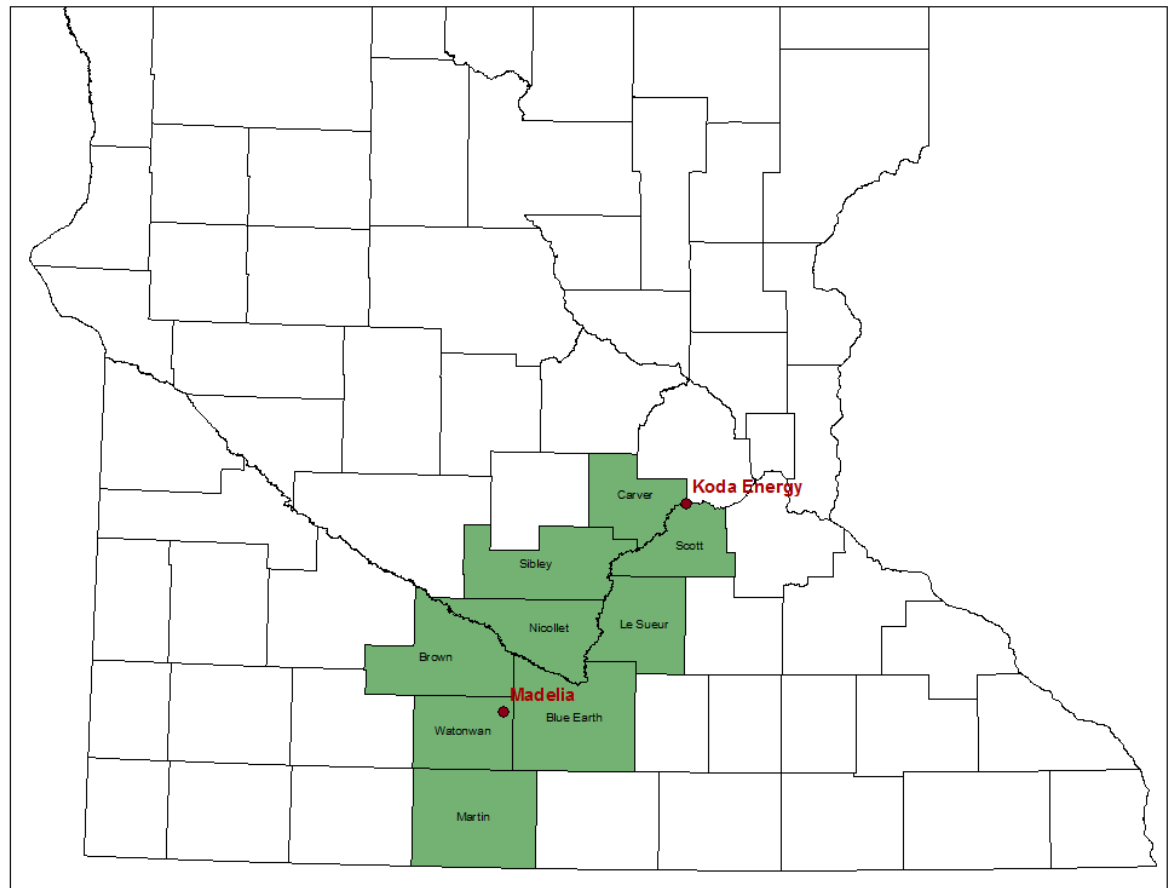
Farmers Willingness to Supply



- Risk
- Attitudes and Perceptions
 - Environmental Services
 - Invasive Species

Agricultural Landowner Survey

- 15,000 Farmland Owners
- 800 Surveys
- Fall 2010



Farm Household

$$\text{Max } U(x, ES, IS)$$

$$\text{Subject to } p_x x = \pi_c(p_c, c_c, CPI) + w$$

π_c =Profit P_c =Price c_c =Cost

p_x =Price of household goods

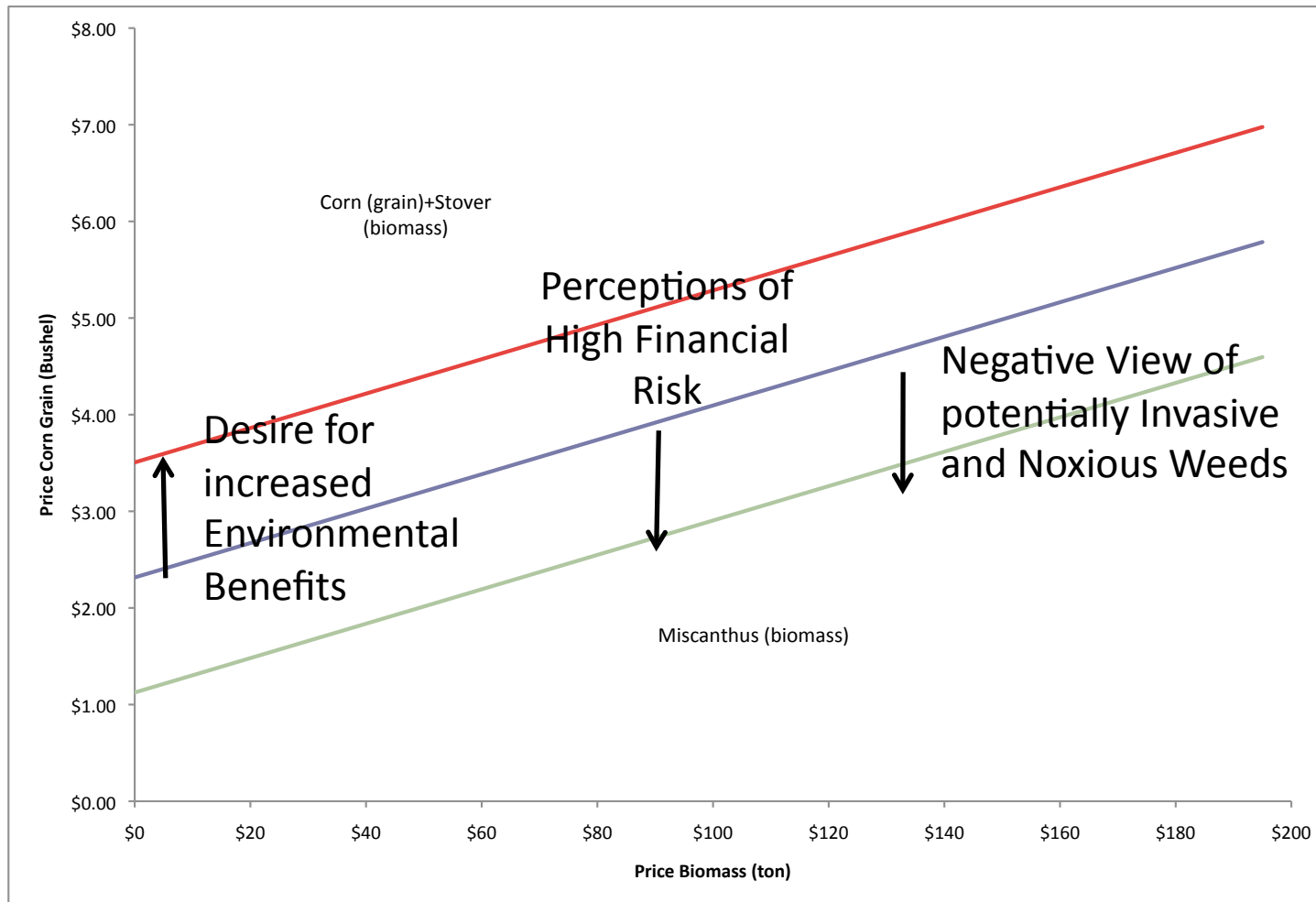
x =consumption of household goods

w =nonfarm income

U is increasing in Environmental Services (ES)

U is decreasing in Invasiveness (IS)

Crop Choice with Environmental Services and Invasiveness concerns



Economics in Risk Assessment

- Risk Assessments can benefit from economics in estimating exposure and effects
- Identify economic conditions which have a higher risk of invasion
 - Lower Corn Prices
 - Higher Biomass Prices
- Identify landscapes that have a higher risk of invasion.
 - Low Productivity

Future Research

- Further develop climate matching, invasion, and planting potential components of model
- Analyze survey results
- GIS model of exposure risk of the Upper Midwest.

Thank You

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