Empirical Analysis of the Sources of Corn Used for Ethanol Production in the United States: 2001-2009

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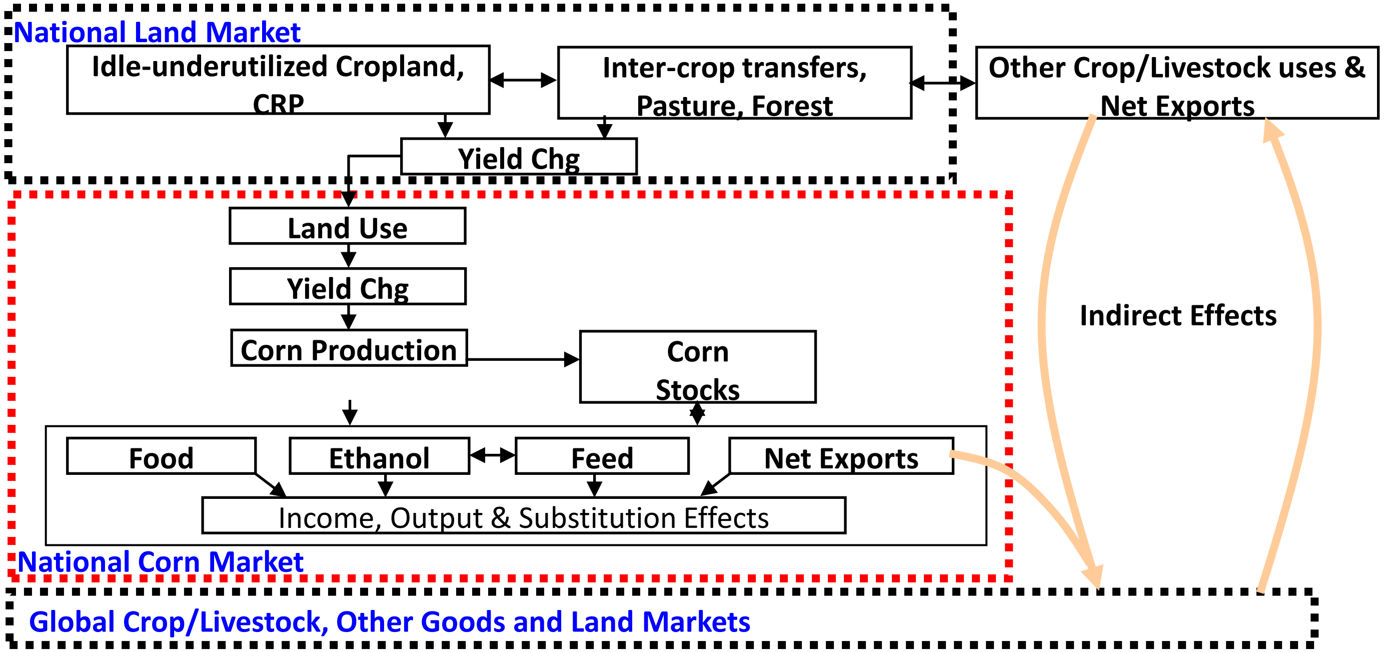
Outline

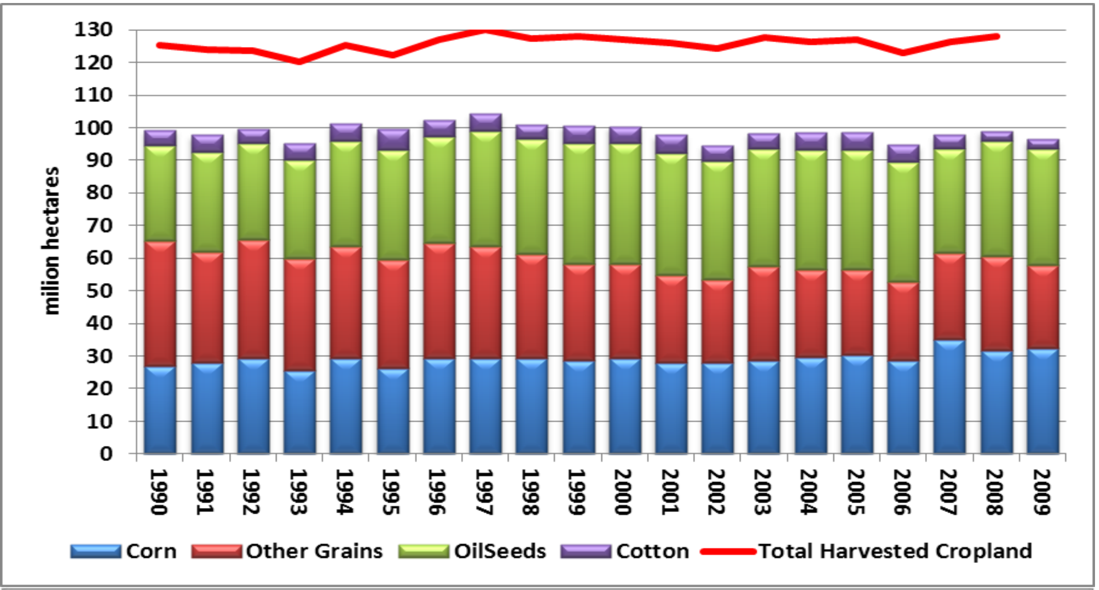
- Introduction
- Review of the Empirical Data
- Methodology & Results
- Conclusions

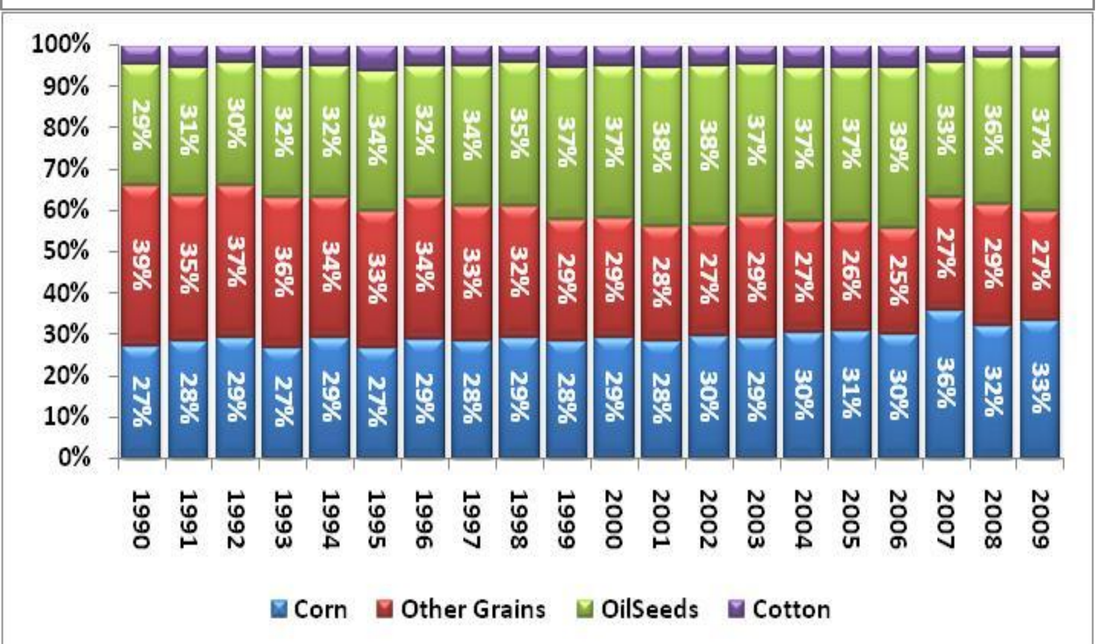
Indirect Land Use Change (ILUC) Unobservable; Estimation Involves Many Assumptions



- ILUC is unobservable and depends on a multitude of factors
  - Modeling the complex interactions of these factors involves many assumptions
- Rapid growth in ethanol production over the last decade
  - Provides empirical data to begin evaluating these assumptions

Review of the Empirical Corn Data: Harvested Area Changed Little from 2001-2009





- Harvested cropland changed little since 1990
- Corn share of major crops area around 30%
- Oilseeds share about 37%

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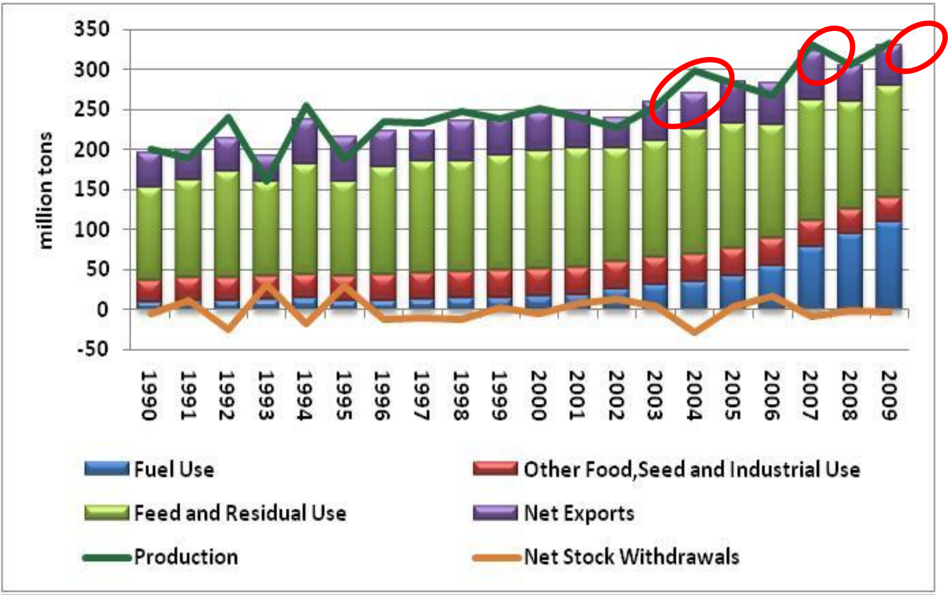
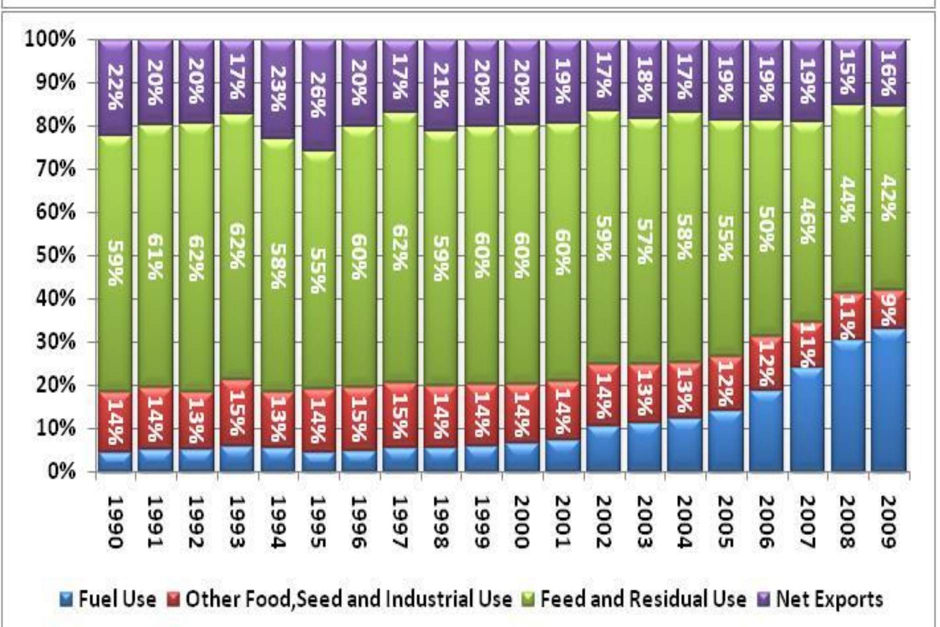
Review of the Empirical Corn Data: Exports Up By 50% from 2002 to 2007; Use for Ethanol Quintupled





- Corn production increased in 2003,2004, 2007 & 2009
- Export share stable from 2001- 2007
- Ethanol use share - 2001-2009: +26%
- Other uses share - 2001-2009: -23%

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Index Decomposition Analysis (IDA): Isolates the Contributions of Individual Factors

- **Used extensively for energy decomposition analysis (see references)**
- **Allocates the change in a given variable (y) to each contributing factor *ceteris paribus* - if all other factors were held constant**

- **Decomposition analysis is based on the total differential of a general function of the following form:**

$$y = x_1 . x_2 . \ldots . x_n$$

- **The log. mean divisia index (LMDI I) formulation:**

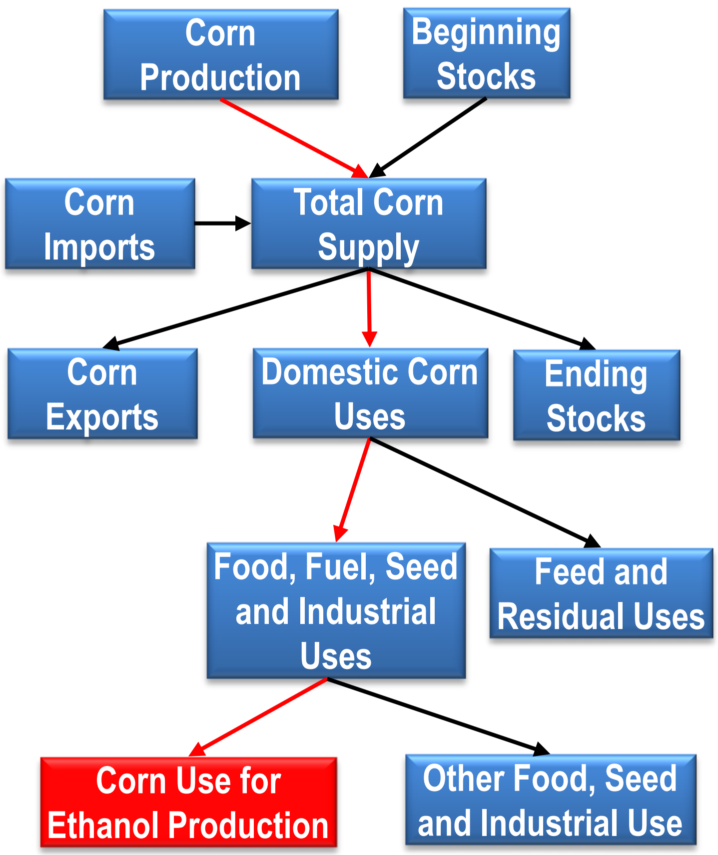
$$\Delta y^D = \sum_{i=1}^{n} \left(\frac{(y_{t1} - y_{t0})}{ln\left(\frac{y_{t1}}{y_{t0}}\right)} \right) ln\left(\frac{x_{i,t1}}{x_{i,t0}}\right) = \sum_{i=1}^{n} \Delta y \frac{g_{xi}}{g_y}$$

Factor Contributions

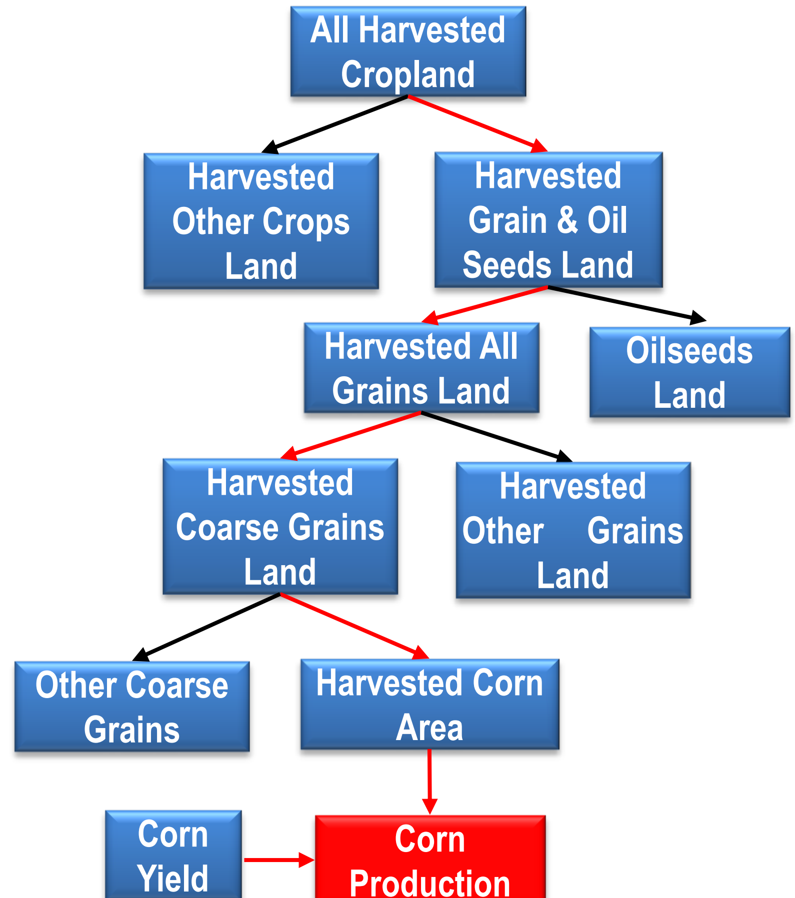
- **Addresses need to isolate the role of individual factors**

Decomposition Analysis: Corn Use for Ethanol Relationship with Demand/Supply Factors

Corn Supply and Distribution



Corn Land Use



- **Index Decomposition Analysis traces the pathway highlighted by red arrows**

Decomposition Analysis: Multiplicative Relationship Describes the Role of Factors in Corn Use for Ethanol

Domestic Use Reallocation; Domestic Share of Supply; Supply

$$Q_{ce} = \left(\frac{Q_{ce}}{Q_{ffsi}}\right)\left(\frac{Q_{ffsi}}{Q_{dom}}\right)\left(\frac{Q_{dom}}{Q_{sup}}\right)\left(\frac{Q_{sup}}{Q_{prd}}\right)Q_{prd}$$

Yield; Inter-Crop Land Transfers; Land Expansion

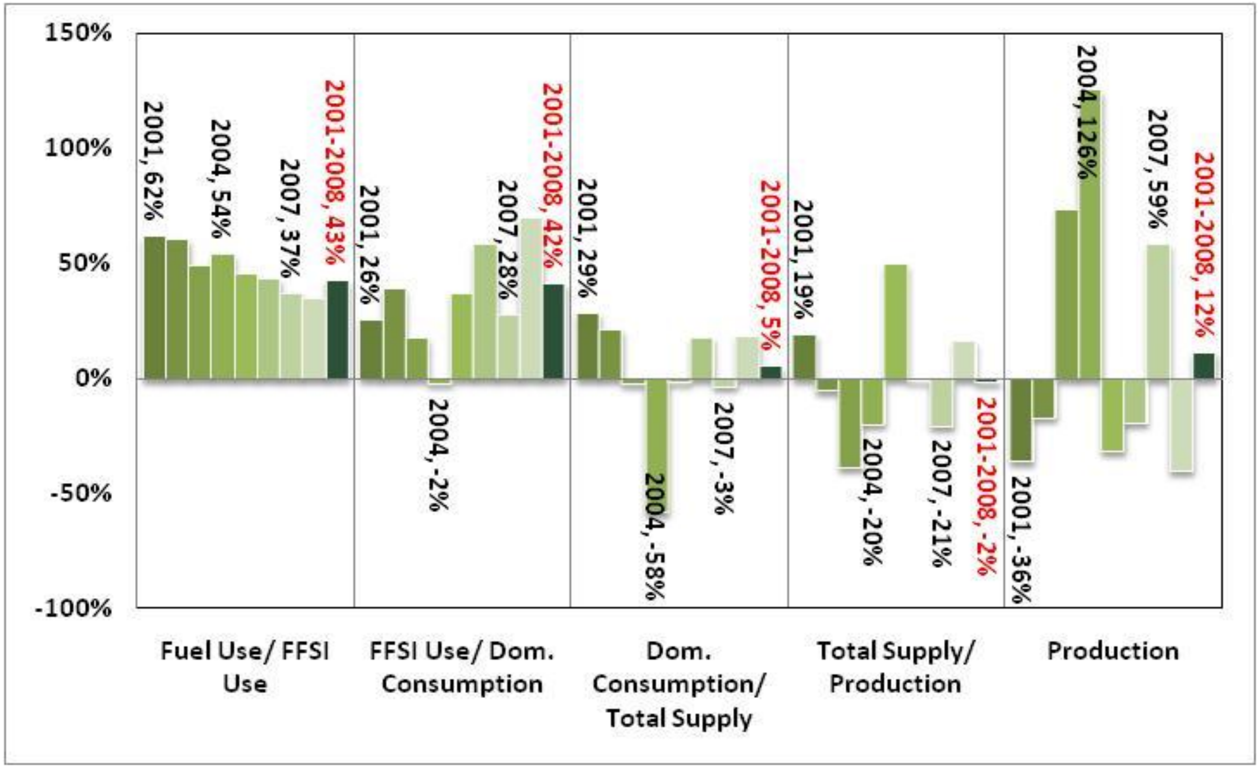
$$Q_{prd} = Y_{corn}\left(\frac{A_{corn}}{A_{cgrn}}\right)\left(\frac{A_{cgrn}}{A_{grn}}\right)\left(\frac{A_{grn}}{A_{grn+oilsd}}\right)\left(\frac{A_{grn+oilsd}}{A_{all}}\right)A_{all}$$

Q_{ce} = Corn use for ethanol production (million tons)
Q_{ffsi} = Corn use for food, fuel, seed and industrial purposes (million tons)
Q_{dom} = Total domestic corn use (million tons)
Q_{prd} = Total corn production (million tons)
Q_{sup}= Total corn supply (million tons)

Y_{corn} = Annual corn yield in (tons/ha)
A_{corn} = Annual corn harvested area (mha)
A_{cgrn} = Annual coarse grain harvested area (mha)
A_{grn} = Annual all grain* harvested area (mha)
$A_{gn+oilsd}$ = Annual all grain plus oilseeds harvested area (mha)**
A_{all} = Annual total harvested cropland area (mha)

* Grains include corn, barley, oats, rye, sorghum (coarse grains), wheat, milled rice (other grains)
** Oilseeds include soybean, cottonseed, peanut, rapeseed, and sunflower seed

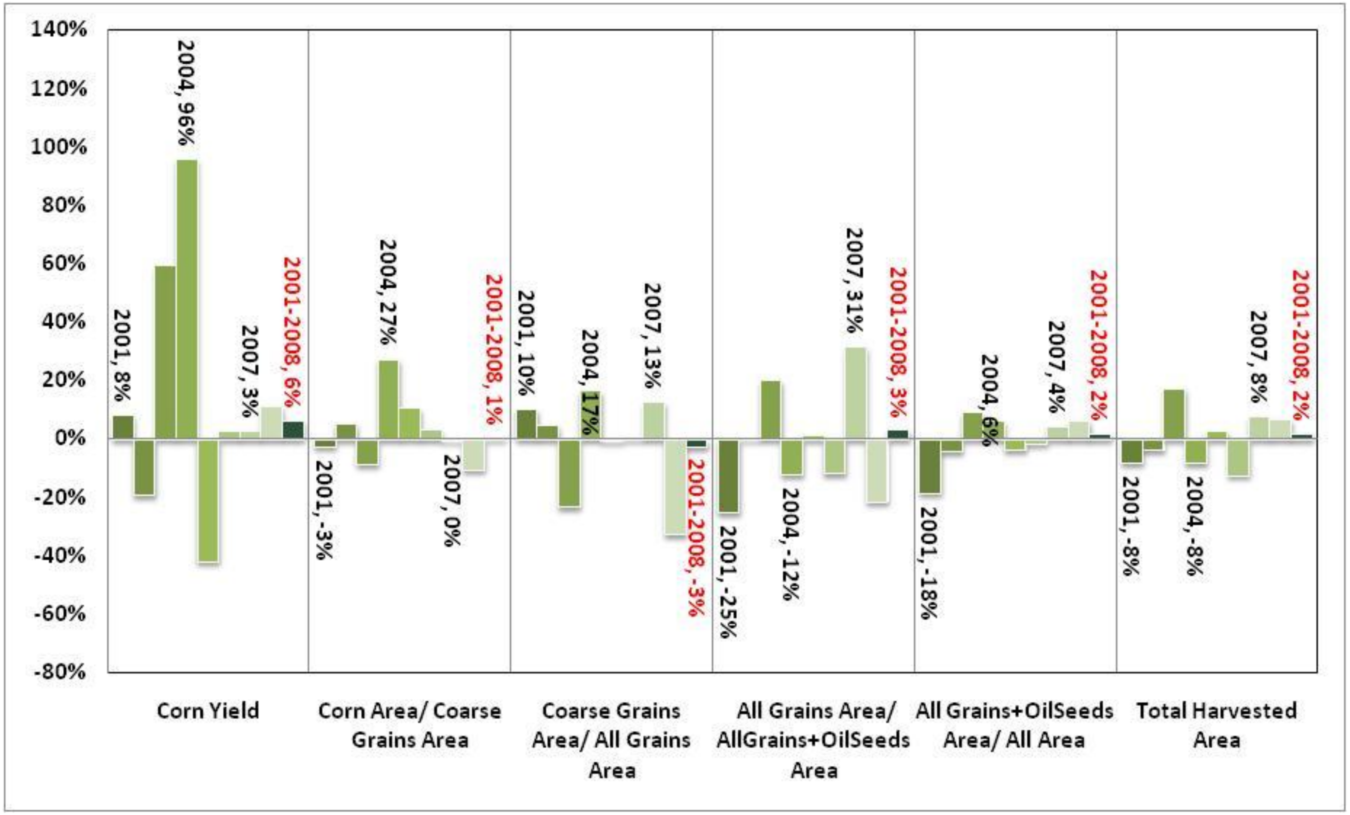
Decomposition Results 2001-2008*: Domestic Use Reallocations and Production Accounted for Most of the Change in Corn Use for Ethanol



- **Net Contribution from domestic use reallocation - 2001-2008: 85%**
- **Net Contribution from domestic share of supply - 2001-2008: 5%**
- **Net contribution from supply/production ratio - 2001-2008: -2%**
- **Net Contribution from production - 2001-2008: 12%**

* The decomposition analysis did not include 2009 because data on total harvested cropland area was not available.

Decomposition Results 2001-2008 : Yield Provided About Half of Total Production Contribution



- **Net contribution from yield from 2001-2008: ~6%**
  - **50% of production contribution**
- **Net Contribution from Land Expansion: 3%**
- **Net Contribution from Inter-Crop Land Transfers: 2%**

Decomposition Results 2001-2008: Factor Contributions Vary from Year to Year

- All years
  - Contribution from domestic use re-allocations were significant in all years
- 2003, 2004 & 2007 : All years of healthy economic growth
  - Production contributions large in all years
  - Contribution from domestic share of supply decreased
  - Demand increases met by production rather than diversion of exports
- 2001, 2002 & 2008: All years of market decline
  - Production contributions declined in all years
  - Contribution from domestic share of supply increased
  - Export demand reductions
- 2005,2006: Healthy economic growth in 2005; slowdown in 2006
  - Production contributions declined in both years
  - Contributions from domestic share of supply decreased in 2005, but increased in 2006

Conclusions: Key Assumptions Associated with ILUC Played A Small Role in the 2001-2008 Data Based on Decomposition Results

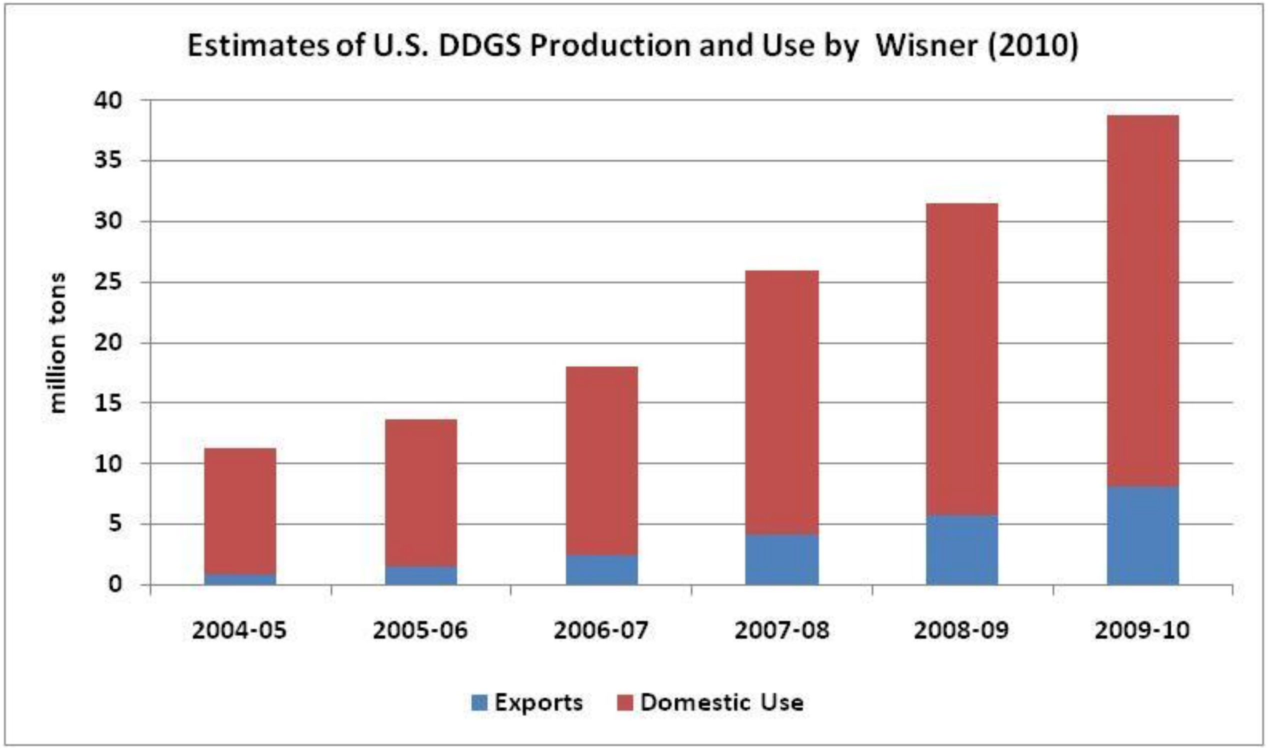
- Net increase in corn use for ethanol from 2001-2008 mainly from:
  - Re-allocation of domestic corn use in favor of ethanol
  - Increased production (half due to yield change)
- Contributions from factors behind ILUC not large in 2001-2008 data
  - Contribution from the domestic use share of supply small
    - Export share changes were small
  - Contributions from land factors were also small
- Domestic market's response to corn use for ethanol very flexible
- Year to year variations in factor contributions
  - Cannot use single year observation or two-point comparisons to predict long-term ILUC
  - Crucial dynamics in the determinants of ILUC require further examination

Additional Slides

Economic Conditions Has Crucial Influence on the Domestic and Export Crop Markets

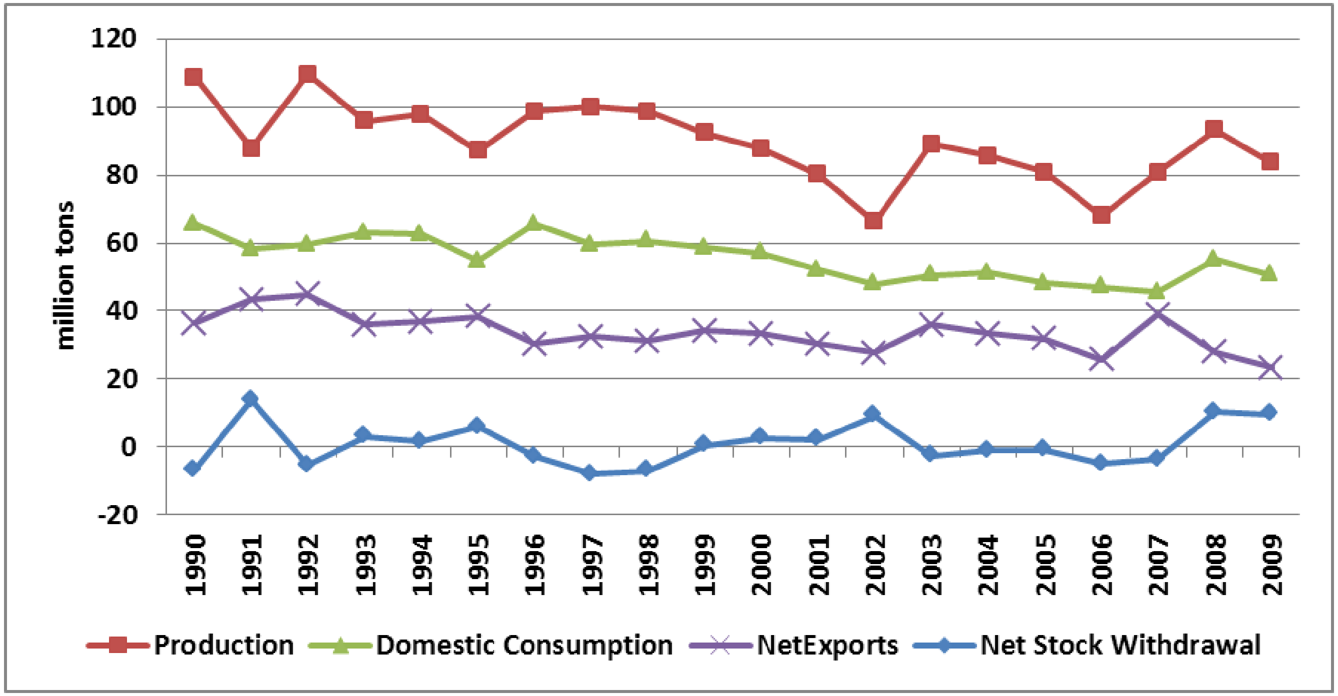
- 2001 & 2002: economy in recovery
  - Corn production declines; corn ethanol begins to increase
- 2003,2004: economic growth
  - Corn production increases; corn ethanol increases rapidly
- 2005,2007: economic growth
  - Corn production declined in 2005, increased in 2007; corn ethanol keeps increasing
- 2006: economic slowdown
  - Corn production declines; corn ethanol keeps increasing
- 2008: economic decline
  - Corn production declines; corn ethanol keeps increasing

Other Markets 2004-2009: DDGS Production/Use



- Corn ethanol returns between 30-40% of corn use as DDGS
- Exports of DDGS estimated at 6 million tons of corn by 2008
  - In addition to the increase in corn exports during the period
- Studies suggest higher efficiency of DDGS relative to corn/soybean (Bremer et al, 2010)

Other Markets - All Grains (Minus Corn) Supply/Use: 1990-2009 – Declining production trend 1990-2002



- **All grains (minus corn) production increased in 2003, 2007 & 2008; corn production increased in 2003,2004 & 2007**
- **Domestic use declined slightly from 2002-2007**
- **Exports increased in 2003 & 2007**

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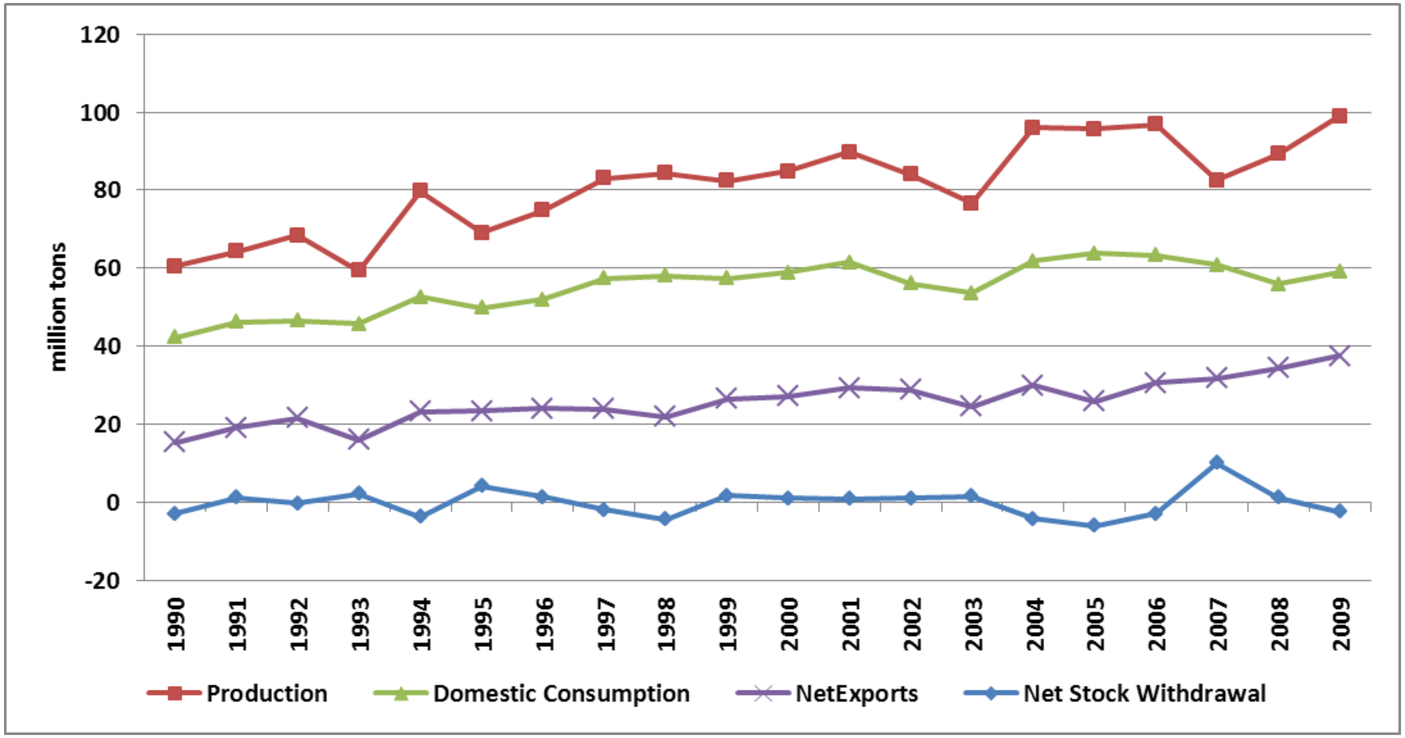
Other Markets - Oilseeds Supply/Use: (1990-2009)



- **Oilseeds production increased in 2003 and was flat through 2006; corn production increased in 2003,2004 & 2007**
- **Domestic use rose slightly from 2003-2006; declined in 2007 & 2008**
- **Exports increased from 2003 – 2007, with a slight dip in 2005**

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