

**ACE 427  
Spring 2009**

***Lecture 8***

***Forecasting the Supply of Crops***

**by  
Professor Scott H. Irwin**

**Required Readings:**

**Glauber, J.W. “Prospects for the US Farm Economy in 2009.”  
Presentation at the USDA Agricultural Outlook Forum, February 2009.  
(class website)**

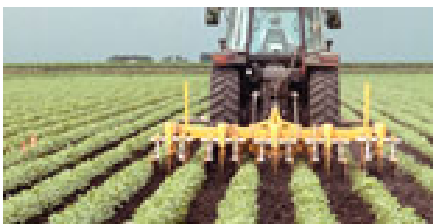
**Irwin, S., D. Good, and M. Tannura. “Forming Expectations About  
2008 U.S. Corn and Soybean Yields—Application of Crop Weather  
Models that Incorporate Planting Progress.” MOBR 08-03, Department  
of Agricultural and Consumer Economics, University of Illinois at  
Urbana-Champaign, July 2008.**

## Decision Context for Supply Forecasting

One way of modeling supply response for an agricultural crop is to relate \_\_\_\_\_ to \_\_\_\_\_ and other supply-related variables

Another way of modeling supply response is to directly relate \_\_\_\_\_ to \_\_\_\_\_ and other supply-related variables

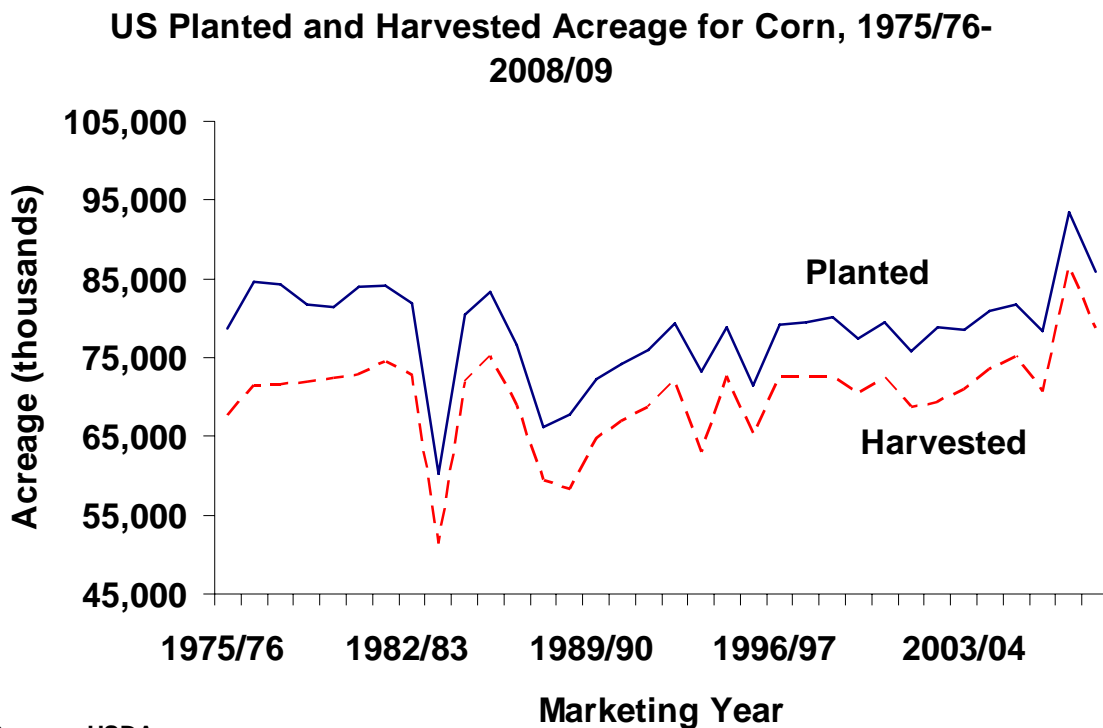
- This approach is generally followed in forecasting agricultural supplies
- Acreage planted is part of quantity produced that is \_\_\_\_\_ by farmer
- Yield will depend on weather, pests, and diseases and has \_\_\_\_\_ relationship to variables under a farmer's \_\_\_\_\_, once the acreage decision is made



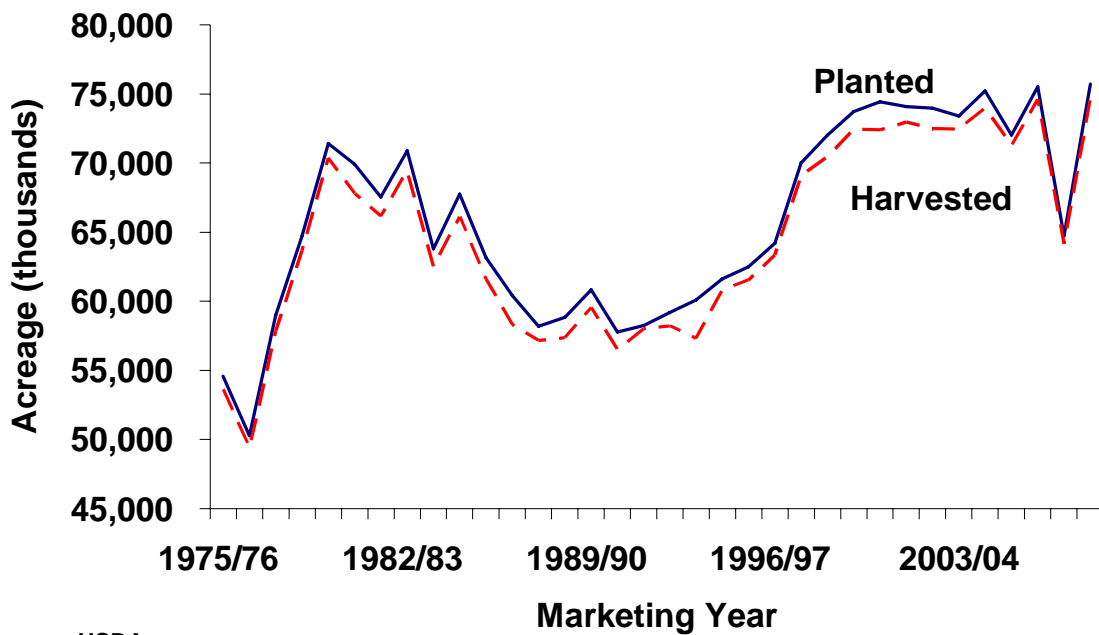
## Planted and Harvested Acreage

All \_\_\_\_\_ acres will not be \_\_\_\_\_ due to drought, flooding, disease and insect infestations

- Since acreage losses generally are due to \_\_\_\_\_ causes, farmers' have little control over the \_\_\_\_\_ of losses
- However, this does not mean acreage losses are \_\_\_\_\_



US Planted and Harvested Acreage for Soybeans,  
1975/76-2008/09



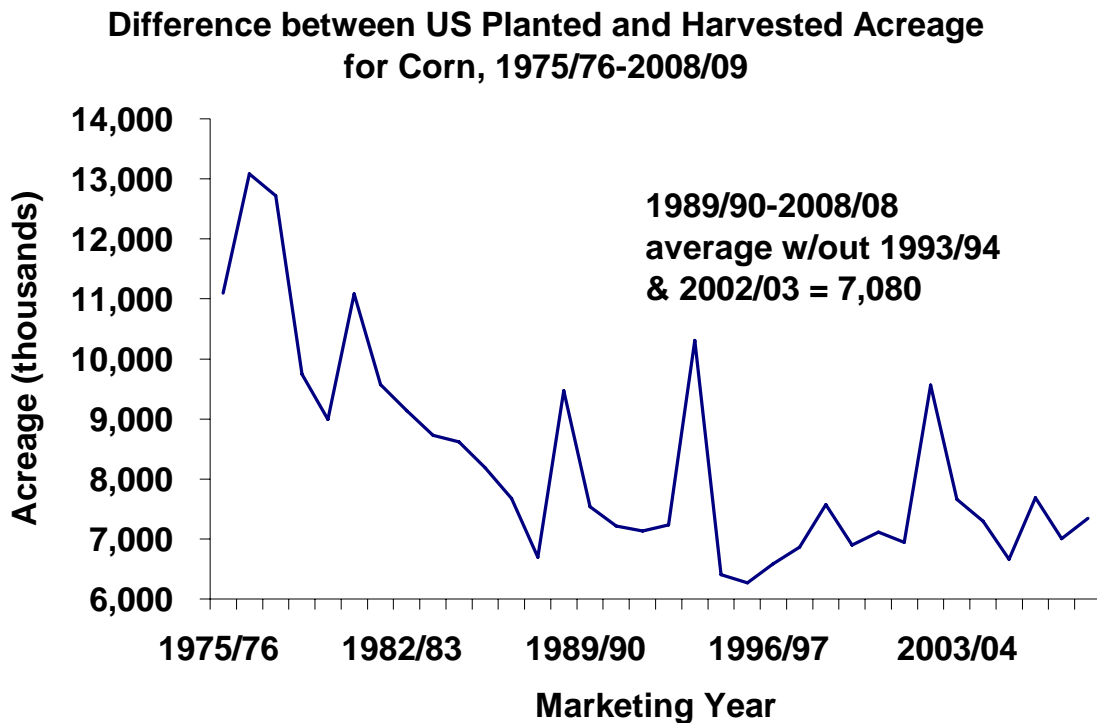
Source: USDA

Two approaches to estimating the \_\_\_\_\_ planted acreage \_\_\_\_\_

- Fixed number of acres abandoned
- Loss ratio for abandoned acres

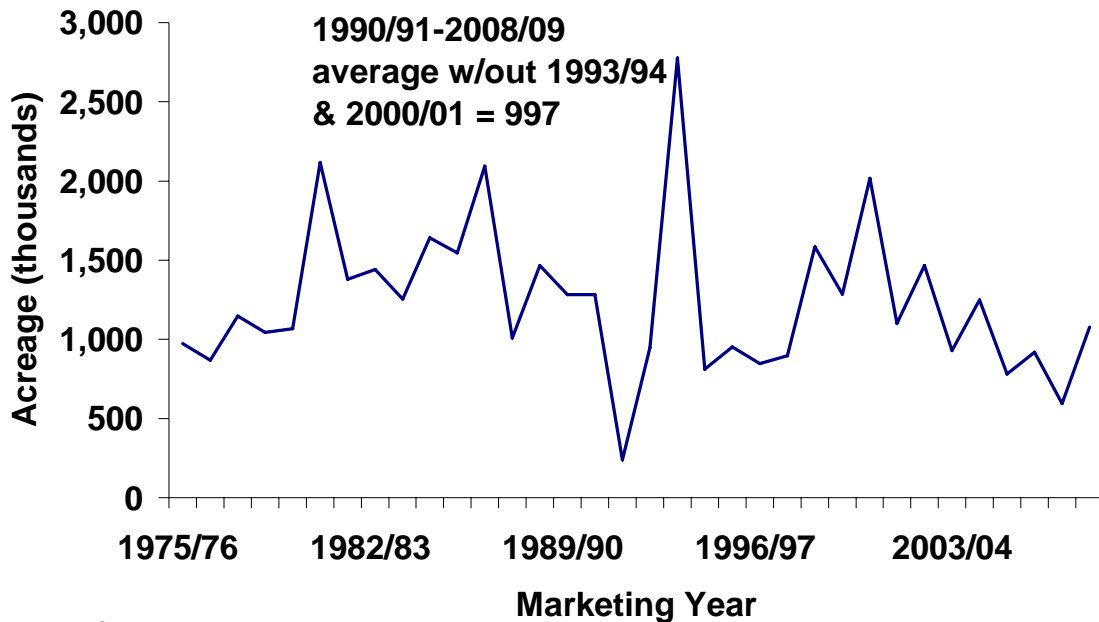
## Fixed Acreage Approach

- Some analyst's argue that a relatively \_\_\_\_\_ number of planted acres are \_\_\_\_\_ to be lost each year
  - \_\_\_\_\_ acreage in corn varies little from year-to- year
  - Acreage lost to flooding, insects, poor growing conditions in "normal" weather years also \_\_\_\_\_ little



Source: USDA

**Difference between US Planted and Harvested Acreage  
for Soybeans, 1975/76-2008/09**

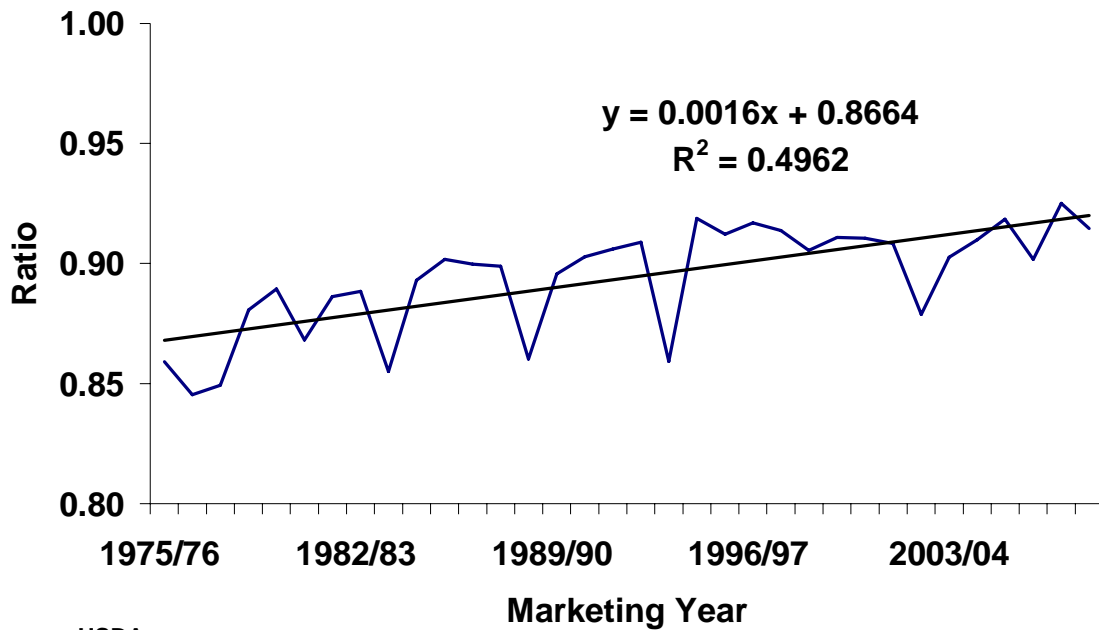


Source: USDA

## Loss Ratio Approach

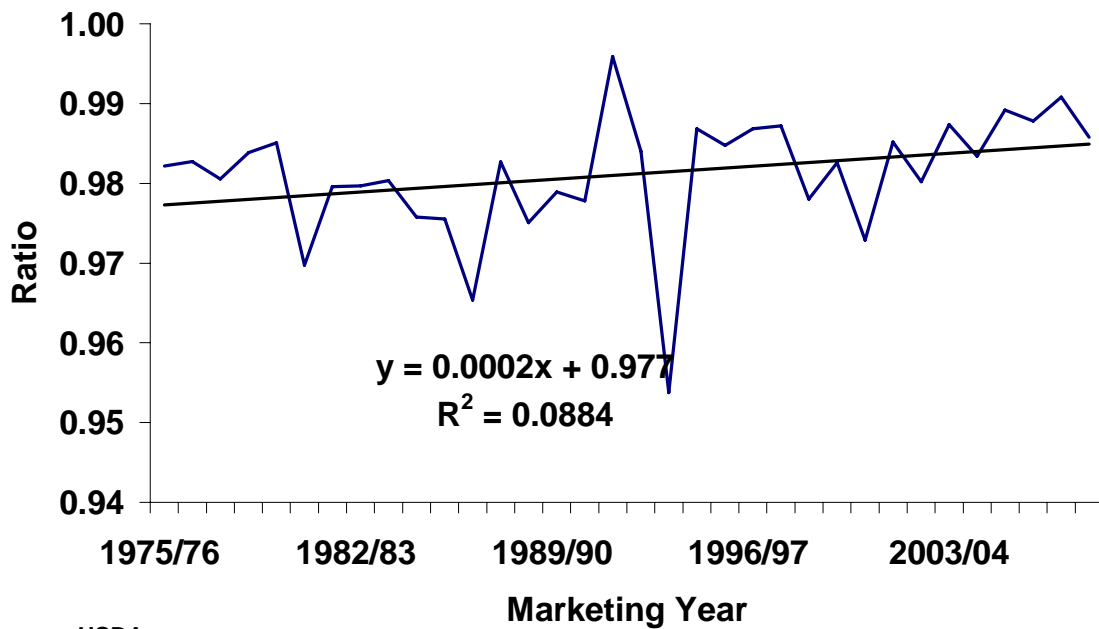
- Some analyst's argue it is better to assume that a \_\_\_\_\_ percentage of planted acres is \_\_\_\_\_ to be lost each year
- Abandoned acreage is then proportional to planted acreage
- Derive harvested acreage forecast based on \_\_\_\_\_ or \_\_\_\_\_ loss ratio

**Ratio of US Planted to Harvested Acreage for Corn,  
1975/76-2008/09**



Source: USDA

**Ratio of US Planted to Harvested Acreage for Soybeans,  
1975/76-2008/09**

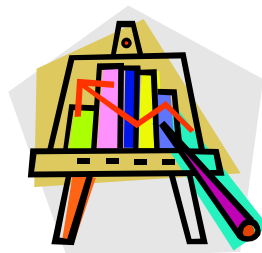


Source: USDA

- Previous evidence suggests it is reasonable to assume that acreage loss ratio is reasonably \_\_\_\_\_ over the last decade
  - \_\_\_\_\_ for corn
  - \_\_\_\_\_ for soybeans

## Economic Theory and Planted Acreage Decisions

- \_\_\_\_\_ suggests that farmers maximize expected net profit when making \_\_\_\_\_ decisions
- Decision rule to \_\_\_\_\_: equate marginal cost to marginal revenue
  - Marginal cost: increment to \_\_\_\_\_ associated with producing \_\_\_\_\_ of output (planting one more acre)
  - Marginal revenue: increment to \_\_\_\_\_ associated with producing \_\_\_\_\_ of output (planting one more acre)



- In a competitive market, each farmer's \_\_\_\_\_ is the prevailing market \_\_\_\_\_ (price takers)
- As market price changes, the marginal revenue confronting a farmer changes
- With an upward sloping marginal cost curve and \_\_\_\_\_, a profit maximizing farmer will \_\_\_\_\_ production (plant more acres) as market price increases

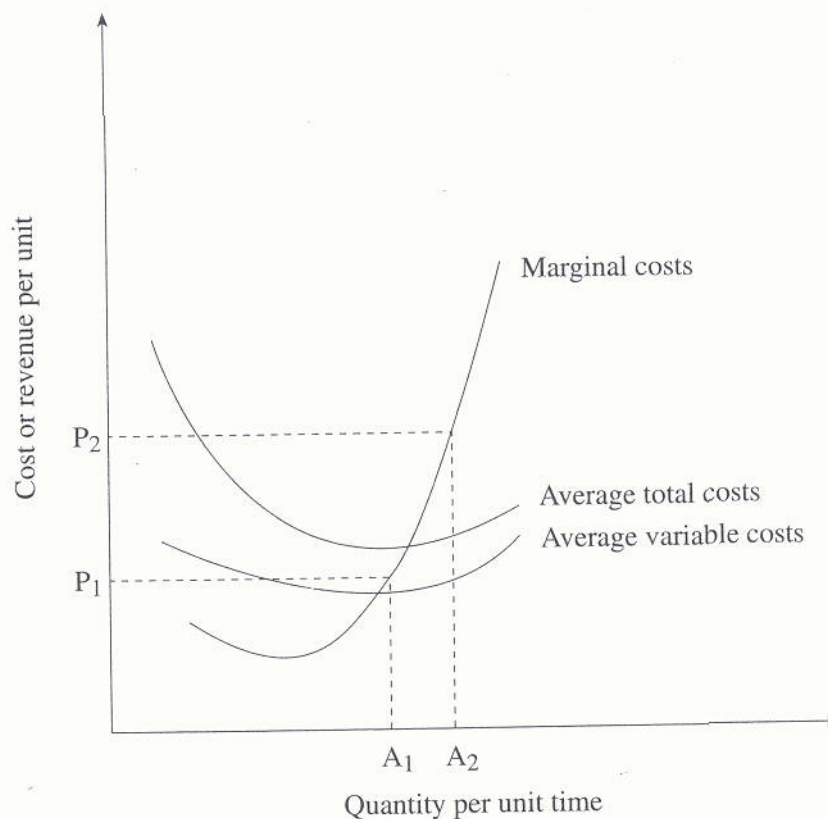


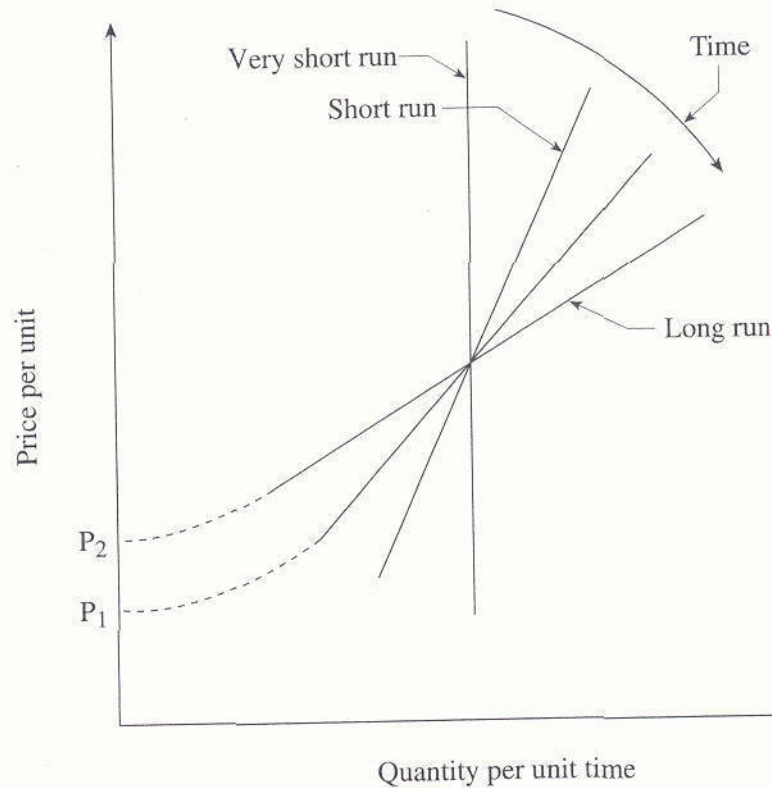
Figure 4-1. Cost curves and optimum output at alternative prices

## *Market Supply*

Market supply is based on the \_\_\_\_\_ response of all farm firms

In technical terms, the market supply curve under perfect competition is the \_\_\_\_\_ of the marginal cost curve for each farm firm above average variable cost

The responsive of market supply to price depends on the \_\_\_\_\_ allowed for \_\_\_\_\_



**Figure 4-2.** Changing supply-price relationships through time

## *Price Elasticity of Acreage Supply*

The price elasticity of acreage supply is the \_\_\_\_\_ in acreage supplied by farmers for a \_\_\_\_\_ percent change in price

$$E_s = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \left( \frac{\Delta Q}{\Delta P} \right) \left( \frac{P}{Q} \right)$$

To estimate supply elasticity, we must control for the effect of other \_\_\_\_\_

Most typically done by specifying regression models, where annual crop acreage is a function of

- Expected \_\_\_\_\_ price
- \_\_\_\_\_ prices
- \_\_\_\_\_
- Expected price for products that \_\_\_\_\_ in production
- Risk
- Government \_\_\_\_\_ effects
- Lagged effects

The regression slope estimate on expected price is the term  $\left(\frac{\Delta Q}{\Delta P}\right)$  and mean values for  $P$  and  $Q$  are usually plugged into the second term  $\left(\frac{P}{Q}\right)$

Most estimates of acreage response elasticities for major crops (corn, soybeans, and wheat) for \_\_\_\_\_ or less are in the range of \_\_\_\_\_

### ***Difficulties in Estimating Acreage Supplied Elasticities***

The long list of variables that need to be included in supply regressions suggests predicting supply elasticity will be \_\_\_\_\_ due to the \_\_\_\_\_ involved

- Government \_\_\_\_\_ are a major complicating factor
  - 1970s and 1980s
    - Set-asides and target prices for corn
    - Conservation Reserve Program

- 1990s
  - Starting in 1996, \_\_\_\_\_ legislation allowed complete acreage flexibility
  - Price supports still maintained
- Often run into a “degrees of freedom” problem
  - First, we do not want to use data too remote in history as \_\_\_\_\_ and government \_\_\_\_\_ have \_\_\_\_\_ substantially over time
    - *farmdoc* website lists data for only the last 34 marketing years
    - Given the change in farm programs instituted in 1996, it is not unreasonable to argue that only data since \_\_\_\_\_ is relevant to forecasting farmers’ \_\_\_\_\_ acreage decisions

- Second, our theory discussion highlights the \_\_\_\_\_ variables that should be included in a supply regression model
- But, with only 20-30 observations, using 6-10 variables leaves relatively few \_\_\_\_\_ observations
  - This means that regression coefficients will be hard to estimate \_\_\_\_\_
  - Not enough "free" variability, or \_\_\_\_\_
- Overall conclusion: estimating acreage response elasticity is \_\_\_\_\_



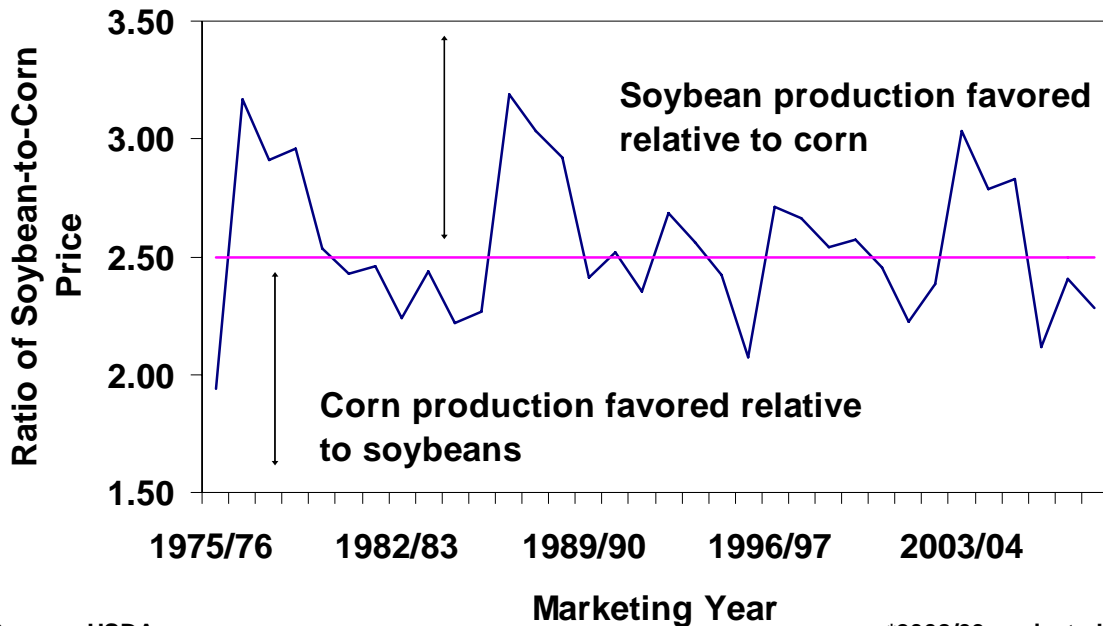
## Ratio Indicators

- Given the complexities, analysts often combine variables into \_\_\_\_\_ that provide important economic \_\_\_\_\_ for supply decisions
- For crops, one of the most widely-followed is the \_\_\_\_\_
  - Corn and soybeans \_\_\_\_\_ for the same resources in production
  - \_\_\_\_\_ concept

### *Soybean-Corn Price Ratio*

- Indicator of incentive to \_\_\_\_\_ acreage between soybeans and corn
- Key is the breakeven ratio (BEPR)
  - Ratio that equates the \_\_\_\_\_ from producing corn and soybeans
  - \_\_\_\_\_ typically is assumed BEPR

**Ratio of US Farm Price of Soybeans to US Farm Price of Corn, 1975/76-2008/09\***



Source: USDA

\*2008/09 projected

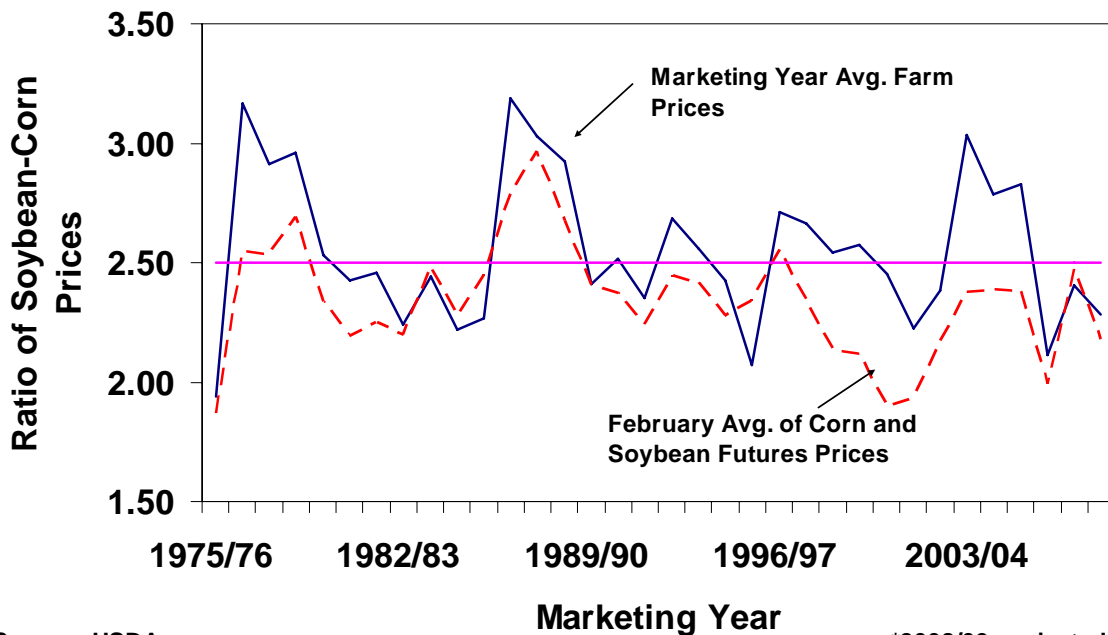
## What is the Right Soybean-Corn Price Ratio?

To answer this question, we must delve into the topic of how farmer's form price \_\_\_\_\_ when making acreage \_\_\_\_\_

- Traditional view is that expectation is the \_\_\_\_\_ price prevailing \_\_\_\_\_ (cobweb model)
- More recent view is that farmers are forward looking and use \_\_\_\_\_ for harvest delivery at the time the decision is made (rational expectations)

- Essentially, the question is whether farmers base planting decisions on \_\_\_\_\_ or \_\_\_\_\_ prices

Alternative Soybean-Corn Price Ratios, 1976/77-2008/09\*



Source: USDA

\*2008/09 projected

- Old-crop price ratio slightly favors \_\_\_\_\_ to \_\_\_\_\_ acres
- New crop price ratio also favors \_\_\_\_\_ to \_\_\_\_\_ acres
  - Note that relationship between old crop and new crop price ratios \_\_\_\_\_ after 1998/99



## Limitations of Soybean-Corn Price Ratio

The relative level of government price supports can distort market price signals

- 2000:
  - National average loan rate for soybeans \_\_\_\_\_
  - National average loan rate for corn \_\_\_\_\_
  - Ratio: \_\_\_\_\_, soybean production encouraged relative to corn

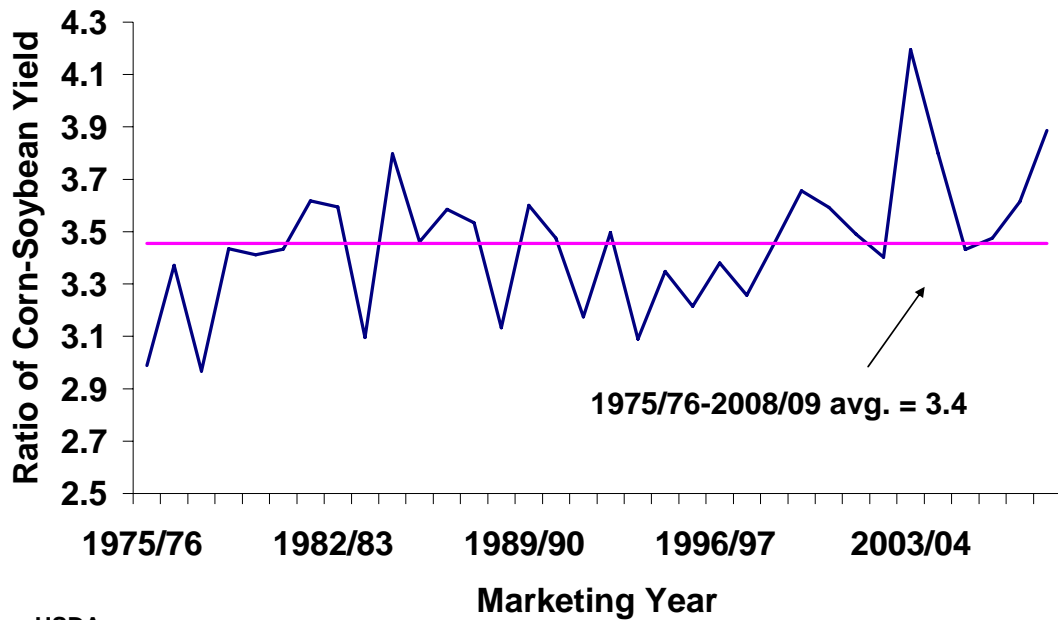
Relative profitability of soybeans and corn can change

Key: BEPR assumes \_\_\_\_\_ relative level of production costs and yields

- \_\_\_\_\_ can improve for soybeans relative to corn, and vice versa
- \_\_\_\_\_ of soybean can rise relative to the price of corn, and vice versa

- \_\_\_\_\_ for soybeans can rise relative to those for corn, and vice versa

**Ratio of US Average Corn Yield to Soybean Yield,  
1975/76-2008/09**



Source: USDA

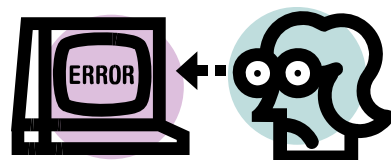
## USDA Acreage Surveys

- An alternative approach that avoids many of the problems discussed above is to directly \_\_\_\_\_ farmers about their planting intentions
- USDA surveys farmers about acreage planting intentions in \_\_\_\_\_ and \_\_\_\_\_
- Since the USDA acreage surveys are so widely followed, it is important to examine the \_\_\_\_\_

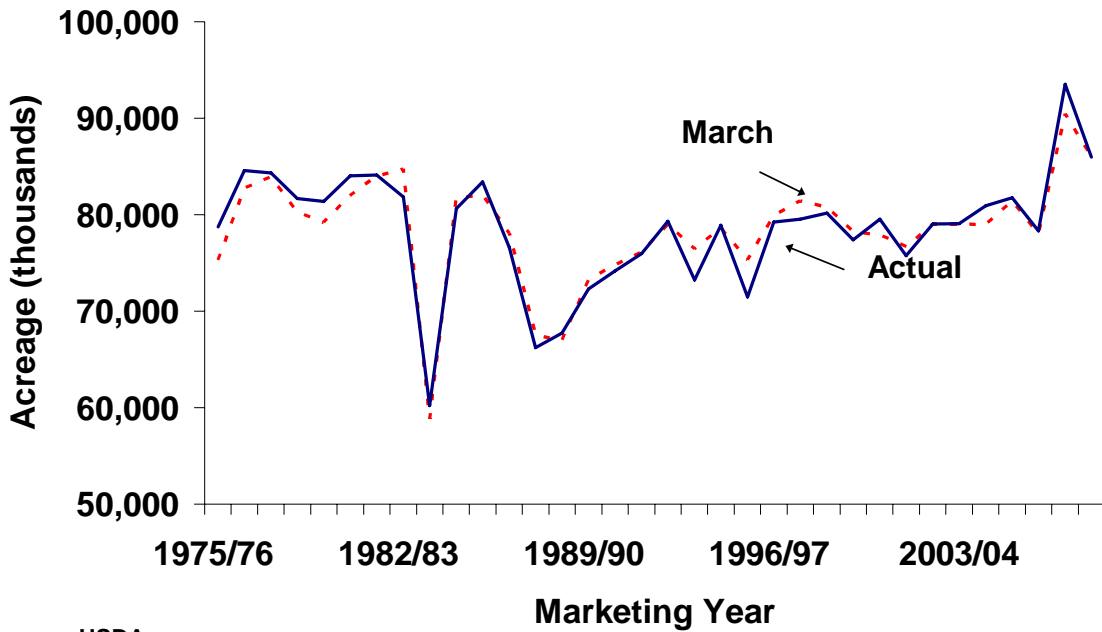
### *Accuracy of USDA Acreage Surveys*

We are especially interested in two questions

- \_\_\_\_\_: Is there any tendency for farmer's to systematically \_\_\_\_\_ estimate acreage?
- \_\_\_\_\_: Are there any pronounced patterns in the forecast errors that would indicate less than \_\_\_\_\_ forecasts?

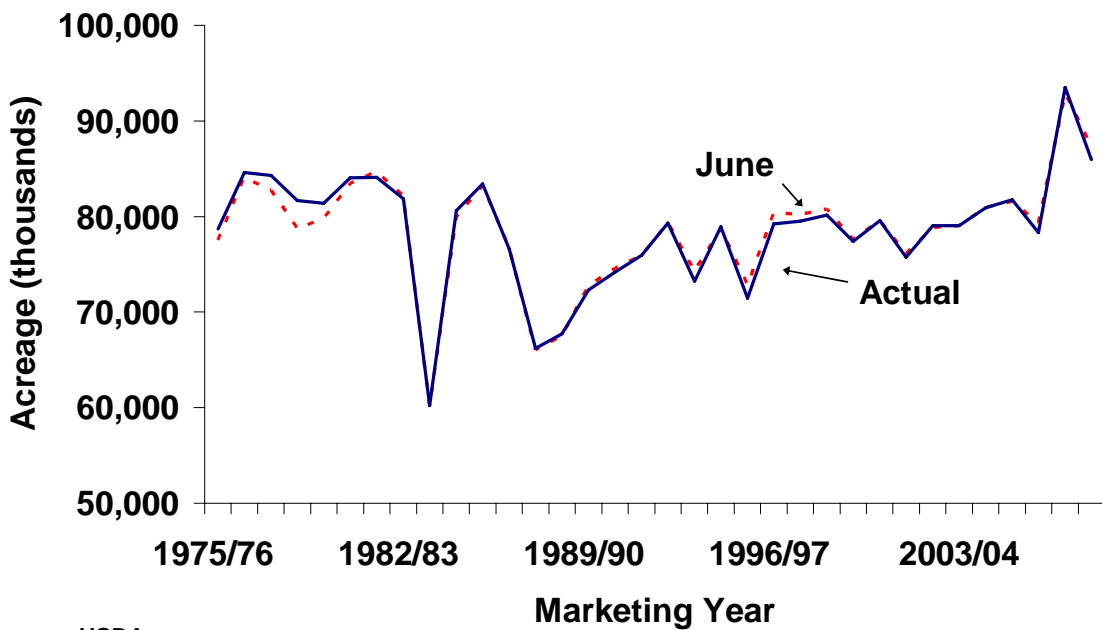


**March USDA Planted Acreage Intentions for Corn vs. Actual Planted Acreage, 1975/76-2008/09**



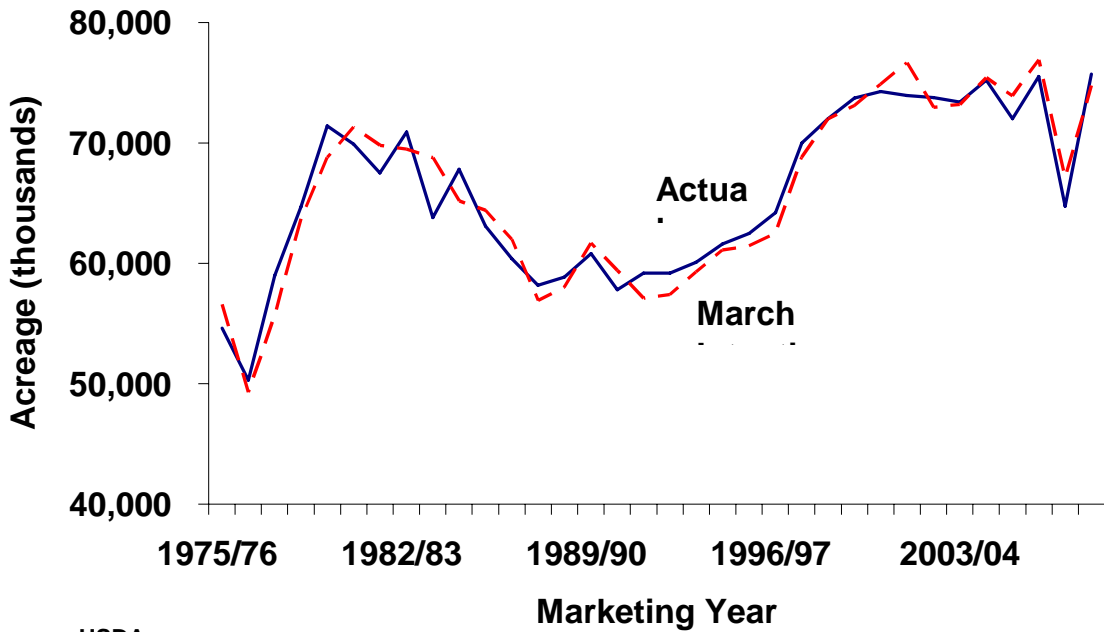
Source: USDA

**June USDA Planted Acreage Estimate for Corn vs. Actual Planted Acreage, 1975/76-2008/09**



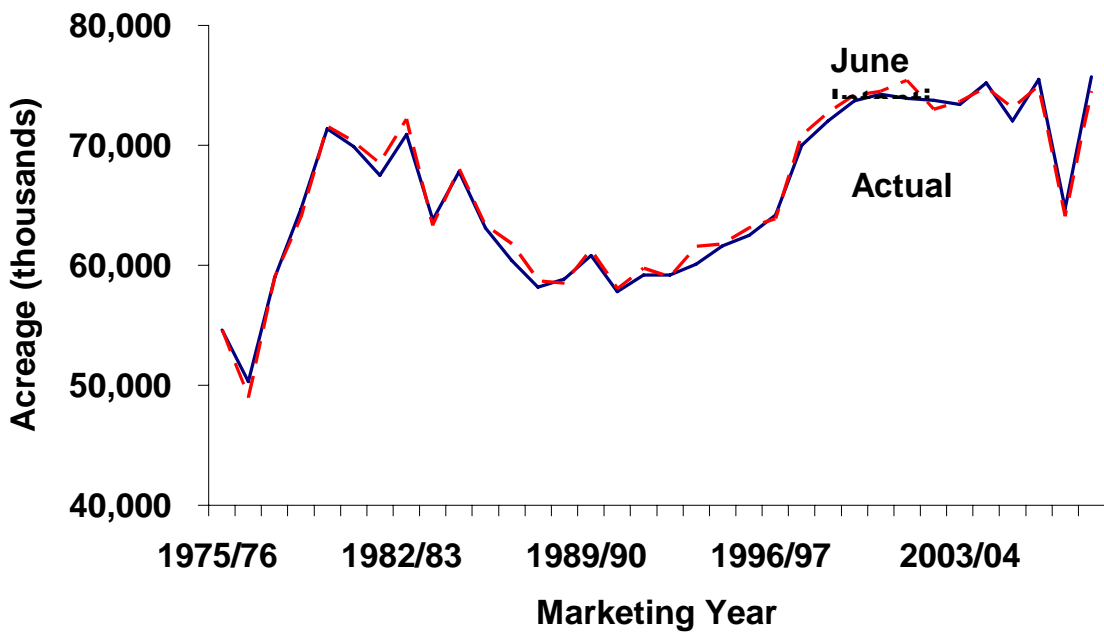
Source: USDA

**March USDA Planted Acreage Intentions for Soybeans vs. Actual Planted Acreage, 1975/76-2008/09**



Source: USDA

**June USDA Planted Acreage Estimate for Soybeans vs. Actual Planted Acreage, 1975/76-2008/09**



Source: USDA

## *Forecast Error for USDA Acreage Surveys*

Define,

- $A_t$  as actual planted acreage in year  $t$
- $PI_t$  as planting intentions (March or June) in year  $t$
- Then, the forecast error in year  $t$  is,

$$Error_t = A_t - PI_t$$

- Note: We will always define the forecast error as ACTUAL VALUE – FORECAST VALUE

### *Forecast Error Example*

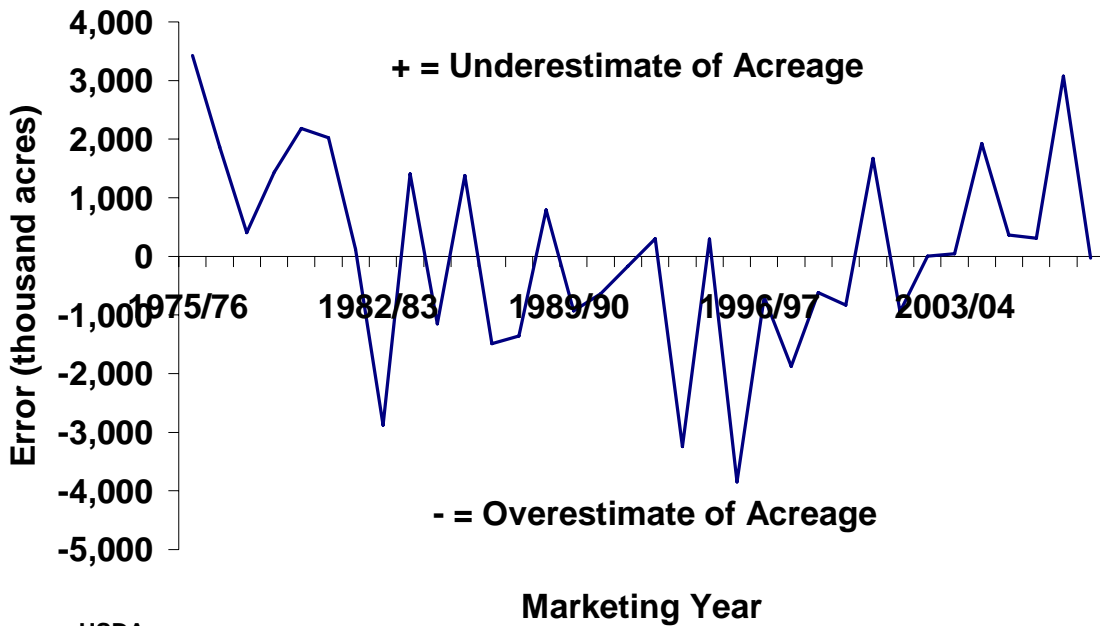
March 1999 Corn Error

Actual: \_\_\_\_\_ thousand acres

Intentions: \_\_\_\_\_ thousand acres

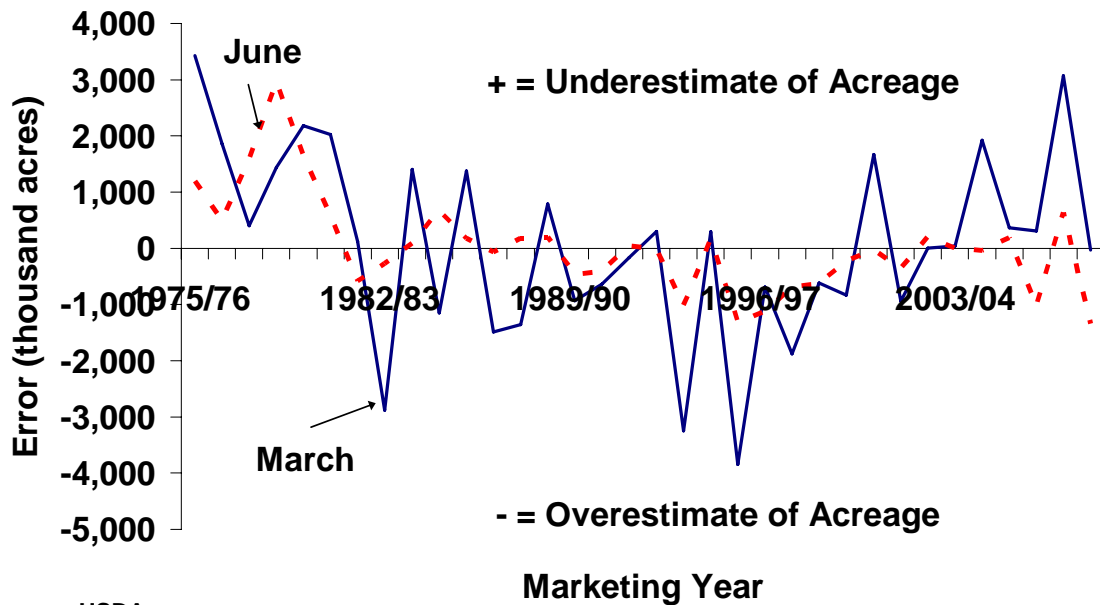
Error = \_\_\_\_\_ = + 675 thousand acres

**Error for March USDA Planted Acreage Intentions in Corn, 1975/76-2008/09**



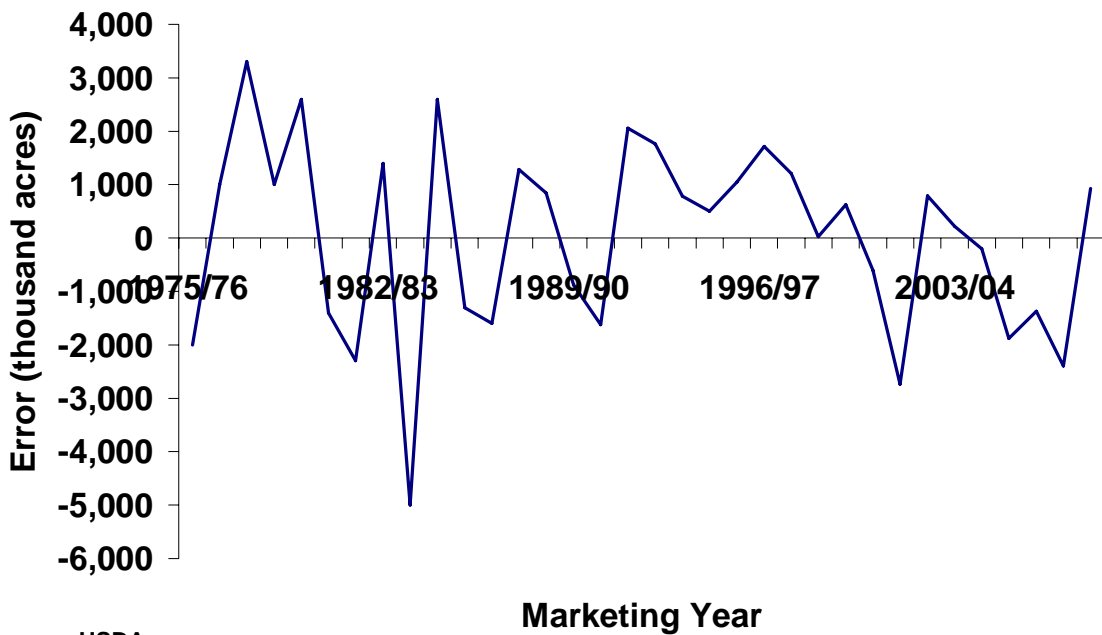
Source: USDA

**Error for March USDA Planted Acreage Intentions and June Planted Acreage Estimate in Corn, 1975/76-2008/09**



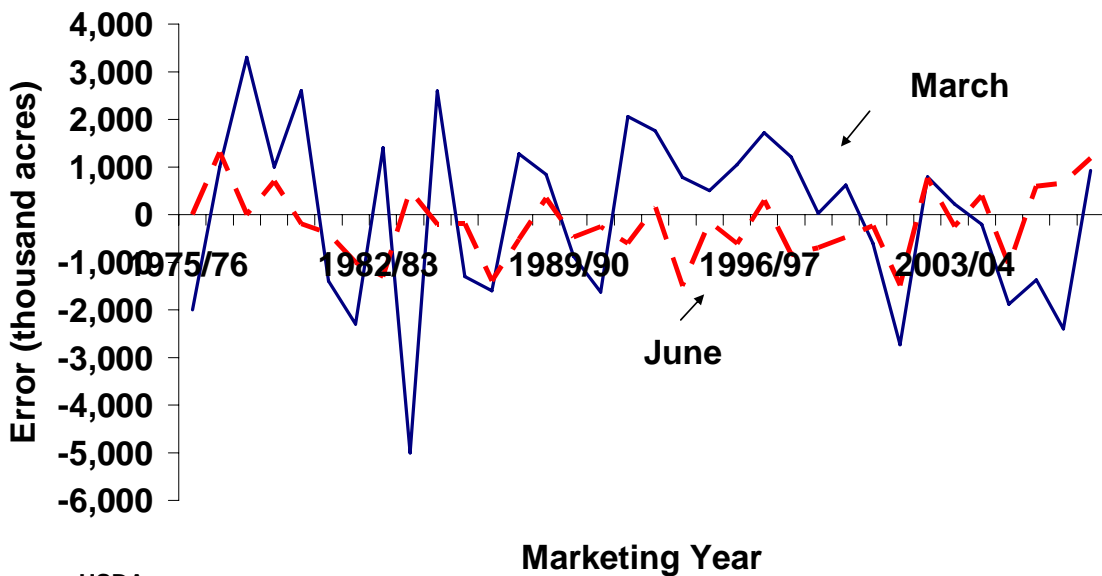
Source: USDA

**Error for March USDA Planted Acreage Intentions in Soybeans, 1975/76-2008/09**



Source: USDA

**Error for March USDA Planted Acreage Intentions and June Planted Acreage Estimate in Soybeans, 1975/76-2008/09**



Source: USDA

## *Conclusions*

- Overall, evidence suggests that USDA acreage surveys provide reasonably \_\_\_\_\_ forecasts of actual planted acreage
- Typically, only \_\_\_\_\_ changes in corn and soybean planted acreage forecasts after the USDA releases the June acreage survey
- The USDA acreage surveys are used as the \_\_\_\_\_ for private and public estimates once they are released
- Limitation of this approach is that surveys usually cannot be done much in advance of planting a crop



## ***Forecasting Corn Harvested Acreage***

USDA March 2009 Planting Intentions

86 million acres (expected)

Fixed Loss

7.1 million acres

Harvested Acreage Forecast

$86 - 7.1 = 78.9$  million acres

## ***Forecasting Soybean Harvested Acreage***

USDA March 2009 Soybean Planting Intentions

77.0 million acres (expected)

Fixed Loss

1 million acres

Harvested Acreage Forecast

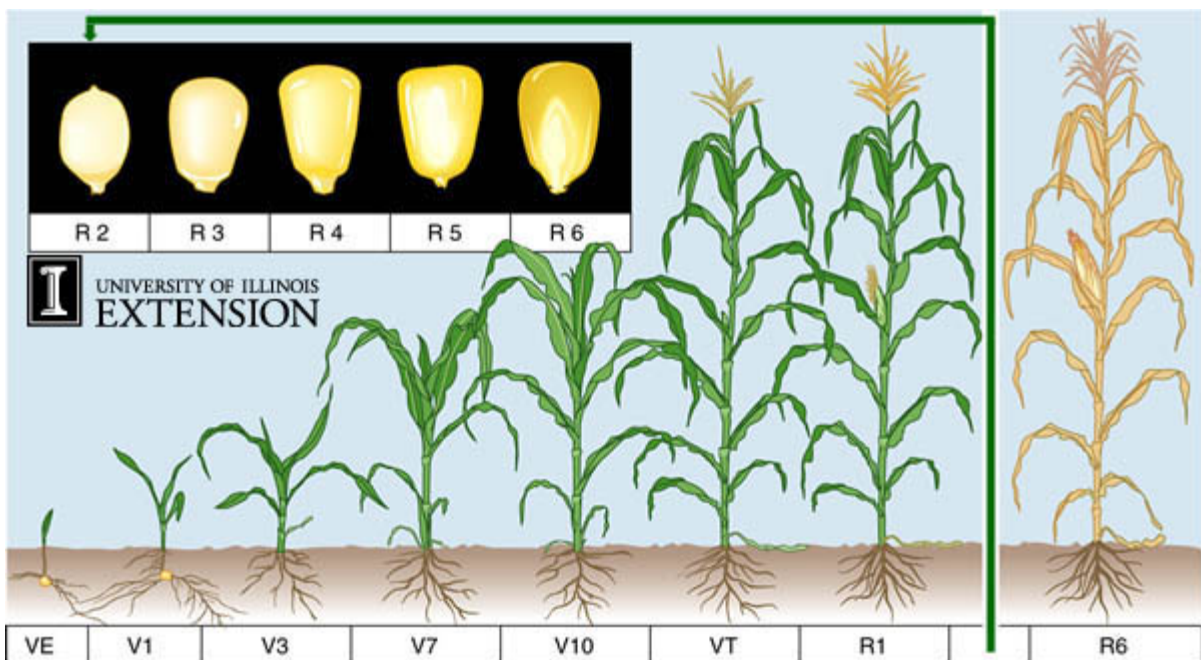
$77.0 - 1 = 76$  million acres

## Forecasting Yield per Acre

- The remaining task in forecasting crop supply during the pre-harvest period is forecasting yield per acre
- Different \_\_\_\_\_ have to be used at various \_\_\_\_\_ during the pre-harvest period
- It is very helpful to have some background on the \_\_\_\_\_ of crops before discussing yield forecasting methods
- Corn and soybeans are \_\_\_\_\_ plant species and have quite different growth characteristics and stages
- These characteristics and stages have important \_\_\_\_\_ for the \_\_\_\_\_ of appropriate yield forecasting methods

## *Brief Guide to Corn Production*

- Corn typically is \_\_\_\_\_ in US Corn Belt during the second half of \_\_\_\_\_ and early \_\_\_\_\_
- Corn plants tend to develop 20 to 21 total leaves, silk about \_\_\_\_ days after emergence, and mature around \_\_\_\_\_ days after emergence



- Corn is a \_\_\_\_\_ plant, which means that once reproduction (fruit production) starts the plant basically \_\_\_\_\_ all vegetative growth
- This implies the plant has limited means of \_\_\_\_\_ fruit production potential if \_\_\_\_\_ weather hits during the critical reproduction period

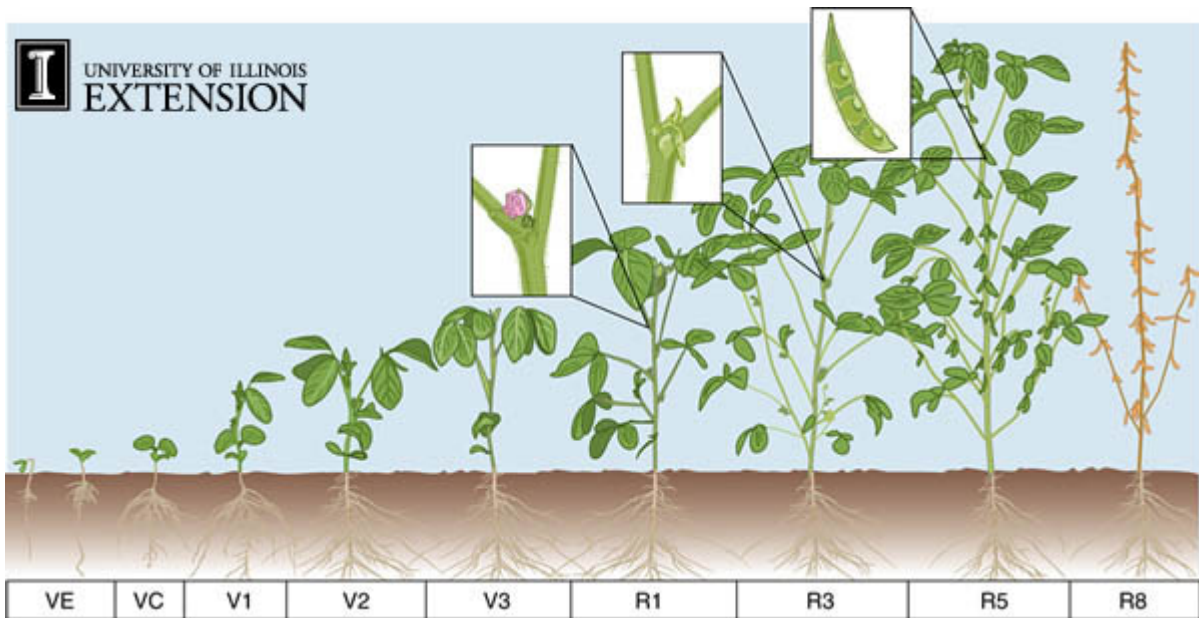
### Effects of Drought on Corn Yield

<b>Stage of development</b>	<b>Percent yield reduction from four consecutive days of visible wilting</b>
Early vegetative	5-10
Tassel emergence	10-25
Silk emergence, pollen shedding	40-50
Blister	30-40
Dough	20-30

Source: Classen, M.M., and R.H. Shaw, 1970. Water deficit effects on corn II - Grain components. *Agron. J.* 62: 652-655.

## *Brief Guide to Soybean Production*

- Soybeans typically are planted in US Corn Belt during the late \_\_\_\_\_ and the first half of \_\_\_\_\_
- Soybean plant growth is regulated by \_\_\_\_\_ or the length of \_\_\_\_\_ in each day
- Flowering usually begins in late July and early August, with \_\_\_\_\_ formation and bean growth generally occurring in August



- Soybeans grown in the Midwest generally are \_\_\_\_\_ plants, which means that once reproduction (fruit production) starts the plants \_\_\_\_\_ some vegetative growth
- This indicates the plant has some means of \_\_\_\_\_ fruit production potential if [adverse](#) weather hits during the initial stages of reproduction

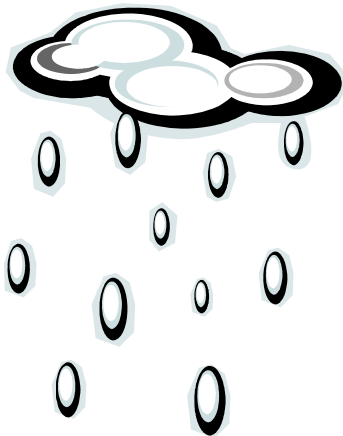
### *Early Forecasts of Yield*

Consider this question: From planting to about mid-June, what \_\_\_\_\_ do we have that is useful for \_\_\_\_\_ corn and soybean yields?

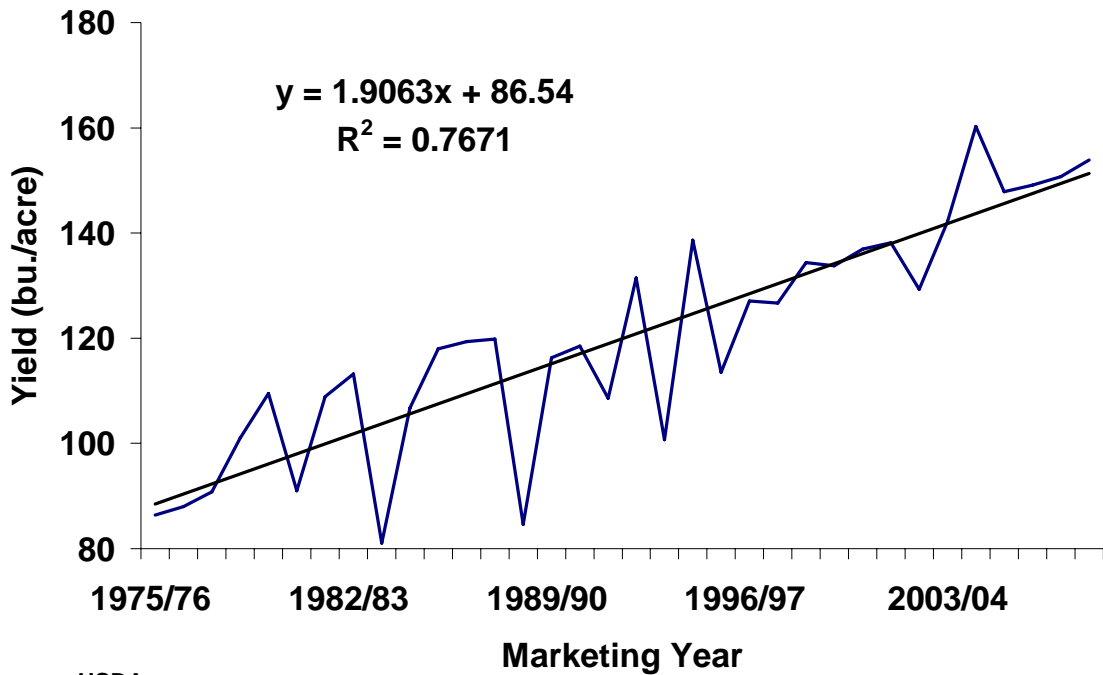
- Both corn and soybeans have not yet reached their critical reproduction stages
- Unless we can forecast weather conditions during reproduction stages, we have \_\_\_\_\_ information that is relevant to predicting yield
- We will have to rely on \_\_\_\_\_ of yields as our best data for forecasting previous to about mid-June

Based on the assumption that weather \_\_\_\_\_ be predicted during the critical summer growing period, the best prediction is obtained by simply \_\_\_\_\_ the \_\_\_\_\_ in yields one year into the future

- The yield trend reflects improving “technology” in the broad sense of the word
  - Improved plant genetics
  - Higher fertilizer rates
  - Better production management
- At a national level, about 70% of the variation in yields explained by “trend”
- The remaining \_\_\_\_\_ of the variation in corn and soybean yield is almost solely explained by summer \_\_\_\_\_ and \_\_\_\_\_

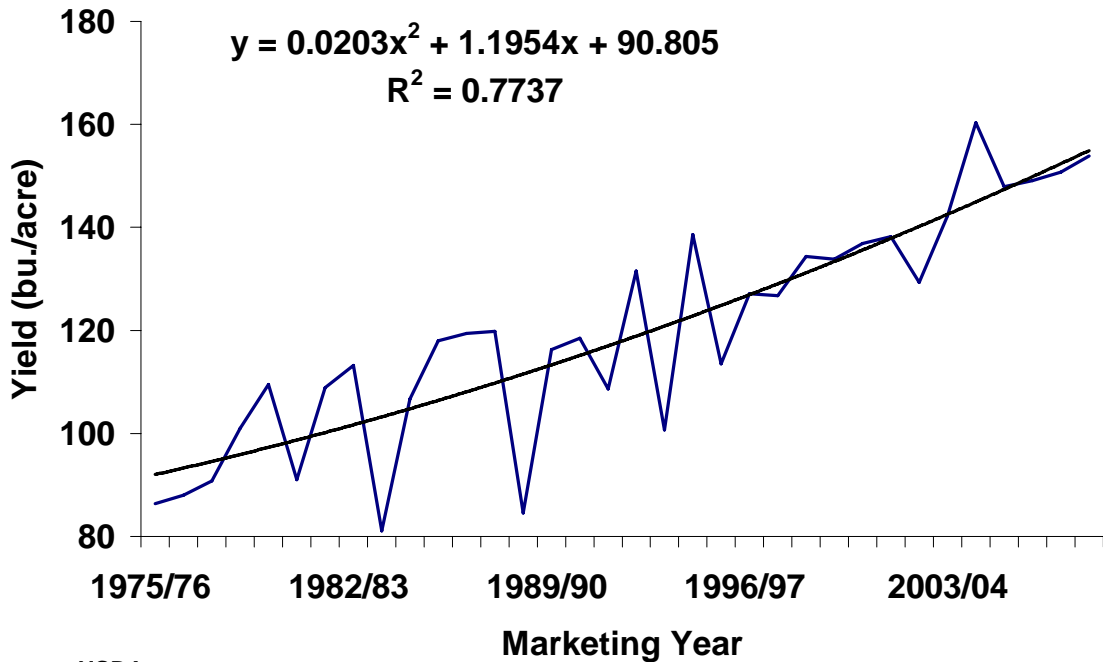


US Corn Yield, 1975/76-2008/09



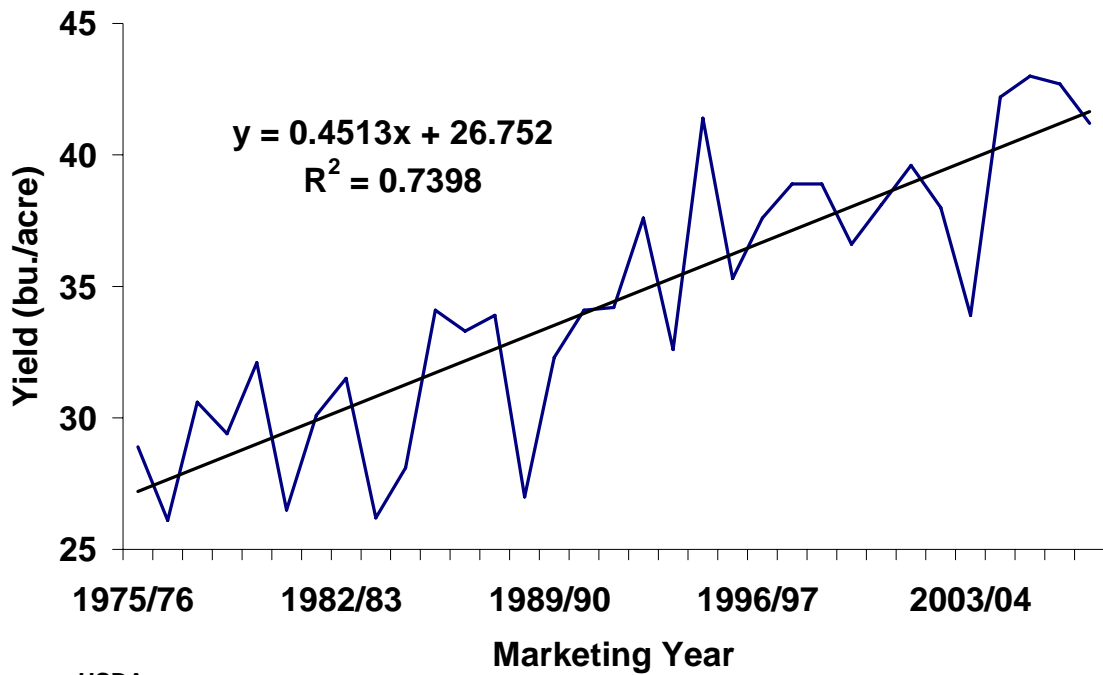
Source: USDA

US Corn Yield, 1975/76-2008/09



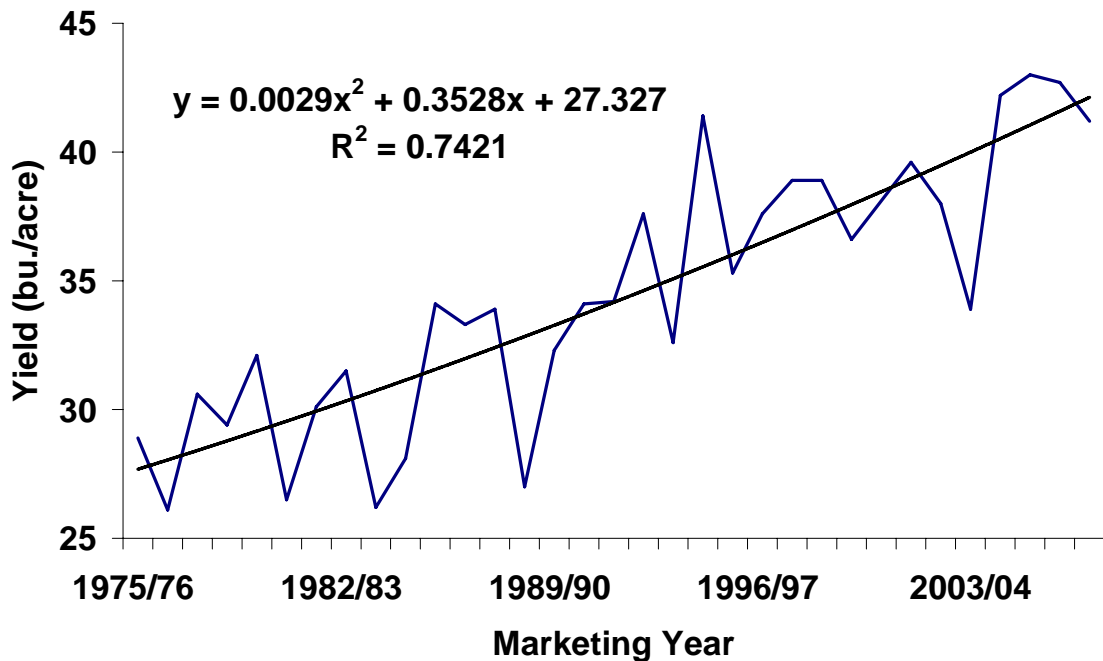
Source: USDA

US Soybean Yield, 1975/76-2007/08



Source: USDA

US Soybean Yield, 1975/76-2007/08



Source: USDA

## Early Season Production Forecasts

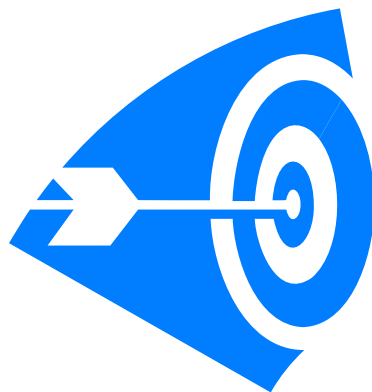
Combine:

- March intentions \_\_\_\_\_ forecast
- Acreage \_\_\_\_\_ projection
- Trend \_\_\_\_\_ forecast

## Improving on Trend Yield Forecasts

As the following information becomes available, we can use it to generate more \_\_\_\_\_ yield forecasts than trend forecasts

- Crop conditions
- Rainfall
- Temperature
- Disease
- \_\_\_\_\_ infestations



## A Timeline of Corn and Soybean Yield Forecasts

Previous to mid-June:

- Trend yield forecasts

Mid-June to July 31:

- USDA/NASS \_\_\_\_\_ ratings
- Regression models based on \_\_\_\_\_ and \_\_\_\_\_ data
- Ratings by crop \_\_\_\_\_
- Satellite imagery data

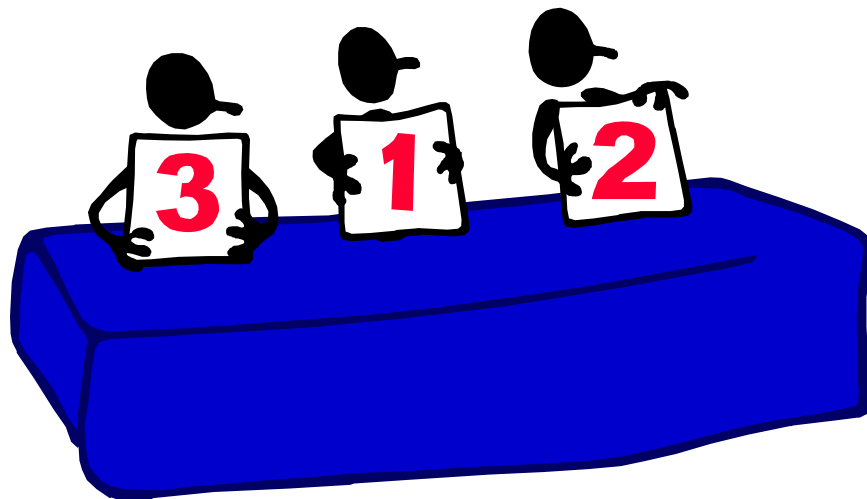
August 1 to November 1:

- \_\_\_\_\_ yield forecasts
- USDA/NASS crop condition ratings
- Regression models based on temperature and rainfall data

- Ratings by crop “scouts”
- Satellite imagery data

## USDA/NASS Crop Conditions Ratings

- \_\_\_\_\_ evaluation of crop conditions
- Non-random panel of local evaluators
- At most, about one per county
- \_\_\_\_\_ are most frequently ag extension agents



## *Release Schedule*

- Crop conditions are evaluated as of the most recent \_\_\_\_\_
- Released on the following Monday after the close of trading at the CBOT
- First crop conditions report generally about the first week of \_\_\_\_\_ and continue up to harvest

Crop conditions are reported as the \_\_\_\_\_ of the crop in the following \_\_\_\_\_

- Very poor
- Poor
- Fair
- Good
- Excellent

# National summary for corn on July 15, 2003:

## Corn: Crop Condition by Percent, Selected States

State	VP	P	F	G	EX
Percent					
CO	1	4	16	49	30
IL	1	5	18	52	24
IN	5	12	31	43	9
IA	1	3	11	56	29
KS	1	8	24	56	11
KY	2	9	23	40	26
MI	1	3	27	54	15
MN	2	3	13	56	26
MO	2	6	25	54	13
NE	1	2	19	52	26
NC	2	5	28	48	17
ND	2	4	17	56	21
OH	4	11	30	41	14
PA	3	9	28	33	27
SD	1	2	13	59	25
TN	3	7	18	53	19
TX	11	19	26	38	6
WI	1	3	14	55	27
18 Sts	2	5	19	52	22
Prev Wk	1	5	21	54	19
Prev Yr	5	13	33	40	9

Ratings may be used as a \_\_\_\_\_ of yield or as inputs to a \_\_\_\_\_ forecasting model:

$$\hat{y}_{tj} = a + b(G_{tj} + E_{tj})$$

where

$\hat{y}_{tj}$  is the forecast yield for year  $t$  in week  $j$

$G_{tj}$  is the percentage of the crop for year  $t$  rated in good condition during week  $j$

$E_{tj}$  is the percentage of the crop for year  $t$  rated in excellent condition during week  $j$

***We use this type of model in the University of Illinois Marketing and Outlook Program***

## Regression Models Based on Temperature and Rainfall Data

For a given crop:

$$\hat{y}_t = a + b_1 T_t + b_2 JUP_t + b_3 JYP_t + b_4 AUP_t + b_5 JUT_t + b_6 JYT_t + b_7 AUT_t$$

$\hat{y}_t$  is the forecast yield for year  $t$  in week  $j$

$T_t$  is a time index (1,2,3, 4,...,T) for year  $t$

$JUP_t$  is June precipitation for year  $t$

$JYP_t$  is July precipitation for year  $t$

$AUP_t$  is August precipitation for year  $t$

$JUT_t$  is June temperature for year  $t$

$JYT_t$  is July temperature for year  $t$

$AUT_t$  is August temperature for year  $t$

- \_\_\_\_\_ yield forecasts are produced as rainfall and temperature data become available
- Before June, assume all weather variables are set to sample averages \_\_\_\_\_
- This is the virtually the same as a simple trend forecast without the weather variables included
- As the growing season progresses use a combination of \_\_\_\_\_ precipitation and temperatures and \_\_\_\_\_ for unknown weather variables
- May be specified for a \_\_\_\_\_ or \_\_\_\_\_ within a state
- May also include other \_\_\_\_\_ such as soil moisture level, soil type, crop maturity and “interaction” terms