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Tidewater Agricultural Research & Extension Center

# Crop Production & Economics


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http://www.arec.vaes.vt.edu/tidewater/soybean/index.html

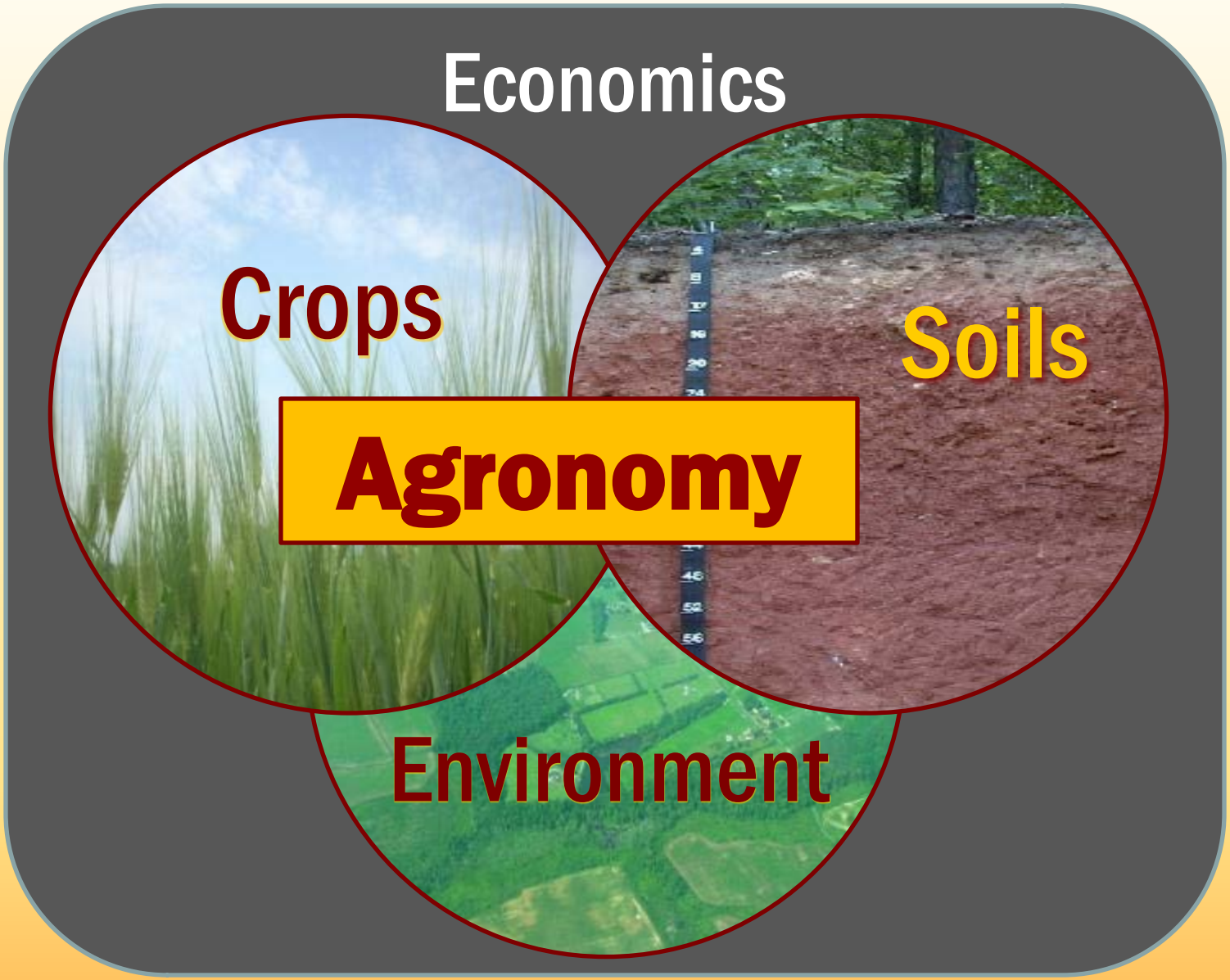
**Virginia Soybean Production**

**@VirginiaSoybean**

# I will not try to fit too much information into 1:15.

# Crop Production & Economics

- Goal: Teach you to think as an agronomist
  - Decisions made must consider agronomic, economic, and environmental impacts.
  - Must be site-specific
    - For Virginia and regions and counties
    - For the farm
    - between fields and within fields


Economics
Crops
Soils
Agronomy
Environment

# Crop Production & Economics

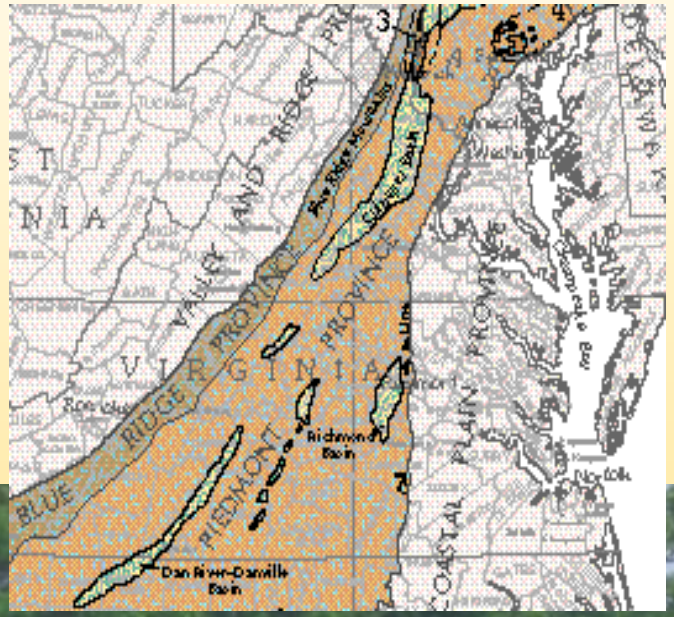
- Goal: Teach you to think as an agronomist
  - Agenda
    - Virginia Agriculture
    - Growth & Development (Corn, Soybean, Wheat)
    - Economic Examples

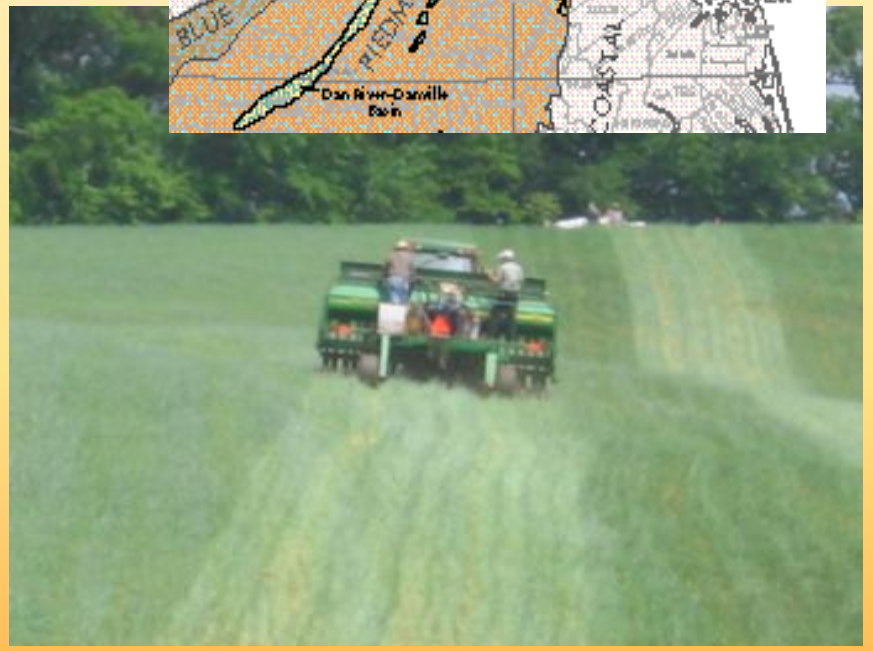
# Physiographic Regions

- **Ridge and Valley**
  - Bordered by the Blue Ridge and Allegheny mountains
  - Cooler climate, shorter season
  - Soils – deep, fertile clays; shallow over limestone
  - Crops – cool season grasses, corn, soybean, alfalfa

# Physiographic Regions

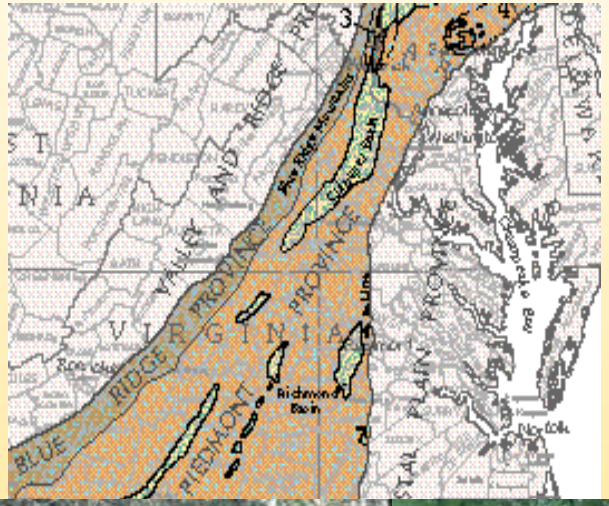
- **Northern Piedmont**
  - Bordered by the Blue Ridge and Coastal Plain
  - 600-700 ft lower in elevation
  - Soils – granite derived, red, clay, acidic, low OM
  - Conservation tillage practices to decrease erosion
  - Crops – CS grasses, corn, soybean, small grains



# Physiographic Regions

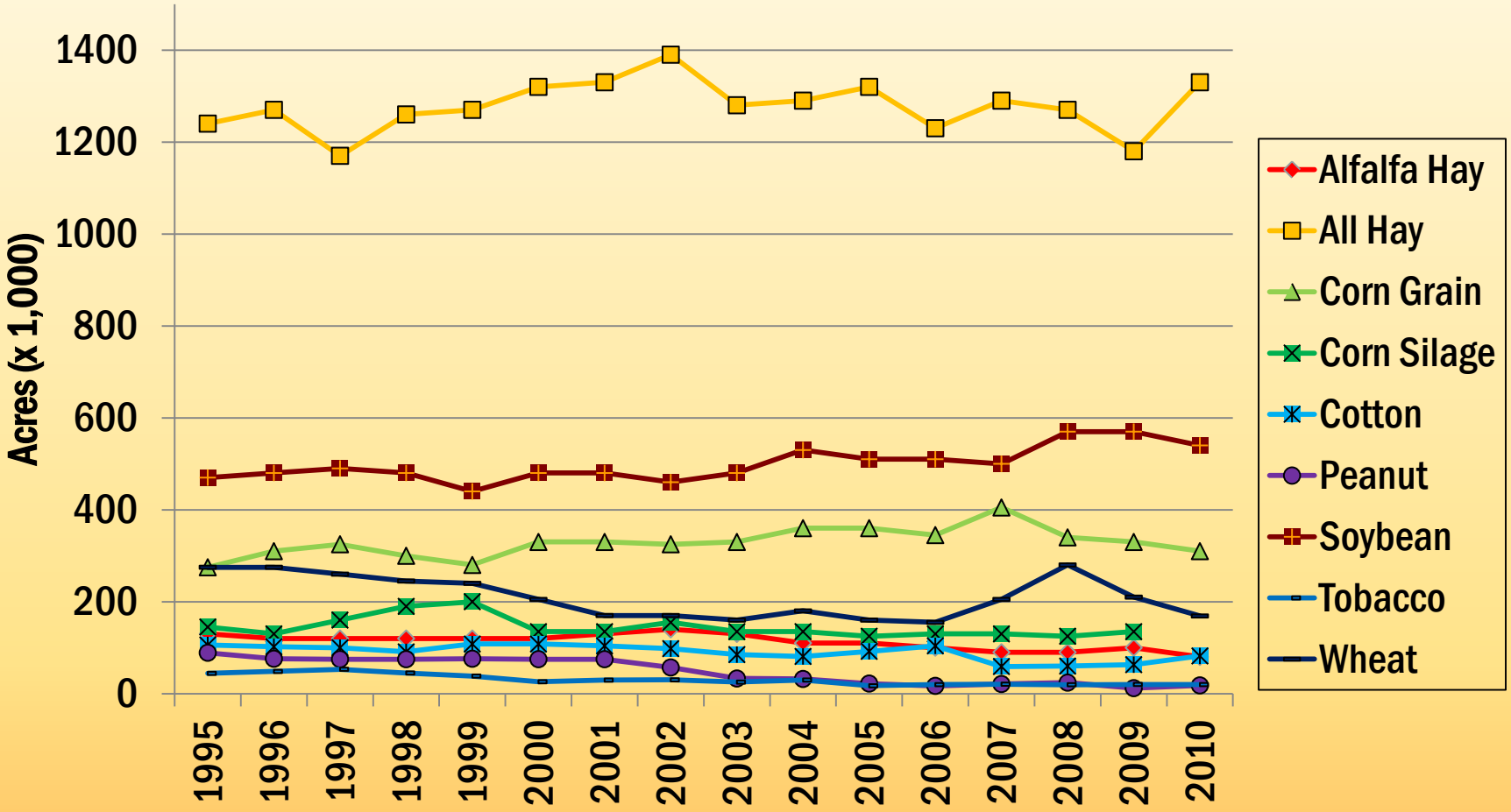
- **Southern Piedmont**
  - James River boundary
  - Longer season
  - Soils – deep, orange-yellow clay, sandy loam , drought prone
  - Conservation tillage in most crops
  - Crops –corn, cotton, CS & WS grasses, soybean, small grains, tobacco




# Physiographic Regions

- **Coastal Plain**
  - Begins at fall line on west
  - Long season
  - Soils – v.deep, high in sand, low clay and OM, drought prone
  - Conservation tillage in most crops
  - Crops – corn, soybean, small grains, vegetables

# Virginia Crop Acreage (1995-2010)



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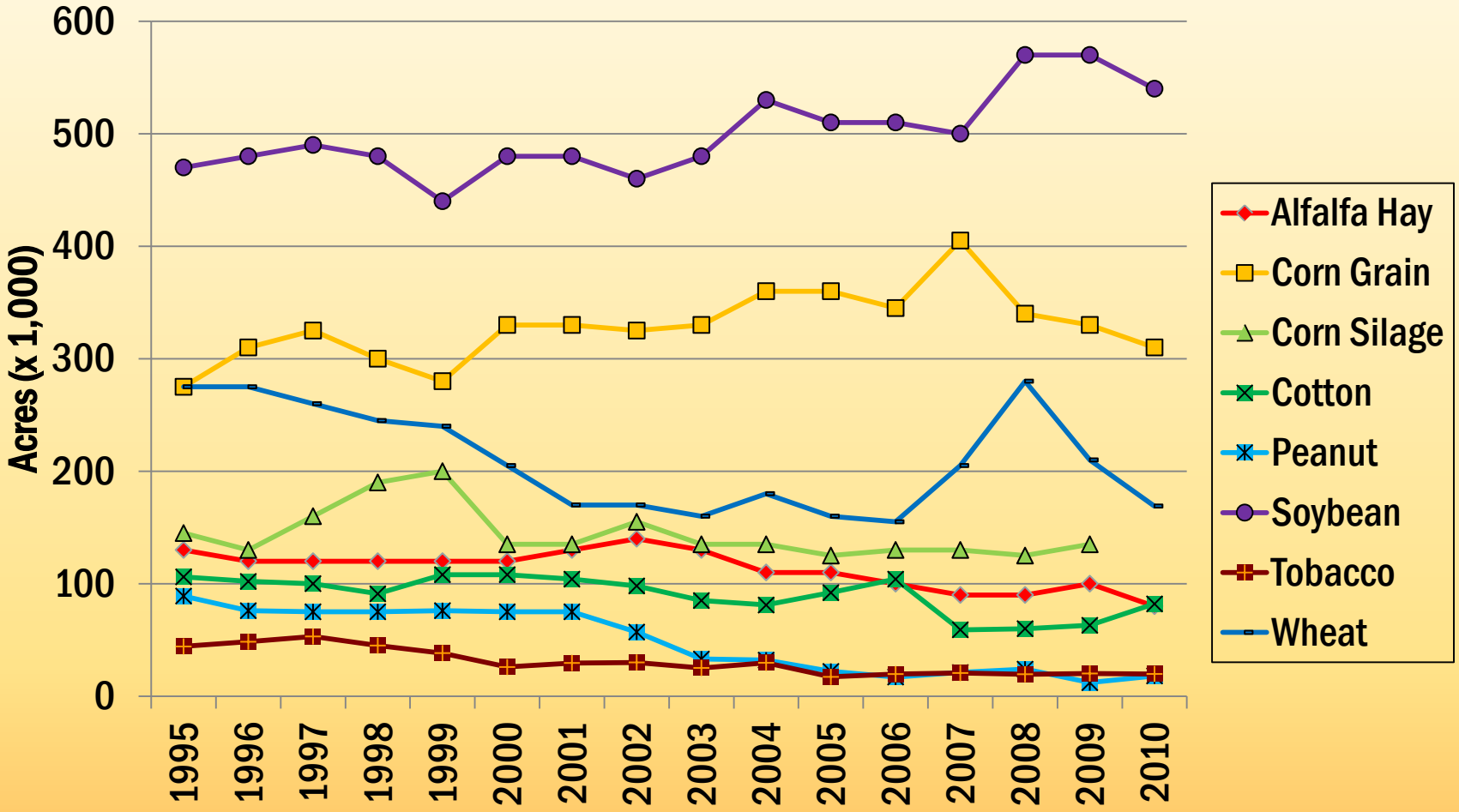
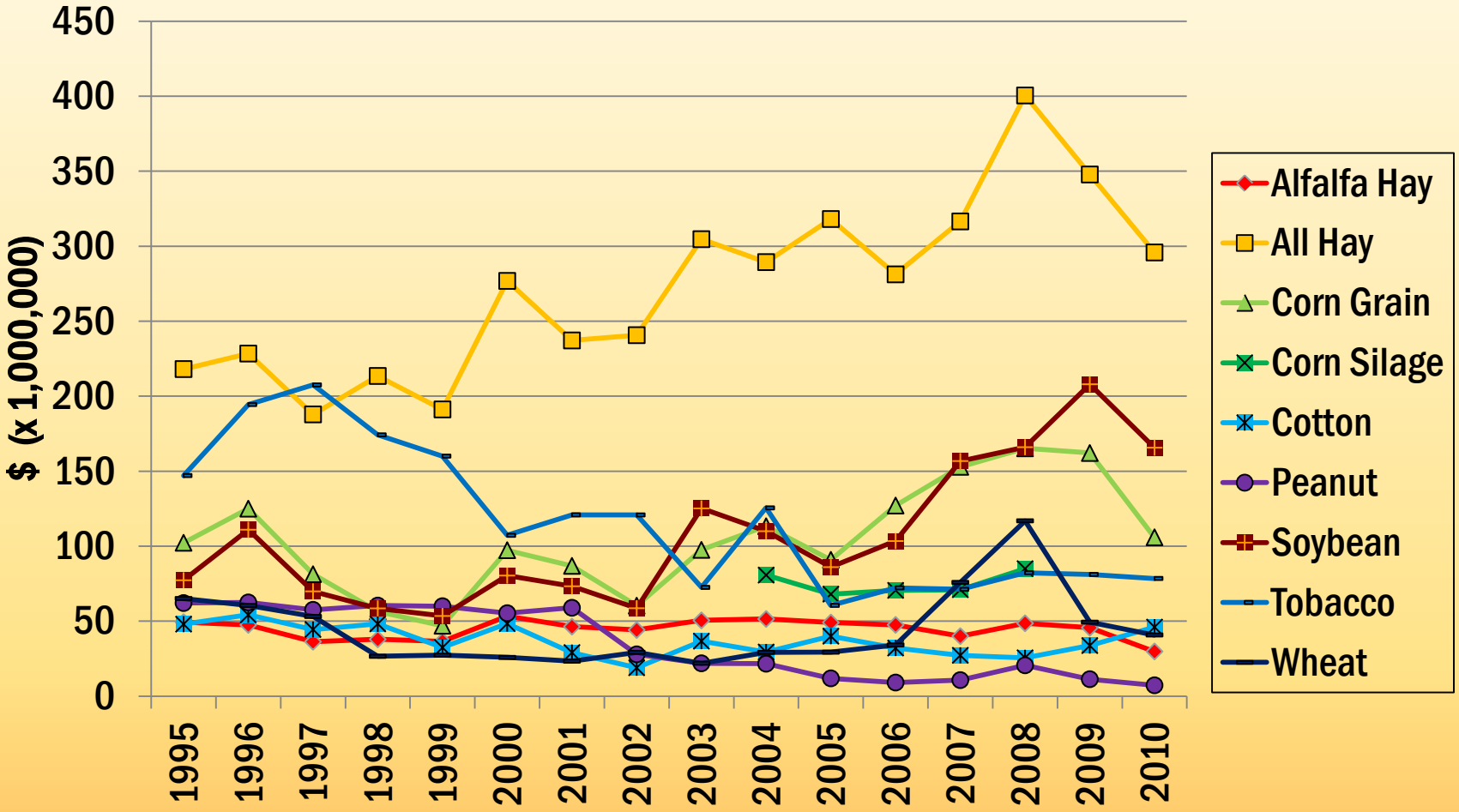
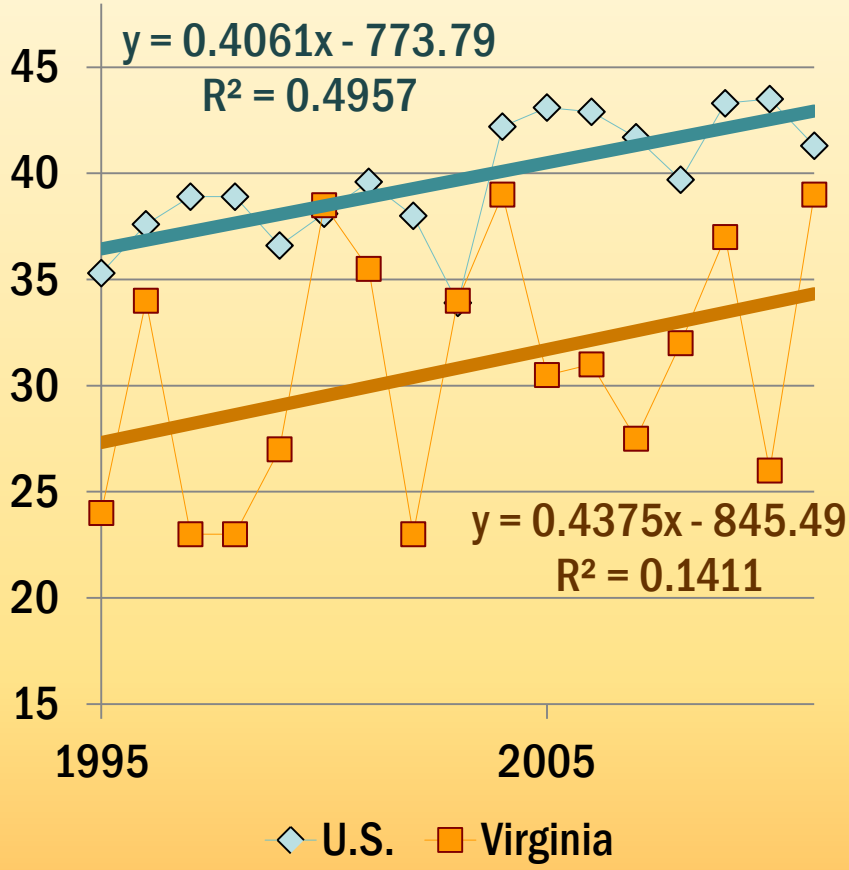


# Virginia Crop Value (1995-2010)

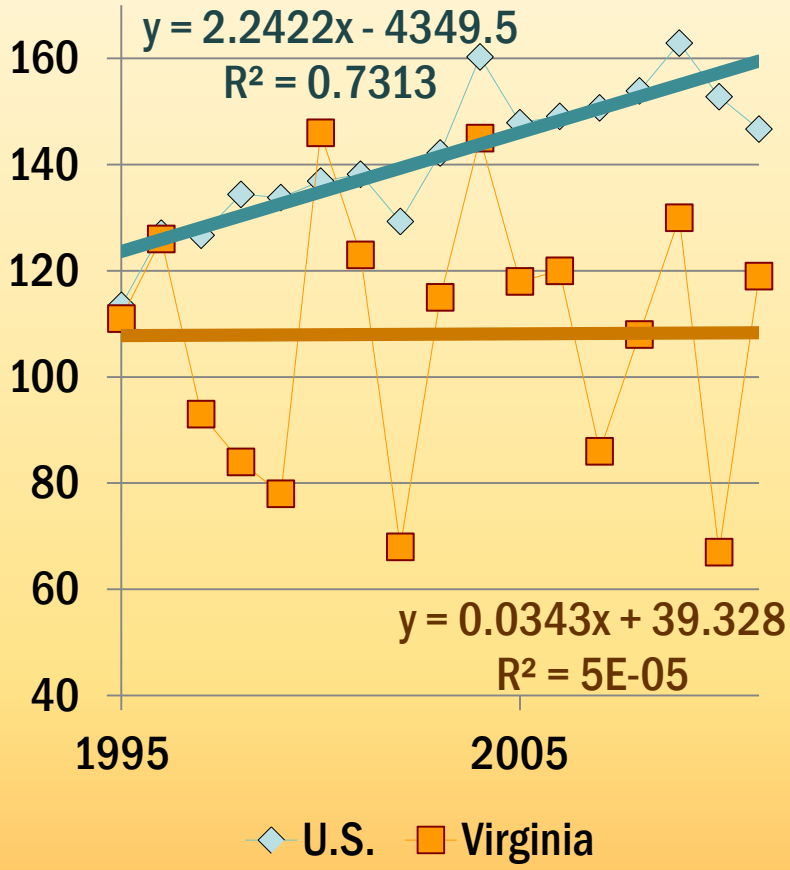


# U.S. versus Virginia Yields (1995-2011)

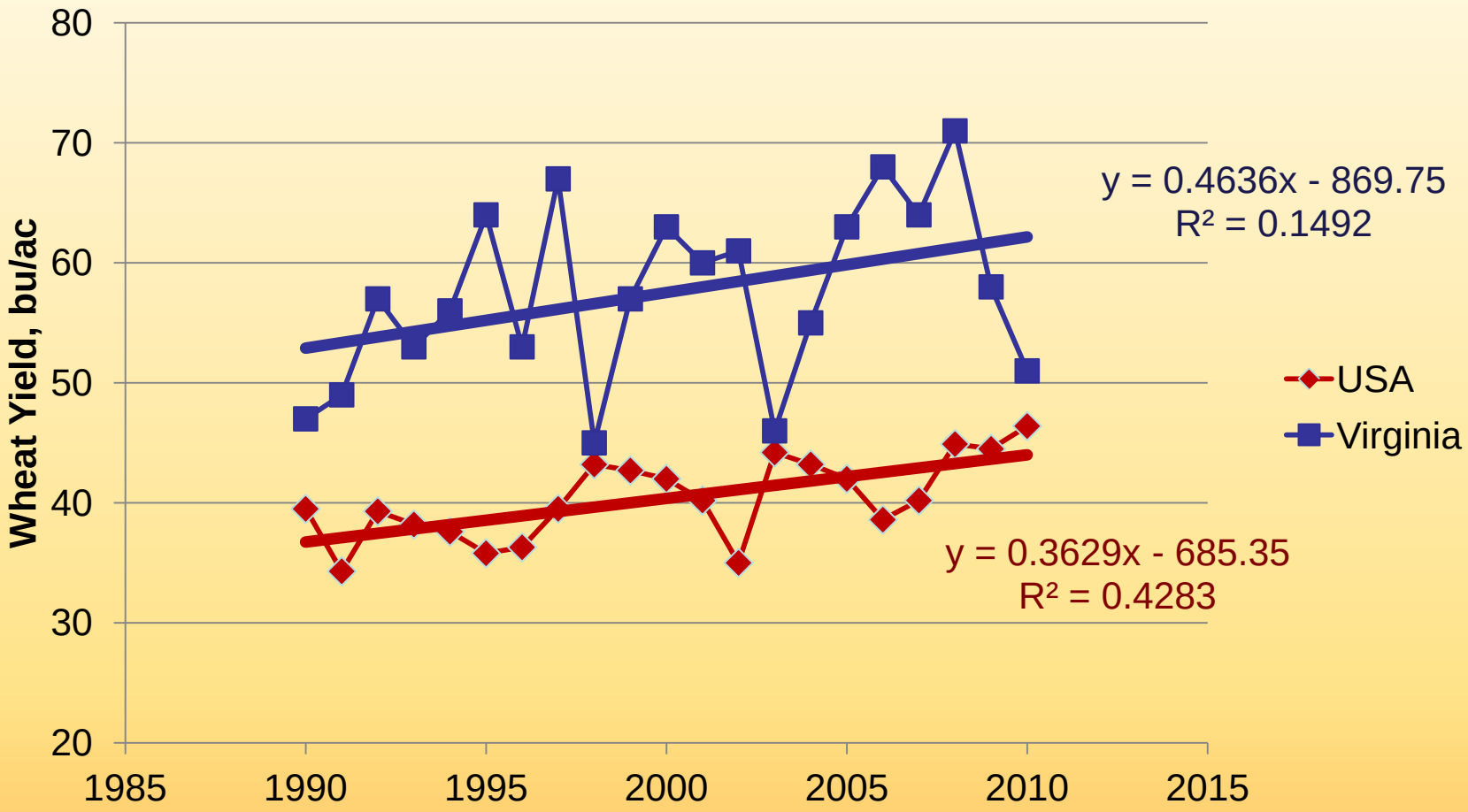
## Soybean



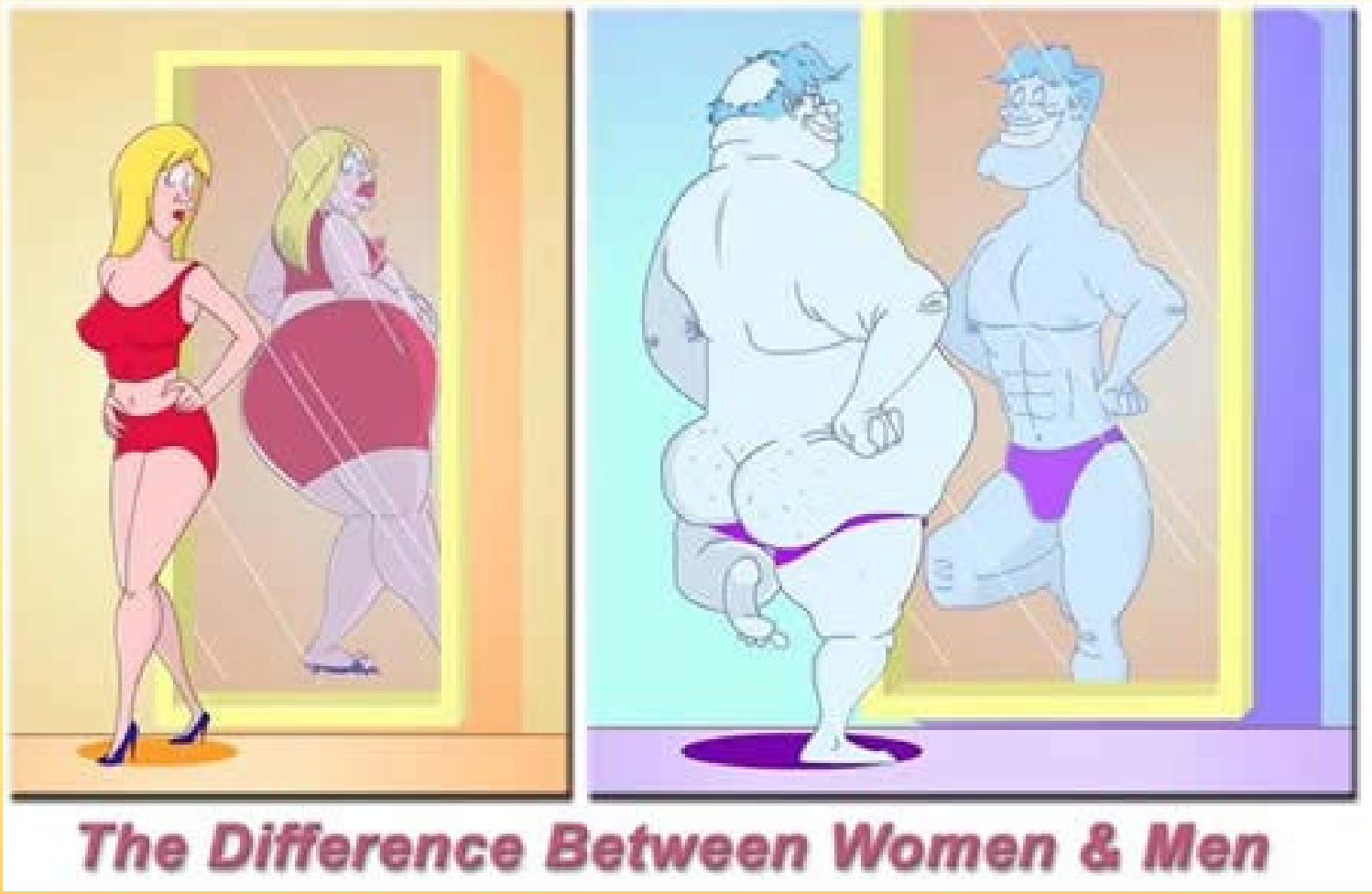

## Corn



# Historic Wheat Yields



# Our interpretation of facts may cloud our judgment.



# Facts change; principles do not.

"Facts mean nothing unless they are rightly understood, rightly related, and rightly interpreted."

- R.L. Long

# Agronomic Decisions Must Apply:

1. the right information (knowledge)
2. to the right situation and place
3. at the right time
4. in the right amount

} understanding reasoning

**In order to do this, we must base our decisions on principles, not on remembered facts!**

# Simplify, simplify, simplify!

# Agronomic Principles

- **Can be understood by focusing on the basics:**
  1. Variety/Hybrid Development & Selection (Genetics)
  2. Crop Growth & Development (Crop Physiology)
  3. Environmental Influences (Crop Ecology)

# Growth vs. Development

- Growth = increase in dry weight of the plant
- Development = the addition of new organs
  - Can have growth without development
  - But, cannot have development without growth

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# What determines amount of growth?

## Rate (lbs/time)

## X

## Duration (time)

# Economic Yield

Bushels/Acre =

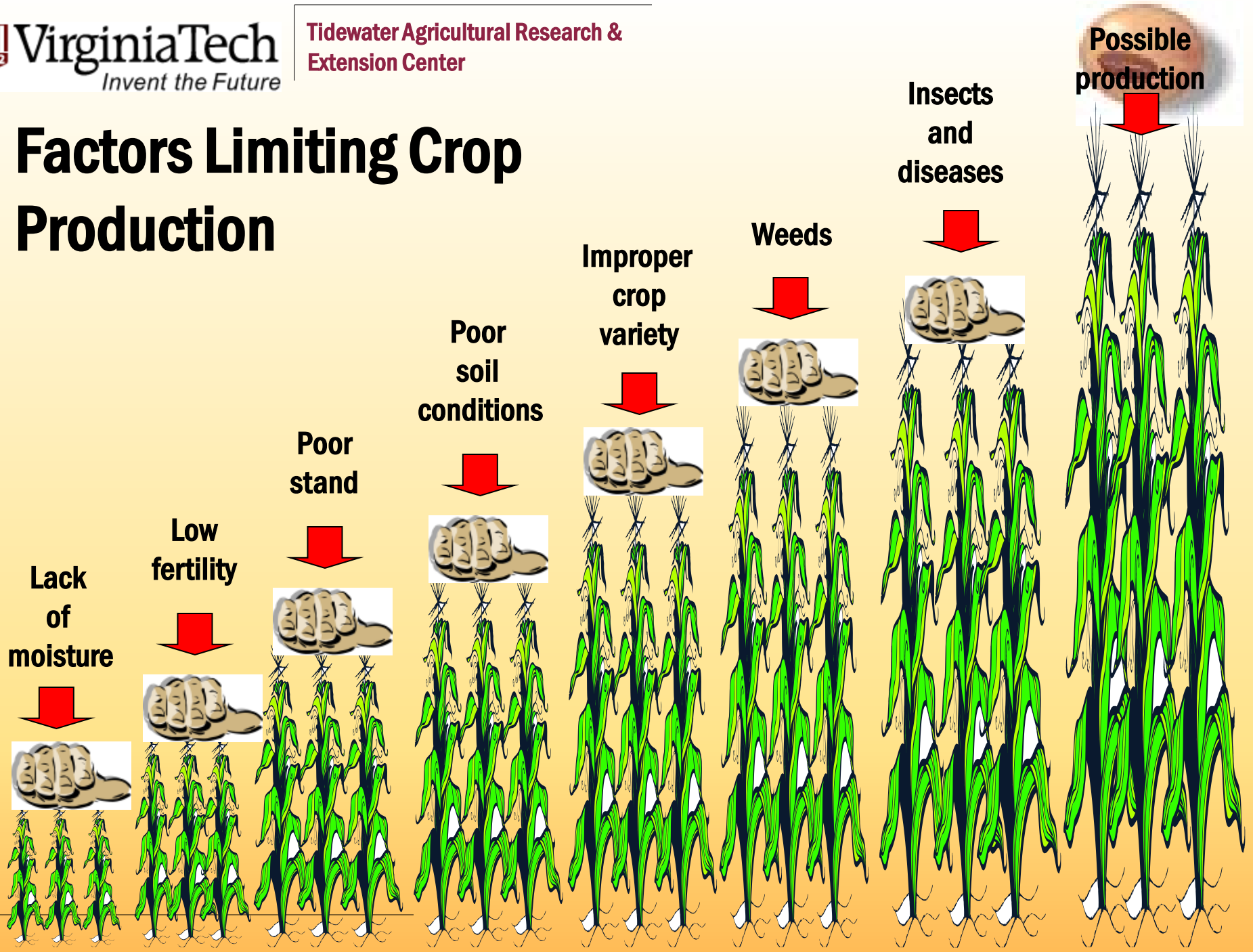
Plants/Acre

x Pods/Plant

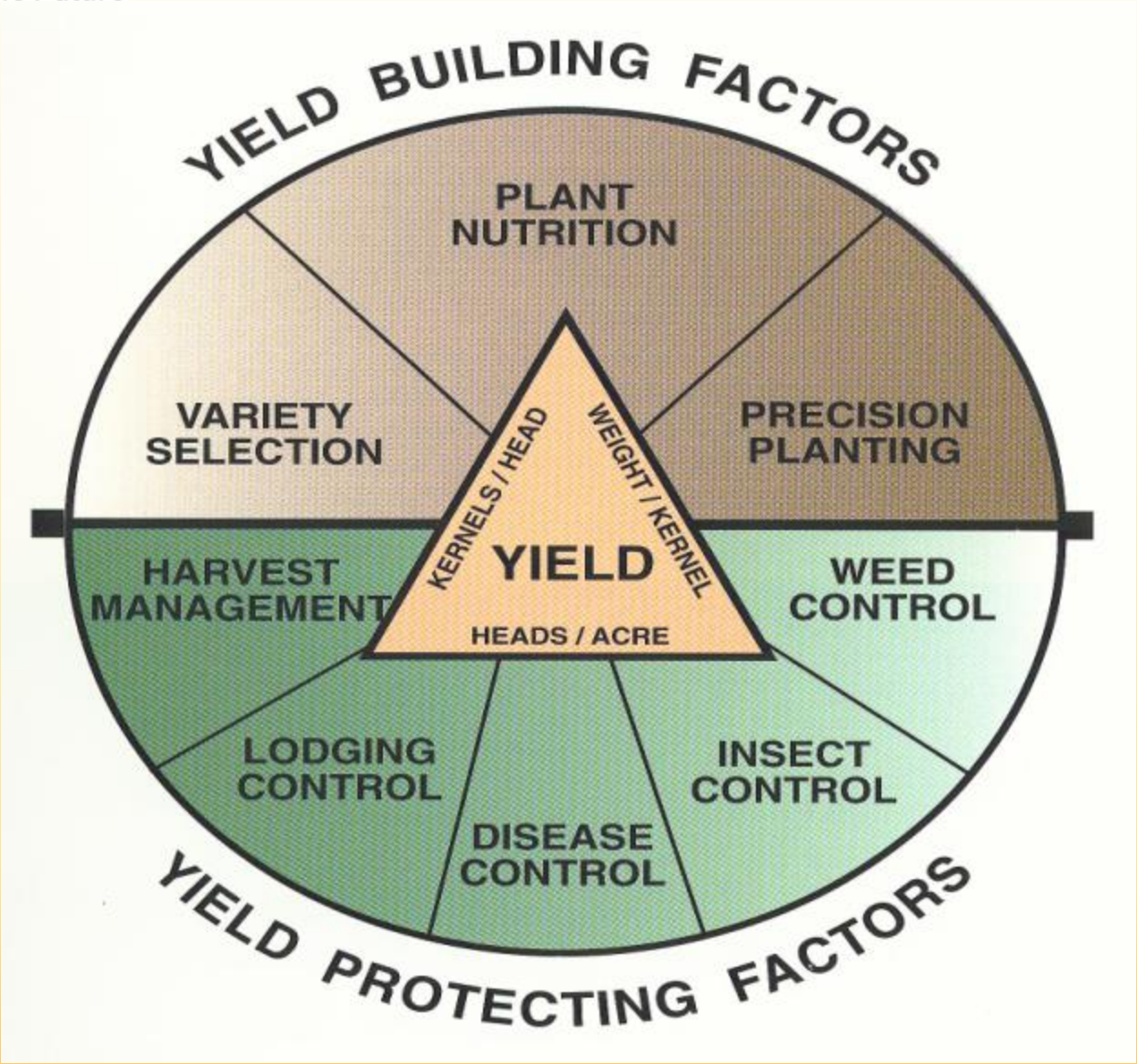
x Seeds/Pod

x Seed Weight

# Factors Limiting Crop Production



# If necessary, simplify.


YIELD BUILDING FACTORS
PLANT NUTRITION
VARIETY SELECTION
PRECISION PLANTING
KERNELS / HEAD
WEIGHT / KERNEL
YIELD
HEADS / ACRE
HARVEST MANAGEMENT
WEED CONTROL
LODGING CONTROL
DISEASE CONTROL
INSECT CONTROL
YIELD PROTECTING FACTORS

**Soybean have ~150 bushel yield potential!**

**So why do we average only 30 bu/acre?**

**Environmental resources are li**

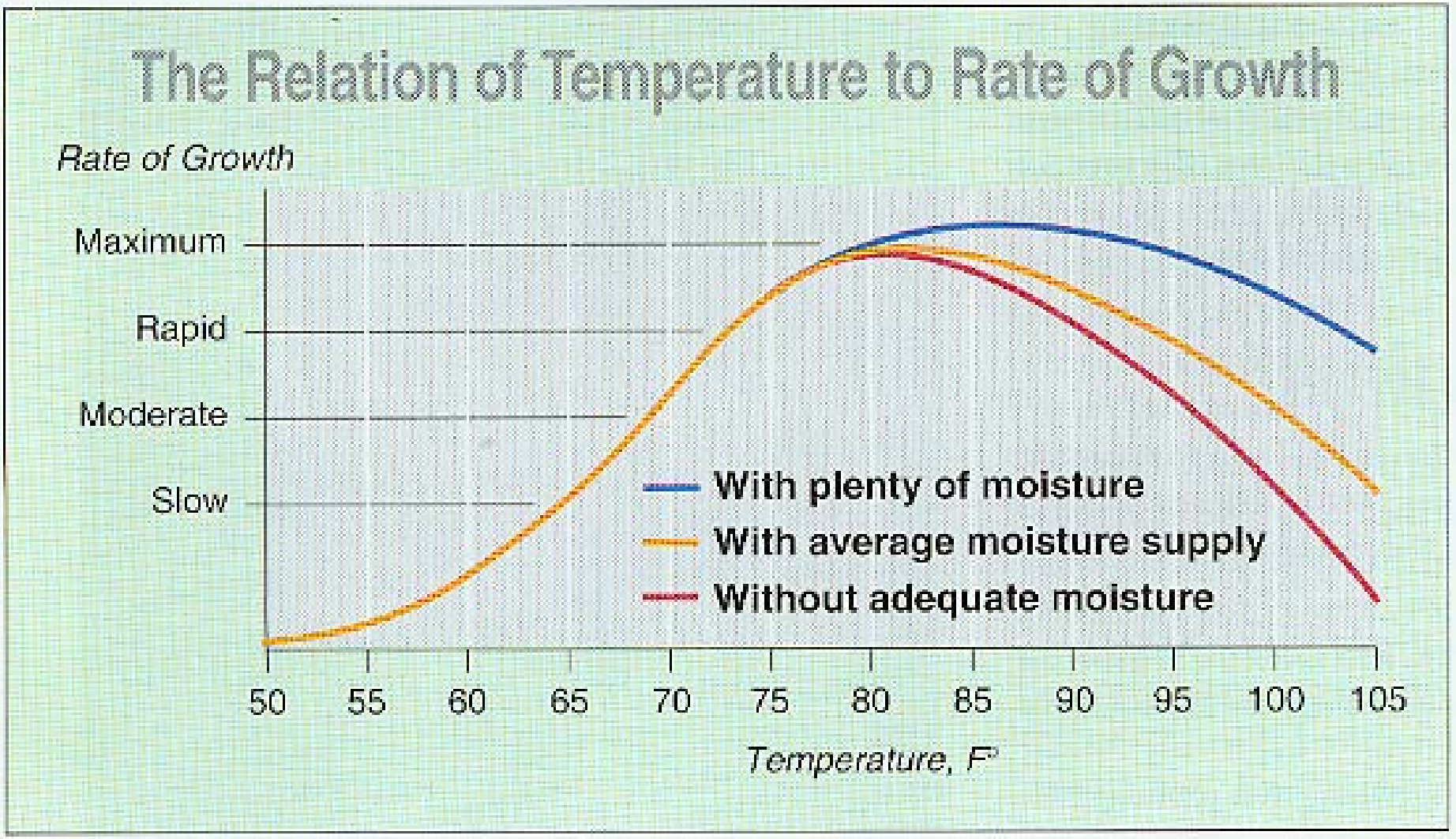
**What are our limiting**

**What about Temperature ?**

**Wat** **Light**

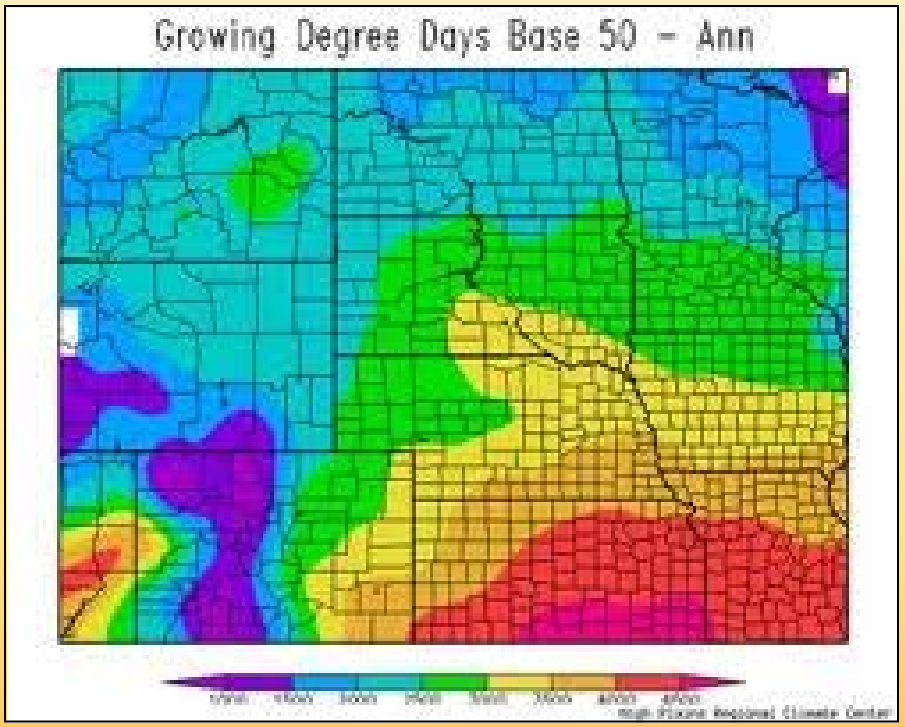
**ents** **CO2**

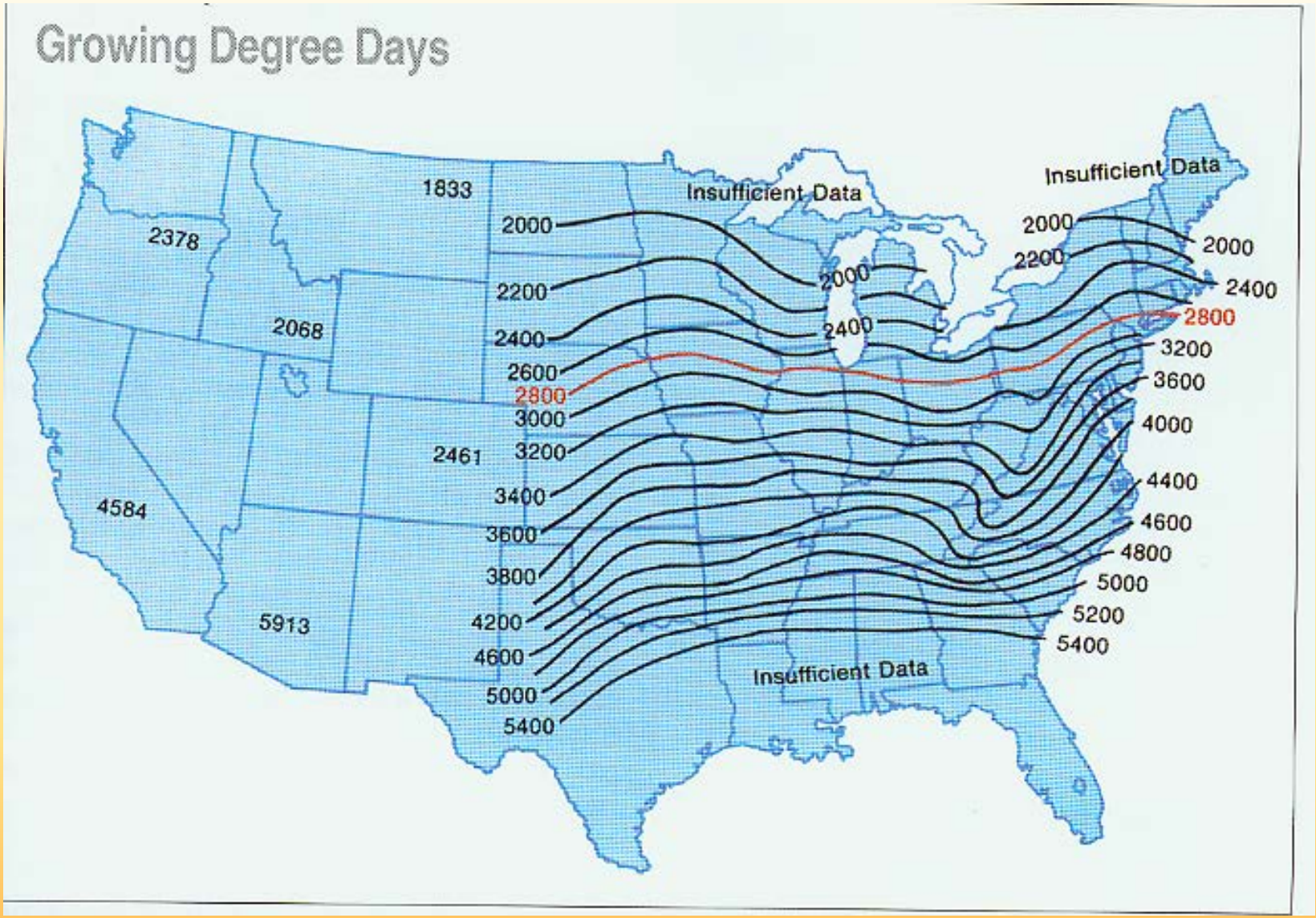
**O2**


The Relation of Temperature to Rate of Growth
Rate of Growth
Maximum
Rapid
Moderate
Slow
With plenty of moisture
With average moisture supply
Without adequate moisture
50
55
60
65
70
75
80
85
90
95
100
105
Temperature, F°

# Heat unit (GDD) concept

- GDD = ((Tmax-Tmin) / 2) – 50F
  - Difference between avg. temp and 50
  - Limits
    - Upper 86 F
    - Lower 50 F
  - Range
    - 0 – 36 GDD per day

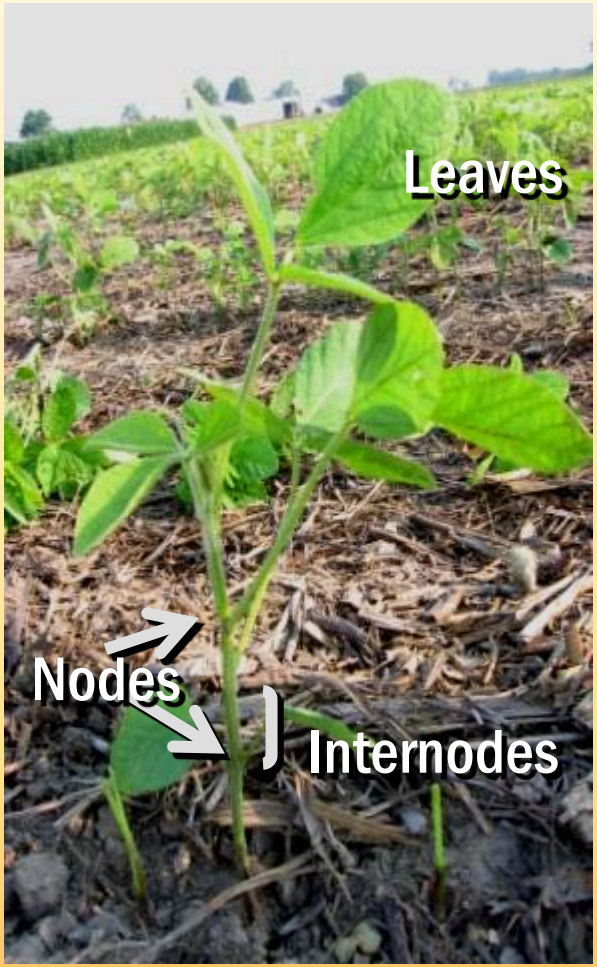


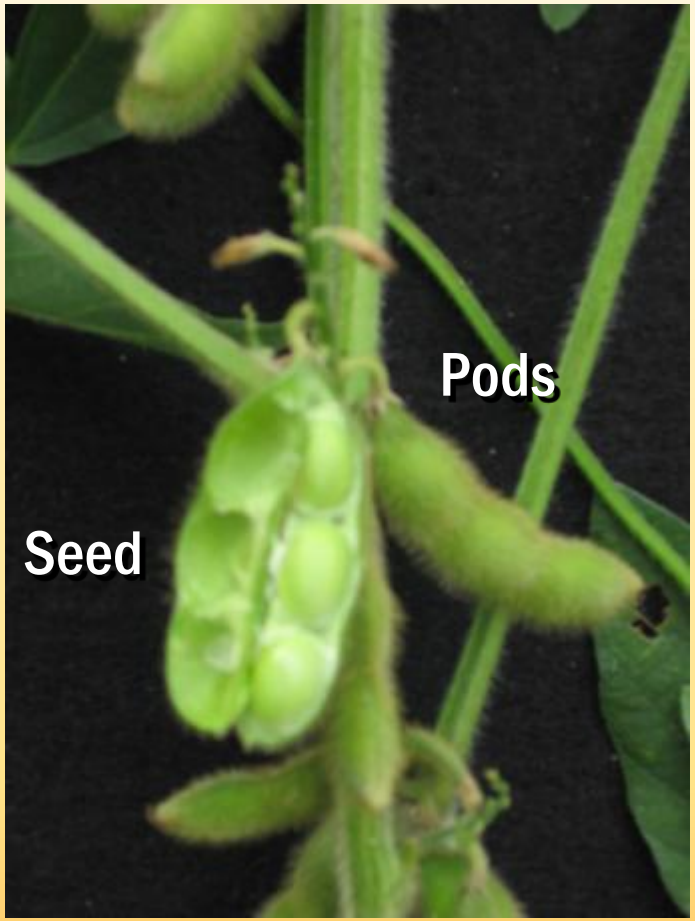

Growing Degree Days
1833
2378
2068
2461
4584
5913
Insufficient Data
Insufficient Data
Insufficient Data
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4200
4600
5000
5400
2000
2200
2000
2400
2000
2400
2800
3200
3600
4000
4400
4600
4800
5000
5200
5400

# Growth vs. Development

- Growth = increase in dry weight of the plant
- Development = the addition of new organs
  - Can have growth without development
  - But, cannot have development without growth

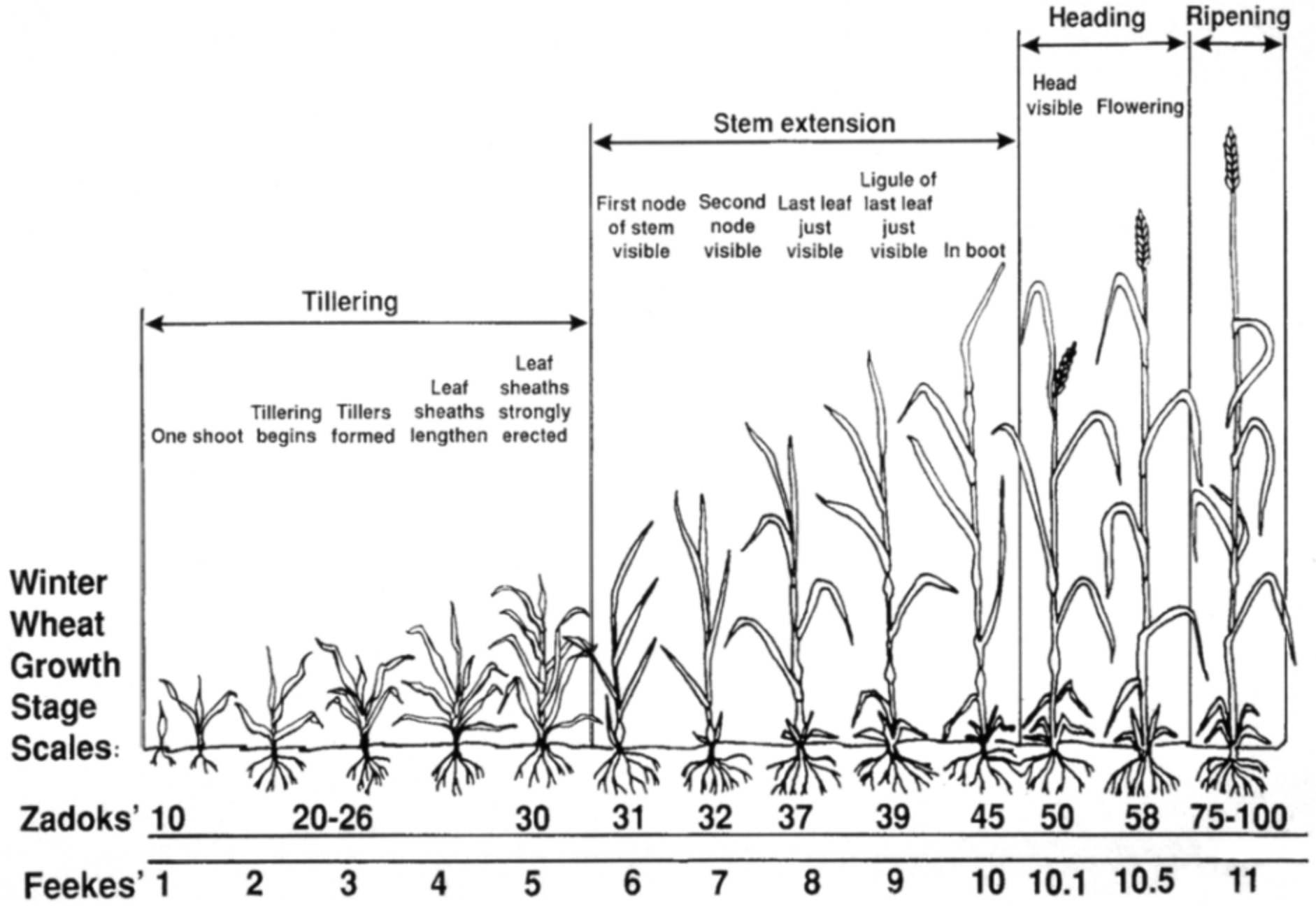
# Development



# Corn Developmental

- V12 – 12 leaves, kernel row number set, maybe


Heading
Ripening
Head visible
Flowering
Stem extension
First node of stem visible
Second node visible
Last leaf just visible
Ligule of last leaf just visible
In boot
Tillering
One shoot
Tillering begins
Tillers formed
Leaf sheaths lengthen
Leaf sheaths strongly erected
Winter Wheat Growth Stage Scales:
Zadoks' 10 20-26 30 31 32 37 39 45 50 58 75-100
Feekes' 1 2 3 4 5 6 7 8 9 10 10.1 10.5 11

# Corn Developmental Stages

## Vegetative Stages

- VE (emergence)
- V1 (first leaf)
- V2 (second leaf)
- V3 (third leaf)
- V(n) (nth leaf)
- VT (tasseling)

## Reproductive Stages

- R1 (silking)
- R2 (blister)
- R3 (milk)
- R4 (dough)
- R5 (dent)
- R6 (physiological maturity)

# Development is controlled by temperature

| Stage | GDD Accumulated |
|---|---|
| VE | 120 |
| V2 | 220 |
| V4 | 355 |
| V6 | 470 |
| V8 | 585 |
| V10 | 720 |
| V12 | 815 |
| VT | 1150 |
| R1 – Silking | **1250-1400** |
| R5 – Dent | 2130-2450 |
| R6 – Black Layer | 2350-2900 |

# Vegetative and Reproductive Stages of Soybean*

## Vegetative

VE = Emergence

VC = Unrolled unifoliate leaves

V1 = Unrolled first-trifoliate leaf

V2 = Unrolled second-trifoliate leaf

V3 = Unrolled third-trifoliate leaf

V(n) = Unrolled $n^{th}$ trifoliate leaf

## Reproductive

R1 = Beginning flower (bloom)

R2 = Full flower

R3 = Beginning pod

R4 = Full pod

R5 = Beginning seed

R6 = Full seed

R7 = Physiological maturity

R8 = Full maturity

*All plants in a field will not be in the same stage at the same time. Specific V or R stages is defined As when 50% or more of the plants in the field are in or beyond that stage.

# Soybean Growth Habit & Photoperiod

## Determinate (MG 5 or later)

## Indeterminate (MG 4 or earlier)

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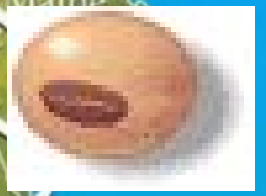
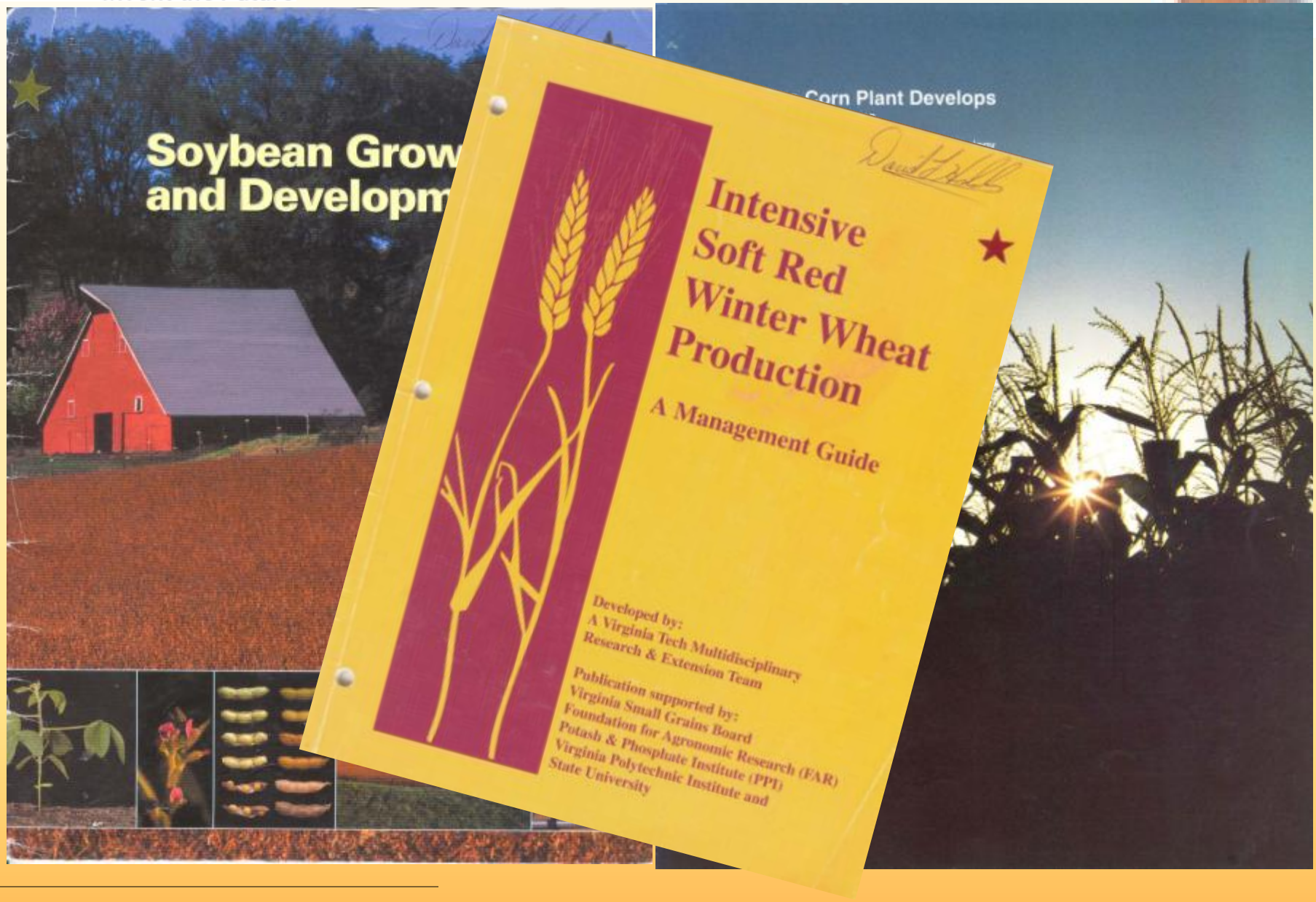
# Soybean Classification

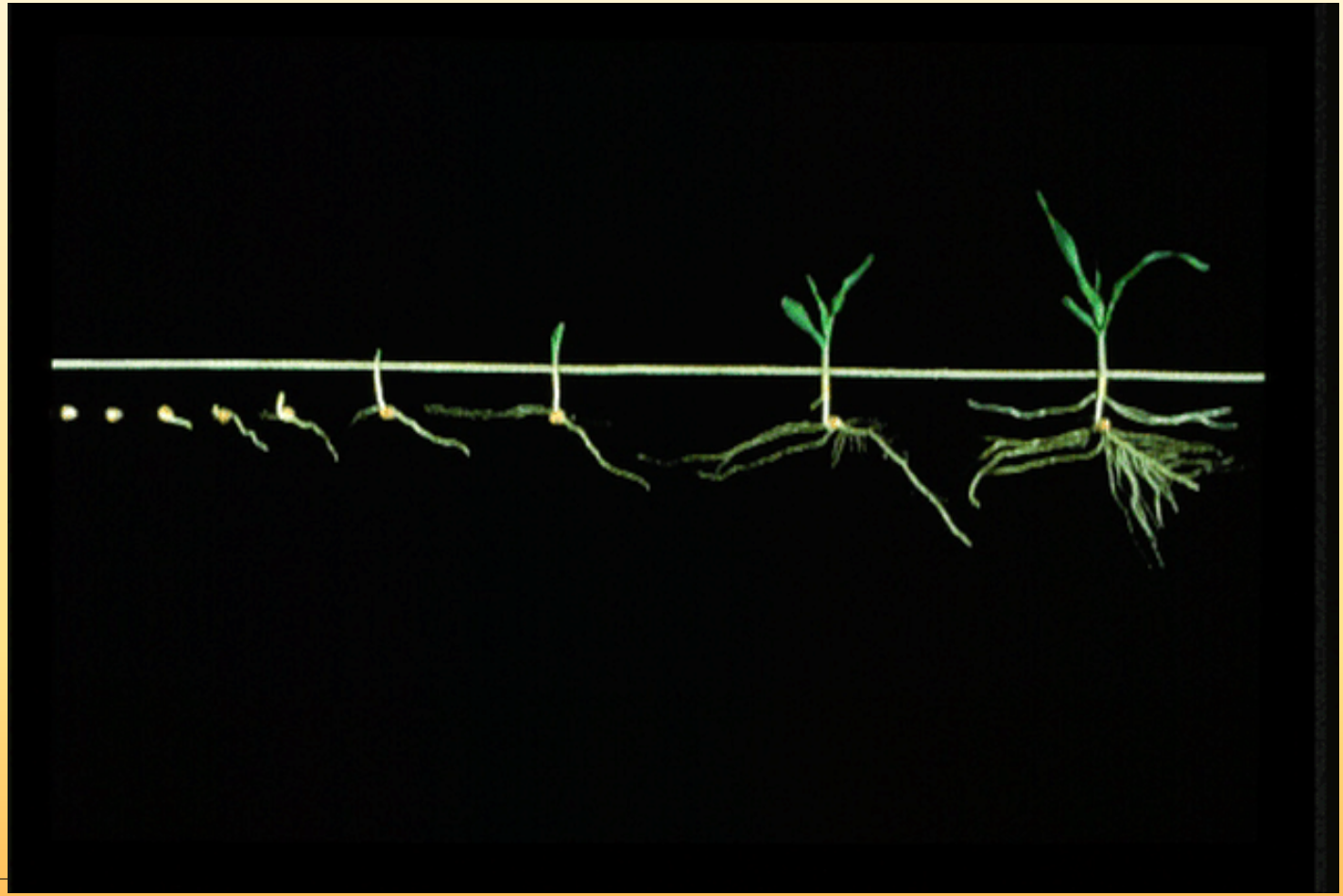


# Questions? Comments?


Soybean Grow
and Developm
Corn Plant Develops
Intensive
Soft Red
Winter Wheat
Production
A Management Guide
Developed by:
A Virginia Tech Multidisciplinary
Research & Extension Team
Publication supported by:
Virginia Small Grains Board
Foundation for Agronomic Research (FAR)
Potash & Phosphate Institute (PPI)
Virginia Polytechnic Institute and
State University

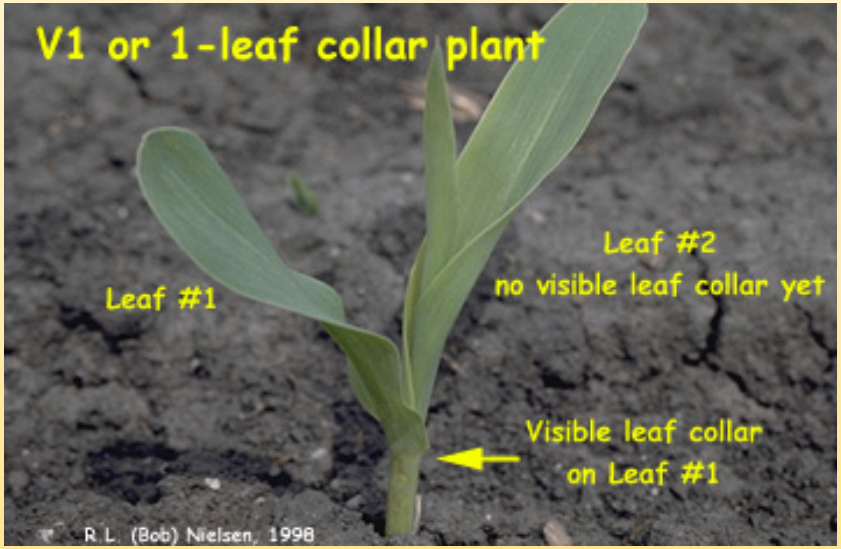
# Corn Developmental Stages

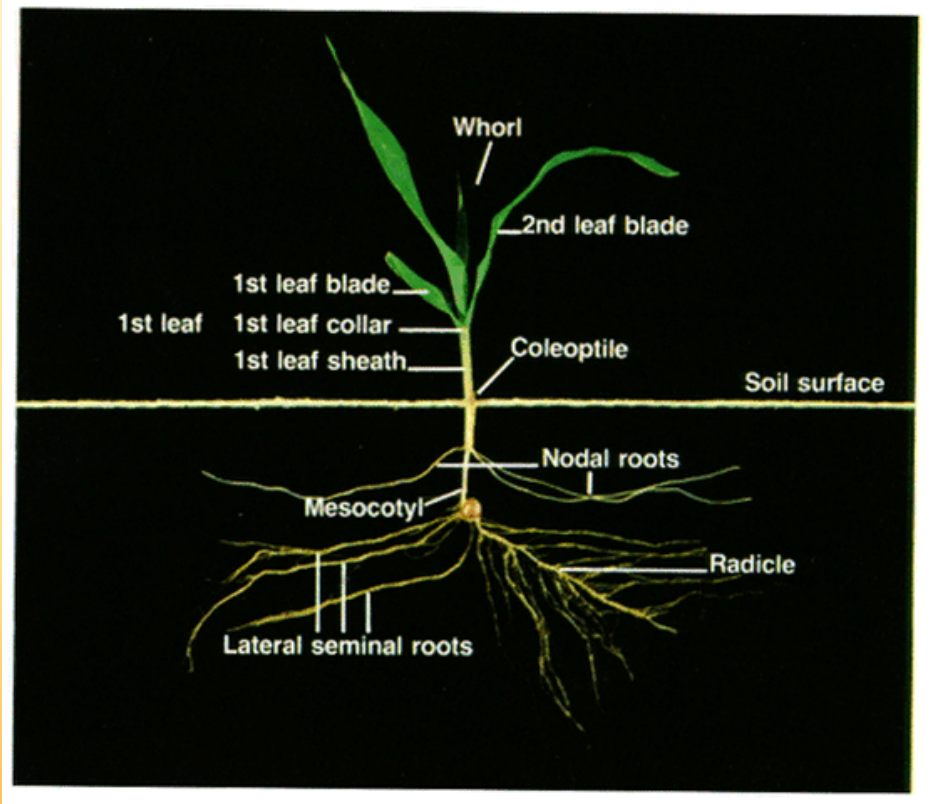
- VE - emergence



# Corn Developmental Stages

- V2 – 2 leaves



# Corn Developmental Stages

- V6 – 6 leaves emerged, all leaves formed, growing point reaches soil surface

# Corn Developmental Stages

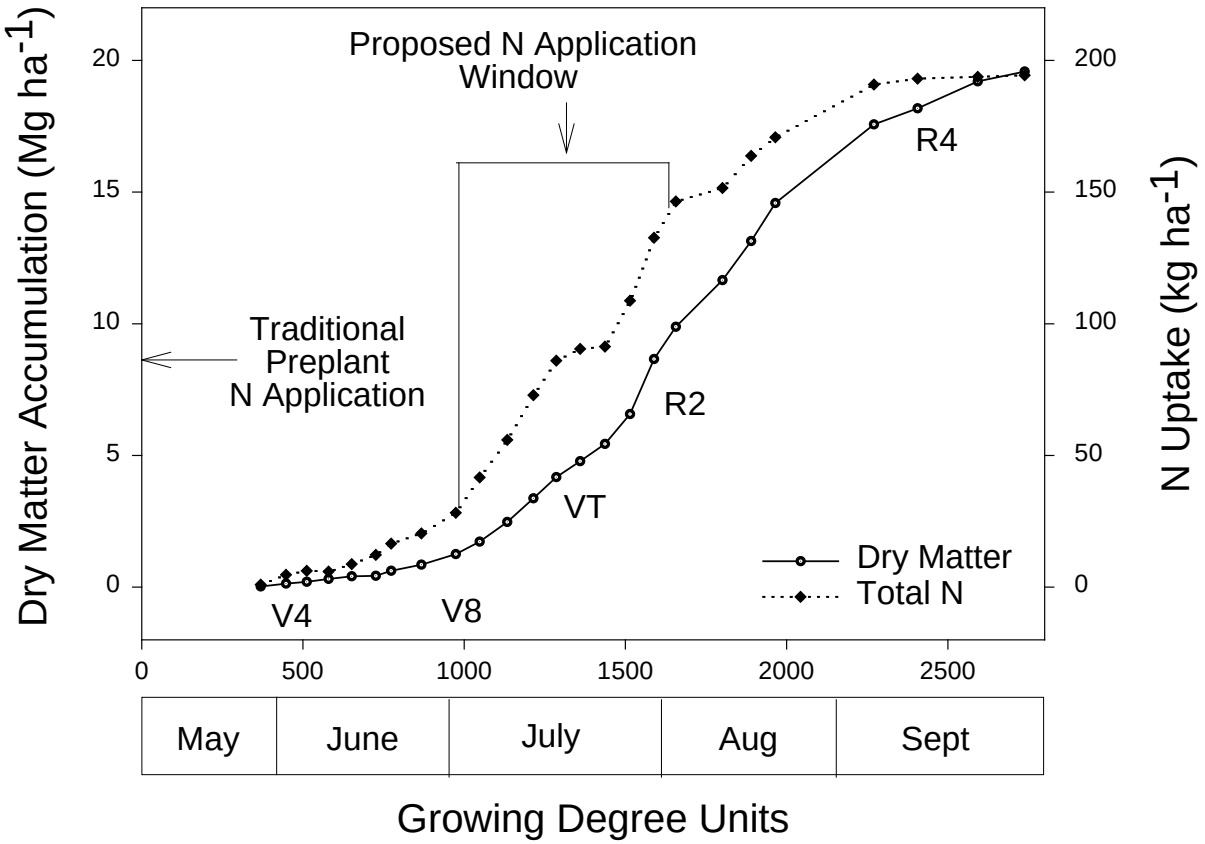
- V8 – 8 leaves, potential kernel row number being determined

# N Fertilizer Rate

## 1.0 lb N Per Bu Yield Potential

- (56 lbs/bu) * (1 - 0.15) = 47.6 lbs dry matter/bu
- Corn grain: 9% protein = 1.44%N
- (47.6 lbs dm/bu) * (0.0144) = 0.69 lbs N/bu
- Efficiency of uptake:
  - 69% eff. = (0.69 lbs N / 1.0 lb N applied) (100%)
  - 60% eff. = (0.69 lbs N / 1.15 lb N applied) (100%)

# Corn Nitrogen



# Sub-Surface Placement

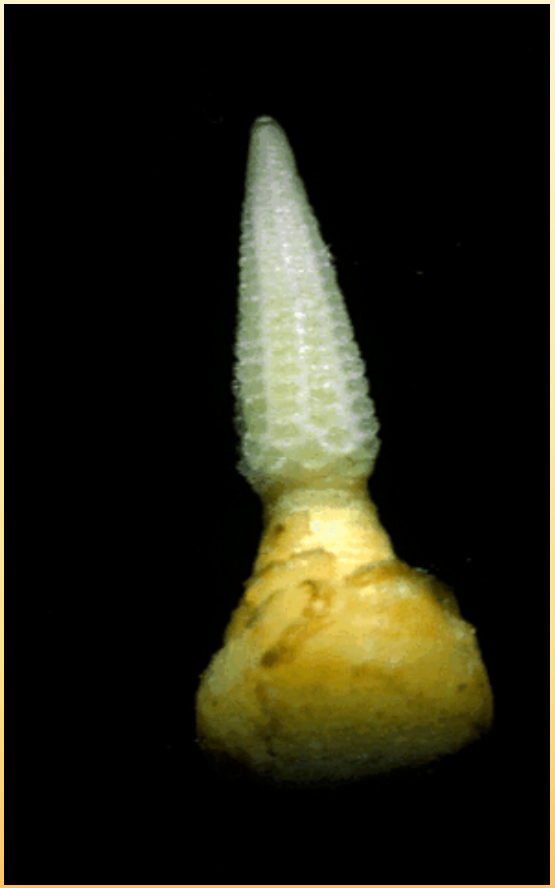
# Optimum Starter Band and Sidedress N Rates for No-till Corn

| Soil Series | Starter Band* N Rate (lbs/ac) | Side-dress N Rate (lbs/ac) | Yield (bu/acre) |
|---|---|---|---|
| Pamunkey | 66 | 0 | 89 |
| Slagle sil | 70 | 93 | 168 |
| Pamunkey fsl | 70 | 80 | 154 |
| Slagle sl | 49 | 125 | 128 |
| Turbeville sl | 27 | 107 | 111 |
| Cullen l | 44 | 58 | 126 |
| Eubanks sil | 70 | 0 | 122 |
| Ross l | 70 | 93 | 105 |
| Pamunkey sil | 70 | 93 | 148 |

*Starter band placed 2x2. N rates were 10, 30, 50, 70 lbs N/acre.

# Corn Developmental Stages

- V12 – 12 leaves, kernel row number set, maybe



# Corn Developmental Stages

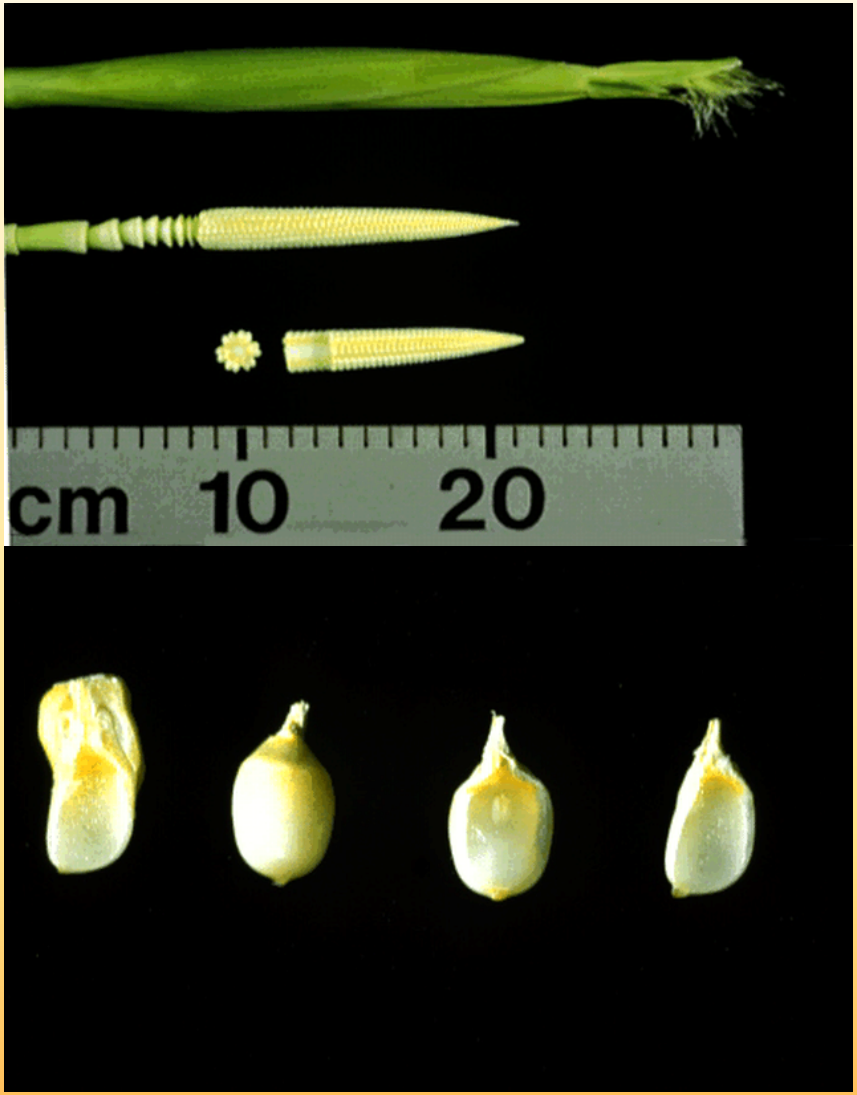
- V16 – 16 leaves or about 1 wk prior to silking, kernels per row set

# Corn Developmental Stages

- VT – Tasseling,

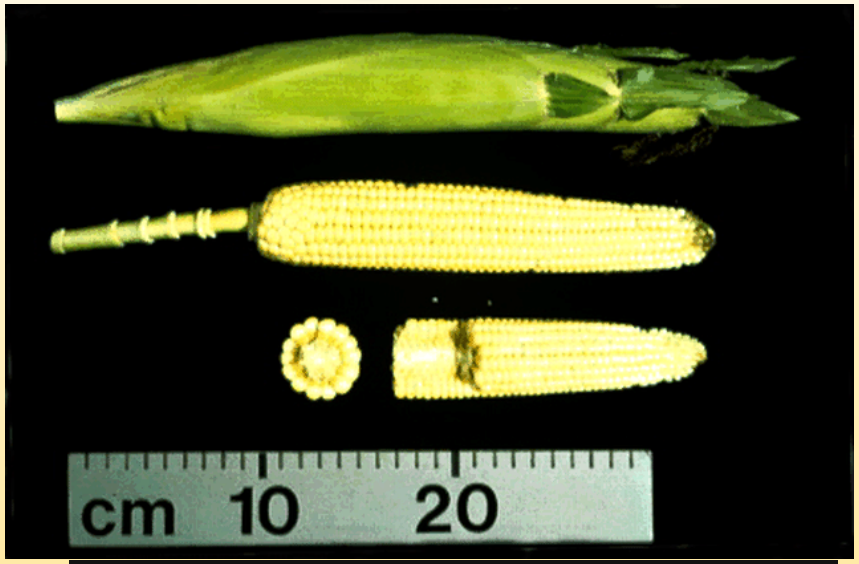
# Corn Developmental Stages

- R1 – Silking
- R2 - Blister

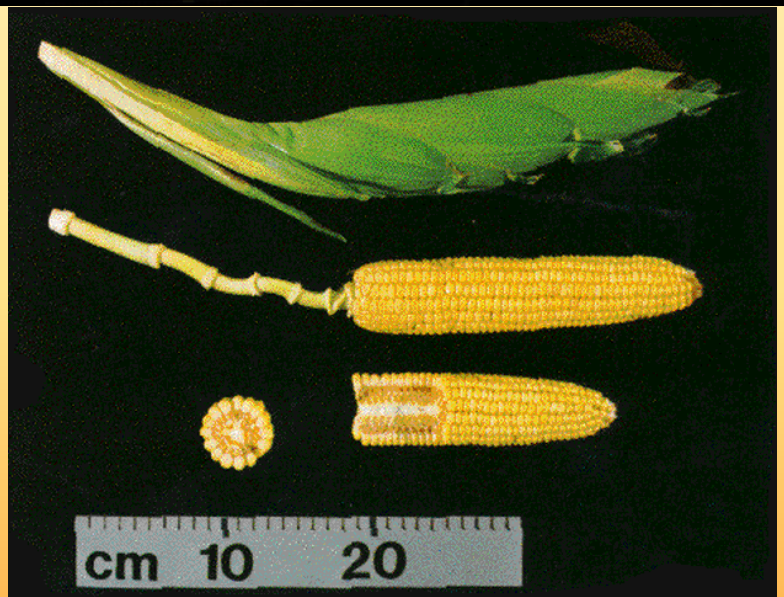


# Corn Developmental Stages

- R3 – Milk

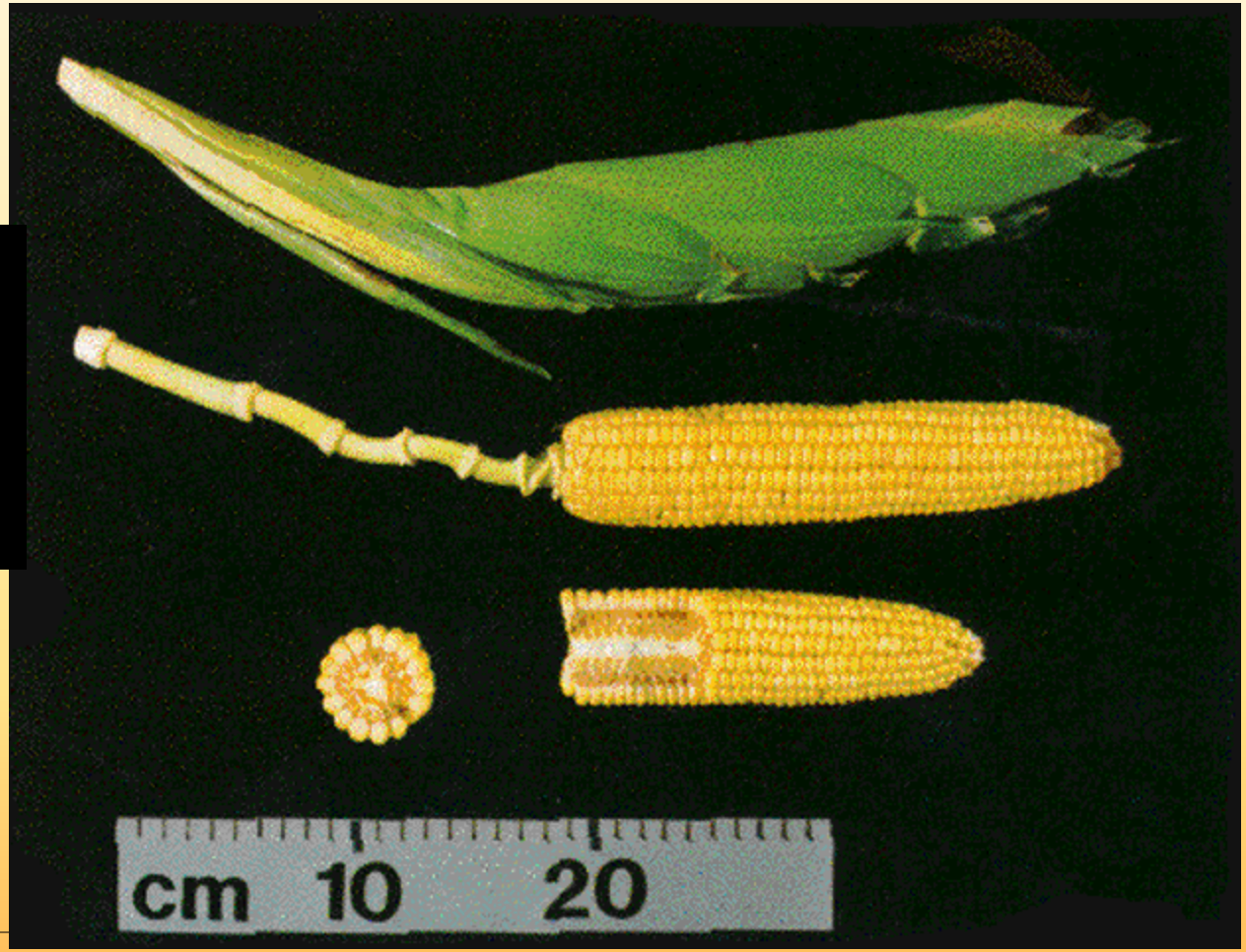



- R4 - Dough



# Corn Developmental Stages

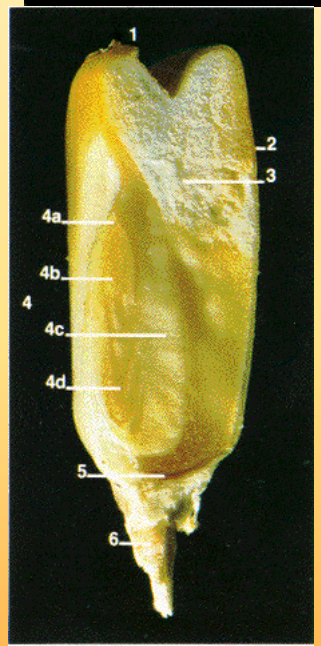
- R4 - Dough



# Corn Developmental Stages

- R5 – Dent


- R6- Black layer



# Vegetative and Reproductive Stages of Soybean*

## Vegetative

VE = Emergence

VC = Unrolled unifoliate leaves

V1 = Unrolled first-trifoliate leaf

V2 = Unrolled second-trifoliate leaf

V3 = Unrolled third-trifoliate leaf

V(n) = Unrolled $n^{th}$ trifoliate leaf

## Reproductive

R1 = Beginning flower (bloom)

R2 = Full flower

R3 = Beginning pod

R4 = Full pod

R5 = Beginning seed

R6 = Full seed

R7 = Physiological maturity

R8 = Full maturity

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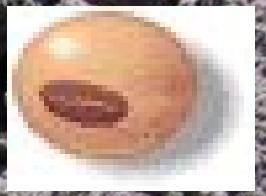

# Vegetative Development Stages

## VE Soybean

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# V1 Soybean

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# V2 Soybean


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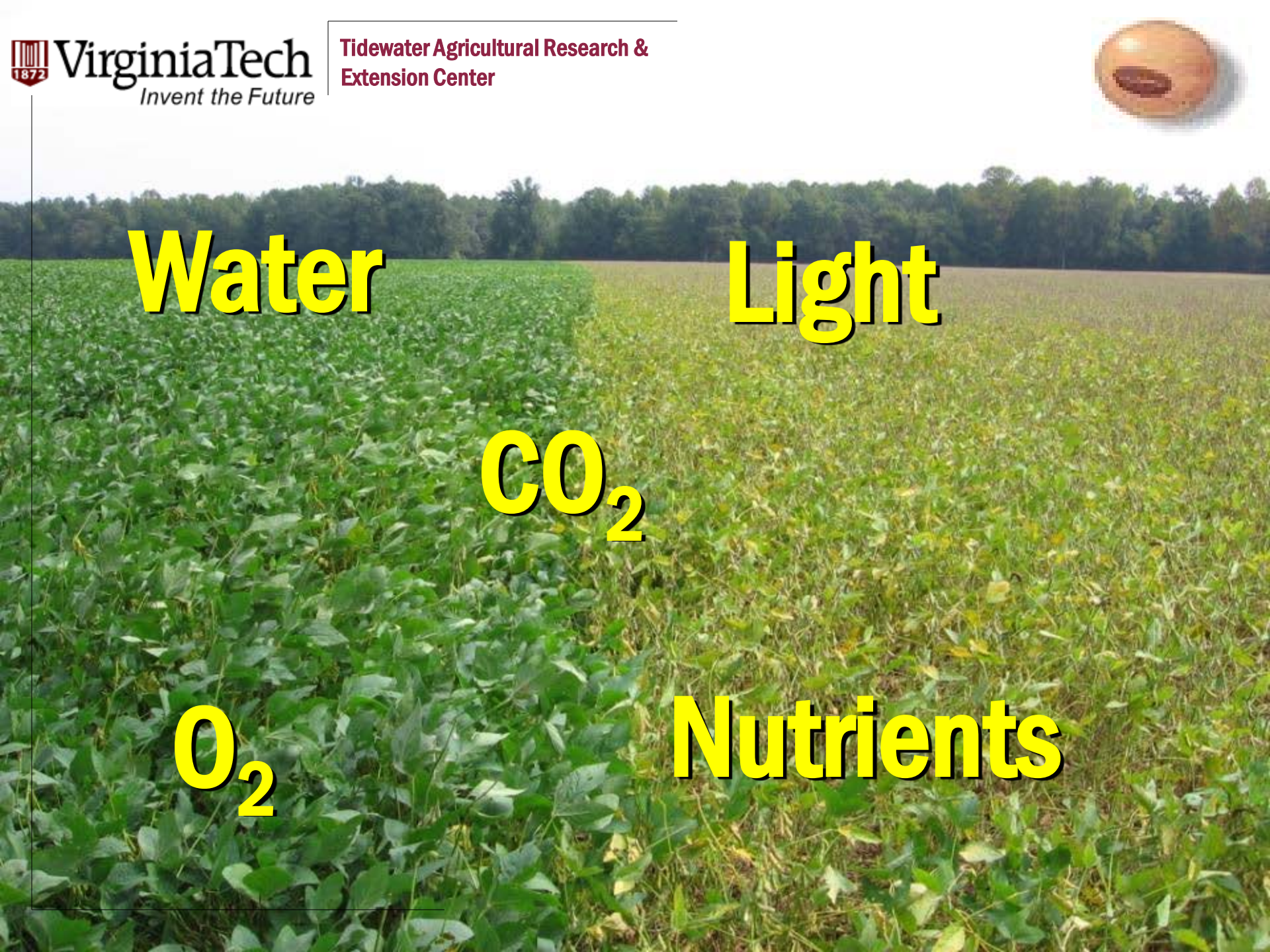
Water
Light
$CO_2$
$O_2$
Nutrients

# Staging Reproductive Soybeans

## R1

## R2

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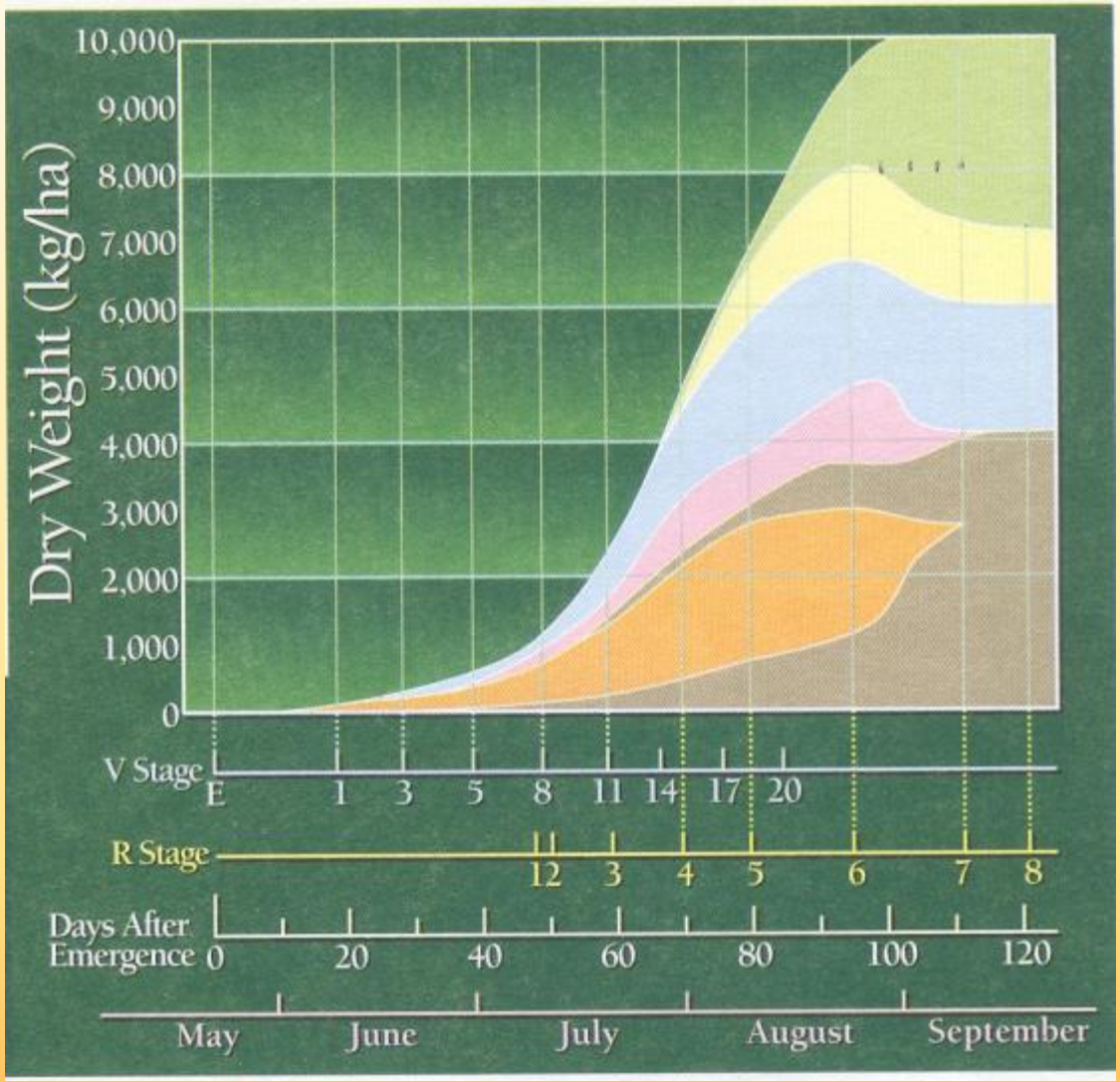
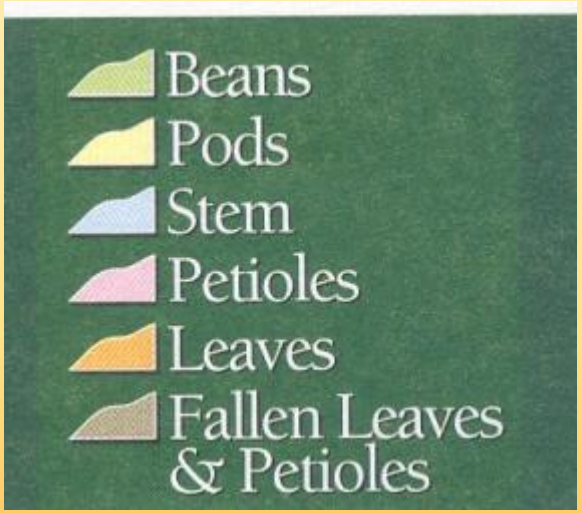
# Soybean Dry Weight Accumulation

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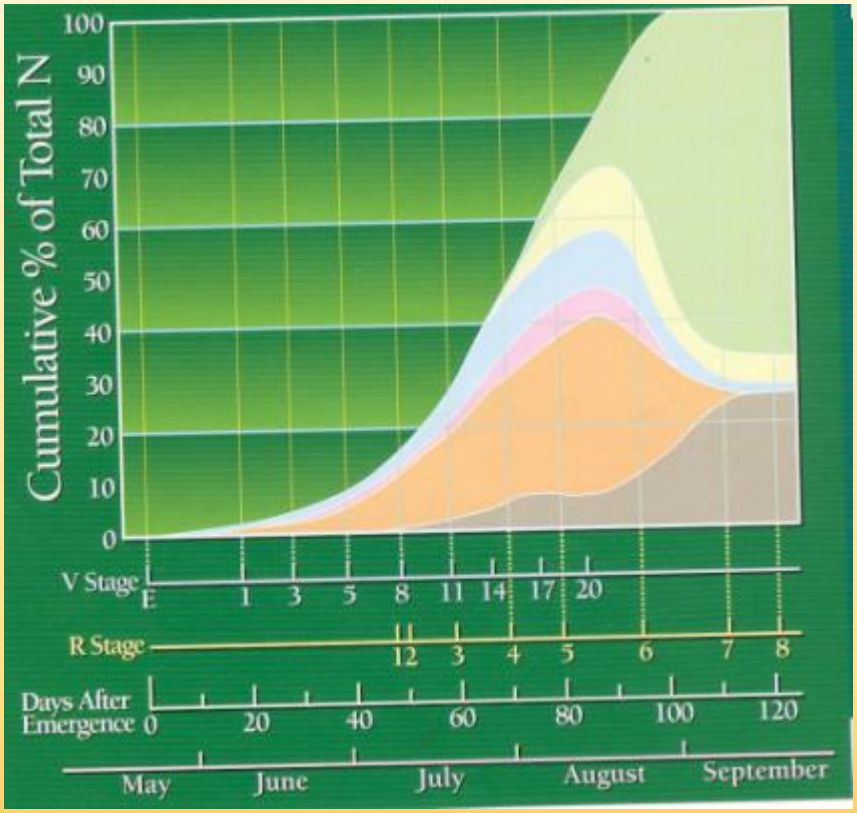
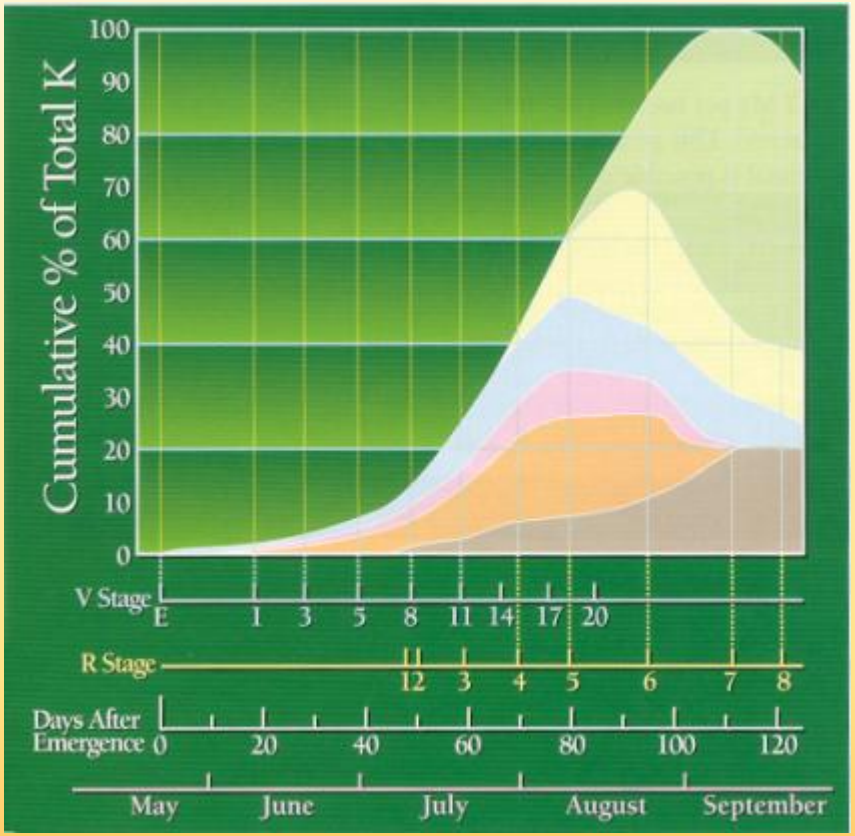
# Soybean Nutrient Uptake

## Nitrogen




## Potassium

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# Staging Reproductive Soybeans – Pod Formation



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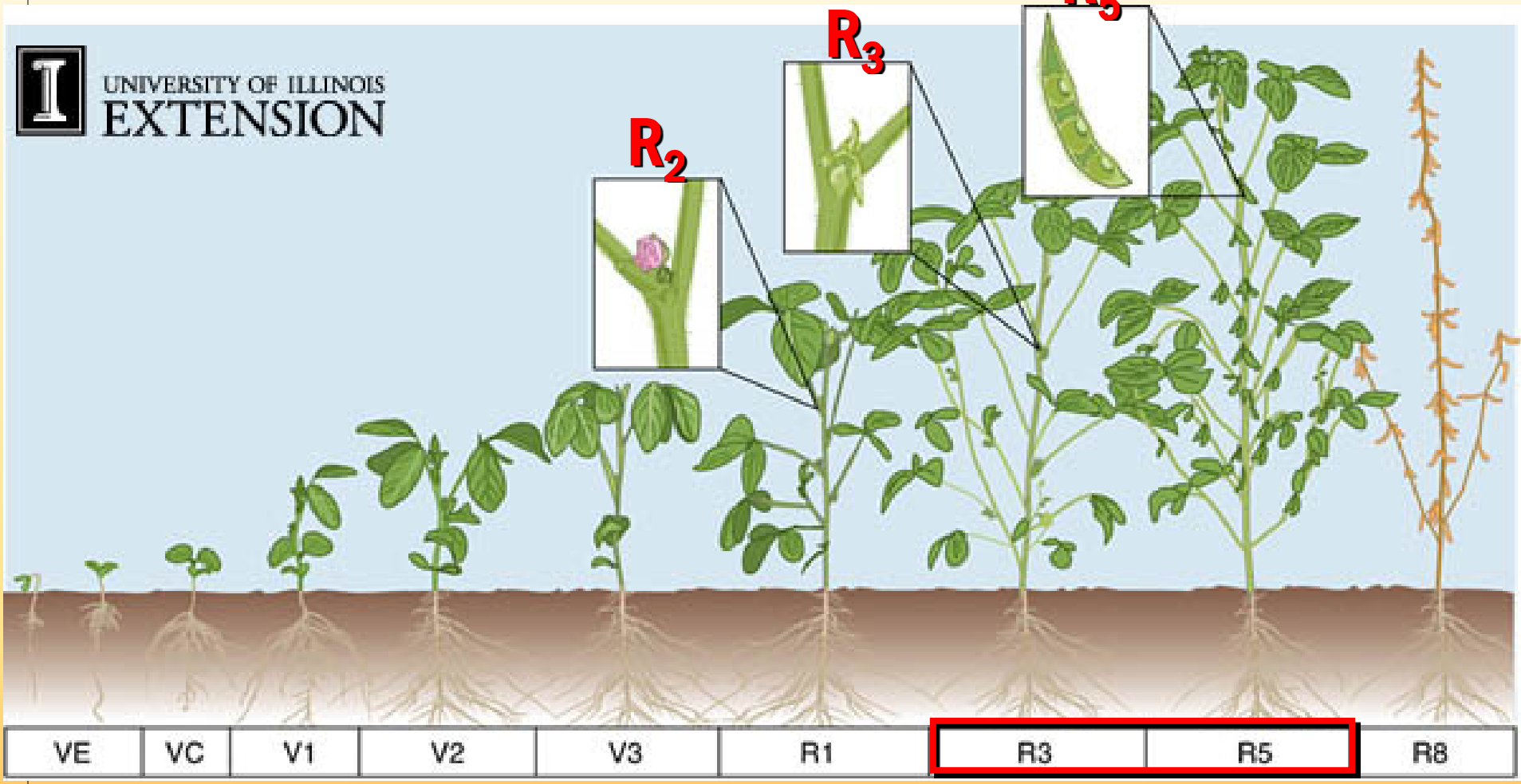
# Fungicide Spray Window




Fungicide Window

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# Staging Reproductive Soybeans


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# Seed Formation through Maturity

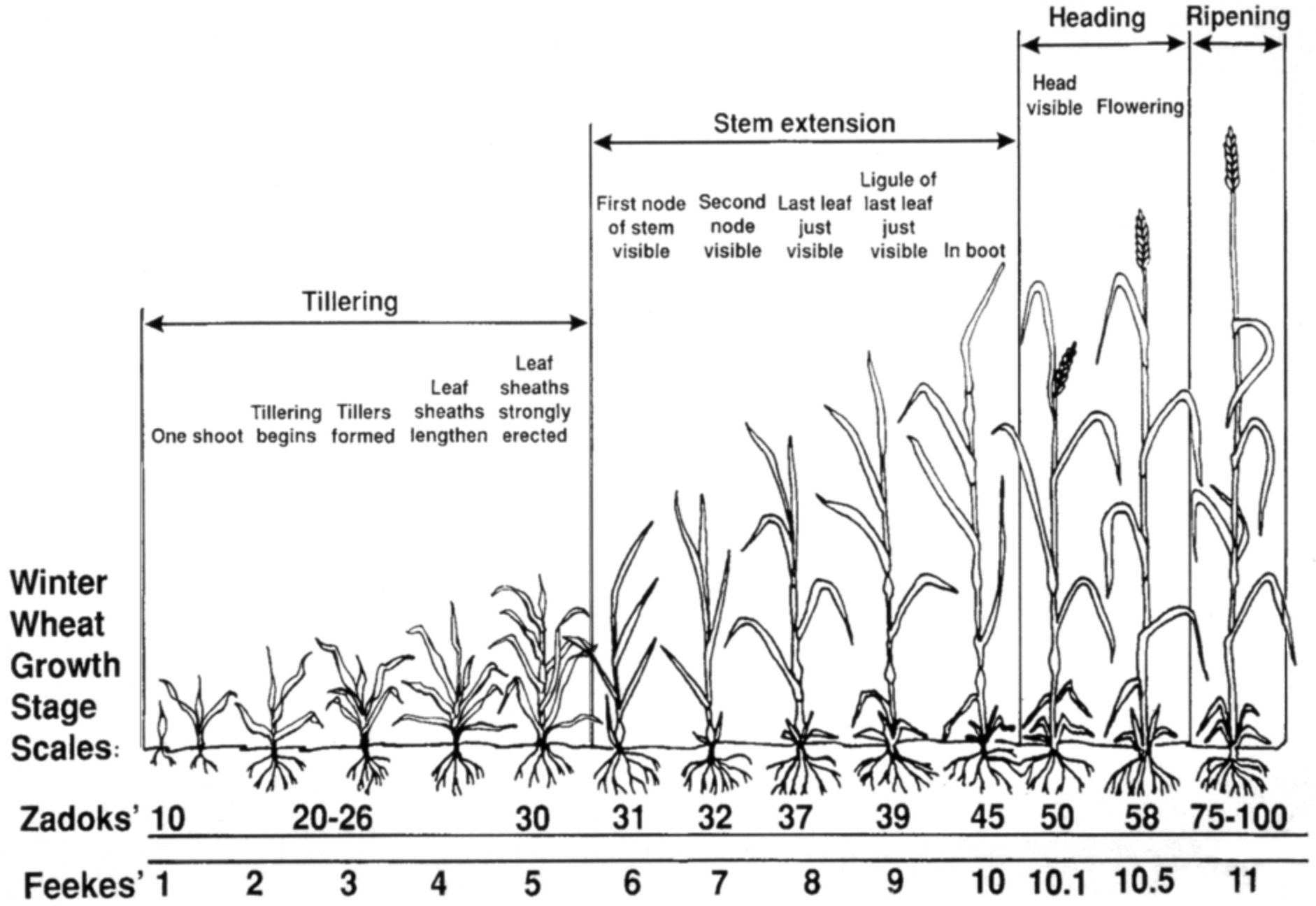
## Estimated Yield Achieved at Stated Development Stage

| 13-15 days | | 18-20 days | | 8-10 days |
|---|---|---|---|---|
| R5 | R6 | R6.75 | R7 | R8 |

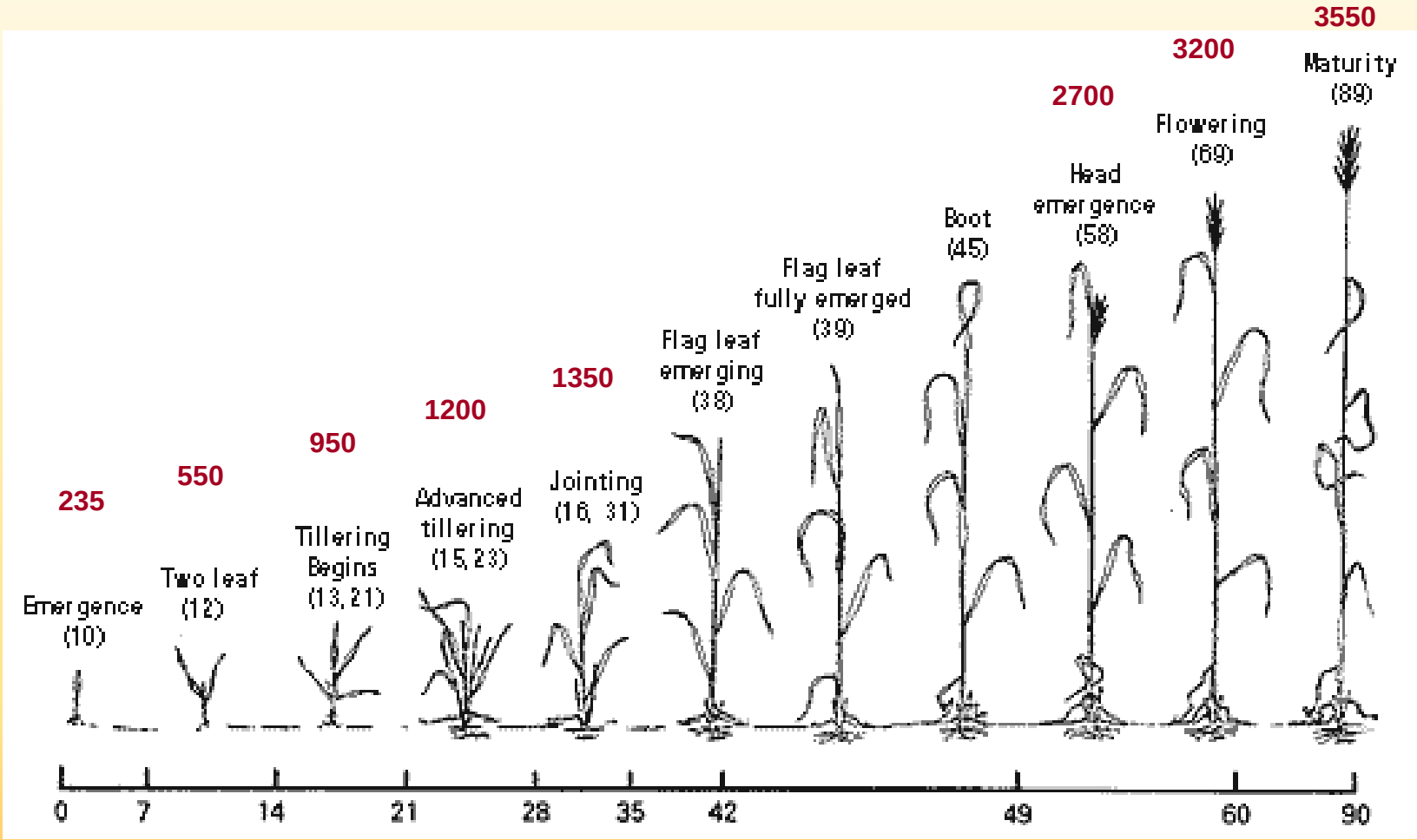
| 25% | 50% | 91% | 98% | 100% |
|---|---|---|---|---|

e.g., Bushels Achieved by Listed Stage

| | | | | |
|---|---|---|---|---|
| 12.5 | 25 | 46 | 49 | 50 |
| 15 | 20 | 36 | 39 | 40 |
| 7.5 | 15 | 27 | 29 | 30 |


Heading
Ripening
Head visible
Flowering
Stem extension
First node of stem visible
Second node visible
Last leaf just visible
Ligule of last leaf just visible
In boot
Tillering
One shoot
Tillering begins
Tillers formed
Leaf sheaths lengthen
Leaf sheaths strongly erected
Winter Wheat Growth Stage Scales:
Zadoks' 10 20-26 30 31 32 37 39 45 50 58 75-100
Feekes' 1 2 3 4 5 6 7 8 9 10 10.1 10.5 11

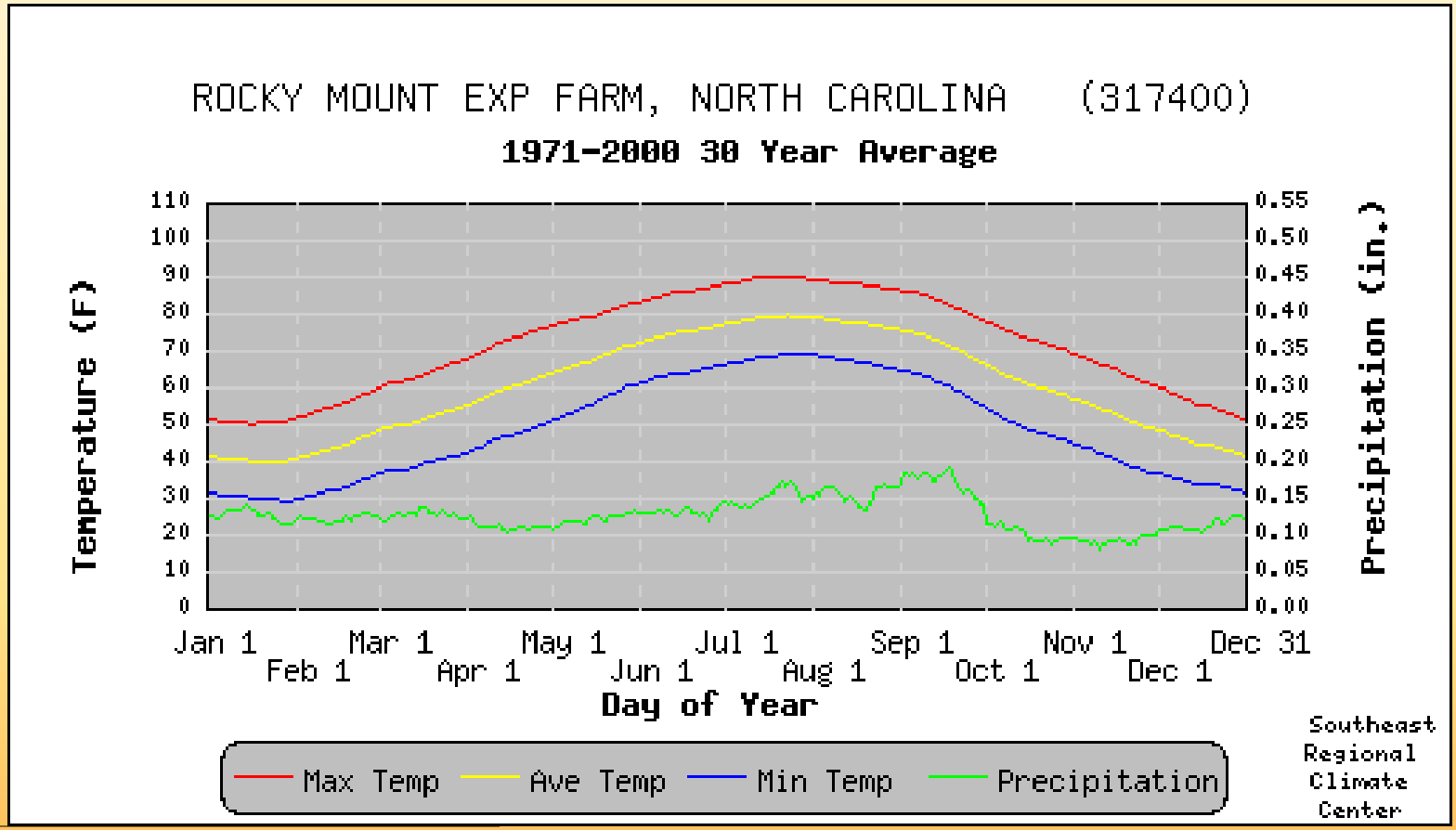
# Estimated GDD (base 32ºF) Required to Reach Key Developmental Stages




Zadoks stage, in parenthesis

# Wheat

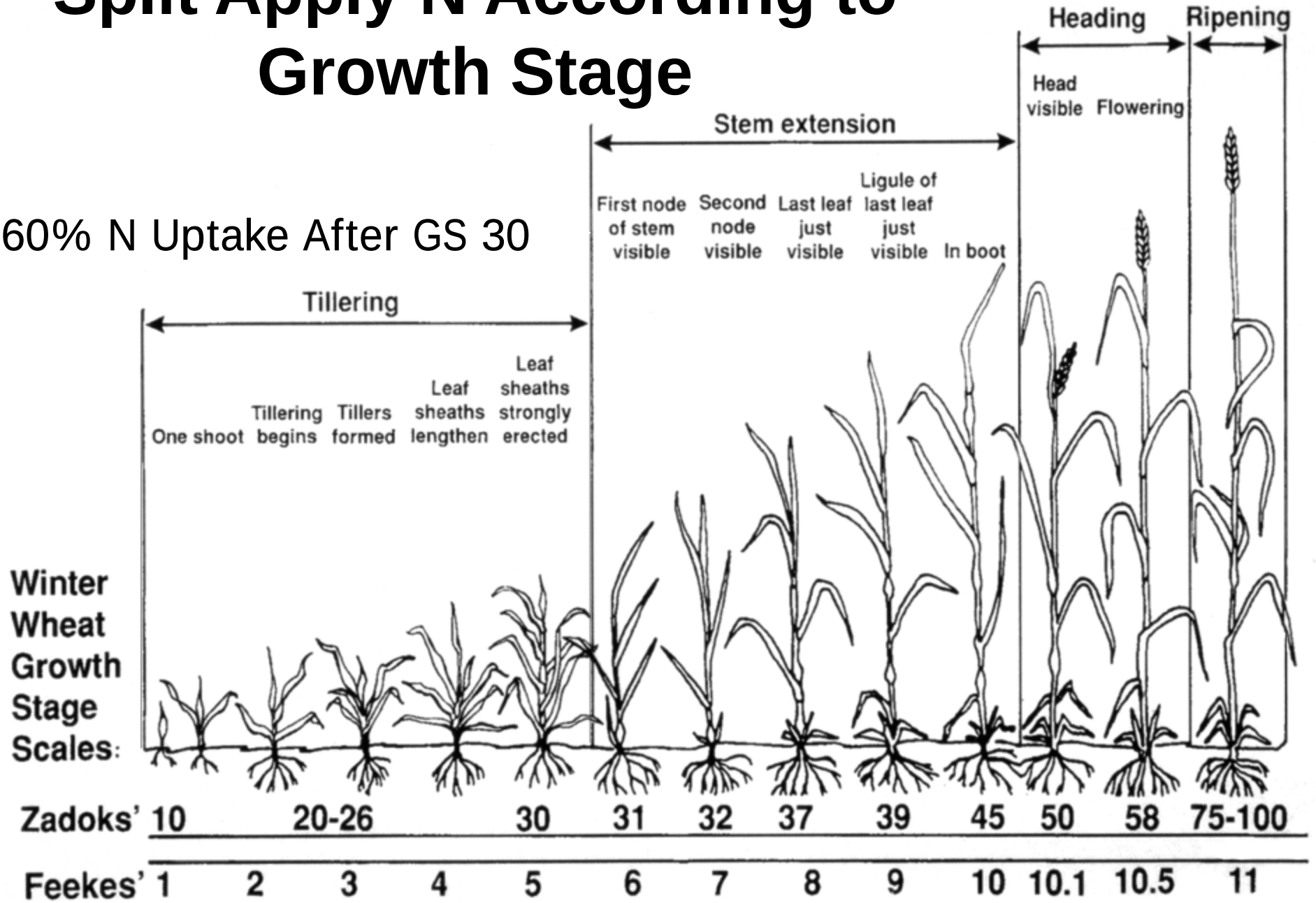
- Daylength Sensitivity
  - What triggers the change from vegetative to reproductive growth?



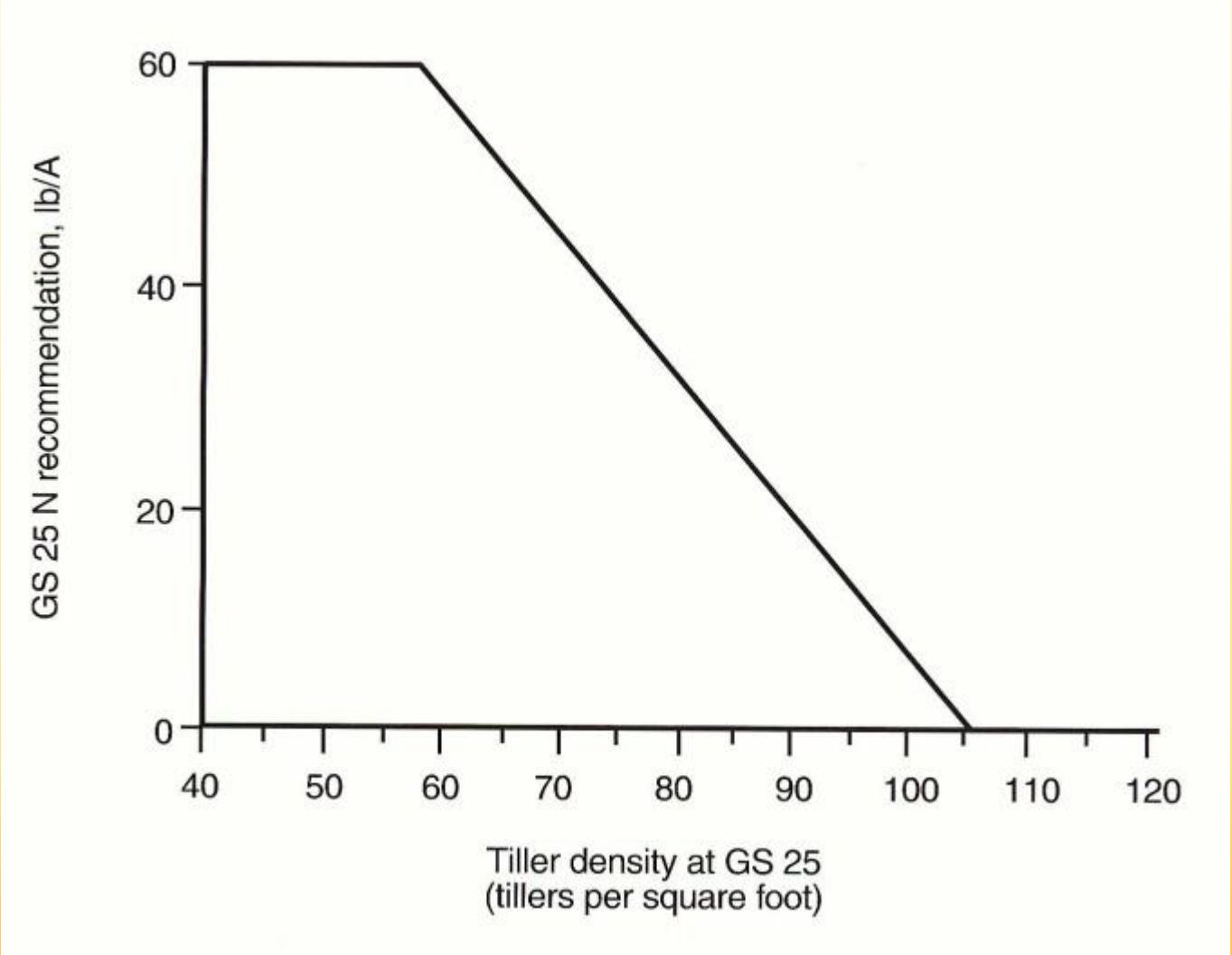
# Nitrogen Management In Winter Wheat Production

# Split Apply N According to Growth Stage

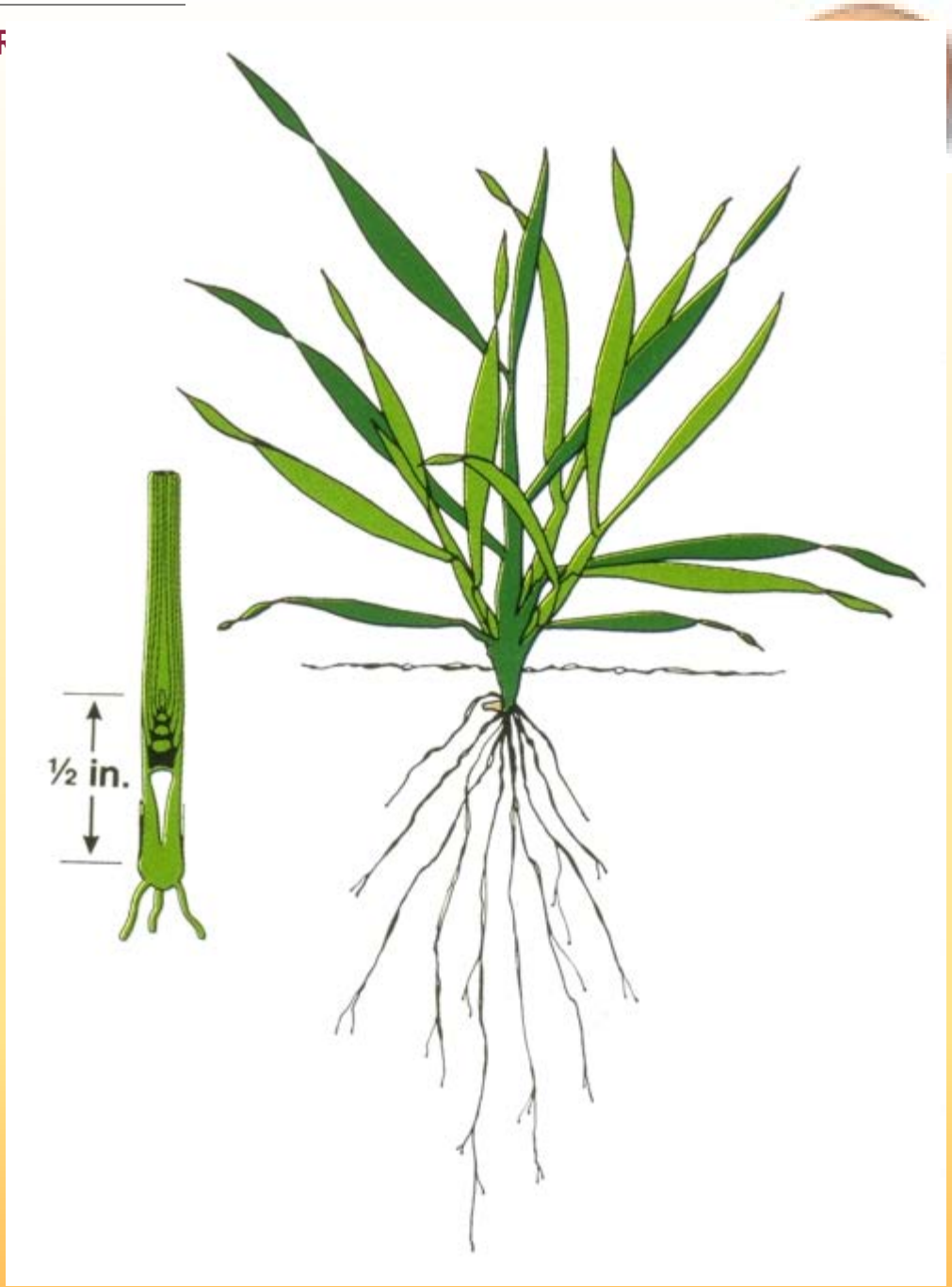
60% N Uptake After GS 30



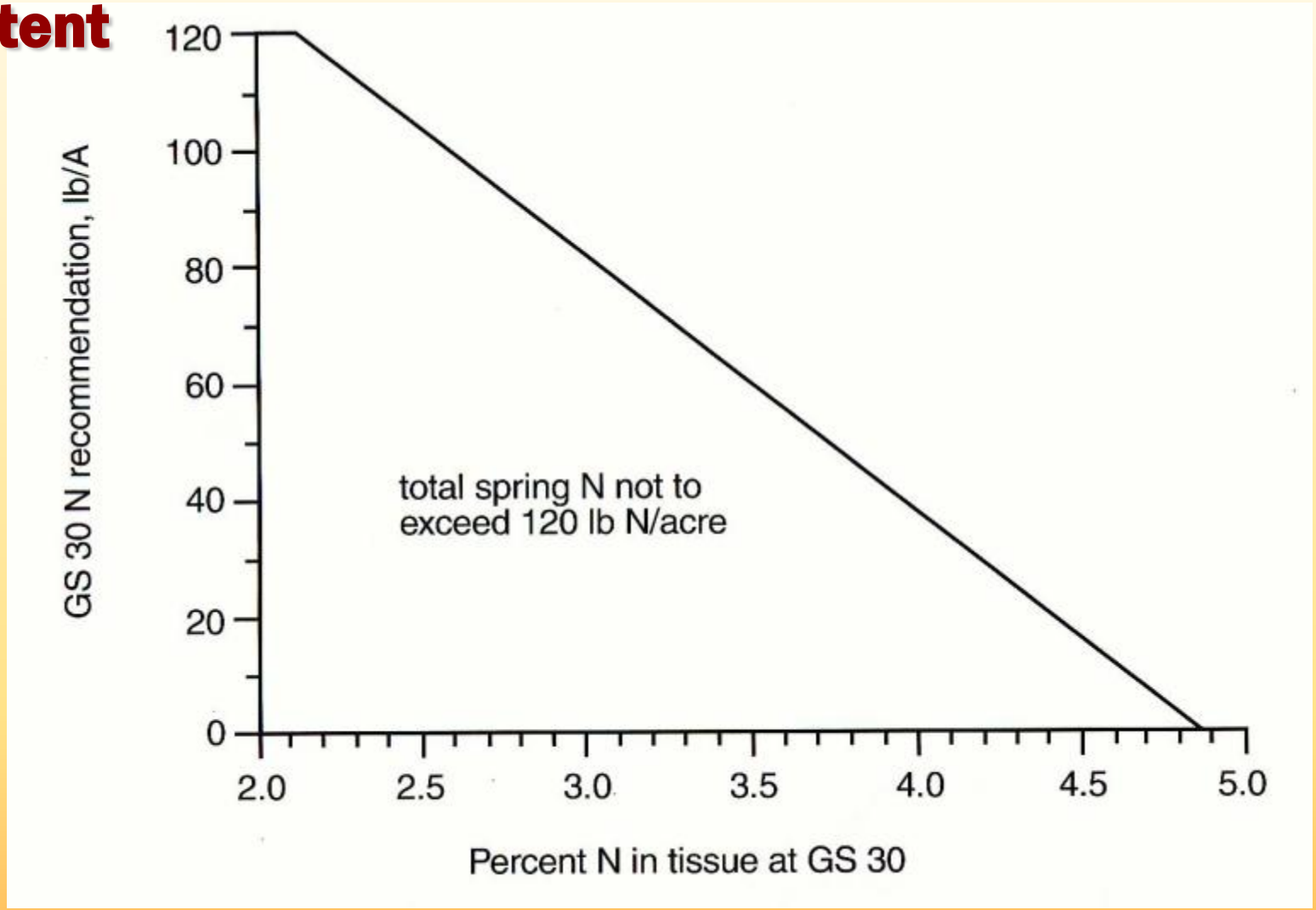
# GS 25 N Rate: Directly Related to Tiller Numbers



# Growth Stage 30
# Just prior to jointing



# GS 30 N Application: Directly Related to Tissue N Content



# Weeds, Insects, and Disease

- Weed Control information
  - Site specific
  - See the VT Pest Management Guide

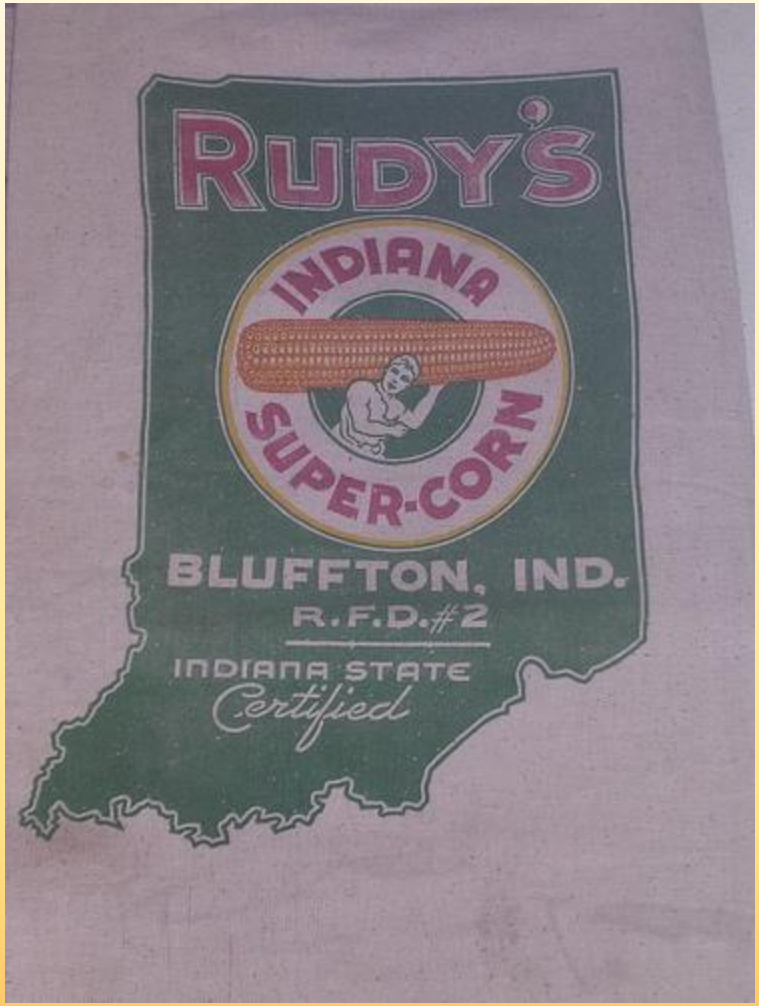
http://pubs.ext.vt.edu/456/456-016/456-016.html


S. Hagood


S. Hagood

# Variety/Hybrid Selection Considerations

- Adaptation
- Performance Data
  - Yield & Test wt.
  - Flowering/Heading
  - Disease resistance
  - Lodging/Standability
- Use Quality Seed



# Hope I've kept your attention!

# Economics of Crop Production

# The Three Components of Profit

- Crop Yield
- Production Cost
- Selling Price Received

# Production Costs

- **Fixed Costs:**
  - Land, Labor, Machinery & Management – Little or no change
- **Variable Costs:**
  - Seed, Chemicals & Fuel –
    - Change little with yield
  - Fertilizer, Harvesting & Drying –
  - Change the most

# Corn Budget – 135 bu/acre yield

- Gross income @ $5.00/bu = $675.00
- Total variable cost = $395.36
- Return above variable cost = $279.64
- Total fixed cost = $114.43
- Total cost = $509.79
- Return to land, management risk = $165.21

# Corn Budget – 90 bu/acre yield

- Gross income @ $5.00/bu = $450.00
- Total variable cost = $370.00
- Return above variable cost = $80.00
- Total fixed cost = $101.48
- Total cost = $471.48
- Returns to land, management Risk = $-21.48

# When to fertilize???

- Fertilize if You'll Get a RETURN on Your Investment

# Response to Fertilizer Depends on:

- Cultural Practices Used
- Soil Productivity
- Soil Test Level
- Method of Fertilizer Application

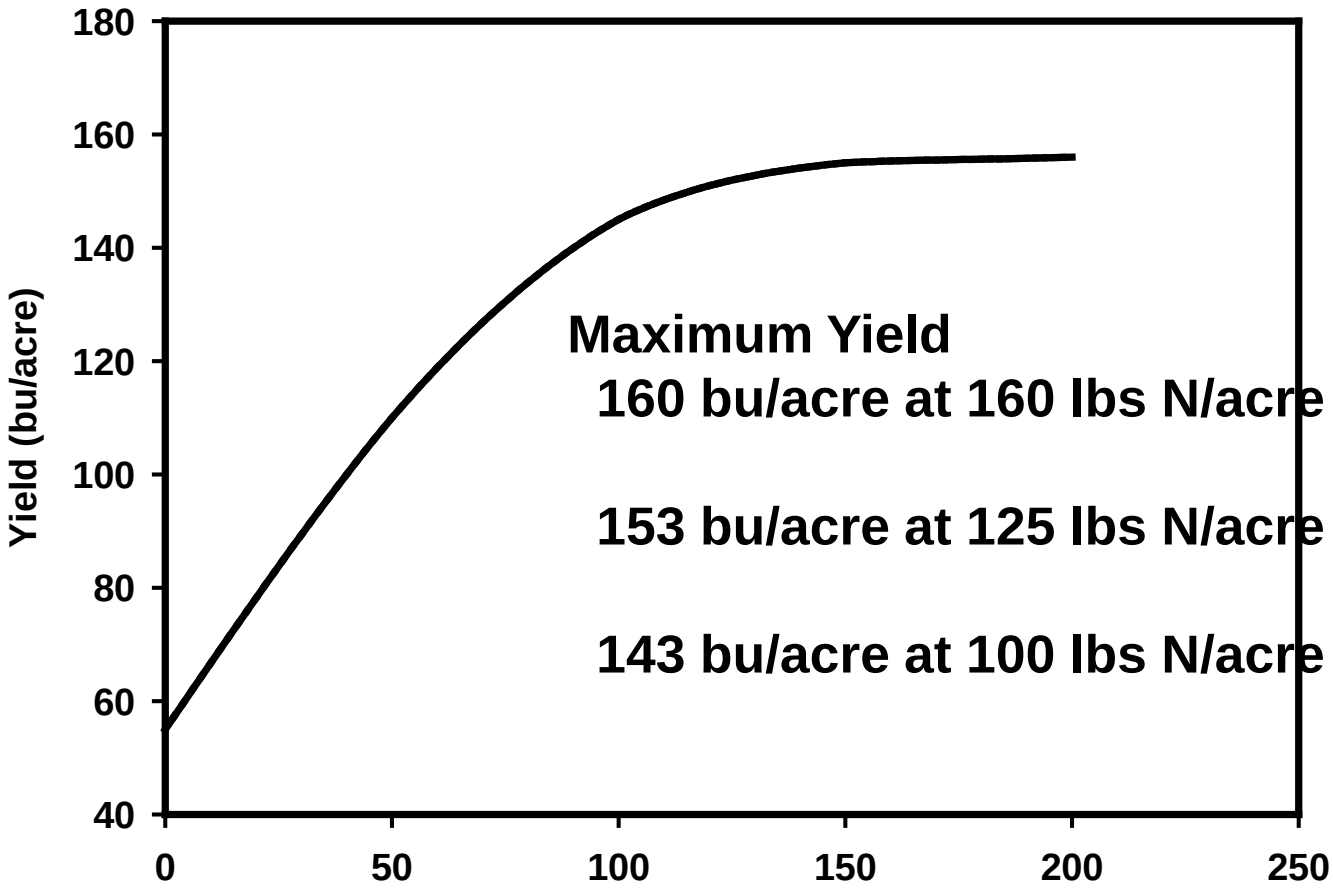
# Corn response to nitrogen, Cecil sandy loam, 5 year average yields

| N Application | Corn Yield |
|---|---|
| lb / acre | bu / acre |
| 0 | 35 |
| 40 | 44 |
| 80 | 50 |
| 120 | 54 |
| 160 | 55 |
| 200 | 56 |
| 240 | 56 |

# Corn response to nitrogen, Congaree silt loam, 5 year average yields

| N Application | Corn Yield |
|---|---|
| lb/acre | bu/acre |
| 0 | 101 |
| 40 | 133 |
| 80 | 157 |
| 120 | 176 |
| 160 | 190 |
| 200 | 198 |
| 240 | 198 |

# Corn Grain Yield Response to N Fertilizer




M.M Alley (2003)

# Fertilize the Most Productive Soils the Heaviest

| Nitrogen Increment | Yield Increase, bu/acre | | |
|---|---|---|---|
| | Cecil | Davidson | Congaree |
| 1st 40 lb | 9 | 45 | 32 |
| 2nd 40 lb | 6 | 20 | 24 |
| 3rd 40 lb | 4 | 10 | 19 |
| 4th 40 lb | 1 | 6 | 14 |
| 5th 40 lb | 1 | 3 | 8 |

# Economic return from 40 lb increments of fertilizer N applied to continuous corn (3-yr average)+

| N rate lb/acre | Yield bu/acre | Value of Yield Inc. | Cost of N Inc. | Return |
|---|---|---|---|---|
| | | ---------- $ ---------- | | |
| 0 | 93 | --- | --- | --- |
| 40 | 115 | 132.00 | 12 | 120.00 |
| 80 | 131 | 96.00 | 12 | 84.00 |
| 120 | 138 | 42.00 | 12 | 30.00 |
| 160 | 144 | 36.00 | 12 | 24.00 |
| 200 | 145 | 6.00 | 12 | -6.00 |

+ Assumes $0.60/lb N and $6.00/bu corn. Source, Bundy (1987)

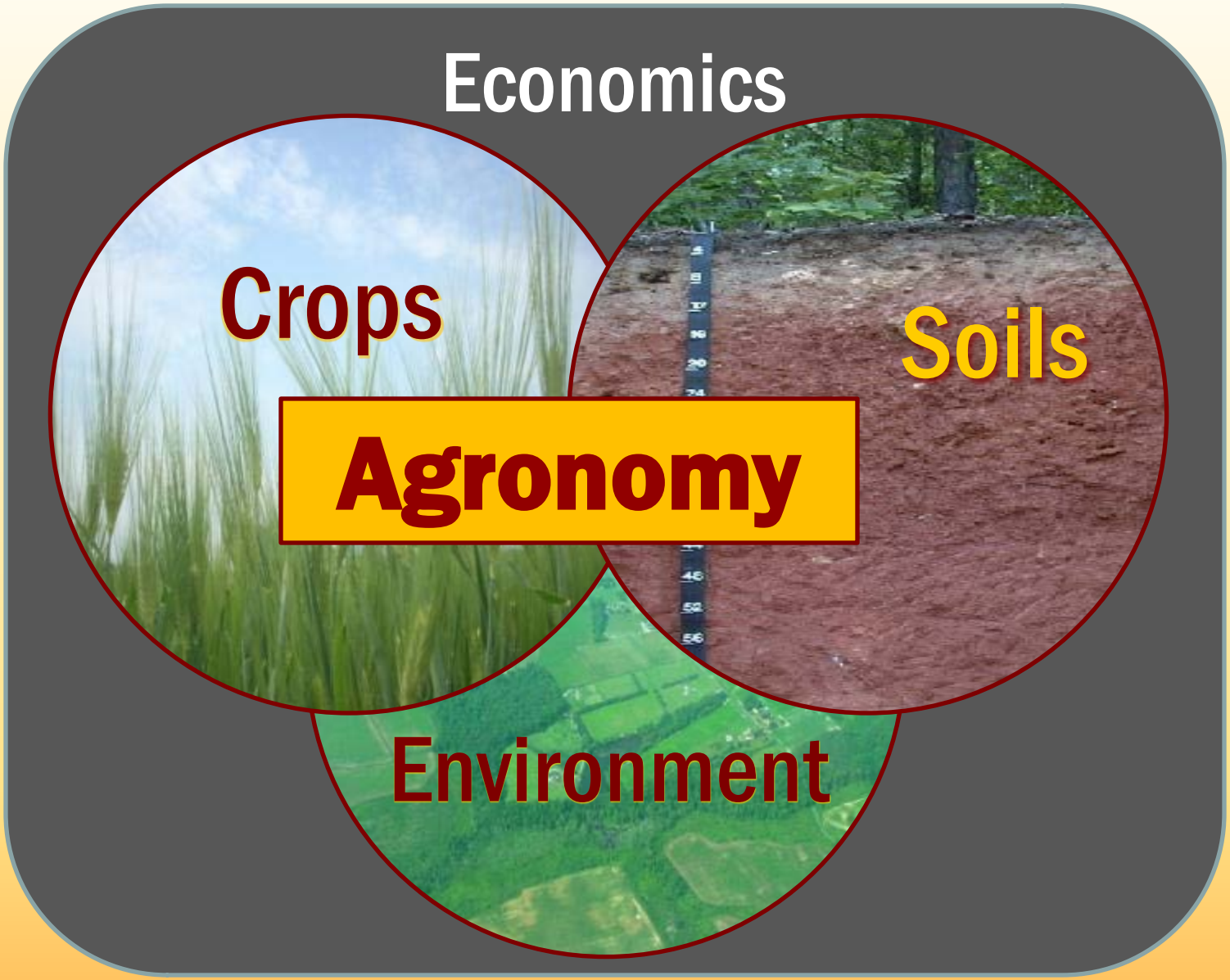
# Economic return from 40 lb increments of fertilizer N applied to continuous corn (3-yr average)+

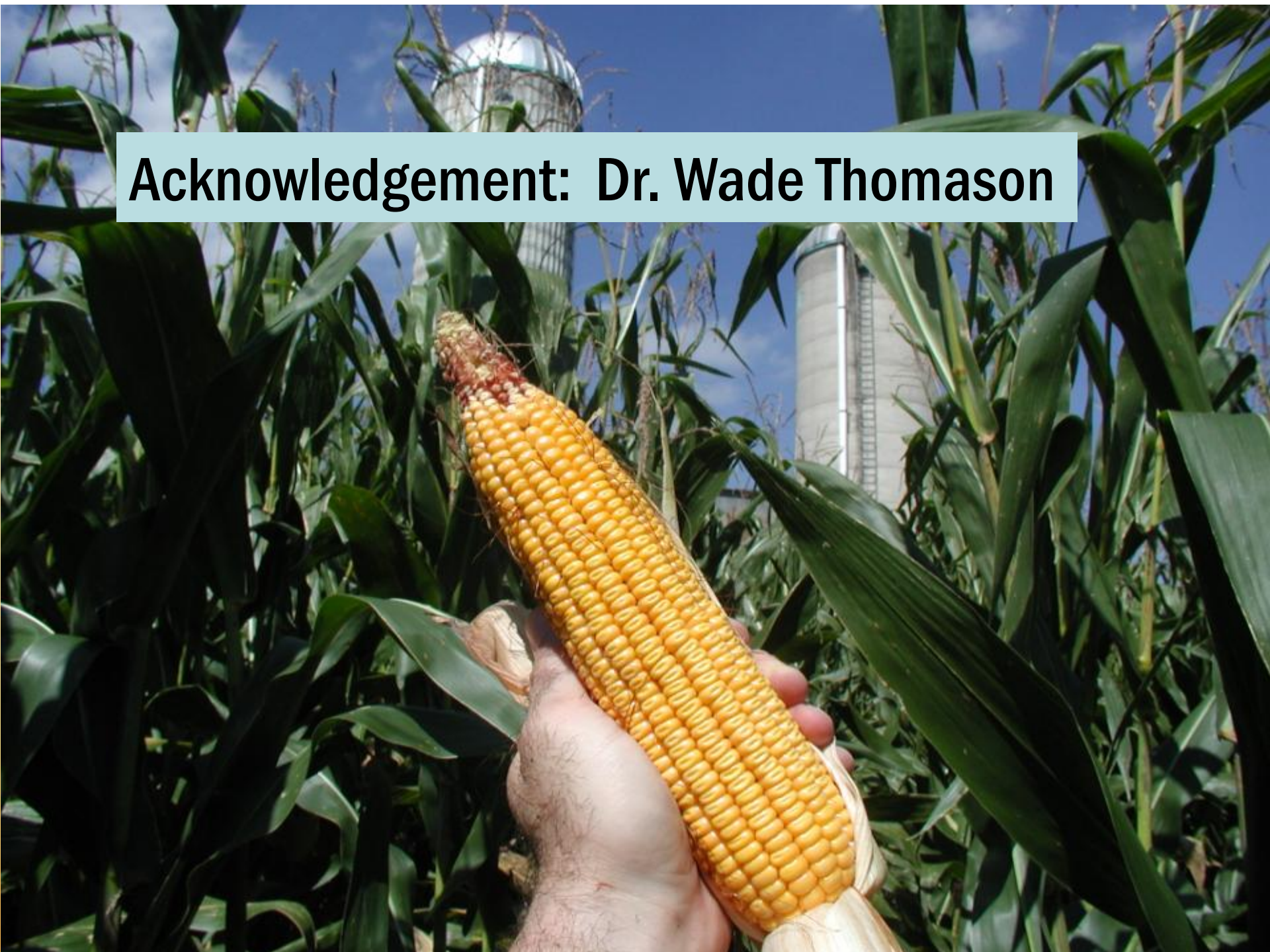
| N rate lb/acre | Yield bu/acre | Value of Yield Inc. | Cost of N Inc. | Return |
|---|---|---|---|---|
| | | ---------- $ ---------- | | |
| 0 | 93 | --- | --- | --- |
| 40 | 115 | 77.00 | 20 | 57.00 |
| 80 | 131 | 56.00 | 20 | 36.00 |
| 120 | 138 | 24.50 | 20 | 4.50 |
| 160 | 144 | 21.00 | 20 | 1.00 |
| 200 | 145 | 3.50 | 20 | -16.50 |

+ Assumes $0.50/lb N and $3.50/bu corn

# Corn response to nitrogen, Davidson clay loam, 5 year average yields

| N Application | Corn Yield |
|---|---|
| lb / acre | bu / acre |
| 0 | 65 |
| 40 | 110 |
| 80 | 130 |
| 120 | 140 |
| 160 | 146 |
| 200 | 149 |
| 240 | 149 |


Economics
Crops
Soils
Agronomy
Environment


Acknowledgement: Dr. Wade Thomason

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