How Prices and Costs Affect IPM

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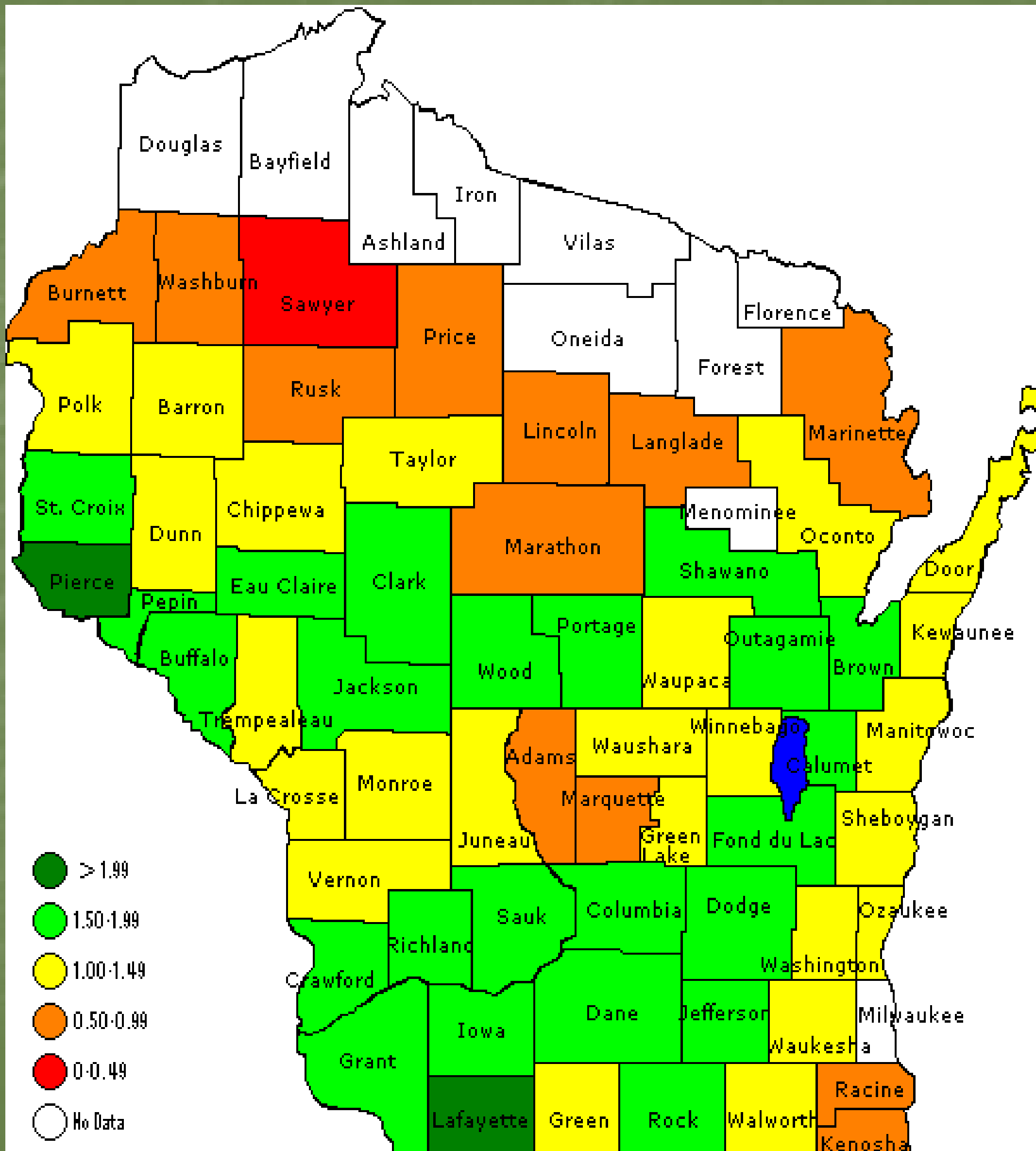
Crop Prices are High

- Closing prices on CBOT Tuesday 1/15
- Dec 08 corn \$5.29/bu
- Nov 08 soybean \$12.85/bu
- Sep 08 wheat \$8.57/bu
- Sep 08 oats \$3.47/bu
- These price drive the image that farmers are rolling in the money

Yields are Increasing

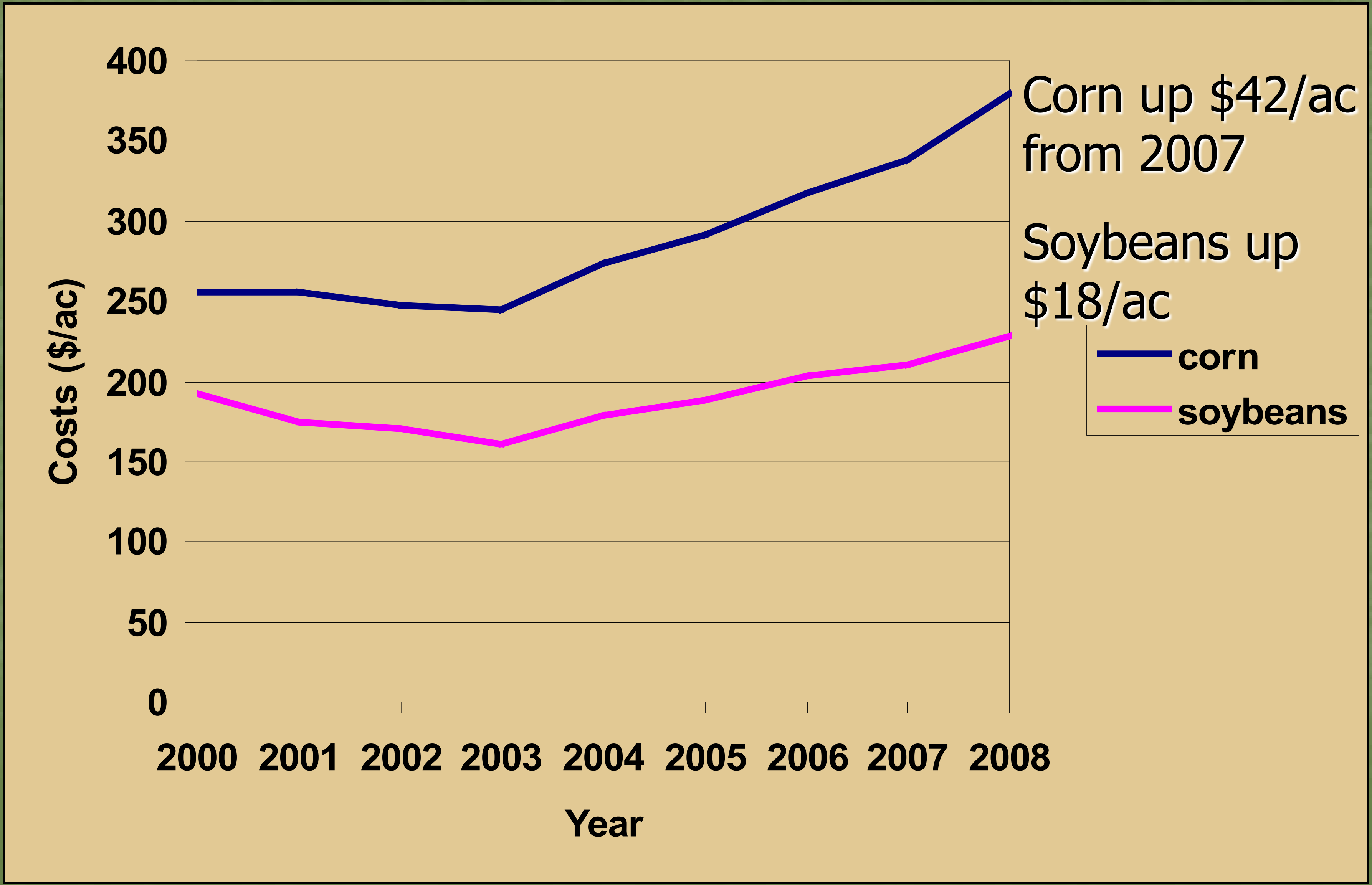


Annual increase (bu/ac) in NASS county average yield for corn from 1977 to 2006, estimated by regression

Input Costs Have Increased

- Fertilizer prices are leading the way
  - Anhydrous and Nitrogen Solutions up about 50% from last year
  - Phosphorus and potassium even more
- Seed prices have risen as well
  - Seed corn up about 15%
  - Depends on the varieties and traits you buy
- Inflationary pressure on remaining inputs driven by energy costs and weak dollar

U of IL non-land costs for corn and soybean production in northern IL



Today’s Questions and Goals

- These cost and price changes affect the value of IPM and thresholds, but how?
- Are they so far from the usual prices and costs that IPM has to catch up?
- Present the theory of IPM and how prices and costs affect thresholds
- Present some empirical results

Economics of IPM: Theory

- Returns without pest control

  $$R_{no} = PY(1 - IDN) - G$$

- Returns with pest control

  $$R_{trt} = PY(1 - IDN(1 - K)) - C - G$$

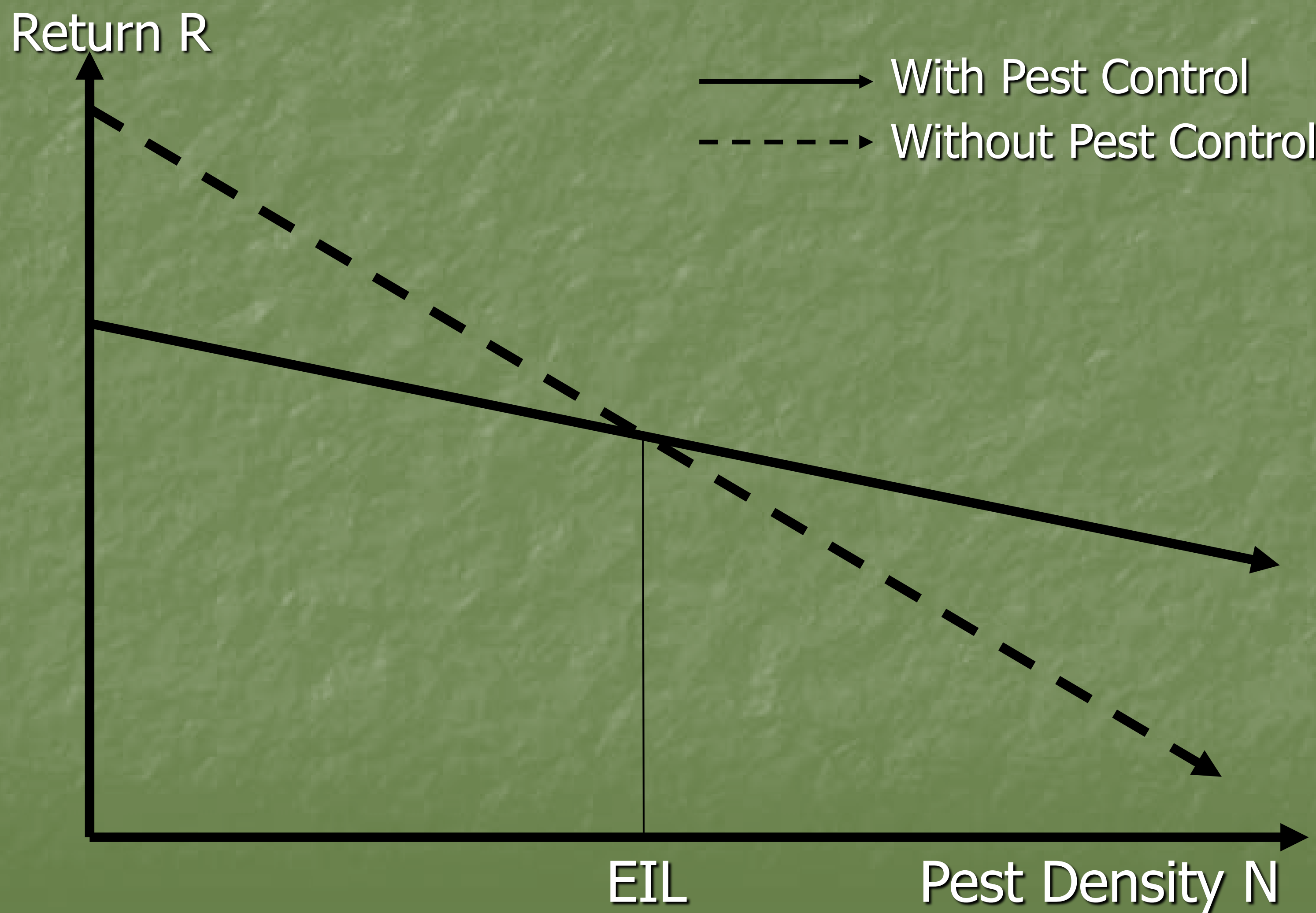
P = crop price Y = crop yield
I = injury per pest (e.g. corn borer tunneling)
D = yield loss per unit injury
N = pest population density
K = pest control efficacy (% kill)
G = cost of productionC = cost of pest control

Economics of IPM: Theory

- IPM observes the pest density N and if it's high enough, recommends treatment
- How high is high enough?
- Find the pest density N where R_{no} equals R_{trt}
  - Set $R_{no} = R_{trt}$ and solve for N
- This N is called the Economic Injury Level (EIL)

$$N = EIL = \frac{C}{PYIDK}$$

Graphical Derivation of EIL



EIL and IPM

- If the observed pest density is less than the EIL, better off not treating
- If the observed pest density exceeds the EIL, then better off treating
- Example: If western crw adult beetles on yellow sticky traps in soybean field exceed threshold, then treat for crw next year

EIL, Prices, and Costs

- Use this equation EIL = C / (PYIDK) to examine effect of prices and costs on IPM
- Notice cost of production G not part of EIL
  - Cost of fertilizer, tillage, etc. do not affect IPM
- Yield (Y) specific to the crop and farmer
- Injury per pest (I) and yield loss per unit of injury (D) are pest specific
- Treatment efficacy (K) specific to the pest control treatment

EIL, Prices, and Costs

- Simplify EIL = C / (PYIDK)
  - Define α = YIDK = number specific to pest, pest treatment, and crop
- EIL becomes EIL = C / (αP), or the ratio of the cost of the pest control treatment (C) over the “adjusted” crop price (αP)
- The α factor adjusts the crop price for the specifics of the pest, the crop, and the pest control technology

The EIL Is Another Price Ratio!!!

- EIL = C / αP is another price ratio
  - N fertilizer rate via N:Corn price ratio
  - Corn plant density via Seed:Corn price ratio
- EIL = Insecticide:Corn price ratio
- EIL = TechFee:Corn price ratio
- Just adjust price ratio for the specifics of the pest, the crop, and the technology (α)

EIL, Prices, and Costs

- If control cost increases 10%, increase EIL 10% and use less pest control
  - $EIL_{new} = (1.1C) / \alpha P = 1.1 \times EIL_{old}$
- If crop price increase 10%, decrease EIL <ins>not quite</ins> 10% and use more pest control
  - $EIL_{new} = C / (\alpha 1.1P) = EIL_{old} / 1.1$
  - $EIL_{old} / 1.1 = 0.909 \times EIL_{old},$ or a 9.1% drop
- If both the cost of control and the crop increase 10%, EIL does not change

Is it really this simple?—Not Quite!

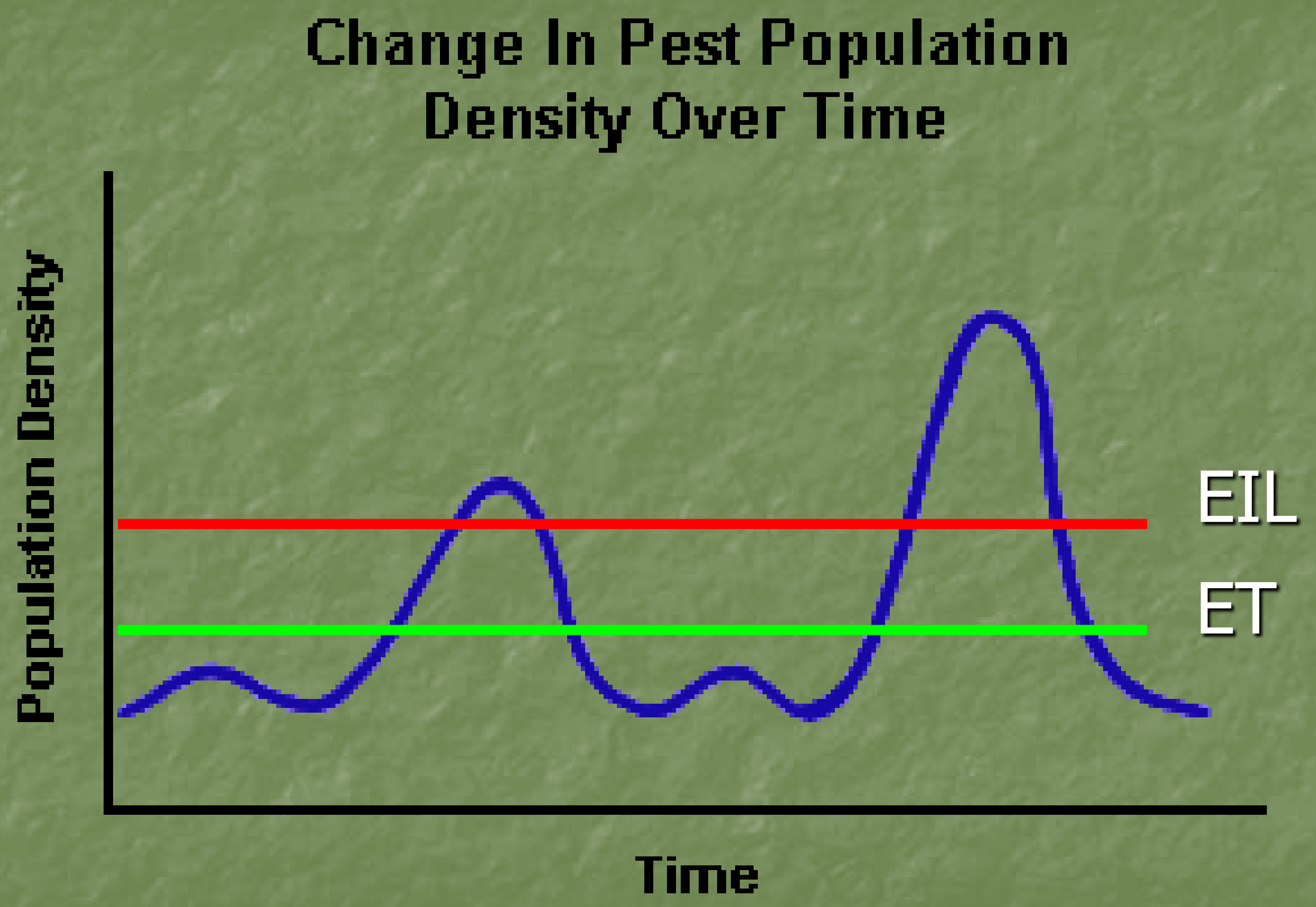
- EIL changes with specifics of the pest, the crop, and the technology (α = YIDK)
  - Pests evolve, hybrids improve, and technologies change
- Returns equations (R_{no} & R_{trt}) usually non-linear, making it difficult to solve for EIL
- Most of these variables are actually random, greatly complicating the analysis

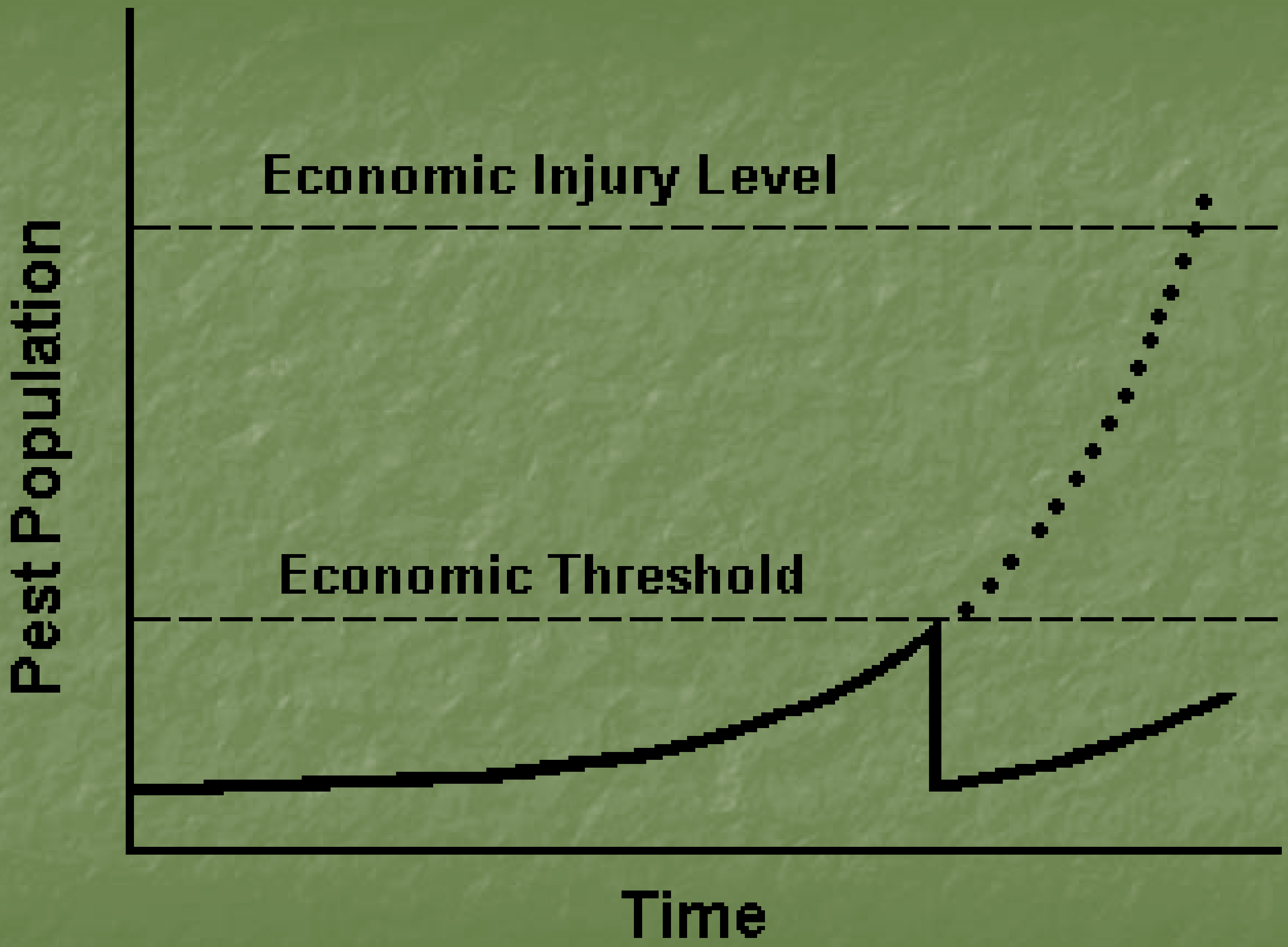
IPM, Prices and Costs: Practice

- Two types of pest control with IPM
- Curative (in-season)
  - Wait to see pest, then decide if/when to treat
  - Foliar sprays for soybean aphids, Colorado potato beetle, leaf hoppers, etc.
- Preventative (pre-season)
  - Apply treatment at planting before see pest
  - Bt corn, soil insecticide, seed treatments and systemic insecticides for CRW, ECB, etc.

IPM, Prices and Costs: Practice

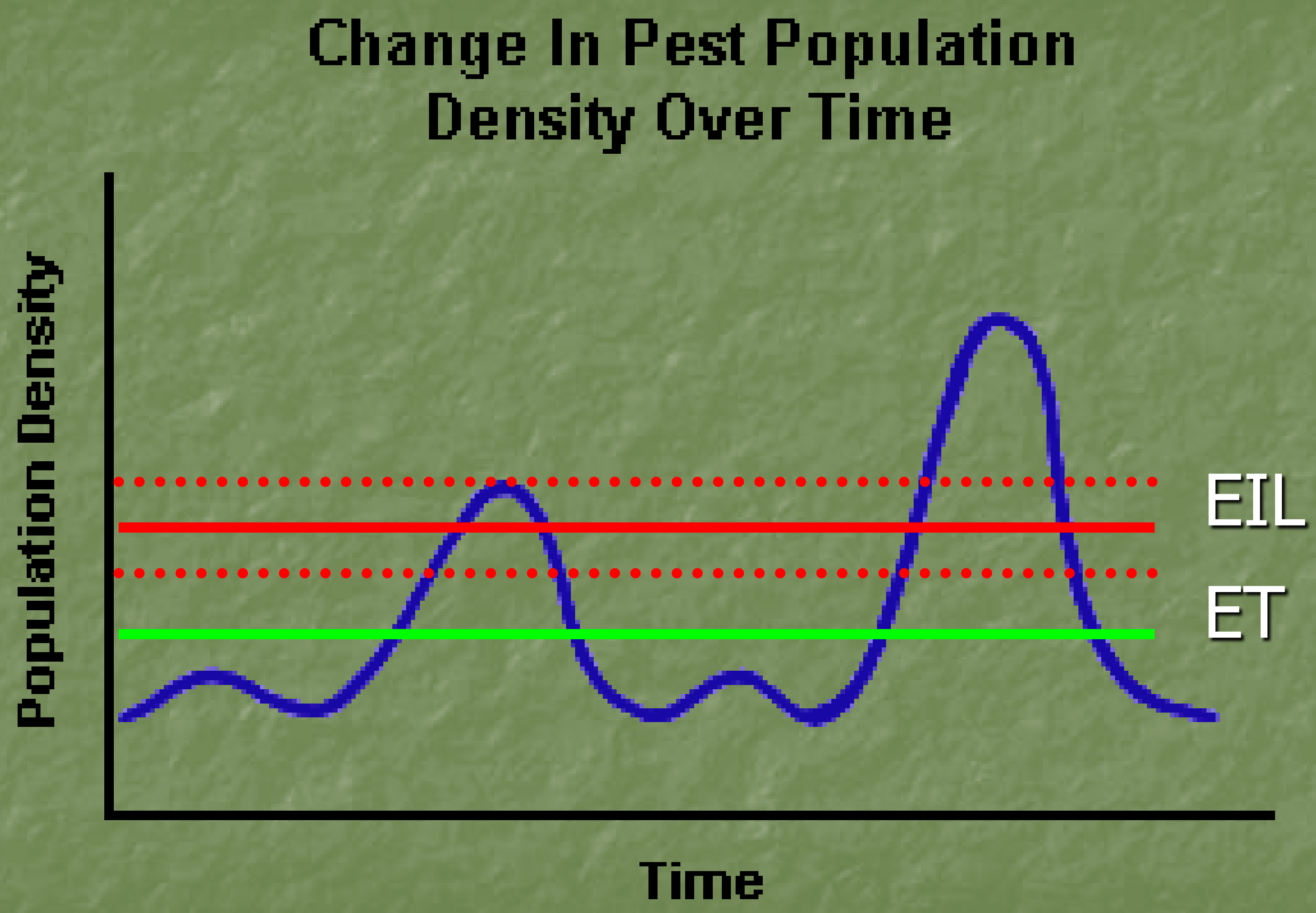
- Curative Control: IPM uses economic threshold (ET), not EIL
  - Dynamic pest population during season
  - If wait until pest at EIL, too late, damage done
  - Time lag to apply treatment
  - Takes time for treatment to work
- Set ET < EIL to adjust for time gap


Change In Pest Population
Density Over Time
Population Density
Time
EIL
ET


Economic Injury Level
Economic Threshold
Pest Population
Time

Economic Threshold (ET) and Prices and Costs

- "Slack" built into curative IPM system
- ET accounts for this, so use ET, despite changes in prices and costs
  - EIL moves around as prices and costs change (plus Y, I, D, and K), but ET stays same
- Update ET when have major changes
  - Soybean aphid ET = 250 aphids/plant
  - 150 bu/ac or $20/bu soybeans


Change In Pest Population
Density Over Time
Population Density
EIL
ET
Time

IPM, Prices and Costs: Practice

- Preventative Control: EIL's respond to price and cost changes
- North Central IPM: Cullen, Mitchell, & Stute
  - Western corn rootworm soybean variant IPM in 1st year corn based on yellow sticky traps in soybean fields the preceding year
  - Deriving EIL's for RW Bt corn, soil insecticides and seed treatments
  - Finding ways to reduce cost of IPM

WCRW Soybean Variant IPM

- Collecting field data and developing economic model of IPM to derive EIL
- Not as simple as plotted before
  - Curved functions, random variables
- Generally supported the 5 BTD EIL
- Then corn prices increased, a lot!

EIL and Corn Price ($19.20/A RW Bt corn Tech Fee)

Mean Yield / Corn Price	150 bu/A	200 bu/A
	EIL (BTD)	EIL (%Δ)
2.00	6.06	3.29 (-46%)
2.50	3.29	2.69 (-18%)
3.00	2.50	2.33 (-7%)
3.50	1.96	1.68 (-14%)
4.00	1.22	0.57 (-53%)
4.50	0.83	0.30 (-64%)
5.00	0	0 (-0%)

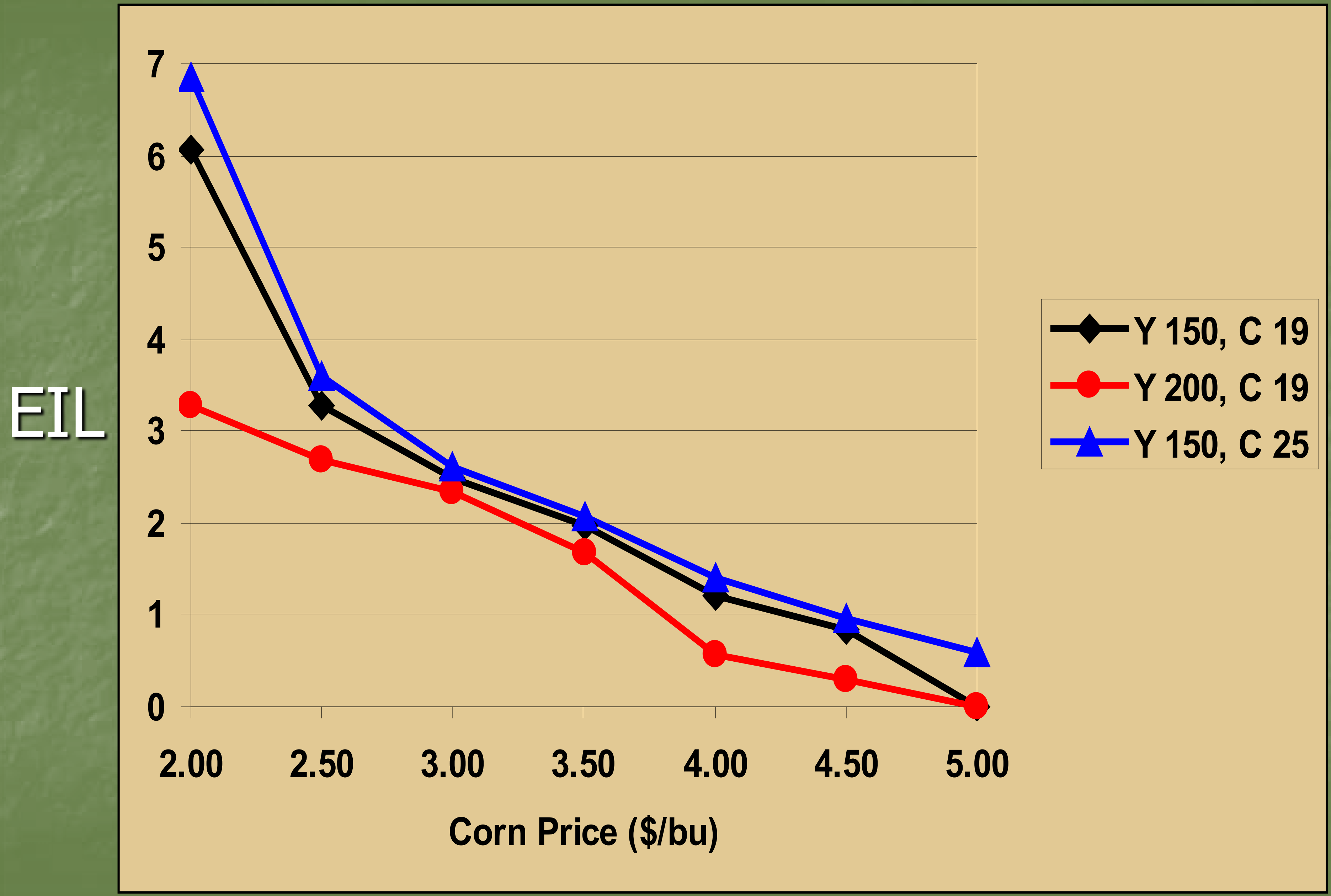
EIL and Corn Price (150 bu/A mean yield)

Tech Fee / Corn Price	$19.20/A	$25.00/A
	EIL (BTD)	EIL (%Δ)
2.00	6.06	6.84 (13%)
2.50	3.29	3.61 (10%)
3.00	2.50	2.62 (5%)
3.50	1.96	2.08 (6%)
4.00	1.22	1.41 (16%)
4.50	0.83	0.95 (14%)
5.00	0	0.60 (--)

EIL and Corn Price (150 bu/A mean yield, $19.20 tech fee)

Corn Price	Price %Δ	EIL %Δ
2.00	-43%	209%
2.50	-29%	68%
3.00	-14%	28%
3.50*	**0%**	**0%**
4.00	14%	-38%
4.50	29%	-58%
5.00	43%	-100%

*$3.50/bu is the base case for %Δ



EIL
7
6
5
4
3
2
1
0
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Corn Price ($/bu)
Y 150, C 19
Y 200, C 19
Y 150, C 25

EIL, Prices, and Costs

- Increasing Cost from \$19.20 to \$25 is a 32% increase in C
  - EIL increases 5% to 16% non-linearly
- Increasing mean yield from 150 to 200 is like a 33% increase in price
  - EIL decreases 7% to 64% non-linearly
- Varying corn price between \$2 to \$5 is plus/minus 43% relative to \$3.50/bu
  - EIL varies +200% to -100%

EIL, Prices, and Costs

- Direction of EIL response is as expected
  - Increasing treatment cost increases EIL so treat less often
  - Increasing crop price (or yield) decreases EIL so treat more often
- Model non-linearity and randomness cause EIL to not respond as neatly as in theory
  - Results are <u>very specific</u> to this pest-crop-control system

Effect of Prices and Costs on IPM

- Curative/in-season economic thresholds
  - Generally not responsive to prices & costs, as the system has built in "slack"
  - Use 250 aphids/plant ET for soybean aphids
- Preventative EIL
  - Respond to prices & costs, but non-linearly
  - Cost increases, raise EIL so treat less
  - Price, Yield, Efficacy increase, lower EIL so treat more
  - If $5/bu corn prices, plant RW Bt corn in variant areas, unless has a very high price