

Western Corn Rootworm Soybean Variant: An Application of Partial Budgeting

University of Wisconsin
Farm and Industry Short Course
December 12, 2006
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Introduction

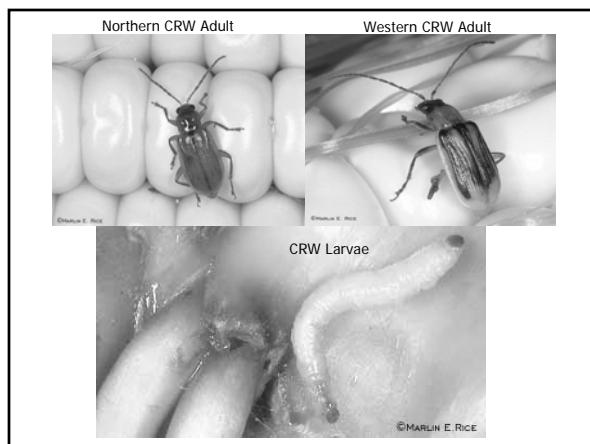
1. Overview of the western corn rootworm soybean variant problem
2. Partial budget analysis of the value of different corn rootworm control methods
3. Goal: to illustrate how I use partial budget analysis in my extension work

Corn Rootworm

- Complex of 4 species: western, northern, southern, and Mexican
- In Wisconsin, the western and the northern are the most problematic species
- Rootworms are the primary insect pest of corn in the U.S.
- About \$1 billion/year in yield loss and \$150-200 million/year in control costs

Rootworm Life Cycle

- Eggs hatch in spring when corn starts to grow and larvae move up to 3 feet to find corn plants
- Larvae feed on roots in spring and summer (100's/plant), then pupate
- Larval feeding causes yield loss from disrupted plant processes, plus increases lodging for additional yield loss
- Adults emerge from soil in late July and all of August, mate, fly around lots, and lay eggs in soil during August and September



Rootworm Control Problems

- Northern and western rootworm larvae generally can only survive on corn roots
- Historically only continuous corn had rootworm problems
- Soil insecticide at plant is a common control method for continuous corn
- Rootworm control is/was a factor behind predominance of corn-soybean rotation
- In 1990's both northern and western corn rootworm developed rotation resistance

Rootworm Rotation Resistance

- Northern corn rootworm extended diapause
 - Eggs hatch after 2 or 3 winters, when corn again planted in field
 - Problem centered along MN-SD-IA border
- Western corn rootworm soybean variant
 - Lays eggs in soybeans (other crops too), so eggs hatch the following year in corn
 - Problem centered along northern IL-IN border, spread quickly into MI and OH and now WI

Current Rootworm Control Options

1. Soil Insecticide
2. Seed Treatments
3. Transgenic Corn (YieldGard Rootworm)

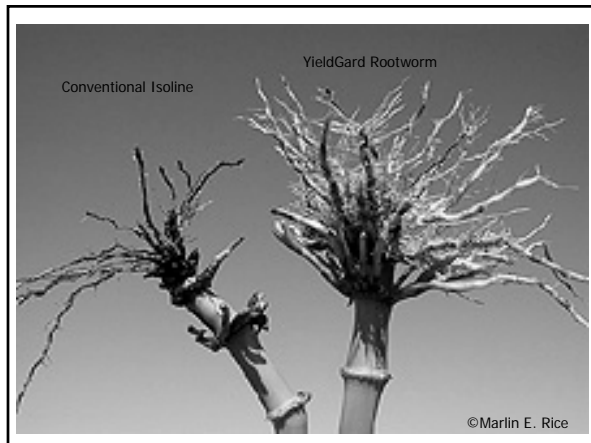
Assessing rootworm damage

Root Ratings: number describing amount of root damage

Assessing rootworm populations

Count adults in corn field (scouting)

Sticky trap counts of adults in soybean field



Why am I doing CRW today?

- Commercial release of YieldGard Rootworm (Bt corn) in 2003
- Confirmation of western corn rootworm soybean variant in southern WI in 2004
- UW-Extension (Cullen, Stute, Mitchell) developing program on the soybean variant for southern WI this December before seed purchase
- My contribution: Economic analysis of the value of different control methods

Partial Budget Analysis of Rootworm Control Methods

- Compare the costs and benefits of each corn rootworm control option
- Focus on costs that change (seed, insecticide), not all costs (tillage, fertilizer)
- Hard part: Determining yield loss without control and yield benefit with each control

Assumptions

- Analyze at the \$/ac level and use a range of assumptions for sensitivity analysis
- Expected yield: low 125 bu/ac, medium 150, high 175 bu/ac
- Corn price: low \$3.00/bu, medium \$3.50/bu, high \$4.00/bu
- Seedcorn: 80,000 seeds/bag

Assumptions

- Planting densities
 - low 30,000, or 2.67 ac/bag
 - medium 33,000, or 2.42 ac/bag
 - high 36,000, or 2.22 ac/bag
- Seed Treatment (Poncho 1250): \$40/bag
 - low \$15.00/ac, medium \$16.50/ac, high \$18.00/ac
- Soil Insecticides: \$16-\$18/ac
 - Force \$18/ac, Aztec \$17.50/ac
 - Capture \$16/ac, Lorsban \$16/ac (or little less)
- YieldGard Rootworm: \$48/bag
 - low \$18.00/ac, medium \$19.80/ac, high \$21.60/ac

Yield Effects

Convert adult sticky trap counts (beetles/trap/day) from Soybean Trapping Network into estimated percent yield loss the following year

Step 1: Use O'Neal et al. (2001) formula to convert beetles/trap/day into estimated root rating (1-6 scale) the following year, assuming no rootworm control used

$$RR_{no} = 1.96 + 0.22 \times (\text{beetles/trap/day})$$

Step 2: Convert RR_{no} into root ratings with each treatment using field trial data

$$RR_{st} = 1 + 0.687 \times (RR_{no} - 1)$$

$$RR_{si} = 1 + 0.432 \times (RR_{no} - 1)$$

$$RR_{bt} = 1 + 0.262 \times (RR_{no} - 1)$$

(Source: author estimated)

Step 3: Convert root ratings into % yield losses using Mitchell, Gray and Steffey (2004) data

$$\%YL_{no} = 0.063 \times (RR_{no} - 1) \times \text{Price} \times \text{Yield}$$

$$\%YL_{st} = 0.063 \times (RR_{st} - 1) \times \text{Price} \times \text{Yield}$$

$$\%YL_{si} = 0.063 \times (RR_{si} - 1) \times \text{Price} \times \text{Yield}$$

$$\%YL_{bt} = 0.063 \times (RR_{bt} - 1) \times \text{Price} \times \text{Yield}$$

(Source: author estimated)

County	Sites	Avg B/T/D
Columbia	5	0.35
Dane	3	0.53
Green	3	0.51
Jefferson	5	2.07
Kenosha	2	2.51
Racine	2	1.81
Rock	10	3.75
Walworth	9	5.04

Results

- Built spreadsheet so can update analysis quickly when make changes
- Show results for three different densities
 - 2.5 Beetles/Trap/Day (Kenosha County)
 - 3.75 Beetles/Trap/Day (Rock County)
 - 5 Beetles/Trap/Day (Walworth County)

Net Benefit (\$/ac) for Each Control Method vs No Control
with different planting densities: 2.5 Beetles/Trap/Day

Yield	Price	Seed Treatment			YieldGard RW			Soil Insecticide	
		Low	Med	High	Low	Med	High	\$16/ac	\$18/ac
125	3.00	-3.83	-5.33	-6.83	8.33	6.53	4.73	20.26	20.26
125	3.50	-1.97	-3.47	-4.97	12.72	10.92	9.12	23.64	23.64
125	4.00	-0.11	-1.61	-3.11	17.10	15.30	13.50	27.02	27.02
150	3.00	-1.60	-3.10	-4.60	13.59	11.79	9.99	24.32	24.32
150	3.50	0.63	-0.87	-2.37	18.86	17.06	15.26	28.37	28.37
150	4.00	2.87	1.37	-0.13	24.12	22.32	20.52	32.42	32.42
175	3.00	0.63	-0.87	-2.37	18.86	17.06	15.26	28.37	28.37
175	3.50	3.24	1.74	0.24	25.00	23.20	21.40	33.10	33.10
175	4.00	5.84	4.34	2.84	31.14	29.34	27.54	37.82	37.82

Net Benefit (\$/ac) for Each Control Method vs No Control
with different planting densities: 3.75 Beetles/Trap/Day

Yield	Price	Seed Treatment			YieldGard RW			Soil Insecticide	
		Low	Med	High	Low	Med	High	\$16/ac	\$18/ac
125	3.00	-1.80	-3.30	-4.80	13.12	11.32	9.52	23.95	23.95
125	3.50	0.40	-1.10	-2.60	18.31	16.51	14.71	27.95	27.95
125	4.00	2.60	1.10	-0.40	23.50	21.70	19.90	31.94	31.94
150	3.00	0.84	-0.66	-2.16	19.35	17.55	15.75	28.74	28.74
150	3.50	3.48	1.98	0.48	25.57	23.77	21.97	33.53	33.53
150	4.00	6.12	4.62	3.12	31.80	30.00	28.20	38.32	38.32
175	3.00	3.48	1.98	0.48	25.57	23.77	21.97	33.53	33.53
175	3.50	6.56	5.06	3.56	32.83	31.03	29.23	39.12	39.12
175	4.00	9.64	8.14	6.64	40.09	38.29	36.49	44.71	44.71

Net Benefit (\$/ac) for Each Control Method vs No Control
with different planting densities: 5.0 Beetles/Trap/Day

Yield	Price	Seed Treatment			YieldGard RW			Soil Insecticide	
		Low	Med	High	Low	Med	High	\$16/ac	\$18/ac
125	3.00	0.23	-1.27	-2.77	17.92	16.12	14.32	27.64	27.64
125	3.50	2.77	1.27	-0.23	23.90	22.10	20.30	32.25	32.25
125	4.00	5.31	3.81	2.31	29.89	28.09	26.29	36.86	36.86
150	3.00	3.28	1.78	0.28	25.10	23.30	21.50	33.17	33.17
150	3.50	6.33	4.83	3.33	32.28	30.48	28.68	38.70	38.70
150	4.00	9.37	7.87	6.37	39.47	37.67	35.87	44.23	44.23
175	3.00	6.33	4.83	3.33	32.28	30.48	28.68	38.70	38.70
175	3.50	9.88	8.38	6.88	40.66	38.86	37.06	45.15	45.15
175	4.00	13.43	11.93	10.43	49.04	47.24	45.44	51.60	51.60

Main Point

- Seed treatments generally do not create enough benefits to justify their costs
- Cost of soil insecticide or YieldGard RW generally justified in Walworth and eastern/southeastern Rock County, especially for fields with high average yields and/or high price
- Remember: 5% benefit is worth much more in a good year than in a bad year

What's missing from this analysis?

1. Cost of lodging and benefit for control
2. Cost of refuge for YieldGard RW
3. Non-financial costs of soil insecticides and associated non-financial benefits of YieldGard RW and seed treatments
4. Uncertainty: random yield, price and corn rootworm damage