Crop Choice, Non-Target Pest Levels, Yield Loss and Their Effect on Insecticide Use in South Dakota

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Introduction

The rapid adoption of genetically modified (GM) crops in South Dakota prompted us to examine changes in pest management practices over time. GM adoption has been linked to decreased need for pesticides (Cornejo 2005, Vialou 2008). Surprisingly, as Figure 1 indicates, South Dakota has experienced an increase in the proportion of acres treated with insecticide over the past two decades leading to an investigation of why this has occurred. Figure 2 is an extension of this information, showing the location of the outliers visible in Figure 1. The outliers represent counties that are spraying an unusually high percentage of their acres. These counties tend to be clustered, especially in 2002 and 1987. Seemingly, counties with widespread insecticide use remain in the south-east portion of the state. One outlier, Shannon county in 2007, represents a county will very few acres planted with crops, thus easily achieving a high proportion of planted acres treated with insecticide.

Figure 2. Indicates the location of the outliers by year, visible in Figure 1.

Due to data limitations the answers to many of our questions could not be addressed directly. There is limited information about GM adoption and pest infestation in South Dakota so the following research uses the proportion of different crops planted as a way to identify general trends in insecticide use.

Objectives

1) Investigate the main causes of the increase in acres treated with insecticide
2) Establish whether there is a link between the type of crop planted and acres treated with insecticide
3) Determine whether there is a relationship between yield loss and acres treated with insecticide

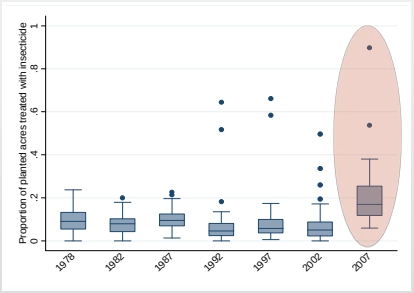


Figure 1. Proportion of planted acres that were treated with insecticide. This is the dependent variable is the regression analysis discussed below.

Conclusions

Because of data limitations the full extent of the relationship between the type of crops planted and the impact on insecticide use is not fully known. The results of this analysis lend themselves to a series of stylized facts, which taken together tell the story of insecticide use in South Dakota.

The number of acres planted with corn has increased
Several factors have contributed to the increase in acres of corn planted in South Dakota. Over time, the development of corn varieties that were better suited to South Dakota's shorter growing season led to a gradual increase in corn production. This, though, was compounded by the ethanol boom, which might account for much of the increase in corn production shown in 2002 and 2007.

The number of acres planted with soybeans has decreased in 2007
By 2007 the soybean aphid had infested all soybean producing counties in South Dakota (Catangui). This combined with a high demand for corn may have contributed to the decrease in soybean acres planted in 2007.

Adoption of GMO varieties has increased dramatically
Given South Dakota's high levels of GMO adoption one would expect that insecticide use would decrease over time. The results from the regression suggest that corn has contributed to the overall increase in insecticide use. The reasons for this will be the subject for future study.

The proportion of acres treated with insecticide has increased
Our analysis suggests that there are three variables that significantly increase insecticide use, corn and hay acres planted and the presence of the soybean aphid. Overall, hay acres have been decreasing over the years, so this is unlikely to account for the large upswing in acres treated in 2007. The largest contributor, the variable with the largest coefficient, is the presence of the soybean aphid while corn has a slightly lower impact on acres treated.

Methodology and Data

To ascertain the effect of different variables on insecticide use for all counties in South Dakota, a fixed effects model was employed. A fixed-effect model is often used on non-experimental data, where a scientific control group is not available or possible, treating each observation as its own control (Allison, 1). This model also accounts for time-invariant unobserved effects that are not captured with available data (Wooldridge, 461).

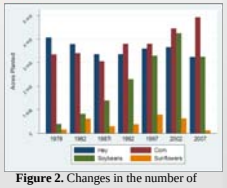
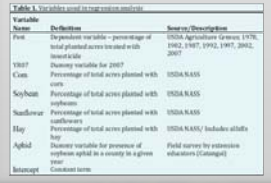


Figure 2. Changes in the number of acres that are planted with various crops.

Eqtn 1. $$Y_{it} = \delta_1 + \delta_2 YR07_{2it} + \delta_3 Aphid_{3it} + \beta_1 Corn_{1it} + \beta_2 Soybean_{2it} + \beta_3 Sunflower_{3it} + \beta_4 Hay_{3it} + \alpha_i + U_{it}$$

Eqtn 2. $$Y_{it} = \delta_1 + \delta_2 YR07_{2it} + \delta_3 Aphid_{3it} + \beta_1 Corn_{1it} + \beta_2 Soybean_{2it} + \beta_3 Sunflower_{3it} + \beta_4 Hay_{3it} + \beta_4 Corn * 07_{4i} + \beta_5 Soybean * 07_{5i} \alpha_i + \beta_6 Sunflower * 07_{6i} + \beta_7 Hay * 07_{6i} + U_{it}$$

For the i county in the t year.



Two regressions are presented in this paper. The first uses all of the variables listed in Table 1, notice the presence of only a dummy variable for 2007 (see Eqtn 1). The second regression includes interaction terms all variables interacted with the 2007 dummy variable.

Results

The following display highlights some unexpected results from the regression analysis. Initially the model included yield loss variables, but because of lack of significance the variables were dropped. This will be an avenue for future research.

Overall, the regression results indicate that the type of crop matters when looking at acres treated with insecticide. Corn and hay were positive and significant, meaning the larger the proportion of these crop planted within a county the larger the proportion of acres treated with insecticide. The soybean variable was negative, but when the aphid is considered there may be a positive affect on acres treated when soybeans and aphids are both present in a county. Also, there is a statistical difference between 2007 and all other years. Because of this, a second regression was completed that included interaction terms.

Table 2. Results from panel regression

Variable	Coefficient	Robust standard error	t-statistic
Yr07	0.0822	0.0139	5.93***
Corn	0.2592	0.0847	3.06***
Soybean	-0.1208	0.5416	-2.23**
Sunflower	0.0522	0.0731	0.71
Hay	0.2286	0.0834	2.74***
Aphid	0.0325	0.0174	1.87*
Intercept	-0.0245	0.0327	-0.75
Overall model	F = 21.32	P = .0000	R^2 =0.3538

***significant at 1% level
**significant at 5% level
*significant at 10% level

Corn
Is highly significant and positive. This result was not expected given South Dakota's high GMO adoption.

Soybean
Anecdotal evidence suggests that soybean are sprayed intensely. The results suggest soybeans have a negative impact on the proportion of acres treated.

Aphid
The aphid variable shows that when the aphid is present in a county the proportion of acres sprayed increases.

Significant 2007 interaction terms:

Hay Sunflower Corn

Table 3. Results from panel regression analysis with interaction terms

Variable	Coefficient	Robust standard error	t-statistic
Corn	0.2168	0.0928	2.34**
Soybean	-0.0961	0.0504	-1.91*
Sunflower	-0.0124	0.0734	-0.17
Hay	0.2002	0.0806	2.84**
Corn*07	0.2546	0.0992	2.57***
Soybean*07	-0.0020	0.1277	-0.01
Sunflower*07	0.4392	0.1498	2.93***
Hay*07	0.1053	0.0287	3.66***
Intercept	-0.007	0.0320	-0.23
Overall Model	F= 26.43	Prob= 0.000	R^2= 0.364

***significant at 1% level
**significant at 5% level
*significant at 10% level

Using interaction terms, the variables were analyzed further to focus on the cause of the increase in 2007. The results suggest that corn, sunflower and hay all contributed to the increase in the proportion of acres planted. These results are displayed in Table 3. Soybean acres planted in 2007 do not seem to be correlated with the increase in the proportion of acres treated with insecticide, though overall soybeans remain significant and negative.

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Acknowledgments

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For further information

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