Effective Conventional to Organic Transitioning Treatment Methods for Maximum Crop Yield

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Background:

Economic growth rates within the field of agriculture has exploded throughout the general population (Dimitri, 2002; Greene, 2013; Greene, 2014). Growth in this market is pushing for improved production methods. One of these areas includes organic, rather than conventional, farming techniques. While studies show that organic production permits higher crop yield per acre, many farmers fear that the transition from conventional to organic would not be worth it due to the possibility for monetary loss during the three years between cutting out chemicals and having their crops certified to be sold for higher organic prices (Delante et al, 2003; Chase, Delate, & Johann, 2009; ERS-USDA, 2003). The goal of this study was to determine an effective treatment method for transitioning from conventional to organic farmland. To determine this, we analyzed six years worth of crop yield variables collected from controlled farmland plots at the North Carolina Department of Agriculture Cherry Farm Research Facility in Goldsboro, NC, under six different treatments: conventional throughout all six years; fertilizer, herbicide, and pesticide removal for all six years; fertilizer removal for the first two years, followed by herbicide and pesticide removal for the remaining years; herbicide removal for the first two years, followed by fertilizer and pesticide removal for the remaining years; pesticide removal for the first two years, followed by herbicide and fertilizer removal for the remaining years; and a gradual reduction of fertilizers, pesticides, and herbicides over the first two years and then complete elimination in the remaining years. Upon accounting for much of the variation that occurs naturally within agricultural systems, trends reveal themselves and suggest a deep relationship between crop yield, time, and agricultural treatment method.

References:

- Chase, C., Delate, K. & Johann, A. (2009). *Making the transition from conventional to organic: Iowa state university extension and outreach.* Retrieved 1/29, 2015.
- Delate, K., Duffy, M., Chase, C., Holste, A., Friedrich, H., & Wantate, N. (2003). An economic comparison of organic and conventional grain crops in a long-term agroecological research (LTAR) site in iowa. *American Journal of Alternative Agriculture, 18*(1), 59.
- Dimitri, C. (2002). In United States. Department of Agriculture. Economic Research Service (Ed.), *Recent growth patterns in the U.S. organic foods market*. Washington, DC: U.S. Dept. of Agriculture, Economic Research Service.
- Economic Research Service - USDA. (2003). *Economics of organic production.* Retrieved 1/29, 2015.
- Greene, C. (2013). *Growth patterns in the US organic industry (amber waves - USDA).* Retrieved 1/29, 2015
- Greene, C. (2014). *Organic market overview (ERS - USDA).* Retrieved 1/29, 2015.

Procedures and Results:

The first step towards determining the most effective treatment method required sorting through the recorded crop yield variables to find those that would be the most effective for further analyses. This was conducted by analyzing the scatter plots, histograms, and correlation values between all of the crop yield variables: soybean yield, jumbo sweet potato yield, one sweet potato yield, canner sweet potato yield, biomass sweet potato yield, wheat grain yield, wheat straw yield, cabbage yield, and cabbage average head weight. Upon analyzing their relative normalities and significant ($p<0.05$) correlations amongst each other, soybean yield, biomass sweet potato yield, wheat grain yield, and cabbage yield were selected as the most useful crops variables. These data were then parsed into categories, relative to the round of crop production they were in; the crops classified as conventional were separated from those considered organic. The scatter plots, histograms, and correlations of these newly parsed crop yield variables are displayed in Figure 1.

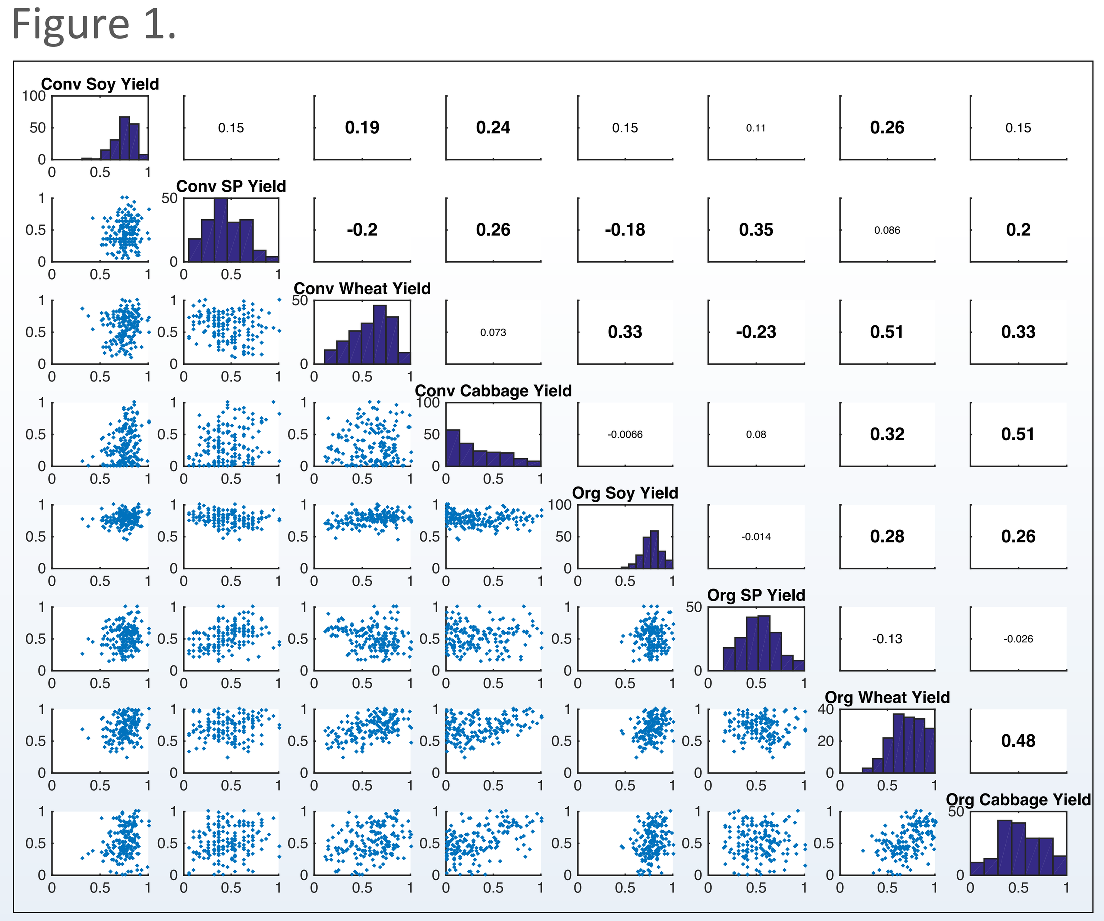

Figure 1

At this point in the analysis, the data were parsed into two categories: the round of organic transitioning period, and the specific crop grown and measured. To simplify this, the crop yield values from the conventional period were added together to create an additive conventional crop yield variable, and the crop yield values from the organic period were added together to create an additive organic crop yield variable. Combining the variables generally requires the acceptance of five assumptions:

1. *There must be multiple continuous variables.* Figure 1 revealed this to be true.
2. *There must be linear relationships between the variables.* Significant correlations between these variables, shown in Figure 1, confirmed this.
3. *The sample sizes must be large*. The data analyzed included 180 points of measurement from which yield and other dependent variable data were collected.
4. *The variables must have adequate sphericity. In other words, the variances of the combined groups should not be significantly different*. This was tested using Mauchly's test for sphericity and ultimately revealed that the data significantly ($p<0.05$) low sphericity. Despite the numerical violation of this assumption, the analyses were continued due to the relatively similar distributions of the variables displayed in Figure 1.
5. *The variables should not have any significant outliers.* Soybean yield was the only variable with significant outliers, but they were acceptance as if they were not there, as to conserve variance.

After addressing all of the assumptions, the additive crop yield values were created.

The next step for analysis involved confirming that the round of crop production had a significant affect on the additive crop yield. This was tested using a repeated measures regression model of Crop Yield ~ Treatment. The significant p-value ($p<0.05$) for the model's intercept implies that time has a significant effect on additive crop yield, but the high p-value for the treatment's interaction with the round of crop production revealed that time did not significantly affect the treatment, as expected. This suggested that a significant, unaccounted for variable attributes to a difference in variance between the two rounds of crop production.

In order to determine the discover the identity of these varying affects on additive crop production, additive crop production was analyzed separately using ANOVA, depending on whether the crops were in the conventional stage or organic stage. The affects of the different treatments were analyzed using dummy variables (represented as D1 through D6). The models and their outputs are included in Figure 2.

Model	Outcomes
AdditiveOrganic~D2+D3+D4+D5+D6	D1 is sig different from D4 and D5
AdditiveOrganic~D1+D3+D4+D5+D6	n/a
AdditiveOrganic~D1+D2+D4+D5+D6	n/a
AdditiveOrganic~D1+D2+D3+D5+D6	D4 is sig different from D1
AdditiveOrganic~D1+D2+D3+D4+D6	D5 is sig different from D1
AdditiveOrganic~D1+D2+D3+D4+D5	n/a
AdditiveConventional~D2+D3+D4+D5+D6	n/a
AdditiveConventional~D1+D3+D4+D5+D6	D2 is sig different from D3
AdditiveConventional~D1+D2+D4+D5+D6	D3 is sig different from D2 and D4
AdditiveConventional~D1+D2+D3+D5+D6	D4 is sig different from D3
AdditiveConventional~D1+D2+D3+D4+D6	n/a
AdditiveConventional~D1+D2+D3+D4+D5	n/a

Figure 2

Figure 2 can be summarized as follows: the conventional treatment had a significantly different affect on organic additive crop yield than the treatments that immediately eliminated herbicides and pesticides (1.242 and 1.213 times more, respectively). Simultaneously, the treatment that immediately eliminated fertilizers had a significantly different affect on conventional additive crop yield than the organic treatment and the treatment eliminating herbicides (1.254 and 1.320 time more, respectively). Boxplots in Figure 3 display the distributions of the additive crop yields specific to the relative treatment.

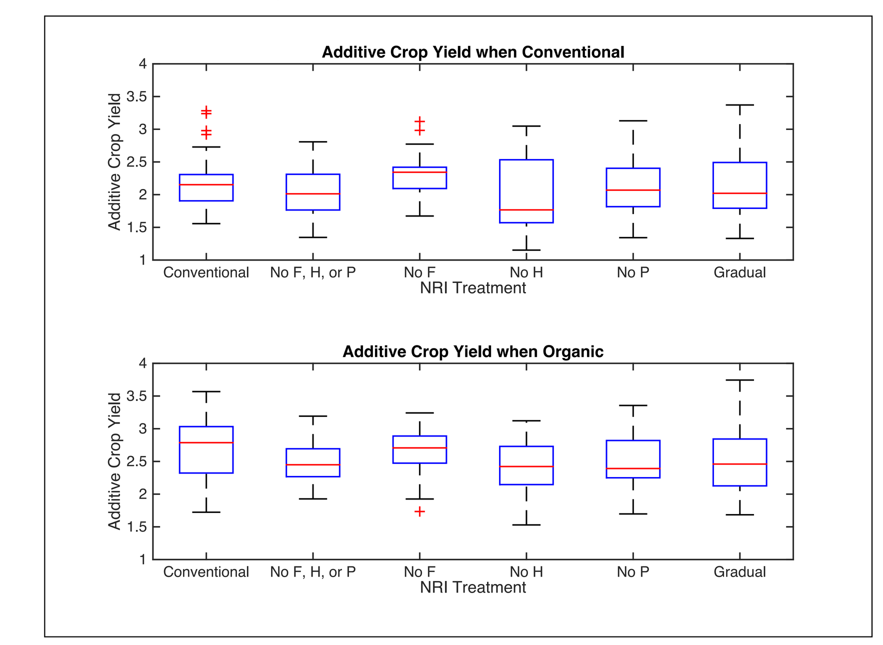

Figure 3

Conclusion:

The findings explained thus far imply that different treatment variables have different affects on the additive crop yield before and after that the fields become certified organic. Much more statistical analyses have been conducted past the data discussed here, but their interpretations need further confirmation. These further analyses will need to be accounted for later on to ensure that much of the statistical variation is accounted for.

SOUTHERN SARE Sustainable Agriculture Research & Education

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