PERCEIVED LINT YIELD INCREASES FROM VARIABLE RATE INPUT APPLICATION

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Abstract

Adoption of precision farming depends on improved lint revenue and/or reduced input cost relative to the cost of adoption. Limited information is available about whether farmers perceive lint yield increases. Understanding how farmers' perceptions about how variable rate input application affects lint yield may inform consultants, Extension, and others on how to advise cotton farmers when making decisions about precision farming adoption. The objective of this research was to examine farmers' perceptions of lint yield increases following variable rate input application of inputs. Data were obtained from a survey of cotton farmers in 11 southern states in which farmers were asked about their perceptions of lint yield increases following variable rate input application. Tobit regression was used to analyze their perceptions. Results suggest that farmers who used variable rate technology to apply growth regulators, insecticides, or fertilizers perceived lint yield increases of 45 kg ha^{-1}, 74 kg ha^{-1}, and 52 kg ha^{-1} more than those who did not. Farmers who variable rate applied fungicides perceived yield increases of 36 kg ha^{-1} less than others. Farmers who were optimistic about the future profitability of precision farming perceived lint yield increases of 24 kg ha^{-1} more than others.

Introduction

Adoption of precision farming is driven by cotton farmers' perceptions about the effectiveness of precision technologies in improving lint yields and reducing input costs, relative to the cost of adoption. Precision farming may increase profit through increased yield or reduced input use. It is a management practice that relies on spatial information technologies to aid in decisions relating to crop production, including variable rate input application to improve efficiency if the spatial information indicates inefficiencies in uniform rate application. Studies comparing uniform rate with variable rate fertilization found that variable rate application of nitrogen (e.g., Bronson et al., 2006; Khosla et al., 2002; Koch et al., 2004; Thrikawala et al., 1999; Wang et al., 2003; Yang, Everitt, and Bradford, 2001), phosphorus (e.g., Wittry and Mallarino, 2004), and lime (Bongiovanni and Lowenberg-Deboer, 2000; Wang et al., 2003) may lead to yield increases or decreases in total inputs applied. However, limited information is available regarding how farmers' perceptions of lint yield increases are influenced by use of precision technologies. Understanding these relationships may inform consultants, Extension, and those who advise them about the factors affecting cotton farmers' perceptions about increases in lint yield resulting from variable rate input application.

Objective

This research examines farmers' perceptions of lint yield increases, given their use of variable rate input application.

Methods and Procedures

Data

Data were obtained from a survey of cotton farmers in 11 southern states (Cochran et al., 2006). Farmers were asked about their perceptions of lint yield increases (kg ha^{-1}) following variable rate input application. Questionnaires were mailed to 12,043 cotton farmers in January and February 2005. A total of 1,215 cotton farmers responded (10% response rate). After discarding responses with missing data, the sample included 827 observations. Of these, 93 respondents provided perceived lint yield increases resulting from variable rate input application.

Econometric Methods

Tobit regression was used to analyze farmer perceptions of lint yield increases (PY) as a limited dependent variable. The model for PY was specified as (Greene, 2003),

(1) $PY_i = \beta' x_i + \varepsilon_i$, if $\beta' x_i + \varepsilon_i > 0$, and $PY_i = 0$, if $\beta' x_i + \varepsilon_i \leq 0$,

where PY_i is the perceived lint yield increase for the i^{th} cotton farmer (kg ha^{-1}), x_i is a vector of explanatory variables for the i^{th} cotton farmer, β is a vector of parameters, and ε_i is a normally distributed random error with zero mean and constant variance σ^2. The model was estimated using maximum likelihood. Marginal effects and six scenarios of farmers with hypothetical characteristics summarize the results. The six scenarios included a Baseline Scenario where perceive lint yield increase was estimated when all independent variables were set to their means. Scenario 1 assumed the Baseline, except all significant variables were set to 0. Scenario 2 assumed Scenario 1, but the farmer variable rate applied fungicide. Scenario 3 assumed Scenario 2, except the farmer thought precision farming would be profitable in the future. Scenario 4 assumed Scenario 3, except the farmer variable rate applied growth regulator. Scenario 5 assumed Scenario 4, except the farmer variable rate applied fertilizer or lime. Scenario 6 assumed Scenario 5, except the farmer variable rate applied insecticide. Thus, for Scenario 6 all significant variables were set equal to 1, with remaining variables equal to their means.

Results

Marginal Effects

The dependent and independent variables in the Tobit regression are reported in Table 1 along with their definitions, means, and marginal effects. The significant marginal effects of the independent variables suggest that farmers who used variable rate technology to apply growth regulators, insecticides, or fertilizers perceived lint yield increases of 45 kg ha^{-1}, 74 kg ha^{-1}, and 52 kg ha^{-1} more than those who did not (Table 1). Farmers who variable rate applied fungicides perceived yield increases of 36 kg ha^{-1} less than others (Table 1). Variable rate application of herbicides was not correlated with yield perceptions. Thus, farmers perceived greater lint yield increases from variable rate application of some inputs than from other inputs. In addition, lint yield monitoring did not affect yield perceptions, nor did livestock production, farm size, land tenure, age, education, income, computer use, or the number of years the farmer had variable rate applied inputs. Farmers who were optimistic about the profitability of precision farming perceived lint yield increases of 24 kg ha^{-1} more than others (Table 1).

Table 1. Variable names, definitions, means, and estimated marginal effects for cotton producers who perceived a lint yield increase after variable rate application of inputs

Variable	Definition	Mean	Marg. Effect
Dependent Variable			
PY	Perceived lint yield increase from variable rate application of inputs (kg ha^{-1})	130.91	
Independent Variables			
LIVEST	1 if produced livestock, else 0	0.26	-3.07
PROFFUT	1 if thought precision agriculture profitable, else 0	0.84	21.44[a]
ACRES	Area in cotton production (404.69 ha)	0.41	-4.52
LANDTEN	Area owned divided by total area farmed (%)	35.89	0.08
AGE	Age of operator (years)	49.16	-2.11
QUADAGE	Age squared	2559.00	0.03
EDUC	Formal education of operator (years)	14.72	-0.43
INCOME	1 if pretax income greater than $150,000, else 0	0.45	6.28
COMINMA	1 if used computer for farm management, else 0	0.75	4.53
PDA	1 if used a PDA in the field, else 0	0.03	31.17
EXTEN	1 if perceived Extension helpful in Prec. Ag, else 0	0.66	6.77
YRADOPT	Years precision agriculture was used	5.02	0.37
GRTHREG	1 if variable rate applied growth regulator, else 0	0.20	39.57[b]
FUNG	1 if variable rate applied fungicide, else 0	0.04	-31.89[a]
HERB	1 if variable rate applied herbicide, else 0	0.08	-1.76
INSECT	1 if variable rate applied insecticide, else 0	0.13	66.32[b]
VRPKL	1 if variable rate applied P, K or lime, else 0	0.67	46.33[a]
YM	1 if used a lint yield monitor, else 0	0.26	-3.98
ERS1	1 if farm in ERS Region 1, else 0	0.08	111.37[b]
ERS5	1 if farm in ERS Region 5, else 0	0.03	-11.05
ERS7	1 if farm in ERS Region 7, else 0	0.03	2.52
ERS9	1 if farm in ERS Region 9, else 0	0.45	33.94[c]
JULPRECI	County average July precipitation (z-score, 1972)	5.04	6.28
JULSUN	County average July sunlight hours (z-score, 1972)	286.27	-0.28

[a] Significant at the 1% level. [b] Significant at the 10% level. [c] Significant at the 5% level.

Scenarios

The results of the Baseline and Scenarios 1-6 are reported in Figure 1. Perceived lint yield increases were lowest for farmers who variable rate applied fungicides alone (23 kg ha^{-1} increase) (Scenario 2) because of its negative marginal effect. Combining variable rate fungicide application with perceptions of a profitable future for precision farming increased the perceived yield increase to 46 kg ha^{-1} (Scenario 3). Adding variable rate growth regulator to the mix (Scenario 4) increased the perceived lint yield increase to 76 kg ha^{-1} but further adding variable rate fertilizer or lime only had a slight impact on the perceive lint yield increase to 79 kg ha^{-1} (Scenario 5). Lastly, adding variable rate insecticide, so that the farmer variable rate applied fungicide, growth regulator, fertilizer or lime and insecticide, and thought the future of precision farming would be profitable, increased the perceive yield increase from variable rate input application to 129 kg ha^{-1}.

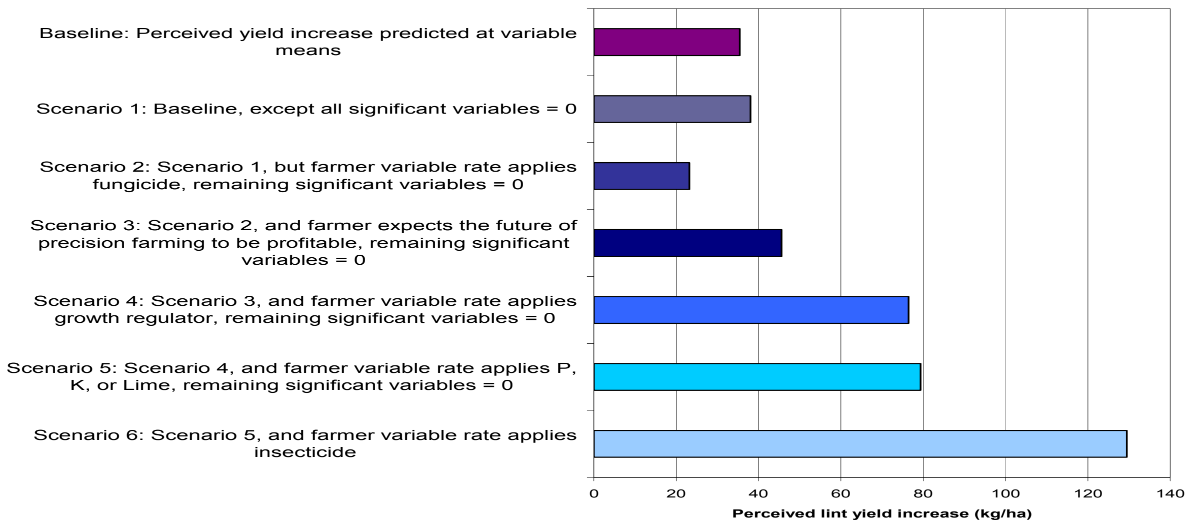

Figure 1. Perceived cotton lint yield increases predicted for farmers with various characteristics

Conclusions

Results from this research suggest that the typical cotton farmer who variable rate applies inputs perceives lint yield increases from those applications. Knowledge related to perceived increases in yield provides information about only one side of the economic question of what influences precision farming adoption. Further research is needed to determine the factors affecting farmers' perceptions of reduced input costs from variable rate input application, and how farmers form perceptions from their experiences with precision farming.

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