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ECONOMICS AND MARKETING

Tennessee and Mississippi Upland Cotton Producer Willingness to Participate in Hypothetical Crop Insurance Programs

Christopher N. Boyer*, Kimberly L. Jensen, Dayton Lambert, Elizabeth McLeod, and James A. Larson

ABSTRACT

Changes under the Agricultural Act of 2014 have reconnected federally subsidized crop insurance to conservation compliance and eliminated direct payments that were tied to conservation compliance. The net effects of these changes on compliance with conservation standards and on the environment are uncertain, especially in regions such as the southern U.S. where direct payments are higher than crop insurance subsidies. We assess two hypothetical pilot programs that strengthen the link between federally subsidized crop insurance and conservation compliance with cover crop (CC) and no-till (NT) adoption by offering an additional Environmental Quality Incentive Program cost-share payment to producers who also purchase Stacked Income Protection Plan (STAX) crop insurance. We determined the factors that affect Tennessee and North Central Mississippi cotton producer willingness to participate in the hypothetical pilot programs. Data were collected using a mail survey of cotton producers conducted in early 2015. A bivariate probit model was estimated to determine the factors that affect cotton producer willingness to participate in two pilot programs. Results found that 35% of the cotton producers would be willing to participate in the CC/STAX pilot program, whereas 28% indicated they would participate in the NT/STAX pilot program. Producer age, income, debt-to-asset ratio, and future purchase of STAX influenced their willingness to participate in the pilot programs. Results from this study could aid in the discussion of the upcoming farm bill.

C.N. Boyer, K.L. Jensen, D. Lambert, E. McLeod, and J.A. Larsdon, Department of Agricultural and Resource Economics, University of Tennessee-Knoxville, Knoxville, TN 37996.
*Corresponding author:cboyer3@utk.edu

Farms with wetland or highly erodible (marginal) land are required to develop and implement an approved conservation plan to qualify for crop insurance premium assistance under the Agricultural Act of 2014 (2014 Farm Bill) (U.S. Congress, 2014). The 2014 Farm Bill also eliminated direct payments, which were withheld from producers who did not have an approved conservation plan for marginal lands, thus removing an incentive to be conservation compliant. The environmental impacts from this change are difficult to forecast. Claassen (2012) concluded that making federally subsidized crop insurance subject to conservation compliance could compensate for some of the lost conservation incentives from the elimination of direct payments in some regions of the U.S. However, in regions where direct payments were historically higher than crop insurance premium subsidies (e.g., Mississippi Delta), the incentives through federally subsidized crop insurance will likely fall short of those provided by direct payments (Claassen, 2012). Furthermore, given the voluntary nature of crop insurance, its effectiveness as an instrument to encourage environmental conservation depends on producer willingness to enroll (Howden et al., 2007). Consequently, the impact of federally subsidized crop insurance on conservation compliance in regions such as the Mississippi Delta is uncertain.

In the delta of Mississippi and West Tennessee, upland cotton (*Gossypium hirsutum* L.) received the largest share of total direct payments among crops from 1995 to 2012 (Environmental Working Group, 2015). Furthermore, cotton leaves minimal crop residue on the soil surface, increasing the probability of soil erosion and nutrient runoff (Bradley and Tyler, 1996). These environmental concerns generated considerable research on using best management practices (BMPs) to reduce soil erosion and nutrient runoff in cotton production with cover crops (CC) and no-till (NT) planting.

Winter CC and NT increase soil residue, which reduces soil erosion, conserves nutrients, builds organic content, and improves water retention in the Southeast U.S. (Boquet et al., 2004; Daniel et al., 1999a, b; Foote et al., 2015; Hanks and Martin, 2007; Kornecki et al., 2015; Larson et al., 2001b). Specifically for cotton production in Tennessee, Larson et al. (2001b) found CC could increase yields depending on the CC species; however, economic analyses find CC profitability in cotton production to be mixed (Cochran et al., 2007; Giesler et al., 1993; Larson et al., 2001a, b). NT production has been found to be profitable more often than conventional tillage for cotton produced in the southeastern U.S. due to yield gains (Cochran et al., 2007; Giesler et al., 1993; Hanks and Martin, 2007; Larson et al., 2001a; Toliver et al., 2012).

Even though CC and NT can provide multiple agronomic, environmental, and economic benefits, their adoption is somewhat limited. The 2012 Agricultural Census reported that approximately 3% of all cropland in the U.S. (4.1 million ha) was planted to CC in 2011 (USDA NASS, 2012), but studies have found the number of users varies by crop and region (Bergtold et al., 2012; Boyer et al., 2014; Dunn et al., 2016; Wade et al., 2015). Wade et al. (2015) reported CC adoption is primarily located in the southeastern U.S. Boyer et al. (2014) surveyed cotton producers in 14 southern states and found that approximately 35% of producers used CC in cotton production. NT planting was reported on more than 39 million ha in the 2012 Agricultural Census (USDA NASS, 2012). Although NT increased between 2007 and 2012 and is higher than CC use, NT covers less than half of U.S. cropland (USDA NASS, 2012). Similar to CC, NT adoption is mainly practiced in the southeastern U.S. NT/strip till was used on approximately 40% of all U.S. cotton land (Wade et al., 2015).

Federal programs such as the Environmental Quality Incentive Program (EQIP) were established to encourage the voluntary adoption of BMPs on working farmland. The program provides producers with cost-share payments for using BMPs such as CC EQIP 340 (USDA NRCS 2011a) and NT EQIP 329 (USDA NRCS 2011b). Producers work with USDA NRCS agents to document and implement BMPs in return for partial reimbursement of the BMP costs (Reimer and Prokopy, 2014). In 2014, EQIP provided cost-share payments for the use of CC and NT on more than 526,000 ha, an increase from 2013 (USDA NRCS, 2015). Funding for EQIP is projected to continue increasing through 2018, making EQIP a core component of U.S. conservation policy (Lubben and Pease, 2014).

However, recent studies indicate that producers are cautious to adopt BMPs because of the perceived risk and/or belief that these practices reduce yields (Arbuckle Jr. and Roesch-McNally, 2015; Reimer et al., 2012).Crop insurance is one of the primary tools producers have used to manage price, production, and financial risk for decades (Kay et al., 2012). Cotton producers in regions where indemnity payments for crop insurance are historically low, such as the Mississippi Delta, might perceive production risk (i.e., yield variability or yield loss) to be lower from events covered under crop insurance than from yield loss following the adoption of a BMP. Improving the link between federally subsidized crop insurance and conservation compliance in the Mississippi Delta for cotton might be needed to encourage compliance.

Under the 2014 Farm Bill, cotton producers fall into a unique policy position relative to other crop producers. The shallow-loss revenue protection and price protection programs under Title I were not available to cotton producers. However, cotton producers can enroll in the Supplemental Coverage Option (SCO) or the Stacked Income Protection Plan (STAX). The STAX program is available only to upland cotton producers. The SCO and STAX are similar to Group Risk Income Protection. Both programs cover county-wide losses and they are designed to complement an individual's insurance policy. Thus, producers could simultaneously purchase an individual policy and an SCO or STAX policy. The individual policy would cover deeper losses, whereas the SCO or STAX policy would cover shallow losses (Campiche, 2013a). Because most U.S. cotton producers have coverage levels of 70% or lower on individual policies, they could receive up to 20% STAX coverage (a 10% deductible) (Campiche, 2013b).

We evaluate two hypothetical pilot programs that link EQIP cost-share payments for adopting CC or NT to a STAX crop insurance policy to encourage adoption of these BMPs. This policy mechanism would offer an additional EQIP cost-share payment to producers who also purchase a STAX policy. We determined the factors that affect Tennessee and North Central Mississippi cotton producer willingness to participate in the hypothetical pilot programs that incentivize the adoption of CC or NT coupled with purchase of a STAX policy through an increase in EQIP cost-share payments. Coppess (2016) describes an opportunity to connect conservation policies with the crop insurance program in the upcoming farm bill. This study could help shape that discussion.

MATERIALS AND METHODS

Data and Survey. Data were collected from a 2015 survey of cotton producers in Tennessee and Mississippi. A total of 607 mail surveys were sent to 367 cotton producers in Tennessee and 240 producers in the North Central Mississippi counties (Fig.1). The Cotton Board provided mailing addresses for producers who marketed cotton in 2014.

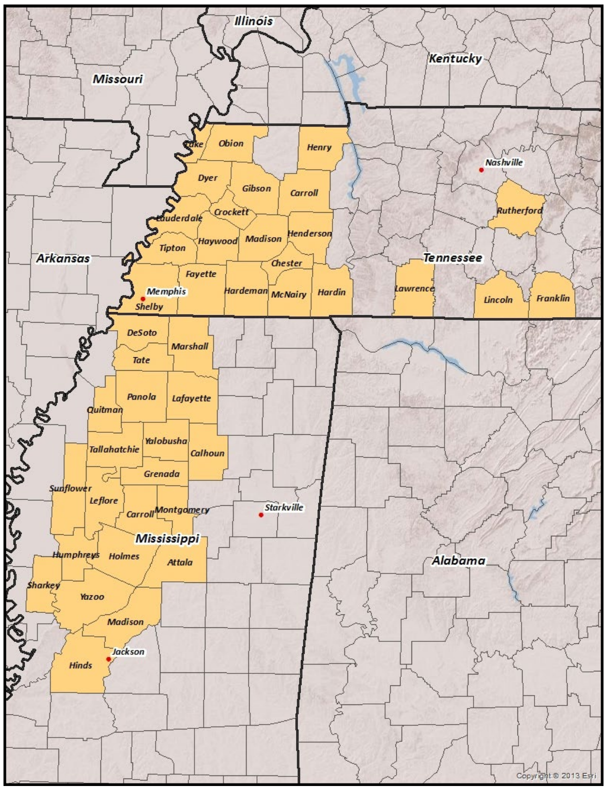

Figure 1. Tennessee and Mississippi counties included in the survey.

Survey implementation followed Dillman's total design method (Dillman, 2001). Survey questionnaires were mailed in February of 2015 along with a postage-paid return envelope and a cover letter explaining the purpose of the survey. Approximately a week after the initial mailing, a postcard was sent as a reminder. Approximately two weeks after the postcard, a second copy of the survey was mailed to producers who had not yet responded. Of the 607 cotton producers on the mailing list, 86 surveys were returned (a response rate of 14.2%). The response rate was similar to previous cotton producer surveys in this region (e.g., Boyer et al., 2014). Surveys with incomplete responses were removed from the data, giving 65 useable survey responses, giving a final response rate of 11%.

The survey included four sections. The first section included questions about the producer's farm such as farm location, and irrigated and non-irrigated planted area in 2014.The second section focused on the producer's use and perceptions of CC and NT. We asked producers if they used CC or NT in 2014. We also asked producers to rate the likelihood (1 = extremely unlikely,…, 5 = extremely likely) of the potential outcomes from using CC or NT. The third section included questions on the use of risk-management strategies such as futures, options, and crop insurance. In this section, two questions were asked about the producer willingness to participate in a hypothetical pilot crop insurance program that linked CC to STAX (CC/STAX) or another hypothetical pilot crop insurance program that linked NT to STAX (NT/STAX). The questions asked if the producer would be willing to participate in the CC/STAX or NT/STAX pilot programs if the EQIP cost-share payment per hectare for adopting CC or NT increased by \$22 ha^{-1}for the respective pilot program. Because studies have reported limited adoption of CC and NT by producer, we provided surveyed producers with information on these programs. The final section included questions on farm income, debt, and age.

Variable Descriptions and Hypothesized Effects. Table 1 presents the names, descriptions, and mean values of the variables included in the model. The likelihood a producer would participate in CC/STAX or NT/STAX pilot program was hypothesized to be higher for a producer who was already using CC or NT. By enrolling in either pilot program, a producer already using CC or NT could increase the EQIP cost-share payment and receive subsidized crop insurance. We also hypothesized the likelihood of participating in the CC/STAX and NT/STAX pilot programs would increase if a producer planned to participate in the STAX program in 2015 (STAX). If a producer was already planning on participating in the 2015 STAX program, adopting a BMP with its accompanying agronomic and economics benefits (Larson et al., 2001a, b) and higher EQIP cost-share payments would encourage participation in each of the pilot programs. Furthermore, STAX is a new insurance policy offered to cotton producers since 2015. The uncertainty of the costs and benefits of this new policy might discourage some producers from participating in STAX. For example, research finds that the uncertainty of yield effects from some BMPs has been a barrier of adoption (Baumgart-Getz et al., 2012; Prokopy et al., 2008; Reimer et al., 2012). Producers willing to participate in STAX might therefore not be concerned with the uncertainty surrounding the hypothetical crop insurance policy.

Table 1. Descriptions and summary statistics of dependent and independent variables

Variable Name	Description	Hypothesized Sign	Mean	Standard Deviation
Dependent variables				
CC/STAX	= 1 if would participate in the cover crop with Stacked Income Protection Plan pilot program, 0 otherwise		0.35	0.479
NT/STAX	= 1 if would participate in the no-till with Stacked Income Protection Planpilot program, 0 otherwise		0.28	0.452
Independent Variables				
CC	= 1 if used cover crop on cotton in 2014, 0 otherwise	+	0.25	0.436
NT	= 1 if used no-till on cotton in 2014, 0 otherwise	+	0.77	0.424
STAX	= 1 if planned to use with Stacked Income Protection Plan in 2015, 0 otherwise	+	0.32	0.469
AGE	= Age of the primary decision maker	+	57.58	11.836
AGE^2	= Age squared of the primary decision maker	-	3454.04	1340.41
FUTOP	= 1 if producer used cotton futures or options contracts to manage risk, 0 otherwise	+/-	0.19	0.393
INCOME	= 1 if the producer's 2013 household income was greater than $100,000, 0 otherwise	+	0.23	0.426
DEBT	= 1 if financed debt was $40 or more for every $100 of assets, 0 otherwise	+	0.25	0.433
STATE	=1 if the producer's farm was located in Tennessee, 0 otherwise	-	0.71	0.453
IRR	=1 if the producer used irrigation , 0 otherwise	-	0.25	0.433
INS	=1 if the producer purchased crop insurance last year for cotton production, 0 otherwise	+	0.87	

We hypothesized that a producer's age (AGE) would affect willingness to participate in a pilot program. Ervin and Ervin (1982) found that older producers are less likely to adopt BMPs because their remaining career is shorter, making them less likely to change. Several studies found that as age increased, producers were less likely to adopt BMPs (Arbuckle Jr. and Roesch-McNally, 2015; Baumgart-Getz et al., 2012; Prokopy et al., 2008; Reimer et al., 2012). We include a quadratic term for age with the expectation that the probability of participation increases at a decreasing rate with age. The use of futures and/or options contracts (FUTOP) to manage risk was uncertain on the likelihood of participation in the pilot programs. Because these producers are already managing risk, they also might be interested in the additional risk-management potential provided by the pilot programs (Baumgart-Getz et al., 2012). However, these producers could view futures and options contracts as a substitute to STAX. If the producer's farm income (INCOME) was greater than $100,000 and their farm debt-asset ratio (DEBT) was greater than 40%, we expected they would be more likely to participate in the pilot programs. Higher incomes are correlated with BMP adoption (Arbuckle Jr. and Roesch-McNally, 2015; Baumgart-Getz et al., 2012). Higher farm debt increases the financial vulnerability of a farm, which might increase a producer's desire to protect against losses.

A fixed effect for the state where the farm is located (STATE) was included in the model to control for unobserved factors corresponding with these states. We hypothesized the producer would be less likely to participate in either of the pilot programs if they irrigated (IRR). Studies have shown irrigation can be a substitute for crop insurance (Barham et al., 2011; Dalton et al., 2004). Purchasing crop insurance for cotton in 2014 (INS) was hypothesized to positively affect the likelihood of participating in either pilot program.

Methods. The likelihood of participating in either hypothetical program (CC/STAX or the NT/STAX) was determined using a bivariate probit regression (Greene, 2011). This model allows the joint determination of participation in either pilot program. The observed and unobserved factors that impact a producer's decision to participate in either pilot program might be correlated. Let I_1^* represent the producer's decision to participate in the CC/STAX program and I_2^* represent the decision to participate in the NT/STAX program. The joint participation decision is

$$(1) \quad I_1^* = \boldsymbol{\beta}'\mathbf{x} + u_1, \quad I_1 = \begin{cases} 1 \ \ if \ \ I_1^* > 0 \\ 0 \ if \ \ I_1^* \leq 0 \end{cases},$$

$$(2) \quad I_2^* = \boldsymbol{\beta}'\mathbf{x} + u_2, \quad I_2 = \begin{cases} 1 \ \ if \ \ I_2^* > 0 \\ 0 \ if \ \ I_2^* \leq 0 \end{cases},$$

with

$$(3) \quad \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \sim BVN\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_{12} \\ \rho_{12} & 1 \end{bmatrix}\right),$$

where **x** is a matrix of independent variables; β is a vector of coefficients determining the relationship between participation and the independent variables; and *BVN* is the bivariate standard normal cumulative distribution function. The dependent variables for CC/STAX participation (I_1) and NT/STAX participation (I_2) equal 1 when a cotton producer is willing to adopt the respective pilot program (0 otherwise).A likelihood ratio test was used to test the null hypothesis of 0 correlation between willingness to participate in the two pilot programs ($\rho_{12} = 0$). If the null hypothesis is rejected, estimation of the joint participation decision under the above assumptions is appropriate, and the bivariate probit model is appropriate. Failure to reject the null hypothesis suggests the participation decision can be estimated separately (Greene, 2011).

The coefficients of a bivariate probit model do not directly represent the marginal change in the probability of participation (Greene, 2011). Marginal effects indicate the impact of a one unit change in an independent variable on the dependent variable. For binary independent variables, the marginal effect is interpreted as a *ceteris paribus* change in the probability of adopting a pilot program, given the binary independent variable equals one (Greene, 2011). The marginal effect of a continuous independent variable is interpreted as a *ceteris paribus* change in the probability of adopting a pilot program, given a unit change in the continuous variable. The bivariate probit model and marginal effects were estimated using STATA 12 (STATA, 2012). The precision and significance of the overall model were evaluated with the percentage of observations correctly predicted and the likelihood ratio test, respectively.

RESULTS AND DISCUSSION

Variables used in the bivariate probit model are presented in Table 1. Approximately 35% of the cotton producers indicated they would be willing to participate in the CC/STAX pilot program and 28% indicated they would participate in the NT/STAX pilot program. However, the survey data suggest that 25% of cotton producers in the survey region currently use CC, whereas 77% use NT. The percentage of CC use was similar to Boyer et al. (2014) for cotton producers in 14 southern states. However, the percentage using NT was higher than reported by Horowitz et al. (2010) and in the 2012 Agricultural Census (USDA NASS, 2012). Interestingly, more cotton producers were willing to participate in the CC/STAX pilot program than the NT/STAX program even though more producers use NT than CC. This result suggests that the proposed CC/STAX program could encourage additional cotton producers in the study area to use CC on more land, whereas the NT/STAX program could do so to a lesser extent.

Approximetely 32% of cotton producers indicated they would use STAX in 2015. According to USDA Risk Management Agency (RMA) data, 28% of Tennessee planted area was insured through STAX in 2015, and in Mississippi the percent of insured planted area was 43% (USDA RMA, 2015). A state land-weighted average of those percentages suggests that 38% of the cotton-planted area in those states was enrolled in STAX.

The average age of the producers in the survey was approximately 58 years old, which is one year older than what Boyer et al. (2014) observed. Approximately 19% of cotton producers indicated they used futures or options to manage risk. This was higher than what previous studies have reported for cotton producers use of futures and option to manage price risk (Isengildina and Hudson, 2001; Pace and Robinson, 2012; Vergara et al., 2004). Taxable income in 2013was greater than $100,000 for 23% of the cotton producers, and approximately 25% of the cotton producers had a debt-to-asset ratio greater than 40%. Most of the producers were located in Tennessee (71%), and 87% of the cotton producers had purchased crop insurance for cotton in the past year. Approximately 25% of the producers indicated they used irrigation for cotton production.

The correlation coefficient of the residuals for the pilot programs (ρ_{12}= 0.631) was positive and significant ($p \leq 0.01$), suggesting gains in efficiency by simultaneously modeling willingness to participate in the pilot programs (Greene, 2011). Estimated coefficients and marginal effects from the bivariate probit model are shown in Table 2. The model was statistically significant overall based on the likelihood ratio test. The bivariate probit model correctly classified 65% and 71% of the observations for willingness to participate in the CC/STAX or NT/STAX programs, respectively.

Table 2. Estimated bivariate probit model for willingness to participate in the pilot programs for cover crop with Stacked Income Protection Plan (CC/STAX) and no-till with Stacked Income Protection Plan (NT/STAX) for cotton producers in Tennessee and Mississippi

Variable Name	CC/STAX		NT/STAX	
	Estimated coefficients[Z]	Marginal effect[Z]	Estimated coefficients[Z]	Marginal effect[Z]
Intercept	-2.479	-	-12.845[b]	-
CC	-0.366	-	-	-
NT	-	-	-0.004	-
STAX	1.182[a]	0.333[a]	0.937[b]	0.232[b]
AGE	0.215[b]	0.061[b]	0.441[b]	0.110[b]
AGE^2	-0.002[b]	-0.0006[b]	-0.004[b]	-0.001[b]
FUTOP	0.601	-	1.046[b]	0.258[b]
INCOME	-0.994[b]	-0.279[b]	-0.974	-
DEBT	0.309	-	0.779[c]	0.193[c]
STATE	-0.124	-	-0.148	-
IRR	-0.222	-	-0.244	-
INS	-0.862	-	-0.316	-
Rho			0.631[a]	
Likelihood Ratio Test	<0.001		<0.001	
Percent correctly classified	65.0%		71.3%	

Note: CC/STAX = cover crop with Stacked Income Protection Plan pilot program and NT/STAX = no-till with Stacked Income Protection Plan pilot program.

[Z] The letters a, b, and c represent significance at the 1%, 5%, and 10%, respectively.

The estimated coefficients and marginal effects for the variables representing prior use of CC and NT practices were not significant, suggesting that prior use and knowledge of those BMPs did not significantly influence willingness to participate in either pilot program. Producers planning to purchase a STAX policy in 2015 were 33% more likely to participate in the CC/STAX pilot program ($p \leq 0.05$) and 23% more likely to participate in NT/STAX pilot program ($p \leq 0.05$) relative to those who were not planning on purchasing a STAX policy. These results suggest that the additional incentive provided through the proposed programs might effectively encourage STAX participants to use CC and NT.

Producer age affected the decision to participate in the CC/STAX and NT/STAX pilot programs ($p \leq 0.05$). The positive coefficient for age and the negative coefficient for age squared indicate the probability of participating in these pilot programs increases at a decreasing rate as a producer's age increases. The estimates suggest that the probability of being willing to participate in the CC/STAX program increases with age up to 54 years ($= -0.215/(2*-0.002)$), but decreases thereafter. Similarly, the probability of participating in the NT/STAX program increases with age up to 55 years, but decreases thereafter.

If the producer used futures and options to manage risk, the likelihood of participating in NT/STAX increased 26% ($p \leq 0.05$). The probability of participating in the CC/STAX pilot program decreased by 28% if a producer had a farm income greater than \$100,000 in 2013 ($p \leq 0.05$). Conversely, producers making less than \$100,000 per year were more likely to adopt the pilot program. This result is counter to other research on BMP adoption (Arbuckle Jr. and Roesch-McNally, 2015; Baumgart-Getz et al., 2012). Farmers with lower incomes might believe that they are less able to withstand production and price risks and thus are more likely to carry supplemental, shallow-loss crop insurance. Having a debt-to-asset ratio greater than 40% increased producer willingness to participate in the NT/STAX pilot program by 19% ($p \leq 0.10$). Producers with more debt relative to assets might find an additional incentive to help manage risk beneficial. The results indicate that producers with higher levels of debt relative to assets and with lower farm income were more likely to participate in the pilot programs.

CONCLUSIONS

Changes in the 2014 Farm Bill link federally subsidized crop insurance to conservation compliance and eliminated direct payments that were tied to conservation compliance. The former increased the incentive to be conservation compliant, whereas the latter decreased the incentive, relative to the former farm bill. The net effect of these policy changes on producers' incentive to remain conservation compliant is uncertain, especially in regions such as western Tennessee and the delta of Mississippi. We examined western Tennessee and North Central Mississippi cotton producer willingness to participate in hypothetical pilot programs that would incentivize use of CC or NT practices coupled with crop insurance (CC/STAX or NT/STAX, respectively) via an additional cost-share payment above current EQIP payment levels.

We found that 35% of the cotton producers indicated they would be willing to participate in the CC/STAX pilot program, whereas 28% indicated they would participate in the NT/STAX pilot program. Results from the bivariate probit model indicated that producers planning to use STAX in 2015 were 33% more likely to participate in the CC/STAX pilot program, and 23% more likely to participate in NT/STAX pilot program, whereas the use of CC or NT did not significantly impact their willingness to participate in either pilot program. A producer's age, income, and debt-to-asset ratio also influenced willingness to participate in the pilot programs.

Limitation of this study is the small sample size and lack of data to project the effectiveness of these programs on conservation compliance. Future research could expand this survey to other regions of the U.S. and other crops, and measure the additional acres in CC and NT production from having these pilot programs available. This would provide more insight into the conservation effects of these programs. However, the hypothetical CC/STAX and NT/STAX programs evaluated in this study appear to have potential to encourage CC or NT adoption by improving the linkage between federally subsidized crop insurance and conservation compliance. Further research is needed on improving the link between conservation compliance and crop insurance with innovated policies.

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