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Incentive Payments for Planting Upland Bird Habitat Field Borders in Tennessee

Nathaniel Scott Bruce
University of Tennessee, Knoxville, nbruce1@vols.utk.edu

To the Graduate Council:

I am submitting herewith a thesis written by Nathaniel Scott Bruce entitled "Incentive Payments for Planting Upland Bird Habitat Field Borders in Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Christopher Boyer, Major Professor

We have read this thesis and recommend its acceptance:

Chris Clark, Aaron Smith

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Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

Incentive Payments for Planting Upland Bird Habitat Field Borders in Tennessee

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ABSTRACT

Crop yields along field perimeters that are adjacent to trees and other tall-herbaceous are known to have the lowest yields in a field. An alternative use of these areas that might be more profitable and sustainable is to remove the land from crop production and enroll these areas into the upland bird habitat (UBH) buffer program. However, the adoption of UBH buffers have been limited by producers, despite being eligible for receiving an incentive payment for adopting UBH buffers. Therefore, the objective of this thesis was to determine the breakeven incentive payment for corn [*Zea mays* L.] and soybean [*Glycine max* L.] producers to convert field perimeters adjacent to tree lines into UBH buffers. Simulation models were established to find distributions of annualized incentive payments that would be required for Tennessee corn and soybean producers to adopt UBH buffers. The models were built using five years (2008-2012) of corn and soybean yield data from 69 West Tennessee fields. Enterprise budgets for establishing switchgrass [*Panicum virgatum* L.], big bluestem grass [*Andropogon gerardi* L.], and indiangrass [*Sorghastrum nutans* L.] UBH borders were developed and historical corn prices, soybean prices, and production costs were collected. The average incentive payment a corn producer would require to plant field borders next to trees with UBH buffers ranged from between $97-$109/acre, while soybean producers would require a payment between $169-$189/acre depending on the UBH species. Results are also presented when the current incentive payment levels are increased and decreased to determine how producers might respond to policy changes. The results may help inform state policy makers in

determining if the current incentive payment is sufficient to influence Tennessee producers to replace tree lines into a UBH buffer.

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CHAPTER I: INTRODUCTION AND PROBLEM IDENTIFICATION

Crop yields along field perimeters that are adjacent to trees or other tall-herbaceous are typically lower than yields in interior portions of the field (Boatman and Sotherton, 1988; Nuberg, 1988; Fischer et al., 1998; Sparkes et al., 1998; Miller et al., 2001; Kuemmel, 2003; Marshall, 2004; Kitchen et al., 2005; Reynolds et al., 2007). Trees and other tall-herbaceous plants reduce total sunlight hours and increase competition for available nutrients, thus negatively impacting adjacent crop yields (Boatman and Sotherton, 1988; Nuberg, 1988; Fischer et al., 1998; Sparkes et al., 1998; Miller et al., 2001; Kuemmel, 2003; Marshall, 2004; Kitchen et al., 2005; Reynolds et al., 2007). Therefore, uniformly managed fields will likely be less profitable along field perimeters that are adjacent to trees than other portions of the field (Cassman, 1999; Kuemmel, 2003; Kitchen et al., 2005).

In Tennessee, crop fields are typically irregular shaped and have trees and other tall-herbaceous plants along field perimeters. Research has shown that soybean [*Glycine max* L.] and corn [*Zea mays* L.] yields, which are the top two produced crops in Tennessee (United States Department of Agriculture National Agricultural Statistical Service (USDA-NASS, 2016a), can be negatively impacted by field boundary vegetation (Miller et al., 2001; Kitchen et al., 2005; Sklenicka and Šálek, 2005; Reynolds et al., 2007; Barbour et al., 2008). A potentially more profitable and sustainable use of field perimeters adjacent to trees and other tall-herbaceous plants for Tennessee corn and soybean producers might be to remove these portions of the field from production and enroll these areas into the Conservation Reserve Program (CRP).

The CRP was enacted in 1985 under the USDA Food Security Act with the aim of reducing soil erosion, enhancing wildlife population, and protecting soil quality by retiring erodible crop and pasture lands from agricultural production (USDA-Farm Service Agency (FSA), 2015a). If the land is eligible, the voluntary program pays participants to remove land from production for a set number of years (USDA-FSA, 2015a). Over time, the total area enrolled in the CRP has increased to over 24 million acres (USDA-NASS, 2015), and new programs within the CRP have been developed to focus on various high-priority conservation issues (USDA-FSA, 2015b).

The upland bird habitat (UBH) buffer program, which is Conservation Practice Number 33, is one of these programs. The UBH program provides producers a cost-share payment (i.e., incentive payment) to remove field borders from production and plant vegetation to enhance the population of grassland-dependent birds (USDA-FSA, 2015b). UBH buffers can be planted in several different native warm-season grasses that provide nesting, brood rearing, and cover for grassland-dependent birds such as quail (USDA Natural Resource Conservation Service (NRCS), 2004). To qualify for the UBH program, cropland must be suitable to establish bird populations and have been in crop production for at least four of the last six years (USDA-FSA, 2015b). Unlike other CRP programs, cropland is not required to be classified as highly erodible to qualify for the UBH program. Despite the recent decrease in over 1.3 million acres of total CRP enrolled acres, the acres enrolled in the UBH program has increased from 244,350 in 2014 to 257,160 in 2015 (USDA-NASS, 2015, 2014) with the goal of reaching 300,000 acres in the United States (USDA-FSA, 2017). Similarly, Tennessee cropland enrolled in the

UBH program has shown a slight increase from 5,192 acres to about 5,277 acres in 2015 (USDA-NASS, 2015, 2014).

Tennessee has also experienced a declining northern bobwhite quail [*Colinus virginianus*] population over recent years (Hinnebusch 2008; Tennessee Wildlife Resources Agency (TWRA), 2017). This decline has been attributed to reductions in available protective cover and nesting areas (TWRA, 2017). Removal of windbreak and hedgerow areas on crop fields significantly reduced the population of northern bobwhite quail by 70-90% in some areas of the state (TWRA, 2017). Burger et al. (1999) reported that decline in quail population in the southeastern United States has resulted in the economic impact of quail hunting across 11 southeastern states to decrease over $13 million since 1980. Thus, restoring bobwhite quail protective cover and nesting areas has become a major component in the TWRA Strategic Plan (2014).

The UBH program has the potential to mitigate the declining northern bobwhite quail population in Tennessee over recent years (Hinnebusch, 2008). Hinnebusch (2008) sampled the population of grassland dependent birds in Tennessee and Kentucky from 2003 to 2007 and found that agricultural fields with neighboring permanent grass vegetation areas, such as UBH buffers, can increase the population of northern bobwhite quail. The TWRA Strategic Plan (2014) encouraged UBH program enrollment as a strategy for increasing the northern bobwhite quail population in Tennessee, in addition to providing technical assistance to landowners in managing grassland habitat areas. Moreover, the TWRA has offered an additional incentive payment, in conjunction with the payments provided by the CRP UBH program, if producers establish UBH buffers (Tennessee State Government (TSG), 2011).

The conversion of less productive cropland along field perimeters into UBH buffers has potential for increasing the quail population in Tennessee. Increasing quail populations could increase economic impacts in rural economies as well as increase producers' profits. Furthermore, increasing quail populations could provide producers with supplemental income through leasing land for hunting during the winter months. Harper et al. (2009) reported that the average hunting lease in Tennessee was around $1,500 annually in 1999 dollars.

However, limited research exists on the economics of planting UBH buffers for producers in the southeastern United States. One recent study examined the impacts of planting UBH buffers on non-irrigated corn and soybean producer's net returns, and found net returns for corn production increased but soybean net returns decreased (Barbour et al., 2008). Producers would relinquish any profits from planting crops in these areas, which implies that cost-share payments or incentives could be necessary to encourage adoption. Thus, another approach would be to estimate the incentive payment that would be required for Tennessee producers to plant a UBH buffer along field perimeters adjacent to trees. These estimates could be compared to current incentive payment levels for the UBH program, which could help explain producer adoption of UBH buffers. This type of analysis might also guide the USDA NRCS in providing sufficient incentive payments for producers to remain profitable after planting UBH buffers.

Research Objectives

The objective of this research was to determine the incentive payment where Tennessee corn and soybean producers would breakeven from converting field perimeters adjacent to trees into UBH buffers for three different buffer grass scenarios (switchgrass, indian grass, and big bluestem grass).

CHAPTER II: REVIEW OF LITERATURE

Research shows that trees and other tall-herbaceous plants along field perimeters can create unique micro-climates along field borders that reduce temperature, sunlight, and rainfall, negatively impacting crop growth potential (Kuemmel, 2003). Others have found that these areas have increased competition of fertilizer and water, limiting available nutrients and water to crops, causing yield loss in these areas (Boatman and Sotherton, 1988; Nuberg, 1988; Sparkes et al., 1998; Miller et al., 2001; Marshall, 2004).

For example, Kitchen et al. (2005) evaluated how cropland field characteristics such as soil, landscape, field shape, and density of trees along field borders can impact producers' profitability. Soil, landscape, and harvest yields were measured from an 89 acre field planted in a corn and soybean rotational system over a 10-year period in Missouri. Within the field, there was a 33 to 49 feet wide tree line that divided the field into a northern and southern portion. They found that yields were negatively impacted up to 197 feet into the field. Additionally, the field had two other tree lines located on the north and east borders of the field. They stated that yields were reduced up to 66 feet into the field. Field maps showing profitability across the field indicated that profits were lower in the areas near tree lines. The maps also suggested that the negative impact on corn was greater than soybeans.

Sklenicka and Šálek (2005) evaluated the competitive interactions of tree line perimeters on the growth and yields of corn on eight fields ranging from 37 to 74 acres in Central Bohemia, Czech Republic over a 5-year period. Trees located in the perimeter areas of each field measured 76 to 89 feet tall and reduced corn yields about 66 to 197 feet into the field, depending on if the tree line area was located in the northern, southern, eastern, or western portion of the field. They found that shading from the tree line was the most important factor for decreased corn yields in the study when tree line areas were located in either the eastern or western portion of the field.

Reynolds et al. (2007) evaluated the effects of tree competition on corn and soybean yields by intercropping hybrid poplar and silver maple trees with corn and soybeans on 98 acres in southern Ontario over a 2-year period. They found that decreased sunlight from neighboring tree competition had a greater impact on corn yield, while decreased soil moisture from neighboring tree competition had a larger impact on soybean yields.

Producers have been hesitant to enroll land into the UBH program, because they believe planting field margins can increase weed pressure or harbor pest species, ultimately decreasing crop productivity (Marshall, 2004). However, Stamps et al. (2008a, 2008b) evaluated the impact of four different herbaceous borders that are eligible for the UBH program on corn and soybean yields over a 3-year period in Missouri. Herbaceous borders tested included warm-season grass/legume mixture, a cool-season grass/legume mixture, fescue, and control corn or soybean border depending on the crop planted. They found that none of the herbaceous borders negatively impacted either corn or soybean yields.

Another potential reason for producers not planting UBH might be limited economic insight into how UBH buffers impact producer profits. Only Barbour et al. (2008) has examined the impacts of planting UBH buffers on producer’s net returns.

Barbour et al. (2008) evaluated Mississippi corn and soybean producers' net returns when non-irrigated cropland adjacent to woods or other herbaceous plants was converted into UBH buffers. They used field-level yield data from actual producers' fields in Mississippi from 2000-2003. They assumed that UBH buffers were planted within the first, second, third, and fourth swath of the combine from the field border. Net returns for corn production increased when the first swath along the field perimeters adjacent to woods or other herbaceous plants was converted into UBH buffers, but soybean net returns decreased when UBH buffers were installed. Barbour et al. (2008) concluded that UBH buffers were not profitable for soybeans because yield loss from tree competition along field perimeters was not as severe as corn, and that soybean cost of production was lower than corn.

These studies provide useful insight into understanding the profitability of planting UBH buffers, but more research is needed. Research has determined that producer enrollment in the CRP increases when incentive payments increase (Esseks and Kraft, 1986; Norris and Batie, 1987; Schaible et al., 2007). Thus, estimating the incentive payment levels that where Tennessee producers would breakeven from converting field perimeters adjacent to trees in a UBH buffer could be helpful in further understanding producers' adoption of UBH. This type of analysis might also guide state policy makers in understanding if the USDA NRCS is providing sufficient incentive payments for producers to remain profitable after planting UBH buffers.

CHAPTER III: CONCEPTUAL FRAMEWORK

The decision to remove field perimeters adjacent to tree lines from crop production and enroll them into the UBH program could be motivated by financial (i.e., net returns) and non-financial benefits (i.e., conservation). The non-financial benefits are not easily estimated and are specific to the producer. The financial benefits, or net returns, are straightforward to calculate for corn and soybean production with and without UBH. The producers' net returns when UBH are not planted can be expressed as:

$$NR_i^{WF} = (P_i Y_i^{WF} - C_i^P) * A^{WF}, \tag{1}$$

where NR_i^{WF} is the expected net returns ($/field) for the whole-field for crop *i (i* = soybean, corn) without a buffer; P_i is the price ($/bu); Y_i^{WF} is the expected yield (bu/acre) for the whole-field; C_i^P is the cost of production ($/acre); and A^{WF} is the total acres for the whole-field.

If the producer decides to plant field perimeters adjacent to tree lines into UBH, the total acres of crop production decreases. The field perimeter acres planted into UBH buffers would incur the annualized cost of establishing the UBH. Producers' net returns when planting a UBH buffer can be expressed as:

$$NR_{ik}^{UBH} = \left(P_i Y_i^{UBH} - C_i^P\right) * (A^{WF} - A^{UBH}) - \left(C_k^{UBH} - CS_{ik}^{UBH}\right) * A^{UBH}, \tag{2}$$

where NR_{ik}^{UBH} is the expected net returns ($/field) when a producer plants *k*th (*k* = switchgrass (SG), indian grass (IG), and big bluestem grass (BB)) grass in the UBH buffer; Y_i^{UBH} is the expected yield (bu/acre) for the field that was not converted into a UBH buffer; A^{UBH} is the assumed acres planted in UBH buffer; C_k^{UBH} is the expected annualized cost ($/acre) when a producer plants a UBH buffer; and CS_{ik}^{UBH} is the annualized incentive payments ($/acre) provided to the producer for implementing a UBH buffer.

Equation (1) can be set equal to equation (2) and the expected breakeven incentive payment required by producers to convert field perimeters adjacent to tree tines into UBH can be found. This is expressed as:

$$CS_{ik}^{UBH} = C_i^P - P_i \frac{A^{WF}}{A^{UBH}}\left(Y_i^{WF} - Y_i^{UBH}\right) - P_i Y_i^{WF} - C_k^{UBH}. \quad (3)$$

Producers who are motivated solely by financial benefits (i.e., a profit maximizing producer) would plant a UBH buffer if the incentive payment was greater than expected breakeven incentive payment.

CHAPTER IV: MATERIALS AND METHODS

Data

Yields

Corn and soybean yields were collected from 69 actual West Tennessee producer non-irrigated fields from 2008 to 2012 to evaluate tree line effects on yields to promote conservation practice adoption in cropland areas producers are less profitable. The 69 fields were located in Henderson, Decatur, and Gibson counties (Figure 1). The fields ranged in size from 1.4 to 146.49 acres with an average field size of 17.69 acres. Most fields were no-till planted in a corn and soybean annual rotational system. Yield data was collected using combines equipped with a Global Positioning System (GPS) yield monitor. Yield data was downloaded to a personal computer and cleaned through ArcGIS 10.4 software (Environmental Systems Research Institute (ESRI) 2016). The length of the observed yield grid size varied across fields, ranging from 4 to 8 feet. The width of each grid is consistent at 20-feet for corn (i.e., 8-row planter) and 25-feet for soybean (i.e., 10-row planter). The grid-yields were totaled and divided by the total number of acres harvested to find the average yield per acre for each field.

The portions of fields adjacent to a tree line were identified using ArcGIS. Tree lines were defined as an area with more than three trees growing next to each other. The fields varied in the percentage of field perimeter areas covered in tree line vegetation. The fields ranged from having 0 to 23.64% with an average of 8.65% of field perimeters covered in tree line vegetation. The corn and soybean grid-yield observations in the first swath of the combine along the tree line were designated as the tree line yields. These were the areas assumed to be planted in the UBH buffer program. Figure 2 shows an example of a determined tree line area and first pass observation on 1 of the observed 69 fields. The red lined areas indicate where the field's determined tree line areas were located, while the blue lines indicate the extent of the first swath of the combine perimeter for the entire field. The spacing between the blue and red lined areas were where UBH buffers were assumed to be planted.

Table 1 shows the summary statistics of the yields for the entire field, yields located in the tree line areas, and yields for the entire field without the tree line areas planted. Average corn yields were 137 bu/acre for the entire field, but average corn yields located in the tree line areas were 85 bu/acre. When these areas were removed from production, the average corn yield for the remaining portion of the field increased to 140 bu/acre. Similarly for soybeans, average yields were 41 bu/acre for the entire field, but increased to 44 bu/acre when field perimeters adjacent to tree tines were not planted. The average corn and soybean yields from the dataset are representative of Decatur, Gibson, and Henderson corn and soybean producers as the actual 2016 yield estimates for were 139 bu/acre for corn, and 45 bu/acre for soybeans, respectively (USDA-NASS, 2016b, 2016c) .

Budgets

Producers face uncertainty and are going to make decisions based on expected profits. One way to model uncertainty is to use historical production costs and prices. Budgets for no-till corn and soybean production were collected for the last 21 years (1994-2015) from the University of Tennessee, Knoxville (UTK)-Agricultural and Resource Economics Department (AREC) Enterprise Crop Budgets (2015) because the budget from 21 years ago was the oldest available. All production costs were adjusted into 2015 real dollars. The average cost of production for corn in 2015 dollars was $334/acre with a low of $232/acre and a high of $584/acre. The cost of production for soybean ranged from$144/acre to $457/acre with an average of $211/acre. The expected prices received for corn and soybean in Tennessee were collected from USDA NASS during 1994-2015 and converted into 2015 real dollars (USDA-NASS, 2016d). Figure 3 shows the average corn and soybean prices in 2015 real dollars over the past 21 years. Corn price ranged from $2.50/bu to $6.86/bu with an average of $3.99/bu in 2015 dollars (USDA-NASS, 2016d). The average soybean price was $9.48/bu in 2015 real dollars and prices ranged from $6.33/bu to $13.75/bu (USDA-NASS, 2016d).

Establishment budgets were developed for SG, IG, and BB and can be seen in Tables 2-4, respectively. These costs were annualized over a 10-year useful life, assuming an 8% annual discount rate, to be the cost of the UBH buffer. The 8% discount rate was chosen because this followed past UTK AREC 2007 warm-season forage budgets. The establishment costs for each grass included: seed, fertilizer, herbicides, labor, and machinery. Seed prices were obtained from the Tennessee Farmers' Cooperative and were $21.72/lb for SG, $20.59/lb for IG, and $11.75/lb for BB. Granular fertilizer prices were also collected from the Tennessee Farmers' Cooperative and were $0.55/lb of N (NO3 (Nitrate)), $0.69/lb of P (P2O5 (Potassium Oxide)), and $0.48/lb of K (K20 (Phosphate)). Fertilizer was applied following University of Tennessee Extension recommendations of 30 lb/acre N, 30 lb/acre P, and 30 lb/acre K for IG and BB, while the recommended rates for establishing SG was zero N, 40 lb/acre P, and 80 lb/acre K (Holcomb et al. 2015; AREC 2009). Fertilizer costs for the three grasses were $75.20/acre for SG and $60.80/acre for IG and BB. Herbicides, labor, and machinery costs were taken from the UTK AREC 2007 warm-season forage budgets and adjusted into 2015 dollars. Weeds were controlled using 1.5 pint of gramoxone max and 0.5 pint of surfactant prior to seeding any of the three vegetation options, which follows University of Tennessee Extension recommendations. Herbicide costs were $14.78/acre, labor costs were $9.87/hour, and machinery costs were $26.28/acre. Machinery costs consisted of fuel costs that were $7.78/acre, oil and filter costs that were $1.16/acre, repairs and maintenance costs that were $4.15/acre, and interest on operating capital that was $13.19/acre.

These grasses can be difficult to establish; thus, a 10% reestablishment cost was included. The total costs of establishment with the 10% risk of failed establishment were $416.99/acre for SG, $316.92/acre for IG, and $286.46/acre for BB. The annualized costs were $62.14/year/acre for SG, $47.23/year/acre for IG, and $42.69/year/acre for BB. Following establishment, no other costs were assumed for these UBH borders as per NRCS guidelines for the program.

Methods

Simulation Model

Equation (3) indicates factors such as prices, yields, allocated acres to UBH buffer, costs associated with implementing UBH, and crop can impact the required annualized incentive payment to encourage producers to plant UBH buffers. Uncertainty around prices of outputs and inputs are important to consider when setting incentive payments to compensate producers over a period of time. Also, considering the variability across fields, such as yields, and size would be helpful in setting long-term incentive payments. Therefore, Monte Carlo simulations were developed to estimate distributions of annualized incentive payments required for corn and soybean producers to plant each UBH buffer by each grass and crop. The model is expressed as

$$\widetilde{CS}_{ik}^{UBH} = \tilde{C}_i^{P} - \check{P}_i \frac{\tilde{A}^{WF}}{\tilde{A}^{UBH}} \left(\tilde{Y}_i^{WF} - \tilde{Y}_i^{UBH}\right) - \tilde{P}_i \tilde{Y}_i^{WF} - C_k^{UBH}. \tag{4}$$

where tildes ("~") indicate random variables.

Simulation and Econometrics to Analyze Risk (SIMETAR©) was used to develop the distributions and perform the simulations (Richardson et al. 2008). A total of 5,000 net return observations were simulated for each grass and crop combination. Stochastic prices of inputs, corn, and soybean along with yields and acres of fields were introduced into the equations by resampling with replacement the observed prices. Negative incentive payments that were found in the simulation model were assumed to be zero. However, a positive value indicates the payment a producer would require to plant UBH. The simulated incentive payments were used to evaluate the probability producers could convert field perimeters adjacent to trees into UBH without reducing their net returns at various payment levels.

Simulation Analysis

The establishment budgets created for SG, IG, and BB were used to calculate annualized UBH incentive payments following the current USDA NRCS payment structure (USDA-NRCS, 2016). This payment structure consists of three one-time, per acre payments (OTPs) to producers at the beginning of their CRP contracts. OTPs include a continuous CRP incentive payment (CCRP), a signing incentive payment (SIP), and a practice incentive payment (PIP). The CCRP payment is 50% of the total establishment cost for each vegetation option, which is \$208.49/acre for SG, \$158.46/acre for IG, and \$143.23/acre for BB. The SIP payment is a flat rate payment of \$100/acre for all grasses (USDA-NRCS, 2016). The PIP payment is either 80% of the CCRP payment or 40% of the total establishment cost for each vegetation option (USDA-NRCS, 2016). PIP payments for each vegetation option were \$166.80/acre for SG, \$126.77/acre for IG, and \$114.58/acre for BB. The current payment structure also pays producers an annual rental payment (ARP) per enrolled acre for the duration of the CRP contract (USDA-NRCS, 2016). ARP payments were the same for all three vegetation types and averaged \$86.05/acre in Tennessee during 2015. OTPs and ARP payments were annualized over a contract length of 10 years at an 8% discount rate. The total annualized incentive payment for each UBH vegetation option was found to be \$133.52/year/acre for SG, \$120.10/year/acre for IG, and \$116.01/year/acre for BB.

Analyses were conducted on how eight hypothetical changes in the incentive payment levels might impact the probability producers would convert field perimeters adjacent to trees into UBH. Four of the scenarios included a 25% and 50% increase in both ARP and OTPs payments, and the other four scenarios included a 25% and 50% decrease in both ARP and OTPs payments.

CHAPTER V: RESULTS AND DISCUSSION

Table 5 presents the summary statistics of the breakeven incentive payments for producers to convert field perimeters adjacent to tree lines into UBH without reducing their net returns (equation 4). The average incentive payment for corn ranged from $97/acre to $109/acre while soybean producers would require a payment between $169/acre to $189/acre, depending on the UBH species. Planting UBH buffer in SG required the greatest incentive payments on average for corn and soybean producers, followed by IG and BB. Incentive payments were lower for corn production than for soybean production, indicating the negative impact of tree lines along field perimeters was greater for corn production than soybean production. This aligns with previous research that observed trees along field perimeters had a greater adverse effect on corn yields than soybean yields (Kitchen et al., 2005; Reynolds et al., 2007), and what Barbour et al. (2008) concluded that converting field perimeters to UBH was more profitable for corn than soybean production.

The cumulative distribution functions (CDFs) of breakeven incentive payments by UBH buffer are presented in Figure 4 for corn and Figure 5 for soybeans. Additionally, the CDFs of incentive payments by UBH buffer composition for both corn and soybeans are given in Figure 6 for SG, Figure 7 for BB, and Figure 8 for IG, respectively. The CDFs indicate the probability producers could convert field perimeters adjacent to tree lines into UBH without negatively impacting their net returns at a given incentive payment level. The figures indicate that approximately 25% of corn and soybean producers would not require an incentive payment to convert field perimeters adjacent to trees into UBH. That is, the producer would increase their net returns by removing these areas of the field from production and planting a UBH without an incentive payment. These figures also show that the UBH program would not be well suited for some producers unless the incentive payments were substantially increased.

The incentive payment for each grass under the current USDA NRCS incentive payment structure as well as the eight different hypothetical changes to the current payment structure are presented in Table 6. For all scenarios, incentive payments were found to range between $85/acre to $187/acre depending on the native warm-season grass used (Table 6). Table 7 shows the probability producers could convert field perimeters adjacent to tree lines into UBH buffer without negatively impacting their net returns at the given incentive payment level. For example, at the current incentive payment level 53% of the corn producers could convert field perimeters adjacent to tree lines into UBH buffer without reducing their net returns. For soybean, soybean producers had approximately a 39% could convert field perimeters adjacent to tree lines into UBH buffer without reducing their net returns at the current incentive payment level.

If the ARP was increased by 25%, the probability producers could convert cropland adjacent to tree lines into a UBH buffer without negatively impacting their net returns slightly increased to 57% for corn and 42% for soybeans. Increasing the OTPs by 25% resulted in a higher incentive payment than the 25% increase in ARP; thus, the probability producers could convert field perimeters adjacent to tree lines into a UBH buffer without negatively impacting their net returns increased to 57%-59% for corn and 42%-43% soybean. If the ARP was further increased by 50%, approximately 60%-61%

of corn and 44% of soybean producers would breakeven from converting field perimeters adjacent to tree lines into UBH buffers. When OTPs were increased 50%, the probability corn and soybean producers could convert field perimeters adjacent to tree lines into a UBH buffer without reducing their net returns slightly increased to approximately 62-65% and 46-47%, respectively.

Conversely, if the ARP was decreased by 25%, the probability corn and soybean producers who could convert field perimeter cropland areas adjacent to tree lines into UBH buffers without reducing their net returns slightly decreased to 49-50% and 37%, respectively. The probability of producers that could convert field perimeters adjacent to tree lines into a UBH buffer without reducing their net returns decreased slightly further to approximately 49% for corn and 36%-37% for soybeans when the OTPs were reduced by 25%. These probabilities are reduced further when the OTPs and ARP payments were decreased by 50%. The results indicate that producer adoption of a UBH buffer is more sensitive to changes in the OTPs than the ARP payments.

The results suggest that current incentive payment levels provided by USDA NRCS for the UBH program could encourage some producers to plant field perimeters adjacent to tree lines into UBH, even without the TWRA offering additional incentive payments to producers. Communicating results from these economic analysis could be used to further expand UBH buffers in Tennessee.

CHAPTER VI: CONCLUSION AND IMPLICATIONS

Little is known about how planting UBH buffers on cropland adjacent to tree lines might impact producers' net returns in the Southeast United States, and how much producers would need to be compensated to plant UBH buffers in these areas. The objective of this study was to determine the incentive payment required by corn and soybean producers to convert field perimeters adjacent to tree lines into UBH buffers. Monte Carlo simulation models were developed to simulate distributions of annualized cost-share payments that would be required for Tennessee corn and soybean producers. Five years (2008-2012) of corn and soybean yield data from 69 typical West Tennessee fields was used. The probability producers that could plant UBH adjacent to tree lines without reducing their net returns at various cost-share payment levels was found.

The average cost-share payment for corn and soybean producers ranged from $97 to $109/acre and $169 to $189/acre, respectively. Soybean producers would require a higher cost-share payment than corn producers, suggesting that soybean production was not as negatively impacted by tree line competition along a field perimeter as corn production. Planting a BB UBH buffer required the smallest cost-share payments on average for corn and soybean producers. The results suggest that current cost-share payment levels provided by USDA NRCS for the UBH program are sufficient to encourage some producers to plant field perimeters adjacent to tree lines into UBH. The results may help inform agencies in determining the cost-share payment required to influence Tennessee producers to replace traditional crop production adjacent to trees with an UBH buffer.

Future research should evaluate producer willingness to adopt UBH buffers for each estimated incentive payment level through survey analysis. Survey analysis can also be useful in determining the non-financial benefits of installing UBH buffers after adoption, such as evaluating if weeds are suppressed or if northern bobwhite quail populations are becoming established. Additional future research should also evaluate the local economic impacts of increased numbers of quail hunters when producers adopt UBH borders in addition to negotiating hunting lease sales.

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APPENDIX

Table 1. Average Corn and Soybean Yields (bu/acre) from 69 Fields in Henderson, Decatur, and Gibson Counties Tennessee, from 2008-2012

Year	2008	2009	2010	2011	2012	Average
Field Location/Crop				*Corn*		
Whole-Field Harvest Yield	148	146	107	145	132	137
Tree line Harvest Yield	108	101	55	94	65	85
Whole-Field Harvest Yield Without Tree Line	150	150	111	149	141	140
				Soybean		
Whole-Field Harvest Yield	52	41	42	36	43	41
Tree Line Harvest Yield	43	35	28	26	32	30
Whole-Field Harvest Yield Without Tree Line	53	42	42	39	42	44

Table 2. Switchgrass Establishment Budget for Tennessee in 2015

Item	Unit	Quantity	Price	Amount
Variable Expenses				
Seed	lb	10.00	$21.72	$217.20
No-Till Drill Rental	acre	1.00	$9.60	$9.60
Nitrogen (NO3[a])	lb	0.00	$0.55	$0.00
Phosphorus (P2O5[b])	lb	40.00	$0.69	$27.60
Potassium (K20[c])	lb	80.00	$0.48	$38.40
Fertilizer Application	acre	1.00	$9.20	$9.20
Gramoxone Max	pt	1.50	$4.33	$6.50
Surfactant	pt	.50	$0.63	$0.32
Herbicide Custom Application	acre	1.00	$7.97	$7.97
Fuel[d]	acre	1.00	$7.78	$7.78
Oil and Filter[d]	acre	1.00	$1.16	$1.16
Repairs and Maintenance[d]	acre	1.00	$4.15	$4.15
Interest on Operating Capital	acre	1.00	8.00%	$13.19
Land Rent	acre	1.00	$20.00	$20.00
Total Variable Cost	acre	1.00		$363.07
Fixed Costs				
Depreciation[d]	acre	1.00	$2.58	$2.58
Interest[d]	acre	1.00	$3.34	$3.34
Insurance[d]	acre	1.00	$0.22	$0.22
Total Fixed Costs	acre	1.00		$6.14
Labor Cost	hour	1.00	$9.87	$9.87
Total Establishment Cost	acre	1.00		$379.08
10% Risk of Re-Establishment	acre	10.00%		$37.91
Total Cost With 10% Risk of Re-establishment	acre	1.00		$416.99
Annualized Total Cost of Establishment With 10% Risk	acre	1.00		$62.14

[a]NO3=Nitrate
[b]P2O5=Potassium Oxide
[c]K2O=Phosphate
[d]Costs are associated with operating a 100hp tractor and 10' rotary mower.

Table 3. Indian Grass Establishment Budget for Tennessee in 2015

Item	Unit	Quantity	Price	Amount
Variable Expenses				
Seed	lb	7.00	$20.59	$144.13
No-Till Drill Rental	acre	1.00	$9.60	$9.60
Nitrogen (NO3[a])	lb	30.00	$0.55	$16.50
Phosphorus (P2O5[b])	lb	30.00	$0.69	$20.70
Potassium (K20[c])	lb	30.00	$0.48	$14.40
Fertilizer Application	acre	1.00	$9.20	$9.20
Gramoxone Max	pt	1.50	$4.33	$6.50
Surfactant	pt	.50	$0.63	$0.32
Herbicide Custom Application	acre	1.00	$7.97	$7.97
Fuel[d]	acre	1.00	$7.78	$7.78
Oil and Filter[d]	acre	1.00	$1.16	$1.16
Repairs and Maintenance[d]	acre	1.00	$4.15	$4.15
Interest on Operating Capital	acre	1.00	8.00%	$9.70
Land Rent	acre	1.00	$20.00	$20.00
Total Variable Cost	acre	1.00		$272.10
Fixed Costs				
Depreciation[d]	acre	1.00	$2.58	$2.58
Interest[d]	acre	1.00	$3.34	$3.34
Insurance[d]	acre	1.00	$0.22	$0.22
Total Fixed Costs	acre	1.00		$6.14
Labor Cost	hour	1.00	9.87	$9.87
Total Establishment Cost	acre	1.00		$288.11
10% Risk of Re-Establishment	acre	10.00%		$28.81
Total Cost With 10% Risk of Re-establishment	acre	1.00		$316.92
Annualized Total Cost of Establishment With 10% Risk	acre	1.00		$47.23

[a]NO3=Nitrate
[b]P2O5=Potassium Oxide
[c]K2O=Phosphate
[d]Costs are associated with operating a 100hp tractor and 10’ rotary mower.

Table 4. Big Bluestem Grass Establishment Budget for Tennessee in 2015

Item	Unit	Quantity	Price	Amount
Variable Expenses				
Seed	lb	10.00	$11.75	$117.50
No-Till Drill Rental	acre	1.00	$9.60	$9.60
Nitrate (NO3)	lb	30.00	$0.55	$16.50
Phosphate (P2O5)	lb	30.00	$0.69	$20.70
Potassium Oxide (K20)	lb	30.00	$0.48	$14.40
Fertilizer Application	acre	1.00	$9.20	$9.20
Gramoxone Max	pt	1.50	$4.33	$6.50
Surfactant	pt	.50	$0.63	$0.32
Herbicide Custom Application	acre	1.00	$7.97	$7.97
Fuel[a]	acre	1.00	$7.78	$7.78
Oil and Filter[a]	acre	1.00	$1.16	$1.16
Repairs and Maintenance[a]	acre	1.00	$4.15	$4.15
Interest on Operating Capital	acre	1.00	8.00%	$8.63
Land Rent	acre	1.00	$20.00	$20.00
Total Variable Costs	acre			$244.41
Fixed Costs				
Depreciation[a]	acre	1.00	$2.58	$2.58
Interest[a]	acre	1.00	$3.34	$3.34
Insurance[a]	acre	1.00	$0.22	$0.22
Total Fixed Costs	acre	1.00		$6.14
Labor Cost	hour	1.00	9.87	$9.87
Total Establishment Cost	acre	1.00		$260.42
10% Risk of Re-Establishment	acre	10.00%		$26.04
Total Cost With 10% Risk of Re-establishment	acre	1.00		$286.46
Annualized Total Cost of Establishment With 10% Risk	acre	1.00		$42.69

[a]NO3=Nitrate
[b]P2O5=Potassium Oxide
[c]K2O=Phosphate
[d]Costs are associated with operating a 100hp tractor and 10’ rotary mower.

Table 5. Summary Statistics of the Simulated Distributions of Incentive Payments Required ($/acre/year) for Corn and Soybean Producers to Adopt Each Grassed UBH Option

	Corn			Soybean		
Estimated UBH	SG	IG	BB	SG	IG	BB
Mean	$109	$99	$97	$189	$174	$169
Standard Deviation	178	170	168	263	256	254

Note: UBH = upland bird habitat border; SG = switchgrass; IG = indiangrass; BB = big bluestem

Table 6. Estimated Incentive Payment Levels for Each Grassed UBH Option at Current Payment Levels and Under Each Hypothetical Scenario

Cost Share Payment Level Scenario	Estimated UBH		
	SG	IG	BB
50% Decrease in ARP	$252.07	$218.91	$208.80
50% Decrease in OTPs	$226.25	$213.35	$209.42
25% Decrease in ARP	$290.60	$257.43	$247.33
25% Decrease in OTPs	$273.84	$251.75	$245.00
Current Incentive Payment Level	$329.94	$296.77	$286.67
25% Increase in ARP	$367.64	$334.48	$324.38
25% Increase in OTPs	$392.08	$346.02	$331.99
50% Increase in ARP	$406.17	$373.01	$362.90
50% Increase in OTPs	$462.70	$401.89	$383.38

Note: UBH = upland bird habitat border; SG = switchgrass; IG = indiangrass; BB = big bluestem; ARP = annual rental payments; OTPs = one-time payments

Table 7. Probability Corn and Soybean Producers could Plant Field Borders adjacent to Tree Lines in UBH without Reducing Net Returns

	Corn			Soybean		
Incentive Payment Level	SG	IG	BB	SG	IG	BB
Incentive Payment Level with 50% Decrease in ARP	46.77%	45.83%	45.50%	34.65%	34.77%	34.73%
Incentive Payment Level with 50% Decrease in OTPs	44.42%	45.31%	45.56%	33.19%	34.44%	34.77%
Incentive Payment Level with 25% Decrease in ARP	50.28%	49.50%	49.22%	36.88%	37.06%	37.06%
Incentive Payment Level with 25% Decrease in OTPs	48.75%	48.96%	49.00%	35.91%	36.72%	36.92%
Current Incentive Payment Level	53.87%	53.23%	52.99%	39.20%	39.43%	39.47%
Incentive Payment Level with 25% Increase in ARP	57.28%	56.83%	56.64%	41.47%	41.78%	41.86%
Incentive Payment Level with 25% Increase in OTPs	59.47%	57.91%	57.37%	42.95%	42.50%	42.34%
Incentive Payment Level with 50% Increase in ARP	60.71%	60.42%	60.29%	43.81%	44.19%	44.31%
Incentive Payment Level with 50% Increase in OTPs	65.59%	63.05%	62.19%	47.28%	46.01%	45.62%

Note: UBH = upland bird habitat border; SG = switchgrass; IG = indiangrass; BB = big bluestem; ARP = annual rental payments; OTPs = one-time payments

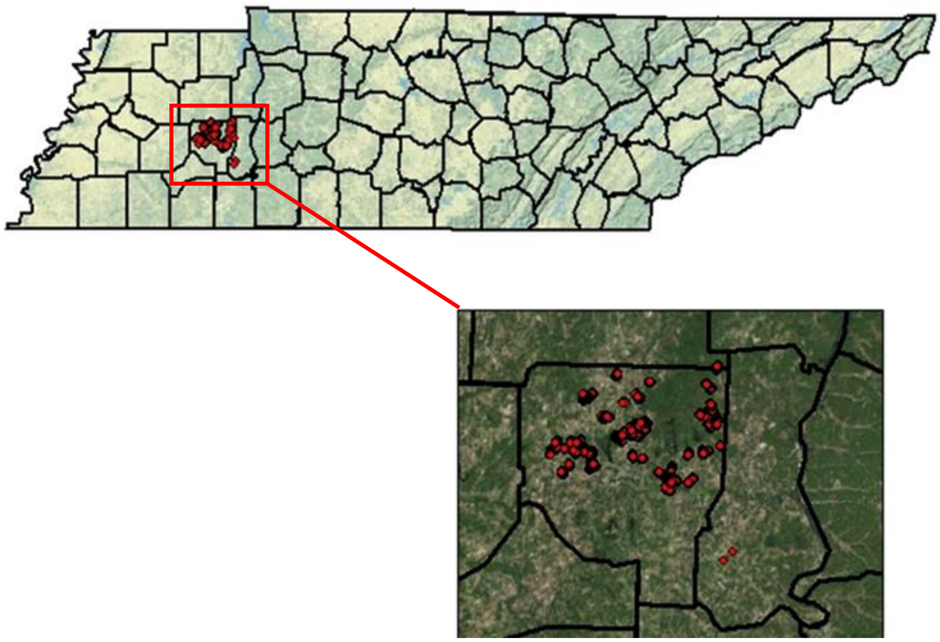

Figure 1. Sampled 69 Field Locations within Tennessee

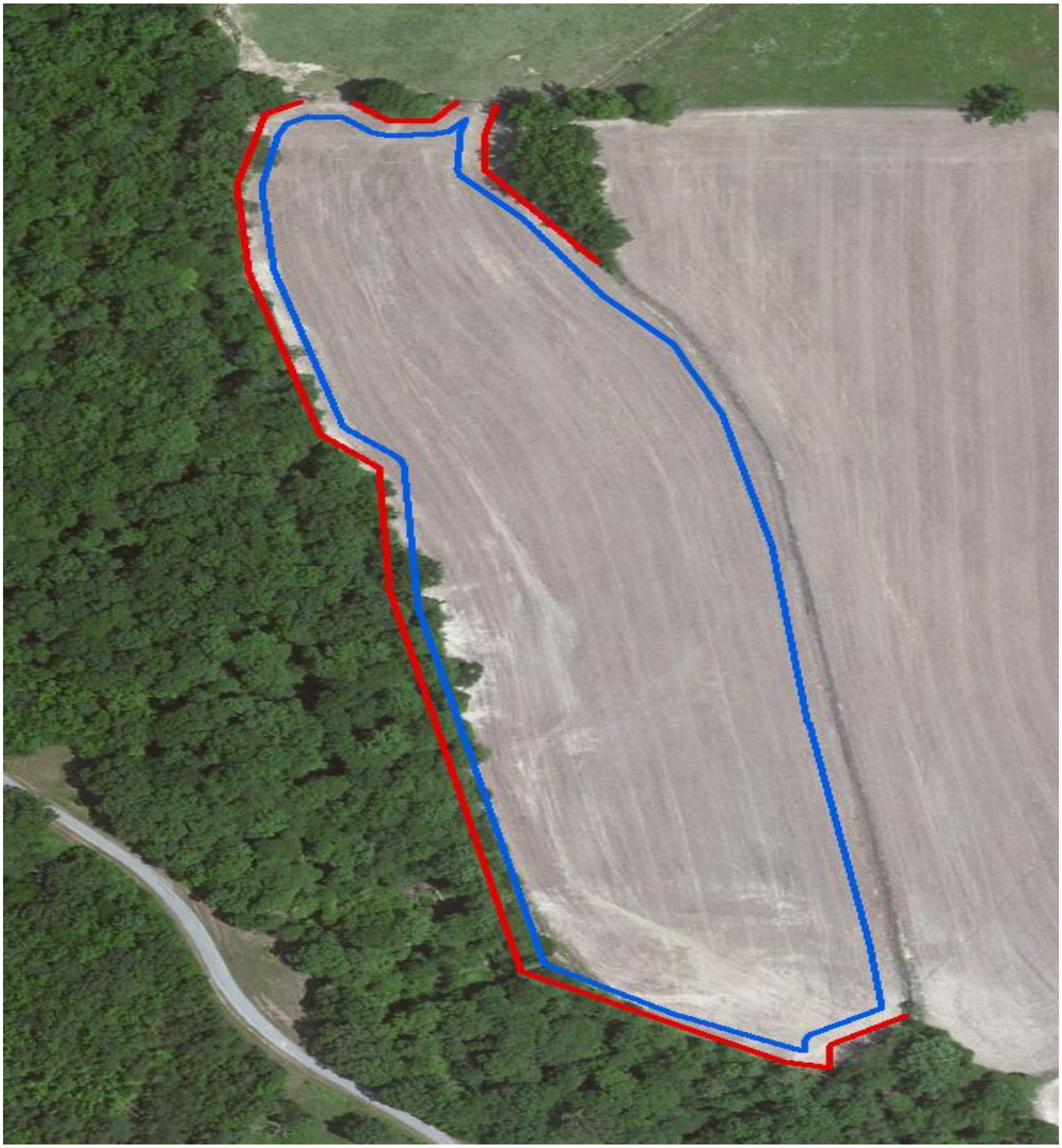

Figure 2. Field Example Displaying Tree Line, First Combine Swath, and Assumed Planted Upland Bird Habitat Border Areas

Figure 3. Real 2015 Corn and Soybean Prices ($/bu) Over the Past 21 Years in Tennessee

Source: USDA-NASS (2016b)

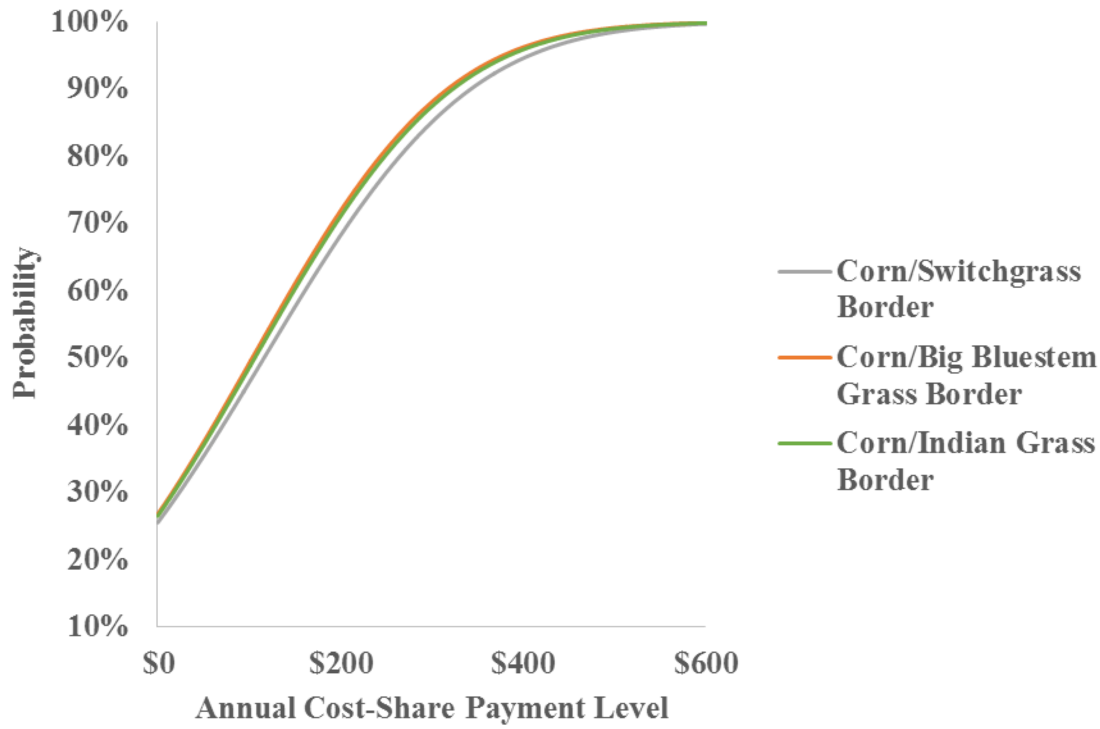

Figure 4. Probability Corn Producers would Breakeven from Converting Field Borders Adjacent to Tree Lines into UBH at Various Cost-Share Payments

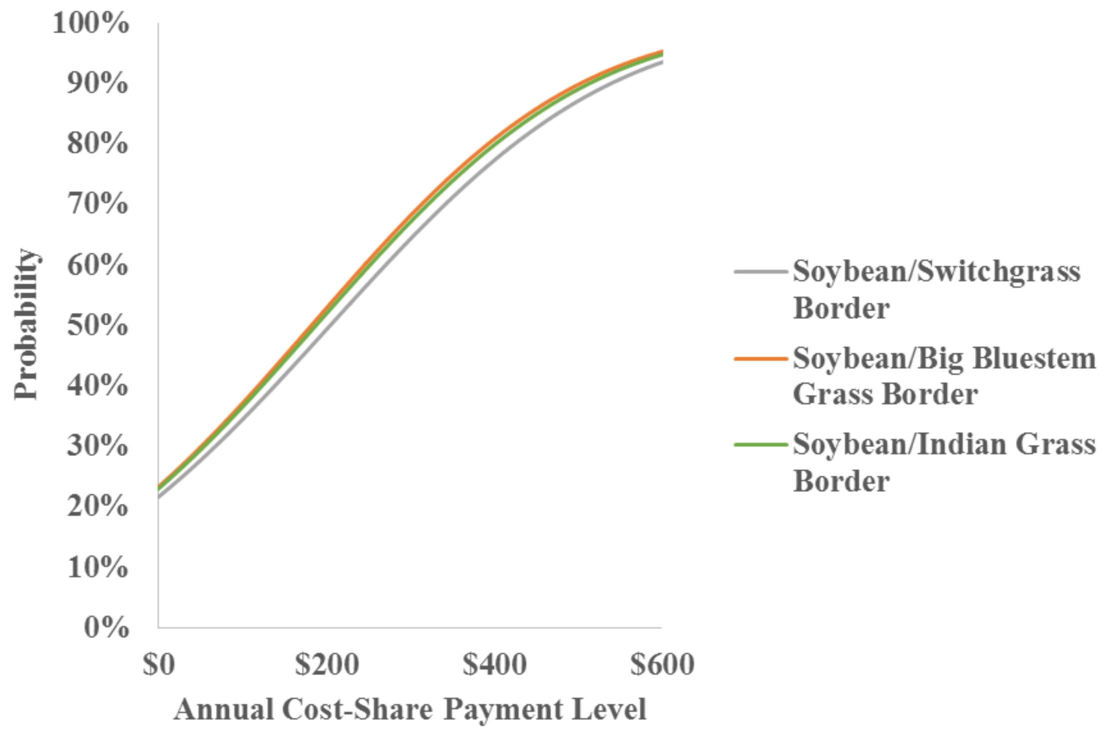

Figure 5. Probability Soybean Producers would Breakeven from Converting Field Borders Adjacent to Tree Lines into UBH at Various Cost-Share Payments

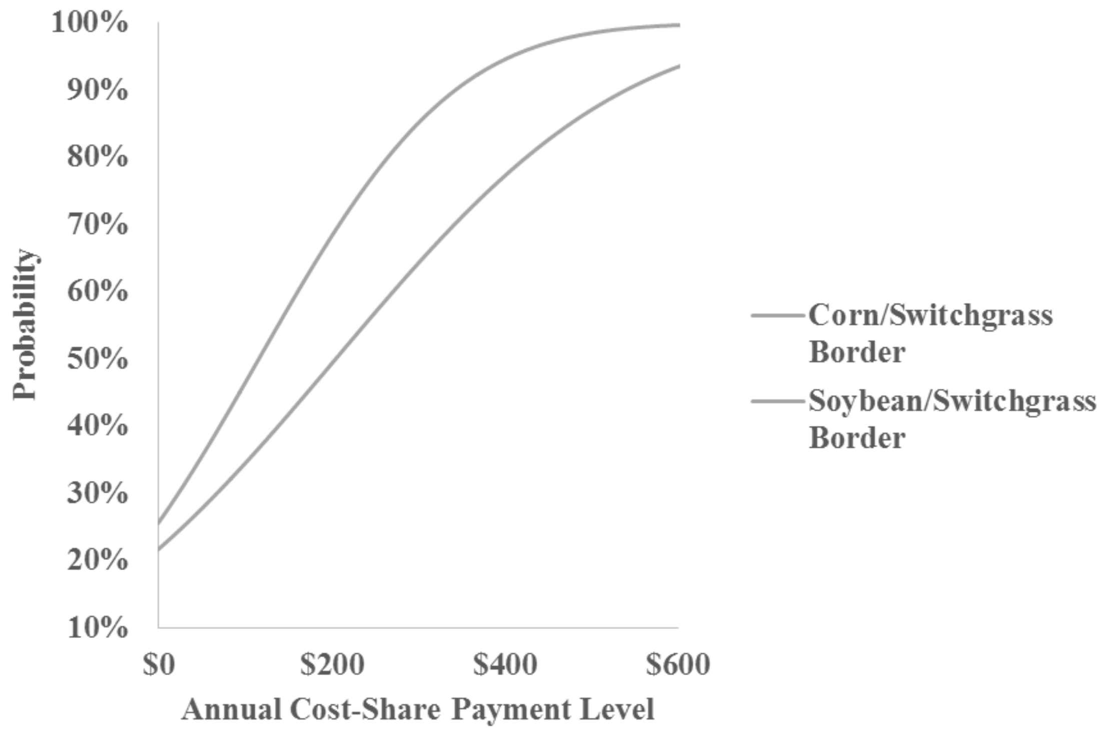

Figure 6. Probability Corn and Soybean Producers would Breakeven from Converting Field Borders Adjacent to Tree Lines into Switchgrass UBH at Various Cost-Share Payments

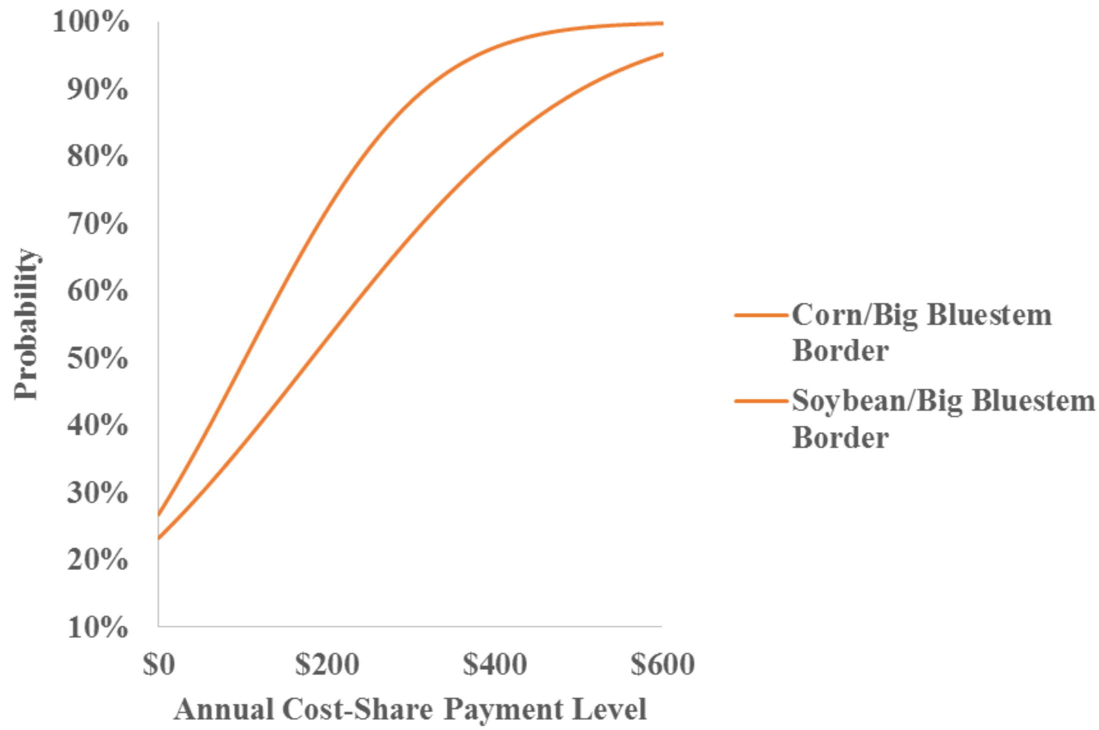

Figure 7. Probability Corn and Soybean Producers would Breakeven from Converting Field Borders Adjacent to Tree Lines into Big Bluestem Grass UBH at Various Cost-Share Payments

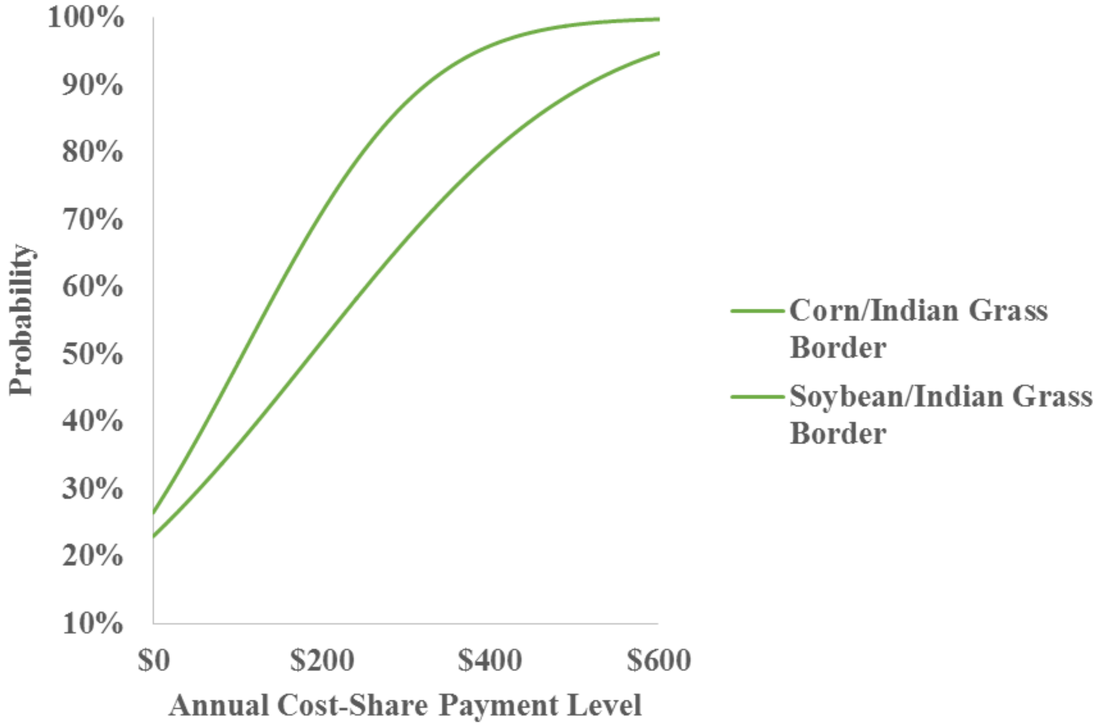

Figure 8. Probability Corn and Soybean Producers would Breakeven from Converting Field Borders Adjacent to Tree Lines into Indian Grass UBH at Various Cost-Share Payments

VITA

Nathaniel Bruce was born in Pittsburgh, Pennsylvania to Ann Trocchio and Scott Bruce. He grew up in Hudson, Ohio, and attended Hudson High School. He returned to the Allegheny Plateau to pursue a Bachelor of Science in Environmental and Natural Resource Economics at West Virginia University in Morgantown. Nathaniel continued his education to pursue a Master of Science degree in Agricultural Economics at the University of Tennessee at Knoxville. He graduated in May 2017.