ASSESSING TEXAS FARMERS' COVER CROPPING BEHAVIOR THROUGH KNOWLEDGE AND ATTITUDES

by

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DEDICATION

For Dad and Aditi: you watched it begin, and I saw it through to the very end.

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
Fe	Iron
N	Nitrogen
P	Phosphorous
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
WTP	Willingness to Pay
Zn	Zinc

I. INTRODUCTION

Cover crop implementation in the United States is a limited practice with potential for significant economic benefit if properly integrated into modern agricultural systems (Roth et al., 2018). Although research related to cropping and its benefits for both soil and farm profits have been conducted, the literature is limited in scope. Very few studies have been conducted on the economic impact of cover cropping in general, although it is increasing, and even fewer studies have been conducted statewide. No literature on the economic benefits of cover cropping specific to Texas was found. Despite Texas' prominence as the state with the highest number of farms, shortcomings in research on the value of cover cropping limit farmers' opportunity and willingness to adopt the practice (Plastina et al., 2018). Even though the change in Texas farm profitability in response to cover crop adoption is yet to be determined, the following general statement can be made: the choice to not adopt cover crops (e.g. to leave the soil bare between cash crop harvests) contributes to erosion and soil degradation in the form of lost fertility (Dunn et al., 2016). Further, factors influencing the short-term and long-term cover cropping behavior by farmers are not well studied but could include hardiness zones, input costs, cover crop type, soil texture, attitudes, knowledge, and demographic factors.

Several factors influence farmers' choice of cover crop. The type of cover crop that is suitable to a region and the soil texture are factors that should be considered together. Depending on the soil's texture, the cover crop that is best suited for use may vary and farmers are expected to choose the most suitable option for their soil texture. The decision to choose a cover crop is usually done by farmers who are willing to experiment through trial and error (Dunn et al., 2016). The suitability of a cover crop for a given region is influenced by the hardiness zone in which the cover crop is planted. Hardiness zones can aid in selection of cover crops that thrive best in that region with least possible input and greater economic benefit for farmers. Hardiness zones demonstrate the average temperatures of a region, and farmers can use that information when choosing a cover crop. Texas is within hardiness zones 7b to 10a (USDA, 2012). These influential factors have been considered when attempting to ascertain the type of cover crops farmers in Texas are likely to choose for their farms (if any) and will be mentioned further in the methodology section.

II. OBJECTIVES

The surveys described in this thesis are designed to 1) evaluate Texas farmers' knowledge and attitudes towards regenerative agricultural practices; 2) observe Texas farmers' decision-making when it comes to cover cropping; and 3) determine the probability of Texas farmers making a regenerative decision when given a choice between alternatives.

III. LITERATURE REVIEW

The literature reviewed in this section was divided into five different categories as seen in Figure 1 and Table 1, with a focus on cover cropping. To aid in the determination of Texas farmers' knowledge of regenerative agricultural practices, it is first necessary to establish the key areas needed for a general understanding of regenerative agriculture. The first key area to be discussed is the input cost of nitrogen fertilizers associated with cover cropping; the second key area is soil organic carbon (SOC); the third key area is soil health; the fourth key area is direct costs; the fifth area is cash crop yield; and the sixth area is farmer behavior. 54 total articles were reviewed, and the proportion of these articles which pertain to cover cropping can be seen in Table 2 at the end of this literature review.

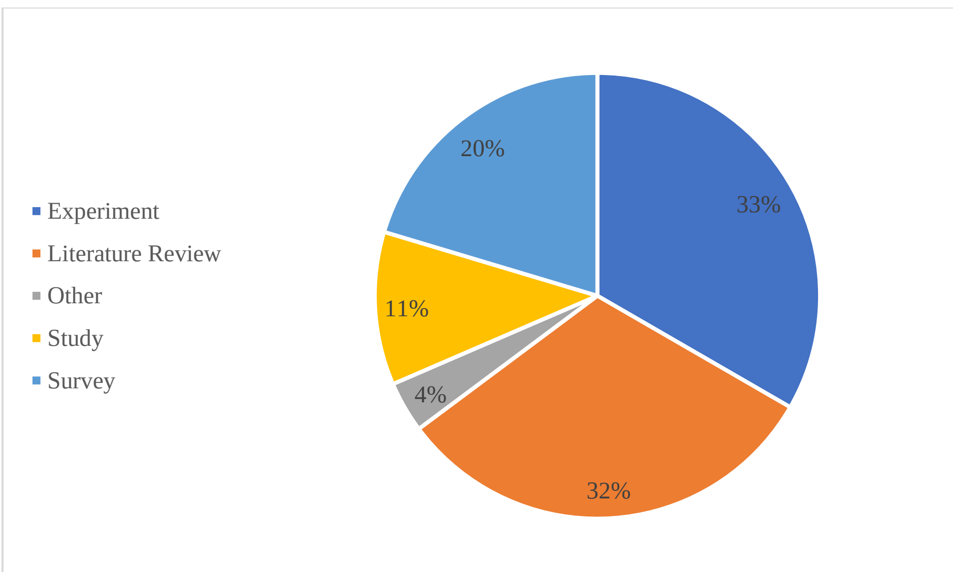


Figure 1: Percent of Literature Reviewed by Category

Table 1: Quantity of Literature Reviewed by Category

Literature Category	***Count of Literature Category***
Experiment	18
Literature Review	17
Other	2
Study	6
Survey	11
Total	**54**

When evaluating farmers' knowledge of cover cropping, it is necessary to consider the input cost associated with fertilizer applications. Nitrogen fertilizers are significant input costs for farmers, but the cost can be reduced by using leguminous cover crops. Fertilizer averages at 35.6%, 17.2%, 35%, and 14.5% of operating expenses in the United States for producing corn, soybean, wheat, and cotton; respectively (USDA, 2021). Nitrogen fertilizer use in Europe was reduced by 23-31 kg/ha when legumes were used as a cover crop or intercrop (Preissel et. al., 2017). Reduced input costs increase economic benefits for farmers even if legumes do not increase yield. Although input costs in the Preissel et al. (2017) study were reduced, it was also stated that results varied, and economic benefits were not consistent across models. It was unclear why this was so but increases the need for further research into interactions between cover crops used, soil, and effect on farmers' profits, if any. Even if legumes are found to not consistently reduce input cost, there is still the potential for legumes to increase yield with their nutritional benefits and biomass contribution to the soil. With an increased yield, farmers can sell more, and the economic benefit would not be reduced input cost but increased income. There is also the potential for farmers to increase income and reduce their input cost. Texas soils, including that of the Blackland Prairie, are traditionally deficient in nitrogen and phosphorous (Hickey and Onken, 1995). Due to its nitrogen deficiency, the

Blackland Prairie requires significant use of nitrogen fertilizers (Torbert et al., 2001; Kissel et al., 1976). Because legumes fix nitrogen, there is the potential to reduce the need for nitrogen fertilizers with the incorporation of legumes into crop rotations (Tijare et al, 2017). Nitrogen and phosphorous levels correlate, meaning as leguminous cover crops fix nitrogen in the soil, more phosphorous will become available for subsequent crops to take up (Wang et al., 2021). With the increase in nitrogen from legumes, the need for traditional nitrogen fertilizers is decreased (Preissel et al., 2017). This reduces the input cost associated with nitrogen fertilizers and could provide an economic benefit to Texas farmers by increasing their profit margins if the reduction in fertilizer cost is greater than the increased cost of seeding and planting the leguminous cover crop. Although there have been economic benefits of approximately \$122 ha^{-1} yr^{-1} from using legumes instead of nitrogen fertilizers, these results are not consistent (Preissel et al., 2017). The marginal benefits of nitrogen fixation in the soil from cover crops decrease over time (Bergtold et al., 2019). Specifically, when clover cover crops were plowed under, the N made available by the legumes was used for two subsequent plantings but was not able to be used by a third planting (Hipp, 1987). This indicated that cover crops should be used at least every two cash crop rotations or more frequently to achieve maximum benefits from the increased nitrogen levels. Because of their ability to fix nitrogen in the soil, there is evidence that legumes reduce the need for nitrogen fertilizers (Stagnari et al., 2017; Tijare et al., 2017). One study shows that legumes fix nitrogen, suppress weeds, and increase yield (Lu et al., 2000). Besides fixing nitrogen, leguminous cover crops can increase iron, zinc, and phosphorus uptake when planted with cereal crops (Xue et al., 2016).

Another segment of knowledge of which Texas farmers should be aware involves cover cropping and increased soil organic carbon levels. Cover crops were the second most effective method of improving soil organic carbon (SOC), behind biochar applications (Bai et al., 2019). This comprehensive review of journal articles by Bai et al. (2019) indicated that the effects of management and local factors such as soil type and climate are responsible for the success of increasing SOC. It was stated that some studies show negative effects of soil conservation practices when management is inefficient, or the cover crop chosen was not suitable to the soil texture. Soil texture strongly affects the amount of carbon sequestered. With an increase in clay fractions, SOC decreases (Bai et al., 2019; Meersmans et al., 2012). Dos Reis et al. (2014) determined that soil texture as well as the cover crop chosen affects the quantity of carbon sequestered in the soil. Low SOC reduces yield in agricultural ecosystems worldwide (Lal, 2018). According to Wright and Nichols (2002), a glycoprotein called glomalin accounts for 27% of the stored carbon in the world's soils. Glomalin levels can be raised by no-till or cover crop practices. Cover crops have been shown to increase SOC at an increasing rate as management practices stay constant in a long-term setting (Bai et al., 2019; Steenwerth and Belina, 2008).

The third area on which Texas farmers were set to be evaluated were their soils. The soils of farmland in the Texas Blackland Prairie are primarily shrinking and swelling clays, which makes them subject to cracking and nutrient runoff. Cover crops can help to reduce these issues, which can make the process of farming easier for Texas farmers in the long run. This shrinking and swelling nature of the Blackland Prairie makes estimates of erosion and runoff difficult to measure, although it has been done. Arnold et al. (2005)

employed a SWAT hydrologic model to estimate soil cracking in Reisel, TX. The estimation of surface runoff assumed that tillage would help close cracks, so does not account for conservation practices such as no-till farming. Cracking associated with clay soils can increase groundwater pollution by allowing substance infiltration into lower subsoils that cannot be reached by roots. Estimates of surface runoff in this study by Arnold et al. (2005) were stated to be low quality due to the soil’s swelling and shrinking. Harmel et al. (2006) demonstrated that winter cover crops reduce erosion in Blackland Prairie watersheds. Increased levels of the glycoprotein glomalin, which can be a result of cover crop usage, boost resistance to erosion and degradation and increase productivity in soils (Wright and Nichols, 2002). Cover crops also reduce erosion because they protect the surfaces of soils (Lu et al., 2000).

When attempting to assess potential influential factors for cover crop adoption, direct costs should be considered. Bergtold et al. (2019), identified four primary direct costs associated with cover crops: seed, planting, fertilizer application, and termination costs. These direct costs are present regardless of the cropping method the farmer uses (ex: conventional, no-till, etc.). Long-term profits can be increased when these input costs are reduced, given that most costs of cover cropping are up front and short-term (Snapp et al., 2005). Bergtold et al. (2019) found that cover crops are profitable in the long-term and may or may not be profitable in the short-term. Carbon farming done by farmers using cover crops and no-till methods may become profitable due to carbon credits given for increased carbon sequestration in the soil (Barth, 2016). Research into conventional agriculture has shown profitability is affected most by yield and less by reducing input costs, so it will likely be more beneficial for farmers to focus on increasing their yields

(Creamer et al., 1996; Lu et al., 2000). This is not a viable solution in the long term, if there is a sudden fall in market prices or the costs of inputs rise, simply increasing yield will not be sufficient for a farmer to remain profitable (Odum, 1989; Henry et al., 2011). Additionally, research into regenerative agriculture indicates that yield is not the only factor that influences profitability, and yield may be overemphasized (LaCanne and Lundgren, 2018; Cusworth et al., 2021).

According to Swanson et al. (2018), adding cover crops into the rotation increases farmers' debt and difficulty in maintaining a good financial state. The costs associated with integrating cover crops are one of the largest and most contributing factors dissuading farmers from using them in their rotations. Cover crops can increase farmers' costs by 5-10%, which may not be the sustainable option for small margin producers in the short term. Zhou et al. (2021) showed that N fertilizer savings due to cover crop usage was not enough to offset the input costs associated with planting the cover crops. It is likely that farmers will need more economic incentives to incorporate cover crops into their rotations than a minor reduction in their input costs. Some research has shown net returns were not affected when seed costs increased (DeLaune et al., 2020). The indirect cost associated with human welfare (well-being) could be severe without sustainable methods like cover crops or no-till methods (Millennium Ecosystem Assessment, 2005).

Yield is another factor which should be brought into consideration when evaluating farmers’ decision-making processes. In a study by DeLaune et al. (2020), cover crops did not significantly increase yield for various tilling practices but did increase seed costs. However, a study by Jarecki and Lal (2003) showed crop yield from cover crops increased, as did SOC. In Texas, SOC increased by up to 550 kg ha^{-1} y^{-1}

when yield increased (Jarecki and Lal, 2003). Yield is not the only valuable factor to consider when attempting to improve the economic standing of a farming operation due to the influence of market factors, input subsidies, etc. (Odum, 1989). If global production is to continue to increase without sustainability, soil degradation and issues with crop production will also increase (DeLong et al., 2015). Cover crops increase weed suppression, although the sowing density of cover crops appeared to have diminishing marginal returns over time on the level of weed suppression that was able to be obtained (Kruidhof et al., 2008). Weed suppression through cover cropping has the potential to increase cash crop yields. In the short term, yield was less for a no-tillage cover cropping system than it was in a conventional farming system (Lewis et al., 2018). When mixed species cover crops were used, conventional tillage and no till did not have differences in yield or margin. Zhou et al. (2021) indicated that increases in yield due to cover crop usage was not very significant, although the difference was present. Additionally, this focus on increasing only yield to improve profits will have environmental effects which could have been otherwise avoided (Odum, 1973). Some research has shown net returns were not affected when seed costs increased (DeLaune et al., 2020). Morton et al. (2006) demonstrated how a change in crop biomass due to the inclusion of cover crops in the rotation changed the yield of the cash crop. Cover crop inclusion provides farmers with both indirect costs and benefits to their production functions. Some types of cover crops were shown to increase profitability with proper management. These cover crop varieties were both grasses and legumes. Research from Nielson et al. (2015) showed a decrease in short-term yield after a cover crop was used. In the long-term, however, yields of cash crops associated with cover crops become more stable (Lotter et al., 2003; Snapp et al., 2005). This long-term stability could be an influential factor to consider when it comes to farmers who are more risk averse. More risk-averse farmers may appreciate the stability which comes with a long-term investment in cover crops.

Regarding farmers' cover cropping behaviors, several influential factors have been identified: knowledge, perceptions/attitudes, and demographic factors. "Robust results" (clear results with positive indicators of the benefits associated with cover cropping) increase the rate of cover crop adoption (Daryanto et al., 2019). Cover crops provide ecosystem services that are traditionally undervalued. Leguminous cover crops can increase crop productivity in situations where the agricultural practice uses low input levels (Daryanto et al., 2019; Stagnari et al., 2017). Generally, being more informed (ie. having a greater education) is associated with positive attitudes and these positive perceptions are considered highly influential factors (Armstrong and Impara, 1991; Bergtold et al., 2012). Positive attitudes or perceptions include optimistic outlooks on the success of cover cropping or other regenerative practices. Negative attitudes or perceptions include pessimistic outlooks on the success of cover cropping, or perceived difficulty with changes in behavior. Attitudes are associated with behavior, and farmers with positive attitudes towards cover cropping due to their education are more likely to adopt cover crops into their rotations (Arcury, 1990; Wauters et al., 2010). Research by Werner et al. (2017) has shown that not only were farmers with positive attitudes more likely to integrate cover crops into their rotation, but they were also more likely to continue doing so in the future. Demographic factors include income levels or farm size. Previous research has shown that income levels do affect cover cropping adoption (Bergtold et al., 2012). Farm size is linked to perceived difficulty of integrating the cover crop (Bergtold et al., 2019; Bergtold et al., 2012). Arbuckle and Ferrell (2012) found that farmers with larger farms tended to perceive greater difficulty in integrating cover crops, and often chose not to use them because of that perception. This perceived difficulty may affect the farmers' choices between cover cropping or another alternative and so has been included in the model methodology in the next section. Generally, being more informed (ie. having a greater education) is associated with positive attitudes and these positive perceptions are considered highly influential factors (Armstrong and Impara, 1991; Bergtold et al., 2012). Attitudes are associated with behavior, and farmers with positive attitudes towards cover cropping due to their education are more likely to adopt cover crops into their rotations (Arcury, 1990; Wauters et al., 2010). Research by Werner et al. (2017) has shown that not only were farmers with positive attitudes more likely to integrate cover crops into their rotation, but they were also more likely to continue doing so in the future.

Table 2: Literature Review Subject Classification

Author	Year Published	Title	Behavioral Theory	Carbon Sequestration	Cover Cropping	Hardiness Zones	Input Costs	Nitrogen Fixation	Perceptions and Knowledge	Soil Texture	Yield
Arbuckle and Ferrell	2012	Attitudes toward cover crops in Iowa: benefits and barriers	x		x				x		
Arbuckle and Roesch-McNally	2015	Cover crop adoption in Iowa: The role of perceived practice characteristics			x				x		
Arcury	1990	Environmental attitude and environmental knowledge							x		
Armstrong and Impara	1991	The impact of an environmental education program on knowledge and attitude							x		
Arnold et al.	2005	Estimation of soil cracking and the effect on surface runoff in a Texas Blackland Prairie watershed									x
Bai et al.	2019	Responses of soil carbon sequestration to climate-smart agriculture practices: A meta-analysis		x	x						

Barth	2018	*Farmers are Capitalizing on Carbon Sequestration: How Much is Your Carbon-Rich Soil Worth?*		x				
Bergtold et al.	2019	A review of economic considerations for cover crops as a conservation practice			x	x		x
Bergtold et al.	2012	Demographic and management factors affecting the adoption and perceived yield benefit of winter cover crops in the southeast	x		x		x	x
Creamer et al.	1996	A comparison of four processing tomato production systems differing in cover crop and chemical inputs			x			x
Cusworth et al.	2021	Agroecological break out: Legumes, crop diversification and the regenerative futures of UK agriculture.			x			x

Daryanto et al.	2019	Valuing the ecosystem services of cover crops: barriers and pathways forward	x		x	x			x
DeLaune et al.	2020	Agronomic and economic impacts of cover crops in Texas rolling plains cotton			x	x			x
DeLong et al.	2015	The soil degradation paradox: Compromising our resources when we need them the most						x	
Dos Reis et al.	2014	Carbon sequestration in clay and silt fractions of Brazilian soils under conventional and no-tillage systems		x				x	
Dunn et al.	2016	Perceptions and use of cover crops among early adopters: Findings from a national survey	x		x		x		
Harmel et al.	2006	Runoff and soil loss relationships for the Texas Blackland Prairies ecoregion						x	

Henry et al.	2011	The impact of a fungicide and an insecticide on soybean growth, yield, and profitability							x
Hickey and Onken	1995	Spatial variability of soil-test nitrogen and phosphorus on Texas Southern High Plains sandyland soils						x	
Hipp	1987	Nitrogen: Residual effects of clover on nitrogen nutrition of crops grown on Blackland soils			x	x		x	
Jarecki and Lal	2003	Crop management for soil carbon sequestration		x	x				
Jourdain et al.	2020	Farmers' preference for cropping systems and the development of sustainable intensification: a choice experiment approach	x		x		x		
Kissel et al.	1975	Losses of nitrogen in surface runoff in the Blackland Prairie of Texas						x	

Kruidhof et al.	2008	Ecological weed management by cover cropping: effects on weed growth in autumn and weed establishment in spring		x				
LaCanne and Lundgren	2018	Regenerative agriculture: merging farming and natural resource conservation profitably		x	x			x
Lal	2018	Digging deeper: A holistic perspective of factors affecting soil organic carbon sequestration in agroecosystems	x	x				
Lewis et al.	2018	Soil benefits and yield limitations of cover crop use in Texas High Plains cotton		x			x	x
Lotter et al.	2003	The performance of organic and conventional cropping systems in an extreme climate year						x
Lu et al.	2000	Cover crops in sustainable food production	x	x	x	x		x

Meersmans et al.	2012	A novel soil organic C model using climate, soil type and management data at the national scale in France	x					
Millenium Ecosystem Assessment	2005	Ecosystems and human well-being: wetlands and water		x				
Morton et al.	2006	The economics of cover crop biomass for corn and cotton		x				x
Nielson et al.	2015	Cover crop effect on subsequent wheat yield in the central Great Plains		x			x	x
Odum	1989	Input management of production systems			x			x
Odum	1973	Energy, ecology, and economics			x			x
Plastina et al.	2018	Annual net returns to cover crops in Iowa		x				
Preissel et al.	2017	Introducing legumes into European cropping systems: Farm-level economic effects	x	x	x	x		x
Rosolem et al.	2002	Root growth and nutrient accumulation in cover crops as affected by soil compaction		x				

Roth et al.	2018	A cost analysis approach to valuing cover crop environmental and nitrogen cycling benefits: A central Illinois on farm case study.		x		x			
Snapp et al.	2005	Evaluating cover crops for benefits, costs and performance within cropping system niches		x	x				x
Stagnari et al.	2017	Multiple benefits of legumes for agriculture sustainability: an overview		x		x			x
Steenwerth and Bellina	2008	Cover crops enhance soil organic matter, carbon dynamics and microbiological function in a vineyard agroecosystem	x	x					
Swanson et al.	2018	Understanding budget implications of cover crops		x	x		x		
Tijare et al.	2017	Effect of cover crops on yield of hybrid cotton in Vertisol		x				x	x

Torbert et al.	2001	Tillage system, fertilizer nitrogen rate, and timing effect on corn yields in the Texas Blackland Prairie						x	x
USDA	2012	USDA plant hardiness zone map			x				
USDA	2021	Commodity costs and returns				x			
Wang et al.	2021	Long-term cover crops improved soil phosphorus availability in a rain-fed apple orchard		x				x	
Wauters et al.	2010	Adoption of soil conservation practices in Belgium: an examination of the theory of planned behaviour in the agri-environmental domain	x	x			x	x	
Wayman et al.	2017	Organic and conventional farmers differ in their perspectives on cover crop use and breeding		x			x		

Werner et al.	2017	Farm level implementation of soil conservation measures: farmers’ beliefs and intentions		x	x	
Wright and Nichols	2002	Glomalin: hiding place for a third of the world's stored soil carbon	x			
Xue et al.	2016	Crop acquisition of phosphorus, iron and zinc from soil in cereal/legume intercropping systems: a critical review		x		
Zhou et al.	2021	Crop rotation, cover crop, and poultry litter effects on no-tillage cotton profitability.		x		x

IV. METHODS

A preliminary survey was distributed to Texas farmers online. The purpose of the preliminary survey was to determine farmers' attitudes and knowledge of regenerative agricultural practices, including cover cropping. This was to evaluate some of the influential factors when it comes to Texas farmers' decision-making, which was intended to be addressed by the final survey. The preliminary survey was conducted through Qualtrics. Questions in the survey were designed using mixture of Likert scale questions and some open-ended questions. In the beginning of the survey, some introductory questions were asked. They ranged from inquiries about familiarity with cover crop types to questions about the general location of the Texas farm. Some of the questions within the survey address the adoption (or lack of adoption) of cover cropping and farmer's self-disclosed reasons for doing so. Additionally, the preliminary survey provided an indication of what knowledge farmers' lack regarding cover cropping. The data collected from the preliminary survey was collected to aid the determination of clarifications needed in the final survey to ensure informed decision-making. Some questions were preceded by a short explanation of a term or topic to help ensure that the farmers were providing informed responses.

The knowledge portion of the preliminary survey was designed to ask questions such as "Does cover cropping increase carbon sequestration?" and "Do cover crops help to reduce nutrient runoff?". Farmers were asked to choose from options "Yes", "No", "Maybe", and "I don't know" for this style of question. This was to aid the determination of gaps in Texas farmers' knowledge, which influences farmers' likelihood of adopting cover cropping. Cronbach's alpha for the knowledge section of the preliminary survey was 0.94. The perceptions or attitude section of the survey included questions like "Do you believe that long-term benefits of cover cropping outweigh the short-term costs?" and "Current data suggests that cover crops can improve soil health and potentially improve farmers' yields or profits. Does this change your opinion on the importance of cover cropping?". Cronbach's alpha for the attitude section of the preliminary survey was 0.72.

Based on the information collected from the preliminary survey about producers' perception and knowledge, a second, final survey was distributed online via Qualtrics to Texas farmers. The purpose of the final survey was to determine how Texas farmers make decisions for or against regenerative agricultural practices based on their knowledge and attitudes as established by the preliminary survey. Questions developed for the final survey were created around the opinions, beliefs, and knowledge that Texas farmers voiced in the preliminary survey. The final survey was set up with the same or similar questions as the preliminary survey as well as a series of choice sets from which farmers chose their preferred cropping alternative. Before each decision, farmers were provided with necessary information to ensure that they were educated about the potential implications of their decision.

The following variables were collected from the survey: the farmers' choice to incorporate cover crops, their choice between varieties of cover crop, their choice between short-term costs and long-term benefits, and their valuation of their soils. In addition to these variables, the previous knowledge and attitude questions from the preliminary survey were also included. Cronbach's alpha for the knowledge and attitude sections of the final survey were 0.57 and 0.77 respectively.

A decision-making tree from which the farmers made their choices resembled the ones below (Figures 2 and 3). Decision trees are necessary for creating visual representations of the associations between decisions and the reasons for making those decisions. Pattern recognition and data analysis is simplified with the use of decision trees (Myles et al., 2004). For example, if a farmer chose to integrate cover crops in the final survey, the farmer would then be able to choose between types of cover crops to implement or how much land to use for cover cropping. These additional questions in the decision tree could provide greater insight into farmers' decisions for or against cover cropping and to what capacity. Farmers were also given information about each cover crop and the soil of a hypothetical farm so that they could make more informed decisions. As the farmer continued to make decisions, previous questions were repeated to determine if the farmer would change their decision later.

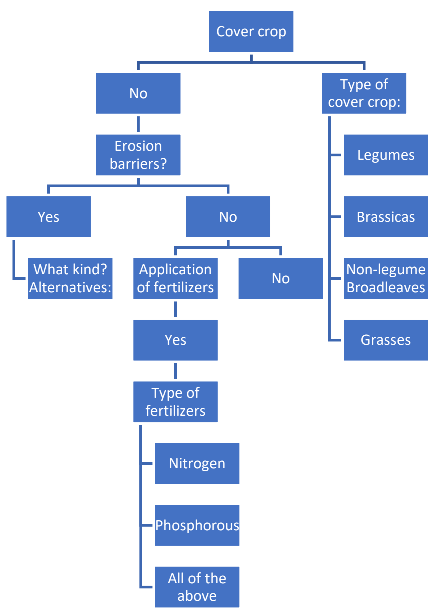


Figure 2: Cover crop decision tree

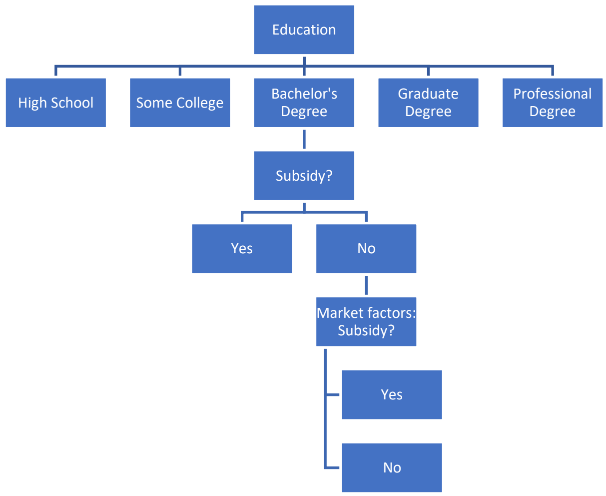


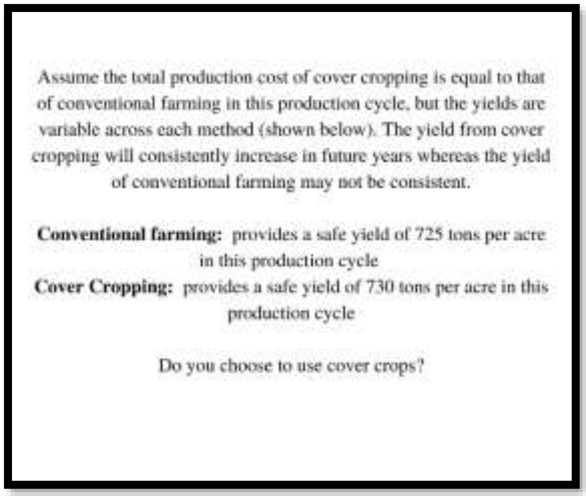
Figure 3: Education decision tree

In the final survey, if a farmer indicated that they would use a cover crop, they were asked to indicate the desired percent of land utilized for the purpose of cover cropping. This was to allow farmers to self-disclose the level of cover crop adoption that they would be willing to try. The level of adoption is influenced by the type of cover crop that farmers use (Wayman et al., 2017). Varying levels of adoption could include no adoption (0% of the farmland is dedicated to cover crops) up to complete adoption (100% of the farmland uses cover crops), with all other variables being held constant. These recurring questions were meant to aid the process of determining if the proportion of the land that is used in cover cropping affects farmers' decisions to use cover crops. Some questions about the cover cropping choice included information about a hypothetical soil texture. This was to determine if soil texture was an influential factor in farmers' cover cropping behavior.

Theoretical Model Justification

The choice set portion of the final survey data will be analyzed following the contingent valuation model as established by Zainudin et al. (2016). Their research emphasizes detailed descriptions of the choice to be made, an appropriate setting for the decision, and collection of demographic data in association with the choices. The preliminary survey data and the knowledge and attitude sections of the final survey provide the necessary indicators of farmer preferences before analysis can be completed.

Within the choice set portion of the final survey data are single bounded dichotomous choices as seen in figures 4 and5. The initial choice created a baseline scenario or “bid” level, and the following choices were the same scenario repeated using different values to assess farmers’ willingness to pay. Jourdain et al. (2020) suggests that farmers have a negative WTP for losses in soil fertility from agricultural production using methods that degrade soil. This indicates that farmers may not be willing to utilize cover crops or other regenerative practices until they have personally observed their soils becoming degraded. Figure 4 is an example of a baseline choice where the Texas farmer has the choice to decline or accept the offer to use cover crops for a season. Figure 5 is an example of the same decision with different price points based on the farmer’s previous decision.

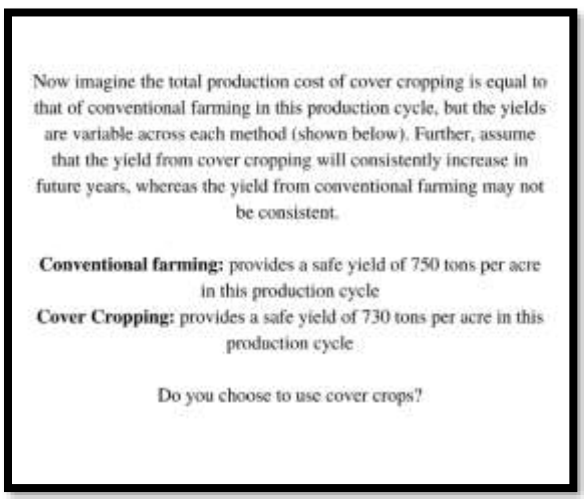


Assume the total production cost of cover cropping is equal to that of conventional farming in this production cycle, but the yields are variable across each method (shown below). The yield from cover cropping will consistently increase in future years whereas the yield of conventional farming may not be consistent.

Conventional farming: provides a safe yield of 725 tons per acre in this production cycle
Cover Cropping: provides a safe yield of 730 tons per acre in this production cycle

Do you choose to use cover crops?

Figure 4: Baseline Decision in Contingent Valuation



Now imagine the total production cost of cover cropping is equal to that of conventional farming in this production cycle, but the yields are variable across each method (shown below). Further, assume that the yield from cover cropping will consistently increase in future years, whereas the yield from conventional farming may not be consistent.

Conventional farming: provides a safe yield of 750 tons per acre in this production cycle
Cover Cropping: provides a safe yield of 730 tons per acre in this production cycle

Do you choose to use cover crops?

Figure 5: Secondary Decision in Contingent Valuation

In this instance, contingent valuation is a stated preference method of interpreting how farmers value cover cropping as an alternative to conventional farming methods based on analysis as described by Carson and Hanemann (2005). Through contingent valuation, Texas farmers indicate their preferences towards their perceived utility of cover cropping. To assess farmers' value of cover cropping over conventional production methods, multinomial logistic regression was used for the choice set portion of the final survey data (El-Habil, 2012; Böhning, 1992). This form of regression analysis allows for both the dichotomous choices and choices involving more than three options.

$$P \log\left(n_j(x_i)\right) = \frac{\exp\,(\alpha_{0i} + \beta_{1j}\chi_{1i} + \beta_{2j}\chi_{2i} + \cdots + \beta_{pj}\chi_{pi})}{1 + \sum_{j=1}^{k-1} \exp\,(\alpha_{0i} + \beta_{1j}x_{1i} + \beta_{2j}\chi_{2i} + \cdots + \beta_{pj}x_{pi})}$$

The same question at multiple production or “bid” levels was asked of respondents. Respondents were asked to choose between “yes” and “no”. The prices listed were based on percentage increases in cost, not on current market prices. Farmers were asked to choose between conventional farming methods and cover cropping when the cost of cover cropping was equal to, 10% greater, 15% greater, and 20% greater than those conventional methods. This was to determine the upper limit of farmers’ willingness to pay, which is the purpose of a single bounded dichotomous choice analysis.

V. RESULTS

The preliminary survey data was collected through Qualtrics and analyzed primarily through the "Likert" package in R. The link to the survey was distributed to Texas farmers online. Total responses to the preliminary survey totaled 16, with 11 complete responses to every question. Some of the farmers chose not to answer every question and left some of their answers blank. Additionally, demographics and open-ended questions were typically the ones most often skipped.

Regarding demographics for the preliminary survey, the respondents were primarily white, not of Hispanic origin. Most farmers were between the ages of 25 and 34 (figure 6).

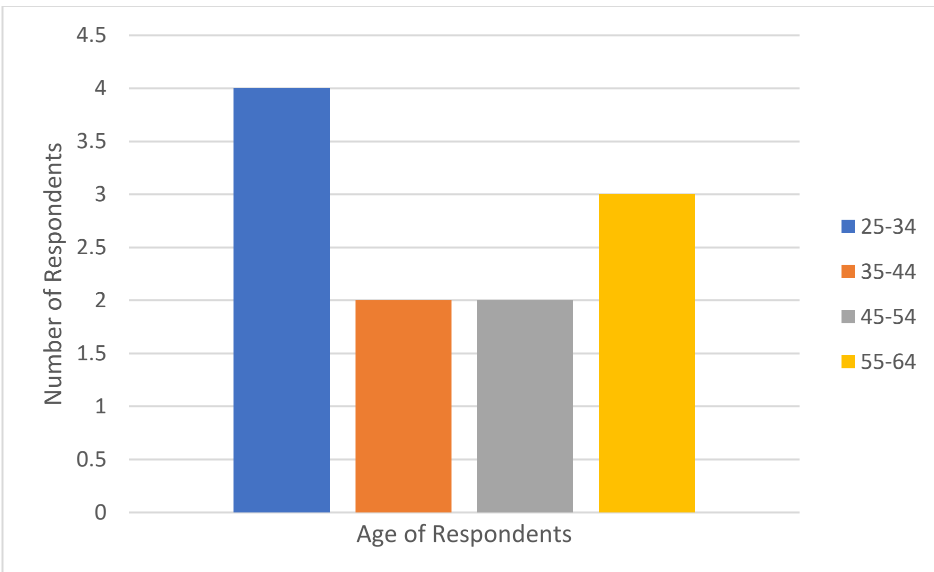


Figure 6: Age of Respondents in Preliminary Survey

Results for the preliminary survey are shown in the figures below. Figure 7 shows the responses to knowledge questions and some highlights will be discussed here. 90.9% of the Texas farmers in the survey responded with "I don't know" or "Maybe" when asked if grass cover crops increase soil compaction. The correct answer to this question

("Do grass cover crops increase soil compaction?") was no (Rosolem et al., 2002). 50% of the Texas farmers surveyed answered "I don't know" or "Maybe" when asked if healthy soils were light brown. When asked if cover crops reduce soil organic matter, 90.9% of the survey respondents answered with "I don't know" or "Maybe". Only 9.1% answered no, which was the correct answer since cover crops can increase soil organic matter.

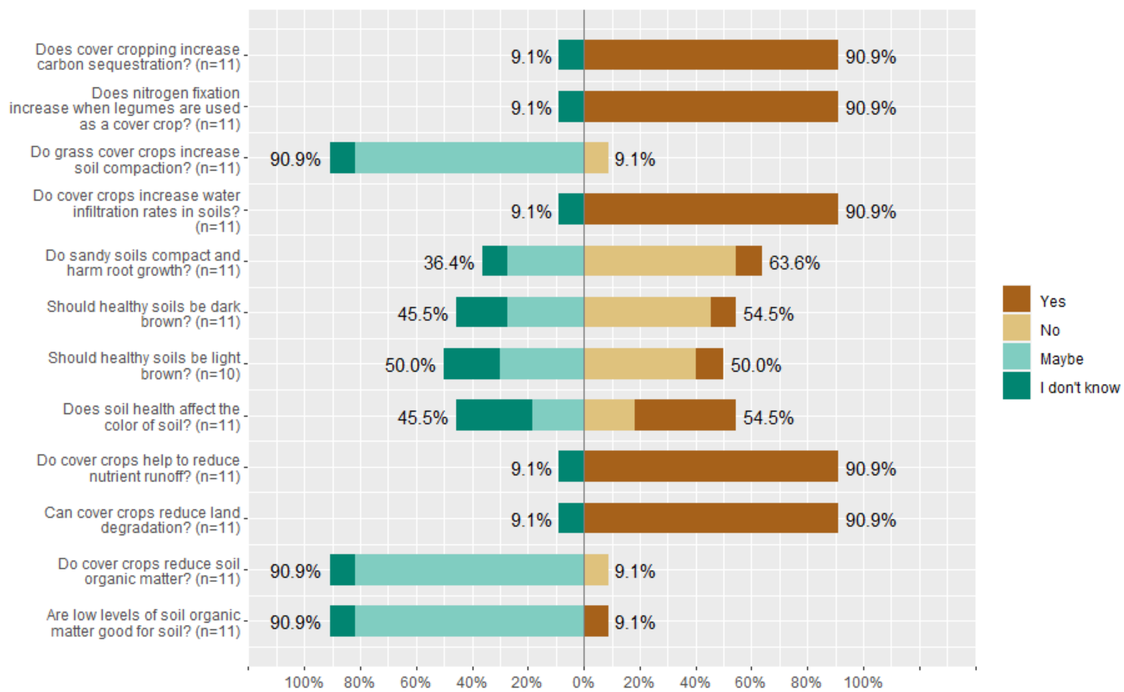


Figure 7: Preliminary Knowledge Assessment of Texas Farmers.

For questions with answers ranging from "Definitely Yes" to "Definitely Not", the results are shown in Figure 8. Many of these questions were to assess Texas farmers' attitudes but the first question of this section was also knowledge-based due to chart size requirements. For some questions, it was necessary that they be preceded by an explanation of the topic so that farmers could provide informed answers. 63.6% of survey respondents indicated that their attitudes towards cover cropping behavior would change when presented with information on how cover cropping potentially improves yield and profit. 63.6% also did not believe farmers were making sufficient profit for the goods they produce. 45.5% answered “Definitely Yes” or “Probably Yes” and 45.5% answered “Definitely Not” or “Probably Not” when asked if the cost of cover cropping outweighed the benefits. 81.8% of respondents believed that the long-term benefits justified the short-term costs while 18.2% of respondents answered, “Maybe or Maybe Not”. When asked if they believed regenerative agricultural practices were profitable in the long term, 36.4% answered “Definitely Yes” or “Probably Yes” whereas 18.2% answered “Probably Not” and 45.5% answered “Maybe or Maybe Not”. 70% of respondents claimed a willingness to pay higher costs now to prevent further profit losses in the future and 30% claimed that they might be willing. 63.6% of respondents considered themselves to practice regenerative agriculture while 27.3% did not and 9.1% were unsure.

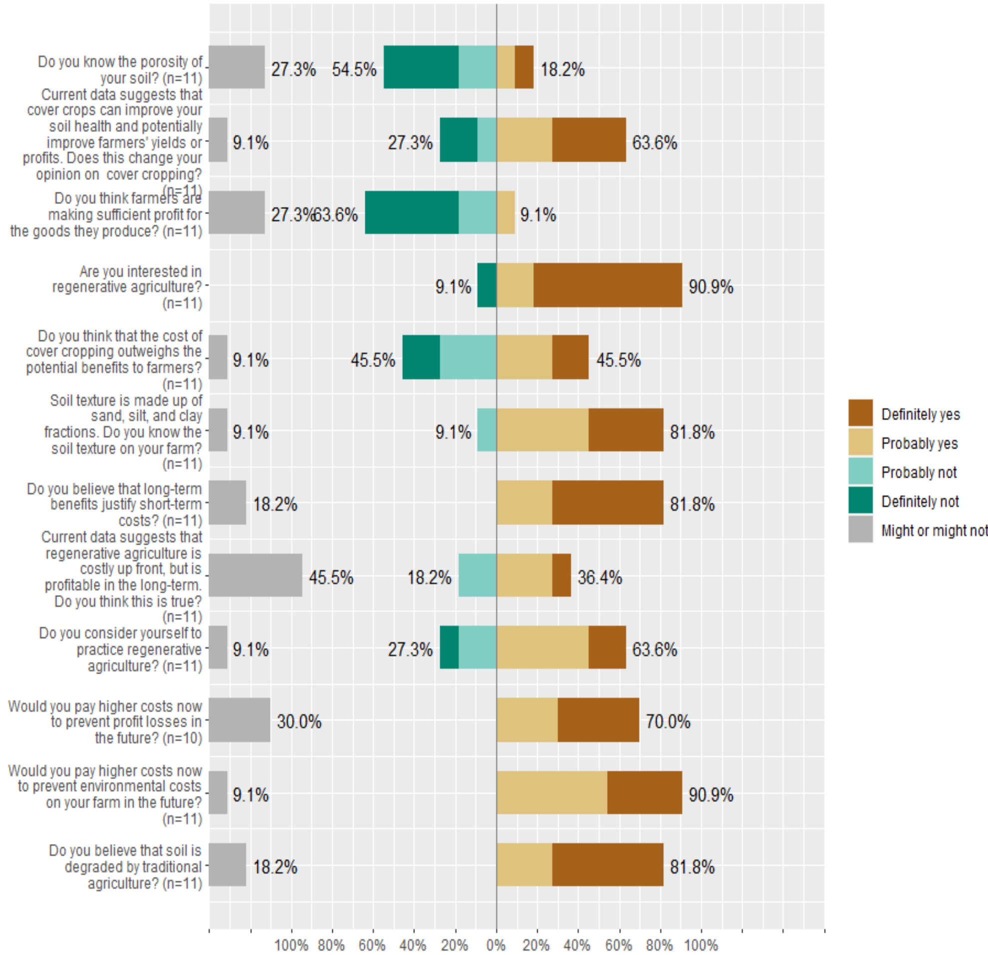


Figure 8: Preliminary Perceptions Assessment of Texas Farmers.

After the preliminary survey was disseminated, the final survey was released via Qualtrics. The farmers surveyed were primarily from the Small Producer's Initiative, a program run by Texas State University. Out of 24 survey responses, 12 completed the survey and provided useable data. The farmers were located in the regions shown in figure 9, which shows the Texas county where their farm is located as well as the acreage of their farm in that county. As with the preliminary survey, the demographics questions were often left blank.

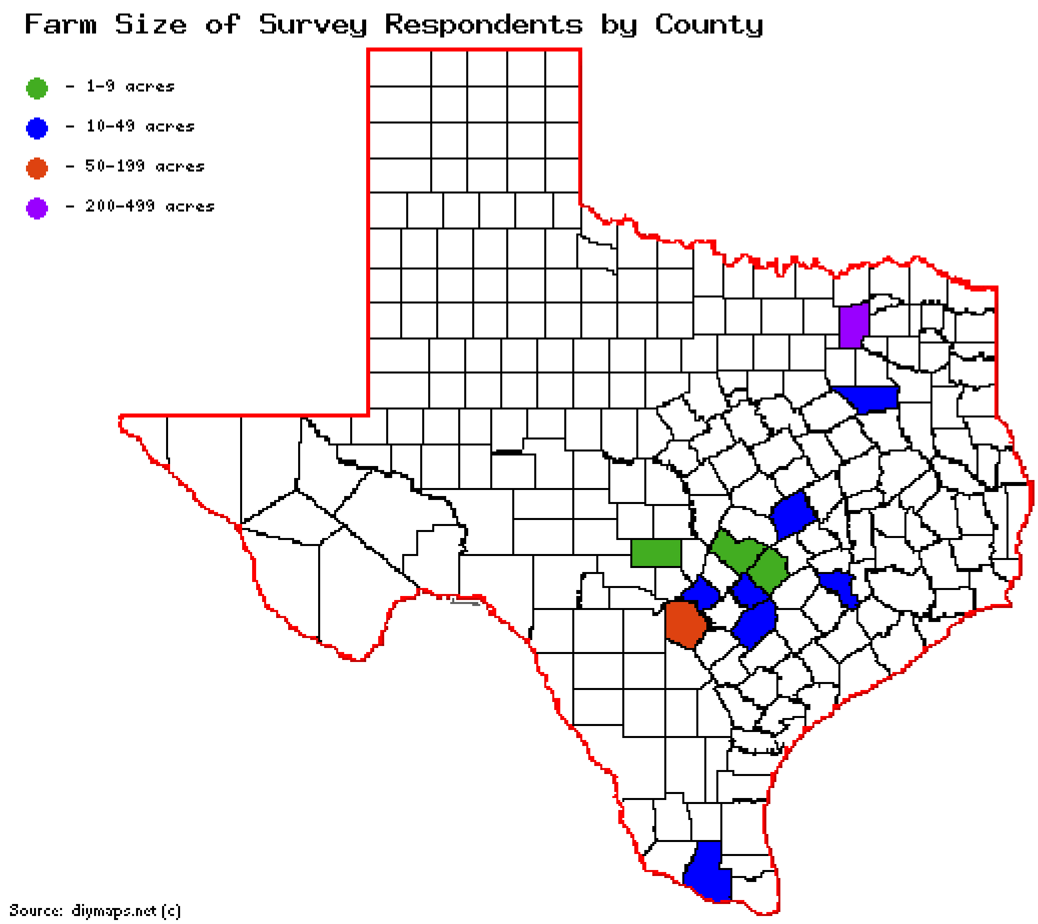


Figure 9: Farm Size of Final Survey Respondents by County

Most farmers surveyed in the final survey were between the ages of 35 and 44 as shown in figure 10. This is a slightly older age group than in the preliminary survey. The Likert scale questions, where the answers ranged from "Definitely Yes" to "Definitely Not", are shown in figure 11. For the survey questions with answers ranging from "Yes", "No", "Maybe", and "I don't know", figure 12 is shown.

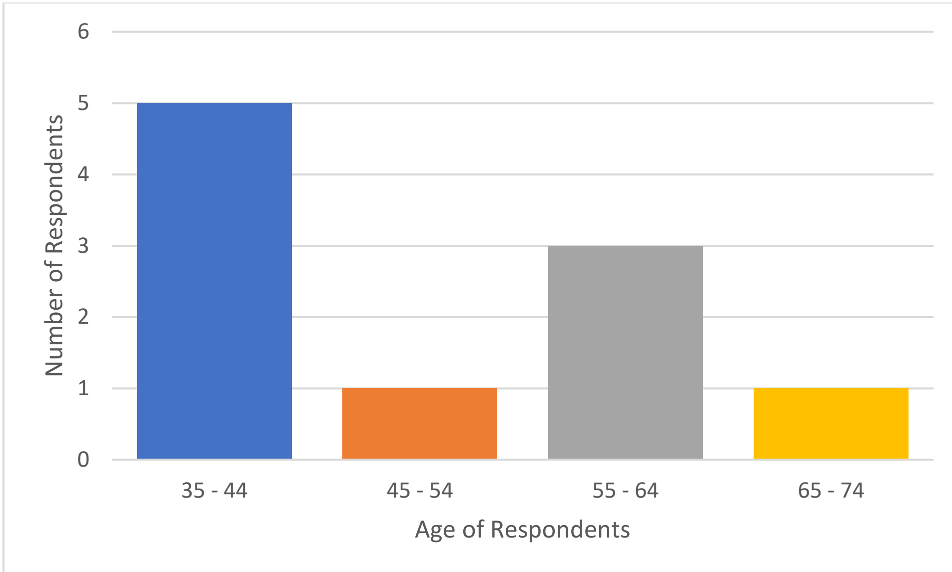


Figure 10: Age of Respondents in Final Survey

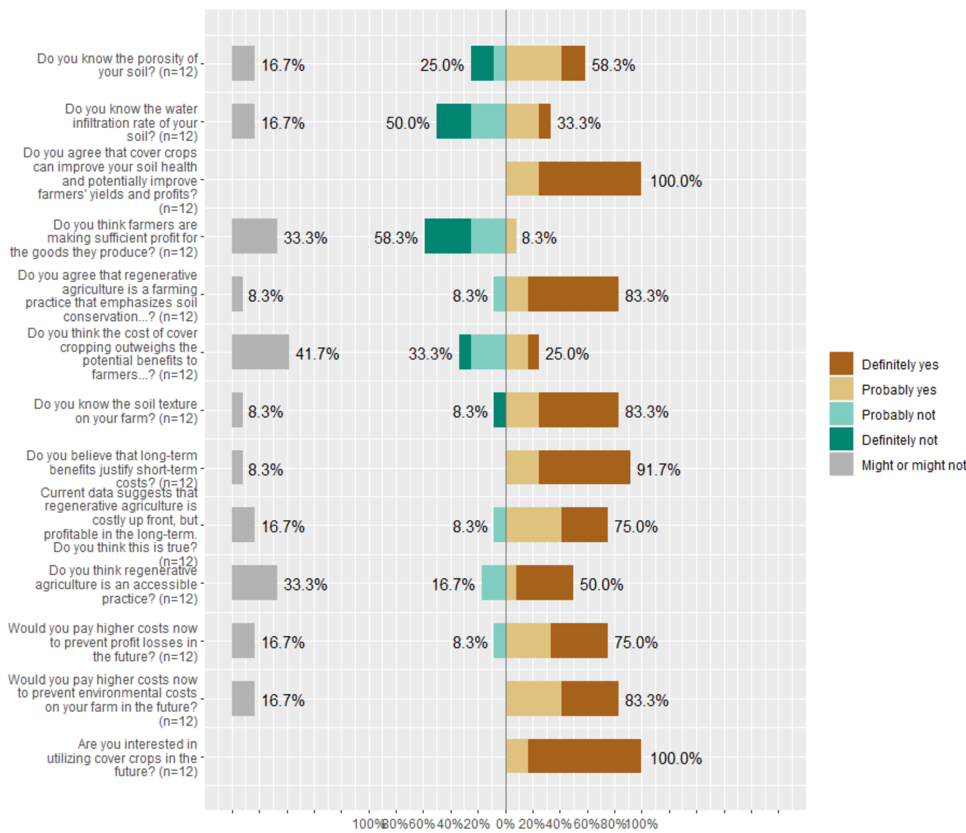


Figure 11: Responses in Final Survey to Questions Where Responses Range from "Definitely Yes" to "Definitely Not".

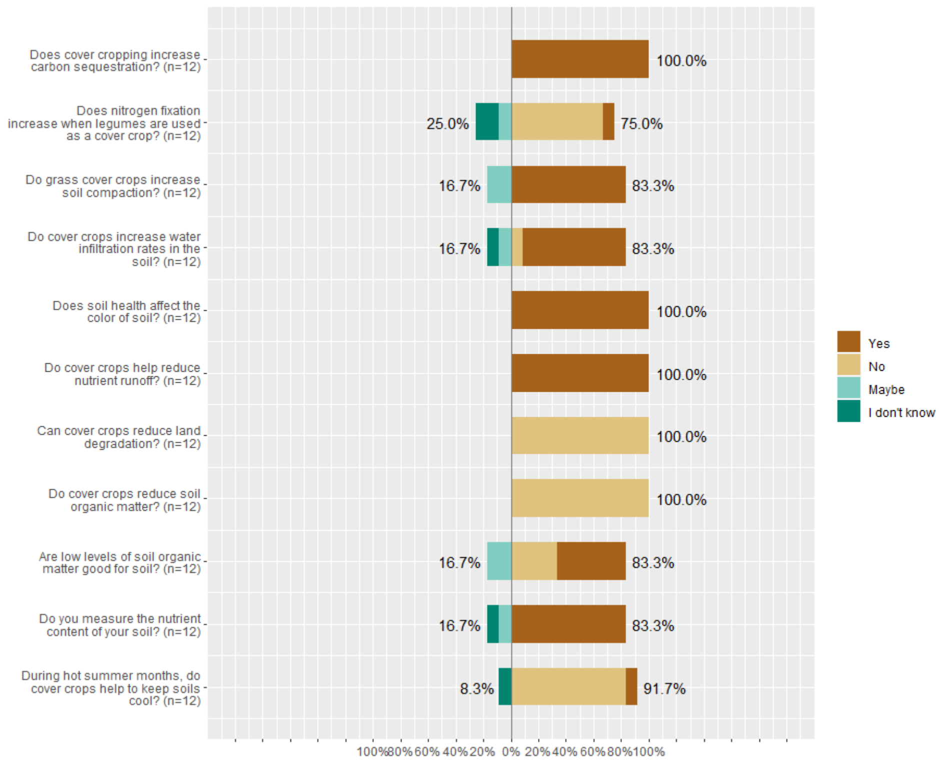


Figure 11: Final Survey Questions Where Responses Range from "Yes" to "I don't know".

When asked about the potential factors that could deter their adoption of cover crops, the most common response from Texas farmers was concerns over increased expenditures (figure 13). This same concern over increased expense was observed in a question regarding the potential risks that farmers associated with cover cropping (figure 14).

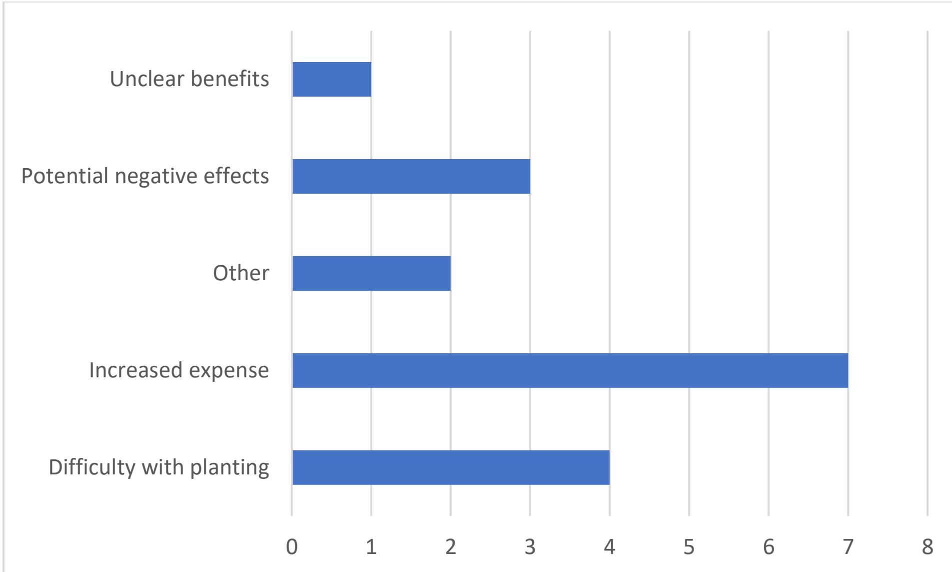


Figure 13: Deterrents for Cover Crop Adoption

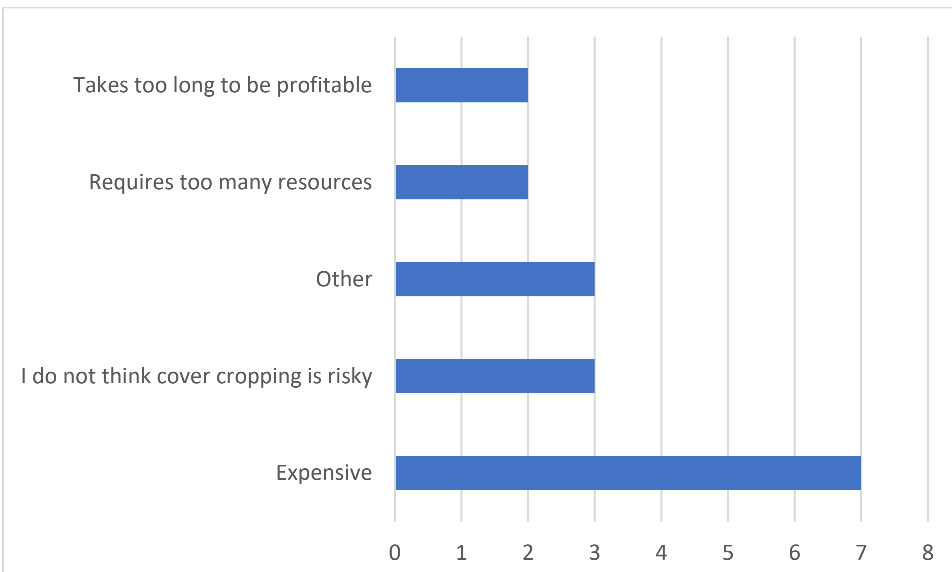


Figure 14: Risk and Cover Cropping Behavior

Table 3: Z test of Coefficients

	Estimate	Std. Error	Z Value	Pr(>|z|)	
(Intercept)	62.15779	25.56186	2.4317	0.01503	*
BID	-0.07098	0.029473	-2.4085	0.01602	*

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

After the Likert scale questions were addressed, the contingent valuation section of the final survey was next. There were five different initial “bid” levels asked of respondents, ranging from two baseline production levels and three price levels, each at 10%, 15%, and 20% increases from the baseline prices. Education, age, and income were considered to be influential factors in the model but were not included in table 3 due to missing variables. Because of this, only the bid level was included in the model. Bid prices were significant at the 0.05 level. As bid prices increased, “yes” responses decreased.

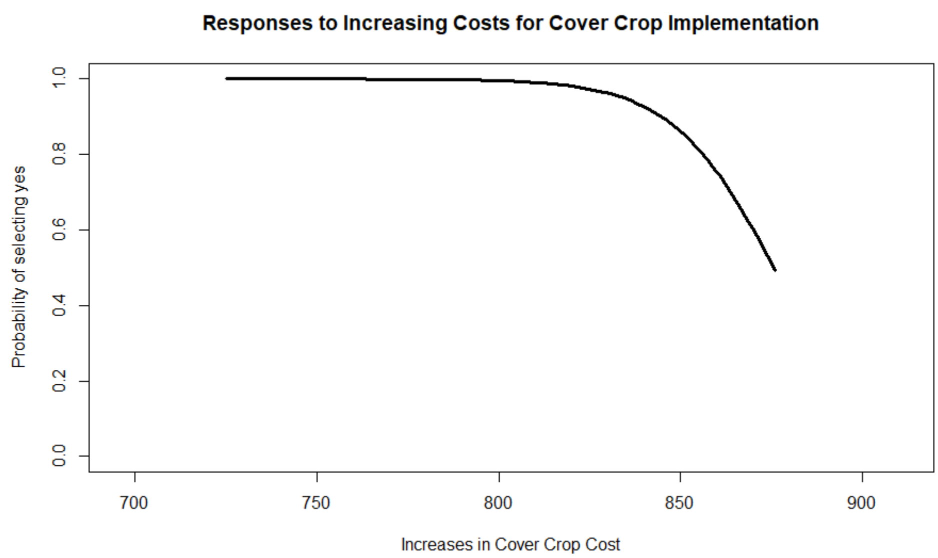


Figure 15: Responses to Increasing Costs of Cover Cropping

The probability of respondents selecting “yes” to the bid prices decreased after the price increased by 15% and almost half of responses were no when the price increased by 20% (figure 15). This indicates that Texas farmers are less likely to choose to incorporate cover crops into their rotation after the cost of cover cropping increases by 15% or more. These results could be helpful in the design of a larger study.

VI. DISCUSSION

There are some indicators in the both the preliminary and the final survey data that could be used to determine gaps in Texas farmers' knowledge of cover cropping. Farmers were unsure if grass cover crops increased or decreased soil compaction. Farmers were unsure of visual indicators of soil health. Farmers were unsure if cover crops decreased soil organic matter or increased soil organic matter. Farmers were divided on whether soil health affected the color of the soil.

The survey data is also useful to determine potential indicators of opportunities to improve farmers' perceptions on cover cropping and, therefore, their adoption of the practice. Farmers were unsure if cover cropping was profitable in the long term. Farmers did not believe they were making sufficient profit for the goods they produced. Farmers were divided on if cover cropping was too costly to be beneficial.

The preliminary survey data used only 11 full responses, and the final survey used only 12, so the sample size may be too small to accurately represent small Texas farmers, their opinions, and their decision-making. There is some skewness in the survey results which may cause it to over-emphasize farmers' perceptions or knowledge in a given area. This may also be due to the small sample size. The data may be biased in favor of regenerative agricultural practitioners, and it may not capture the opinions and decision-making processes of Texas farmers who practice conventional methods, as many of the survey respondents for both the preliminary and the final survey indicated that they considered themselves to practice regenerative agriculture. Although it may not be fully representative, there is the potential for these results to be useful in further research as gaps in knowledge and poor perceptions towards cover cropping have been identified. With further outreach, it would be possible for a greater number of Texas farmers to be surveyed using similar questions and methods, and more representative data could be acquired to truly assess where improvements could be made in modern Texas farming.

The gaps in farmers' knowledge could possibly be reduced through further education on regenerative agricultural practices like cover cropping. With greater knowledge of the benefits of cover cropping and its practical applications, farmers may become more willing and more likely to incorporate cover crops into their rotations. Additionally, the negative perceptions that some farmers have of cover cropping practices could be addressed through education and further outreach. Since knowledge and attitudes are positively correlated, greater knowledge of cover cropping, and other regenerative practices could potentially improve their attitudes and their cover crop adoption.

APPENDIX SECTION

Understanding Farm Decisions from Texas Small Farmer Perspectives v1

Start of Block: Default Question Block

Informed Consent
Study Title: THE SHORT AND LONG TERM BENEFITS OF INTEGRATING COVER CROPS INTO TEXAS FARMLAND: EFFECTS ON PROFITABILITY AND SOIL HEALTH

Principal Investigator: Dr. Pratheesh Omana Sudhakaran
Email: pratheesh81@txstate.edu

Phone: 512-245-2459

Co-Investigator: Katherine Westerman
Email: k_w277@txstate.edu
Phone: N/A
Sponsor: Texas State University

This consent form provides information about why this study is being conducted and why you are being invited to participate. It also describes the nature of your participation as well as any potential risks, inconveniences, or discomforts that you may experience while participating. We encourage you to ask questions at any time. You will be given a copy of this form to keep as proof of verbal consent.

PURPOSE AND BACKGROUND
You are invited to participate in an exercise that will help us learn about producers' perceptions of cover crops and the implications cover cropping practices have for the profitability of agricultural production. The information gathered will be used to analyze the factors that affect producers' production decisions, which will help us understand the nature of producers' knowledge about sustainable production practices. The results of this study will provide evidence that can be used to help educate the industry on how practices can be modified to make agricultural production more sustainable. You are being asked to participate because you are a producer above 18 years of age and make production decisions for your farming operations.

PROCEDURES
If you agree to be in the study, you will be asked to participate in a survey which will be given to you by a representative from Texas State University. The survey will be conducted online and will last approximately 20 minutes. During the survey, you will be

asked to provide information about your perceptions on sustainability practices. You will also be provided with information before each decision to ensure you are making decisions to the best of your knowledge.

RISKS/DISCOMFORTS

In the event that some of the questions or prompts make you uncomfortable or upset, you are always free to decline to answer or to stop your participation at any time. Participating in this study may involve increased risk of exposure to easily transmitted infectious diseases due to in-person interactions with the research team. The research team will follow local regulations and institutional policies, including using personal protective equipment (PPE), environment hygiene, and following social distancing guidelines according government regulations and policies in effect. If you have any questions or concerns, please discuss them with your research team.

BENEFITS/ALTERNATIVES

There will be no direct benefit to you from participating in this study. However, the information that you provide will help us form recommendations to farmers and government agencies. The recommendations will help farmers produce food products more sustainably. Government agencies can utilize the results of the study to design constructive policies that promote sustainable agricultural practices.

EXTENT OF CONFIDENTIALITY

Reasonable efforts will be made to keep your personal information private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team, and the Texas State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants. Your name and other personal details will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

PARTICIPATION IS VOLUNTARY

You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to participate, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled.

QUESTIONS

Do you consent to participate in this study? If yes, do you have any questions before we begin? If you have any questions or concerns about your participation in this study, you may contact the Principal Investigator, Pratheesh Omana Sudhakaran: 512-245-2459 or pratheesh81@txstate.edu . This project 7942 was approved by the Texas State IRB on September 29, 2021. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Denise Gobert 512-245-8351 – (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

○ Yes

○ No

Page Break

Q4
Welcome!

The focus of this survey is on production technology choice, and will take about 20 minutes to complete. The survey consists of two parts: decision-making and demographics.

In the first section, you will be presented with various scenarios. In each scenario, you will be asked to make a choice between two alternative production methods. After making each choice, you will then be asked to provide details about the motivation(s) behind your choice. Information will be given prior to these questions such that you can make an informed decision. There are no right or wrong answers.

The second section of the survey will ask you to provide generic demographic details, which will be used for classification purposes. No personal information will be shared.

End of Block: Default Question Block

Start of Block: Farm Characteristics

Q39 Are you a Texas farmer?

○ Yes

○ No

Q40 How long have you been participating in agriculture?

○ 1-5 years

○ 6-10 years

○ 11- 15 years

○ more than 15 years

Q48 Do you consider your farm to be

- ○ Conventional
- ○ Regenerative
- ○ Certified Organic
- ○ Organic (not certified)
- ○ Other ____

Q41 What product do you produce on your farm?

- ☐ Oilseed or grain crops (corn, sorghum, wheat, etc.)
- ☐ Cotton
- ☐ Hay
- ☐ Livestock (for sale)
- ☐ Livestock (for meat)
- ☐ Bees and Honey
- ☐ Eggs
- ☐ Dairy Products
- ☐ Vegetable Crops
- ☐ Fruit Crops
- ☐ Nut crops
- ☐ Nursery or greenhouse production
- ☐ Value-added products
- ☐ Other, please specify ________________

Q61 Do you use cover crops?

◯ Yes

◯ No

Q42 How many acres of land do you operate?

◯ 1-9 acres

◯ 10-49 acres

◯ 50-199 acres

◯ 200-499 acres

◯ 500-999 acres

◯ 1,000 acres or more

Q43 In what Texas County is your farm or ranch located?

▼ Anderson ... Zavala

End of Block: Farm Characteristics

Start of Block: Knowledge and Perception on Cover Cropping

Q49 The next segment of the survey will concern your knowledge of and preferences towards cover cropping.

Q50 Please rate your answers on the scale below.

	Definitely yes	Probably yes	Might or might not	Probably not	Definitely not
Do you know the porosity of your soil?	○	○	○	○	○
Do you know the water infiltration rate of your soil?	○	○	○	○	○
Do you agree that cover crops can improve your soil health and potentially improve farmers' yields and profits?	○	○	○	○	○
Do you think farmers are making sufficient profit for the goods they produce?	○	○	○	○	○
Do you agree that regenerative agriculture is a farming practice that emphasizes soil conservation and reducing environmental damage caused by traditional agriculture?	○	○	○	○	○

Do you think the cost of cover cropping outweighs the potential benefits to farmers' yields, profits, and/or soil health?	○	○	○	○	○
Soil texture is made up of sand, silt, and clay fractions. Do you know the soil texture on your farm?	○	○	○	○	○
Do you believe that long-term benefits justify short-term costs?	○	○	○	○	○
Current data suggests that regenerative agriculture is costly up front, but profitable in the long-term. Do you think this is true?	○	○	○	○	○
Do you think regenerative agriculture is an accessible practice?	○	○	○	○	○

Would you pay higher costs now to prevent profit losses in the future?	○	○	○	○	○
Would you pay higher costs now to prevent environmental costs on your farm in the future?	○	○	○	○	○
Are you interested in utilizing cover crops in the future?	○	○	○	○	○

Q51 Please rate your answers on the scale below.

	Yes	Maybe	No	I don't know
Does cover cropping increase carbon sequestration?	○	○	○	○
Does nitrogen fixation increase when legumes are used as a cover crop?	○	○	○	○
Do grass cover crops increase soil compaction?	○	○	○	○
Do cover crops increase water infiltration rates in the soil?	○	○	○	○
Does soil health affect the color of soil?	○	○	○	○
Do cover crops help reduce nutrient runoff?	○	○	○	○
Can cover crops reduce land degradation?	○	○	○	○
Do cover crops reduce soil organic matter?	○	○	○	○
Are low levels of soil organic matter good for soil?	○	○	○	○
Do you measure the nutrient content of your soil?	○	○	○	○

During hot summer months, do cover crops help to keep soils cool?	○	○	○	○
Does soil compaction make seeding and growing crops easier?	○	○	○	○

Q7 What, as a farmer, would deter you from using cover crops? Select all that apply.

- ▢ Increased expense
- ▢ Unclear benefits
- ▢ Potential negative effects
- ▢ Difficulty with planting
- ▢ Other ____

End of Block: Knowledge and Perception on Cover Cropping

Start of Block: Production Decision

Q5 Cover crops are crops that will not be harvested after planting. They protect your soil from erosion and add organic matter and/or nutrients back into the soil. They may increase your costs in the short term, but they may also increase your yield in the long term. As with conventional production methods, for a given production cycle, you will have to cover all input costs (such as tillage and fertilizer costs) to make the soil ready for production. Imagine you are a cotton farmer in the Texas Blackland Prairie and you are about to select a production method for cotton crop coming year. You can choose between conventional farming and cover cropping.

Q44 Imagine the total production cost of cover cropping is 10% higher than that of conventional farming in this production cycle, but the total production cost of cover cropping would decrease in future years.

Do you choose to use cover crops?

- ◯ Yes
- ◯ No

Q29 What percentage of your land would you cover with cover crops?

- ◯ 10% or less
- ◯ 25%
- ◯ 50%
- ◯ 75%
- ◯ 100%

Q22 Which cover crops would you use in this scenario?

- ◯ Grasses
- ◯ Legumes
- ◯ Non-Legume Broadleaves
- ◯ Brassicas
- ◯ A mix of two or more

Q15 Assume the total production cost of cover cropping is 15% higher than that of conventional farming in this production cycle, but the total production cost of cover cropping would decrease in future years.

Do you still choose to use cover crops?

- ◯ Yes
- ◯ No

Q46 What percentage of your land would you cover with cover crops?

- ◯ 10% or less
- ◯ 25%
- ◯ 50%
- ◯ 75%
- ◯ 100%

Q16 Which cover crops would you use in this scenario?

- ◯ Grasses
- ◯ Legumes
- ◯ Non-Legume Broadleaves
- ◯ Brassicas
- ◯ A mix of two or more

Q36 Assume the total production cost of cover cropping is 20% higher than that of conventional farming in this production cycle, but the total production cost of cover cropping would decrease in future years.

Do you still choose to use cover crops?

- ○ Yes
- ○ No

Q47 What percentage of your land would you cover with cover crops?

- ○ 10% or less
- ○ 25%
- ○ 50%
- ○ 75%
- ○ 100%

Q58 Which cover crops would you use in this scenario?

- ○ Grasses
- ○ Legumes
- ○ Non-Legume Broadleaves
- ○ Brassicas
- ○ A mix of two or more

Q37 Now imagine the total production cost of cover cropping is equal to that of conventional farming in this production cycle, but the yields are variable across each method (shown below). Further, assume that the yield from cover cropping will consistently <u>increase</u> in future years, whereas the yield from conventional farming may not be consistent.

Conventional farming: provides a safe yield of 750 tons per acre in this production cycle
Cover Cropping: provides a safe yield of 730 tons per acre in this production cycle

Do you choose to use cover crops?

- ◯ Yes
- ◯ No

Q31 What percentage of your land would you cover with cover crops?

- ◯ 10% or less
- ◯ 25%
- ◯ 50%
- ◯ 75%
- ◯ 100%

Q59 Which cover crops would you use in this scenario?

- ◯ Grasses
- ◯ Legumes
- ◯ Non-Legume Broadleaves
- ◯ Brassicas
- ◯ A mix of two or more

Q38 Assume the total production cost of cover cropping is equal to that of conventional farming in this production cycle, but the yields are variable across each method (shown below). The yield from cover cropping will consistently <u>increase</u> in future years whereas the yield of conventional farming may not be consistent.

Conventional farming: provides a safe yield of 725 tons per acre in this production cycle
Cover Cropping: provides a safe yield of 730 tons per acre in this production cycle

Do you choose to use cover crops?

- ◯ Yes
- ◯ No

Q57 What percentage of your land would you cover with cover crops?

- ◯ 10% or less
- ◯ 25%
- ◯ 50%
- ◯ 75%
- ◯ 100%

Q60 Which cover crops would you use in this scenario?

- ◯ Grasses
- ◯ Legumes
- ◯ Non-Legume Broadleaves
- ◯ Brassicas
- ◯ A mix of two or more

End of Block: Production Decision

Start of Block: Tillage Questions

Q9 Tillage is the process of overturning soil and uprooting plant residue to make the planting of next season's crop an easier process. By uprooting the soil, tillage increases negative environmental effects such as erosion, compaction, nutrient runoff, and ponding.

There are several methods of preparing the soil for planting, and some farmers choose tillage alternatives to protect their soils. Common methods that farmers use to prepare their soils include:

Tillage: turning over the soil

No-till: using herbicide applications, mowing, crimping, etc. to kill a cover crop while seeding or drilling small holes in the soil in which to place seeds

Low-till: using more shallow methods to place seeds in the soil

Q10 As a farmer, would you till your soils?

- ○ Yes
- ○ No

Q11 Which soil preparation method would you use on your soils?

- ◯ Tillage
- ◯ No-Till
- ◯ Low-Till
- ◯ Whichever method is easiest
- ◯ Whichever method is most profitable now
- ◯ Whichever method is most profitable in the future

Q33 Based off of the description of your soils and tillage, how do you feel about the decision to till your soils?

- ◯ Extremely good
- ◯ Somewhat good
- ◯ Neither good nor bad
- ◯ Somewhat bad
- ◯ Extremely bad

Q12 Before you answer the next question, consider the following scenario: you are a farmer who has never used cover crops before and who is currently profitable. Your margin of profit is small and, as a result, you are looking for ways to increase your profits. You have heard of cover cropping but are not well informed about the effects that cover crops have on your profitability in the short and long term.

Q13 Given the scenario above, do you think choosing to use cover crops

- Is risky
- May be a risk
- Is not a risk

Q14 Which reasons do you think cover cropping would be a risky behavior for you as the farmer in the above scenario? Select all that apply

- Expensive
- Difficult
- Takes too long to be profitable
- Requires too many resources
- Other ____
- I do not think cover cropping is risky

Q53 How important is soil health for your farm?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

Q52 Which do you consider to be more important: yield or revenue? Why?

____

Q17 As a farmer, consider the following scenario: you live in the Texas Blackland Prairie, which has a heavy clay soil that is subject to compaction and ponding. The soil is also nitrogen deficient, which could be handled by either using legume cover crops or nitrogen fertilizer.

Q18 Would you use cover crops in this scenario?

- ○ Yes
- ○ No

Q30 What percentage of your land would you cover with cover crops?

- ○ 10% or less
- ○ 25%
- ○ 50%
- ○ 75%
- ○ 100%

Q28 Would you use nitrogen fertilizers in this scenario?

- ○ Yes
- ○ No

Q34 Would you consult outside sources or experts to determine how much nitrogen fertilizer to apply?

- Definitely yes
- Probably yes
- Might or might not
- Probably not
- Definitely not

Q35 Select how many pounds of nitrogen per acre you would apply to your soils.

- 20lbs per acre or less
- 30-40lbs per acre
- 40-50lbs per acre
- 50-60lbs per acre
- 60-70lbs per acre
- 70-80lbs per acre
- 80-90lbs per acre
- 90-100lbs per acre
- 100lbs per acre or more

Q19 As a farmer, you have knowledge of your soils. Consider the following scenario: you live in the Texas Blackland Prairie, which has a heavy clay soil that is subject to compaction and ponding. *Tillage* is a major cause of compaction and is the most common method of preparing soil. It is also commonly perceived as the easiest method of preparing soils for planting.

Q20 Do you choose to till your soil?

◯ Yes

◯ No

Q21 Which method of preparing your soils would you use in this scenario?

◯ Tillage

◯ No-Till

◯ Low-Till

◯ Whichever method is easiest

◯ Whichever method is most profitable now

◯ Whichever method is most profitable in the future

Q32 Based on the description of your soils and tillage in the above scenario, how do you feel about the decision to till your soils?

◯ Extremely good

◯ Somewhat good

◯ Neither good nor bad

◯ Somewhat bad

◯ Extremely bad

End of Block: Tillage Questions

Start of Block: Types of Legumes as Cover Cropping

Q8 There are four main types of cover crops:

Legumes, such as beans or clover, which provide nitrogen to the soil.
Brassicas, such as radishes or rape, which increase biomass in the soil.
Grasses, such as ryegrass or forage sorghum, have deep roots which reduce soil compaction.
Non-Legume Broadleaves, such as buckwheat or sesame, aid weed suppression and prevent erosion.

Q6 As a farmer, and assuming you have *no* specific knowledge of your soil, which cover crop would you choose to cover your soil?

○ Legumes

○ Brassicas

○ Grasses

○ Non-Legume Broadleaves

○ A mix of two or more

End of Block: Types of Legumes as Cover Cropping

Start of Block: Subsidy

Q56 If you were to receive a subsidy for using cover crops instead of conventional crops, would you use cover crops?

○ Yes

○ No

End of Block: Subsidy

Start of Block: Demographics

Q23 The next few questions are to collect demographic information. Your information will not be shared. This is just to determine the relationship between demographic factors and your choices.

Q25 What is your gender?

- ◯ Male
- ◯ Female
- ◯ Non-binary / third gender
- ◯ Prefer not to say

Q24 What is your ethnicity?

- ◯ White
- ◯ Black or African American
- ◯ American Indian or Alaska Native
- ◯ Asian
- ◯ Native Hawaiian or Pacific Islander
- ◯ Other

Q26 What is your age?

- Under 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65 - 74
- 75 - 84
- 85 or older

Q27 What is your highest level of education?

- Less than high school
- High school graduate
- Some college
- 2 year degree
- 4 year degree
- Professional degree
- Doctorate

Q55 What was your major in college?

____

Q54 What is your annual income?

- Less than $10,000
- $10,000 - $19,999
- $20,000 - $29,999
- $30,000 - $39,999
- $40,000 - $49,999
- $50,000 - $59,999
- $60,000 - $69,999
- $70,000 - $79,999
- $80,000 - $89,999
- $90,000 - $99,999
- $100,000 - $149,999
- More than $150,000

Q63 Are you willing to let us contact you about your responses or for future research? If so, please leave your contact information below.

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End of Block: Demographics

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