AN ANALYSIS OF COVER CROP USE IN SOUTHEASTERN ROW CROP PRODUCTION: ECONOMICS, PRODUCTION PRACTICES, AND PERCEPTIONS

by

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(Under the Direction of Yangxuan Liu)

ABSTRACT

Cover crops are known to generate many environmental and economic benefits. However, only a small portion of cropland in the Southeastern United States currently utilizes cover crops in the rotation system. This paper utilizes a comprehensive survey conducted throughout Georgia, Alabama, and Florida to identify current production practices to further understand the missing links that currently inhibit cover crop adoption in the Southeast. The data collected provide insight about what can be done to encourage further cover crop adoption throughout the southeast. We find that farmers are challenged by the additional cost, both economic and opportunity, of implementing cover crops, and the lack of educational materials that could help them to incorporate cover crops into their rotation more seamlessly and successfully. We also find that farmers reap unintended benefits from contiguous cover crop use through improved environmental conditions in the field.

INDEX WORDS: Cover Crop, Southeast, Conservation, Perceptions, Production Practices

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The use of cover crops has a long and rich history, with evidence suggesting that they were used in China as early as the 5th century B.C. (Pieters, 1927). Though contrary to our modern definition of cover crops, which are used to provide ground cover for reduced erosion and strengthened biological benefits (Sarrantonio & Gallandt, 2003), they were instead used in a constant rotation to provide seasonal food and fiber, eliminating fallow periods. Contiguously planted crops were widespread throughout the United States until the years after World War II with the introduction of synthetic fertilizers and pesticides. Synthetic fertilizers have allowed for the simplification of cropping systems, and therefore, the removal of cover crops from the majority of intensively managed cropland, leading to an increase in fallow periods (Mitsch et al., 2001). Winter cover crops saw a drastic decline in use afterwards (Groff, 2015). The 2017 United States Department of Agriculture Census of Agriculture reported that only 12% of harvested row crop acreage in the United States included a cover crop in the rotation (U.S. Department of Agriculture, 2017). During the 2010-2011 season, cover crops were adopted by approximately 4% of farmers on some portion of their cropland, while less than 0.3% of farms use cover crops on all of their acreage (Wade, Claassen, & Wallander, 2015).

Streamlined production systems, many of which are often monocultures, raise questions about the long-term environmental impacts and sustainability of such practices (Kirschenmann,

2007). Although monoculture systems have been highly successful in the production of food and fiber, they create inadmissible amounts of stress on the ecosystem, resulting in an unsustainable economic framework (Altieri, 2000). As environmental sustainability issues have become more recognized in recent times, the value of cover crops in the preservation and improvement of cropland has continually increased (Chatterjee, 2013; Kaspar & Singer, 2011). Over the past few decades, cover crop use has once again been on the rise as our society has become more environmentally aware and soil degradation has become a significant challenge for the sustainable future of agriculture.

1.2 RESEARCH MOTIVATION

Cover crops have been recognized as a crucial component in diversified crop rotations (Snapp et al., 2005), providing both agronomic and economic benefits (Bayer et al., 2000). It has been found that implementing cover crops into existing crop rotations can improve or maintain soil quality, prevent erosion, increase biomass, and reduce the need for tillage (Kaspar, Radke, & Laflen, 2001). Cover crops can also improve groundwater quality from decreased nutrient leaching (Ruffo, Bullock, & Bollero, 2004), reduce irrigation water usage (V. G. Allen et al., 2005), achieve weed suppression (Fisk et al., 2001), and increase carbon sequestration (Reicosky & Forcella, 1998).

However, most benefits provided by cover crops are realized only with continuous, long-term use of cover crops. Furthermore, multiple conservation practices, such as cover crops and reduced tillage, provide complementary benefits to farmers when in combined use (Wade et al., 2015). Fan et al. (2020) also found that the adoption of cover crops and reduced tillage can increase cotton yield, reduce input costs, and reduce risk related to income variability. In the short-run, most costs associated with conservation agriculture are incurred by the farm (Knowler

& Bradshaw, 2007), increasing risk due to the upfront investment and delay in benefits as a result of the new conservation practice (Fathelrahman et al., 2011). The absence of short-run economic advantages has been found to negatively influence adoption rates (Faé et al., 2009).

1.3 RESEARCH OBJECTIVE

There is currently much conflicting information related to the economic costs and benefits of cover crop use. The costs associated with cover crop adoption are highly dependent upon management practices (Bergtold et al., 2017), which are often highly dependent on the farmer's level of risk aversion (Adusumilli et al., 2020). These management practices have yet to be uniformly defined because of the heterogeneity of all aspects of farm operations. Lack of familiarity can also hinder the implementation of cover crops as a conservation practice (Nassauer et al., 2011). Previous research has found that farmers who have already adopted cover crops believe that economic incentives will need to be greater to encourage further adoption, even if farmers recognize the need to protect, preserve, and improve their cropland (Roesch-McNally et al., 2017). This can be attributed to the concern about the yield gap between crops managed using conservation practices and those managed conventionally (Ponisio et al., 2015; Reganold & Wachter, 2016; Tilman et al., 2011).

With a long production season due to warm weather, cover crops can be more extensively and successfully used in the southeast than in other regions of the U.S. (Sarrantonio & Gallandt, 2003). However, southeastern row crop producers have few research findings that specifically identify current conservation practices being used, such as cover crops and reduced tillage (Varco, Spurlock, & Sanabria-Garro, 1999). Plastina et al. (2018) conducted research in the Midwest using partial budget analysis to identify changes in costs and revenues associated with these conservation practices, but the production practices used with cover crops in the southeast

are largely unknown. Cover crop adoption in the southeast is continuing to become more commonplace, explained largely by their allelopathic weed suppression abilities (Duzy, 2017). There is much research that evaluates the biological benefits of cover crops (Kunz et al., 2016; Marshall, 2012; Staver & Brinsfield, 1998). However, there is limited information on the production practices used and their economic effect on the viability of a crop rotation that includes cover crops in the southeast.

The objective of this research is to identify current production practices when cover crops are used in an existing cash crop rotation that includes cotton, peanuts, or corn in the southeast using a comprehensive survey. Perceived risk can significantly impact adoption rates. It is important to understand the current production practices being used when cover crops are implemented to determine what improvements can be made to further increase efficiency and return on investment. It is also paramount to understand farmers' perceptions of cover crops to recognize policy and farmer education implications, and how much further cover crop use can be expanded.

CHAPTER 2

LITERATURE REVIEW

Cover crop use has been on the rise as a whole in the United States over the last ten years (Zulauf & Brown, 2019). From 2012-2017, cover crop acreage rose by 50% from 10.3 million acres in 2012 to 15.4 million acres in 2017 (Zulauf & Brown, 2019). Figure *1* Cover crop adoption rate changes from 2012 to 2017 for Alabama, Florida, Georgia, and the U.S. shows that cover crops as a share of cropland acreage in the U.S. grew from 2.6% in 2012 to 3.9% in 2017, with an average of a 1.4% increase in the southeast (Zulauf & Brown, 2019). Georgia's adoption rate rose the most out of the other southeastern states by a rate of 3.3% from 2012-2017, while Alabama's adoption rate rose 0.9% and Florida's adoption rate remained steady over the same time period (Zulauf & Brown, 2019). Cover crops are used most frequently by farmers who have shorter season cash crops which are typically higher in value, making them able to more successfully manage a further diversified rotation (Lambert et al., 2007; Lichtenberg, 2004; Singer, Nusser, & Alf, 2007; Snapp et al., 2005). Both Georgia and Alabama produce more cotton than any other field crops in their state. This could be a potential explanation for both of them increasing their adoption rates from 2012-2017. Furthermore, the weather conditions in these two states only allows for a single crop per year in most of the region, resulting in an extended fallow period during the winter season. Alternatively, Florida produces very few field crops in comparison to their fruit and vegetable production and the weather conditions allow for

multiple crops during the year, leaving less land in fallow. This could explain why Florida's adoption rate remained steady since most fruit and vegetable producers do not use cover crops.

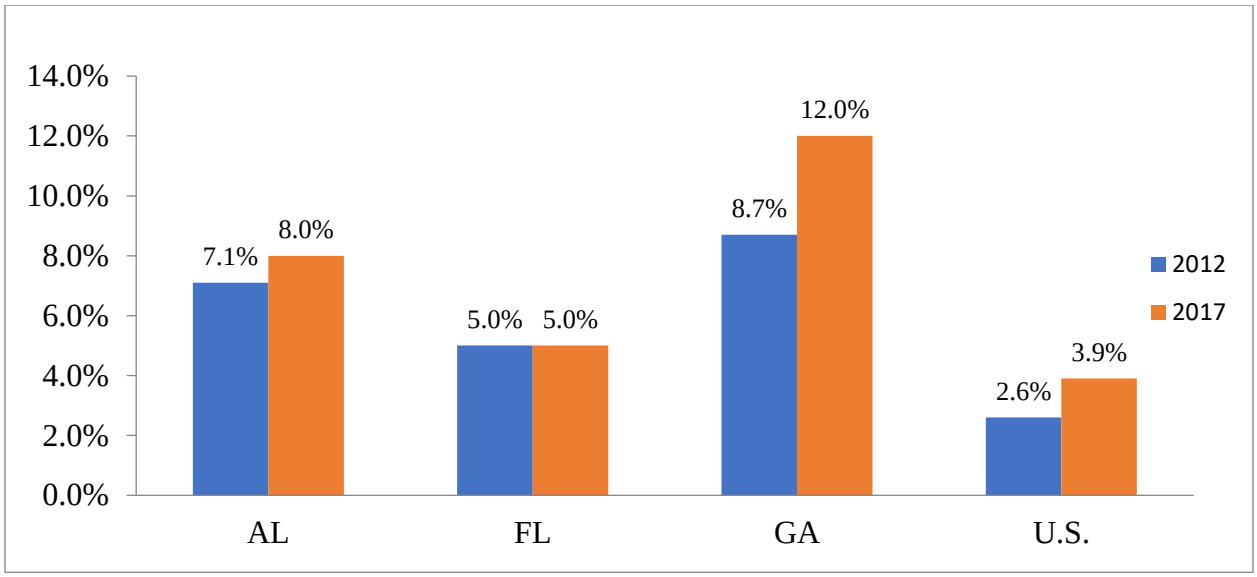

Figure 1 Cover crop adoption rate changes from 2012 to 2017 for Alabama, Florida, Georgia, and the U.S.

Different cover crop species may optimize multifunctionality, allowing farmers to reap more benefits from implementation. Maximization of benefits from cover crop implementation occurs when the appropriate species mix is selected for the following cash crop and the crop residue is managed to augment both agronomic and economic returns (Ashford & Reeves, 2003; Wortman, Francis, & Lindquist, 2012b). Diversifying the cover crop mix can help increase the number of ecosystem services provided (Gamfeldt & Hillebrand, 2008; Tilman, 1996; Tilman et al., 2001; Trenbath, 1999; Wortman et al., 2012b). Oftentimes, the ecosystem services provided by cover crops create positive feedbacks. These enhancements can include yield stabilization, reduced input requirements, and increased profitability (Schipanski et al., 2014).

Common motivations of cover crop adoption include environmental awareness and trust in information sources (Ranjan et al., 2019), as well as the reduction in fertilizer needs since many cover crops, especially leguminous crops, provide much of the nitrogen that is needed for the following cash crop (Stuart, Schewe, & McDermott, 2014). Most farmers who continue using cover crops have reported it is because of the potential long-term benefits cover crops provide (Plastina et al., 2018a). These benefits are dependent upon the type of cover crop, cultural practices, soil type, management history, and the climate in which the cover crop is located (Blanco-Canqui et al., 2011). Among the most significant of these benefits are erosion mitigation, reduced irrigation and pesticide usage, improved soil quality and fertility, and reduced tillage needs. Each of these benefits has the potential to reduce costs, helping to offset the additional cost incurred to adopt cover crops. This section discusses in detail the associated benefits and barriers of adoption of cover crops from previous research.

2.1 EROSION MITIGATION AND PREVENTION

Sediment is the top pollutant produced by agriculture (Hoorman, 2009). Especially in the southeastern part of the United States, two commonly cultivated crops, cotton and peanuts, leave little residue behind after harvest, making those fields highly susceptible to soil erosion and sediment runoff (Nyakatawa, Reddy, & Lemunyon, 2001; Siri-Prieto, Reeves, & Raper, 2007b). Cover crops and cover crop residue can provide protection from soil erosion (D. Allen & Borchers, 2016). Organic matter on the soil surface helps to slow the momentum of surface water, decreasing its ability to move soil particles (Sarrantonio & Gallandt, 2003). Organic matter on the soil surface as little as 10% has been found to reduce the rate of erosion by as much as 30% (Moldenhauer & Langdale, 1995). Increased soil macroaggregates and reduced microaggregates suggest that adding cover crops to acres under no-till can also lead to less soil

erosion and improve the soil structure while also building its water transmission ability (Blanco-Canqui et al., 2011).

2.2 WATER INFILTRATION AND IRRIGATION USAGE

Agriculture is the primary consumer of water (Rosengrant & Cai, 2001). In many parts of the country, irrigation is currently being utilized at unendurable rates (V. G. Allen et al., 2012). As a result, groundwater supplies are declining and farmers are oftentimes being forced to switch from irrigated to dryland farming (Baumhardt et al., 2016; Haacker, Kendall, & Hyndman, 2016). Summer crops such as cotton, peanuts, and corn typically realize the highest economic return, but are highly susceptible to drought conditions (Franzluebbers & Stuedemann, 2014).

Cover crops have been shown to increase water infiltration into the soil (Unger & Vigil, 1998), as cover crops can prevent soil crusting (Lee & McCann, 2019). Conventional tillage without cover crops has been shown to have 54% less soil moisture penetration than cover crops used under a no-till practice (Truman, Shaw, & Reeves, 2005). Even in years that are drier than normal, cover crops have been found to improve soil water content and storage abilities (Basche et al., 2016). Allen et. al (2005) found that a cotton-forage-beef stock steer rotation reduced overall irrigation use and required less nitrogen fertilizer application while simultaneously improving profitability.

However, cover crops can deplete water in the soil needed by the following cash crop early in the planting season (Unger & Vigil, 1998). Research findings suggest that the timing of cover crop termination closer to the planting of the following cash crop results in reduced soil moisture and nutrient availability, leading to diminished yield potential (Snapp et al., 2005). It is paramount to precisely time termination of the cover crop to optimize field conditions for the

following cash crop. Farmers who currently utilize irrigation systems have been found to be up to 16% more likely to adopt cover crops because they are less worried about depleting the available soil moisture for the following cash crop (Bergtold et al., 2012).

2.3 WEED SUPPRESSION

With the inclusion of biotechnology in several major cash crops, herbicide-resistant weeds have seen a rapid increase, reducing crop yields and increasing production costs (Duzy et al., 2016). When used in combination with herbicides in rotations under reduced tillage, cover crops can provide enhanced weed control and support improved and more consistent yields (G. A. Johnson, Defelice, & Helsel, 1993; Wicks, Crutchfield, & Burnside, 1994). Early season weed control can be expected from cover crops, but other weed control methods are still needed for the remainder of the season (Teasdale, 1996). Herbicide use can be reduced when sufficient cover crop residue remains after the planting of the subsequent cash crop, and likely be switched to, only postemergence herbicide programs (Teasdale et al., 2002).

Cover crops' ability to suppress weeds is related to cover crop residue and allelopathic residues released by the cover crop. Allelopathic substances can be released into the soil via leachates, root exudates, or through the decomposition of plant biomass (Bonanomi et al., 2006; Farooq et al., 2011). To achieve the optimal level of weed management, the cover crop must provide sufficient residue, creating an adverse environment for the weed to germinate. The level of weed management provided by the cover crop is more dependent upon the amount of residue rather than the type of cover crop utilized (Mohler & Teasdale, 1993; Teasdale & Mohler, 1992). It is found that cover crop residue can reduce weed density by approximately 50%-75% (Crutchfield, Wicks, & Burnside, 1985; Teasdale, 1993). Furthermore, living mulches provide more effective weed control than dead mulches (Hoorman, 2009). The increased competition

from the living mulch helps to displace weeds and provide detrimental competition for light, nutrients, and space (Bezuidenhout, Reinhardt, & Whitwell, 2012).

2.4 PEST AND DISEASE CONTROL

Increased system diversity, such as the incorporation of cover crops into the cash crop rotation, has been found to reduce the number of herbivore insects due to the abundance of their natural enemies not otherwise found in monocultures (Altieri, 1994). When intercropped with cover crops, densities of natural enemies found in the following cash crop are enhanced (Tillman et al., 2004). Cover crops have been found to reduce pressure from insects through an increase in the predator communities during the cash crop growing season (Bowers et al., 2020) . However, cover crops can provide habitat for both beneficial and harmful insect pests. Some cover crops harbor aphids which serve as a significant source of food for beneficial insects such as lady beetles (Bugg, Dutcher, & McNeill, 1991).

The type of tillage used is also a determinant of how successful a cover crop is at managing insect pests. Conventional tillage makes many agricultural systems difficult environments for natural insect enemies, while reduced tillage can help to conserve the natural enemy density from the cover crop so that they can disperse into the following cash crop. Additionally, cover crops can also help to reduce foliar diseases, curtailing the need for fungicide application (Teasdale et al., 2002).

2.5 TILLAGE

Producers adopting cover crops are more likely to use conservation tillage, which is due to the benefits of increased plant residue from using conservation tillage practices (Teasdale et al., 2002). Conservation tillage can help to preserve deep soil porosity, allowing for increased water absorption (D. Allen & Borchers, 2016), and eliminate compaction issues caused by

multiple tillage passes under conventional tillage. Additionally, no-till planting has been found to achieve higher returns relative to conventional tillage planting (Hanks & Martin, 2007) and reduces production risk related to yield variability (Jaenicke, Frechette, & Larson, 2003; Larson et al., 2001a).

2.6 SOIL ORGANIC MATTERS AND BIOMASS

The impact of cover crops on the soil physical properties is conditionally dependent on the ability of the cover crop to add to the soil organic matter concentration (Blanco-Canqui et al., 2011). The planting date of cover crops affects the amount of biomass produced and the overall performance of the cover crop in the rotation (Price et al., 2012). Optimizing biomass can potentially improve soil productivity, and therefore, crop yield (T. A. Morton, Bergtold, & Price, 2006), and can also help to suppress weeds (Reddy, 2003). An increase in biomass and improved water holding capacity can help retain water during drought years. However, when no-till or reduced tillage is used in combination with cover crops to increase biomass, the stratification of soil nutrients can occur. The decaying plant residue from the cover crop can cause issues for the growing cash crop by confining nutrients and making them less accessible to the cash crop (Larson et al., 2001a).

2.7 NUTRIENT LOSSES AND FERTILIZER

Extended fallow periods can have a devastating, long-term ecological and economic impact through the reduction of soil organic carbon and fertility (Hansen et al., 2012). The majority of nutrient losses in agricultural acreage, about 50% of the total losses of both nitrogen and phosphorus, occur during fallow periods (Udawatta, Motavalli, & Garrett, 2004; Udawatta et al., 2006). In humid climates such as the southeast, mineralization of soil organic matter in the

fall means that the primary time for nitrogen leaching to occur is during the typically fallow period from November to May (Meisinger et al., 1991).

Cover crops help to reduce nitrogen leaching by taking up available nitrogen in the soil during the fallow period (Cameron, Di, & Moir, 2013; Strock, Porter, & Russelle, 2004; Tonitto, David, & Drinkwater, 2006). They have also been shown to reduce nitrate leaching when compared to the use of inorganic nitrogen fertilizer (Harris et al., 1994). Cover crop uptake of nitrogen depends on several factors such as the amount of nitrogen available in the soil, climate, cover crop species, in addition to establishment and termination factors, including seeding rate and the date of planting and termination (Hoorman, 2009). Recovery of reactive nitrogen entering agroecosystems by crop biomass averages 45%-55% globally (Galloway & Cowling, 2002; Smil, 1999), with the remaining surplus lost through denitrification, leaching, and erosion (Tonitto et al., 2006). Cover crops can also boost bio-availability of phosphorous and other mineral-derived nutrients (Vance, Uhde-Stone, & Allan, 2003).

To reduce nitrogen losses, farmers should coordinate the release of nitrogen from the cover crop as a result of decomposition of plant residue to the peak uptake needs of the following cash crop (Sievers & Cook, 2017). Optimal timing of nitrogen mineralization is required to attain high yields as a result of cover crop use (Tonitto et al., 2006). The release of nutrients provided by cover crops can be variable, which is heavily dependent upon environmental conditions and plant residue quality. The substrate quality, amount of aeration, soil moisture and temperature, and microbial and faunal heterotrophs affect the decomposition rate and subsequent nutrient release from the cover crop. Weather, climate, and soils influence the rate of decomposition and nutrient quality as well (Jani et al., 2015; Vazquez, Stinner, & McCartney, 2003). Cover crop residue incorporation into the soil through disking or plowing typically

results in rapid nitrogen mineralization, leading to increased plant availability. However, residue maintained on the soil surface has been found to increase nitrogen uptake by the cash crop, and in turn, improve yield (Sainju & Singh, 2001).

Hybrid systems that combine the use of manure with cover crops and inorganic fertilizers to meet nitrogen and phosphorous needs of the cash crop could be a potential solution for reducing excess nutrient runoff. This hybrid system uses cover crops and manure applied at the planting of the cash crop to reduce or eliminate the need for additional nitrogen inputs and simultaneously balance phosphorous needs without causing an over-fertilization issue. Systems that only use manure with no cover crop have not been shown to improve nitrogen and phosphorous synchrony as found in the hybrid system (Maltais-Landry & Crews, 2020).

Fertilizer is one of the main input costs, especially in crops that require large amounts of nitrogen, such as corn. Previous findings have shown that if cover crops could reduce the need for fertilizer applications by 50% or more, cover crop adoption will increase (Miller, Chin, & Zook, 2012). Cover crops that fix large amounts of nitrogen can help to reduce the fertilizer costs. One study showed that cover crops could reduce optimal nitrogen rates when used in a cotton rotation compared to cotton following no cover crop (G. V. Johnson & Raun, 2003). Farmers who do not reduce their nitrogen application rate based on available nitrogen from the preceding cover crop are failing to benefit from the fertilizer cost savings created by the cover crop (G. V. Johnson & Raun, 2003; Larson et al., 1998). However, multiple studies have found that nitrogen application is still required because the cover crop does not replace all of the application (Lu et al., 2000; Mallory, Posner, & Baldock, 1998; Snapp et al., 2005). The potential for leguminous cover crops to provide nitrogen for the following cash crop is impacted by weather and other environmental conditions that affect the release of nitrogen from decaying

biomass. It is important to realize that this release may not occur during the peak demand period of the cash crop, meaning that nitrogen application will still be required, increasing costs (Larson et al., 2001a).

2.8 CROP AND LIVESTOCK INTEGRATION

An integrated crop and livestock rotation system could be the economical answer to the long-term sustainability of agriculture (Krall & Schuman, 1996). Using cover crops for grazing cattle and other livestock has been shown to be a valuable asset to producers with forage needs while simultaneously increasing the level of diversity in the crop rotation (Faé et al., 2009). Many of the species used as cover crops provide exceptional sources of forage that can be harvested for, or grazed by, livestock (Franzluebbers, 2007; Sulc & Tracy, 2007). The forage produced can add economic value through increased weight gain of the livestock (Faé et al., 2009) and also allows for less susceptibility of the livestock to non-ideal weather conditions (Lawrence & Strohbehn, 1999). Grazing can also help to recover some of the expenses associated with cover crop adoption (Schomberg et al., 2014) through reduced winter feed costs. Manure returned to the field by grazing, along with recommended applications of nitrogen fertilizer, has been shown to increase yields. Studies have shown that the re-integration of grazing livestock influences the expansion of cover crop adoption (Roesch-McNally et al., 2017).

However, many farmers are hesitant to integrate livestock into their crop rotation. Many are concerned about issues related to grazing such as increased soil compaction, loss of beneficial biomass, hindrance of water infiltration, and the potential loss of yield benefits. Livestock activities that are a result of grazing such as defecation, urination, defoliation, and trampling can be highly destructive to the soil structure (Mullins & Burmester, 1997).

Compaction caused by cattle, especially on wet fields, is one of the main disadvantages of grazing cover crops (Bergtold et al., 2017). This is especially important to farmers in the southeast where the majority of the nation's cotton and peanuts are cultivated since both crops are highly susceptible to soil compaction (Jordan et al., 2001).

The degree of soil compaction varies and is dependent upon factors such as soil texture, stocking and grazing activity, cover crop species, and soil water content (Greenwood & McKenzie, 2001). Excessive precipitation without sustainable evaporation rates makes the soil highly susceptible to compaction issues caused by grazing livestock, decreasing soil porosity and available oxygen and nutrients. Acreage with greater saturation rates can be trafficked without causing increased compaction issues in the presence of cover crops (Blanco-Canqui et al., 2011). Although cover crops can help to reduce compaction issues, they may not be as effective if the soil is near full saturation. Thus, it is important to ensure that stocking density of livestock does not exceed the available forage to limit traffic inundation that can lead to excess soil compaction issues (Franzluebbers & Stuedemann, 2008). In addition, the increased organic matter available to the soil from manure can help to improve soil physical properties, including a higher rate of water infiltration and residue decomposition, potentially reducing compaction issues (Roberson et al., 1995).

An alternative to grazing is the baling of cover crops. However, baling has been found to be less beneficial than grazing since it reduces biomass, soil protection, and productivity. Some of the benefits of using cover crops are eliminated when biomass is removed since this can substantially reduce cash crop yield benefits normally seen with the use of cover crops (Bergtold et al., 2017). The additional biomass optimizes soil and crop productivity (T. A. Morton et al., 2006) and reduces nutrient leaching while improving nutrient uptake efficiency (Wade et al.,

2015). It also helps protect against wind erosion and maintains moisture levels (Karlen et al., 2009). Low amounts of biomass from baling can lead to additional compaction issues (Tollner, Calvert, & Langdale, 1990). Decreased biomass leads to a lower perceived yield benefit of the cover crop for farmers using them strictly for conservation purposes (Snapp et al., 2005). Cover crops are also better grazed than baled due to the additional labor and machinery costs associated with baling (Kelln et al., 2007).

2.9 YIELD

An important economic consideration when determining whether to implement cover crops is if the practice results in a reduction or gain in yield (Ranjan et al., 2019). Yield has proven to be a major variable for budget revenue, with farmers reporting mixed results after planting a cover crop (Hancock et al., 2020). Differences in soil quality seem to be the best predictors of changes in yield, suggesting that long-term cover crop use will further stabilize yield (Cai et al., 2019). Findings suggest that yield losses attributed to cover crops are due to incomplete termination, reduced soil moisture, or nutrient deficiency or immobilization (Mischler et al., 2010; Unger & Vigil, 1998).

2.10 CROPLAND LEASES

Out of the top-down management practices, land tenure has been found to be the most inhibiting when it comes to cover cropping decisions (L. W. Morton & Brown, 2011). This is an interesting and important finding given that cash renting has more than doubled over the last twenty years (Barry, Escalante, & Moss, 2002; Paulson & Schnitkey, 2014). Owner-operators are more likely than cash renters to implement conservation practices, such as cover crops and reduced tillage, since they are in control of the duration, and therefore long-term benefits, of these practices. Share renters have been found to behave much like owner-operators (Soule,

Tegene, & Wiebe, 2000), most likely explained by the fact that the conservation of the cropland is in their best interest if they are to reap any of the yield benefits provided by such practices.

The use of no-till practices is oftentimes a substitute for cropshare terms. This is because the main purpose of cropsharing is to encourage land conservation while maximizing yield, which is accomplished by no-till (D. Allen & Lueck, 1992). The increased implementation of no-till practices has largely resulted in the transition from cropshare contracts to cash rent contracts, with leases typically being for one year and rarely longer than three years (D. Allen & Borchers, 2016). Since benefits reaped from conservation practices typically require several consecutive years of implementation before they are realized, cash renters bear considerable risk regarding lease tenure. This risk is observed since the cash renters are responsible for the upfront costs associated with implementing conservation practices and are not guaranteed any tenure for the lease of the cropland (Soule et al., 2000).

2.11 ECONOMIC RETURNS

On-farm economic benefits are one of the most critical determinants of whether a farmer will choose to adopt conservation practices such as cover crops (Lichtenberg, 2004; Pannell et al., 2006; Reimer, Thompson, & Prokopy, 2012). Crop enterprise risk, yield volatility, run-off, and soil erosion are several of the main profitability issues faced by farms utilizing crop rotations that include an extended fallow period. However, in the short-term, fallow periods between cash crops are more attractive than cover cropping in the absence of consideration of the long-term benefits provided by cover crops. Some benefits provided by cover crops, such as reduced erosion and increased soil organic matter, do not directly generate revenue and are not usually included in crop budgets, meaning cover crops are less economically attractive to farmers (Acharya et al., 2019).

The economic outcome observed from the use of cover crops is highly dependent upon input costs for both the cover crop and cash crop, establishment costs, cash crop yields and quality, market price of the cash crop, and unrelated events such as weather, etc. (Bergtold et al., 2017). Previous research has found that yield influences the level of net return to some extent, while the cost of cover crop implementation is the main concern (Reddy, 2003). Cover crops that or grazed or harvested for forage can help to offset some of the adoption costs. It is important to note, however, that one study found that cover crops can still yield positive returns even in the absence of use for forage or grazing (Hughes & Langemeier, 2020). Bowers et al. (2020) also found that when cover crops are implemented in the cropping system, production costs and net returns were comparable to conventional production practices (Bowers et al., 2020). In addition, cover crops used in conservation tillage systems can help to reduce spatial variability in cash crop yield, in turn reducing variability in net returns (Bergtold et al., 2005).

Opportunity costs, such as those from additional management hours required, must also be taken into account (Plastina et al., 2018c). Some farmers may have higher skill specialization, further increasing their opportunity cost when making changes (Ghadim & Pannell, 1999). The increased adoption rate of cover crops has resulted in more competition for labor and custom hire work. An interesting finding related to farmer experience is that it has a negative impact on the perceived benefit of cover crops (Archer & Reicosky, 2009; Larson et al., 2001a; Pannell et al., 2006), most likely explained by farmers having streamlined production practices, therefore increasing their opportunity cost when making changes in the adoption process. Farmers have reported that they chose not to use cover crops because of increased labor and custom hire costs (Lira & Tyner, 2018). This has been observed due to the fact that many farmers have limited time and must prioritize which tasks they complete themselves and which they hire out (Plastina

et al., 2018a). Additional termination costs have not been observed when cover crops were terminated using a method typical of the farmer's spring management practices (Plastina et al., 2018c).

2.12 BARRIERS TO ADOPTION

Common barriers to adoption include current management practices, establishment and termination costs (Krajewski, 2017; Reimer, Weinkauf, & Prokopy, 2012; Roesch-McNally et al., 2017), perceived risk of adoption, land tenure if the cropland is rented, (Ranjan et al., 2019), and if so, what the terms are (Soule et al., 2000), and changing from conventional tillage to reduced tillage or no-till (Xie, 2014). When adoption of conservation practices requires new technology, such as equipment, it requires farm finances to be sufficient and stable, often hindering adoption by smaller or more risky operations (Knowler & Bradshaw, 2007). The additional cash outlay required to incorporate winter cover crops into the rotation is concerning to many farmers. Cover crop seed availability and the lack of markets for these alternative crops also create barriers. Predictable yield and economic benefits from cover crop use will be necessary to increase adoption rates (Wortman et al., 2012a).

Additional labor and management hours have also been found to be a significant barrier to adoption, suggesting that simplified technologies could encourage higher adoption rates. The difficulty, due oftentimes to lack of knowledge or experience, in the timing of management decisions for cover crops is another of the most frequently stated reasons for choosing not to adopt, or only adopting for perhaps one season (Roesch-McNally et al., 2017). Lack of familiarity of which cover crop species to use is yet another concern of farmers who either currently use, or would like to use, cover crops in their current cash crop rotation.

Farmers are largely controlled by factors beyond the farm gate, such as commodity value chains, that limit what crops they can use in their rotations and still remain successful (Bartels et al., 2013). Crop insurance policies oftentimes control whether farmers can use cover crops at all. Many policies state that if cover crops are used in the rotation, it may result in the loss of crop insurance, while others do not clearly state terms involving cover crop use, deterring many farmers from planting them (Carlisle, 2016).

2.13 COST-SHARE PAYMENTS AND AGRICULTURAL POLICY

Many policies are designed to encourage a behavioral change in farmers so that they may adopt conservation practices they may not otherwise choose to adopt (Pannell & Claassen, 2020). Some policies include funding to increase or enhance educational opportunities for farmers while others can provide monetary incentives for adoption (Pannell & Claassen, 2020). Conservation practices that are highly attractive to landowners may not require monetary incentives (Pannell & Claassen, 2020). Instead, extension programs can be an effective means of educating farmers and provide the necessary education and support to encourage further adoption (Pannell & Claassen, 2020). On the other hand, practices that are less adoptable, such as those that are more costly, may require incentive payments or other modes to encourage adoption (Pannell & Claassen, 2020). Conservation practices that are more cost-responsive can be implemented at a lower cost-share rate while simultaneously achieving a higher adoption rate (Lichtenberg, 2004). Cost-share assistance can help reduce the risk that is typically observed at the outset of adoption, as only one-third of farmers perceived a yield benefit (Bergtold et al., 2012). With continued and consistent adoption, these programs could potentially be reduced as the practice becomes more mainstream since returns have been shown to stabilize long-term.

It is necessary to understand benefits of conservation practices when deciding upon effective policy measures to increase adoption rates. Many benefits are realized on-farm, but many more are realized off-farm, meaning that this can be used to justify policies which create funding for education or monetary incentives for farmers to adopt conservation practices (Knowler & Bradshaw, 2007). Furthermore, ecosystem services provided by cover crops used on extensively managed cropland are disproportionately enhanced relative to economic benefits (Asbjornsen et al., 2014; Daigh et al., 2014; Gopalakrishnan, Negri, & Salas, 2012; Helmers et al., 2012; Liebman et al., 2013; Meehan et al., 2013) under current market and policy conditions (Manatt et al., 2013).

In addition, policymakers must understand the likelihood of partial adoption and if benefits will be realized immediately, or if they will require continued use over multiple seasons (Pannell & Claassen, 2020). Partial adoption is caused by issues such as the current crop rotation and its compatibility with cover crop use (Tran & Kurkalova, 2019; Wade, Kurkalova, & Secchi, 2016), heterogeneous quality of cropland (Wade & Claassen, 2017), varying weather conditions (Soule et al., 2000), and limited availability of inputs, inhibiting full adoption (Doole, Blackmore, & Schilizzi, 2014).

Some policies provide incentives for farmers to trial a certain conservation practice, such as cover crops. This creates a policy risk, however, since a trial does not guarantee adoption, whether partial or whole-farm. Nonetheless, incentive payments that encourage trials help to spur improved management practices and cover costs associated with learning a new method. The possibility of adoption is typically abandoned by farmers if the trial does not perform well enough after payments are discontinued (Pannell & Claassen, 2020). It will also be important to modify current farm policies that seem to encourage monoculture and other types of

specialization in agriculture if we are to adjust to more conservation agriculture practices (Siri-Prieto, Reeves, & Raper, 2007a). Policies with reduced incentives to adopt conservation practices in favor of monoculture with mandated tillage applications will need to be drastically changed or eliminated to encourage better practices for a sustainable future (Friedrich, Kassam, & Taher, 2009).

The extent of sustained adoption induced by conservation program payments in the U.S. is not well-known (Claassen & Ribaudo, 2016; Jackson-Smith et al., 2010). A study of farmers in Washington state indicated a mean willingness to pay value of $4.52 per acre, but this value is not known for other regions of the country (Chouinard et al., 2008). In the past, more farmers have participated in implementing conservation practices if incentive payments increased over time (Cooper, 2003), indicating that subsidies provided to farmers who implement these practices will cause a significant increase in the adoption rate. Cover crops are perceived by farmers as being a costly conservation practice, and it is important for the agricultural policy to provide monetary incentives necessary to encourage adoption (Atwell, Schulte, & Westphal, 2009). Singer, Nusser, & Alf (2007) found that more than half of farmers would plant cover crops if a cost-share program were available to help offset some of the costs associated with implementation into the rotation. It is necessary to better understand the impact of all these factors to determine the level of incentive needed to encourage the desired adoption rate of conservation practices.

2.14 EDUCATION IMPLICATIONS

A higher level of education has been found to be positively correlated with a higher likelihood of adoption of a new practice, such as cover cropping (McBride & Greene, 2013; Schimmelpfennig & Ebel, 2016; Weber & McCann, 2015). Sufficient education about

conservation practices is necessary to further encourage adoption (Knowler & Bradshaw, 2007). Previous findings suggest that farmers must be aware of a new practice, such as cover crops and other conservation practices, and must have a positive attitude about it for them to choose to adopt that practice. When farmers have a positive attitude about a new practice, such as cover cropping, they are more likely to at least trial the practice. A positive attitude is not enough, however, for adoption to take place when isolated from other decision factors, such as taking on the additional cost and management hours (Prokopy et al., 2019). However, education has been found to have a negative impact on the perception of yield benefits if the farmer has higher skill specialization due to the higher opportunity cost of changing enterprises (Bergtold et al., 2012).

Education about which cover crops will best fit a farmer's operation will be needed if they are to realize the most benefit from their cover crop (Lira & Tyner, 2018). The education programs for cover crops should target farmers with more diverse crops planted and younger farmers. Crop diversity already in place on a farm may increase cover crop adoption rates. This can be attributed to the lower cost barrier if the farmer already owns a diverse range of equipment and has more experience with different crop types (Arbuckle & Roesch-McNally, 2015; Singer et al., 2007). Younger farmers are assumed to be more likely to adopt cover crops since benefits are realized in the long-run, over a period of years (Lee & McCann, 2019). Going forward, more education and subsidy programs will be very important for the increased adoption of cover crops (Bergtold et al., 2017).

CHAPTER 3

METHODOLOGY

Following the methodology developed by Plastina et. al (2018), this research utilized a comprehensive survey to investigate cover crop use in Georgia, Alabama, and Florida row crop rotations. The survey was designed to identify current production practices when cover crops are used in the rotation as well as perceptions farmers hold about the challenges they pose and the perceived benefits of their use. For consistency, farmers were asked to always refer to the same farm throughout the survey, even if they own or manage more than one farm that utilizes cover crops. The survey also asked farmers to identify changes in production practices with the adoption of cover crops by asking them detailed questions about their cover crop planting and termination methods, tillage methods, the cash crop planted following the cover crop, and the cover crop species or mix chosen. Additionally, we asked them questions to identify changes in costs and revenues associated with cover crop use. These included questions about irrigation usage, changes in inputs such as fertilizer and fuel, and cropland leases. Farmers were also asked to rank the top three benefits they feel cover crop use provides and the top three challenges posed by their use.

3.1 SURVEY DESIGN

The beginning framework for the southeastern cover crop survey was the paper and Qualtrics online surveys developed by Plastina et. al (2018). Based on the survey design method from Dillman, Smyth, and Christian (2014), , we have worked with southeastern specialists to

further develop and modify the survey questionnaire to more accurately reflect southeastern row crop production practices. The final version of the southeastern cover crop survey consists of seven sections (Appendix 1): basic farm information, cover crop planting method, cover crop termination method, revenues and costs, tillage practices, previous rotation, and perceptions about cover crops. Although the survey questionnaire is quite lengthy when considering the number of questions included, we utilized a logic system so that respondents only had to answer questions that applied to their practices. For farmers who had never planted a cover crop before, they only answered the first and last sections of the survey so that we could still collect information to understand how they currently perceive the use of cover crops.

3.2 CONTACT INFORMATION COLLECTION

The survey was distributed to farmers in Georgia, Alabama, and Florida and responses were collected by phone, through mail, and through Qualtrics. Contact information for individual farmers was collected by reaching out to county extension offices in Georgia and Florida, regional extension agents in Alabama, and research specialists through the University of Georgia Cooperative Extension Service, the Institute of Food and Agricultural Sciences through a partnership between the University of Florida and Florida A & M University, and the Alabama Cooperative Extension System through a partnership between Auburn University and Alabama A & M University. Local Natural Resource Conservation Service (NRCS) centers were also contacted, as they provide funding to many farmers to implement cover crops and can reach out to farmers who they believe may be interested. Lastly, we reached out to commodity groups in each state. These included the Georgia Cotton Commission, the Georgia Peanut Commission, the Georgia Corn Commission, the Alabama Peanut Producers Association, the Alabama Cotton Commission, and the Florida Peanut Producers Association. In addition to these, we also

reached out to county Farm Bureau offices in Georgia, state board members of the Florida Farm Bureau Federation, and leaders of the Alabama Farmers Federation. Each of these entities received an email (Appendix 4) stating the objective of our research, the types of participants we were looking for, and a link to the online survey. We asked them to forward along the information to any farmers they had in mind who utilize cover crops in their cash crop rotations.

As contact information for individuals was collected, we also reached out to farmers asking if they knew of any other farmers who would also be willing to participate in our survey. This snowball method proved to be a successful tool in gathering more interested participants for survey distribution. Each participant was asked ahead of time to indicate which response collection method they prefer to ensure the best response rate possible and efficient use of funds for postage and printing expenses.

3.3 SURVEY DISTRIBUTION

The data collection period was from January 28, 2021 to March 31, 2021. This period was selected to avoid the harvest and planting seasons for cotton, peanuts, and corn so that we could achieve as many responses as possible. Due to the traveling restrictions in place because of COVID-19 during the survey period, it was difficult to recruit participants through in person meetings to conduct the survey. To address this challenge, we worked closely with county agents and provided farmers with multiple ways to fill out the survey, including mailing the paper survey, access to the online survey, and conducting the survey through phone calls. We utilized a mixed mode questionnaire and survey implementation method and followed the timeline suggested by Dillman et al. (2014) to achieve the highest response rates. Below we discuss in detail about the timeline for each round of survey correspondences for both the online survey and the mailed survey.

The first mail package (Appendix 3) included a copy of the survey questionnaire, the initial invitation cover letter, and an invitation postcard that we asked recipients to share with other farmers they know who may be interested in completing our survey. We also included a return envelope with prepaid postage and a return address so they could easily return the completed survey. The postcard asking for contact information for additional participants included space for that information as well as a link to the online survey. The purpose of this package was to introduce farmers to the purpose of our research and ask for their participation. The email contacts (Appendix 3) were very similar in structure and content to that of the mailing packages. The first email contact included an initial invitation letter and a link to the online survey.

The second mailing was sent one week later to the entire mailing list and included a thank-you reminder letter. The intent of the thank-you reminder letter was to remind farmers about the survey with the hope that the prompt timing of the second letter would prevent the initial survey packet from being thrown out. The letter for the second email was very similar in nature to that of the mailed version. The second email contact included the online survey link and thank-you reminder letter. One deviation from the mailing package was that emails were only sent to farmers who had not yet completed a survey.

Fourteen days after the second mailing, we sent a reminder postcard to remind farmers about the survey and hopefully garner more responses from anyone who had forgotten without having to incur additional postage and printing expenses from having to send an additional copy of the survey and prepaid return envelope. One week following the reminder postcard, we sent a follow-up reminder letter as well as a second copy of the survey questionnaire with another prepaid return envelope and invitation postcard. This package was sent to anyone who we had

not yet received a response from. The objective of the follow-up reminder letter was to politely insist that the recipient complete the survey and conveyed the importance of their individual response to the research. A second copy of the questionnaire was included. As with the mailing package, the third email contact included a follow-up reminder letter and the online survey link and was only sent to farmers who had not yet participated in the survey.

The final contact included a final reminder letter. This contact was sent eleven days after the follow-up reminder to everyone who we had not yet received a response from. Similarly, the fourth and final email contact included a final reminder letter and the online survey link, which did not expire.

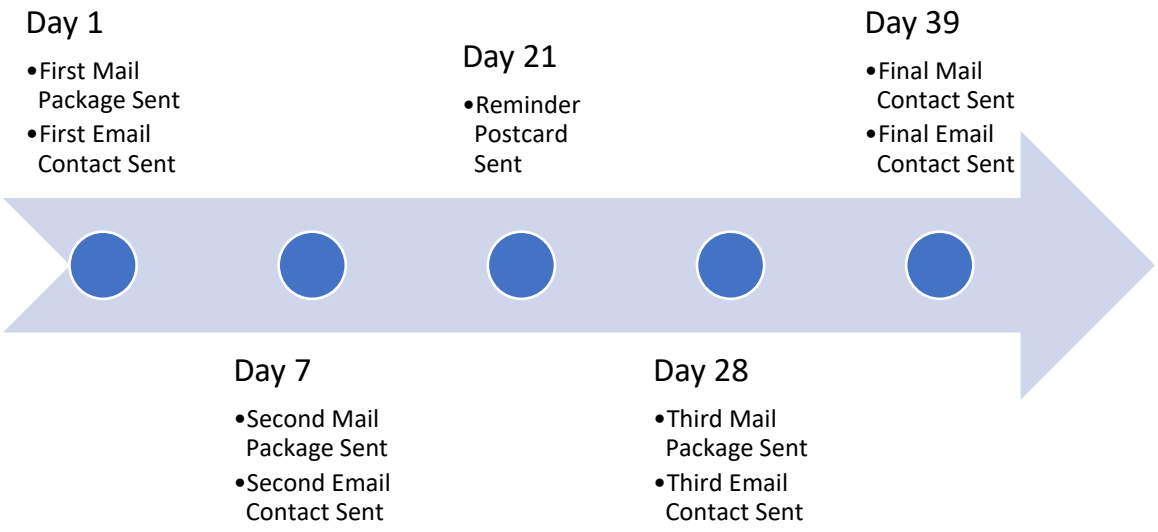

Figure 2 Survey timeline for the mail package and email packages.

CHAPTER 4

RESULTS AND DISCUSSION

We received a total of 46 responses to our southeastern cover crop survey, several of which were incomplete. Due to the type of research being conducted, we chose to include incomplete responses to collect as much information as possible. We tallied the number of responses for each question to ensure accuracy in our analysis and in any comparisons. Because of the extensiveness of the survey, it was designed with embedded logic so questions that were displayed were conditionally based on previous answers. Each question was analyzed individually. This survey asked farmers about their most recent cover crop and cash crop practices prior to January 2020. Except for the few questions in the survey that asked farmers to do otherwise, farmers were asked to refer to the same farm and the same cover or cash crop throughout the survey.

4.1 FARM DEMOGRAPHICS

Figure 3 shows the allocation of respondents by the state where their farm was located. Forty-four farmers indicated the location of their farm, with 31 of the respondents being located throughout 22 Georgia counties, mostly concentrated in the southern part of the state. Florida producers represented nine of the responses we received and were located throughout seven counties in the northern part of the state. We received four responses from farmers in four Alabama counties spread throughout the state. Most of the respondents have planted a cover crop on their farm in recent years, with only two farmers out of 46 reporting that they have never

planted a cover crop on their farm. Thirty-eight producers reported that the most recent year they planted cover crops was in 2019. The remaining six producers reported that the most recent year was either 2018 or 2017.

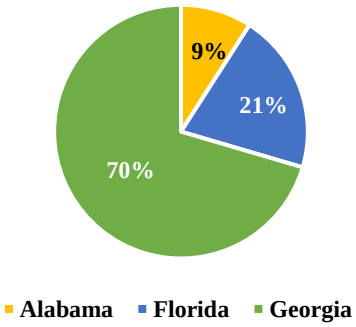

Figure 3 Percentage of total responses received of farm locations by state.

Figure *4* shows the number of years producers have planted a cover crop on their farm. The most common response was 0-5 years, with few farmers planting a cover crop for more than 20 years. Out of the 43 responses received for this question, the average number of years producers planted cover crops was 11.47 years. Additionally, we asked respondents to report the cumulative acreage they have planted to cover crops since they began cover cropping. Out of 42 responses received, the average cumulative acreage planted to cover crops was approximately 8,713 acres. If we consider that the average years a cover crop has been planted on a farm, the average number of cover crop acres planted on a farm is approximately 760 acres per year.

The results from Figure 4 show a very interesting trend with several possible explanations. Most farmers have only grown a cover crop from 0-5 years. However, there is a spike at 16-20 years, showing that there are some farmers who have adopted cover cropping long-term. For farmers who have grown a cover crop for five years or less, they have likely not realized the long-term benefits that a cover crop can provide. Furthermore, farmers who have

grown a cover crop for 15+ years have likely realized many of the long-term benefits, which is why they continue to plant a cover crop.

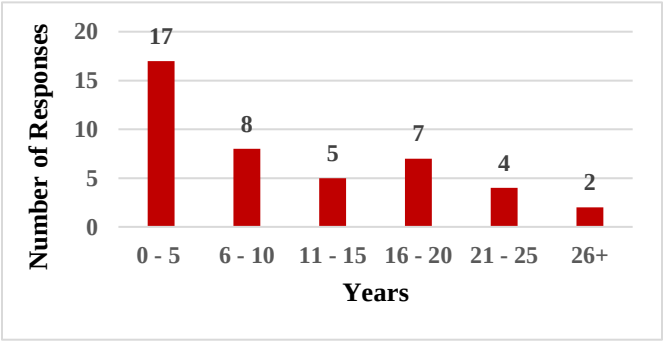

Figure 4 Number of years overall that a cover crop has been planted on the same farm.

Figure 5 shows the size of the farm. Five hundred to 999 acres was the most common farm size range, with 24% of farms falling into this category out of the 46 responses received for this question. Farm sizes of 2,000+ acres and 1,000 – 1,999 acres were the next most common farm sizes at 22% and 20%, respectively.

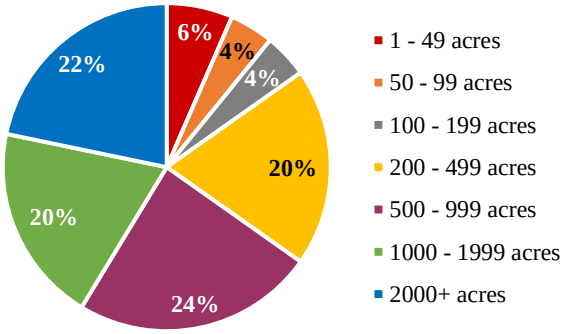

Figure 5 Percentage of total responses received for each farm size acreage range.

Figure *6* shows the percentage of responses using a monoculture versus a mixed species. Fifty-one percent (22) of the respondents indicated they use a cover crop monoculture with the

remaining 49% (21) using a mixed species. Figure *7* shows that cereal rye was the most common cover crop monoculture utilized by producers. Each of the remaining cover crop species received less than three responses. Table 1 shows the mixes that the remaining 21 farmers indicated they utilize on their farm. Nine of the mixes included annual ryegrass, while 12 mixes included cereal rye. Other common elements of the mixes were a variety of clover or a variety of oats. Ten mixes included at least one variety of clover and 12 mixes (13 responses) included at least one variety of oats.

There are many attributes of cereal rye that make it an excellent choice for a cover crop in the southeast. It can be planted late into the fall, meaning that a later cotton harvest date would not inhibit a farmer from being able to plant cereal rye once the cotton has been harvested. It also has several physical properties that make it a good choice for farmers who are interested in reaping environmental benefits from the cover crop. Cereal rye has an extensive root system which helps to not only hold the soil in place and reduce erosion, but also helps to aerate the soil. When the cereal rye is allowed to reach maturity, it is able to scavenger for, and capture, nitrogen and hold it for an extended period of time, allowing the potential for this nitrogen to be saved and used for the following cash crop. It can also help reduce the need for potassium application since it increases the amount of usable potassium near the soil surface for the following cash crop. When mature at termination, cereal rye leaves abundant biomass on the surface of the soil, providing surperior weed and pest suppression. It is especially effective against herbicide-resistant weed varieties and nematodes.

Based on the cover crop mixes found in Table 1, it appears most farmers are concerned with nitrogen fixation since many of them include either annual ryegrass, cereal rye, or a type of clover. Each of these are effective at reducing soil erosion, recycling and storing important

nutrients such as nitrogen, and leave large amounts of biomass behind after termination. For farmers who use their cover crop for grazing, these are all nutrient-dense for the livestock as well, and can help to offset some of the winter feed costs if grazed or harvested for forage.

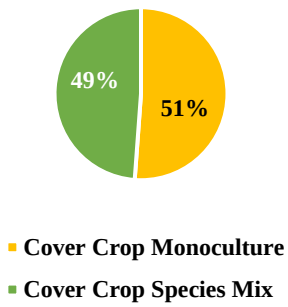

Figure 6 Percentage of responses received indicating a cover crop monoculture versus mix being used on a farm.

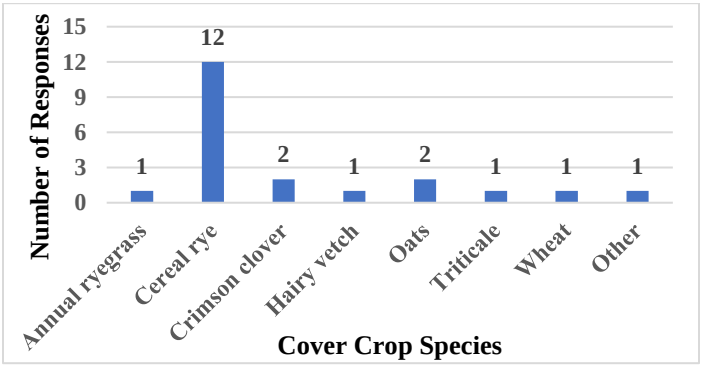

Figure 7 Species planted as cover crop monoculture.

Table 1 Cover crop mixes used by survey respondents.

Mix Number:	Cover Crop Mix	Number of Responses:
1.	barley + sugar beets	1
2.	crimson clover + oats	1
3.	annual ryegrass + cereal rye + oats + wheat	1
4.	Austrian winter peas + cereal rye + crimson clover + hairy vetch + mustards + oats + radish + rapeseed + turnips + triticale + wheat + balansa clover	1
5.	annual ryegrass + Austrian winter peas	1
6.	annual ryegrass + Austrian winter peas + cereal rye + crimson clover + hairy vetch + mustards + oats + radish + rapeseed + turnips + triticale	1
7.	annual ryegrass + white clover	1
8.	annual ryegrass + cereal rye + oats + triticale	1
9.	cereal rye + hairy vetch + mustards + oats + radish + turnips + wheat + black oats	1
10.	cereal rye + crimson clover + mustards + radish	1
11.	cousack black oats + balancia fixation clover	1
12.	cereal rye + millet + crabgrass	1
13.	annual ryegrass + Austrian winter peas + cereal rye + crimson clover + hairy vetch + oats + turnips	1
14.	annual ryegrass + crimson clover + wheat	1
15.	radish + wheat	1
16.	cereal rye + wheat	1
17.	annual ryegrass + oats + wheat	1
18.	cereal rye + oats	1
19.	Austrian winter peas + cereal rye + crimson clover + hairy vetch + radish	1
20.	annual ryegrass + cereal rye + crimson clover + oat + radish + wheat	1
21.	oats + wheat	2

4.2 COVER CROP PLANTING PRACTICES

Figure 8 shows the range of the number of acres planted to a cover crop in the most recent year a cover crop was planted on the farm. The most common range was 100-499 acres, indicating that cover crops are not typically planted on 100% of a farm's acreage if we consider that the most common farm size acreage range was 500-999 acres. This research aimed to

compare the changes in costs, revenues, and production practices for farmers who have acreage both with a cover crop and without a cover crop. To expand agricultural sustainability, further research should be conducted to understand more about why farmers do not appear to plant cover crops on 100% of their acreage. It is possible that some of them may be trialing the practice, while others are using it as a risk management strategy. Perhaps some farmers do not have enough time after harvest to get the cover crop planted and established before it is too late. Some farmers may only use cover crops in their fields with erosion issues to better help hold the soil in place between cash crops. We need to understand more about why farmers have not fully adopted cover crops on 100% of their acreage so that we can find ways to encourage cover cropping in the future.

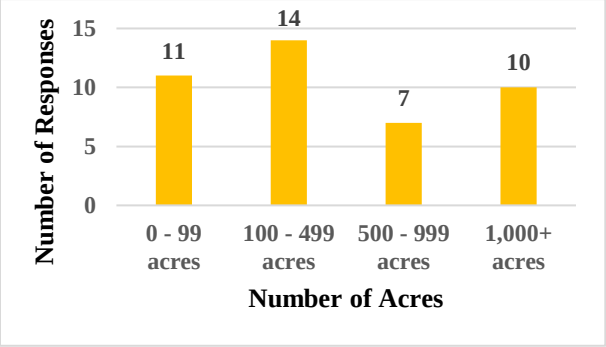

Figure 8 Number of acres planted to cover crop in the most recent year a cover crop was planted on the farm.

Cover crop seed costs were collected in dollars per acre and separated by seed costs for a monoculture versus the seed cost of a mixed cover crop. We received 41 responses to this question. Figure 9 shows the distribution of responses for monoculture, with 12 farmers indicating their seed cost ranged from $10-$19 per acre. The average seed cost for a monoculture reported was approximately $23.53 per acre. Unsurprisingly, the reported costs for

a cover crop seed mixture were largely higher than that of a monoculture. Figure 10 shows more of a spread in the responses for mixed cover crop with the $20-$29 range being the most common. The average seed cost reported for a cover crop mix was approximately $25.88 per acre.

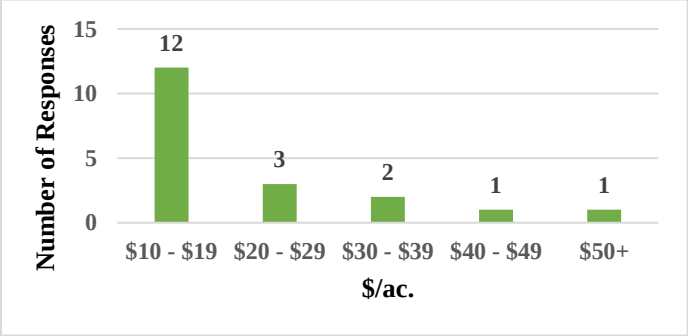

Figure 9 Seed cost per acre for a cover crop monoculture.

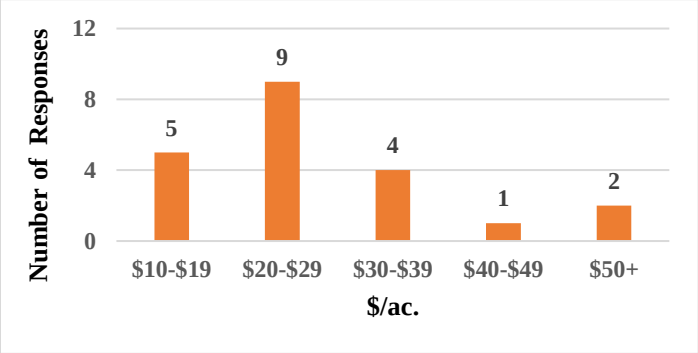

Figure 10 Seed cost per acre for a cover crop mix.

Regardless of whether an irrigation pivot was present or not, most farmers did not irrigate their cover crop. Farmers who only irrigate a portion of their cover crop are included in the 19% of respondents in Figure 11 who do irrigate their cover crop. We received 43 responses, with only one farmer indicating they irrigate 100% of their cover crop. Eight farmers reported the

average acre-inches of irrigation applied to their cover crop. The average irrigation amount applied was approximately two acre-inches.

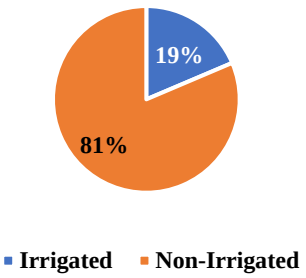

Figure 11 Percentage of farmers who apply irrigation to at least some of their cover crop acreage.

A slight majority of farmers apply fertilizer to their cover crop, with Figure 12 showing 58% of 43 respondents reporting they apply fertilizer to at least some of their cover crop acreage. Seventeen farmers of those who fertilize their cover crop fertilize 100% of their cover crop acres. For farmers who fertilize their cover crop, we asked them to report all the types of fertilizer they use. Figure 13 shows nitrogen to be the most commonly applied fertilizer to a cover crop. Some of the fertilizers mentioned in the "Other" category included sulfur, Insol, and urea.

There are several possible explanations for apply fertilizer to crop crop. It is possible that some farmers want the cover crop to establish quickly and successfully if they are wanting to terminate early, allowing plenty of time to plant the following cash crop. When the cover crop is successfully established, it can more quickly begin providing many of the environmental benefits associated with cover cropping such as reducing soil erosion and scavenging for nitrogen and other nutrients. Yet another possible explanation for why farmers are still applying nitrogen to their cover crop is because they hope the excess nitrogen will be stored for use by the following cash crop. Lastly, some farmers may not be reaping the full benefits of cover crops if they are still applying nitrogen, even when it is not needed. Cover crops are able to reduce production

costs in many instances, but farmers may not always see these benefits if they do not adjust their practices accordingly.

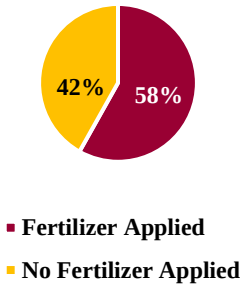

Figure 12 Percentage of farmers who apply fertilizer to at least some of their cover crop acreage.

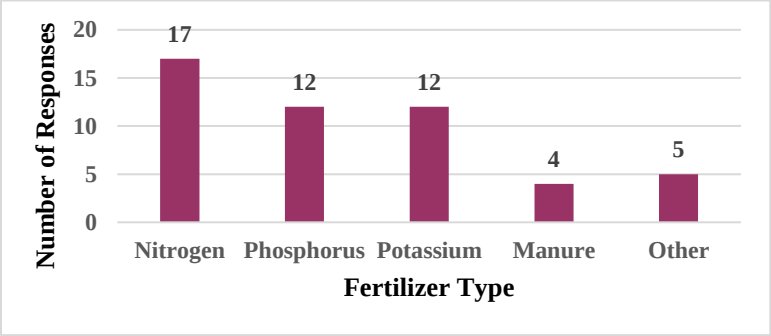

Figure 13 Type of fertilizer applied to cover crop.

To understand more about the costs incurred for planting a cover crop, we asked farmers if they hired custom work for cover crop planting. Figure 14 shows that five of 43 farmers hired custom planting for at least some portion of their cover crop acreage. Three farmers hired custom broadcast seeding, while the remaining two farmers hired custom drilling to plant their cover crop. Custom broadcast seeding cost an average of $20.67 per acre, with custom drilling costing an average of $26.00 per acre. For farmers who did not hire custom planting work, we asked them to specify the type of planting machinery they used. Figure 15 shows that a no-till drill and broadcast seeder were the two most common types of planting machinery used to plant

the cover crop with a total of 39 responses received. For power machinery, the majority of farmers used a four-wheel drive tractor ranging from 200 – 399 horsepower. The remaining 17 farmers used a two-wheel drive tractor ranging from 30 – 179 horsepower.

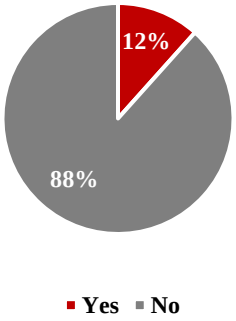

Figure 14 Custom planting hired for cover crop.

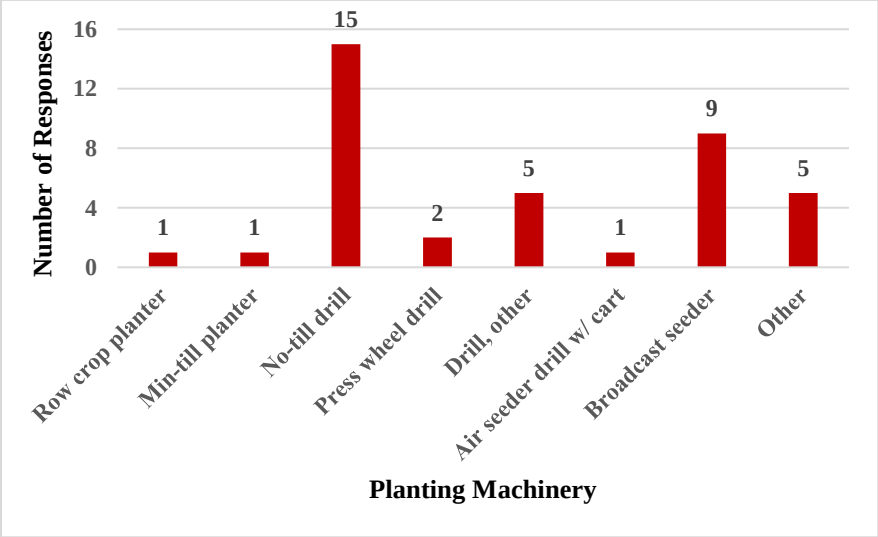

Figure 15 Type of planting machinery used to plant cover crop.

4.3 COVER CROP TERMINATION METHODS

Figure *16* shows that most farmers in the sample used herbicide during cover crop termination. Thirty out of 32 farmers who used herbicide during cover crop termination reported

their herbicide cost for an average of $12.04 per acre. Twelve of the 30 farmers who use herbicide during the termination of their cover crop also used another termination method in addition to herbicide. None of the producers hired any custom work for cover crop termination by herbicide. Seventeen farmers used a self-propelled sprayer. Nine farmers used a two-wheel drive boom-type sprayer for cover crop termination by herbicide.

The majority of farmers indicated that termination of their cover crop does not require additional labor or incur additional costs for them. Only four farmers reported that termination of their cover crop by herbicide required additional unpaid labor hours with an average of 5.56 hours per acre. Five farmers reported incurring additional expenses for termination of the cover crop by herbicide. The average additional expense was $40.00 per acre. These results are not very surprising, as many farmers already incorporate herbicide application into their spring field preparation practices. For these farmers, applying herbicide to the cover crop is likely no more costly, whether in expense or management hours, than applying the herbicide to a field without a cover crop. Farmers who do not already use herbicide to prepare their field in the spring for planting a cash crop are the ones most likely not seeing as much of a return on investment since they are incurring an additional expense to purchase herbicide to terminate the cover crop.

The remaining questions of the termination section asked farmers for further details about other methods used to terminate their cover crop. These methods included those who used tillage, mowing, or roll/crimp in addition to herbicide as a termination method or only tillage, mowing, or roll/crimp to terminate without herbicide. Of the 29 responses we received from farmers who use herbicide as part of the termination process, 12 farmers sprayed herbicide in addition to using another termination method. The remaining 17 farmers used only herbicide to terminate their cover crop. Sixteen of 28 farmers indicated that all their row crop acreage was

planted in a winter cover crop. 24 farmers utilize a single cover crop termination method. Figure 17 shows that the most common method was roll/crimp, which was used by five farmers.

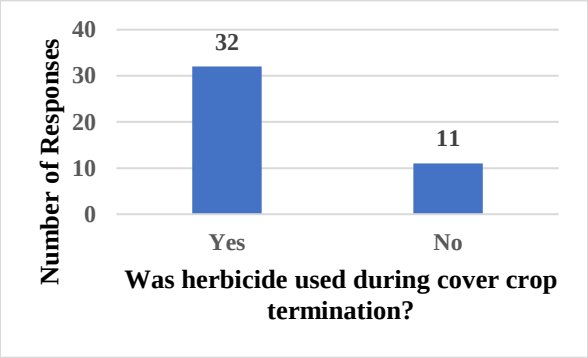

Figure 16 Herbicide use during cover crop termination.

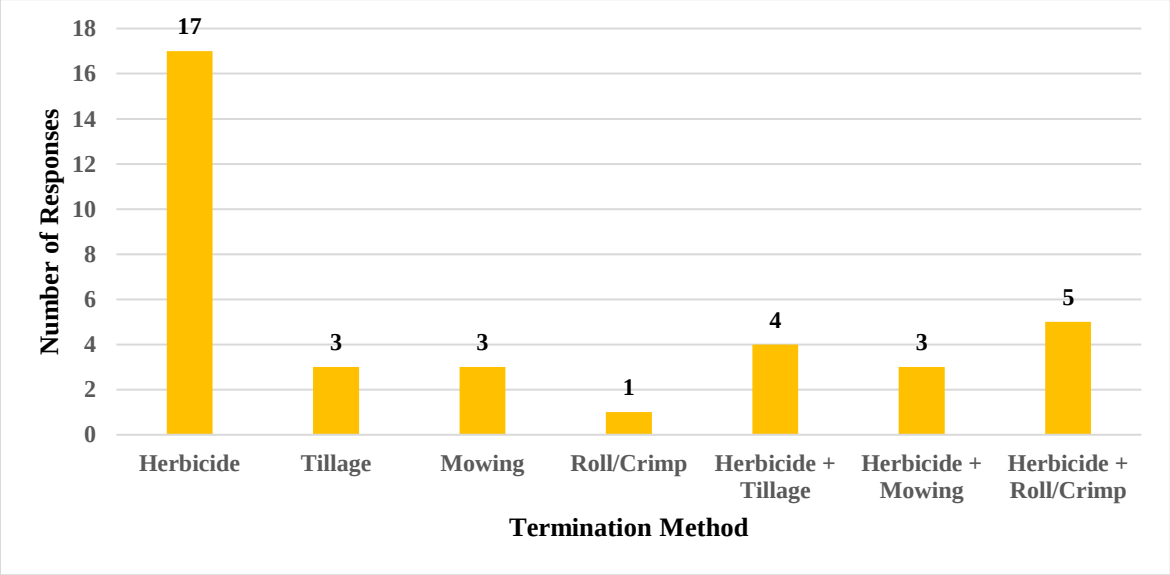

Figure 17 Methods used to terminate cover crop.

Of the six farmers who use tillage at some point during the termination process of their cover crop, only one hired custom tillage work. The farmer who hired custom tillage work reported that he paid $25 per acre. For farmers who terminated their cover crop themselves, three of them used a two-wheel drive tractor, with the tractors ranging in horsepower from 30-179. Two farmers used a four-wheel drive tractor, with horsepower ranging from 200–339.

They each used a different tillage implement. These implements included a spring tooth harrow, row crop cultivator, disk plow, vertical tillage tool, and a roller harrow. Only one of the farmers reported incurring more expense and unpaid labor hours from terminating his cover crop by tillage. This farmer reported that termination of his cover crop required four additional unpaid labor hours per acre and $80 in additional expenses per acre. Two out of five farmers reported that they only tilled their acres with a cover crop. Furthermore, two out of five farmers reported that all their row crop acreage was planted in a cover crop. Since we know that three farmers tilled their acres both with and without a cover crop, it is likely safe to conclude that farmers who already till their acres, regardless of the presence of a cover crop, are the ones who do not incur any additional expenses to terminate their cover crop through tillage.

Of the three farmers who used mowing as a termination method for their cover crop, none of them hired any custom mowing work. One of the farmers indicated they used a two-wheel drive tractor with 120 – 149 horsepower. They each used a different mowing implement. These included a rotary mower, flail mower, and a mower conditioner. Two farmers reported that they incurred more expense and unpaid labor hours for terminating their cover crop by mowing. The average additional unpaid labor hours required to terminate the cover crop by mowing was 5.13 hours per acre. Only one farmer reported incurring additional expenses. This farmer reported that he spent an extra $15 per acre to terminate his cover crop by mowing. Each of the three farmers said they only mowed their acreage under a cover crop with only one who had planted all his acreage in a cover crop. Since mowing is not a typical way to prepare a field for planting a cash crop in the spring, this is a likely explanation for why two out of three farmers who used mowing to terminate their cover crop incurred additional expenses when doing so. We also know that the three farmers who used mowing to terminate their cover crop only mowed their

acres with a cover crop present, with only one of these farmers having all of their acreage planted in a cover crop.

Five farmers indicated using rolling/crimping during the termination of their cover crop. Three of them used one pass to terminate their cover crop, combining both herbicide and rolling/crimping in the same pass. The remaining two farmers used two passes to terminate their cover crop: one pass with herbicide and one pass for rolling/crimping. Each of the farmers who used rolling/crimping to terminate their cover crop did so themselves, and none of them any hired custom rolling/crimping for cover crop termination. Two farmers used a two-wheel drive tractor with horsepower of 120–179. The other three farmers used a four-wheel drive tractor ranging in horsepower from 200 – 339. Two farmers used a smooth drum roller, while the other three farmers used a roller/crimper. Only one farmer said that he incurred additional expenses or unpaid labor hours from terminating his cover crop by rolling/crimping. Four out of five farmers said they only used rolling/crimping on their acres with cover crops. Three of these five farmers said that all their acreage was under a cover crop.

4.4 CHANGES IN COSTS AND REVENUES

In the survey, we also asked farmers to identify the changes in costs and revenues associated with implementing cover crops into the cash crop rotation. Figure 18 shows most farmers indicated that they do not graze or harvest their cover crop to recuperate some of the additional expenses incurred from adding cover crops to the current cash crop rotation. For the 10 farmers who do graze or harvest their cover crop, they saved an average of $71.00 per acre. Depending on the type of cover crop management practices used, given the figures reported for the planting and termination of the cover crop, this is likely enough to cover those expenses, or at least offset most of them by adding grazing or harvest their cover crop. One important fact to

consider is that for farmers to be able to participate in the cost-share program, they are not allowed to graze the cover crop. For some farmers, this could be an explanation for their lack of participation in a cost-share program.

Figure 19 shows that eight out of 39 farmers harvested their cover crop seed either to sell or use to reseed the following year. The reported average cost savings or revenue generated from harvesting the cover crop seed was $82.67 per acre. Just as with grazing the cover crop or harvesting for forage, this is likely enough to offset the cover crop planting and termination expenses. However, most farmers are not harvesting their cover crop seed. A few possible explanations for this could be that they do not have the right equipment, they do not have enough time to harvest it before planting the following cash crop, or perhaps they do not realize the value of their seed if they were to sell it. Potential reasons for farmers who would choose harvest the seed for themselves to not harvest the seed in a given year may have chosen either not to plant a cover crop the following year, or to plant a different type and do not have a need to harvest their seed. One last explanation could be that farmers who participate in a cost-share program cannot harvest the cover crop, such as wheat, to sell as a cash crop.

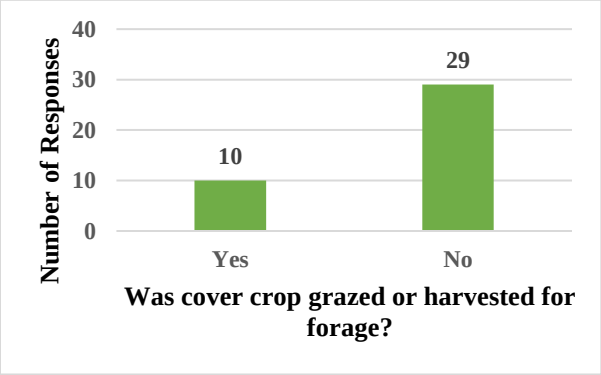

Figure 18 Number of farmers who graze or harvest their cover crop for forage.

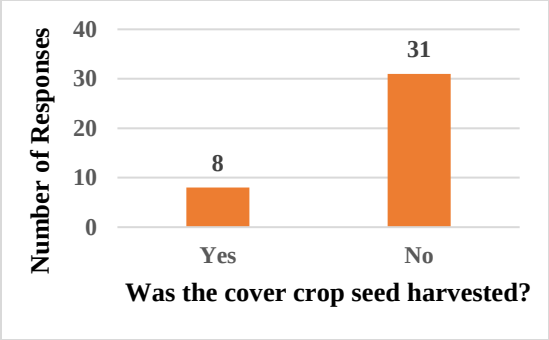

Figure 19 Number of farmers who harvested their cover crop seed.

For many farmers, agricultural program payments are an integral part of their livelihood. Cost-share program payments for cover crops have many regulations that sometimes discourage participation. Cost-share program participation is shown in Figure 20. Only 11 of 39 farmers participated in a cost-share program. For those who participated in a cost-share program, the average payment received was $18,394 with the smallest payment received being $3,000 and the largest payment being $40,000. The average number of acres enrolled in the program was 397 acres. There are many possible explanations for the lack of participation in the current cost-share program because the current program has many limitations. Farmers can only plant certain varieties that are considered as a cover crop to be eligible for the cost-share program.

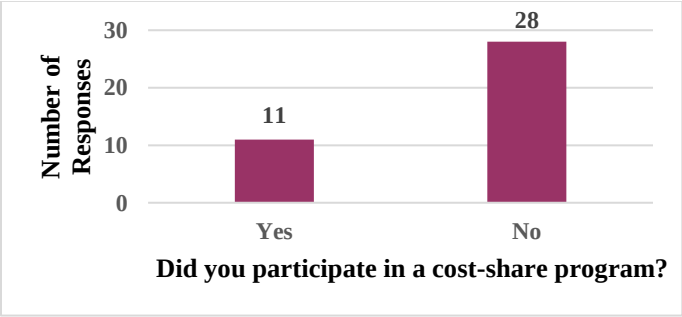

Figure 20 Cost-share program participation.

Table 2 Cost-share program enrollment and payment amounts received.

Producer:	Number of Acres Enrolled:	Total Payment Received:	Average $/ac. Received:
1.	650	$40,000	$61.54
2.	60	$3,000	$50.00
3.	800	$40,000	$50.00
4.	415	$4,150	$10.00
5.	500	$25,000	$50.00
6.	500	$12,000	$24.00
Average:	**487.5**	**$20,691.67**	**$40.92**

To understand more about the challenges and benefits of implementing cover crops into the current rotation, we asked farmers which cash crop was planted most extensively following the cover crop. Figure 21 shows that 22 of 39 farmers who we received a response from for this question planted cotton following their most recent cover crop. For farmers who mentioned planting a cash crop other than cotton, peanuts, or corn, they reported planting wheat, corn silage, and millet.

Given that cotton is highly susceptible to drought conditions and soil compaction, it is no surprise that cotton is commonly planted following a cover crop. However, we must take into account that farmers self-selected themselves to participate in the survey, meaning that our results for the most commonly planted crop are not completely random. We cannot say that cover crops are used most by cotton farmers. What we can say is that many cotton farmers use a cover crop, likely meaning that they are successful. Otherwise, cover crop adoption would likely be discontinued.

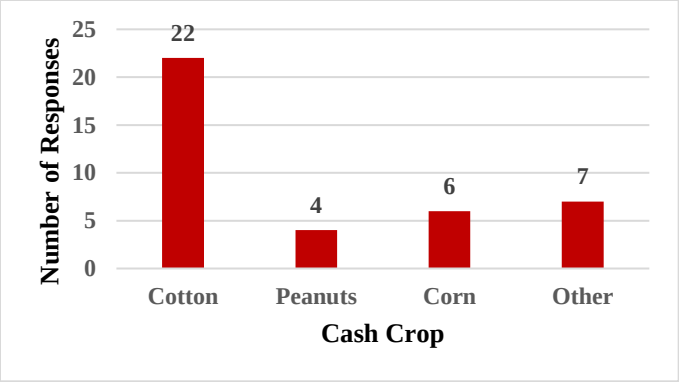

Figure 21 Cash crop planted following most recent cover crop.

The next production practice we asked about was irrigation practices to understand more about changes in cash crop yields both following a cover crop and no cover crop. Figure 22 shows that 22 farmers out of 37 irrigate at least some of their cash crop acreage following their cover crop. Nine of those farmers irrigated 100% of their cash crop acreage following the cover crop. Cotton was the most common irrigated cash crop following the cover crop. Sixteen farmers reported their irrigated cotton yield per acre with an average of 1,213 pounds per acre. Figure 23 shows the most common yield range was 1,001–1,500 pounds per acre for cotton. One response was recorded for irrigated peanut yield at 3,800 pounds per acre. We received 4 responses for irrigated corn yield with an average of 202.5 bushels per acre. The minimum irrigated yield for corn following a cover crop was 165 bushels per acre while the maximum irrigated yield was 235 bushels per acre.

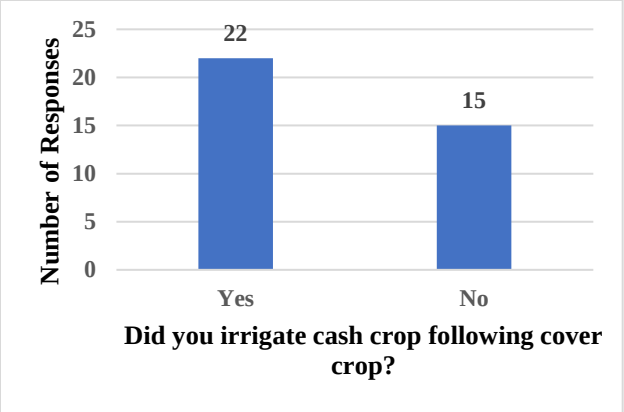

Figure 22 Cash crop irrigation practice following cover crop.

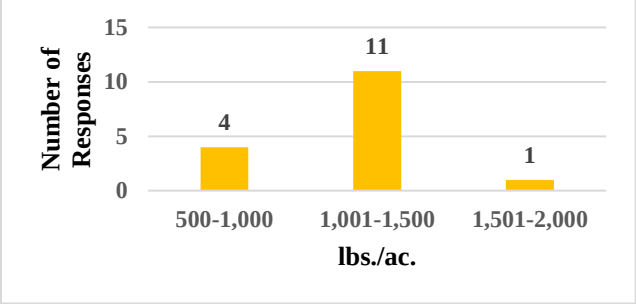

Figure 23 Range of average irrigated yield for cotton following cover crop.

Comparatively, we received 16 responses for dryland cotton yield following a cover crop. The average dryland cotton yield reported was 776.5 pounds per acre. The minimum dryland cotton yield was 441 pounds per acre while the maximum was 1,200 pounds per acre. Figure 24 shows that the most common range for average dryland yield for cotton was 501–1,000 pounds per acre. We also received dryland yield responses for peanuts, corn, and wheat. We received two responses for dryland peanuts following a cover crop which were 3,000 and 4,800 pounds per acre. We received three responses for dryland corn yield following a cover crop with an average yield of 112 bushels per acre. The minimum dryland corn yield was 100 bushels per acre while the maximum was 125 bushels per acre. We received one response for dryland wheat following a cover crop which was 40 bushels per acre.

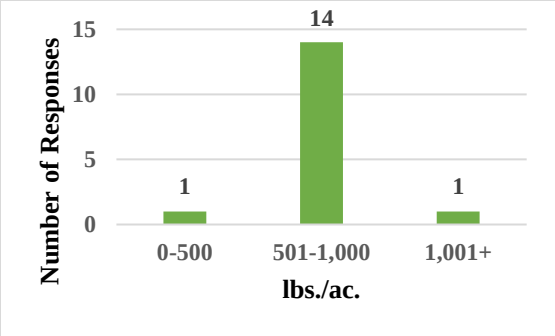

Figure 24 Range of average dryland cotton yield following a cover crop.

In order to make a fair comparison to irrigated and dryland yield of a cash crop following a cover crop, we asked farmers if they planted the same cash crop following no cover crop. Figure 25 shows that only 10 farmers planted the same cash crop following no cover crop. Figure 26 shows that of these farmers, half of them irrigated their cash crop following no cover crop. There are several comparisons we can make for cotton yield to understand more about the impact of cover crops on yield. Irrigated cotton yield versus dryland cotton yield following a cover crop had averages of 1,213 pounds per acre and 776.5 pounds per acre, respectively. This shows that there is an obvious return on irrigating cotton following a cover crop. Alternatively, irrigated versus dryland cotton yield following no cover crop was 1,180 pounds per acre and 833 pounds per acre, respectively. When compared to irrigated cotton following no cover crop, there is a slight improvement of 33 pounds per acre in yield for irrigated cotton following a cover crop. However, there is a decrease in yield of 56.5 pounds per acre for dryland cotton following a cover crop versus dryland cotton following no cover crop.

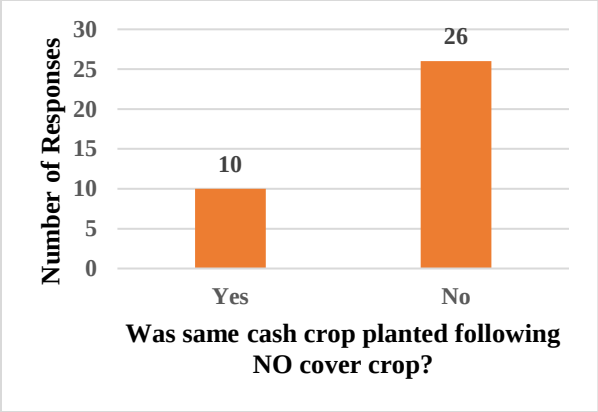

Figure 25 Number of farmers who planted same cash crop following NO cover crop.

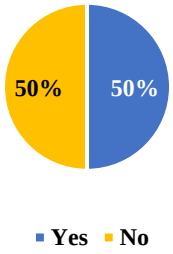

Figure 26 Percentage of farmers who irrigated their cash crop following NO cover crop.

Table 3 Reported cash crop yields.

Producer:	Cash Crop:	Irrigated Yield Following Cover Crop:	Irrigated Yield Following NO Cover Crop:	Dryland Yield Following Cover Crop:	Dryland Yield Following NO Cover Crop:
1.	Cotton	1,100 lbs./ac.	1,100 lbs./ac.	800 lbs./ac.	n/a
2.	Cotton	n/a	n/a	700 lbs./ac.	n/a
3.	Cotton	1,350 lbs./ac.	n/a	n/a	n/a
4.	Cotton	1,225 lbs./ac.	n/a	850 lbs./ac.	n/a
5.	Cotton	1,000 lbs./ac.	n/a	650 lbs./ac.	n/a
6.	Cotton	1,200 lbs./ac.	n/a	750 lbs./ac.	n/a
7.	Cotton	1,250 lbs./ac.	n/a	1,200 lbs./ac.	n/a
8.	Cotton	1,300 lbs./ac.	n/a	n/a	n/a
9.	Cotton	1,500 lbs./ac.	n/a	n/a	1,200 lbs./ac.
10.	Cotton	1,150 lbs./ac.	1,220 lbs./ac.	1,000 lbs./ac.	n/a
11.	Cotton	1,400 lbs./ac.	1,500 lbs./ac.	800 lbs./ac.	n/a
12.	Cotton	n/a	n/a	875 lbs./ac.	n/a
13.	Cotton	925 lbs./ac.	n/a	708 lbs./ac.	n/a
14.	Cotton	n/a	n/a	850 lbs./ac.	n/a
15.	Cotton	1,700 lbs./ac.	n/a	441 lbs./ac	n/a
16.	Cotton	1,250 lbs./ac.	n/a	n/a	n/a
17.	Cotton	1,250 lbs./ac.	n/a	900 lbs./ac.	n/a
18.	Cotton	n/a	n/a	700 lbs./ac.	700 lbs./ac.
19.	Cotton	912 lbs./ac.	n/a	n/a	n/a
20.	Cotton	900 lbs./ac.	900 lbs./ac.	600 lbs./ac.	600 lbs./ac.
21.	Cotton	n/a	n/a	600 lbs./ac.	n/a
22.	Peanuts	3,800 lbs./ac.	n/a	3,000 lbs./ac.	3,000 lbs./ac.
23.	Peanuts	n/a	n/a	4,800 lbs.ac.	n/a
24.	Peanuts	3,800 lbs./ac.	n/a	3,000 lbs./ac.	3,000 lbs./ac.
25.	Peanuts	n/a	n/a	4,800 lbs.ac.	n/a
26.	Peanuts	n/a	n/a	3,000 lbs./ac.	n/a
27.	Corn	n/a	n/a	110 bu/ac.	n/a
28.	Corn	n/a	n/a	125 bu/ac.	n/a
29.	Corn	200 bu/ac.	n/a	n/a	n/a
30.	Corn	165 bu/ac.	n/a	110 bu/ac.	110 bu/ac.
31.	Corn	210 bu/ac.	210 bu/ac.	n/a	n/a
32.	Corn	235 bu/ac.	n/a	n/a	n/a
33.	Corn Silage	n/a	n/a	100 bu/ac.	n/a
34.	Wheat	n/a	n/a	40 bu/ac.	n/a

Four farmers reported their average irrigated cotton yield following no cover crop. The average irrigated cotton yield following no cover crop was 1,180 pounds per acre. Only one farmer reported their average irrigated corn yield following no cover crop which was 210 bushels per acre. Three farmers reported their average dryland cotton yield following no cover crop. The average dryland cotton yield following no cover crop was 833 pounds per acre. One farmer reported their average dryland peanut yield following no cover at 3,000 pounds per acre. We also received only one response for dryland corn yield following no cover crop at 110 bushels per acre.

We next asked for if any of their costs were different following a cover crop versus for their acreage following no cover crop. One farmer indicated that his nitrogen fertilizer cost was different. Four farmers reported that their cost to repair acres with soil erosion were different following a cover crop. Two farmers said that their irrigation amount changed in their acres following a cover crop versus those following no cover crop. Six farmers did not observe any difference in costs for acres following a cover crop versus those following no cover crop. Figure 27 shows two farmers indicated there was a difference in their tillage costs for acres following a cover crop versus those following no cover crop.

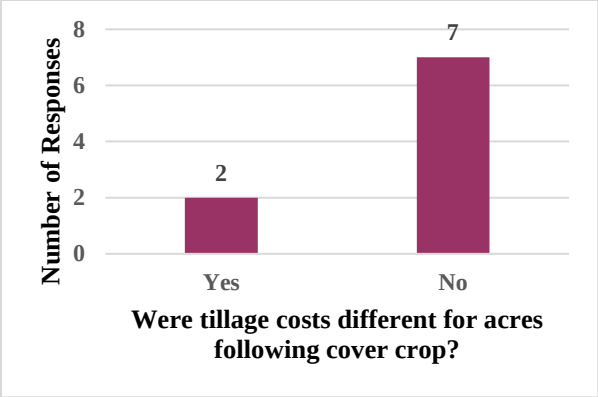

Figure 27 Number of farmers who observed difference in tillage costs for acres following a cover crop versus acres following NO cover crop.

We then wanted to find out more about cropland leasing and how the use of cover crops affects leasing terms, so we first asked farmers whether they lease cropland. Figure 28 shows that 27 out of 34 farmers lease at least some of their row crop acreage. Figure 29 shows that only one farmer out of 27 who responded to the next question indicated that he does not plant a cover crop on the rented cropland. We also asked farmers if they were able to get better leasing terms if they plant cover crops on the rented cropland. No farmers reported that they were able to get a better rental rate if they plant a cover crop on the leased cropland. Three farmers of 26 reported that they were able to obtain a longer lease term because they planted a cover crop on the leased acreage. Leasing row crop acreage in the southeast is difficult, as there is much competition. For farmers who are able to obtain a longer lease due to them planting a cover crop on the leased land, they are able to avoid some of the yearly competition for the leased land.

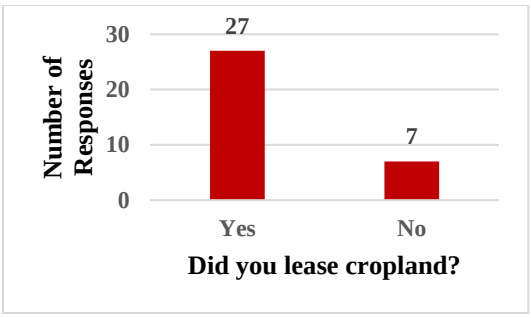

Figure 28 Number of farmers who lease at least some of their row crop acreage.

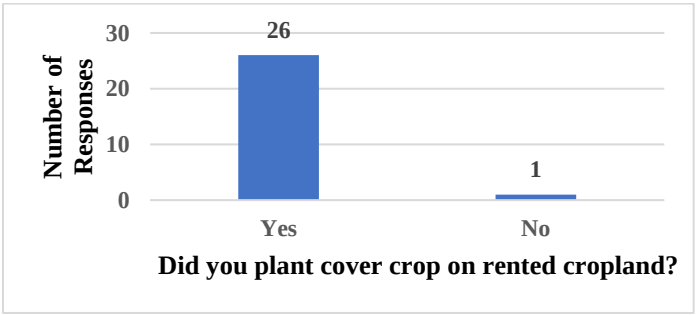

Figure 29 Number of farmers who plant cover crop on leased cropland.

4.5 CASH CROP TILLAGE PRACTICES FOLLOWING COVER CROP

To find out if cover crops changed tillage practices for the following cash crop, we asked farmers what tillage practice they used following the cover crop. Six farmers used reduced tillage both following a cover crop and following no cover crop. One farmer utilized rotational no-till both following a cover crop and following no cover crop. We then asked farmers how many tillage passes they used to prepare the field for planting the following cash crop. Of the 8 farmers who responded, Figure 30 shows that 50% of them only utilize one tillage pass to prepare the field for the following cash crop. For the farmers who responded to this question, we asked them to what kind of tillage implement they used for each pass. For the first pass, two farmers reported using a strip-till rig. The remaining three farmers said they used a strip-till rig with a roller to prepare the field for the following cash crop. For the three farmers who used a

second pass to prepare the field for the following cash crop, each reported using a different type of tillage implement. The implements mentioned were a strip-till rig, a strip-till rig with a roller, and a chisel plow. The one farmer who also used a third tillage pass reported using a strip-till rig with a roller in the third tillage pass.

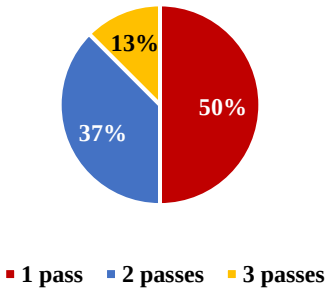

Figure 30 Number of tillage passes used to prepare field for cash crop following cover crop.

Table 4 Tillage implements used to prepare field for following cash crop.

Producer:	Number of Tillage Passes Used:	Tillage Implement Used for Each Pass:
1.	1	strip-till rig
2.	1	strip-till rig w/ roller
3.	1	strip-till rig
4.	1	strip-till rig w/ roller
5.	2	1st pass - other 2nd pass - strip-till rig
6.	2	1st pass - 15ft. disk plow 2nd pass - 10ft. chisel plow
7.	3	strip-till rig for all passes

4.6 CROP ROTATION HISTORY

The next section of the survey aimed to learn more about the previous crop rotation prior to the most recent cover crop that was planted on the farm. Thirty-five farmers indicated the

cash crop planted most extensively prior to the most recent cover crop planted on the farm, with Figure 31 showing that cotton was the most common cash crop. We then asked farmers if they planted a cover crop prior to this cash crop. Figure 32 shows that a large majority of 35 farmers who responded also planted a cover crop prior to the previous year's cash crop.

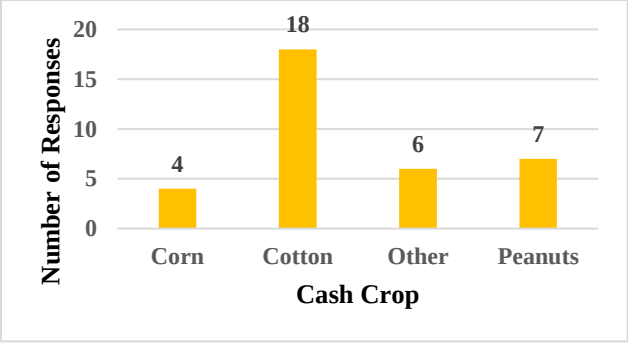

Figure 31 Cash crop planted most extensively prior to most recent cover crop planted on farm.

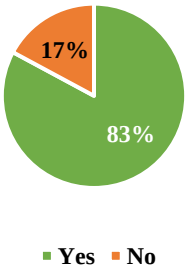

Figure 32 Percentage of farmers who planted a cover crop prior to previous year's cash crop.

Table 5 Same cash crop with same cover planted in two consecutive years.

Producer:	**Cash Crop:**	**Cover Crop:**
1.	Cotton	cereal rye
2.	Cotton	cereal rye
3.	Cotton	cereal rye
4.	Cotton	oats
5.	Cotton	cereal rye
6.	Cotton	cereal rye
7.	Cotton	cereal rye
8.	Cotton	cereal rye
9.	Cotton	cereal rye
10.	Cotton	cereal rye
11.	Corn	cereal rye + wheat
12.	Corn	crimson clover + oats

Table 6 Same cash crop with different cover crop planted in two consecutive years.

Producer:	Cash Crop:	Year 1 Cover Crop:	Year 2 Cover Crop:
1.	Cotton	annual ryegrass + crimson clover	barley + sugar beets
2.	Cotton	Austrian winter peas	annual ryegrass + Austrian winter peas
3.	Cotton	cereal rye	cereal rye + hairy vetch + mustards + oats + radish + turnips + wheat + black oats
4.	Cotton	cereal rye	Cousack black oats + balancia fixation clover
5.	Cotton	annual ryegrass + Austrian winter peas + cereal rye + crimson clover + hairy vetch + oats + rapeseed	annual ryegrass + Austrian winter peas + cereal rye + crimson clover + hairy vetch + oats + turnips
6.	Cotton	annual ryegrass + cereal rye + hairy vetch + triticale + flax	hairy vetch
7.	Cotton	cereal rye	Austrian winter peas + cereal rye + crimson clover + hairy vetch + radish
8.	Peanuts	wheat	cereal rye
9.	Peanuts	oats	cereal rye + oats
10.	Peanuts	wheat	oats + wheat
11.	Corn Silage	cereal rye	millet + crabgrass

Table 7 Different cash crop with same cover crop planted in two consecutive years.

Producer:	Year 1 Cash Crop:	Year 2 Cash Crop:	Cover Crop:
1.	Peanuts	Corn	rye
2.	Peanuts	Cotton	oats + wheat

Table 8 Different cash crop with different preceding cover crops planted in two consecutive years.

Producer:	Year 1 Cash Crop:	Year 1 Cover Crop:	Year 2 Cash Crop:	Year 2 Cover Crop:
1.	Peanuts	oats + wheat	Cotton	annual ryegrass + oats + wheat

4.7 PERCEPTIONS OF COVER CROP USE

The last section of the survey aimed to understand more about current perceptions of cover crops by farmers in the southeast. This section consisted of four questions, with the first question asking farmers if they believe using cover crops in the cash crop rotation increases farming profitability. Figure 33 shows that of the 37 farmers who answered this question, only 3 farmers indicated that they do not believe cover crops contribute to farming profitability. We then asked them if they would consider planting a cover crop in the future, with all of them answering that they would.

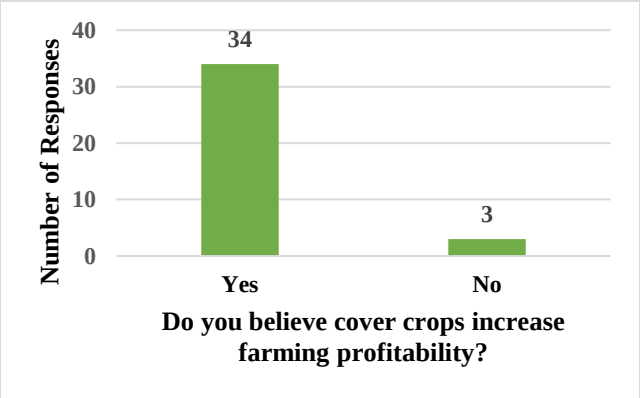

Figure 33 Farmers' current perception of cover crop contribution to farming profitability.

We then asked farmers to rank what they believe are their top three challenges and benefits associated with cover crop use on their farm. **Error! Reference source not found.**

shows the challenges of cover crop use mentioned by farmers in the southeast, ranked from most challenging to least challenging. To determine ranks, we assigned points to each farmer's response. For example, if a farmer chose "cover crop seed availability" as the top challenge, this response received 3 points. For his response indicating his second most challenging issue, that response received two points. And finally, the third most challenging issue was assigned one point. We did this for each farmer and added up all of the points for each individual response. We then took that number and divided it by the total number of respondents (36) to be able to rank each challenge.

The most commonly mentioned challenge of cover crop use was the additional time and labor required to manage the cover crop. Many farmers also said that cover crop seed costs are too high and that the additional cost of planting and managing a cover crop stymies cover crop adoption. For farmers who chose "other," some of the issues mentioned were having the right machinery to plant through the cover crop, too much growth after ripping to plant the cover crop, and increased pest pressure.

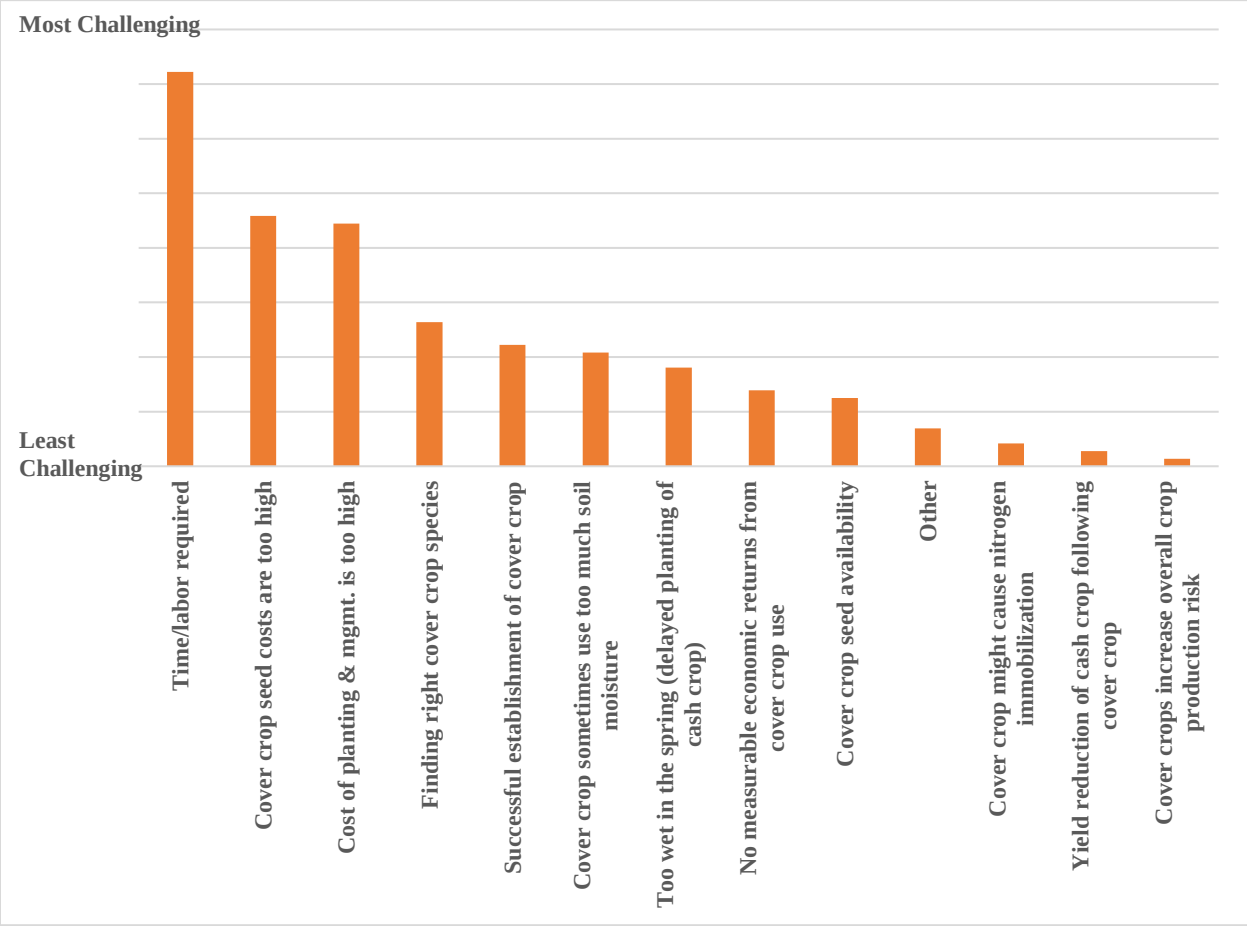

Figure 34 Ranked challenges of cover crop use in the southeast.

Figure 35 shows the benefits of cover crop adoption mentioned by farmers, ranked from most beneficial to least beneficial. The same point system used for the challenges of cover crop use was again utilized to rank benefits provided by cover crop adoption. For each farmer, the benefit indicated as their number one item was assigned three points, while the item ranked at number three was assigned one point.

Not surprisingly, reducing soil erosion and loss was the benefit ranked most highly, followed by soil aeration and increased water infiltration. Many farmers also ranked building soil carbon and organic matter and increasing biodiversity very highly. Farmers who mentioned

"other" said that some of the other benefits they feel cover crops provide included insect pest control and improved fertility.

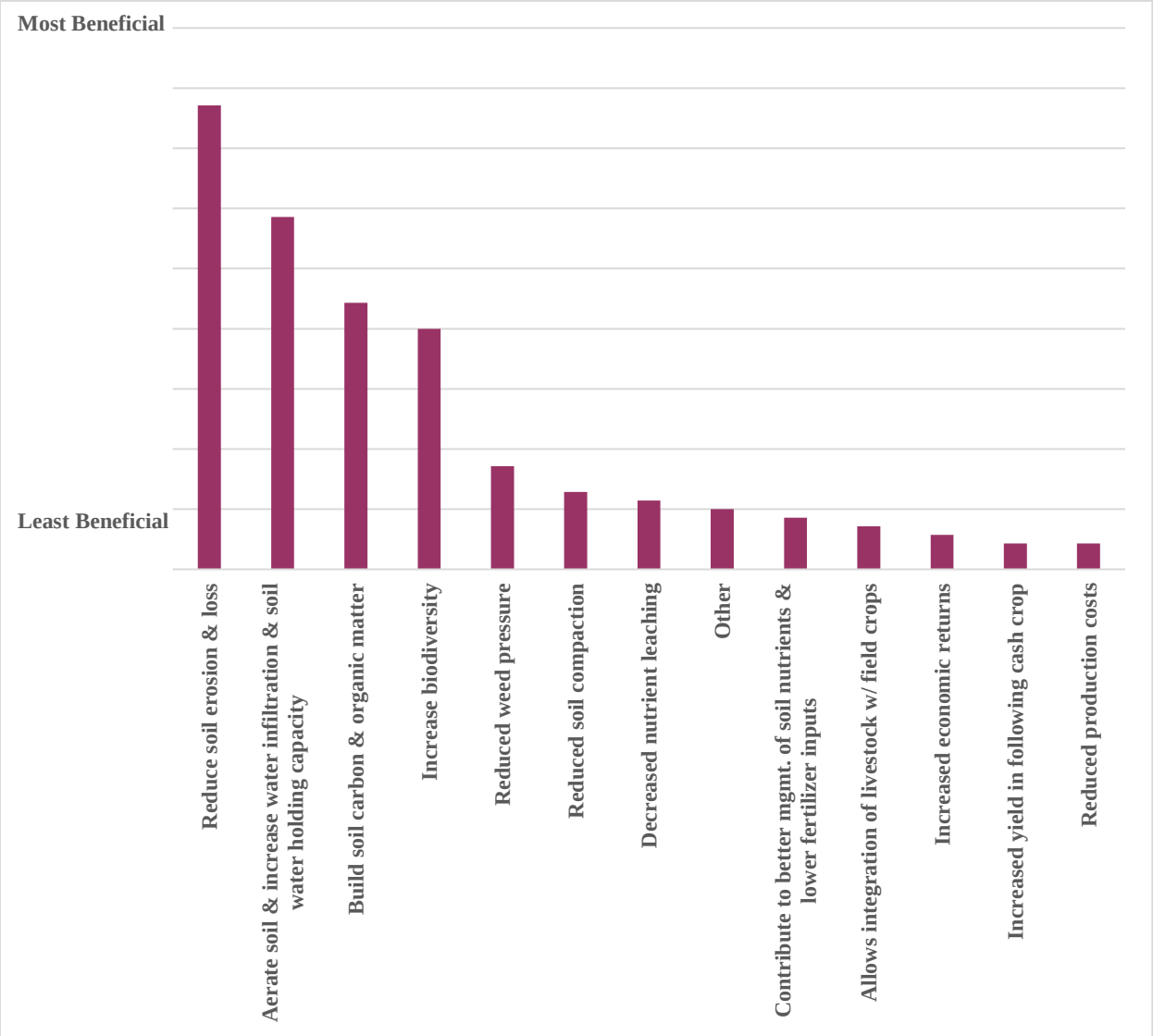

Figure 35 Ranked benefits provided by cover crop adoption.

4.8 CHALLENGES OF DATA COLLECTION AND IMPACT ON RESULTS

As with any data collected via a survey, there will be several fundamental issues that are unavoidable. The first issue with our data is the limited number of responses we received. This fact makes it challenging to draw conclusions that wholly represent the population of

southeastern row crop farmers. Survey fatigue is currently a major issue among agricultural producers. Much of the data collected about current farming operations is collected through a survey. Farmers who participate oftentimes do not receive any type of incentive for their participation. The main reason most farmers currently participate in surveys is because of their recognition of the importance of such research.

This leads to another issue which is the lack of variety in the responses we received. The majority of respondents were from Georgia and grew cotton as their main cash crop. We did not receive many responses from farmers in Florida and Alabama, and we also did not receive many responses from farmers who grow peanuts, which is the other main cash crop in the southeast. Therefore, the conclusions we were able to draw from this research are applicable for a much smaller group of farmers than we originally intended.

Another issue with the way we collected responses stems from the way we were able to inform farmers of the survey's existence. We contacted farmers mostly through extension agents and NRCS offices. They spread the information to farmers they thought might be interested, meaning that their judgment of a farmer's interest in completing the survey already eliminated potential respondents. Furthermore, farmers who did receive the information chose whether they wanted to complete the survey, meaning that our results suffered from self-selection bias.

Issues with individual responses were present as well. The level of completeness of the responses we received hindered our ability to draw additional conclusions. We received many complete responses, but also received many incomplete responses due to the design of the survey. Respondents who mailed in a paper survey obviously did not have to complete the entire survey, but those who completed the Qualtrics survey also did not. We designed the survey

where respondents could leave most questions blank, if needed. They also could submit the survey without answering all of the questions.

The last issue with responses was the accuracy of the responses we received. We followed up with as many farmers as we could if there were questions regarding their answers to some of the questions, but we were unable to get in touch with others. For the paper surveys, handwriting was hard to read for some responses while some of the online responses had issues with typos. Other accuracy issues included farmers guessing for answers to many of the questions, meaning that we can only trust the conclusions from this research as much as we can the accuracy of the responses.

As far as being able to draw some basic conclusions from this research, all of the results we have compiled are based solely on what we were able to learn from the survey responses as a whole. To draw more specific conclusions about what changes in practices affect specific parts of the operation, we would need to analyze each individual response. Not only would we need to analyze each response, we would also need some best management practices for a similar operation to compare to. Instead, we are aiming to draw some conclusions about current cover cropping practices of the average southeastern row crop farmer to make some suggestions about how to make cover crop adoption a more sustainable practice.

4.9 PERCEIVED CHALLENGES OF COVER CROP ADOPTION

The main challenge mentioned by farmers who have, or would like to, implement cover crops into their current cash crop rotation is the additional time and labor required by the cover crop. However, when asked to indicate the amount of additional expenses or unpaid labor hours required by the cover crop, most farmers did not indicate incurring any additional expenses or unpaid labor hours. Although it is not possible to completely eliminate all additional expenses

and unpaid labor hours, educational opportunities to guide farmers to use the most efficient management practices could help to alleviate this issue. Farmers who can use knowledge gained can eliminate some of the trial-and-error mistakes that most farmers make when first implementing a cover crop with no prior knowledge.

The next most challenging factor of utilizing a cover crop is the high cost of the cover crop seed. With a cover crop monoculture seed cost averaging $23.53 per acre in our sample and a mixed cover crop seed cost averaging $25.88 per acre, a cover crop is relatively expensive to plant given that most farmers do not currently graze or harvest their cover crop, which would help to offset some of that expense. Instead, it is important for farmers to find the most beneficial cover crop for their operation to achieve the desired benefits. Although it is hard to quantify the benefits provided by cover crop use, we must look at the cost savings or revenue afforded by cover crop use through savings in erosion repair and yield benefits.

The high cost of planting and managing a cover crop is yet another challenge of implementing cover crops. Fifty-eight percent of farmers said they apply fertilizer to their cover crop and 19% irrigate their cover crop. Terminating their cover crop is also an additional expense but may not require much more expense if the farmer uses the same method, such as herbicide, to prepare the field for their cash crop, regardless of if a cover crop was planted prior to that crop or not. Again, farmers must consider all of the environmental benefits implementing a cover crop provides that help to offset some of the monetary expense of planting and managing a cover crop.

Some farmers mentioned that the cover crop sometimes uses too much soil moisture as one of the challenges they face when implementing a cover crop into their current rotation. Given this information, very few farmers irrigate their cover crop. However, many farmers do

irrigate their following cash crop. It is possible that if a different cover crop were to be chosen, this issue could be eliminated. If the biomass from the cover crop remains on the field after termination, it can help to protect the soil from the sun and wind, which both contribute to increased evaporation of water from the soil. On the contrary, some farmers mentioned that cover crops leave the field too wet in the spring, delaying the planting of the following cash crop. This can again be alleviated by changing the management practices.

Several farmers mentioned not receiving any measurable economic returns from using a cover crop, and some even reported reduced yield in the following cash crop. Before we can make any finite conclusions about what caused these issues, it would be important to learn more about the rainfall that year, since the decrease in yield was found in the dryland cotton, suggesting the issue could be related to the irrigation or rainfall amount instead of the cover crop itself.

Cover crop seed availability is yet another challenge farmers face when they choose to add a cover crop into their current rotation. For farmers who are worried that the cover crop might lead to nitrogen immobilization, they should choose a cover crop known for adding nitrogen to the soil and releasing it when the following cash crop needs it. Many times, cover crops can reduce the need for synthetic fertilizers, meaning the farmer may need to change the type of cover crop they use.

The least common challenge of using cover crops mentioned by farmers is an increase in crop production risk. Without knowing why a farmer chose this specific challenge, it is hard to speculate as to the cause of the perceived increased risk. An individual farmer's relative risk aversion is likely a determining factor in their choosing this challenge as one of the top three they face. It also depends on how effectively and efficiently the farmer manages their cover

crop. Other farmers could be referring to the issue of not being able to obtain crop insurance if a cover crop is used on the farm.

4.10 PERCEIVED BENEFITS OF COVER CROP ADOPTION

The biggest benefit mentioned by farmers that is provided by cover crop use is the reduction in soil erosion and loss. The additional biomass and the lack of long-term fallow period between crops helps to protect the soil from all types of erosion. This helps the farmer conserve soil nutrients, reducing the need for fertilizer inputs which is another benefit many of them mentioned. Four farmers reported a change in their costs to repair soil erosion and loss in their fields. Three of these farmers saw a reduction in their expense, with two farmers able to reduce their soil erosion cost by $20 per acre and one farmer reporting a reduction of $50 per acre.

Increased biodiversity also helps to control weeds and insect pests, reducing the need for pesticides. Biodiversity allows plants with allelopathic abilities to grow and help control weed emergence and existence. It also provides habitat for beneficial insect species that are natural enemies of the crop's pests. Given this information, it is possible that biodiversity can lead to a reduction in pesticide costs for the cash crop. Of the 13 farmers from the survey who had planted the same cash crop both following a cover crop and following no cover crop, none of them reported changing their pesticide use. One possible explanation for this could be that they did not adjust their cultural practices to account for the change in crop pests. Others may not have seen a change in weeds, insects, or other pests.

Reduced soil compaction is yet another benefit farmers have mentioned that cover crops can provide. This can help the emergence of the following cash crop as well as reducing the need for tillage. The reduction in the need for tillage also reduces nutrient leaching, which helps

the farmer to save on fertilizer application. For farmers who graze their cover crop, the alleviation of soil compaction provided by the cover crop can help to make livestock integration possible. Integrating livestock into the rotation helps promote cost savings for livestock feed and also adds natural fertilizer to the field from livestock waste.

A reduction in the need for fertilizer inputs can provide substantial cost savings in farmers adjust their production practices and do soil testing to determine their fertilizer needs following a cover crop. One farmer mentioned that he had a change in the need for nitrogen fertilizer application when comparing the same cash crop both following a cover crop and following no cover crop.

The last benefits to discuss are the potential increased yield in the following cash crop and a reduced need for irrigation. Farmers who irrigated their cotton following a cover crop had an average yield increase of 33 pounds per acre versus irrigated cotton following no cover crop. Two farmers in the survey reported a change in their irrigation application for their cash crop following a cover crop versus the same cash crop following no cover crop. One of these farmers reported the amount of the reduction in the irrigation application as 2 acre-inches less.

CHAPTER 5

CONCLUSION

Through this research, we have learned more about the current production practices farmers are utilizing in the southeast when it comes to adopting cover crops. We also learned from them the perceptions they currently have about the use of cover crops. Although we had a small sample size and did not have many farmers who grow the same cash crop both following a cover crop and no cover crop to compare economic and environmental outcomes, we were still able to gain some valuable insight into cover crop implementation in the southeast.

5.1 POLICY IMPLICATIONS

After speaking with many Extension and NRCS offices, several farmers, and hearing feedback through the survey, it is evident that better cost-share programs will be needed to further promote cover crops and sustain adoption rates into the future. There are many hurdles currently associated with the cost-share program for cover crops. From limiting the species that can be planted as a cover crop, to controlling what can be done with the cover crop at termination, current programs are extremely limiting, explaining the limited participation rate in the current program. Lack of knowledge of the program's existence and a lack of understanding of its details are also limiting factors for farmers who would potentially participate in such a program.

Current limitations to the species that can be planted as a cover crop by the cost-share program decrease farmers' aptitude to plant a cover. For farmers who have grown a cover crop in the past, they likely have experimented with different types of cover crops on their farm and have found the one that works best for them. Many times, farmers select a cover crop based on the type of benefits they want to obtain from it. For farmers who have never grown a cover crop before, they may not be willing to begin the practice if the type of cover crop they desire to plant is not part of the cost-share program. If they do not reap the benefits they desire, they are not likely to incur the additional expense and management hours required by the cover crop. The species limitation can also hinder a farmer's ability to obtain crop insurance since many policies do not currently support cover cropping, and if they do, they are very strict about the type of cover crop species they allow. If the limitations of the crop insurance policy and the cost-share program do not align properly, this can also hinder farmers' participation in the current program.

Another issue with the current cost-share program mentioned by farmers is the length of the benefits. Many farmers stated that the length of the program for each farmer to receive benefits will need to be longer for farmers to fully adopt cover cropping. The cost-share program is available to get many farmers started, but funding is cut off oftentimes before the practice has been successfully and fully adopted by a farmer. Funding for experimentation is needed so that a farmer has time to determine the mix that works best for their farm and the goals they want the cover crop to meet.

What can be done with a cover crop when it comes time to terminate it is also limited by the current cost-share program. Farmers are only allowed to use a traditional termination method and cannot graze the cover crop or harvest it for forage or its seed. While this is less limiting than many of the others mentioned, it can still be discouraging to some farmers who desire to

achieve a higher level of efficiency with the time and money they have invested into their cover crop.

To aid farmers heavily affected by the COVID-19 pandemic, USDA's Risk Management Agency (RMA) has created the Pandemic Cover Crop Program, also known as PCCP, to help offset some of the costs incurred by farmers who planted a qualifying cover crop. This program allows most farmers who have crop insurance coverage to be eligible for a premium benefit of up to $5.00 per acre, but no more than the full premium owed. Farmers must have insured their spring crop.

5.2 FARMER EDUCATION TO IMPROVE COVER CROP ADOPTION RATES

Yet another change needed to increase cover crop adoption s an increase in educational opportunities for farmers. Many of the challenges mentioned by farmers that are obstacles for them to adopt cover crops could be alleviated by providing more targeted educational opportunities. Farmers have expressed that in addition to the costs they incur and the additional labor required to manage a cover crop, the difficulty in choosing the correct species or mix for their farm and being able to successfully establish the cover crop and make timely management decisions to obtain the desired outcome. An expansion in Extension programs throughout the southeast will be integral in the effort to expand successful cover cropping to contribute to the sustainability of row cropping.

5.3 COVER CROPPING TO IMPROVE THE SUSTAINABILITY AND FUTURE OF AGRICULTURE

Although there are many challenges associated with implementing cover crops into the current cash crop rotation, cover crops provide many benefits as well. Among the most important benefits of utilizing a cover crop are the environmental benefits they provide. Natural

resource conservation is becoming more important with each passing day as the world's population grows and farmland acreage shrinks. With improved cost-share program policies and increased educational opportunities, farmers will be able to more successfully and efficiently manage cover crops in the future. As more and more farmers achieve success with cover crops, other farmers will likely adopt cover crops as well. Increased adoption is paramount in the successful and efficient production of row crops in the future.

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APPENDIX

Appendix 1. Southeast Cover Crop Survey Questionnaire

Southeastern Cover Crops Survey

Department of Agricultural and Applied Economics
College of Agricultural & Environmental Sciences
UNIVERSITY OF GEORGIA

Department of Agricultural & Applied Economics
University of Georgia - Tifton Campus
2360 Rainwater Road
Tifton, GA 31793

Dear Operator:

Incorporating cover crops into a commercial farming operation has become a recommended practice. Have you ever stopped to consider what is the return on investment (ROI) of those cover crops?

The University of Georgia is trying to estimate the ROI on cover crops to develop best management practices that address the economic as well as the agronomic aspects of cover crop use.

Your response is voluntary, but cooperation is critical to developing an accurate measure of the impacts of adopting of cover crops. Facts about your farm operation will be kept completely confidential and used only for statistical purposes in combination with data from the other respondents. Title 7, U.S. Code, Section 2276 prohibits public disclosure of personal information, including reported data.

Please use your farm records to provide the best estimates of your true costs, revenues, and management practices. If a response is not received, a representative may contact you to collect data.

Your cooperation is sincerely appreciated. If you have any questions about the survey, please do not hesitate to contact me.

Sincerely,

Yangxuan Liu, Ph.D.
Assistant Professor and Principal Investigator
(229) 386 - 3512
yangxuan.liu@uga.edu

Section 1. Basic Information

1. **What is the size of your farm? (Please circle one number)**

1 to 49 acres 001	1	500 to 999 acres	5
50 to 99 acres	2	1,000 to 1,999 acres	6
100 to 199 acres	3	2,000 acres or more	7
200 to 499 acres	4		

2. **Have you ever planted a cover crop? (Please circle one number)**

Yes ..... 002 1 ➔ ***Continue***

No ..... 2 ➔ ***Go to Section 7.***

3. **How many years have you planted cover crops prior to January 2020?** 003_____ Years

4. **Which is the most recent year you planted cover crops prior to 2020?** 004_____

5. **How many cumulative acres have you planted to cover crops prior to January 2020 since you first started this practice?** 005_____ Acres

Please answer all following questions thinking of the farm where you planted cover crops in the most recent year entered in item 4. If you planted cover crops on more than one farm, please refer to the farm with the most accurate production records. For consistency, always refer to the **SAME FARM** throughout the survey.

6. **Where is this farm located?** **State:** 006 _____ **County:** 007_____

7. **What was your most extensively used cover crop or cover crop mix on this farm for the year reported in item 4? (Please circle all that apply)**

Annual ryegrass 008	1	
Austrian winter peas	2	
Cereal rye	3	
Crimson clover	4	
Hairy vetch	5	
Lupine	6	
Mustards	7	
Oats	8	
Radish	9	
Rapeseed	10	
Turnips	11	
Triticale	12	
Wheat	13	
Other:	14	

Section 2. Cover Crop Planting

Please answer the following questions focusing only on your experience with the cover crop or cover crop mix chosen in Section 1 for the most recent year prior to 2020.

1. **How many acres were planted to this cover crop?** 009 _____ Acres
2. **What was your cost per acre for the cover crop seed?** 010 $_____/Acre
3. **Did you irrigate your cover crop? (Please circle one number)**

   Yes, for all acres ..... 011 1 → ***Continue***

   Yes, for some acres ..... 2 → Percent of acres 012 _____ % → ***Continue***

   No ..... 3 → ***Go to item 5.***

4. **How many acre-inches of irrigation were applied to this cover crop?** 013 _____ Acre-Inches
5. **Did you apply fertilizer to your cover crop? (Please circle one number)**

   Yes, for all acres ..... 014 1 → ***Continue***

   Yes, for some acres ..... 2 → Percent of acres 015 _____ % → ***Continue***

   No ..... 3 → ***Go to item 7.***

6. **What fertilizer did you apply to your cover crop? (Please circle all that apply)**

   Nitrogen 016 1

   Phosphorous 2

   Potassium 3

   Manure 4

   Other: _____ 5

7. **Did you hire custom work for planting your cover crop? (Please circle one number)**

   Yes, for all acres ..... 017 1 → ***Continue***

   Yes, for some acres ..... 2 → Percent of acres 018 _____ % → ***Continue***

   No ..... 3 → ***Go to item 9.***

8. **What was the predominant custom planting method you hired, and how much did you pay per acre (excluding seed costs) to plant the cover crop with this method? (Please circle one number)**

		Cost per Acre 020
Aerial seeding 019	1 →	$_____
Broadcast seeding	2 →	$_____
Drilling	3 →	$_____
Other planting method: _____	4 →	$_____

If you planted all your cover crops with hired custom work, go to Section 3. Otherwise, please continue.

9. **What machinery did you use to plant cover crops on the non-custom hired acres?**

9.1 Power machinery (Please circle one number)

2-wheel drive or mechanical front wheel drive tractor:		4-wheel drive tractor:	
30-49 HP 021	1	200-289 HP	9
50-69 HP	2	290-339 HP	10
70-89 HP	3	340-399 HP	11
90-119 HP	4	400 and over HP	12
120-149 HP	5	Other types:	
150-179 HP	6	Tracked Crawler Tractor 350 HP	13
180-219 HP	7	Other: _____	14
220 and over HP	8		

9.2 Planting machinery (Please circle one number)

Row Crop Planter ... 022	1	➔ Width	023_____	Rows
Min-Till Planter	2	➔ Width	024_____	Rows
No-Till Drill	3	➔ Width	025_____	Feet
Press Wheel Drill	4	➔ Width	026_____	Feet
Drill, Other	5	➔ Width	027_____	Feet
Air Seeder Drill w/ cart ..	6	➔ Width	028_____	Feet
Broadcast Seeder	7			
Other: _____ ...	8			

Section 3. Cover Crop Termination

Please answer the following questions focusing only on your experience with the cover crop or cover crop mix chosen in Section 1 for the most recent year prior to 2020.

1. **Did you use herbicide during the termination of your cover crop? (Please circle one number)**

Yes 029	1	➔ ***Continue.***
No	2	➔ ***Go to item 9.***

2. **How much did you spend on herbicides to terminate your cover crop?** 030 $_____/Acre

3. **Did you hire custom work for terminating your cover crop with herbicide? (Please circle one number)**

Yes, for all acres 031	1	➔	***Continue***
Yes, for some acres	2	➔ Percent of acres 032_____%	➔ ***Continue***
No	3	➔	***Go to item 5.***

4. **How much did you pay for hiring custom work to terminate your cover crop with herbicide (including fuel, labor, etc. but excluding herbicide costs)?** 033 $_____/Acre

If you terminated all your cover crops with hired custom work, go to item 9. Otherwise, please continue.

5. What machinery did you use to terminate your cover crop with herbicide on the non-custom hired acres?

5.1 Power machinery (Please circle one number)

2-wheel drive or mechanical front wheel drive tractor:		4-wheel drive tractor:	
30-49 HP 034	1	200-289 HP	9
50-69 HP	2	290-339 HP	10
70-89 HP	3	340-399 HP	11
90-119 HP	4	400 and over HP	12
120-149 HP	5	Other types:	
150-179 HP	6	Tracked Crawler Tractor 350 HP	13
180-219 HP	7	Self-propelled	14
220 and over HP	8	Other: _____	15

5.2 Spraying machinery (Please circle one number)

Sprayer, Boom-Type 035	1	Spray Tank & Boom	5
Hooded Sprayer	2	Sprayer, self-propelled	6
Spray Buggy	3	Sprayer mounted to roller/crimper	7
Sprayer, Air Carrier	4	Other: _____	8

6. Did terminating the cover crop with herbicide require more expenses or unpaid labor hours than applying herbicide in the spring to your acres without cover crops? (Please circle one number)

Yes ..... 036 1 ➔ ***Continue***

No ..... 2 ➔ ***Go to item 8.***

7. Additional labor hours/Acre: 037 _____ **Additional expenses:** 038 $_____/Acre

8. Please circle one number in each line:

	Yes	No
I only applied herbicide to my acres with cover crops 039	1	2
All my acres were under cover crops 040	1	2

9. Did you use any of the following additional termination methods? (Please circle one number)

Tillage 041	1	➔ ***Go to Section 3a.***
Mowing	2	➔ ***Go to Section 3b.***
Rolling/Crimping	3	➔ ***Go to Section 3c.***
I did not use any other termination methods	4	➔ ***Go to Section 4.***
Other: _____	5	➔ ***Continue.***

10. What was your termination cost per acre? 042 $_____/Acre ➔ ***Go to Section 4.***

Section 3a. Termination with Tillage

1. **Did you hire custom work for terminating your cover crop with tillage? (Please circle one number)**

   Yes, for all acres ..... 043 1 → ***Continue***

   Yes, for some acres ..... 2 → Percent of acres 044 _____% → ***Continue***

   No ..... 3 → ***Go to item 3.***

2. **How much did you pay for hiring custom work to terminate your cover crop with tillage (including fuel, labor, etc.)?** 045 $_____/Acre

If you terminated all your cover crops with hired custom work, go to Section 4. Otherwise, please continue.

3. **What machinery did you use to terminate your cover crop with tillage in the non-custom hired acres?**

   3.1 Power machinery (Please circle one number)

2-wheel drive or mechanical front wheel drive tractor:		4-wheel drive tractor:	
30-49 HP 046	1	200-289 HP	9
50-69 HP	2	290-339 HP	10
70-89 HP	3	340-399 HP	11
90-119 HP	4	400 and over HP	12
120-149 HP	5	Other types:	
150-179 HP	6	Tracked Crawler Tractor 350 HP	13
180-219 HP	7	Other: _____	14
220 and over HP	8		

   3.2 Tillage machinery (Please circle one number)

Spring Tooth Harrow 047	1	Spike Tooth Harrow	2	Rotary Tiller	3
Row Crop Cultivator	4	Roller Packer	5		

Chisel Plow 6	→	Width	048 _____	Feet
Disk Plow 7	→	Width	049 _____	Feet
Mold-Board Plow Bottom 8	→	Number of Bottoms ..	050 _____	Bottoms
Offset Disk 9	→	Width	051 _____	Feet
Tandem Disk 10	→	Width	052 _____	Feet
Vertical Tillage Tool 11	→	Width	053 _____	Feet
Roller Harrow 12	→	Width	054 _____	Feet
Field Cultivator 13	→	Width	055 _____	Feet
Field Cultivator-Incorporator .. 14	→	Width	056 _____	Feet
Disk, Field Cultivator 15	→	Width	057 _____	Feet
Disk & V-Ripper 16	→	Width	058 _____	Feet

   Other: _____ 17

4. **Did tilling one acre with cover crops require more expenses or unpaid labor hours than tilling one acre without cover crops? (Please circle one number)**

   Yes ..... 059 1 → ***Continue***

   No ..... 2 → ***Go to item 6.***

5. **Additional labor hours/Acre:** 060 _____ **Additional expenses:** 061 $_____/Acre

6. **Please circle one number in each line:**

	Yes	No
I only tilled my acres with cover crops 062	1	2
All my acres were under cover crops 063	1	2

Go to Section 4.

Section 3b. Termination by Mowing

1. **Did you hire custom work for terminating your cover crop by mowing? (Please circle one number)**

Yes, for all acres ..... 064 1 → ***Continue***
Yes, for some acres ..... 2 → Percent of acres 065 _____% → ***Continue***
No ..... 3 → ***Go to item 3.***

2. **How much did you pay for hiring custom work to terminate your cover crop by mowing (including fuel, labor, etc.)?** 066 $_____/Acre

If you terminated all your cover crops with hired custom work, go to Section 4. Otherwise, please continue.

3. **What machinery did you use to terminate your cover crop by mowing in the non-custom hired acres?**

3.1 Power machinery (Please circle one number)

2-wheel drive or mechanical front wheel drive tractor:		4-wheel drive tractor:	
30-49 HP 067	1	200-289 HP	9
50-69 HP	2	290-339 HP	10
70-89 HP	3	340-399 HP	11
90-119 HP	4	400 and over HP	12
120-149 HP	5	Other types:	
150-179 HP	6	Swather Conditioner Self-Propelled	13
180-219 HP	7	Tracked Crawler Tractor 350 HP	14
220 and over HP	8	Other: _____	15

3.2 Mowing machinery (Please circle one number)

Mower, Sickle 068	1	Swather Conditioner (Up to 13ft)	8
Mower, Rotary	2	Swather Conditioner (14ft & over)	9
Mower, Flail	3	Flail chopper	10
Rotary Hay Mower	4	Forage Harvester Corn Head	11
Mower Conditioner	5	Forage Harvester Pickup Head	12
Rotary Mower Conditioner (Up to 10ft)	6	Other: _____	13
Rotary Mower Conditioner (11ft & over)	7		

4. **Did mowing one acre with cover crops require more expenses or unpaid labor hours than mowing one acre without cover crops? (Please circle one number)**

Yes ..... 068 1 → *Continue*

No ..... 2 → *Go to item 6.*

5. **Additional labor hours/Acre:** 070 _____ **Additional expenses:** 071 $_____/Acre

6. **Please circle one number in each line:**

	Yes	No
I only mowed my acres with cover crops 072	1	2
All my acres were under cover crops 073	1	2

Go to Section 4.

Section 3c. Termination by Rolling/Crimping

1. **How many passes did you use to terminate your cover crop? (Please circle one number)**

One pass with only rolling/crimping 074	1
One pass with rolling/crimping and herbicide together	2
Two passes with one pass herbicide and another pass rolling/crimping	3
Other: _____	4

2. **Did you hire custom work for terminating your cover crop by rolling/crimping? (Please circle one number)**

Yes, for all acres ..... 075 1 → *Continue*

Yes, for some acres ..... 2 → Percent of acres 076 _____% → *Continue*

No ..... 3 → *Go to item 4.*

3. **How much did you pay for hiring custom work to terminate your cover crop by rolling/crimping (including fuel, labor, etc.)?** 077 $_____/Acre

If you terminated all your cover crops with hired custom work, go to Section 4. Otherwise, please continue.

4. **What machinery did you use to terminate your cover crop by rolling/crimping in the non-custom hired acres?**

4.1 Power machinery (Please circle one number)

2-wheel drive or mechanical front wheel drive tractor:		4-wheel drive tractor:	
30-49 HP 078	1	200-289 HP	9
50-69 HP	2	290-339 HP	10
70-89 HP	3	340-399 HP	11
90-119 HP	4	400 and over HP	12
120-149 HP	5	Other types:	
150-179 HP	6	Swather Conditioner Self-Propelled	13
180-219 HP	7	Tracked Crawler Tractor 350 HP	14
220 and over HP	8	Other: _____	15

4.2 Rolling/Crimping machinery (Please circle one number)

Smooth Drum Roller 079	1	Cultipacker	4
Roller/crimper	2	Other: _____	5
Strip-Till Rig with Roller	3		

5. Did rolling/crimping one acre with cover crops require more expenses or unpaid labor hours than rolling/crimping one acre without cover crops? (Please circle one number)

Yes ..... 080 1 → ***Continue***

No ..... 2 → ***Go to item 7.***

6. Additional labor hours/Acre: 081 _____ **Additional expenses:** 082 $_____/Acre

7. Please circle one number in each line:

	Yes	No
I only rolled/crimped my acres with cover crops 083	1	2
All my acres were under cover crops 084	1	2

Section 4. Revenues and Costs

Please answer the following questions focusing only on your experience with the cover crop or cover crop mix chosen in Section 1 for the most recent year prior to 2020.

1. Was your cover crop grazed or harvested for forage? If yes, how much revenue or cost savings did you get from it? (Please circle one number)

Yes ..... 085 1 → Revenues or cost savings ..... 086 $_____/Acre

No 2

2. Did you harvest the seed produced by the cover crop? If yes, how much revenue did you get from selling the cover crop seed, or how much cost savings did you save from reusing the cover crop seed? (Please circle one number)

Yes ..... 087 1 → Revenues or cost savings ..... 088 $_____/Acre

No 2

3. For this farm, did you participate in a cost-share program? If yes, what was the total payment, and the number of acres in the program(s)? (Please circle one number)

Yes ..... 089 1 → Total payment ... 089a $_____ → Number of Acres... 089b _____

No 2

4. What cash crop did you plant most extensively following your cover crop? (Please circle one number)

Cotton ..... 091 1 Corn for grain or seed ..... 2 Peanuts 3

Other: _____ 4

5. How many acres did you plant to this cash crop following your cover crop? 092 _____ Acres

6. **Did you irrigate the cash crop planted after the cover crop? (Please circle one number)**

Yes, for all acres ..... 093 1 → *Continue*

Yes, for some acres ..... 2 → Percent of acres 094 _____% → *Continue*

No ..... 3 → *Go to item 8.*

7. **What was your average irrigated yield for the cash crop reported in item 4 following the cover crop in those acres?**

_____095 Bu/Acre for Corn and Other _____096 Lbs./Acre for Cotton and Peanut

If you irrigated all your cash crop acres following your cover crop, go to item 9. Otherwise, please continue.

8. **What was your average dryland yield for the cash crop reported in item 4 following the cover crop in those acres?**

_____097 Bu/Acre for Corn and Other _____098 Lbs./Acre for Cotton and Peanut

9. **Did you also plant the cash crop reported in item 4 above on acres following NO cover crop? (Please circle one number)**

Yes ..... 099 1 → *Continue*

No ..... 2 → *Go to item 17.*

10. **How many acres did you plant to this cash crop following NO cover crop?** 100_____Acres

11. **Did you irrigate the cash crop reported in item 4 following NO cover crop? (Please circle one number)**

Yes, for all acres ..... 101 1 → *Continue*

Yes, for some acres ..... 2 → Percent of acres 102 _____% → *Continue*

No ..... 3 → *Go to item 13.*

12. **What was your average irrigated yield for the cash crop reported in item 4 in the acres following NO cover crops?**

_____103 Bu/Acre for Corn and Other _____104 Lbs./Acre for Cotton and Peanut

If you irrigated all cash crop acres following NO cover crop, *go to item 14. Otherwise, please continue.*

13. **What was your average dryland yield for the cash crop reported in item 4 in the acres following NO cover crops?**

_____105 Bu/Acre for Corn and Other _____106 Lbs./Acre for Cotton and Peanut

14. Compare your acres following cover crops versus your acres following NO cover crops: were your costs and practices different for any of the following categories? If yes, please circle the number and enter the values to the right (Please include all costs associated with the cover crop and cash crop).

	Were your costs or practices different? Yes	No		Value following cover crops	Value following NO cover crops
Cash crop planting populations. Seeds/acre ... 107	1	2	*If yes,* → 119	_____ 131	_____
Cash crop seed costs. $/acre ... 108	1	2	*If yes,* → 120	_____ 132	_____
Cash crop planting costs (excluding seed costs). $/acre ... 109	1	2	*If yes,* → 121	_____ 133	_____
Nitrogen fertilizer costs. $/acre ... 110	1	2	*If yes,* → 122	_____ 134	_____
Phosphorous and potassium costs. $/acre ... 111	1	2	*If yes,* → 123	_____ 135	_____
Manure costs. $/acre ... 112	1	2	*If yes,* → 124	_____ 136	_____
Insecticide costs. $/acre ... 113	1	2	*If yes,* → 125	_____ 137	_____
Fungicide costs. $/acre ... 114	1	2	*If yes,* → 126	_____ 138	_____
Herbicide costs. $/acre ... 115	1	2	*If yes,* → 127	_____ 139	_____
Soil testing costs. $/acre ... 116	1	2	*If yes,* → 128	_____ 140	_____
Costs to repair acres with soil erosion. $/acre 117	1	2	*If yes,* → 129	_____ 141	_____
Irrigation amount. Per acre-inch ... 118	1	2	*If yes,* → 130	_____ 142	_____

15. How many additional management hours did your cover crop require on top of your typical management hours for your cash crop following NO cover crops? If none, please enter "0". 143 _____ hours

16. Are tillage costs different for your acres following cover crops than for your acres following NO cover crops? (Please circle one number)

Yes ... 144 1
No ... 2

17. Did you rent cropland in the most recent year you planted cover crops prior to 2020? (Please circle one number)

Yes ... 145 1 → *Continue*
No ... 2 → *Go to Section 5.*

18. Did you plant cover crops on that rented cropland? (Please circle one number)

Yes ... 146 1 → *Continue*
No ... 2 → *Go to Section 5.*

19. Did planting cover crops on rented land help you negotiate better terms? (Please circle one number)

Yes ... 147 1 → *Continue*
No ... 2 → *Go to Section 5.*

20. Please circle one number in each line.

I negotiated a lower rent. Yes..... 148 1 No..... 2 *If yes,* → I saved: 150 $_____/Acre

I negotiated a longer lease. Yes..... 149 1 No..... 2 *If yes,* → Additional years: 151 _____

Section 5. Tillage

If your answer to Item 9 in Section 4 was yes, please continue. Otherwise, please go to Section 6.

1. What tillage practice did you use for the cash crop reported in item 4, Section 4? (Please circle one number in each line)

	Conventional (full-width) tillage	Vertical tillage only (i.e. Aerway, Turbo-till, Salford, etc.)	Reduced tillage only (i.e. strip tillage, mulch tillage, etc.)	Rotational no-till (i.e. no-till cotton and tillage prior to planting peanut)	Continuous no till
On acres following cover crops..... 152	1	2	3	4	5
On acres following NO cover crops... 153	1	2	3	4	5

If you chose 5 in both, please go to Section 6. Otherwise, please continue.

2. How many tillage passes did you use to prepare the field for planting the cash crop? Please ***DO NOT*** include tillage passes used for terminating the preceding cover crop. (Please circle one number)

1 pass..... 154 1 2 passes..... 2 3 passes..... 3

3. Did you hire custom work to till your acres in preparation for planting the cash crop? Please only answer according to the number of passes you answered in *Item 2.* (Please circle one number in each cell. If you choose 2 "for some acres", please enter the percent of acres custom tilled)

	In acres following cover crops	In acres following NO cover crops
1st pass	Yes, for all acres ... 155 1	Yes, for all acres ... 157 1
	Yes, for some acres .. 2 → 156 _____%	Yes, for some acres ... 2 → 158 _____%
	No ..... 3 → Go to Item 5.	No ..... 3 → Go to Item 5.
2nd pass	Yes, for all acres ... 159 1	Yes, for all acres ... 161 1
	Yes, for some acres .. 2 → 160 _____%	Yes, for some acres ... 2 → 162 _____%
	No ..... 3 → Go to Item 5.	No ..... 3 → Go to Item 5.
3rd pass	Yes, for all acres ... 163 1	Yes, for all acres ... 165 1
	Yes, for some acres .. 2 → 164 _____%	Yes, for some acres ... 2 → 166 _____%
	No ..... 3 → Go to Item 5.	No ..... 3 → Go to Item 5.

4. How much did you pay for hiring custom work for tillage in each pass? Please only answer according to the number of passes you answered in *Item 2*.

	1st pass	2nd pass	3rd pass
In acres following cover crops.....	167 $_____/acre	169 $_____/acre	171 $_____/acre
In acres following NO cover crops....	168 $_____/acre	170 $_____/acre	172 $_____/acre

If you tilled all your cover crop and non-cover crop acres with hired custom work in item 3, go to section 6. Otherwise, please continue.

5. Tillage machinery

5.1 Codes for power machinery:

2-wheel drive or mechanical front wheel drive tractor:		4-wheel drive tractor:	
30-49 HP 173	1	200-289 HP	9
50-69 HP	2	290-339 HP	10
70-89 HP	3	340-399 HP	11
90-119 HP	4	400 and over HP	12
120-149 HP	5	Other types:	
150-179 HP	6	Swather Conditioner Self-Propelled	13
180-219 HP	7	Tracked Crawler Tractor 350 HP	14
220 and over HP	8	Other: _____	15

5.2 What power machinery did you use to till non-custom hired acres? Please only answer according to the number of passes you answered in *Item 2.* (Enter code from table above).

	1st pass	2nd pass	3rd pass
Following cover crops	174 _____	176 _____	178 _____
Following NO cover crops	175 _____	177 _____	179 _____

5.3 Codes for tillage machinery. Please indicate size for codes 6-16.

Spring Tooth Harrow 180	1	Spike Tooth Harrow	2	Rotary Tiller	3
Row Crop Cultivator	4	Roller Packer	5	Strip-Till Rig	6
Strip-Till Rig with Roller	7				
Chisel Plow	8	→ Width	181 _____	Feet	
Disk Plow	9	→ Width	182 _____	Feet	
Mold-Board Plow Bottom	10	→ Number of Bottoms ..	183 _____	Bottoms	
Offset Disk	11	→ Width	184 _____	Feet	
Tandem Disk	12	→ Width	185 _____	Feet	
Vertical Tillage Tool	13	→ Width	186 _____	Feet	
Roller Harrow	14	→ Width	187 _____	Feet	
Field Cultivator	15	→ Width	188 _____	Feet	
Field Cultivator-Incorporator ..	16	→ Width	189 _____	Feet	
Disk, Field Cultivator	17	→ Width	190 _____	Feet	
Disk & V-Ripper	18	→ Width	191 _____	Feet	
Other: _____	19				

5.4 What tillage machinery did you use to till non-custom hired acres? Please only answer according to the number of passes you answered in *Item 2.* (Enter code from table above).

	1st pass	2nd pass	3rd pass
Following cover crops	192 _____	194 _____	196 _____
Following NO cover crops	193 _____	195 _____	197 _____

Section 6. Previous Rotation

Please answer the following questions focusing only on your experience with the cover crop or cover crop mix chosen in Section 1 for the most recent year prior to 2020.

1. What cash crop did you plant most extensively prior to this cover crop? (Please circle one number)

Cotton ..... 168 1 Corn for grain or seed ..... 2 Peanuts 3

Other: _____ 4

2. Did you plant a cover crop prior to the cash crop selected in item 1? (Please circle one number)

Yes ..... 199 1 → *Continue*

No ..... 2 → *Go to Section 7.*

3. What cover crop or cover crop mix did you plant most extensively prior to the cash crop selected in item 1? (Please circle all that apply)

Annual ryegrass	200	1
Austrian winter peas		2
Cereal rye		3
Crimson clover		4
Hairy vetch		5
Lupine		6
Mustards		7
Oats		8
Radish		9
Rapeseed		10
Turnips		11
Triticale		12
Wheat		13
Other: _____		14

Section 7. Perceptions about Cover Crops

1. Do you believe planting cover crops would increase farming profitability? (Please circle one number)

Yes 201 1

No 2

2. Would you consider planting cover crops in the future? (Please circle one number)

Yes 202 1

No 2

3. What are the top three challenges posed by using cover crops? (Please rank the top three challenges)

		Rank
Time/labor required for planting and increased management	01	____
Figuring out the right cover crop species for my operation	02	____
Cost of planting and managing cover crops is too high	03	____
Obtaining success in establishing cover crops	04	____
Too wet in the spring - fear of delayed planting of the following cash crop	05	____
Cover crops sometimes use too much soil moisture	06	____
No measurable economic returns when using cover crops	07	____
Cover crop might become a weed in the following year	08	____
Cover crop seed costs are too high	09	____
Yield reduction in the cash crop following cover crop	10	____
Cover crops increase overall crop production risk	11	____
Cover crop seed availability	12	____
Cover crops might cause nitrogen immobilization	13	____
Other: _____	14	____

4. What are the top three benefits you believe cover crops can provide? (Please rank the top three benefits)

		Rank
Aerate the soil and increase water infiltration and soil water holding capacity	01	____
Increase biodiversity, including soil organisms and earthworms	02	____
Build soil carbon and soil organic matter	03	____
Reduce soil erosion and loss	04	____
Contribute to better management of soil nutrients and lower fertilizer inputs	05	____
Decreased nutrient leaching into rivers or groundwater	06	____
Reduced soil compaction and improved soil structure and strength	07	____
Increased economic returns	08	____
Reduced production costs	09	____
Increased yield in the cash crop following cover crop	10	____
Cover crops reduce overall crop production risk	11	____
Reduced need for tillage	12	____
Reduced weed pressure	13	____
Allows integration of livestock with field crops	14	____
Other: _____	15	____

5. If you would like to add details to your responses or provide feedback about the survey, please use the following space:

Thank you for your help!

Appendix 2. Mail Correspondence Letters and Post Cards

UNIVERSITY OF GEORGIA

Dept. of Agricultural & Applied Economics

Southeastern Cover Crop Research

To: Crop Producer
From: Dr. Yangxuan Liu, Ph.D.
Assistant Professor & Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

The use of cover crops has a long and rich history. After a drastic decline in their use with the introduction of synthetic fertilizers, their use is once again on the rise as our society has become more environmentally aware. As farmers are having to produce more food, fiber, and fuel with less available farmland for our growing population, it is important to identify the most efficient and sustainable production practices.

I am writing to ask you to help us understand the current production practices, the costs and benefits, and the general perceptions of cover crop use. The best way for us to do this is through asking farmers like you to complete our 30-minute survey. Our research will help to further understand the missing elements (i.e. education, better funding, etc.) that will help increase cover crop adoption to provide for a more sustainable future.

Please return your completed survey in the enclosed stamped envelope. Your responses are voluntary and will be kept confidential. **If you have any questions about this survey, please contact Madison Harkins by phone at (706) 817-8781 or email at mgharkins93@uga.edu.**

By taking this survey, you will be adding greatly to our understanding of what elements are needed to help farmers adopt more sustainable practices while maintaining profitability. I look forward to receiving your response.

Sincerely,

Yangxuan Liu

Dr. Yangxuan Liu
Principal Investigator
University of Georgia – Tifton Campus

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UNIVERSITY OF GEORGIA

Dept. of Agricultural & Applied Economics

Southeastern Cover Crop Research

To: Crop Producer
From: Dr. Yangxuan Liu, Ph.D.
Assistant Professor & Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

Last week, we mailed you a letter asking for your help with a study about cover crop use and management practices in the southeast region.

If you have already completed and returned the survey, please accept our sincere thanks. If not, please complete and return the survey as soon as possible. We are very appreciative of your help with this important research.

If you do not have a questionnaire, or if you have any questions, please contact Madison Harkins by phone at (706) 817-8781 or email at mgharkins93@uga.edu.

Sincerely,

Yangxuan Liu

Dr. Yangxuan Liu
Principal Investigator
University of Georgia – Tifton Campus

2360 RAINWATER RD., TIFTON, GA 31793
T (229) 386 - 3512 E YANGXUAN.LIU@UGA.EDU

REMINDER

STAMP

SOUTHEASTERN COVER CROP SURVEY

ADDRESS LABEL

UNIVERSITY OF GEORGIA

Dear Crop Producer,

You should have recently received a survey in the mail from the University of Georgia. If you have already completed and returned the survey, we appreciate your response and ask that you disregard this reminder.

This is a reminder that survey responses are requested back by **March 31st, 2021**.

If you no longer have the original copy of the survey but would like to participate, a second copy of the survey will be arriving soon. If you prefer to respond to this survey via the internet, you may take the survey online at the following web address:

https://tinyurl.com/secovercrops

Your response to this survey is extremely valuable and greatly appreciated. Thank you for taking the time to assist with this survey.

If you have any questions, comments, or concerns regarding this survey, please contact Madison Harkins by email: mgharkins93@uga.edu.

Thank you!

Yangxuan Liu

Dr. Yangxuan Liu

UNIVERSITY OF GEORGIA

UNIVERSITY OF GEORGIA

Dept. of Agricultural & Applied Economics

Southeastern Cover Crop Research

To: Crop Producer
From: Dr. Yangxuan Liu, Ph.D.
Assistant Professor & Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

About a month ago, we sent you a survey asking you about your perceptions of cover crop use and how their use affects your costs and revenues. To the best of our knowledge, we have not yet received your responses. Our farming industry faces a growing number of challenges regarding maintaining sustainability with a growing population and limited resources.

We are writing again because of the importance of your responses for helping to get accurate results so that we can achieve a more sustainable future for agriculture together. It is only by hearing from farmers like you that we can obtain accurate results that truly represent current practices and returns provided by cover crop use.

Simply complete the enclosed questionnaire and return it in the stamped envelope provided. Your responses are voluntary and will be kept confidential. **If you have any questions, please contact Madison Harkins by phone at (706) 817-8781 or email at mgharkins93@uga.edu.**

Thank you so much for your help with this important research that will help support and enhance the future of agriculture!

Sincerely,

Yangxuan Liu

Dr. Yangxuan Liu
Principal Investigator
University of Georgia – Tifton Campus

2360 RAINWATER RD., TIFTON, GA 31793
T (229) 386 - 3512 E YANGXUAN.LIU@UGA.EDU

UNIVERSITY OF GEORGIA

Dept. of Agricultural & Applied Economics

Southeastern Cover Crop Research

To: Crop Producer
From: Dr. Yangxuan Liu, Ph.D.
Assistant Professor & Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

In recent weeks, our research team has asked you, as a southeastern row crop producer, to let us know about your perceptions about cover crop use, your current production practices, and how that affects your return on investment. The survey response deadline is ***March 31st, 2021***.

You can help us by filling out the questionnaire we mailed to you and returning it in the provided stamped envelope.

As environmental sustainability becomes more important for the future of agriculture, we believe that cover crop adoption will allow for a more successful and improved outlook. We hope that the results of this study will contribute to a better future for all producers.

This is the last contact we will be sending you about this survey, as we are bringing this phase of the project to a close. **If you have any questions, please contact Madison Harkins by phone at (706) 817-8781 or email at mgharkins93@uga.edu.**

Thank you so much for your help with this important research that will help support and enhance the future of agriculture!

Sincerely,

Yangxuan Liu

Dr. Yangxuan Liu
Principal Investigator
University of Georgia – Tifton Campus

2360 RAINWATER RD., TIFTON, GA 31793
T (229) 386 - 3512 E YANGXUAN.LIU@UGA.EDU

SOUTHEASTERN COVER CROP SURVEY

Dear Crop Producer,

We appreciate your help during this phase of our research. It is because of farmers like you who are willing to participate in our survey that we will be able to conduct our research to help other farmers adopt more sustainable practices.

If you know of any other farmers who would be interested in participating in this project, please share the online survey link below with them or include their contact information on the back of this card and mail this card together with the paper survey back to us.

https://tinyurl.com/secovercrops

Thank you for your help!

Yangxuan Liu

Dr. Yangxuan Liu

UNIVERSITY OF GEORGIA

Name: _____
Phone: _____
Email address: _____
Mailing address: _____

Name: _____
Phone: _____
Email address: _____
Mailing address: _____

Name: _____
Phone: _____
Email address: _____
Mailing address: _____

Appendix 3. Qualtrics Correspondence Letters

Dear Crop Producer,

The use of cover crops has a long and rich history. After a drastic decline in their use with the introduction of synthetic fertilizers, their use is once again on the rise as our society has become more environmentally aware. As farmers are having to produce more food, fiber, and fuel with less available farmland for our growing population, it is important to identify the most efficient and sustainable production practices.

I am writing to ask you to help us understand the current production practices, the costs and benefits, and the general perceptions of cover crop use. The best way for us to do this is through asking farmers like you to complete our 30-minute survey. Our research will help to further understand the missing elements (i.e. education, better funding, etc.) that will help increase cover crop adoption to provide for a more sustainable future. Please use the following link to complete the online survey:

Your responses are voluntary and will be kept confidential. **If you have any questions about this survey, please contact Madison Harkins by phone at (706) 817-8781 or email at mgharkins93@uga.edu.**

By taking this survey, you will be adding greatly to our understanding of what elements are needed to help farmers adopt more sustainable practices while maintaining profitability. I look forward to receiving your response.

Sincerely,

Dr. Yangquan Liu
Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

Last week, we emailed you asking for your help with a study about cover crop use and management practices in the southeast region.

If you have already completed the survey, please accept our sincere thanks. If not, please use the link below and complete the survey as soon as possible. We are very appreciative of your help with this important research.

https://ugeorgia.ca1.qualtrics.com/jfe/form/SV_0la69XYB3pk2kq9

If you have any questions, please contact Madison Harkins by phone at (706) 817-8781 or email at mgharkins93@uga.edu.

Sincerely,

Dr. Yangquan Liu
Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

About a month ago, we sent you a survey asking you about your perceptions of cover crop use and how their use affects your costs and revenues. To the best of our knowledge, we have not yet received your responses.

We are writing again because of the importance of your responses for helping to get accurate results, so that we can achieve a more sustainable future for agriculture together. It is only by hearing from farmers like you that we can obtain accurate results that truly represent current practices and returns provided by cover crop use.

Simply use the link below to complete the survey at your convenience.

LINK

Your responses are voluntary and will be kept confidential. **If you have any questions, please contact Madison Harkins by phone at (706) 817-8781 or by email at mgharkins93@uga.edu.**

Thank you so much for your help with this important research that will help support and enhance the future of agriculture!

Sincerely,

Dr. Yangxuan Liu
Principal Investigator
University of Georgia – Tifton Campus

Dear Crop Producer,

In recent weeks, our research team has asked you, as a southeastern row crop producer, to let us know about your perceptions about cover crop use, your current production practices, and how that affects your return on investment. The survey response deadline is ***March 31st, 2021***.

You can help us by filling out the questionnaire with the link below.

https://ugeorgia.ca1.qualtrics.com/jfe/form/SV_0la69XYB3pk2kq

This is the last contact we will be sending you about this survey, as we are bringing this phase of the project to a close. **If you have any questions, please contact Madison Harkins by phone at (706) 817-8781 or by email at mgharkins93@uga.edu.**

Thank you so much for your help with this important research that will help support and enhance the future of agriculture!

Sincerely,

Dr. Yangxuan Liu
Principal Investigator
University of Georgia – Tifton Campus

Appendix 4. Email Correspondence Letter

Dear ANR Agents,

We are now collecting responses for our Southeastern Cover Crop Research Survey. We would really appreciate your help in advertising our survey to your network so that we can get more farmers to participate to ensure variability in our data. Below is the information and the link:

The use of cover crops can yield many environmental benefits and has great potential to ensure long-term sustainability. As farmers are having to produce more food, fiber, and fuel with less available farmland for our growing population, it is important to identify the most efficient and sustainable production practices. By taking this survey, you will help us to understand the current production practices, the costs and benefits, and the general perceptions of cover crop use. The survey will take approximately 30 minutes to complete. Your participation will help us to further understand the missing elements (i.e. education, better funding, etc.) that will help increase cover crop adoption and provide for a more sustainable future.

Thank you very much for your participation and please, click on the link to take the survey:
Southeastern Cover Crop Survey

If the link above doesn't work, please copy and paste the following in your browser:
https://ugeorgia.ca1.qualtrics.com/jfe/form/SV_0la69XYB3pk2kq9

If you have any questions about this survey, please contact the Agricultural and Applied Economics Department, University of Georgia, Madison Harkins by email at mgharkins93@uga.edu or Dr. Yangxuan Liu by email at Yangxuan.Liu@uga.edu.