Current Production Practices for Cover Crops in Southeastern United States





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Abstract

As environmental sustainability awareness grows, the role of cover crops in preserving and enhancing cropland has become increasingly valued. This study surveys 46 farmers from January 28, 2021, to March 31, 2021, in Georgia, Alabama, and Florida to explore current practices in integrating cover crops into row crop production. Findings show cereal rye is the preferred cover crop, with no-till drill and broadcast spreading being the most common planting methods and herbicides the main termination method.

INTRODUCTION

With environmental sustainability issues becoming more widely recognized, the value of cover crops in the preservation and improvement of cropland has increased (Chatterjee, 2013; Kaspar and Singer, 2011; Wallander et al., 2021; Scavo et al., 2022). This resurgence is partly driven by increasing societal awareness of environmental issues but also the recognized challenge of soil degradation for the sustainable future of agriculture (Zulauf and Brown, 2019; Sawadgo and Plastina, 2022).

In 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 used cover crops on all of their acreage (Wade, Claassen, and Wallander; 2015). By 2017, the United States Department of Agriculture Census of Agriculture reported that 12% of harvested row crop acreage in the U.S. included a cover crop in the rotation (U.S. Department of Agriculture, 2017). During this time, the adoption of cover crops in the Southeast was on the upswing, with the net increase in cover crop acres between 2012 and 2017 in the Southern Seaboard region reaching 460,447 acres (Sawadgo and Plastina, 2022). 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 and Gallandt, 2003).

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, and Laflen, 2001). Cover crops can also improve groundwater quality from decreased nutrient leaching (Ruffo, Bullock, and Bollero, 2004), reduce irrigation water usage (Allen et al., 2005), suppress weeds (Fisk et al., 2001), increase beneficial insect conservation (Bowers et al., 2020), and increase carbon sequestration (Reicosky and Forcella, 1998).

However, only a few studies have focused on conservation practice use among Southeastern row crop producers (Varco, Spurlock, and Sanabria-Garro, 1999). Hancock et al. (2020) used focus group interviews to identify cost and revenue changes and the perceived advantages and challenges to the adoption of cover crops by Georgia's cotton and peanut producers. Researchers found that producers exhibited different preferences for cover crop species across irrigated and dryland cotton production in Texas (Fan et al., 2020a; Fan et al., 2020b). Plastina et al. (2018a; 2018b; 2018c; Plastina et al. 2023) conducted research in the Midwest to identify changes in costs and revenues associated with cover crops, but the production practices used with cover crops in the Southeast are largely unknown. Nassauer et al. (2011) used surveys to identify production practices when cover crops were used in a cash crop rotation, including cotton, peanuts, and corn in the Southeast. It is important to understand the production practices used when cover crops are implemented to determine what improvements can be made to increase efficiency and improve the efficacy of policies fostering adoption.

MATERIALS AND METHODS

In accordance with the methodology established by Plastina et al. (2018a; 2018b; 2018c), this study employed surveys to investigate the utilization of cover crops in row crop rotations across Georgia, Alabama, and Florida. To maintain consistency, participating farmers were instructed to consistently refer to the same farm throughout the survey, even if they owned or managed multiple farms. Detailed questions were asked regarding cover crop planting and termination methods, tillage practices, the subsequent cash crop, and the specific cover crop species or mix adopted.

Survey responses were collected through phone interviews, mailed questionnaires, and an online survey hosted on Qualtrics. Contact details for individual farmers were obtained by engaging county extension offices in Georgia and Florida, regional extension agents in Alabama, and research specialists from the University of Georgia Cooperative Extension Service, the Institute of Food and Agricultural Sciences (in collaboration with the University of Florida and Florida A&M University), and the Alabama Cooperative Extension System (in partnership with Auburn University and Alabama A&M University). Furthermore, various commodity groups and agricultural organizations, including the local Natural Resource Conservation Service centers, 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, were contacted. County Farm Bureau offices in Georgia, state board members of the Florida Farm Bureau Federation, and leaders of the Alabama Farmers Federation were also contacted. These entities were requested to disseminate the online survey to relevant farmers.

A snowball sampling technique was employed to increase participant recruitment, with farmers asked to identify and recommend other potential participants. The data collection period spanned from January 28, 2021, to March 31, 2021, strategically chosen to avoid the cotton, peanut, and corn harvest and planting seasons. COVID-19-related travel restrictions during the survey period posed challenges in conducting in-person meetings, so to address this constraint, we offered farmers multiple avenues to complete the survey, including mailed paper surveys, access to the online survey, and phone interviews. A mixed-mode questionnaire and survey implementation method were adopted, adhering to the timeline proposed by Dillman et al. (2014) to optimize response rates, as illustrated in Figure 1.

RESULTS AND DISCUSSION

Farm Demographics

A total of 46 responses were obtained, and of the 44 farmers who specified the location of their farm, 31 (70%) were located across 22 counties in Georgia, primarily concentrated in the Southern region of the state. Florida producers provided nine (21%) responses, dispersed across seven counties in the Northern part of the state. Furthermore, four (9%) responses were received from farmers in Alabama, spanning four counties throughout the state. The majority of respondents had engaged in cover crop planting on their farms in recent years, with only two out of the 46 farmers indicating that they had never planted a cover crop.

Figure 2 presents an overview of the duration of cover crop adoption among producers. The predominant response indicates that a substantial number of farmers have been cultivating cover crops for 0-5 years, with fewer participants reporting cover crop engagement exceeding 20 years. Among the 43 responses answering for the question of the duration of cover crop adoption, the average duration of cover crop cultivation by producers was 11.47 years.

Figure 3 outlines the distribution of farm sizes among the survey respondents. The most prevalent farm size range was 202.3 to 404.3 hectares (500 to 999 acres), encompassing 24% of the 46 surveyed farms. Farm sizes exceeding 809.4 hectares (2,000 acres) and those falling within the range of 404.7 to 809.0 hectares (1,000 to 1,999 acres) were the next most frequent categories, representing 22% and 20% of the respondents, respectively. The predominant farm sizes among cover crop-utilizing producers in the surveyed region concentrated in the category above 202.3 hectares (500 acres) with medium- to large-scale agricultural operations.

In Figure 4, it is evident that cereal rye stands out as the predominant choice for cover crop monoculture among producers. Among the respondents, 49% (21) reported utilizing a cover crop monoculture, while the remaining 51% (22) opted for a mixed-species approach. This nearly equal split highlights the varied preferences for monoculture versus mixed-species cover crops among producers in the surveyed region.

Table 1 further details the specific mixes employed by the 21 farmers who adopted a mixed-species. Notably, nine of these mixes incorporated annual ryegrass, while 12 involved cereal rye. Additionally, various clover species and oats were common components of these mixes, with 10 responses including at least one variety of clover and 13 responses using at least one variety of oats. This diversity underscores the range of cover crop species employed by producers in the surveyed region. These species not only contribute to soil health and fertility but also align with the nutritional needs of livestock when cover crops are utilized for grazing. Farmers leveraging cover crops for grazing purposes may find these nutrient-dense options beneficial, potentially offsetting winter feed costs through grazing or harvesting for forage (Plastina et al., 2023).

Cover Crop Planting Practices

Figure 5 illustrates the distribution of area planted to cover crops in the most recent year across surveyed farms. The predominant range was 40.5-201.9 hectares (100-499 acres), suggesting that cover crops are typically not planted on the entirety of a farm's acreage, with the prevailing farm size falling within 202.3-404.3 hectares (500-999 acres) for the most common range. The data implies that farmers are selectively incorporating cover crops on specific portions of their land, rather than implementing them uniformly across the entire farm. Figure 6 illustrates the distribution of cover crop seed expenditures, where the average seed cost for monoculture was $58.14 per hectare ($23.53 per acre), and the average seed cost for cover crop mix was approximately $63.95 per hectare ($25.88 per acre).

In terms of cover crop management, the irrigation and fertilization practices employed by farmers were explored. From the 43 responses obtained from answering the question for irrigation and fertilization practices, a significant majority of farmers chose not to irrigate their cover crops. Only 19% of respondents irrigated their cover crop, including those who irrigate only a portion of their cover crop. Out of the respondents who irrigate, one farmer reported irrigating 100% of their cover crop, and an average irrigation amount of approximately 5.08 cm (two acre-inches) was applied by a subset of eight farmers. For fertilization practices, 58% of the 43 respondents applied fertilizer to at least some of their cover crop acreage. Among those who fertilize their cover crop, 17 farmers reported fertilizing 100% of their cover crop acres. Figure 7 discusses the types of fertilizers used, with nitrogen emerging as the most commonly applied fertilizer to cover crops. The fertilizer mentioned in the "Other" category is sulfur.

In our investigation of cover crop-related expenses, we delved into the hiring of custom work for cover crop planting among farmers. Out of 43 respondents answering the question of custom work, five respondents (12%) acknowledged hiring custom planting services for at least a portion of their cover crop area. Among these respondents, three farmers used custom broadcast seeding, while the remaining two chose custom drilling as their planting method. The associated costs averaged $51.08 per hectare ($20.67 per acre) for custom broadcast seeding and $64.25 per hectare ($26.00 per acre) for custom drilling.

For those who did not opt for custom planting services, we explored the types of planting machinery they employed. Figure 8 illustrates that among the 39 responses answered the question for custom planting service, the no-till drill and broadcast seeder are the two most commonly used types of planting machinery for cover crops. In terms of power of the tractor used, the majority of farmers used a four-wheel-drive tractor,

with a horsepower range of 200-399. Additionally, 17 farmers reported utilizing a two-wheel-drive tractor, with horsepower ranging from 30-179.

Cover Crop Termination Methods

Figure 9 provides an overview of methods used during cover crop termination among sampled farmers. A total 39 responses answered the question of cover crop termination method, 32 farmers opted for herbicide application to terminate their cover crop, and 12 reported supplementing herbicide with another method, including roll/crimp, tillage, and mowing, while 17 relied solely on herbicide; three farmers didn't disclose the method they used in addition to herbicide. Seven farmers adhered to a singular cover crop termination method other than herbicide, including tillage, mowing, and roll/crimp.

Among the 32 farmers that used herbicide to terminate their cover crop, 30 farmers disclosed the associated herbicide costs, reporting an average expenditure of $29.75 per hectare ($12.04 per acre). Notably, none of the surveyed producers hired custom work for cover crop termination via herbicide. The breakdown of equipment used for herbicide application during cover crop termination includes 17 farmers employing a self-propelled sprayer, while nine farmers utilized a two-wheel-drive boom-type sprayer.

A significant portion of surveyed farmers expressed that the termination of their cover crop imposed minimal additional labor or costs. Only four farmers reported the need for extra, unpaid labor hours for herbicide-based termination, averaging 13.74 hours per hectare (5.56 hours per acre). Additionally, only five farmers indicated incurring supplementary expenses associated with herbicide termination, with an average cost of $98.84 per hectare ($40.00 per acre). These findings align with expectations, considering that many farmers already integrate herbicide application into their routine spring field preparation practices. For these practitioners, applying herbicide to the cover crop likely entails comparable costs, both in terms of expenditure and managerial hours, to applying herbicide in fields without cover crops. Notably, farmers not habitually using herbicide in their spring field preparation sometimes experience less favorable returns on investment, as they face additional costs for herbicide purchase in cover crop termination.

Among the participants utilizing tillage in the termination process of their cover crop, six out of seven respondents provided detailed insights into their tillage practices. Notably, only one farmer opted for custom tillage work, incurring a cost of $61.78 per hectare ($25 per acre). For those who undertook the termination themselves, three employed a two-wheel-drive tractor with horsepower ranging from 30-179, while two used a four-wheel-drive tractor with horsepower ranging from 200-339. Each farmer utilized different tillage implements, including a spring tooth harrow, row crop cultivator, disk plow, vertical tillage tool, and a roller harrow. Only one f armer reported increased expenses and unpaid labor hours for tillage-based termination. This respondent detailed 9.88 unpaid labor hours per hectare (four unpaid labor hours per acre) and $197.68 per hectare ($80 per acre) in extra expenses. Moreover, two out of five farmers exclusively tilled fields to terminate cover crops, and an equal number reported cover cropping on all their row crop acreage. The findings suggest that farmers accustomed to tilling their fields, regardless of the presence of a cover crop, generally do not incur additional expenses for cover crop termination through tillage.

Three out of six farmers who opted for mowing as their chosen termination method for cover crops provided detailed insights into their termination practices, with none of them using custom mowing services. Notably, one farmer reported employing a two-wheel-drive tractor with a horsepower range of 120-149, and each farmer utilized different mowing implements, including a rotary mower, flail mower, and a mower conditioner. Among these farmers, two reported incurring additional expenses and unpaid labor hours for cover crop termination by mowing. The average additional unpaid labor hours required were 12.68 hours per hectare[1] (5.13 hours per acre), and one farmer reported spending an extra $37.07 per hectare ($15 per acre) for mowing as a termination method. Each of the three farmers exclusively mowed acreage under a cover crop, with only one planting cover crops across all of their acreage. Given that mowing is not a conventional method for spring field preparation, the findings suggest that additional expenses may be incurred, particularly when mowing is used exclusively on acreage with a cover crop present.

A subset of five farmers provided detailed insights into their utilization of rolling/crimping as a termination method for cover crops. Three of them adopted a single-pass approach, terminating their cover crop by combining herbicide application with rolling/crimping in the same pass. The remaining two farmers opted for a two-pass strategy, applying herbicide in one pass and subsequently employing rolling/crimping. Farmers personally executed the rolling/crimping process, with none of them seeking custom rolling/crimping services for cover crop termination. The equipment

used varied, as two farmers utilized a two-wheel-drive tractor with a horsepower range of 120-179, while the other three farmers employed a four-wheel-drive tractor with horsepower ranging from 200-339. The choice of rolling/crimping implements also differed, with two farmers using a smooth drum roller, and the remaining three employing a dedicated roller/crimper. Only one farmer reported incurring additional expenses or unpaid labor hours from terminating the cover crop by rolling/crimping. Four out of the five farmers emphasized that they exclusively employed rolling/crimping on areas with cover crops, and three of these farmers covered all their acreage with a cover crop.

Cash Crop Tillage Practices Following Cover Crop

To ascertain the impact of cover crops on tillage practices for succeeding cash crops, our survey asked the tillage methods adopted by farmers following cover crop cycles. The responses revealed a range of practices. Six farmers indicated their use of reduced tillage practices following both cover crops and fallow. Additionally, one farmer employed rotational no-till practices consistently, whether a cover crop was present or not.

The next inquiry focused on the number of tillage passes employed to prepare fields for planting the subsequent cash crop. Among the eight farmers who provided insights into tillage passes, Figure 10 showcases that 50% of them opted for a single tillage pass to ready the field for the next cash crop. It is worth noting that conventional tillage systems in the Southeastern U.S. typically involve an average of two to three tillage passes. The adoption of cover crops presents the potential to reduce the number of tillage passes to just one, a reduction that not only signifies a significant decrease in soil disturbance but also highlights the potential for improved soil health and conservation practices associated with cover crop adoption. By minimizing tillage intensity, farmers can mitigate soil erosion, enhance water infiltration, and promote the retention of soil organic matter, ultimately leading to more sustainable and resilient agricultural systems.

To gain a deeper understanding, respondents were asked to specify the type of tillage implement used for each pass. For the first pass, two farmers reported using a strip-till rig, while the remaining three utilized a strip-till rig with an integrated roller for field preparation. Among the three farmers resorting to a second tillage pass, each employed a distinct implement, ranging from a strip-till rig to a strip-till rig with a roller to a chisel plow. The farmer conducting a third tillage pass opted for a strip-till rig equipped with a roller.

SUMMARY AND CONCLUSIONS

Our research sheds light on the multiplicity of agronomic and management practices that farmers implement when using cover crops, particularly in the Southeastern U.S. The majority of respondents, encompassing a diverse range of farm sizes, reported incorporating cover crops for a duration of 0-5 years. The predominant use of cereal rye, with its notable environmental benefits, emerges as a preferred choice among farmers.

Cover crop termination methods primarily involve herbicide with other termination methods like rolling/crimping, mowing, or tillage. The majority of farmers do not incur additional labor or costs during cover crop termination, highlighting the relative synergies between termination practices and existing field preparation routines. Insights into post-cover crop tillage practices indicate a significant joint adoption of cover crops with reduced tillage, showcasing the potential of cover crops to influence system-wide farm management decisions. The majority of respondents among farmers who adopted cover crops opted for one or two tillage passes, often employing strip-till rigs or other implements aligned with conservation tillage principles. Compared to conventional tillage systems in the Southeastern U.S., which typically involve an average of two to three tillage passes, the adoption of cover crops has the potential to reduce tillage passes.

The results of this study contribute valuable insights into the myriad practices that farmers in the Southeastern U.S. need to consider when implementing cover crops. Future research on the economic costs and benefits of cover crop adoption is needed to help producers evaluate their options in incorporating cover crops into their farm management practices. In turn, these results should raise awareness among policymakers and conservation groups about the private costs faced by farmers implementing cover crops and the need for continued technical and financial support. It would also assist policymakers in designing incentive programs to encourage adoption. Policies encouraging cover crop adoption could include financial incentives such as cost-sharing programs, subsidies, or tax credits to offset initial costs. Education and outreach initiatives, including technical assistance and demonstration projects, could help producers understand the long-term benefits. Additionally, integrating cover crop requirements or

incentives into conservation programs, crop insurance discounts, or carbon credit markets could further promote adoption.

FOOTNOTES

1 Two respondents provided responses to this question, with one respondent indicating an increase of 24.71 additional unpaid labor hours per hectare (10 additional unpaid labor hours per acre) and the other 0.62 additional unpaid labor hours per hectare (0.25 additional hours per acre). The respondent who reported 10 additional unpaid labor hours employs a mixed cover crop system consisting of various varieties, including annual ryegrass, Austrian winter peas, cereal rye, crimson clover, hairy vetch, mustards, oats, radish, rapeseed, turnips, and triticale.

REFERENCES

Allen, V.G., C.P. Brown, R. Kellison, E. Segarra, T. Wheeler, P.A. Dotray, J.C. Conkwright, C.J. Green, and V. Acosta-Martinez. 2005. "Integrating Cotton and Beef Production to Reduce Water Withdrawal from the Ogallala Aquifer in the Southern High Plains." *Agronomy Journal* 97(2): 556–567.

Bayer, C., J. Mielniczuk, T.J.C. Amado, L. Martin-Nero, and S.V. Fernandes. 2000. "Organic Matter Storage in a Sandy Clay Loam Acrisol Affected by Tillage and Cropping Systems in South Brazil." *Soil and Tillage Research* 54(1-2): 101–109.

Bowers, C., M. Toews, Y. Liu, and J.M. Schmidt. 2020. "Cover Crops Improve Early Season Natural Enemy Recruitment and Pest Management in Cotton Production." *Biological Control* 141: 104–149.

Chatterjee, A. 2013. "North-Central US: Introducing Cover Crops in the Rotation." *Crops and Soils* 46(1): 14–15.

Dillman, D.A., J.D. Smyth, and L.M. Christian. 2014. *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. John Wiley & Sons.

Fan, Y., Y. Liu, P.B. DeLaune, P. Mubvumba, S.C. Park, and S. Bevers. 2020a. "Net Return and Risk Analysis of Winter Cover Crops in Dryland Cotton Systems." *Agronomy Journal*. 112(2): 1148–1159. https://doi.org/10.1002/agj2.20091.

Fan, Y., Y. Liu, P.B. DeLaune, P. Mubvumba, S.C. Park, and S.J. Bevers. 2020b. "Economic Analysis of Adopting No-Till and Cover Crops in Irrigated Cotton Production under Risk." *Agronomy Journal* 1(11): 395–405. https://doi.org/10.1002/agj2.20005.

Fisk, J.W., O.B. Hesterman, A. Shrestha, J.J. Kells, R.R. Harwood, J.M. Squire, and C.C. Sheaffer. 2001. "Weed Suppression by Annual Legume Cover Crops in No-Tillage Corn." *Agronomy Journal* 93(2): 319–325.

Hancock, G.A., Y. Liu, A.R. Smith, and A. Plastina. 2020. "Motivations and Challenges of Cover Crop Utilization for Georgia Crop Production." *Journal of American Society of Farm Managers and Rural Appraisers*: 122–128.

Kaspar, T.C., J.K. Radke, and J.M. Laflen. 2001. "Small Grain Cover Crops and Wheel Traffic Effects on Infiltration, Runoff, and Erosion." *Journal of Soil and Water Conservation* 56(2): 160–164.

Kaspar, T.C., and J.W. Singer. 2011. "The Use of Cover Crops to Manage Soil." *Soil Management: Building a Stable Base for Agriculture*: 321–337.

Nassauer, J.I., J.A. Dowdell, Z. Wang, D. McKahn, B. Chilcott, C.L. Kling, and S. Secchi. 2011. "Iowa Farmers' Responses to Transformative Scenarios for Corn Belt Agriculture." *Journal of Soil and Water Conservation* 66(1): 18A–24A.

Plastina, A., J. Acharya, F.M. Marcos, M.R. Parvej, M.A. Licht, and A.E. Robertson. 2023. "Does Grazing Winter Cereal Rye in Iowa, USA, Make It Profitable?" *Renewable Agriculture and Food Systems* 38: e45. https://doi.org/doi:10.1017/S1742170523000388.

Plastina, A., F. Liu, W. Sawadgo, F. Miguez, and S. Carlson. 2018b. "Partial Budgets for Cover Crops in Midwest Row Crop Farming." *Journal of the American Society of Farm Managers and Rural Appraisers*: 90–106.

Plastina, A., F. Liu, W. Sawadgo, F.E. Miguez, S. Carlson, and G. Marcillo. 2018c. "Annual Net Returns to Cover Crops in Iowa." *Journal of Applied Farm Economics* 2(2): Article 2. DOI: 10.7771/2331-9151.1030. Available at: https://docs.lib.purdue.edu/jafe/vol2/iss2/2.

Plastina, A., F. Liu, F. Miguez, and S. Carlson. 2018a. "Cover Crops Use in Midwestern US Agriculture: Perceived Benefits and Net Returns." *Renewable Agriculture and Food Systems* 35(1): 38–48. https://doi.org/10.1017/S1742170518000194.

Reicosky, D.C., and F. Forcella. 1998. "Cover Crop and Soil Quality Interactions in Agroecosystems." *Journal of Soil and Water Conservation* 53(3): 224–229.

Ruffo, M.L., D.G. Bullock, and G.A. Bollero. 2004. "Soybean Yield as Affected by Biomass and Nitrogen Uptake of Cereal Rye in Winter Cover Crop Rotations." *Agronomy Journal* 96(3): 800–805.

Sarrantonio, M., and E. Gallandt. 2003. "The Role of Cover Crops in North American Cropping Systems." *Journal of Crop Production* 8(1-2): 53–74.

Sawadgo, W., and A. Plastina. 2022. "The Invisible Elephant: Disadoption of Conservation Practices in the United States." *Choices* 37(1): 1–13.

Scavo, A., Fontanazza, S., Restuccia, A., Pesce, G. R., Abbate, C., & Mauromicale, G. (2022). "The role of cover crops in improving soil fertility and plant nutritional status in temperate climates. A review." *Agronomy for Sustainable Development* 42(5): 93.

Snapp, S.S., S.W. Swinton, R. Labarta, D. Mutch, J.R. Black, R. Leep, J. Nyiraneza, and K. O'Neil. 2005. "Evaluating Cover Crops for Benefits, Costs and Performance within Cropping System Niches." *Agronomy Journal* 97(1): 322–332.

U.S. Department of Agriculture. 2017. *2017 Census of Agriculture*. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Census_by_State/index.php.

Varco, J.J., S.R. Spurlock, and O.R. Sanabria-Garro. 1999. "Profitability and Nitrogen Rate Optimization Associated with Winter Cover Management in No-Tillage Cotton." *Journal of Production Agriculture* 12(1): 91–95.

Wade, T., R. Claassen, and S. Wallander. 2015. *Conservation-Practice Adoption Rates Vary Widely by Crop and Region*. USDA, Economic Research Service. https://www.ers.usda.gov/webdocs/publications/44027/56332_eib147.pdf?v=42403.

Wallander, S., D. Smith, M. Bowman, and R. Claassen. 2021. Cover Crop Trends, Programs, and Practices in the United States. USDA, Economic Research Service. EIB 222. February 2021.

Zulauf, C., and B. Brown. 2019. "Cover Crops, 2017 US Census of Agriculture." *farmdoc daily* 9(135). https://farmdocdaily.illinois.edu/2019/07/cover-crops-2017-us-census-of-agriculture.html

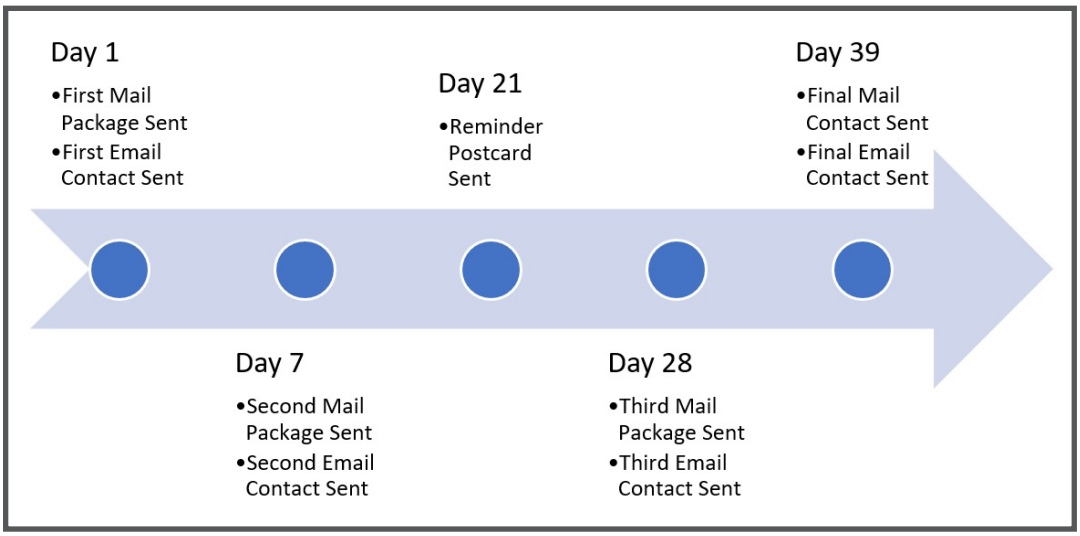

Figure 1. Survey timeline for paper and online surveys in cover crop research

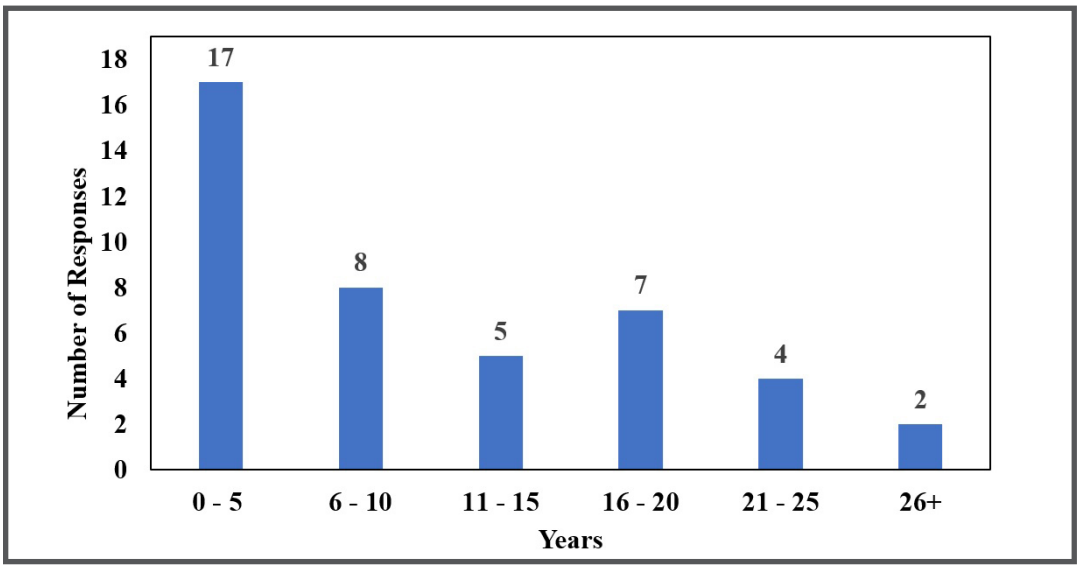

Figure 2. Duration of cover crop adoption across farm

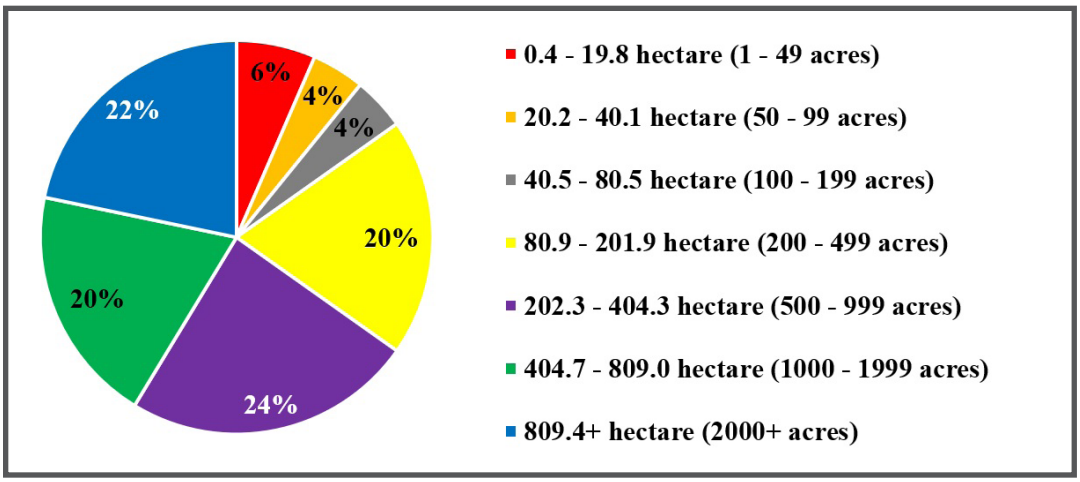

Figure 3. Percentage distribution of responses across farm size ranges

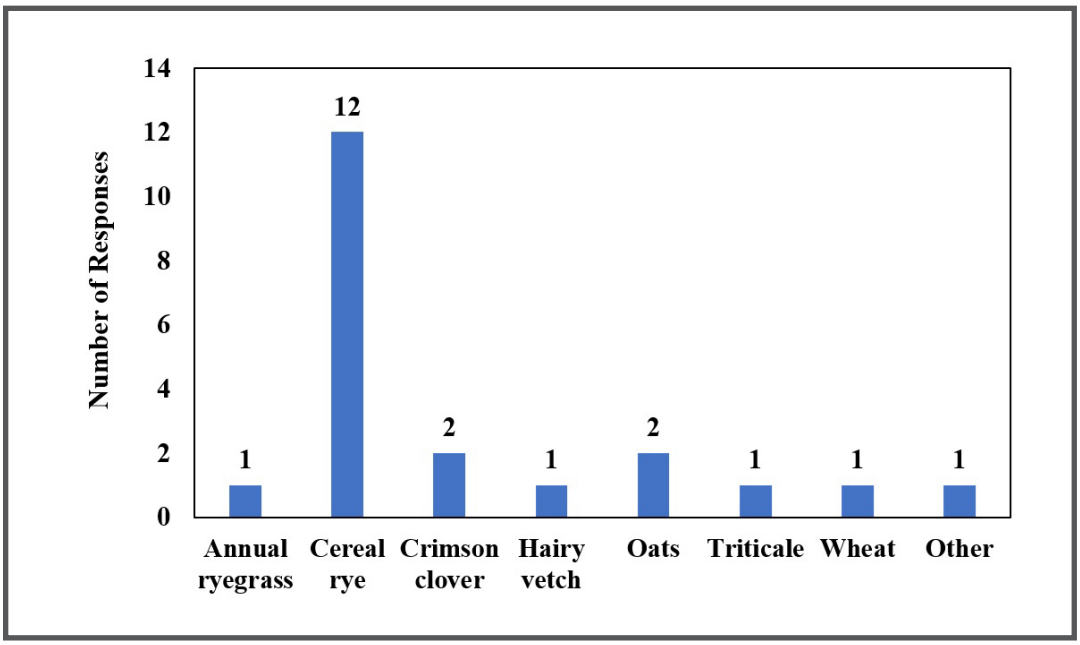

Figure 4. Species planted as cover crop monoculture

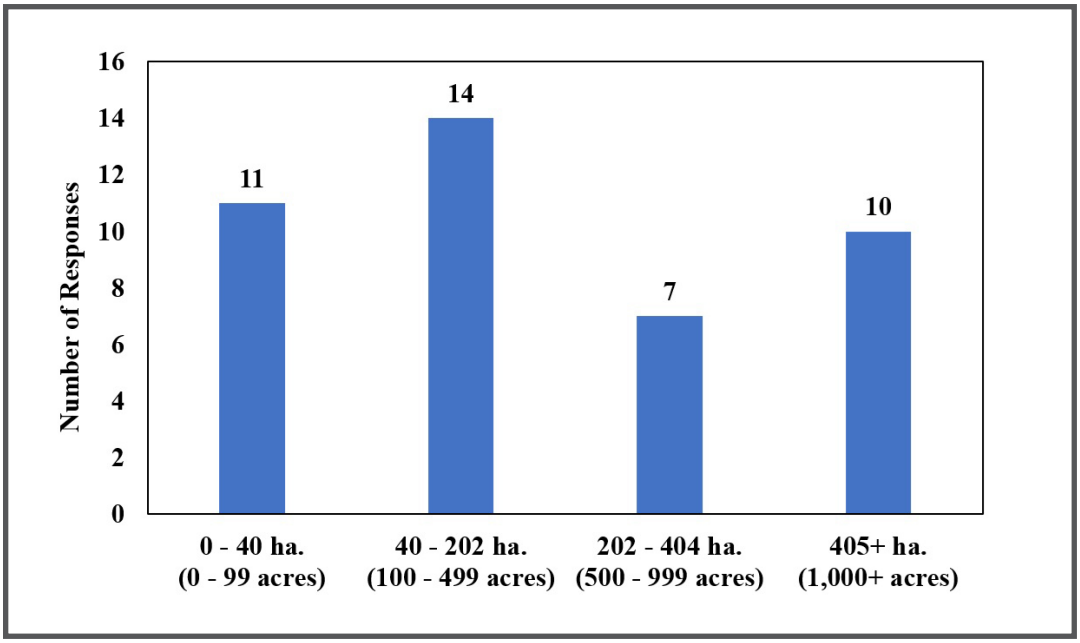

Figure 5. Acres dedicated to cover crop in the most recent year on the farm

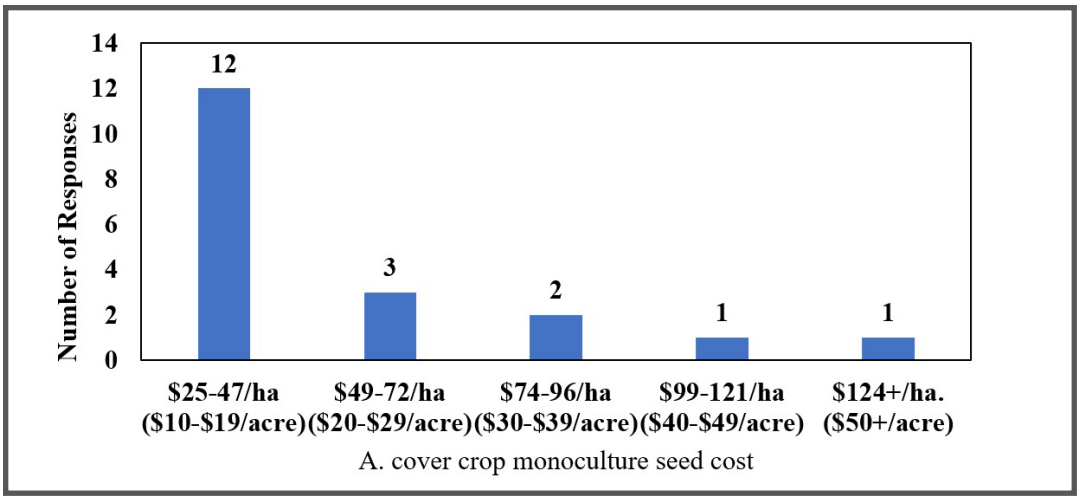

Figure 6. Seed cost per acre for cover crop

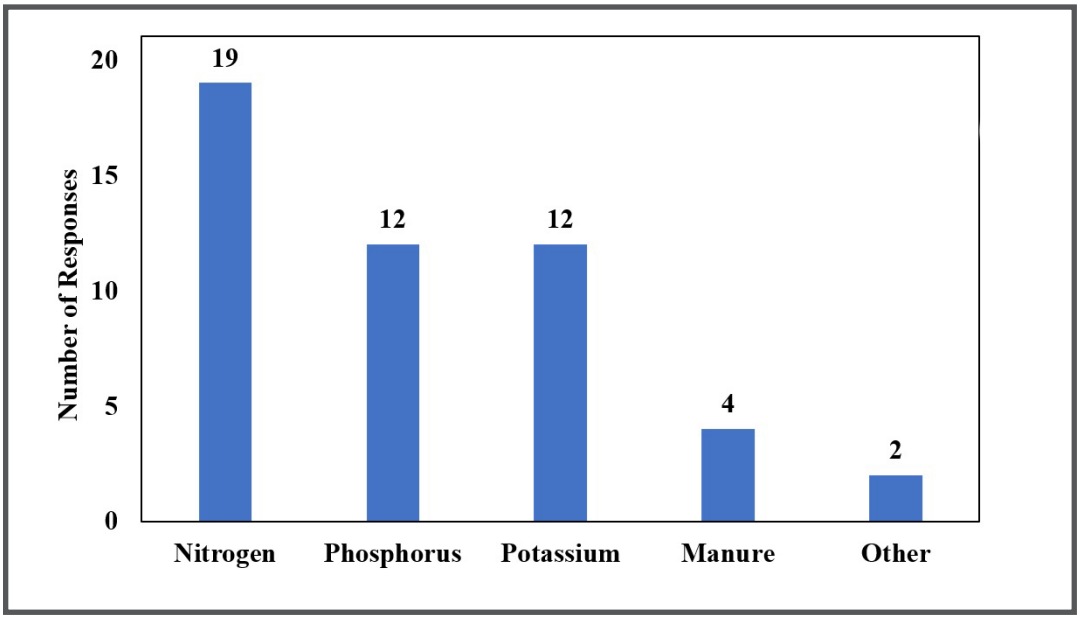

Figure 7. Type of fertilizer applied to cover crop

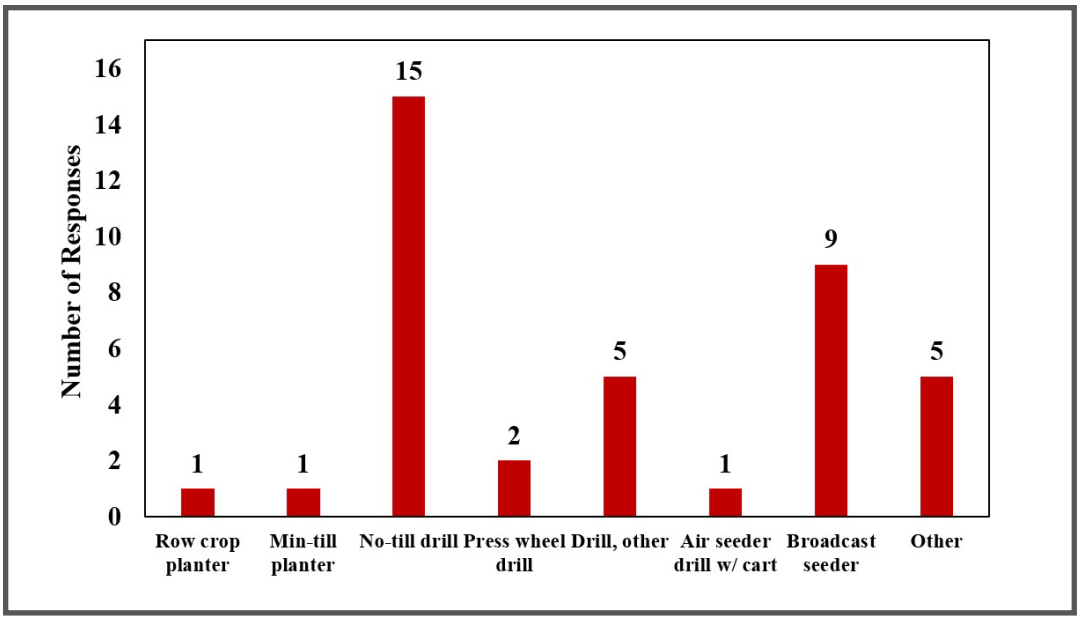

Figure 8. Type of planting machinery used to plant cover crop

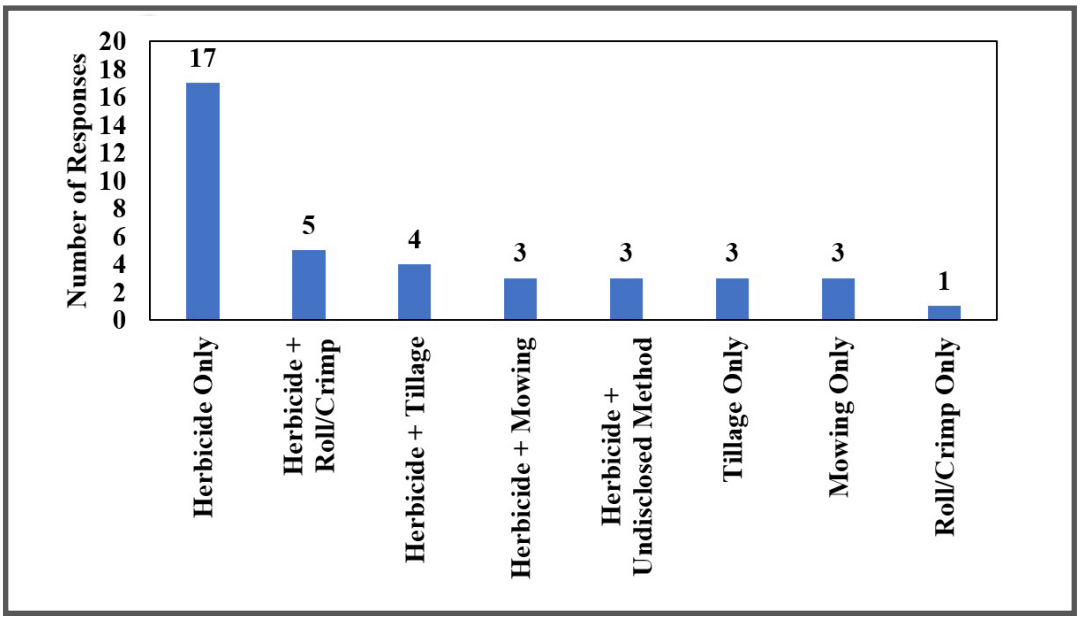

Figure 9. Diverse termination methods employed by survey respondents for cover crop termination

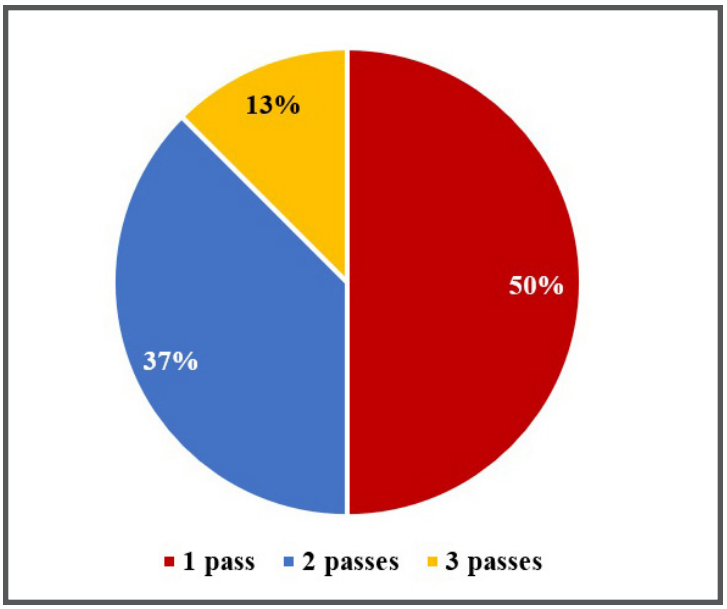

Figure 10. Number of tillage passes employed in field preparation for cash crop following cover crop

Table 1. Diversity in Cover Crop Mixes Utilized by Southeastern Row Crop Producers

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.	Cosaque 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