"You Can't Beat a Cover Crop:" Assessing the Sustainability Outcomes of a Cover Crop Incentive Program in Alabama

by

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ABSTRACT

Conservation agriculture approaches and technologies (e.g., cover crops, variable-rate irrigation) can increase resource use efficiencies and help make intensified agricultural systems more sustainable. Entities across sectors are investing significant funding toward increasing adoption of these methods, and the "Future of Farming" (FF) project is an example of one such initiative. The FF project involves farmers, researchers, and other agricultural professionals in research on conservation agriculture, and it includes a cover crop incentive program (FF-CCIP) which was used as a case study for this project. Literature used to inform this study covered sustainability, technology adoption, cover crops, incentive programs, sustainable intensification, and the agricultural treadmill. Data came from interviews with farmers (n=23) enrolled in the FF-CCIP. Analyses identified trends in farmers' motivations for enrolling; perceptions of incentive programs, cover crops, and production meetings; learning within their social networks; and values and objectives regarding stewardship. These trends were then compared with institutional objectives to understand areas of improvement for future incentive programs. Trends were also compared with research on sustainable intensification (SI), an agricultural approach typically used in international and Global South contexts. Findings suggest that expanded outreach efforts could lead to more effective incentive programs. Findings also suggest that more research on conservation agriculture technologies is needed to assess the potential negative financial outcomes on farmers who adopt these tools and practices. Further, findings demonstrate alignment between conventional agriculture in the US and SI production: economic outcomes tend to be prioritized over environmental and social outcomes in both systems, and the continuous need for technology

generated by ever-increasing demands for market efficiencies contributes to this unbalanced prioritization of outcomes.

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The farmer quoted in the title of this thesis passed away a few months after I interviewed him. This thesis is dedicated to him. Thank you for your honesty and kindness in our brief but meaningful interaction. There is an unfathomable wealth of knowledge and experience behind your statement, “you can’t beat a cover crop,” and I feel blessed to have received even a short conversation’s worth. Thank you for your lifelong commitment to farming, as a vocation and a livelihood.

I would like to thank my family, especially my parents, for your unwavering support and belief in my work over the past two years. I am tremendously indebted to you. Thank you, also, to all my friends whose support and ongoing friendship inspires and motivates me more than you know. There are so many of you. Thank you to Dr. Michelle Worosz, as well, for being the best advisor I could have ever asked for. You were invested in my success the moment I began this program. Your guidance has challenged me often but has always steered me in the right direction—and has ultimately made me into the scholar I am today. Thank you to my committee members, Drs. Ryan Thomson and Audrey Gamble, for your ongoing willingness to help, exchange ideas, and challenge me when needed. Thank you, Garrett, for so many fiery conversations and for always reigniting my belief in the importance of my work. Thank you, also, to the NRT program, through which I’ve grown considerably as a scientist, and through which, most importantly, I’ve made lifelong friends. Thank you especially to Katie Brown, who held it all together. I attribute much of my success in that program to you. Thank you, also, to everyone involved in the Future of Farming project.

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LIST OF ABBREVIATIONS

ACES: Alabama Cooperative Extension System

AERT: Application Evaluation Ranking Tool

ASWCC: Alabama Soil & Water Conservation Committee

CCC: Commodity Credit Corporation

CCCP: Cover Crop Champions Program

CIG: Conservation Innovation Grant

CPA: Conservation Program Application

EQIP: Environmental Quality Incentives Program

FF: Future of Farming: Increasing Adoption of Conservation Practices Among Alabama Row Crop Farmers

FF-CCIP: Future of Farming Cover Crop Incentive Program

NRCS: Natural Resources Conservation Service

PI: Principal Investigator

SARE: Sustainable Agriculture Research & Education

SI: Sustainable Intensification

TAPS: Testing Agricultural Performance Solutions

USDA: United States Department of Agriculture

CHAPTER 1: INTRODUCTION

My time conducting this research and pursuing my Master of Science was supported by a fellowship through the National Science Foundation Research Traineeship in Climate Resilience (NRT) program at Auburn University (NSF Grant #1922687). Through the NRT program, my cohort and I engaged in the study and practice of climate resilience: through coursework, professional development workshops, research, and community outreach. Through the NRT program, we were trained to understand the ways in which climate resilience work transcends traditional disciplinary boundaries, and we were taught innovative, yet practical, approaches to engaging the public in this work. Any opinions, findings, and conclusions or recommendations expressed in this thesis are those of myself and do not necessarily reflect the views of the NSF. This research was further funded by a US Department of Agriculture - Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG) (#NR203A750013G016).

1.1 THE FUTURE OF FARMING PROJECT AND THE COVER CROP INCENTIVE PROGRAM

The following two chapters of this thesis consist of two separate studies, both of which were conducted using the same case study and primary dataset. The case study used was a cover crop incentive program that was a part of larger research project, titled, “The Future of Farming: Increasing Adoption of Conservation Practices Among Alabama Row Crop Farmers” (FF). The FF project (2020–2026) is funded by a US Department of Agriculture - Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG), whose primary goal is “to stimulate the adoption and evaluation of innovative conservation approaches in partnership with agricultural producers” (NRCS and CCC 2019). The FF project includes a wide range of

stakeholders (i.e., farmers, researchers, agriculture industry professionals, Extension professionals, government professionals) in the generation of research on conservation agriculture and in the development of a learning community centered around conservation agriculture. The primary goal of the learning community is to increase the spread of knowledge associated with conservation agriculture. The specific conservation practices and strategies researched related to cover crops, variable rate irrigation, and nutrient budgeting. The FF project was comprised of three primary components: (1) demonstration plots on cooperating farmers' fields in north, south, and central Alabama, (2) stakeholder-engaged field days and events, and (3) a cover crop incentive program (FF-CCIP).

As a part of the FF-CCIP application process farmers were required to list the main cover crop benefits they hoped to receive by enrolling in the program. Enrolled farmers were then given cover crop management plans tailored to achieve their desired benefits. For adopting these management plans, farmers received payments of $50 per acre (for between 25–100 acres) for up to four years. Enrolled farmers were required to have in their crop rotations corn, cotton, soybeans, and/or peanuts. As a part of the FF-CCIP, farmers were also required to acknowledge (1) their "willing[ness] to share [their] experience with the Future of Farming Team and other participating producers" and (2) their "willing[ness] to attend Cover Crop Workshops organized by the Future of Farming Team" (Appendices D and J). These expectations were included to increase farmer involvement in the FF project learning community and, ultimately, to increase the spread of agricultural knowledge.

1.2 RESEARCH QUESTIONS

The research questions used to direct both studies described in this thesis are as follows:

How do sustainability-focused incentive programs influence farmers' adoption of cover crops?

a. *What are farmers' motivations to apply for Cover Crop Incentive Program payments?*
b. *What are farmers' perceptions of the network of farmer-managed learning sites ("learning network") developed by the Future of Farming project?*
c. *What are farmers' perceptions of participating in the co-development of knowledge about cover crops with the Future of Farming learning network?*
d. *Does enrollment in the Cover Crop Incentive Program lead to long-term usage of cover crops?*

1.3 FF-CCIP FARMER INTERVIEWS

Although there were other secondary data sources used, the primary data sources for both chapters were interviews (n=23) conducted with FF-CCIP participants. In these interviews, farmers were asked questions regarding their experiences with, and perceptions of, incentive programs, cover crops, and production meetings; knowledge exchange and learning within their social networks; and their personal values and objectives regarding stewardship on their farms (Appendix B).

1.4 CHAPTER 2: ORGANIZATION AND SUMMARY

The particular research objectives of the first study, "Incentivizing Sustainability in Agriculture: Aligning Institutional Objectives with Farmers' Priorities" (Chapter 2) were: (1) to discern more fully the process by which sustainability outcomes are conceptualized and prioritized at the institutional level and consequently operationalized at the farm level; and (2) to identify areas in which sustainability-focused incentive programs can be brought into better alignment with the sustainability priorities and needs of farmers and, thus, can function more effectively overall. This study begins by reviewing several areas of literature: namely, sustainability, the agricultural treadmill, and cover crop adoption. It then describes the primary and secondary data sources used in the study and the methods of analysis. The primary data sources used were the FF-CCIP

interviews, and the secondary data sources consisted of FF project event attendance sheets (Appendix J), CIG program documents, FF project documents, FF-CCIP administrative documents, and FF-CCIP participant application and verification documents. The documentary data (Appendix M) were used to identify the process by which sustainability priorities were conceptualized at the institutional level (i.e., NRCS) and operationalized at the farm level. This process was framed according to a grounded theory, which was itself developed from the review of the literature and analysis of the data. The framework is visualized in Figure 2.1 and further described at the beginning of "Results and Discussion" (Section 2.6).

Findings are then described according to this grounded theory process, and they indicate that the institutional priorities put forth in the CIG program are generally aligned with the priorities mentioned by FF-CCIP farmers in their interviews. Other findings are then described according to each research question. They further demonstrate that the FF-CCIP is in general alignment with the priorities of FF-CCIP farmers: in terms of their understandings of the benefits of cover crops, their motivations to enroll in the FF-CCIP, their perceptions of and willingness to engage in social learning and knowledge-sharing, and their perceptions of technology adoption. Overall, the findings suggest that the design of the FF-CCIP is well-suited to increase adoption of conservation agriculture technologies and practices and to increase the spread of agricultural knowledge. However, the FF-CCIP struggled to fully accomplish each of its program objectives, which was primarily related to its administrative structure and processes. Further, findings suggest that although technologies are valued by farmers and institutional actors alike, programs like the CIG should be wary of promoting technologies as positive in every case. Technologies can increase farmers' production efficiencies, but they can also perpetuate a need to continually increase efficiencies to make up for losses created by decreasing crop prices (Thompson 1998:108).

1.5 CHAPTER 3: ORGANIZATION AND SUMMARY

The second study, described in Chapter 3, compares the experiences of conventional farmers in the US—using the FF-CCIP as a case study—and the concept of sustainable intensification (SI), which is not typically associated with US agriculture. Literature on sustainability, SI, and the agricultural treadmill were used to develop the conceptual basis for this study and are reviewed first. SI is a concept used to characterize agricultural systems which seek to prioritize both economic and environmental outcomes: maximizing production on existing agricultural lands, thus meeting global food demand, without putting additional land into production (Pretty and Bharucha 2014; Garnett et al. 2013). It is a controversial concept, however, as many scholars have questioned its philosophical basis, practical applications, and the outcomes of its associated approaches (Loos et al. 2014; Mahon et al. 2017; Hunter et al. 2017). Similarly, FF-CCIP farmers were found to pursue both economic (e.g., yield, profitability) and environmental objectives (e.g., soil health, reduced erosion) through their participation in the FF-CCIP, which establishes a link between their experiences and SI. Data collection and analysis are then described: FF-CCIP farmer interviews were the data sources used, and they were analyzed using thematic analysis methods. Findings are described next, and they suggest that there is alignment between large-scale SI systems and conventional agricultural systems in four main respects: (1) the tendency for these systems to deprioritize social outcomes; (2) the tendency for these systems to prioritize economic outcomes over environmental outcomes; (3) the tendency of low commodity prices and high input prices to direct the behavior of these systems toward similar outcomes; and (4) the tendency for these systems to prioritize ever-increasing adoption of technologies. These tendencies are well-explained by the agricultural treadmill (Carolan 2022:8; Cochrane 1958; Hendrickson and James 2005).

Lastly, several conclusions and recommendations are provided. It is recommended that institutional actors use this study to better understand the consequences of sustainability programs that focus on scaling up or intensifying production (Hendrickson 2015), and they should increase efforts to help farmers escape the agricultural treadmill. This should involve increased investment in conservation agriculture initiatives and a redirection of current commodity production toward the lower-input production of higher-value crops. This study should also bolster dialogues between researchers and policymakers by demonstrating that many of the specified priorities of SI are typical of conventional production, as well.

CHAPTER 2: INCENTIVIZING SUSTAINABILITY IN AGRICULTURE: ALIGNING INSTITUTIONAL OBJECTIVES WITH FARMERS' PRIORITIES[1]

2.1 KEYWORDS

Sustainability; conservation agriculture; incentive programs; cover crops; technology adoption; farmer networks; agricultural treadmill; social learning

2.2 ABSTRACT

Agricultural sustainability tends to be operationalized in terms of specific practices, approaches and outcomes. It has proven difficult, however, for funding agencies (e.g., US Department of Agriculture [USDA]) to fully account for the priorities of stakeholders, namely farmers. As a case study, we use a cover crop incentive program (FF-CCIP) that is part of a larger USDA Natural Resources Conservation Service (NRCS)-funded project titled, the "Future of Farming" (FF). In this study we ask, how do the priorities of sustainability-focused incentive programs differ from those of their enrollees? A content analysis of NRCS, FF project, and FF-CCIP documentation was conducted to identify institutional and project priorities. FF-CCIP farmers' priorities were identified via interviews (n=23), which were audio recorded and transcribed for analysis. These data were situated within current institutional (e.g., NRCS) conceptualizations of, and existing literature on, sustainable agriculture, conservation technology, and cover crops. The NRCS and the FF-CCIP were found to be in general alignment with farmers' environmental priorities and perceptions of technology. Further, incentive payments were effective for increasing program enrollment, and many farmers valued the opportunities to experiment that were provided by the incentive payments. However, the FF-CCIP did not meet many of the NRCS's social objectives such as leveraging farmers' social networks to increase adoption.

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Additionally, the incentive payments supported current adopters' cover crop usage but did not increase the number of adopters. Institutional support, as well as a dedicated project coordinator devoted to overseeing the program, would likely have helped meet these objectives. Additionally, funding agencies must be sensitive to the potential downsides of promoting technologies without adequate infrastructure or technical support; these can require farmers to make ongoing capital investments to meet production goals.

2.3 INTRODUCTION

Sustainability is characteristic of agricultural systems designed and maintained to exist in perpetuity: the resources necessary to uphold those systems—environmental, economic, and social (Purvis, Mao, and Robinson 2019)—must be spent and renewed in a continuous cycle. Achieving sustainability requires all three components in equal measure, accounting for synergistic outcomes as well (Hansmann, Mieg, and Frischknecht 2012). Neglect of environmental, economic, or social factors, or clear prioritization of any one factor over another, compromises necessary outcomes. Thus, sustainable agricultural systems and practices must prioritize environmental outcomes (e.g., soil health, nutrient conservation, moisture retention, carbon sequestration), economic outcomes (e.g., profitability, productivity, efficiency), and social outcomes (e.g., food security, livelihood security, community wellbeing) equally (Ikerd 1993). It is doubtful, however, that equilibrium among environmental, economic, and social components can be achieved through maximizing the outcomes of each or even one of these components; to reach sustainability, the pursuit of some outcomes must be *deprioritized.* Environmental philosophers and ethicists have long grappled with questions of how to manage land for food production, while also maintaining the health of the land—for its continued use by humans, but also for the permanence of its broader regenerative capacity. The capacity of the soil to continually regenerate itself is foundational to the existence of

all land-based lifeforms and, thus, to the sustainability of the environment and society. This study examines sustainability as a conceptual and operational ideal within a particular sustainability-focused initiative: an incentive program which seeks to increase adoption of cover crops among conventional row crop farmers.

Aldo Leopold emphasized the "ethical obligation on the part of the private [land] owner" (1949:214), while other scholars have more broadly examined the systems-level phenomena that contextualize, and frequently determine, the behavior of the private landowner, particularly concerning agriculture. Thompson (1986:34) stated, "[t]he conceptual framework of obligations owed by one individual to another fails to capture the moral importance of holistic outcomes." Thompson (1992) elevated Leopold's land ethic and conceptualized a broader agricultural ethic, which is concerned with both systems-level (e.g., institutional) and ground-level (e.g., farmers') decision making. Indeed, a useful conceptualization of agricultural sustainability must be scalable and adaptable in scope and focus, capable of accounting for both levels (Darnhofer et al. 2010). A useful conceptualization of agricultural sustainability must also account for market processes, which are tremendously powerful determinants of decision-making in conventional, commodity agricultural production (Hendrickson and James 2005). Farmers respond to these market processes out of economic self-interest, identifying opportunities to maximize profit. However, they also respond out of economic self-need, being forced to prioritize economic outcomes (i.e., profitability, productivity, efficiency) to remain financially viable.

The Agricultural Treadmill. The process by which these self-interests become self-needs—and by which agriculture tends toward the industrial processes of specialization, standardization, and consolidation (Ikerd 2005:17; Hendrickson 2015)—is known as the agricultural treadmill. Farmers find themselves on the treadmill when making continuous capital

investments (e.g., agrichemicals, equipment), not because they gain a comparative advantage by doing so, but because they need to to produce a competitive yield. As their usage of inputs increases, their yields increase as well, which creates a market surplus. This surplus lowers crop prices, which in turn lowers the returns farmers can make at their typical rates of efficiency. To make a profit off these continually decreasing crop prices, then, farmers must continually increase in efficiency. Further, their increased reliance on inputs causes input prices to climb, and farmers who attempt not to rely on inputs are unable to generate the same yields. Thus, the treadmill requires farmers to make ever-increasing capital investments to survive financially (Carolan 2022:8; Cochrane 1958; Levins 2003; Hendrickson and James 2005; Thompson 1998:108).

The agricultural treadmill demonstrates how market incentives have a gravity-like pull on farmers' decision-making and how political-economic systems assign unequal weights to the environmental, economic, and social components of sustainability. It can be argued that profit-oriented market incentives fundamentally counteract sustainability processes, as markets are definitionally present-focused, and sustainability is definitionally future-focused (Ikerd 2005:64; Thompson 1992:17). Furthermore, market processes are definitionally competitive, while sustainability processes are definitionally cooperative—the environmental, economic, and social components must cooperate with one another to reach equilibrium (Ikerd 2005). Farmers, particularly commodity farmers, compete in a market that rewards profit-seeking behavior, not behavior which seeks to improve water quality, long-term soil health, or the wellbeing of rural communities (Hendrickson 2015). An equitable conceptualization of agricultural sustainability must account for this market imperative and correct for its powerful pull.

Sustainability must eventually move from the conceptual level to the operational level, as it becomes a matter of decisions and priorities. In agriculture, it has proven very difficult to develop

actionable approaches that target each of the three components of sustainability equally, without eventually being confronted with various tradeoffs. For example, to maximize gross yields, using the industrial model of specialization, standardization, and consolidation is ideal (Ikerd 2005). However, these processes can have destructive impacts: exploit and degrade soil (Foley et al. 2005), pollute waterways (Tang et al. 2021), and diminish local economic opportunity, resulting in the depopulation of rural areas (Johnson and Lichter 2019). On the other hand, to maximize environmental and social outcomes, smaller-scale, regenerative farming systems are ideal: they can improve soil health (Giller et al. 2021), increase biodiversity (Schulte et al. 2021), and facilitate local economic growth and autonomy (Ikerd 1993). Regenerative systems have also been found to lead to higher net profits than conventional systems in some cases (LaCanne and Lundgren 2018). Yet, others question whether these systems can realistically support the nutritional and caloric needs of the planet's increasing population (Connor and Mínguez 2012). These tradeoffs are major factors in agricultural decision-making at all levels and represent the sorts of operational frameworks sustainability-focused agriculture initiatives are situated within.

Factors in Cover Crop Adoption. Rogers' (2003) well-known adoption-diffusion framework is commonly applied to agricultural technologies, although cover crops' usage over time is often not as binary or linear as usages of other technologies tend to be. Farmers often use cover crops at varying spatial and temporal degrees and at varying levels of complexity (Han and Niles 2023). Different farmers tend to use cover crops for different reasons, so their usage is often circumstantial, which further contributes to this variability. Farmers' usage of cover crops is also subject to many farm- and market-level influences (Roesch-McNally et al. 2017; Han and Niles 2023). For example, a farmer may choose to plant cover crops before or after some cash crops, but not others. A farmer may also choose, in a given year, to plant a cover crop for its nitrogen fixing

ability, in response to unusually high fertilizer prices. Then the next year, if the prices have gone down, they may choose not to plant cover crops, considering the purchase of chemical fertilizer a more cost-effective choice.

The complex nature of cover crop adoption, however, speaks to the wide range of benefits it can offer. Different cover crop species can fix, scavenge, and mineralize nutrients in the soil, control erosion, retain soil moisture, suppress weeds, increase soil organic matter, disrupt pest cycles, reduce soil surface albedo, reduce soil compaction, provide grazing, and lower soil surface temperature (Adetunji et al. 2020; Kaye and Quemada 2017). Usage of cover crops has also been shown to contribute to increased cash crops yields (SARE et al. 2023:47–48), and many on-farm benefits double as broader climate services (e.g., carbon sequestration, reduction of erosion caused by extreme weather events) (Kaye and Quemada 2017). However, for all their benefits, continuous and ever-expanding usage of cover crops is not always feasible for farmers. In conventional systems, cover crops often require additional inputs of chemicals, equipment, and labor, especially in the short-term before input-reducing benefits may be realized. For example, termination of cover crops frequently necessitates additional expenses related to herbicide application (Bergtold et al. 2017). Further, many farmers have concerns related to certain cover crop management requirements and potential reductions in cash crop yields (Arbuckle and Roesch-McNally 2015; Roesch-McNally et al. 2017). Cover crop usage is increasing in the US (USDA-NASS 2024), but these factors may explain why they are still used on only a fraction of US agricultural land.

The many benefits of cover crops have led to interest within the public, private, and nonprofit sectors, and incentive programs have become a popular approach for supporting adoption (Rosenberg, Pratt, and Szmurlo 2024; Baylis et al. 2022). According to Piñiero et al. (2020:815), economic benefits are the “essential condition” for sustainability-focused incentive programs to

successfully increase adoption, which has led many entities to structure their programs around a payment-per-acre model. Incentive programs have demonstrated the potential to support an increase in cover crop adoption, as well as a continuation and sophistication of usage among current adopters (Bergtold et al. 2017; Myers, Weber, and Tellatin 2019; Cooper and Keim 1996). According to the 2022–2023 National Cover Crop Survey Report, 90% of incentive program participants surveyed demonstrated interest in continuing cover crops once their programs end, and some do, albeit to varying degrees (SARE et al. 2023:74; Chami et al. 2023). Identifying trends in continued usage after incentive programs end is under-researched but of potentially great importance to understanding the long-term outcomes of these programs (Rosenberg, Pratt, and Szmurlo 2024:4). Surdoval et al. (2024:8–9) identified four factors that could limit cover crop adoption and usage during and after incentive programs: a lack of emphasis on cover crops as a "soil health investment;" inflexible and burdensome enrollment processes; a narrow focus on large-scale commodity farmers; and short program duration, which do not align with the timescales needed to fully realize cover crops' on-farm benefits. Roesch-McNally et al. (2017:326) similarly emphasized the need for systems-level changes to overcome "structural barriers" associated with cover crop usage.

Incentive programs can support increased adoption and use of cover crops (Cooper and Keim 1996), but deeper investment in additional farmer outreach approaches is needed. Increased educational offerings have the potential to further adoption, as higher levels of formal education among farmers are most often positively correlated with increased adoption of conservation practices, including cover crops (Prokopy et al. 2008:307; Prokopy et al. 2019:530). Different types of educational offerings may be best suited for different purposes and for farmers at different stages of the adoption process. For example, farmers with existing experience using cover crops

may utilize educational resources (e.g., online videos) focused on the expansion and/or sophistication of their current cover crop usage, but not necessarily on basic management practices; in contrast, a farmer with limited experience using cover crops may require more basic and comprehensive resources. For non-adopters, relational, participatory educational programs have proven to be successful, especially programs which emphasize social learning opportunities and learning through on-farm demonstrations and trials (Bressler et al. 2021; Dunn et al. 2016; Pretty 1995). The Cover Crop Champions program (CCCP) examined in Bressler et al. (2021) is an example of an educational program that successfully integrates participatory, social, and demonstration-based learning methods. Equally important is leveraging farmers' social networks to ensure programs reach as many farmers as possible. Bressler et al. (2021) demonstrate that programs focused on increasing adoption, which are specifically seeking non-adopters, ought to target social networks to increase attendance. Non-adopters may be resistant to typical outreach methods (e.g., receiving information on cover crops through an Extension publication or from an Extension professional), and will likely be more receptive to the idea of adopting if a farmer they personally know is endorsing the practice (Rogers 2003).

The Cover Crop Incentive Program (FF-CCIP). This research project uses a cover crop incentive program in Alabama as a case study, which is part of a larger NRCS Conservation Innovation Grant (CIG)-funded project titled, "The Future of Farming: Increasing Adoption of Conservation Practices among Alabama Row Crop Farmers" (FF). The CIG program's primary goal is "to stimulate the adoption and evaluation of innovative conservation approaches in partnership with agricultural producers" (NRCS and CCC 2019). The FF project, which began in 2020 and will end in 2026, includes stakeholders from across the state (e.g., researchers, farmers, Extension agents, USDA-NRCS affiliates, other industry professionals). It is administered by four

principal investigators (PIs) from Auburn University and an external consultant. In addition, some of the research and administrative tasks are delegated to graduate students, postdoctoral researchers, and project technicians. See Appendix K for more information on the FF project.

The FF project has three main components: (1) demonstration plots on cooperating farmers' fields (n=3) in north, south, and central Alabama, in which various climate-smart technologies are tested; (2) stakeholder-engaged field days and other program events, which contribute to the FF project learning network; and (3) the cover crop incentive program (FF-CCIP). The goal of the FF-CCIP is to increase adoption of cover crops (Appendix C), and participants were recruited to the program largely by local NRCS District Conservationists. District Conservationists play a significant role in the administration of the FF-CCIP overall (Appendix L).

Cover crop mixes and management plans were developed by the FF project team according to participants' stated interests (e.g., moisture retention, weed suppression, erosion prevention). While enrolled, participants receive payments of $50 per acre for up to four years. Participants can enroll between 25 and 100 acres, and all enrolled acres must have in rotation one or more of corn, cotton, peanuts, and soybeans. Additionally, participants were required to acknowledge in their applications their (1) "willing[ness] to share [their] experience with the Future of Farming Team and other participating producers" and (2) their "willing[ness] to attend Cover Crop Workshops organized by the Future of Farming Team" (Appendix D). The goal of these requirements was to increase the spread of agricultural knowledge generated through the FF-CCIP. See Appendix L for more information on the FF-CCIP.

Research Objectives. The objective of this study was to examine how incentive programs influence farmers' adoption of cover crops. More specifically, we examined (1) farmers' motivations for enrolling in the FF-CCIP, (2) farmers' perceptions of the FF project learning

network, (3) farmers' perceptions of engaging in knowledge-sharing within this learning network, and (4) farmers' long-term, post-enrollment incentives for continued usage of cover crops.

2.4 MATERIALS AND METHODS

Five data sources were used: (1) FF-CCIP farmer interviews, (2) FF project event attendance sheets, (3) FF-CCIP farmer application and verification documents, (4) FF project and FF-CCIP grant application and administration documents, and (5) CIG program documents.

FF-CCIP Farmer Interviews. The primary data source consisted of interviews (n=23) conducted with FF-CCIP farmers from July–September 2024. Collection and use of these data were approved by the Auburn University Human Subjects Committee (Protocol #: 202-207 EX 2004). FF-CCIP farmer names, along with the names of all other individuals mentioned in the interviews, were anonymized using a letter-number coding system (Stewart 2022; Robinette 2022; O'Connor 2024). All farmers who were enrolled in the program were interviewed. Farmers were given the option for the interviews to take place in person, via telephone, or via video call. One interview was conducted via Zoom video call, and the rest took place by telephone. Farmers were asked for their consent to record the interviews, and all but one gave their permission. Interviews were transcribed using Otter.ai and reviewed and edited for mistakes. Data for the unrecorded interview were collected through handwritten notes. Interview questions addressed FF-CCIP farmers' experiences with and perceptions of incentive programs, cover crops, and production meetings; knowledge exchange and learning within their social networks; and their personal values and objectives regarding stewardship on their farms (Appendix B).

FF Project Event Attendance Sheets. The second data source consisted of FF project event attendance sheets (Appendix J, Table J.1). Attendance data accounted for all FF project events

(*n*=21) available to farmers enrolled in the FF-CCIP (from 7/15/2021–12/16/2024). All attendance data were logged into a Microsoft Excel spreadsheet.

FF-CCIP Farmer Application and Verification Documents. The third data source consisted of the 2021 and 2022 FF-CCIP application and verification documents. These documents included the USDA-NRCS Conservation Program Application (USDA-NRCS 2019), applicant questionnaire (Appendix E), programmatic screening document (Appendix F), ranking document (Appendix G), recommendations document (Appendix H), and verification document (Appendix I). See Appendix L, Table L.1 for descriptions of each document.

FF Project and FF-CCIP Grant Application and Administration Documents. The fourth data source consisted of documents produced by the FF project team for the CIG program application, and documents produced for the administration of the FF-CCIP. FF project documents included the project abstract, project description, and budget narrative (Prasad et al. 2019). FF-CCIP documents included the FF-CCIP program description (Appendix C) and the FF-CCIP "expectations and criteria" document (Appendix D).

CIG Program Documents. Lastly, documents produced by the NRCS to promote and solicit CIG applications were assessed. These documents include the CIG request for proposals (NRCS and CCC 2019) and CIG grantee communication materials document (NRCS 2019). These documents were converted into Microsoft Word, and the titles of each were replaced with codes respective to different components of the FF project: the grant-level components (e.g., CIG_1), the developmental and administrative components (e.g., FF_1), and the FF-CCIP (e.g., CCIP_1) (Appendix M, Table M.1).

FF-CCIP Interview Data Analysis. FF-CCIP interview data were analyzed in NVivo 15. They were divided into initial thematic parent codes and, further, into more specific child codes

(Lumivero 2023). Data were coded according to direct textual identifiers, contextual identifiers, and/or tone. Parent and child codes are listed in Table 2.1.

Table 2.1. Codes used in analysis of CCIP Interview Data.

Parent Codes	Child Codes
Cover Crop Benefits	Biomass; Cover Crops as a Solution to Reduce Inputs; Cover Crops for Harvest; Crop Residue; Erosion; General Belief in Cover Crops; General Soil Health; Grazing; Ground Cooling; Moisture Retention; Pest Control; Production Benefits of Cover Crops; Soil Nutrients; Soil Organic Matter; Weed Control
Learning and Education	General Social Learning; Initial Adoption and Learning; Learning and Exchanging Knowledge_Agricultural Industry Professionals; Learning and Exchanging Knowledge_Extension Professionals; Learning and Exchanging Knowledge_Other Farmers; Learning and Exchanging Knowledge_Research and Researchers; Learning from Demonstrations; Learning through Experimentation; Learning through Other Resources; Producer Meetings; Seeking Input or Assistance with Specific Concerns; Sharing Information within Social Networks; Withholding Information within Social Networks
Environmental Factors in Production	General Environmental Health; General Soil Health and Fertility; Soil pH; Viability of Land; Weather; Wildlife Pressures
Farm Finances	Accepting Costs to Use Cover Crops; Affording Cover Crops; Balancing Expenses; Debt; Market Competition; Mitigating Risk; Personal Survival; Viability of Finances
Farm Inputs	Chemical Inputs; Decreasing Input for Environmental Benefits; Equipment; Fertilizers; Fuel; Herbicides; Irrigation; Labor; Pesticides; Soil Sampling; Terraces; Tillage; Time
Farming Livelihoods	Faith; Family; Farm Transition; Farming as Community; Friends; Generational Responsibility; Non-Agricultural Threats to Farm; Perceived Future of Farm; Personal Autonomy and Self-Belief; Personal Health; Personal Identity
General Cover Crop Management	Cover Crop Species and Mixes; Expanding Usage of Cover Crops; Fertilizing Cover Crops; Incorporating Cover Crops into the Production System; Planting; Planting Date; Problems with Cover Crops; Process of Realizing Benefits of Cover Crops; Reseeding and Seed Saving; Targeted Approaches with Cover Crops; Termination
Incentive and Cost-Share Programs	Comments on Land Enrolled; Effect of Program on Adoption; Experimentation and Education; Financial Assistance; General Need for Programs; Improvement of Programs; Interest in Future Programs; Minimum Acreage; Other Programs; Program Duration; Program Requirements; Recommender and Recommendation to Enroll
Personal Altruism	Responsibility to Broader Agriculture Environment; Responsibility to Local Environment; Responsibility to Neighbors; Responsibility to Other Farmers
Personal Competencies	[no child codes]

Parent Codes	Child Codes
Personal Growth	[no child codes]
Political Economy of Agriculture	Agriculture and Politics; Auburn; Commodity Prices; Consumer Impacts; Government Subsidies; Long-Term Viability of Row Crop Agriculture
Production Decisions and Approaches	Converting Farm to Another Use; Experiments with Practices or Inputs; Farm Planning; Input Costs; Maintaining Consistent Farming Practices; Rented vs. Owned Land; Technology and Practice Adoption; Viability of Current Production Practices
Production Goals	Efficiency; Profit; Returns on Investment; Short-Term vs. Long-Term Viability; Yield
Relationships	Other Benefits of Social Networks; Perceptions of Other Farmers; Relationship with Landlord(s)

FF Project Event Data Analysis. Attendance spreadsheets were examined to track farmers' attendance at events throughout their time enrolled in the FF-CCIP.

Documentary Data Analyses. Content analyses were conducted on all documentary data to discern the process by which sustainability priorities presented and developed at the institutional levels (USDA, NRCS) are directed, informed, and incentivized through the CIG program, the FF project, and the FF-CCIP, and how they are eventually operationalized at the field-level by farmers (Figure 2.1).

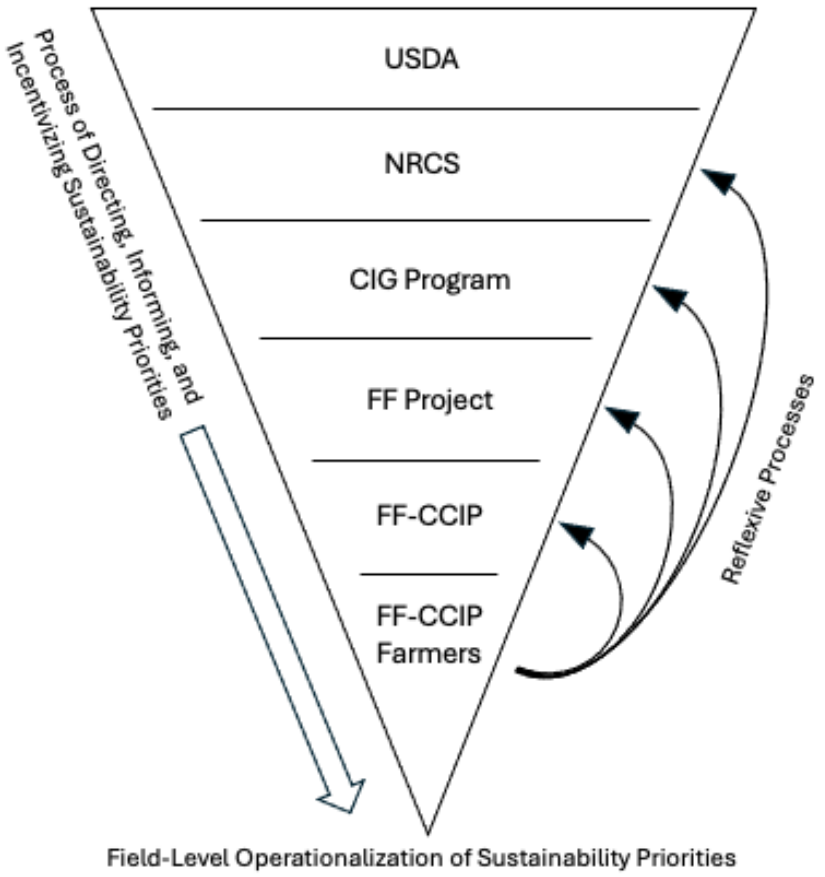

Figure 2.1. Institutional Process of Directing, Informing, and Incentivizing Sustainability Priorities.

This process (Figure 2.1) was developed according to a grounded theory framework which emerged from the review of relevant literature and data analysis. Data from these documents were organized and framed as a top-down process designed to support the farm-level operationalization of institutional sustainability priorities on farms in Alabama. Trends in the data were identified and framed according to their prioritization of specified sustainability outcomes (e.g., soil health, crop yield). Areas of alignment and discordance were identified between institutional sustainability priorities and farmers' sustainability priorities, in order to (1) discern more fully the process by which sustainability outcomes are conceptualized and prioritized at the institutional level and consequently operationalized at the farm level; and (2) to identify areas in which sustainability-

focused incentive programs can be brought into better alignment with the sustainability priorities and needs of farmers and, thus, can function more effectively overall.

2.5 LIMITATIONS

FF-CCIP Application and Interview Discrepancy. Of the applications received, the FF-CCIP accepted 36 in total: 6 from counties in north Alabama, 12 from counties in central Alabama, and 18 from counties in south Alabama. There are several applications whose names and answers to the FF-CCIP questionnaire do not match those of the actual manager of the farmland enrolled and thus are not considered. The results of this study only account for the managers of the farmland enrolled and not for individuals whose names may be included on FF-CCIP applications but who are not involved in the management of the enrolled acres.

FF-CCIP Farmers Missing from Interviews. Two farmers (F99, F100) were enrolled in the FF-CCIP but neglected to continue their participation after the first year. They were the only FF-CCIP farmers not interviewed, as they were unresponsive to multiple requests.

Missing Documents. Although this data was secondary in usage, there were multiple missing documents. Ranking documents (Appendix G) were missing for O10 and F96; an application questionnaire (Appendix E) was missing for F101; a programmatic screening document (Appendix F) was missing for O10; and a verification document (Appendix I) was missing for F36.

Missing Interview Data. In F54's interview, the researcher neglected to ask one question, "when you're faced with making on-farm decisions, how do you balance your long-term goals with short-term economic viability?" (Appendix B). This was an accidental omission.

2.6 RESULTS AND DISCUSSION

The first two sub-sections below describe a grounded theory framework and results from the documentary data analysis, which are organized according to the grounded theory framework. All other sub-sections describe findings related to the FF-CCIP participants, primarily from analysis of the interview data.

Grounded Theory Framework. A grounded theory framework was developed for this study from the literature and data analysis. This framework conceptualizes agricultural decision-making as a complex process of operationalizing sustainability for certain outcomes, at certain levels of sophistication and integration, and for certain periods of time. Farmers are viewed as *operators* of agricultural sustainability, as they, through their individual practices and approaches, are the agents executing sustainability priorities at the farm-level. Frequently, through mechanisms typical of the agricultural treadmill, farmers are pressured to prioritize certain sustainability outcomes in their decision-making. These priorities are most often economic in nature and frequently differ from farmers' preferences, which can lead to cognitive dissonance particularly when faced with decisions that conflict with their personal values: for example, decisions to prioritize short-term economic gain over long-term economic viability and environmental health. According to this framework, institutional actors (e.g., NRCS) can conceptualize, direct, inform, and incentivize the operationalization of sustainability at the farm-level, but only farmers can truly operationalize it (Figure 2.1).

NRCS's Sustainability Priorities and their Operationalization through the FF-CCIP. The USDA's (n.d.) public-facing vision statement includes each of the core components of sustainability—environment, economics, and society:

... to provide economic opportunity through innovation, helping rural America to thrive; to promote agriculture production that better nourishes Americans while also helping feed others throughout the world; and to preserve our Nation's natural resources through conservation, restored forests, improved watersheds, and healthy private working lands.

Through the NRCS, programs have been enacted to decrease the negative environmental impacts of agriculture and to conserve the natural resources associated with agricultural production (NRCS n.d.). The CIG program is an example of how the NRCS directs, informs, and incentivizes sustainability priorities; its administrative structure is top-down in nature but is also guided by reflexive processes in which outcomes at all levels of operation can inform changes at higher levels of the agency (Figure 2.1). The NRCS, as an entity, is structured such that there is ongoing interface between NRCS staff and affiliates and the end users of their programming and services (farmers and landowners). For example, NRCS District Conservationists work directly with farmers, and the feedback they receive can help shape the design and function of NRCS programs.

The CIG On-Farm Conservation Innovation Trials (On-Farm Trials) program (referred to in this study as the CIG program) funds the FF project. The CIG program's primary goal is to "stimulate the adoption and evaluation of innovative conservation approaches in partnership with agricultural producers" (NRCS and CCC 2019:1). The sustainability priorities put forth by the CIG program are environmental, economic, and social in nature. First, environmentally, the CIG program focuses on agricultural practices and technologies which conserve water, soil, and nutrients. Indeed, there is an emphasis on technology and innovation as the primary avenue for reaching these resource use efficiencies. In the CIG request for proposals, three program priorities are listed: "Irrigation Management Technologies," "Precision Agriculture Technologies and Strategies," and "Management Technologies and Strategies" (NRCS and CCC 2019:2–4). Across these three priorities, 13 examples of conservation agriculture practices are given, 10 of which

involve technological solutions, such as the use of irrigation, soil, nutrient, and pest sensors/monitors. The other three examples given are related to management planning and approaches.

Second, economically, these resource use efficiencies can reduce farmers' reliance on certain inputs (e.g., agrichemical, irrigation) and make their operations more efficient overall. However, technological solutions can also be an economic burden, as their use can require significant initial and ongoing investment. To account for the necessary financial investments, the CIG program includes financial assistance mechanisms. Third, socially, the CIG program includes priorities related to knowledge exchange and social learning: farmer-engaged participatory research, on-farm demonstrations of conservation technologies/practices, technical assistance offered to farmers, and efforts taken to understand the various barriers to adoption of conservation technologies/practices (Bressler et al. 2021; Dunn et al. 2016; Rogers 2003). It also emphasizes a need to prioritize "Historically Underserved Producers and Veteran Farmers and Ranchers" (NRCS 2019) and proposes partnerships with organizations who work with these groups as a potential route for accomplishing this priority (NRCS and CCC 2019:9). The NRCS defines historically underserved farmers according to the categories, "Limited Resource," "Beginning," Socially Disadvantaged," and "Veteran" (NRCS 2019). The CIG program accounts for many social *components* of agricultural technology and practice adoption which are well supported by the literature (Prokopy et al. 2019; Piñiero et al. 2020; Šūmane et al. 2017; MacMillan and Benton 2014), and likewise, the program emphasizes the importance of evaluation for understanding potential social *impacts* of practice and technology adoption (NRCS and CCC 2019).

The FF project, as a recipient of the CIG grant, also carries priorities related to the environmental, economic, and social components of sustainability. The following two paragraphs

emphasize particularly relevant areas of alignment between the priorities of the CIG program and the priorities of the FF project and FF-CCIP. The FF project is similarly focused on achieving resource use efficiencies (conserving soil, water, nutrients) through the research, demonstration, and promotion of tools and practices which achieve these efficiencies, as well as through farmer engagement approaches which contribute to increased adoption of these technologies. The FF project aimed to host three series of events per year: each series focused on a given area of conservation agriculture (i.e., cover crops, irrigation, nutrient management) and consisted of three meetings, one each in north, central, and south Alabama (i.e., nine meetings per year). The initial FF project proposal also addressed the need to prioritize "historically underserved farmers," which is further listed as a factor contributing to the project's "innovativeness" (Prasad et al. 2019:4).

The FF-CCIP was also designed to facilitate increased adoption of cover crops for environmental and economic resource use efficiencies. The FF-CCIP was designed to account for many social components of sustainability, as well. It was designed to increase adoption of cover crops through multiple farmer engagement approaches: by offering incentive payments to farmers to offset costs associated with adopting cover crops, by offering expert recommendations on cover crops, and by offering ongoing "access to experts and other growers with cover crop experience" (Appendix C). As a part of the FF-CCIP, enrolled farmers were required to follow certain cover crop management guidelines to qualify for the incentive payments. They were also required, during the application process, to acknowledge their "willing[ness] to share [their] experience with the Future of Farming Team and other participating producers" and their "willing[ness] to attend Cover Crop Workshops organized by the Future of Farming Team" (Appendix D). Further, in the original design of the FF-CCIP, funding prioritized "historically underserved farmers," applicants who had never used cover crops, and applicants who sought funding for a higher level of cover

crop management (e.g., additional species in their cover crop seed mix). See Appendix L, Section L.2 for more information on the FF-CCIP design. The importance of these farmer engagement and inclusion approaches to social sustainability aligns with the literature (Šūmane et al. 2017; MacMillan and Benton 2014; Bressler et al. 2021; Piñiero et al. 2020; Guynn, Player, and Burns 2024). However, despite these intended engagement and inclusion approaches, neither non-adopters nor historically underserved farmers have been enrolled in the FF-CCIP. None of the participants reported being new to cover crops (Appendix A, Table A.1). Most (91%; *n*=21) participants marked "Not Applicable" to a question asking if they "met the criteria" for any of the historically underserved farmer categories (NRCS 2019), and the remaining 9% (*n*=2) left the question blank.

FF-CCIP Participants. Twenty-two (96%) of FF-CCIP farmers were male, and one (4%) was female. When interviewed and asked about the size of the farmland they own and operate, one farmer responded in terms of cover crops acres, to which he answered 130 acres. Of the others who responded in terms of total farmland acres, 17% (*n*=4) farm 500 acres or less, with 200 acres being the lowest; 26% (*n*=6) farm between 501–1,000 acres; 26% (*n*=6) farm between 1,001–2,000 acres; 9% (*n*=2) farm between 2,001–4,000 acres; and 17% (*n*=4) farm more than 4,000 acres, with 8,000 being the highest. The mean and median were 2,069 and 1,200 acres, respectively. F97 acknowledged that his total farmland acreage fluctuates, and F22 mentioned that 2,500 of his 6,000 acres of farmland was in pasture and hay. In their applications, FF-CCIP farmers identified how many years they had used cover crops on their farms: 43% (*n*=10) had used cover crops for 5 years or less; 30% (*n*=7) had used cover crops for between 6–10 years; 13% (*n*=3) had used cover crops for between 11–20 years; and 13% (*n*=3) had used cover crops for 20 years prior to enrollment.

F106 reported having used cover crops for a "long time." Appendix A, Table A.1 provides additional FF-CCIP farmers' demographics.

FF-CCIP Farmer's Motivations to Use Cover Crops and Enroll in the FF-CCIP. Financial assistance was the most cited reason for enrollment in the program: 70% of FF-CCIP farmers (*n*=16) mentioned the incentive payments as being a motivating factor in their decision to enroll. There were differences between farmers as to what they planned to fund using the incentive payments. In their interviews, two farmers described their usage of the incentive payments differently from the others. The largest program participant (8,000 acres) described enrollment as worthwhile:

> [The FF-CCIP] *seemed to be worth the trouble… it didn't move the needle based on its size and our size for us, but it was worthy of my attention to fill out the form and to, you know, comply with it… – F13*

Another (1,400 acres) had the opposite response. He acknowledged that his farm depended on incentive payments from the FF-CCIP and other programs to continue operating:

> *… if these programs hadn't have been in place, we probably wouldn't be farming now. And I mean, we're already looking at going a different direction and trying to do more grass seeds, but we probably wouldn't have had a choice if we weren't doing some of these USDA, and the programs at Auburn and stuff like that… everything has to go absolutely perfect for you to even stand a chance of making money. Or you have to rely on programs with a university or the government to break even… and that's, that's what it is, at least for us right now. – F101*

Regardless, the majority of FF-CCIP farmers' views on incentive payments fell into two thematic categories: "offset input costs" and "mitigate risk of experimentation/self-education" (Table 2.2).

Table 2.2. FF-CCIP Farmers' Intended Usage of FF-CCIP payments.

Planned Usage of Incentive Payments	**FF-CCIP Farmers**	**Representative Quote(s)**
Offset Input Costs	35% (*n*=8)	*With the incentive program we were helped with the cost of* [cover crops]*, so that was easier to justify. But when it becomes a total for myself, that becomes harder to justify. – F39*

Planned Usage of Incentive Payments	FF-CCIP Farmers	Representative Quote(s)
		All this really does is recoup your seed cost. Okay, this ain't your fuel. No labor. – F52 *I want to use cover crops. So if* [an incentive program] *offers 25 acres… that's all I can get… I would take that, because that would help pay for the inputs to be able to do it. – F65*
Mitigate Risk of Experimentation/Self-Education	26% (*n*=6)	*We were trying different mixes of cover crops, and some of those species were fairly expensive, are fairly expensive… we were just trying to get any help we could… any kind of assistance we could to try different mixes and… different dates of getting them planted. – F36* *I'm… a big believer in cover crops, and to be able to experiment and have a little bit more money to play with a few things. – F80* *These programs, like the* [FF-CCIP]*, allow us to try some different things, mitigate some risk with that. You know, if we fail then, you know, it's not totally on us, but a lot of times we find some really good, useful things by trying different things with little risk. – O10*

FF-CCIP farmers spoke more specifically on the effect the incentive payments would have regarding their ongoing use of cover crops. One farmer indicated that he hoped to increase the number of species in his cover crop seed mix but also acknowledged that his usage of cover crops overall would be much more limited once the FF-CCIP ended. He stated,

My cover crop planting this year is cutting way back. [If I'm growing] *cotton, and it's not enrolled in* [the FF-CCIP] *program, we'll have no cover crop this year. I hate that but you can only do so much. – F52*

Another farmer's motivation for enrolling also served as an outlier; they stated that they hoped to provide cover crop management information for the improvement of the FF-CCIP and future programs:

We were trying to teach the program and not the reverse. – F13

The rest of the FF-CCIP farmers' responses fell into three thematic categories. In multiple cases farmers made statements in their interviews aligning with more than one category. The five

categories (Table 2.3) were loosely based on the adoption spectrum developed by Han and Niles (2023).

Table 2.3. FF-CCIP farmers' motivations for enrolling in the FF-CCIP and/or using cover crops.

Motivations for Enrolling	**FF-CCIP Farmers**	**Representative Quote(s)**
Continuation of Cover Crop Usage	*n*=11 (48%)	*I'll use cover crops whether you have the program or not. – F106* *I usually plant some… just about every year, whether there's a program available or not. – F96*
Expansion of Cover Crop Usage	*n*=3 (13%)	*It's kind of been something that we've been looking to do… and see if it's something we want to kind of do on a wider scale. – F103* *It was basically just for me to continue to get some funding to be able to… continue to plant cover crops on as many, many acres as possible. – F65*
Opportunity for Education	*n*=6 (26%)	*I think that, you know, the thing that drew us to it…* [was to] *help generate some information so that we have some better guidelines to kind of operate under. – F22* *I was mainly doing it for education purposes… – F33*

Support for initial adoption of cover crops was not found to be a factor in participants' motivations to enroll in the FF-CCIP, despite the goal of increasing adoption. This represents a shortcoming of the program. However, although the FF-CCIP did not lead to an increase in the amount of cover crop users, expanding, supporting, and optimizing cover crop usage was found to be a primary factor in FF-CCIP farmers' motivations to enroll. This indicates that cover crop acreage overall did increase during the program, which was a goal stated in the FF project narrative (Prasad et al. 2019). Further, many FF-CCIP farmers acknowledged that they planned to continue using cover crops in some capacity after the program ended.

Nine FF-CCIP farmers (39%) indicated that their participation was not contingent on the minimum acreage requirements, and five (22%) of these responded that they would consider enrolling regardless of the minimum. Two participants stated,

I mean anything helps… I haven't really looked at it as, like, what is worth doing as far as the minimum goes. I was just happy that there was any kind of assistance available to do any of it. But everything's so damn expensive. – F101

I would do it regardless. If it wasn't even a payment on it, I would do it. – F106

In addition, four FF-CCIP farmers responded that their participation depended less on the acreage guidelines, and more on the nature and degree of support. Examples include the following quotes:

I want to answer [the acreage question] *almost philosophically, because if you're a 100-acre farmer, five acres may be enough, right? If you're a 10,000-acre farmer, you know, I think it would have to be 1000 acres to be enough to worry about… these incentive programs come with rules, as they should, and so the balancing of participating is, for any farmer, "is it worth the trouble? Are the rules reasonable? Can I farm within the rules? Are they going to inhibit me doing things I think I otherwise have to do to produce a crop, or are they going to enhance? And is the program's value to me, monetarily or agronomically, worth the trouble? – F13*

Really, what I would like to see is not about the acres. To me, it's about the years… you're not going to see the advantage of a cover crop program in one year that you would see the advantage of a cover crop program in five years. – O10

These same farmers' motivations for enrolling in the FF-CCIP all fell under the "Opportunity for Education" thematic category (Table 2.3). This lack of consideration of acreage requirements, alongside the desire to self-educate, further supports the finding that for some farmers the FF-CCIP provides valuable opportunities to explore different cover crop strategies, rather than support farmers' typical cover crop practices or desire to increase cover crop acreage.

Because none of the FF-CCIP farmers were considered first-time cover crop adopters, identifying barriers to adoption was difficult. Existing cover crop users have already overcome many initial challenges to adopting, and their production systems have already, to some degree, been adjusted for cover crop use. However, FF-CCIP farmers demonstrated through their focus on offsetting costs and mitigating risks with cover crops, and through their broader financial concerns, that cover crops usage can be precarious even for a production system acclimated to their use.

Moreover, existing users who have already incorporated cover crops into their production systems continue to rely on incentive payments to meet their cover crop goals.

Numerous environmental benefits of cover crops (e.g., erosion control, increased soil organic matter, moisture retention) were referenced throughout the FF-CCIP interviews as primary reasons for the adoption and use of cover crops. Many farmers acknowledged the economic benefits of cover crop usage, as well: the reduction of on-farm inputs (e.g., chemical, labor, equipment) and their integration into the production system (e.g., grazing, winter harvest). Indeed, FF-CCIP farmers had a strong understanding of the relationship between the economic and environmental benefits of cover crops. They were further aligned with the CIG program's broader goals to increase economic and environmental resource use efficiencies through conservation agriculture practices (conserving soil, water, nutrients).

Factors Contributing to the Effectiveness of the FF-CCIP's Social Learning Objectives. The multifaceted nature of the FF project aligns with a significant base of literature that emphasizes the importance of on-farm demonstration, opportunities for social learning, and incentives to increase adoption of agricultural practices, approaches, and technologies; and to increase the spread of agricultural knowledge (Bressler et al. 2021; Piñiero et al. 2021; Singh et al. 2018). Social learning opportunities were, as a result, built into the initial design of the FF-CCIP: the goal being to develop and foster a culture of knowledge-sharing which could outlast the duration of the FF project. As part of the application and enrollment process, FF-CCIP farmers were required to acknowledge their "willing[ness] to share [their] experience with the Future of Farming Team and other participating producers" and their "willing[ness] to attend Cover Crop Workshops organized by the Future of Farming Team" (Appendices D and L). Regardless, there has been little FF-CCIP farmer attendance at FF project events, even though there were 21 events available for farmers to

attend from 7/15/2021–12/16/2024 (Table J.1). Of the farmers currently enrolled, 43% (*n*=10) have not attended any events; 39% (*n*=9) attended between 1–2 events; and only 17% (*n*=4) attended more than 2 events. An outlier, however, has attended 9 FF project events since enrolling, all of which took place in the south region (Table J.1). In addition, three FF-CCIP farmers stated in their interviews that it was unlikely they would attend an FF project meeting in the future. The reasons cited included personal health and a lack of meeting attendance in general.

At least three additional factors contributed to this poor attendance. The first factor represents the communication challenges that existed between the FF project team and the FF-CCIP farmers. Three FF-CCIP farmers, who had not attended any of the FF project events, were unfamiliar with the project generally, although two of these demonstrated interest in attending future events. When asked if he planned to attend future project events, one responded,

Well, if I'm aware of them, and it fits my schedule. I go to a lot of meetings, but I don't think I've ever attended one of these you're speaking of. – F104

Another four FF-CCIP farmers had attended 11 events but demonstrated a similar lack of familiarity with the project at large. In response to a question asking whether they had participated in any FF project events, two responded,

I don't know what they are... you know what, I don't think your program does a good job of getting outside of Auburn very much. – F13

Not that I know of... possibly could have and didn't realize it, but I don't think I have. – F65

These farmers represent missed opportunities for increased attendance at FF project events.

Second, the number of meetings was somewhat lower than originally planned, which limited the number of available social learning opportunities. Between 2022 and 2024, the first year FF-CCIP farmers would have been expected to attend events, nine cover crop events were initially planned. Only four took place: one in central Alabama, three in south Alabama, and none

in north Alabama. Scheduling was found to be difficult due to distance, seasonal timing, farmer availability, and competition with other Extension events and meetings. In addition, the co-PI responsible for overseeing the FF-CCIP underwent a change in faculty appointment during the FF project, going from 75% to 0% Extension.

Third, there was no process for confirming farmers' ongoing willingness to attend meetings or for verifying their reasons for not attending. Drawing from the documentary data, many FF project and FF-CCIP documents emphasize the "learning node" component of the project and how necessary it is for increasing adoption of cover crops. The FF-CCIP program description restates language from the project narrative on the value of "farmers' engagement approaches" for increasing adoption, and it lists "access to experts and other growers with cover crop experience" as one of the benefits FF-CCIP participants will receive (Appendix C). The FF-CCIP programmatic screening document requires that participants check boxes beside the two expectations regarding engagement in the FF project learning network (Appendix D); indeed, the document states that the boxes "must be checked to be eligible" (Appendix F). These two expectations are framed as being requirements for program eligibility, although the recommendations document, given to each participant after a successful application, did not reiterate them. The recommendations document did reiterate other "General Expectations and Criteria for Management of Cover Crops" (Appendix H), which are specifically related to the environmental components of the FF-CCIP. Furthermore, verification required of FF-CCIP participants was only related to the environmental and economic components: participants were required to keep records of the previous cash crop, cover crop species, and seeding rate, among other information, but there was no required verification of involvement in the learning node (Appendix I).

FF-CCIP Farmers' Perceptions of and Willingness to Engage in Agricultural Knowledge-Sharing. Although the FF-CCIP's social learning objectives were not fully realized, FF-CCIP farmers generally placed a high value on knowledge-sharing within their social networks and on learning from a variety of agricultural professionals. Several farmers spoke generally about the need to continue learning:

> *Well, I think we always need to be learning… you can't stay in the same old rut. And when you get ideas, you know, some ideas are good, and some are not. Some work in your part of the world, and some don't work with me. But it never hurts to try. You know, give it a chance. Don't just do what Granddaddy done for the last 100 years. Find new ways. – F104*

> *My theory is, if you don't learn something every day, you know, you're not listening or looking or whatever. And, I mean, a lot of times, whether it's the university doing it or who's doing it, you're going to pick up something from them, and then it'll be fellow farmers there, and they're going to tell you some things they've done or tried. You know, it's just usually a network and all. – F97*

Stakeholder meetings were the primary way the FF project promoted knowledge-sharing to farmers. FF-CCIP farmers were asked specifically about their perceptions of attending production meetings broadly: 87% (*n*=20) acknowledged that they valued them, and 78% (*n*=18) identified the opportunities to learn as the main reason why. FF-CCIP farmers were also asked about their social networks and which particular stakeholder groups they maintained contact with and valued learning from: 91% (*n*=21) valued learning from other farmers, agricultural industry professionals (e.g., crop consultants, input dealers), and agricultural Extension professionals, and 65% (*n*=15) valued learning from Extension research specialists and/or university researchers. Further, 96% (*n*=22) of FF-CCIP farmers acknowledged that they volunteer information on their production practices within their social networks, and the one farmer who claimed that he does not volunteer information later made a statement indicating that he likely does.

FF-CCIP farmers placed a high value on learning and exchanging knowledge with several groups of agricultural professionals. These findings suggest that they were well-positioned to

operationalize the CIG program's sustainability priorities related to increasing adoption of cover crops.

FF-CCIP Farmers' Perceptions of Technology and Innovation. Many FF-CCIP farmers were in alignment with the CIG program's focus on technology and innovation as a primary way to increase resource use efficiencies and to maintain the long-term viability of their production system. Five FF-CCIP farmers (22%) made general statements on the importance of continually innovating and adopting, or considering the adoption of, new technologies or inputs. One stated,

If somebody's got something that's just come down the tube, or something new, and it seems to be working, and they've seen it work… they tell you, "Hey, you might want to look at this." I mean we may not go whole hog the first year, but we may do a portion, you know. – F97

When asked what their farm might look like in 20-30 years, and what factors they were focusing on to achieve that future, several farmers responded that they expected technology to play a significant role. One farmer stated,

What I envision for my farm in 20 to 30 years is kind of more geared toward, like, what the Midwest has currently going now. I want to create large, efficient fields. I want them to be minimal passes, minimum inputs as possible. That's a clear reason why I like cover crops… I believe we'll see autonomous, hopefully autonomous by then, so not me so much sitting on the tractor. – F80

In addition, five FF-CCIP farmers (22%) specifically mentioned irrigation as playing a significant role in making their farms successful into the future.

Many FF-CCIP farmers aligned with the CIG program and FF project's emphases on technology and innovation as primary factors in maintaining the viability of both their land and production systems. However, this focus on technology adoption, while it can lead to at least temporary efficiencies in both environmental and economic sustainability priorities, is a primary component of the agricultural treadmill (Thompson 1998:108; Cochrane 1958; Hendrickson and

James 2005). Its relationship with the agricultural treadmill is summarized well in F80's quote about "creat[ing] large, efficient fields" and F22's statement:

I think that you have to be progressive in adopting technologies. You can't just wait and try to do it all at one time. You know, if you get too far behind, I think that the cost of getting caught up will be so great that it's nearly impossible. So I don't think you ought to be on the front edge, but I think you ought to be making progress in technology as you go… – F22

This finding represents a systemic tendency in conventional productions systems—from the institutional level to the farm level—to perpetuate processes inherent in the agricultural treadmill. These processes favor farmers who can afford to make continuous capital investments into the adoption and implementation of new technologies.

2.7 SUMMARY AND CONCLUSIONS

This section summarizes the primary results of this study and offers recommendations, focusing on areas of alignment and discordance between institutional and farmers' prioritization of sustainability outcomes. Findings related to the NRCS, CIG, FF Project, and FF-CCIP sustainability priorities are described first. Subsequent findings are then organized according to their relevance to the research objectives of this study: examining (1) farmers' motivations for enrolling in the FF-CCIP, (2) farmers' perceptions of the FF project learning network, (3) farmers' perceptions of engaging in knowledge-sharing within this learning network, and (4) whether enrollment in the FF-CCIP leads to long-term usage of cover crops. Lastly, it concludes with recommendations for future actions.

NRCS, CIG, FF Project, and FF-CCIP Sustainability Priorities. The NRCS is a major division of the USDA devoted to enacting programs focused on assisting farmers in decreasing the negative environmental impacts of agricultural production and in conserving the natural resources used in farming. The CIG program and the FF project are similarly focused on facilitating the

operationalization of sustainability: by achieving resource use efficiencies through conservation agriculture tools and strategies. Further, they emphasize the role of farmer-engagement approaches and evaluation processes to generate increased adoption of these technologies. The FF-CCIP—through its financial and technical assistance, as well as the farmer learning network—serves as one approach to facilitate the adoption of cover crops. However, none of the farmers enrolled in the FF-CCIP identified as non-adopters prior to program enrollment, so an increase in the number of adopters was not a direct outcome of the project. Further, the CIG program, the FF project, and the FF-CCIP identified historically underserved farmers (NRCS 2019) as a priority population, although none of the FF-CCIP farmers identified with this group. Thus, two of the CIG program and FF project's target populations were not included in the FF-CCIP. Participation in the FF-CCIP, however, did contribute to an increase in cover crop acreage overall, which was a primary goal of the program (Prasad et al. 2019). Many enrolled farmers were able to expand, and become more sophisticated in, their cover crop usage through the FF-CCIP.

Farmers' Motivations for Enrolling in the FF-CCIP. The majority of participants identified the incentive payments as a primary reason for enrolling: in particular, to offset input costs. Many farmers also valued the opportunities, provided by the FF-CCIP and the incentive payments, to experiment and self-educate. Because all participating farmers were current adopters, identifying non-adopters' motivations for enrolling was not possible. The latter would likely be different from the motivations of current users. Additionally, FF-CCIP farmers demonstrated a strong understanding of the many production benefits cover crops can have, emphasizing economic outcomes especially (e.g., reduce external inputs). This understanding of the economic benefits may not be consistent across other projects which include non-adopters, as non-adopters would not yet have witnessed these benefits on their farms.

Farmers' Perceptions of Participating in the FF Project Learning Network and Perceptions of the Network Itself. The FF project events were the primary social learning opportunities that were made available to FF-CCIP farmers, and they received mixed results overall: more than 40% had not attended any FF project events. This was partially the result of insufficient outreach, an inability to verify participants' ongoing willingness to attend events, and a reduced number of planned meetings. At the same time, FF-CCIP farmers' social networks and personal interest in learning indicated that there was unmet potential in the learning network component of the project. More than 90% of participants indicated that they valued learning from other farmers, agricultural industry professionals, and Extension professionals, and almost two-thirds indicated that they valued learning from Extension research specialists and/or university researchers. More importantly, nearly all FF-CCIP farmers (96%; n=22) acknowledged that they willingly share information on their production practices within their existing social networks.

The Effect of Enrollment on Long-Term Usage of Cover Crops. Many farmers indicated that they relied on the incentive payments to meet their cover crop goals (i.e., continued or expanded use, self-education), but there were no findings to suggest that enrollment in the FF-CCIP positioned them to continue progressing and expanding their acreage when the program ends. FF-CCIP farmers' usage of incentive payments differed from each other; one farmer identified incentive payments as necessary to his farm's survival, whereas another mentioned them as being worth applying for, but not necessarily "mov[ing] the needle." Most participants used incentive payments to offset input costs or mitigate the risk of experimenting and differentiating their usage of cover crops (e.g., adopting a different cover crop seed mix).

As all FF-CCIP farmers were current adopters at the time of enrollment, no conclusions can be drawn as to how enrollment would have impacted farmers who had not adopted cover crops

prior to enrollment. However, FF-CCIP farmers' dependence on incentive payments may indicate that the FF-CCIP, and other similar programs, are better suited to support the usage of current adopters whose production systems are acclimated to the use of cover crops, but whose cover crop goals are still contingent on receiving the payments. The incentive payment structure may not be attractive to non-adopters who have yet to incorporate cover crops into their production systems (e.g., farmers who have not purchased the necessary equipment to convert to conservation tillage).

Conclusions and Recommendations. These findings indicate that more diligent outreach to farmers, better methods of increasing attendance at FF project events, and more meetings overall, particularly cover crop meetings, would likely have led to more robust involvement in the learning network and greater exchange of knowledge. Additional outreach may have led to more experimentation, sophistication, and expansion of usage. Further, the success of many FF project priorities (e.g., increasing adoption of conservation practices) was dependent upon the development of trust-based relationships: between farmers and researchers, NRCS District Conservationists, and Extension professionals. A team member devoted solely to the coordination and execution of the project would have had the capacity to facilitate the development of those relationships. Moreover, a program coordinator would likely have had a positive effect on meeting sustainability priorities that require more investment (e.g., the inclusion of historically underserved farmers). Requests for grant proposals—which fund projects of similar design to the FF project—should provide the capacity for and encourage, or require, that applicants include in their budgets support for program coordinators. The administration of the FF project (Appendix K) is comprised of a diverse research and Extension team who hold coordination responsibilities, but who also have obligations to other projects, Extension appointment expectations, student advisory roles, teaching appointments, service, and coursework. Thus, some challenges unaccounted for at the design phase

of the FF project could not be addressed fully as the project was being conducted. Also, many authors (e.g., Surdoval et al. 2024, Roesch-McNally et al. 2017) have identified other structural and administrative issues with incentive programs and factors in cover crop adoption more broadly (e.g., tiresome enrollment processes). Project-specific program coordinators would likely contribute to solving these issues as well, beyond those apparent in the FF project. Further, the FF project and other similar projects rely significantly on NRCS District Conservationists and Extension professionals to recruit farmers (Appendix L) from their own professional networks. More institutional support is needed to define and direct the process by which NRCS and Extension professionals recruit participants.

Future programs could be designed explicitly to include opportunities for experimentation. For example, enrolled farmers could be encouraged to mitigate the risk of their experimentation by conducting experiments according to a detailed management plan; or to conduct these experiments at a central location, with the help and guidance of the project team and local Extension professionals. This would generate meaningful research for both the project team and farmers, while allowing participating farmers to put incentive payments toward other objectives. The Testing Agricultural Performance Solutions (TAPS) program developed at the University of Nebraska-Lincoln (n.d.) is an example of a stakeholder-engaged research project which encourages farmers to experiment on research plots at Extension experiment stations. Through this experimentation, social learning between farmers, researchers, and other stakeholders also took place (Burr et al. 2020). The National Wildlife Federation's CCCP is another example of a participatory project which focused specifically on cover crops. The CCCP similarly included avenues for farmers to experiment alongside each other, and for learning communities to develop

as a result. The latter, however, involved experiments on farmers' fields rather than experiment stations (Bressler et al. 2021).

Technology was another component of the CIG program that was found to be valued among FF-CCIP farmers, for its ability to increase resource use efficiencies in particular. Multiple FF-CCIP farmers referenced technology adoption as a continuous and necessary component of their production systems and of agriculture in general. Some also stated that they expect technology to play a significant role in the future of agriculture. However, ongoing technology adoption can further embed farmers on the agricultural treadmill. In these circumstances, the adoption of technology is not a low-risk, optional production decision but is, instead, required to stay operational (Thompson 1998:108; Cochrane 1958; Hendrickson and James 2005). Rigorous evaluation must take place at institutional levels to understand the effects given tools and practices—including conservation technologies—may have regarding the agricultural treadmill, and whether the resulting resource use efficiencies and gains are worth the tradeoff.

CHAPTER 3: WHAT ARE THE COMMONALITIES BETWEEN SUSTAINABLE INTENSIFICATION AND CONVENTIONAL AGRICULTURAL PRODUCTION IN THE US?[2]

3.1 KEYWORDS

Sustainable intensification; sustainable agriculture; conventional agriculture; technology adoption; agricultural treadmill

3.2 ABSTRACT

Sustainable Intensification (SI) in agricultural systems seeks to maximize productivity while increasing ecological health. It is a contentious concept, as some skeptics claim that it is impossible to pursue each of these goals equally. Moreover, some point out that many social impacts are often unaccounted for in SI approaches. This study draws from literature on sustainability, SI, environmental ethics, and political economy to identify trends in how SI is conceptualized and operationalized. The "Future of Farming" (FF) project was used as a case study to identify areas in which conventional, conservation-based agriculture aligns with or differs from SI more broadly. The FF project is a transdisciplinary research and Extension project focused on the adoption of climate-smart technology in Alabama, USA row crop production. Data came from interviews (n=23) conducted with farmers participating in the FF project cover crop incentive program. Data were analyzed to identify trends in the experiences of farmers participating in medium- to large-scale production, as well as trends in their decision-making, perceptions of stewardship, and desired futures for their farms. Findings suggest that the tendency to prioritize economic outcomes over environmental or social outcomes—found in both conservation-based agriculture and SI production—stems from processes that drive the agricultural treadmill.

[2] Formatted for Submission to Agriculture and Human Values

3.3 INTRODUCTION

Sustainability is a systems framework comprised of environmental, economic, and social components. For a system to be considered sustainable, its usage of environmental, economic, and social resources must not exceed its capacity to regenerate those same resources. Gains according to one of its component parts must not be valued over the gains of another (Ikerd 1993; Purvis et al. 2019). In agriculture, sustainable production systems build soil health and increase biodiversity (environmental), meet production demand (economic), and contribute to the health and wellbeing of rural communities (social) (Ikerd 2005). Agricultural systems which value economic gains above environmental and social gains will degrade soil, pollute natural environments, and undermine rural community wellbeing. On the other hand, systems which value environmental and social outcomes more highly than economic outcomes will not meet market requirements for production. Developing a useful definition of agricultural sustainability is difficult, however, as the concept requires a tremendous amount of knowledge about the production system in question and is highly context specific (Ikerd 1993). Agricultural sustainability both *describes* systems and *prescribes* systematic approaches, depending on the system in question and depending on the land in question (Thompson 1992). Thus, what is sustainable in one natural environment may be destructive in another. What is sustainable in one economic market may be a losing venture in another. What supports the continued mental, physical, and spiritual wellbeing of individuals in one social context may be a strain on wellbeing in another. Tremendous attention must be given to ground-level environmental, economic, and social contexts to effectively operationalize sustainability (Ikerd 1993).

Sustainability is conceptualized in relation to the time scale in question (Thompson 1992:13). In contemporary usage, sustainability implies absolute perpetuity, but perpetuity is

rarely a goal in individual or collective decision making, especially economic decision making. Economic entities—individuals and firms—make some decisions that go beyond the immediate short-term, but even the so-called long-term decisions rarely go much further than a few decades into the future (Ikerd 2005:66). Parents, for example, may make economic decisions for the benefit of their children or even their grandchildren, but sustainability is concerned with the viability of natural and social systems for the entire lifecycle of the earth and of humanity—obviously much further than the next two generations. As Ikerd (2005:66) points out, economic decisions are inherently short-term decisions and, as such, have very little to say about true sustainability. However, economic decisions have much to say about the survival and wellbeing of humanity and, as such, clearly require political protections and support. As the world seeks to direct its political-economic systems towards sustainability as a primary objective, economic processes should ideally be embedded within the objectives of larger environmental and social systems, which are much longer-term (Ikerd 2005; Buttel 2000). These environmental and social objectives should, to some degree, serve to regulate the normal operations of economic systems to ensure that short-term outcomes do not gain priority over long-term outcomes. However, current global political systems clearly prioritize economic outcomes over environmental and social outcomes and, in so doing, put the sustainability of the earth and society at risk (Ikerd 2005).

Aldo Leopold, in his famous essay "The Land Ethic," described the failures of the "strictly economic" human-land relationship: if the relationship prioritizes economic self-interest, it deprioritizes the health of the land (1949:203). Even systems designed to conserve natural resources, if they frame their approach in purely economic terms, fail conceptually and, eventually, operationally (Leopold 1949; Ikerd 2005:63). Leopold (1949:224–5) described the relationship between humans and the environment as being "right when it tends to preserve the integrity,

stability, and beauty of the biotic community… [and] wrong when it tends otherwise." At its most conceptual, Leopold (1949) described achieving this right relationship as fundamentally an ethical issue, and the resulting conceptual priorities are direct outcomes of this ethical stance. Ethical decisions are made, knowingly or not, when land is converted from native prairie to row crop land, or from forest to livestock pasture.

This study uses sustainable intensification (SI) as a conceptual lens through which to assess the sustainability of large-scale, input-intensive commodity agriculture in the southeastern US, in which—like SI—yield gains and on-farm ecological health are primary goals. I examined a cover crop incentive program in Alabama to identify areas of alignment and discordance between SI and conservation-based row crop production. This study had two primary objectives: (1) to bolster dialogues regarding different types of intensified agricultural systems and (2) further discern the processes by which intensified systems tend to prioritize economic sustainability outcomes over environmental and social sustainability outcomes.

3.3.1 SUSTAINABLE INTENSIFICATION

In agriculture, SI is a popular conceptual approach used to characterize agricultural systems, policies, initiatives, and on-farm practices which prioritize both short- and long-term goals. SI is concerned with maximizing and optimizing existing agricultural production systems—closing yield gaps—rather than expanding existing production systems (Pretty and Bharucha 2014); the rationale being that this avoids further ecosystem destruction (e.g., deforestation, biodiversity loss) and the resulting environmental impacts (Garnett et al. 2013). Proponents of SI argue that even as agricultural systems are intensified, inputs must be reduced to decrease chemical pollution, greenhouse gas emissions, and other forms of environmental degradation (Thomson et al. 2019; Foley et al. 2011). However, there is a general consensus in SI scholarship that some

degree of negative environmental externalities is to be expected and accepted if agriculture is to sufficiently feed future generations. SI, in this sense, sacrifices land currently in production and, in so doing, "spares" other areas of land and their local ecosystems (Rudel 2020).

Conceptually, SI is based on two premises: (1) food availability must approximately double by 2050 (Mueller et al. 2012; Tilman et al. 2011), and (2) increased agricultural production is the primary method by which this increase must happen (Hunter et al. 2017). Scholars across the SI literature also identify more specific social and environmental outcomes, apart from the objectives of intensified agriculture, that may serve to "take the pressure off" production systems. These include reducing food waste (Rockström et al. 2017); transitioning systems away from commodity production and towards the production of more diverse; higher-value food crops and cropping systems (Pretty et al. 2018); and shifting the diets of rich countries toward more efficiently produced foods (Davis et al. 2016). Many of these changes maintain the same focus on optimizing and maximizing existing systems, but do not necessarily call for deep, systemic changes to the political-economic systems governing agriculture (Naess 1986).

Hunter et al. (2017:386) point out that although SI definitionally prioritizes economic, environmental, and social outcomes, focusing so intently on increased production as the main solution develops a "produce-at-all-costs mentality." This, in turn, creates an imbalance between how these outcomes are prioritized (Rockström et al. 2017): increased production becomes the primary objective, and environmental and social objectives are deprioritized. It is from this process that much of the debate around SI stems. SI is a broad concept, including within its purview entire agricultural systems, policies, research and development approaches, and specified agricultural practices. As a result, different initiatives that identify as SI-focused prioritize outcomes

differently. This weakens the usefulness of the concept as a whole and increases the likelihood for misuse (Mahon et al. 2017; Loos et al. 2014).

Many have questioned the rationale of the "land-sparing" approach that is present in many SI-favoring arguments. The negative environmental externalities associated with large-scale, intensified agriculture are widely known to have expansive downstream effects. For example, the hypoxic "dead zone" in the Gulf of Mexico is the result of agrichemical runoff in the US. These effects, especially in increasingly intensified systems, may not be as easily isolated as the binary "land-sparing" rationale seems to imply (Matson and Vitousek 2006). Also, much of the SI scholarship focuses on the need for continually improving technologies like, for example, precision agriculture. Improved technologies can benefit production systems in terms of input- and resource-use efficiencies, but the increased costs associated with these technologies frequently privilege the owners of large production systems and further marginalize smallholder farmers (Rudel 2020). In addition, improved technologies on a given farm which lead to more efficient, intensified production can incentivize other farmers to adopt those same technologies. This partially negates the land-sparing effect, as it increases the gross amount of land in intensified production (Lambin and Meyfroidt 2011; Rudel 2020). Further, there are many widespread problems in agriculture for which there exist no immediate technological solutions, such as rampant soil loss (Jänicke 2008:562).

Social components and outcomes of SI-focused initiatives are wide-ranging and tend to be prioritized differently for initiatives of differing scales. Large-scale SI initiatives do not tend to prioritize the values and perspectives of smallholder farmers in their approaches (Suhardiman et al. 2016; Liao and Brown 2018), nor do they tend to anticipate nuanced social impacts, which are often complex and differentially positive or negative depending on the demographic and timescale

in question (Meyfroidt 2018). A major issue regarding the social impacts of SI, at a large scale or political-economic level, relates to the systemic issues with market incentives and market competition. SI-produced agricultural products are still subject to the same market incentives as other agricultural products, so economic outcomes have an immediate advantage over environmental and social outcomes. Also, market incentives and government support commonly favor global economic participation and commodity production rather than local economic self-sufficiency and food production (Hendrickson 2015). This results in political-economic entities and farmers often forgoing the needs of their own localities and sending their commodities off to be redistributed according to the global market (Rudel 2020; Borras et al. 2011). These processes can further distance rural communities from the benefits of their agricultural production (Liao and Brown 2018; Rudel 2020). Poorer countries may find themselves responding more to the needs of rich countries than they do to the needs of their own, which has led to arguments that the inefficient and wasteful nature of the global political economy of agriculture may have as much, or more, to do with global food insecurity issues than actual rates of productivity (Holt-Giménez et al. 2012; Fan and Brzeska 2016).

Tradeoffs between desired outcomes are common in SI initiatives and they manifest differently depending on the circumstance (Meyfroidt 2018; Thomson et al. 2019; Rudel 2020). These tradeoffs, however, can be minimized in smallholder contexts, in which farmer perspectives and objectives are prioritized and agroecological approaches are incorporated (Liao and Brown 2018; Suhardiman et al. 2016; Perfecto and Vandermeer 2010). These bottom-up approaches, such as those analyzed in Pretty et al. (2011:10), emphasize “local needs and contexts:” by conducting localized research, engaging local farmers, leveraging and strengthening social infrastructure, and involving the appropriate public and private sector entities and systems. Rudel (2020) further

emphasizes the need for more diversified, agroecological production systems (or "land-sharing" systems) to exist alongside larger-scale intensified systems.

3.3.2 THE AGRICULTURAL TREADMILL

First mentioned by Willard Cochrane (1958), the agricultural treadmill is a theoretical framework used to conceptualize many social, environmental, and economic phenomena associated with agriculture, with a particular focus on identifying the mechanisms which tend to push agricultural operations toward continuous growth and ever-increasing use of inputs (Carolan 2022:8). The agricultural treadmill mirrors many of the self-perpetuating, destructive capitalistic processes first described by Marx (1967 [1848]) and later applied to environmental concerns by Schnaiberg (1980). Schnaiberg's (1980) treadmill of production conceptualizes processes by which entire political-economic entities and systems tend to exploit of a wide range of natural resources including, but not limited to, agricultural resources. The agricultural treadmill, however, focuses on the individual farmer as the primary actor trapped on the treadmill.

On the agricultural treadmill, a farmer may choose to adopt a given technology in pursuit of greater production efficiency, which requires a financial risk. If the risk pays off, the farmer will experience a surge of gross income from increased production, which may outweigh the initial cost of the technology. This competitive advantage, however, will disappear as other farmers see the potential for increased yields. These farmers will adopt the same technology, and the market will adjust with new efficiency and capital input requirements. Farmers who cannot afford to adopt the technology, and thus cannot increase their efficiency, will be unable to generate the necessary yields to make a profit. Many will lose their farms, and their land will become available to the larger, more efficient farmers looking expand their operations in pursuit of even greater efficiency. This creates a cycle in which farmers are required to make continuous capital investments in their

farms to remain financially viable (Hendrickson and James 2005; Carolan 2022:8; Thompson 1998:108).

Conventional monocultures—in which the effects of the agricultural treadmill are most obvious and most consequential—are the product of a primary focus on efficiency (Hendrickson 2015). Efficiency, in all industrial production systems, is best achieved by specializing, standardizing, and increasing the scale of production processes via consolidation, and this is true for conventional agriculture, as well (Ikerd 2005). Agricultural systems, however, differ from other forms of production, in that diversity (especially biodiversity) is necessary for an ecosystem's capacity to sustain agriculture. This tension between the necessity for diversity to achieve environmental gains and the necessity for specialization to achieve economic gains is partially and momentarily resolved by external inputs (e.g., pesticides, chemical fertilizers, irrigation, heavy machinery). These investments, however, lead to increased costs which perpetuate the agricultural treadmill (Carolan 2022:8). Increased inputs also make farmers reliant on the stability of the external markets providing those inputs, the stability of the commodity markets for which they produce, and the stability of the local environment and climate. Market fluctuations and increasingly unpredictable climate pressures make the agricultural treadmill that much more precarious (Carolan 2022:8; Hendrickson 2015).

3.4 BACKGROUND

Data for this study came from interviews (n=23) with Alabama farmers who took part in a cover crop incentive program (FF-CCIP), in which they were paid $50 per acre to include cover crops in their cash crop rotations: i.e., corn, cotton, soybeans, peanuts. Participating farmers were permitted to enroll up to 100 acres and received payments for up to four years. The FF-CCIP, as well, is part of a larger stakeholder-engaged research project, titled, "Future of Farming: Increasing

Adoption of Conservation Practices Among Alabama Row Crop Farmers" (FF), which is funded through a US Department of Agriculture - Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG). The CIG program exists to "stimulate the adoption and evaluation of innovative conservation approaches in partnership with agricultural producers" (NRCS and CCC 2019). The FF project (2020–2026) involves university researchers, farmers, Extension professionals, government professionals, industry professionals, and other stakeholders, and is comprised of three primary components: demonstration plots on cooperating farmers' fields, stakeholder-engaged events, and the FF-CCIP. See Appendix L for more information on the FF-CCIP and Appendix K for more information on the FF project.

3.5 METHODS

Data for this study came from interviews (n=23) conducted with FF-CCIP farmers from July–September 2024; their collection and use was approved by the Auburn University Human Subjects Committee (Protocol #: 202-207 EX 2004). All FF-CCIP farmers were contacted for interviews, and every farmer currently enrolled was interviewed. See Appendix L for more information on FF-CCIP farmers and applications. Table 3.1 provides basic demographic information on FF-CCIP farmers: sex, application years, regional locations, farm sizes, and years of experience using cover crops.

Table 3.1. FF-CCIP Farmer Demographic Data.

Sex	Application Year	Region (AL)[1]	Total Acreage Farmed (Approx.)[2,3,4]	Years Using Cover Crops[5,6]
Male: *n*=22 (96%)	2021: *n*=15 (65%)	South: *n*=11 (48%)	< 500 ac: *n*=4 (17%)	< 5 years: *n*=10 (43%)
Female: *n*=1 (4%)	2022: *n*=8 (35%)	Central: *n*=7 (30%)	501–1,000 ac: *n*=6 (26%)	6–10 years: *n*=7 (30%)
		North: *n*=5 (22%)	1,001–2,000 ac: *n*=6 (26%)	11–20 years: *n*=3 (13%)
			2,001–4,000 ac: *n*=2 (9%)	> 20 years: *n*=3 (13%)
			> 4,000 ac: *n*=4 (17%)	

[1]North counties: Lawrence, Jackson; Central counties: Autauga, Dallas; South counties: Geneva, Houston. [2]Answers taken directly from FF-CCIP interviews. [3]Mean: 2,069 acres; Median: 1,200 acres. [4]F106 reported cover crop acreage specifically (130 ac.) [5]Answers taken directly from FF-CCIP applications. [6] F106 reported having used cover crops for a "long time."

Interview questions (Appendix B) requested information on FF-CCIP farmers' experiences with and perceptions of incentive programs, cover crops, and production meetings (including FF project meetings); knowledge exchange and learning within their social networks; and their personal values of and objectives regarding stewardship on their farms. Particularly important to this study were the four questions about stewardship:

1. *We understand that you may be required to manage your rented land differently, but when you think about the "stewardship" of the farmland you own and operate, what are the most important factors you consider?*
2. *When you're faced with making on-farm decisions, how do you balance your long-term goals with short-term economic viability?*
    a. *Thinking 20-30 years from now, or even longer, what might your farm look like?*
    b. *What factors are you focusing on now to make that possible?*

Farmers were given the option for the interviews to take place in person, on a telephone call, or on a video call. One interview was conducted on a Zoom video call, and the rest took place by telephone. Farmers were asked for their consent to record the interviews, and all but one gave their permission. Interviews were transcribed using Otter.ai and reviewed and edited for mistakes.

Data for the unrecorded interview were collected through handwritten notes. FF-CCIP farmer names, along with the names of all other individuals mentioned in the interviews, were anonymized using a letter-number coding system. Supplementary data on FF-CCIP farmers (also anonymized) came from FF-CCIP 2021 and 2022 application and verification documents, which were compiled into a spreadsheet for analysis. These documents included the USDA-NRCS Conservation Program Application (USDA-NRCS 2019), applicant questionnaire (Appendix E), programmatic screening document (Appendix F), ranking document (Appendix G), recommendations document (Appendix H), and verification document (Appendix I). See Appendix M, Table M.1 for descriptions of each document. All other data on FF-CCIP farmers, such as attendance at FF project events, were collected through the end of 2024.

FF-CCIP interview data were analyzed in NVivo 15. These data were divided into initial thematic parent codes and, further, into more specific child codes (Lumivero 2023). Codes were determined based on their relevance to SI as a concept and an operation; in particular, they were identified based on FF-CCIP farmers' discussions related to balancing economic, environmental, and social outcomes on their farms. Data were coded according to direct textual identifiers, contextual identifiers, and/or tone. Parent and child codes are listed in Table 3.2 below.

Table 3.2. Codes used in analysis of CCIP Interview Data.

Parent Codes	Child Codes
Factors in Decision-Making	Cognitive Dissonances; Commodities; Input Costs; Rented v. Owned Land
Future Viability of Agriculture	
Perceived Future of Farm	
Prioritizing Economic Outcomes	Efficiency; Maintaining Financial Viability[1]; Maintaining Productivity[1]; Profit; Returns on Investment; Yield
Prioritizing Environmental Health	
Stewardship	
Short-Term v. Long-Term Viability	
Technology	

Parent Codes	Child Codes
[1]Data coded under "Maintaining Financial Viability" and "Maintaining Productivity" differ from data coded under the other child codes within Prioritizing Economic Outcomes: they represent FF-CCIP farmers' ambitions to produce high yields efficiently and to generate profit, but farmers emphasized these outcomes as necessary for their farm to remain viable, and not necessarily as objectives for their own sake.	

Data were analyzed to examine FF-CCIP farmers' experiences and perceptions as they related to the conceptual and operational objectives of SI. This included examining FF-CCIP farmers' decision-making related to the prioritization of economic and environmental outcomes; FF-CCIP farmers' perceptions of the social components and impacts of their own farming practices and of agriculture broadly; and farmers' perceptions of the futures of their farms and of agriculture broadly. Central research goals were to discern areas of association and dissociation between conventional agriculture in the US and SI and to demonstrate the manner in which different agricultural systems—including systems with explicitly environmental goals—tend to prioritize economic outcomes over all others. Understanding this process can better inform dialogues between different intensified agricultural systems across the world and their ideological underpinnings.

3.6 LIMITATIONS

Two farmers (F99, F100) were enrolled in the FF-CCIP but neglected to continue their participation after the first year. They were the only FF-CCIP farmers not interviewed, as they were unresponsive to multiple requests. There were also several missing FF-CCIP application and verification documents which included (1) an applicant questionnaire (Appendix E) for F101; (2) a programmatic screening document (Appendix F) for O10; (3) ranking documents (Appendix G) for O10 and F96; and (4) a verification document (Appendix I) for F36. In one interview (F54), the researcher accidentally neglected to ask how the participant balanced long-term goals with short-term economic viability (Appendix B). Also, this project only accounts for the particular case

study being examined; the findings may not necessarily apply in evaluations of other programs. Lastly, to the author's knowledge this is the only study that utilizes a case study to compare conventional agriculture in the US with SI more broadly: this could lead to some difficulty comparing it to and positioning it within the existing SI literature base.

3.7 DISCUSSION AND RESULTS

This section details findings related to FF-CCIP farmers' personal values of stewardship, approaches to balancing their short- and long-term goals, and perceptions of the future of their farms, including factors they focus on to achieve these desired futures. Many farmers' responses indicated that while they may have robust personal values of stewardship, their on-farm decisions frequently prioritize short-term economic outcomes over other outcomes. Many farmers stated that the future of their farms will be dependent on generational dynamics, and that a shift in production type is likely. Economic outcomes, environmental outcomes, and technology adoption were identified most as the factors farmers were focused on to achieve their desired futures. However, many farmers identified low commodity prices and high input prices as significant challenges they face.

3.7.1 FF-CCIP FARMERS' STEWARDSHIP VALUES

In planting cover crops through the FF-CCIP, participating farmers pursued specified environmental objectives (e.g. increasing soil health, retaining soil moisture, cycling nutrients) alongside typical economic objectives (e.g., yield, profit, efficiency) necessary for their farms to remain financially viable. For the purpose of this study, the dichotomy between environmental and economic goals created a conceptual link between conventional agricultural systems of the US, of which the FF-CCIP farmers are a part, and systems identified as SI-focused. Both types of systems are characterized by intensified production and measures taken to ensure the environmental health

necessary to continue intensified production. When asked to name the most important factors of stewardship they consider, 13 FF-CCIP farmers (57%) identified specified environmental outcomes they focus on to maintain the productive capacity of their land. These views are exemplified by the following quotes:

Keeping the terraces up and waterways and keeping the pH up. – F102

Well, number one for me is probably fertility… maintaining good fertility. And probably ranking up there among would be weed control, because that's one of the most expensive things I do throughout the course of a year. – F22

To keep erosion to a minimum, whether it be wind or water, and try to build organic matter in the soil. – F82

Preventing erosion was mentioned by 10 (43%) FF-CCIP farmers as a factor of stewardship they consider, which was the most of any specified factors mentioned. Eight (35%) FF-CCIP farmers responded to this question with broader conceptualizations of stewardship, which they used to direct their prioritization of environmental outcomes. For example, two participants stated,

I want to do practices that help ensure that I'm making the land better, you know. I don't want to be planting something, and then robbing everything… I want to build that land year after year after year. – F4

We just try to do the best practices possible, and the safest… and, you know, what's good for the land and what's good for the environment. – F97

Of these eight participants, three (13%) responded with identical conceptualizations of stewardship: to *leave it better than I found it*. In six (26%) cases their environmental stewardship considerations were mentioned alongside or qualified by economic considerations, which exemplified the sort of prioritization of different outcomes conventional farmers are continuously engaged in. Two mentioned environmental considerations but in a production-based context:

Well, it's just maintaining the viability of the land. So we rigorously take soil samples every year… we like to see how the land is performing coming out of the corn crop, so we know where our problem areas will be, and try to maintain the levels. – F39

It's a big selling point of what we do that we're doing it not just to survive and make money, but we're doing it to hopefully improve [our landlord's] *farm… – F36*

In contrast, three FF-CCIP farmers (13%) responded to the stewardship question with purely economic, production-focused answers:

Honestly, I think at the end of the day… the way that prices are, you've got to figure out what you're making money on… whether you own [your land] *or not, if you're planting it, you're going to treat it in a way that you make the most money. – F101*

[Stewardship] *doesn't matter. It doesn't change. It's all the same. It's to the max, and nothing short thereof there. – F33*

The dirt… good land can make a bad farmer look good, and bad land can make a good farmer look bad… when I buy a piece of dirt, I try not to buy shit… there's a lot of just good land that's just the difference… I can show you my grandma's place where we do this cover crop. I'm gonna make a crop there every single year, unless there's a natural disaster. It just makes [crops]. *– F76*

In their conceptualizations of stewardship, a couple farmers responded that social factors also played a role in their practice of stewardship. For example, one participant drew attention to his relationship with his landlords, stating,

[My landlords] *got faith in me. I want to do the best job I can out there… one of the first persons I go to pay is my landlords. Take care of them. Yep, they get paid first. – F52*

Another acknowledged that his practices can affect his neighbors:

What you do on a farm affects the neighboring property owners. And so you're always having to take into consideration how what you're doing is affecting the neighbors. Not all farmers care about that, but that's what I do. – F65

3.7.2 FF-CCIP FARMERS' SHORT-TERM AND LONG-TERM GOALS

FF-CCIP farmers were asked how they personally balance their long-term goals with short-term economic viability. One responded with "faith;" otherwise, the answers fell into four "Outcome Prioritization" categories (Table 3.3).

Table 3.3. Categories of FF-CCIP farmers' responses to how they balance their long-term goals with short-term economic viability.

Outcome Prioritization	Percentage of FF-CCIP Farmers	Representative Quote(s)
Short-term Economic	48% (*n*=11)	*Whatever I can afford most of the time. There comes a point you got to consider the money part of the benefit, but you really do have to look out way past this year. You gotta look for, what am I gonna gain the next five years? – F104* *There's no such thing as long-term goals anymore. – F33* *That's gonna be hard to answer…money is a driving factor… I don't know that I have too many long-term goals, other than just being able to stay profitable, to be able to keep doing it year in and year out. – F4* *Well, things can't be cost-prohibitive. It's got to have a benefit at the end of the day to try to improve the black ink on the page. – F82* *A lot of people say you can't make it in the long-run if you can't make it in the short-run. So sometimes you have to make decisions for the short-term… but I always try to think about the long-term…. but sometimes we have to make decisions for the short-term. – O10*
Balance Between Outcomes	17% (*n*=4)	*So to be a good manager, you have to think about both… well, you know, business judgement is the short answer to that. – F13* *We try to use just a common-sense approach, and we don't throw everything that we could at it for sure. – F36* *Almost 100% I'm looking at the system for years. I'm not looking short-term. I mean sometimes you have to make decisions to survive. But for the most part, I'm looking at years down the road. – F80* *You always have to have the long-term goals in mind, but you also have to be able to afford to do what you need to do. That's kind of a tradeoff sometimes. But as far as a cover crop goes… that's a short-term and a long-term goal. It works together. – F65*
Consistency of Production Decisions	13% (*n*=3)	*Unfortunately, most of it is kind of one and the same. Most things, we don't change very much. – F103* *It's getting harder and harder. I try to do things whether it looks like it's going to be a good crop or a bad crop… if you don't maintain your crops like you should, 9 times out of 10 you're not gonna make as good a crop as if you followed your regular farming practices. – F96*
Specified Production Decisions	13% (*n*=3)	*If they had a pine tree program now, and would pay me to plant pine trees, I might plant part of my farm in pine trees. – F102* *I just go ahead and… like planting cotton this year. I've got cotton planted and that was stupid. I go ahead with the creatures of habit and hope that the market will change, even though it has not. – F106*

As shown in Table 3.3, answers skewed toward the prioritization of short-term economic outcomes, with 48% (*n*=11) falling under the "Short-term Economic" category. Also, while F80's response was categorized under "Balance Between Outcomes," he still acknowledged that "sometimes [he has to] make decisions to survive." Further, two responses that fell under "Consistency of Production Decisions" referenced specific on-farm decisions, the result of which may not necessarily apply in other decisions. Thus, they were designated to their own separate category. However, F39's answer referenced a choice he made to adjust his crop rotation in response to market prices, which he regretted, and F96's answer described how he prioritizes consistency in his farming practices, regardless of "whether it looks like it's gonna be a good crop or a bad crop;" both responses were in reference to economic outcomes. F103's response was likely economic, as well. He mentions that his short- and long-term goals are "kind of one and the same," but did not offer much further detail. However, when he spoke of stewardship, profitability was a portion of his response. Lastly, farmers whose answers fell under "Specified Production Decisions" responded with specific cases of balancing short- and long-term goals, but the rationale of their responses was not determined to be applicable in all their decision-making. That said, the specific decisions they referenced still prioritized short-term economic outcomes: F102 considered planting a portion of his farm in pine trees; F98 decided not to fertilize his cover crops that year to cut expenses; and F106 decided to maintain his typical rotation and plant cotton, although he regretted it due to low market prices.

3.7.3 FF-CCIP FARMERS' PERCEPTIONS OF THE FUTURE OF THEIR FARMS

FF-CCIP farmers were asked what they perceived their farms might look like in 20–30 years. One participant responded that he expected to use cover crops on the entirety of his farm.

The rest of the answers varied, although many emphasized economic factors as contributing to their reasoning (Table 3.4). Many farmers' responses fell into multiple categories.

Table 3.4. Categories of FF-CCIP farmers' perceptions of their farms in 20–30 years.

Perceived Future of Farm	**Percentage of FF-CCIP Farmers**	**Representative Quote(s)**
Dependent on Generational Transfer	35% (*n*=8)	*It's going to come down to, basically, is it going to worth the effort for the next generation to want to get involved? That'll be something they have to decide. – F22* *I would hope that it would stay in the family, and I would hope that it would continue. But you never know what generations will do. My daddy said one generation will make it and two will break it. – F97*
Shift from Row-Crop Production	30% (*n*=7)	*If it is still here, it may trend toward more of a vegetable or cattle operation. – F103* *Pine trees. Wall to Wall. – F33*
Likely or Potentially Gone	17% (*n*=4)	*The issue with that question is, can we continue to afford to farm and make a living? And right now, what we're facing at this current moment… it's not sustainable. It's not going to last… the last three years or so, the equity has been declining, and we're having to borrow against our equity to stay in business… you can't sustain that for very long. – F65* *20 or 30 years from now, I won't be farming… I just don't see it getting any better… I'm real discouraged about agriculture. – F96*
Uncertain	17% (*n*=4)	*I don't have a clue… I don't have a real good long-term plan in place. – F82* *I don't know. Man, it's hard to make it. I don't farm full-time. I have to supplement other ways. I don't see how people farm for a living. I'm dead serious. – F76*
Maintained As-Is	17% (*n*=4)	*I hope they keep the best land in row crop, and I hope they keep the minimum land in pastures. I hope to keep it just like I got it. That would be my wishes. – F102* *My farm looks exactly like I want it to look in thirty years. – F98*
More Productive	13% (*n*=3)	*Trying to maximize yield potentials in the land that we do have has got to be the bigger focus… hoping that we'll still be able to make progress going forth to make our best ground more productive, to account for losses and overall production growth, for not just our farm, but for the whole area. – F39* *I want to create large, efficient fields. I want them to be minimal passes, minimal inputs as possible. – F80*

Perceived Future of Farm	Percentage of FF-CCIP Farmers	Representative Quote(s)
More Technological	13% (*n*=3)	*I would imagine a lot of automation. Hopefully, high-tech adoption. – F22*

Of the eight FF-CCIP farmers (35%) whose responses were categorized under "Dependent on Generational Transfer," six (26%) referenced generational transfer of their farm within their families as being a factor in the future of their farms but did not speculate on the outcomes. Two, however, responded that they do not expect the farm to remain in the family:

> *I may be the last generation that wants to* [farm]. *I'm 43, and I have a 10-year-old and a 17-year-old, and the oldest doesn't really have any interest. – F103*

> *I have two children… agriculture is not really something they're pursuing… I farm because my dad did, and my granddad, but I'm afraid after me, it may come to an end. – F4*

Of the seven (30%) whose responses fell under "Shift from Row-Crop Production," two farmers (9%) referenced high input prices as contributing to their perceptions, and five (22%) referenced low commodity prices as contributing to their perceptions:

> *When you go into the spring, and you look at the prices of fertilizer, chemicals, fuel, and the market prices of soybeans and especially corn, it looks like you're losing money before you even burn down your cover crop. – F101*

Of the four (17%) who responded that their farm would likely or potentially be gone in the coming decades, three farmers (13%) mentioned other non-agricultural development as contributing to these perceptions (e.g., solar panels, windmills, housing, industry).

3.7.4 FF-CCIP FARMERS' FACTORS FOR FUTURE SUCCESS

FF-CCIP farmers were also asked which factors they focus on to make their desired futures possible. F13 responded that business planning was a primary focus, and F52 responded that faith was a primary focus. F82 responded that he did not have any factors he was focusing to ensure the future success of his farm, but acknowledged, "I need to." The rest of the responses fell into three

categories: 52% of farmers (*n*=12) responded with economic outcomes, 30% (*n*=7) responded with environmental outcomes, and 22% (*n*=5) responded that technology is a factor (Table 3.5). Many responses fell into multiple categories.

Table 3.5. Categories of FF-CCIP farmers' factors for future success.

Factors for Future Success	**Percentage of FF-CCIP Farmers**	**Representative Quote(s)**
Economic Outcomes (Profitability, Financial Viability, Yield, Efficiency)	52% (*n*=12)	*Mainly, kind of controlling our debt… we don't try to spend more than we think our land is capable of producing. – F103* *Right now, just trying to stay alive, whether I have that as an option... and somebody else doesn't decide what the future is. – F33* *Stewardship of the land, I guess, first and foremost. We need it to still be productive…* [we're] *trying to be responsible for the tools that we have and not overuse them to the point where they're no longer available to us. – F39* *Making money. That's the only way to make it successful. – F76*
Environmental Outcomes (Soil Health, Nutrient Retention, Moisture Retention)	30% (*n*=7)	*Get the soil built up best I can. – F104* *We're still trying to do the same practices to make the land better, which includes cover crops, includes using the least amount of chemicals as possible. – F65* *The health of our soil. It all starts there. – F94*
Technology Adoption	22% (*n*=5)	*I think that you have to be progressive in adopting technologies… If you get too far behind, I think that the cost of getting caught up will be so great that it's nearly impossible. – F80* *Irrigation. I'd like to move totally into electric pumps instead of diesel. They're more efficient. – F98*
Specified Approaches	17% (*n*=4)	*I'm probably going to rent it all out to* [a tenant]*, and I'll give him a long-term lease. – F102*
Relationship with Landlord(s)	9% (*n*=2)	*We try to keep our landlords pleased. We try to sort of be able to prove to them that we're managing their resource and trying to maximize their return on their land as much as possible. – F103*

3.7.5 FF-CCIP FARMERS' PERCEPTIONS OF COMMODITY AND INPUT PRICES

Many FF-CCIP farmers directly identified low commodity prices and high input prices as contributing to challenges they face in maintaining financial viability. Nine farmers (39%) identified high input prices as challenging for them, either broadly or regarding specific inputs (e.g., cover crop seed, equipment). Likewise, seven participants (30%) identified low commodity prices as a challenge. Another specifically identified the "profit margin of things" as being a reason why he has to "cater to a high-yield environment." Farmers' sentiments regarding high input prices and low commodity prices are represented in the following quotes:

Our prices have went out the roof on everything, but our prices for our crops have not. And the only way I'm surviving right now, and it's a long time coming, is cattle. Cattle farmers are finally getting rewarded for our production. – F52

The cost of inputs in agriculture right now are astronomical. You can use that word, because it's basically the way it is. – F65

Cover crops seeds are incredibly expensive, especially what I like to plant. – F80

The cotton was down in the 60s, in the high 60s [cents per pound]*, and the soybeans is below $10. And the peanuts are around $450 a ton, and the corn is under $4 a bushel. And by the time you put everything that you need to make a good crop, you just about got to have irrigation to break even… prices are just beating us to death. – F102*

Five (22%) FF-CCIP farmers also speculated on the long-term sustainability of their current commodity production and indicated that they expect a major shift in production to take place at some point. Three farmers stated,

What's probably likely is a shift from your standard commodity production to some other crop… produce crops, something with a little more value. I just currently don't feel like there's a lot of longevity in just doing straight row crop commodities. – F22

Unless the economy changes, and the prices of chemicals and fertilizer change, [the future] *is not going to be row crop… that's just the reality of today… I think things will probably change… you can't stay like this forever. – F101*

Can we continue to afford to farm and make a living? And right now, in what we're facing at this current moment… it's not sustainable. It's not going to last… if something doesn't turn around… the farmland 30 years from now, it's just not going to work like it's going right now. – F65

Three (13%) FF-CCIP farmers speculated on the broader societal impacts of the current state of commodity prices, stating,

I just don't see it getting any better…, all your grain and cotton, everything is rock bottom right now. And it appears that it's not getting any better… I don't see much hope in the farm future, especially at these prices. If these prices stay like they are right now, there's not going to be many farmers left. They simply can't operate under the current prices. – F96

Our country is going to be in a dire situation pretty soon, if something don't change rapidly. – F65

The prices is what's killing everybody… when 1% of the population's farming… I tell you what's going to be the kicker, like this whole ball of wax. You're going to go to the grocery store one day, and then the shelves are going to be empty… that's when you're really gonna be in trouble. – F102

3.8 CONCLUSION

As a part of the FF-CCIP, and the larger FF project, farmers pursued economic and environmental outcomes on their farms—productivity and profitability; soil health and nutrient retention—through the adoption of conservation tools and practices. These dual economic and environmental objectives parallel the objectives put forth by large-scale SI initiatives, which seek to increase production on existing cropland while using practices and strategies that contribute to positive environmental outcomes (Pretty and Bharucha 2014). This section details multiple parallels that were found to exist among the CIG program, the FF project, the FF-CCIP, and large-scale SI initiatives. It also describes parallels found between the perceptions and experiences of FF-CCIP farmers and the goals of SI. Further, it includes a vignette of one participant's experiences to illustrate this parallel between the agricultural treadmill and SI. It concludes with recommendations for productive applications of this study.

First, FF-CCIP farmers' understanding of stewardship reflected many conclusions put forth by the SI literature, in which economic and environmental outcomes are prioritized, and social outcomes are generally less accounted for (Liao and Brown 2018). Environmental outcomes were mentioned by FF-CCIP farmers the most: almost 60% identified specified environmental outcomes, while more than a third described broader conceptualizations of environmental stewardship. Also, 26% situated their understanding of environmental stewardship within a production-based context, which demonstrated the influence of production goals on their views of stewardship. Several FF-CCIP farmers responded to the question regarding stewardship factors with a purely economic response; one of these farmers, F33, effectively dismissed the question of stewardship. Lastly, only two FF-CCIP farmers mentioned social factors (e.g., relationship with landlord, impacts on neighbors) as being included in their understandings of stewardship. One particular characteristic, however, was found to be a common consideration among FF-CCIP farmers regarding the future of their operation: eight (35%) farmers noted that they expected subsequent generations of their family to play a significant role in realizing that future, and two (9%) doubted it would remain in the family.

The second parallel between FF-CCIP farmers and SI was in farmers' responses to how they balance long-term goals with short-term economic viability. Unlike their understandings of stewardship, in which farmers' answers skewed toward environmental outcomes, farmers' responses to how they balance long-term goals with short-term economic viability skewed towards short-term economic outcomes. This represents a potential dissonance between how FF-CCIP farmers conceptualize stewardship and the primarily economic decisions they find themselves forced to make to compete in agricultural treadmill-driven commodity markets (Hendrickson and

James 2005). Nearly half acknowledged that they either prioritize or wholly pursue short-term economic outcomes over long-term goals. As one stated,

There's no such thing as long-term goals anymore. – F33

Similarly, in identifying the factors essential to realize their desired futures, FF-CCIP farmers' responses skewed toward economic outcomes as well: less than a third identified environmental outcomes. These findings suggest that although FF-CCIP farmers may have personal values and objectives that highly prioritize certain environmental outcomes, the need to stay financially viable can outweigh other dimensions of stewardship. Table 3.6 lists three farmers who made separate statements that demonstrate this tradeoff between personal stewardship and the necessity to prioritize short-term economic outcomes.

Table 3.6. FF-CCIP farmers' tradeoffs between stewardship goals and short-term economic outcomes.

Farmer	Personal Stewardship	Prioritization of Short-Term Economic Outcomes
F4	*I want to do practices that help ensure that I'm making the land better. I don't want to be planting something and then robbing everything. I want to build that land year after year after year.*	*I don't know that I have too many long-term goals, other than just being able to stay profitable, to be able to keep doing it year in and year out.*
F95	From handwritten notes: *I want to leave* [my land] *better than I found it.* *I'd love to not have to use as many chemicals. It would be in the best interest of the world.*	From handwritten notes: [Balancing long- and short-term goals] *depends on how much money you made the previous year… I gotta make money.* *Increasing yields is… what it comes down to… increasing yields to stay afloat.*
F97	*We just try to do the best practices possible… what's good for the land and what's good for the environment.*	*Right now, it's tough. I mean, you got to watch everything you do right now… the economic factor, I mean they've got us at such a narrow margin, or even below margin right now.*

FF-CCIP farmers demonstrated that the pressure farmers experience to remain profitable can act at the expense of environmental and social objectives, even if their personal values motivate

them to assign higher priority to these other objectives. Similarly, SI initiatives are often criticized for focusing primarily on production-based outcomes, even if other environmental or social objectives were made explicit (Hunter et al. 2017; Rockström et al. 2017). One participant made a statement regarding his own goals which heavily prioritize economic outcomes, and which parallel the "land-sparing" approach to intensified production put forth by SI (Rudel 2020); he stated that he hopes to "maximize yield potentials in the land that [he] does have… to make [his] best ground more productive."

Findings from this study further suggest that the mechanism by which economic outcomes become prioritized, in both conventional agriculture and SI, occurs as a result of the agricultural treadmill. Both low commodity prices and high input prices are phenomena associated with the agricultural treadmill, and both are factors in capital intensive commodity-based systems and SI systems alike (Hendrickson and James 2005; Thompson 1998:108). High input prices and low commodity prices were mentioned as challenging by 39% and 30% of FF-CCIP farmers, respectively. Others (22%) indicated that they expect the current commodity system to shift at some point, and three (13%) identified broader negative social consequences that may occur if the system does not change. FF-CCIP farmers and the NRCS, who funds the FF-CCIP, demonstrate that many actors and entities in the conventional production system attempt to balance the pursuit of environmental and economic outcomes (and social to some degree) within global commodity markets. This is often true of SI production, as well. Participation within these commodity markets subjects actors and entities—in both conventional and SI production—to similar phenomena: for example, the imperative to pursue ever-increasing efficiency and productivity as a result of falling commodity prices and climbing input prices (Hendrickson and James 2005; Thompson 1998:108).

Increased mechanization through technology adoption is another defining characteristic of the agricultural treadmill and of intensified production systems (Hendrickson and James 2005). More than a third of FF-CCIP farmers made statements regarding the imperative to adopt technology to ensure their farms would be successful into the future. Nearly a quarter (22%) identified irrigation specifically. Ongoing technology adoption was seen by many FF-CCIP farmers as a primary method of increasing resource use efficiencies, and indeed, this same focus on technology was promoted by the FF project and the larger CIG program (Prasad et al. 2019; NRCS and CCC 2019). From the institutional level to the field level, ongoing adoption of technology is often seen as central to ensuring the sustainability of conventional agricultural systems. However, while technology can contribute to the sustainability of a given component of an agricultural system (e.g., water and nutrient use efficiencies), it can further perpetuate the process by which the system as a whole becomes increasingly less sustainable. Both conventional agricultural systems and large-scale SI approaches tend to focus on field-level efficiencies while neglecting higher-level political-economic processes which make the entire systems untenable. Farmers trapped on the agricultural treadmill may see their production systems increase in efficiency as a result of technology, but it is these very efficiencies which drive commodity prices down and force them to further increase their efficiencies each subsequent year (Hendrickson 2015). One FF-CCIP farmer articulated this reality:

I have to either get higher yields or lower my cost or both every year, or I will not be farming. – F80

To illustrate further, F76 articulated many of the impacts the agricultural treadmill can have on conventional farmers. He decided to enroll in the CCIP to achieve resource use efficiencies, and the resulting environmental outcomes, provided by cover crops: erosion prevention, moisture

retention, weed suppression, and increased soil organic matter. The only negatives of using cover crops that he had experienced were, in his words, "getting a stand" and "hav[ing] to fight grasshoppers." Alongside these environmental objectives, however, exists an imperative to continually increase his profitability. He stated,

Making money. That's the only way to make it successful… that's the only thing that will keep you there is to make money. – F76

This participant also said that farming is not his only source of income and that he "[doesn't] see how people farm for a living," indicating that adequate profitability is not an achievable goal for him, even as he pursues "making money" more than any other outcome. He further elaborated the struggle, specifically mentioning high equipment costs and low commodity prices. He said,

The person that's killing us the most is John Deere… it's ridiculous. A sprayer is now 400 or 500 grand… it's ridiculous, and they're not built worth a crap… the money's in the service and fixing the crap… I don't see how people, I mean, you buy a machine that costs a million dollars to pick your cotton, and they're selling the cotton for the same price they sold it for in 1950. That doesn't make very much sense, does it? – F76

In another section of the interview, he offered an analogy similar to the agricultural treadmill, saying,

I feel like a lot of these guys are just a hamster on the hamster wheel man. – F76

F76, like many FF-CCIP farmers and conventional farmers broadly, is participating in an agricultural treadmill-driven system that rewards environmental outcomes only when they double as production efficiencies. This results in conventional farmers rarely prioritizing environmental outcomes except when commodity prices are favorable, which becomes increasingly less common in a system that continually raises the cost of production, while continually decreasing the financial returns on that production (Hendrickson and James 2005).

Entities like the NRCS, which fund conservation agriculture research initiatives and farmer outreach programs, should use this study to better understand the consequences of sustainability programs focused on scaling up or intensifying production (Hendrickson 2015). This study can help these entities understand that farmers' lack of willingness to adopt conservation practices is not necessarily due to a lack of environmental consciousness or stewardship values. FF-CCIP farmers demonstrated that even personal values of stewardship can be subdued by the need to prioritize efficiency and productivity. Political-economic entities' primary focus on assisting farmers in the continual pursuit of greater resource use efficiencies, frequently through the adoption of new technologies, needs to be redirected toward helping farmers escape the agricultural treadmill. In some cases, this escape may involve the use of certain technologies, as well as the adoption of conservation strategies (e.g., cover crops) (LaCanne and Lundgren 2018). It may also involve assisting farmers (e.g., through research, extension, government subsidies) to scale back from input-intensive production and shift toward lower-input production of higher-value crops.

This study should also bolster dialogue between researchers and policymakers by demonstrating that many of the specified priorities of SI (e.g., increased production, increased environmental health) are typical of conventional production, as well. This study helps to demonstrate the processes by which economic outcomes often gain priority over environmental and social outcomes in the global commodity market. Lessons learned from SI initiatives that prioritize local self-sufficiency, agroecological approaches, high-value crops, and "land-sharing" practices, likewise, can assist US entities working to make US commodity agriculture more sustainable (Pretty et al. 2011; Perfecto and Vandermeer 2010; Rudel 2020).

REFERENCES

"About NRCS." N.d. U.S. Department of Agriculture - Conservation Service (NRCS). Retrieved May 19, 2025 (https://www.nrcs.usda.gov/about).

"About USDA." N.d. U.S. Department of Agriculture (USDA). Retrieved May 29, 2025 (https://www.usda.gov/about-usda).

Adetunji, Adewole Tomiwa, Bongani Ncube, Reckson Mulidzi, and Francis Bayo Lewu. 2020. "Management impact and benefit of cover crops on soil quality: A review." *Soil & Tillage Research* 204. DOI: 10.1016/j.still.2020.104717.

Arbuckle Jr., J.G. and G. Roesch-McNally. 2015. "Cover crop adoption in Iowa: The role of perceived practice characteristics." *Journal of Soil and Water Conservation* 70(6):418–429. DOI: 10.2489/jswc.70.6.418.

Baylis, Kathy, Jonathan Coppess, Benjamin M. Gramig, and Paavani Sachdeva. 2022. "Agri-environmental Programs in the United States and Canada." *Review of Environmental Economics and Policy* 16(1):83–104. DOI: 10.1086/718052.

Bergtold, Jason S., Steven Ramsey, Lucas Maddy, and Jeffrey R. Williams. 2017. "A review of economic considerations for cover crops as a conservation practice." *Renewable Agriculture and Food Systems* 34(1):62–72. DOI: 10.1017/S1742170517000278.

Borras Jr., Saturnino M., Ruth Hall, Ian Scoones, Ben White, and Wendy Wolford. 2011. "Towards a better understanding of global land grabbing: an editorial introduction." *The Journal of Peasant Studies* 38(2):209–216. DOI: 10.1080/03066150.2011.559005.

Bressler, Alison, Marta Plumhoff, Lesli Hoey, and Jennifer Blesh. 2021. "Cover Crop Champions: Linking Strategic Communication Approaches with Farmer Networks to Support Cover

Crop Adoption." *Society & Natural Resources* 34(12):1602–1619. DOI: 10.1080/08941920.2021.1980165.

Burr, Charles A., Daran R. Rudnick, Matt C. Stockton, Robert Tigner, and Krystle Rhoades. 2020. "Engaging Farmers and the Agriculture Industry Through the Testing Agricultural Performance Solutions Program." *Journal of Extension* 58(5): Article 13. DOI: 10.34068/joe.58.05.13.

Buttel, F.H. 2000. "Ecological modernization as a social theory." *Geoforum* 31:57–65. DOI: 10.1016/S0016-7185(99)00044-5.

Carolan, Michael. 2022. *The Sociology of Food and Agriculture*. 3rd ed. New York, NY: Routledge.

Chami, Barbara, Meredith T. Niles, Stephen Parry, Steven B. Mirsky, Victoria J. Ackroyd, and Matthew R. Ryan. 2023. "Incentive programs promote cover crop adoption in the northeastern United States." *Agricultural & Environmental Letters* 8. DOI: 10.1002/ael2.20114.

Cochrane, Willard W. 1958. *Farm Prices, Myth and Reality*. Minneapolis, MN: University of Minnesota Press.

"Codes." December 15, 2023. Lumivero. Retrieved May 30, 2025 (https://community.lumivero.com/s/article/NV14Mac-Content-nodes-theme-nodes?language=en_US).

Connor, David J. and M. Inés Mínguez. 2012. "Evolution not revolution of farming systems will best feed and green the world." *Global Food Security* 1:106–113. DOI: 10.1016/j.gfs.2012.10.004.

Cooper, Joseph C. and Russ W. Keim. 1996. “Incentive Payments to Encourage Farmer Adoption of Water Quality Protection Practices.” *American Journal of Agricultural Economics* 78(1):54–64. DOI: 10.2307/1243778.

Darnhofer, Ika, Stéphane Bellon, Benoît Dedieu, and Rebecka Milestad. 2010. “Adaptiveness to enhance the sustainability of farming systems. A review.” *Agronomy for Sustainable Development* 30:545–555. DOI: 10.1051/agro/2009053.

Davis, Kyle F., Jessica A. Gephard, Kyle A. Emery, Allison M. Leach, James N. Galloway, and Paolo D’Odorico. 2016. “Meeting future food demand with current agricultural resources.” *Global Environmental Change* 39:125–132. DOI: 10.1016/j.gloenvcha.2016.05.004.

Dunn, M., J.D. Ulrich-Schad, L.S. Prokopy, R.L. Myers, C.R. Watts, and K. Scanlon. 2016. “Perceptions and use of cover crops among early adopters: Findings from a national survey.” *Journal of Soil and Water Conservation* 71(1):29–40. DOI: 10.2489/jswc.71.1.29.

Fan, Shenggen and Joanna Brzeska. 2016. “Sustainable food security and nutrition: Demystifying conventional beliefs.” *Global Food Security* 11:11–16. DOI: 10.1016/j.gfs.2016.03.005.

Foley, Jonathan A., Navin Ramankutty, Kate A. Brauman, Emily S. Cassidy, James S. Gerber, Matt Johnson, Nathaniel D. Mueller et al. 2011. “Solutions for a cultivated planet.” *Nature* 478:337–342. DOI: 10.1038/nature10452.

Foley, Jonathan A., Ruth DeFries, Gregory P. Asner, Carol Barford, Gordon Bonan, Stephen R. Carpenter, F. Stuart Chapin et al. 2005. “Global Consequences of Land Use.” *Science* 309:570–574. DOI: 10.1126/science.1111772.

Garnett, T., M.C. Appleby, A. Balmford, I.J. Bateman, T.G. Benton, P. Bloomer, B. Burlingame et al. 2013. “Sustainable Intensification in Agriculture: Premises and Policies.” *Science* 341:33–34. DOI: 10.1126/science.1234485.

Giller, Ken E., Renske Hijbeek, Jens A. Andersson, and James Sumberg. 2021. “Regenerative Agriculture: An agronomic perspective.” *Outlook on Agriculture* 50(1):13–25. DOI: 10.1177/0030727021998063.

Guynn, Susan T., W. Kirby Player, and Matthew G. Burns. 2024. “Underserved farmers’ barriers to adoption of the U.S. Department of Agriculture Natural Resources Conservation Service climate-smart agricultural practices in South Carolina.” *Journal of Agriculture, Food Systems, and Community Development* 13(4):121–133. DOI: https://doi.org/10.5304/jafscd.2024.134.008.

Han, Guang and Meredith T. Niles. 2023. “An adoption spectrum for sustainable agriculture practices: A new framework applied to cover crop adoption.” *Agricultural Systems* 212. DOI: 10.1016/j.agsy.2023.103771.

Hansmann, Ralph, Harald A. Mieg, and Peter Frischknecht. 2012. “Principal sustainability components: empirical analysis of synergies between the three pillars of sustainability.” *International Journal of Sustainable Development & World Ecology* 19(5):451–459. DOI: 10.1080/13504509.2012.696220.

Hendrickson, Mary K. 2015. “Resilience in a concentrated and consolidated food system.” *Journal of Environmental Studies and Sciences* 5:418–431. DOI: 10.1007/s13412-015-0292-2.

Hendrickson, Mary K. and Harvey S. James, Jr. 2005. “The Ethics of Constrained Choice: How the Industrialization of Agriculture Impacts Farming and Farmer Behavior.” *Journal of Agricultural and Environmental Ethics* 18:269–291. DOI: 10.1007/s10806-005-0631-5.

Holt-Giménez, Eric, Annie Shattuck, Miguel Altieri, Hans Herren, and Steve Gliessman. 2012. “We Already Grow Enough Food for 10 Billion People… and Still Can’t End Hunger.” *Journal of Sustainable Agriculture* 36:595–598. DOI: 10.1080/10440046.2012.695331.

Hunter, Mitchell C., Richard G. Smith, Meagan E. Schipanski, Lesley W. Atwood, and David A. Mortensen. 2017. “Agriculture in 2050: Recalibrating Targets for Sustainable Intensification.” *Bioscience* 67(4):386–391. DOI: 10.1093/biosci/bix010.

Ikerd, John. 1993. “The need for a systems approach to sustainable agriculture.” *Agriculture, Ecosystems and Environment* 46:147–160. DOI: 10.1016/0167-8809(93)90020-P.

Ikerd, John. 2005. *Sustainable Capitalism: A Matter of Common Sense*. Bloomfield, CT: Kumarian Press, Inc.

Jänicke, Martin. 2008. “Ecological modernisation: new perspectives.” *Journal of Cleaner Production* 16: 557–565. DOI: 10.1016/j.jclepro.2007.02.011.

Johnson, Kenneth M. and Daniel T. Lichter. 2019. “Rural Depopulation: Growth and Decline Processes over the Past Century.” *Rural Sociology* 84(1):3–27. DOI: 10.1111/ruso.12266.

Kaye, Jason P. and Miguel Quemada. 2017. “Using cover crops to mitigate and adapt to climate change. A review.” *Agronomy for Sustainable Development* 37:4. DOI: 10.1007/s13593-016-0410-x.

LaCanne, Claire E. and Johnathan G. Lundgren. 2018. “Regenerative agriculture: merging farming and natural resource conservation profitably.” *PeerJ Life & Environment* 6. DOI: 10.7717/peerj.4428.

Lambin, Eric F. and Patrick Meyfroidt. 2011. “Global land use change, economic globalization, and the looming land scarcity.” *Proceedings of the National Academy of Sciences* 108(9):3465–3472. DOI: 10.1073/pnas.1100480108.

Leopold, Aldo. 1949. “The Land Ethic.” Pp. 201–226 in *A Sand County Almanac*. New York City, NY: Oxford University Press, Inc.

Levins, Richard A. 2003. *Willard Cochrane and the American Family Farm*. Lincoln, NE: University of Nebraska Press.

Liao, Chuan and Daniel G. Brown. 2018 "Assessments of synergistic outcomes from sustainable intensification of agriculture need to include smallholder livelihoods with food production and ecosystem services." *Current Opinion in Environmental Sustainability* 32:53–59. DOI: 10.1016/j.cosust.2018.04.013.

Loos, Jacqueline, David J. Abson, M. Jahi Chappell, Jan Hanspach, Friederike Mikulcak, Muriel Tichit, and Joern Fischer. 2014. "Putting meaning back into 'sustainable intensification.'" *Frontiers in Ecology and the Environment* 12(6):356–361. DOI: 10.1890/130157.

MacMillan, Tom and Tim G. Benton. 2014. "Engage Farmers in Research." *Nature* 509:25–27. DOI: 10.1038/509025a.

Mahon, Niamh, Ian Crute, Eunice Simmons, Md. Mofakkarul Islam. 2017. "Sustainable intensification—'oxymoron' or 'third-way'? A systematic review." *Ecological Indicators* 74:73–97. DOI: 10.1016/j.ecolind.2016.11.001.

Marx, Karl, and Friedrich Engels. (1848) 1967. *The Communist Manifesto*. New York City, NY: Monthly Review.

Matson, Pamela and Peter M. Vitousek. 2006. "Agricultural Intensification: Will Land Spared from Farming be Land Spared for Nature?" *Conservation Biology* 20(3):709–710. DOI: 10.1111/j.1523-1739.2006.00442.x.

Meyfroidt, Patrick. 2018. "Trade-offs between environment and livelihoods: Bridging the global land use and food security discussions." *Global Food Security* 16:9–16. DOI: 10.1016/j.gfs.2017.08.001.

Mueller, Nathaniel D., James S. Gerber, Matt Johnston, Deepak K. Ray, Navin Ramankutty, and Jonathan A. Foley. 2012. “Closing yield gaps through nutrient and water management.” *Nature* 490:254–257. DOI: 10.1038/nature11907.

Myers, Robert, Alan Weber, and Sami Tellatin. 2019. “Cover crop economics: Opportunities to improve your bottom line in row crops.” *SARE Technical Bulletin, Ag Innovation Series*. https://www.sare.org/wp- content/uploads/Cover-Crop-Economics.pdf.

Naess, Arne. 1986. “The Deep Ecological Movement: Some Philosophical Aspects.” *Philosophical Inquiry* 8(1–2):10–31. DOI: 10.5840/philinquiry198681/22.

O’Connor, Cassandra. 2024. “Alabama Agricultural Stakeholders’ Perceptions of Weather and Climate-Based Information and the Influence of these Perceptions on their Decision-Making.” MS Thesis, Department of Agricultural Economics and Rural Sociology, Auburn University.

Perfecto, Ivette and John Vandermeer. 2010. “The agroecological matrix as alternative to the land-sparing/agriculture intensification model.” *Proceedings of the National Academy of Sciences* 107(13):5786–5791. DOI: 10.1073/pnas.0905455107.

Piñiero, Valeria, Joaquín Arias, Jochen Dürr, Pablo Elverdin, Ana María Ibáñez, Alison Kinengyere, Cristian Morales Opazo et al. 2020. “A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes.” *Nature Sustainability* 3:809–820. DOI: 10.1038/s41893-020-00617-y.

Prasad, R., B. Ortiz, A. Gamble, M.R. Worosz, and L. Duzy. 2019. "The Future of Farming: Increasing Adoption of Conservation Practices among Alabama Row Crop Farmers." Conservation Innovation Grants On-Farm Conservation Innovation Trials, Environmental Quality Incentives Program. U.S. Department of Agriculture Natural Resources

Conservation Service (NRCS) and Commodity Credit Corporation (CCC), Washington, DC, 2020-2026.

Pretty, Jules. 1995. “Participatory Learning for Sustainable Agriculture.” *World Development* 23(8):1247–1263. DOI: 10.1016/0305-750X(95)00046-F.

Pretty, Jules. 2018. “Global assessment of agricultural system redesign for sustainable intensification.” *Nature Sustainability* 1:441–446. DOI: 10.1038/s41893-018-0114-0.

Pretty, Jules, Camilla Toulmin, and Stella Williams. 2011. “Sustainable intensification in African agriculture.” *International Journal of Agricultural Sustainability* 9(1):5–24. DOI: 10.3763/ijas.2010.0583.

Pretty, Jules and Zareen Pervez Bharucha. 2014. “Sustainable intensification in agricultural systems.” *Annals of Botany* 144:1571–1596. DOI: 10.1093/aob/mcu205.

Prokopy, L.S., K. Floress, D. Klotthor-Weinkauf, and A. Baumgart-Getz. 2008. “Determinants of agricultural best management practice adoption: Evidence from the literature.” *Journal of Soil and Water Conservation* 63(5):300–311. DOI: 10.2489/jswc.63.5.300.

Prokopy, L.S., K. Floress, J.G. Arbuckle, S.P. Church, F.R. Eanes, Y. Gao, B.M. Gramig, P. Ranjan, and A.S. Singh. 2019. “Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature.” *Journal of Soil and Water Conservation* 74(5):520–534. DOI: 10.2489/jswc.74.5.520.

Purvis, Ben, Yong Mao, and Darren Robinson. 2019. "Three pillars of sustainability: In search of conceptual origins." *Sustainability Science* 14:681–695. DOI: 10.1007/s11625-018-0627-5.

Robinette, McKayla R. 2022. “Maintaining Relevance in Agricultural Extension Programming Using Classical Extension Methods: A Social Network Analysis of the *Future of Farming*

Project." MS Thesis, Department of Agricultural Economics and Rural Sociology, Auburn University.

Rockström, Johan, John Williams, Gretchen Daily, Andrew Noble, Nathanial Matthews, Line Gordon, Hanna Wetterstrand et al. 2017. "Sustainable intensification of agriculture for human prosperity and global sustainability." *Ambio* 46:4-17. DOI: 10.1007/s13280-016-0793-6.

Roesch-McNally, Gabrielle E., Andrea D. Basche, J.G. Arbuckle, John C. Tyndall, Fernando E. Miguez, Troy Bowman, and Rebecca Clay. 2017. "The trouble with cover crops: Farmers' experiences with overcoming barriers to adoption." *Renewable Agriculture and Food Systems* 33(4):322–333. DOI: 10.1017/S1742170517000096.

Rogers, Everett M. 2003. *Diffusion of Innovations*. 5th ed. New York, NY: Free Press.

Rosenberg, Andrew B., Bryan Pratt, and Daniel Szmurlo. 2024. "Impacts of an increase in federal assistance for cover cropping: Evidence from the Environmental Quality Incentives Program." *American Journal of Agricultural Economics* [Early Access]. DOI: 10.1111/ajae.12502.

Rudel, Thomas. 2020. "The variable paths to sustainable intensification in agriculture." *Regional Environmental Change* 20:126. DOI: 10.1007/s10113-020-01720-8.

Schnaiberg, Allan. 1980. *The Environment: From Surplus to Scarcity.* New York, NY: Oxford University Press.

Schulte, Lisa A., Bruce E. Dale, Stefano Bozzetto, Matt Liebman, Glaucia M. Souza, Nick Haddad, Tom L. Richard et al. 2022. "Meeting global challenges with regenerative agriculture producing food and energy." *Nature Sustainability* 5:384–388. DOI: 10.1038/s41893-021-00827-y.

Singh, Ajay, Brian MacGowan, Michael O'Donnell, Bryan Overstreet, Jessica Ulrich-Schad, Michael Dunn, Heidi Klotz, and Linda Prokopy. 2018. "The influence of demonstration sites and field days on adoption of conservation practices." *Journal of Soil and Water Conservation* 73(3):276–283. DOI: 10.2489/jswc.73.3.276.

Stewart, Hannah. 2022. "Co-Developing Climate-Smart Strategies: Enhancing Resiliency Among Alabama Row Crop Producers and Agricultural Stakeholders." MS Thesis, Department of Agricultural Economics and Rural Sociology, Auburn University.

Suhardiman, Diana, Mark Giordano, Lilao Leebouapao, and Oulavanh Keovilignavong. 2016. "Farmers' strategies as building block for rethinking sustainable intensification." *Agriculture and Human Values* 33:563–574. DOI: 10.1007/s10460-015-9638-3.

Šūmane, Sandra, Ilona Kunda, Karlheinz Knickel, Agnes Strauss, Talis Tisenkopfs, Ignacio des Ios Rios, Maria Rivera, Tzruya Chebach, Amit Ashkenazy. 2018. "Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture." *Journal of Rural Studies* 59:232–241. DOI: 10.1016/j.jrurstud.2017.01.020.

Surdoval, Alison, Meha Jain, Erica Blair, Haoyu Wang, and Jennifer Blesh. 2024. "Financial incentive programs and farm diversification with cover crops: Assessing opportunities and challenges." *Environmental Research Letters* 19. DOI: 10.1088/1748-9326/ad35d8.

Tang, Fiona H. M., Manfred Lenzen, Alexander McBratney, and Federico Maggi. 2021. "Risk of pesticide pollution at the global scale." *Nature Geoscience* 14:206–210. DOI: 10.1038/s41561-021-00712-5.

"Testing Ag Performance Solutions." N.d. University of Nebraska – Lincoln (UNL). Retrieved June 24, 2025 (https://taps.unl.edu/).

Thompson, Paul B. 1986. “The Social Goals of Agriculture.” *Agriculture and Human Values* 3:32–42. DOI: 10.1007/BF01535483.

Thompson, Paul B. 1992. “The Varieties of Sustainability.” *Agriculture and Human Values* 9:11–19. DOI: 10.1007/BF02217917.

Thompson, Paul B. 1998. *Agricultural Ethics: Research, Teaching, and Public Policy*. Ames, IA: Iowa State University Press.

Thomson, Allison M., Erle C. Ellis, Héctor Ricardo Grau, Tobias Kuemmerle, Patrick Meyfroidt, Navin Ramankutty, and Gete Zeleke. 2019. “Sustainable intensification in land systems: Trade-offs, scales, and contexts.” *Current Opinion in Environmental Sustainability* 38:37–43. DOI: 10.1016/j.cosust.2019.04.011.

Tilman, David, Christian Balzer, Jason Hill, and Belinda L. Befort. 2011. “Global food demand and the sustainable intensification of agriculture.” *Proceedings of the National Academy of Sciences* 108(50):20260-20264. DOI: 10.1073/pnas.1116437108.

U.S. Department of Agriculture - National Agricultural Statistics Service (NASS). 2024. “2022 Census of Agriculture.” Washington, DC: U.S Department of Agriculture.

U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS). 2019. “Natural Resources Conservation Service Conservation Innovation Grants (CIG) On-Farm Conservation Innovation Trials: Communication Materials for Awardees.” Washington, DC: U.S Department of Agriculture.

U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS). 2016. “Application Evaluation Ranking Tool (AERT).” Washington, DC: U.S. Department of Agriculture.

U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS). 2019.

"Conservation Program Application." Washington, DC: U.S. Department of Agriculture.

U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS). 2020. "CIG_Data." Auburn, AL: U.S Department of Agriculture.

U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS) and Commodity Credit Corporation (CCC). 2019. "Summary Information." *Announcement for Program Funding for NRCS' Conservation Innovation Grants On-Farm Conservation Innovation Trials for Federal fiscal year (FY) 2019*. Washington, DC: U.S Department of Agriculture.

U.S. Department of Agriculture - Sustainable Agriculture Research & Education (SARE), Conservation Technology Information Center, and American Seed Trade Association. 2023. "National Cover Crop Survey Report." Washington, DC: U.S Department of Agriculture.

Appendix A: FF-CCIP Farmers

Table A.1. FF-CCIP farmer demographic data (from FF-CCIP interviews and applications).

Farmer Code	Sex	Application Year	Region (AL)[1]	Total Acreage Farmed (Approx.)[2]	Years Using Cover Crops[3]	FF Project Meetings Attended	Familiarity with FF Project	Stated Interest in Attending Future FF Project Meetings
F94	Male	2021	Central	1200	2 years	0	Unclear	Yes
F76	Male	2021	Central	800	4-5 years	2	None	Yes
F95	Male	2021	Central	900	30 years	0	Unclear	Yes
F22[5]	Male	2021	Central	3500 (row crop); 2500 (pasture and hay)	5 years	1	Yes	Yes
F96	Male	2021	Central	1700	10 years	0	Unclear	Yes
F97	Male	2021	Central	4450 (fluctuates)	10 years	0	Unclear	Yes
F98	Male	2021	South	1200	20 years	0	Unclear	Yes
F33	Male	2021	South	1000	20 years	1	Yes	Yes
F4	Male	2021/2022	South	200	1 year	9	Yes	Yes
F82	Male	2021	South	350	20 years	2	Yes	Yes
F99[4]	Male	2021	South		1 year			
F80	Male	2021	South	400	4 years	4	Yes	Yes
F54	Male	2021	South	1000	8-10 years	5	None	Yes
F100[4]	Male	2021	North					
F39[6]	Male	2021	North	2000	10 years	4	Yes	Yes
F36	Male	2021	North	5000	10 years	1	Yes	None
F13[7]	Female	2021	North	8000	25+ years	2	None	Yes
F101	Male	2022	Central	1400	3 years prior to 2021	0	None	Yes
F102	Male	2022	South	1000	40+ years	0	None	None
F103	Male	2022	North	2750	1 year (2020/2021)	0	Unclear	Yes

Farmer Code	Sex	Application Year	Region (AL)[1]	Total Acreage Farmed (Approx.)[2]	Years Using Cover Crops[3]	FF Project Meetings Attended	Familiarity with FF Project	Stated Interest in Attending Future FF Project Meetings
F104	Male	2022	North	3500	8 years	0	None	Yes
O10	Male	2022	South	1500	8 years	2	Yes	Yes
F106	Male	2022	South	130 (in CCs)	Long time	0	Unclear	None
F52	Male	2022	South	320	5 years	2	Yes	Yes
F65	Male	2022	South	850	5 years	2	None	Yes

[1]North counties: Lawrence, Jackson; Central counties: Autauga, Dallas; South counties: Geneva, Houston. [2]Answers taken directly from FF-CCIP interviews. [3]Answers taken directly from FF-CCIP applications. [4]Farmers unable to be interviewed.

In multiple cases individuals whose names are not on the FF-CCIP applications, but who represent farms enrolled in the FF-CCIP, are also confirmed to have attended FF project events: [5]There are 2 instances of an individual attending as a representative of F22's farm; [6]4 instances of an individual attending as a representative of F39's farm; [7]1 instance of an individual attending as a representative of F13's farm.

Appendix B: FF-CCIP Participant Interview Guide

1. What drew you to the Cover Crop Incentive Program?
2. Have you or do you currently participate in any other incentive programs?
    a. How are the requirements for that program(s) similar or different from the FF-CCIP?
        i. *[if they do not immediately recall the FF-CCIP requirements]* What are the requirements of that program(s)?
    b. Can you describe the enrollment process of that program(s)?
    c. What is the size of the farmland you own and operate?
        i. What is the minimum number of acres an incentive program needs to support for you to consider participating?
3. Did you use ever use CCs before you enrolled in this program?
4. What were your initial goals for enrolling in the FF-CCIP?
    a. Have your goals changed at all from when you first enrolled?
    b. *[if ledger says they graze]* Do you graze on your CCs?
        i. How does grazing change the management practices of these CCs?
5. Have you seen any benefits of having CCs on your farm?
    a. What were your initial goals for adopting CCs?
        i. Have your goals for using CCs changed at all?
    b. Do you plan to continue using CCs after the FF-CCIP ends? Why or why not?
6. Have you participated in any Future of Farming field days or meetings?
    a. If yes, what do you see as the benefits of those meetings?
    b. If no, do you plan to attend any in the future?
    c. Are there other types of production meetings that you go to, formal or informal?
        i. I understand that your time is limited—what is it about this meeting(s) that makes it more of a priority than other meetings?
7. Who do you contact when you need information about CCs?
    a. Why is this your most trusted source of information?
    b. When are you likely to contact this source?
    c. *[feel out during meeting]* Where would you be most likely to communicate with this source?
8. Does talking with other farmers about their practices have any effect on your on-farm decision making (field-level, financial, etc.)?
    a. Do other farmers ask you about your production practices?
        i. *[if not brought up as a practice, specify]* what about CCs?
    b. Do you volunteer information on your production practices?
        i. *[if not brought up as a practice, specify]* what about CCs?
        ii. How are you most likely to share this information?
    c. Is there any information about the use of cover crops you would not be willing to volunteer?
        i. Is there any information on any other production practices you would not be willing to volunteer?
9. Do you talk with Extension county and regional agents about your practices?

    a. Does this have any effect on your on-farm decision making (field-level, financial, etc.)?
    b. Do other Extension county and regional agents ask you about your production practices?
        i. *[if not brought up as a practice, specify]* what about CCs?
10. Do you talk with industry colleagues about your practices (crop consultants, seed dealers, equipment dealers, etc.)?
    a. Does this have any effect on your on-farm decision making (field-level, financial, etc.)?
    b. Do other industry colleagues ask you about your production practices?
        i. *[if not brought up as a practice, specify]* what about CCs?
11. Do you talk with Extension research specialists or university researchers about your practices?
    a. Does this have any effect on your on-farm decision making (field-level, financial, etc.)?
    b. Do other Extension research specialists and university researchers ask you about your production practices?
        i. *[if not brought up as a practice, specify]* what about CCs?
12. We understand that you may be required to manage your rented land differently, but when you think about the "stewardship" of the farmland you own and operate, what are the most important factors you consider?
    a. When you're faced with making on-farm decisions, how do you balance your long-term goals with short-term economic viability?
        i. *[if long-term goals are not brought up]* Thinking 20-30 years from now, or even longer, what might your farm look like?
            1. *[if answer implies farm will still be in the family]* What factors are you focusing on now to make that possible?

Appendix C: FF-CCIP Description

FUTURE OF FARMING

Cover Crops Incentive Program: Description of the Program

Background and Description of the Cover Crops Incentive Program

The Cover Crops Incentive Program is part of a larger project funded through a Conservation Innovation Grant from USDA NRCS titled "The Future of Farming: Increasing Adoption of Conservation Practices among Alabama Row Crop Farms". This project will utilize a systems approach to demonstrate to row crop farmers the combined benefits of cover crops and smart irrigation practices for improving soil health and water- and nutrient-use efficiency while conserving water and energy. Edge-of-the-field monitoring and nutrient budgets will be included to demonstrate reduction in nutrient losses from combined cover crop and smart irrigation practices. In addition, on-farm trials will be used as learning nodes for training and studying the barriers and limitations to adoption of cover crop systems and smart irrigation practices. Several farmers' engagement approaches (one-to-one meetings, small group meetings, field days, workshops) will be used to increase knowledge and adoption of these new practices. The barriers to adoption will be studied through interaction of cooperating farmers and meeting participants. The overall goal of the project is to increase the adoption of environmentally sound, sustainable practices related to conserving soil, water, and nutrients.

The Future of Farming Cover Crops Incentive Program is open to producers in 18 counties in north, central, and south Alabama. Participants will work directly with the Future of Farming cover crop team to develop a cover crop plan that addresses resource concerns and cropping systems specific to the participating producer.

Contract Duration and Payment

The program will be open for applications from June 1 to June 30, 2021. An application may include from 25 to 50 acres of cultivated cropland that is in rotation with corn, cotton, peanuts, and/or soybeans. The enrolled field must be within the program counties (Figure 1). Participants with approved applications will receive:

- $50 per enrolled acre for 3 years,
- Customized cover crop recommendations to address identified resource concern, and
- Access to experts and other growers with cover crop experience.

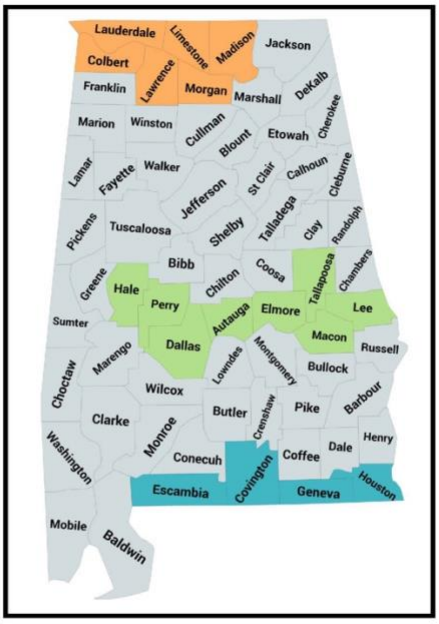

Figure 1. Program counties open for enrollment.

Appendix D: FF-CCIP Expectations and Criteria

FUTURE OF FARMING

Cover Crops Incentive Program: Expectations and Criteria

Expectations and Criteria for Participation

- ☐ Must be EQIP eligible.
- ☐ Must be willing to share your experience with the Future of Farming Team and other participating producers.
- ☐ Must be willing to attend Cover Crop Workshops organized by the Future of Farming Team.
- ☐ Must be willing to complete an annual survey on cover crop management with the Future Farming Team.
- ☐ Must keep records according to the ***Cover Crop Documentation Guidelines.***
- ☐ Plant and manage cover crops according to methods recommended by the Future of Farming Team.
- ☐ During the project cycle (3 years), notify the Future of Farming Cover Crop Team of any planned changes to crops, crop rotations, and/or management of the field to determine if the cover crop recommendation needs to be adjusted.

General Expectations and Criteria for Management of Cover Crops

- ☐ Conservation tillage must be utilized (at least 30% residue remaining after cover crop termination).
- ☐ Cover crop cannot be burned.
- ☐ Cover crop cannot be harvested.
- ☐ Grazing is allowed after a prescription grazing plan is developed by the Future of Farming Team.
- ☐ If specific rhizobium bacteria for selected legumes are not present in the soil, treat seed with appropriate inoculum at time of planting.

The Future of Farming Cover Crop Team will:

- ☐ Assist the participant with identifying the resource concern(s) and objective(s) of adopting cover crops based on the anticipated cropping system.
- ☐ Recommend a cover crop specie(s), seedbed preparation, seeding rates, seeding dates, seeding depths, fertility requirements, and planting and termination methods and timing.
- ☐ Review herbicides used in the cropping systems to verify compatibility with cover crop selection.
- ☐ If required, assist with developing a grazing plan that incorporates cover crops.

Appendix E: FF-CCIP Applicant Questionnaire

FUTURE OF FARMING

Cover Crop Questionnaire

Cover Crop Incentive Program - CIG

This questionnaire will be filed with the applicant's complete application package.

What are the top three benefits you would like to achieve with cover crops in the list below (*only check three*)?	☐Fight Erosion ☐Suppress Weeds ☐Build Soil Health ☐Provide Extra Nitrogen ☐Conserve Soil Moisture ☐Scavenge Nutrients ☐Reduce Soil Compaction ☐Provide Grazing ☐Other: Click or tap here to enter text.
Have you ever planted cover crops?	☐ Yes ☐ No
Have you planted cover crops within the past 5 years?	☐ Yes ☐ No
If you answered "Yes" to the previous question, please proceed to answer questions below. *If you answered "No" to the previous question, STOP HERE. You have completed this form.*	
How long have you planted cover crops?	Click or tap here to enter text.
What species of cover crops have you planted?	Click or tap here to enter text.
At what seeding rates have you planted these cover crops?	Click or tap here to enter text.

In what crop rotation(s) do you currently plant cover crops?	Click or tap here to enter text.
Do you fertilize your cover crop?	Click or tap here to enter text.
How do you terminate your cover crop?	Click or tap here to enter text.
Do you graze cover crops?	Click or tap here to enter text.
What is your greatest challenge in managing your cover crop?	Click or tap here to enter text.

Appendix F: FF-CCIP Programmatic Screening

Programmatic Screening:

Cover Crop Incentive Program - CIG

This screening will be filed with the applicant's complete application package.

Applicant Information:	
Applicant Name:Click or tap here to enter text.	County:Click or tap here to enter text.
Application No:Click or tap here to enter text.	Field Office:Click or tap here to enter text.
Evaluator Name:Click or tap here to enter text.	Date:Click or tap here to enter text.

Eligibility Determination – Select One:	
All boxes must be checked to be eligible ☐ The offered acreage is currently in cultivated cropland that is in rotation with the following crops: corn, cotton, peanut, or soybean. ☐ Participant is willing to share their experiences with cover crop management with the Future of Farming Team at Auburn University and other participating producers ☐ Participant agrees to complete an annual survey on cover crop management with the Future of Farming Team at Auburn University ☐ Participant is willing to attend annual Cover Crop Workshops organized by Future of Farming Team at Auburn University	Eligible
All other applications	Ineligible

D.C. Approval:	Click or tap here to enter text.	Date Approved:	Click or tap here to enter text.

Appendix G: FF-CCIP Ranking Document

CIG Cover Crop Incentive Program
Ranking Document

Issue Questions	Responses
1. The applicant has not planted cover crops in the past 5 years.	
2. The majority of the field where the practice will be installed is classified as HEL	75 Point(s)
3. Will the offered acres address water quality impairments? Must be in a 12 digit watershed with a stream segment on the ADEM 303d list due to pollution from agricultural source (GIS layer "AL2016 303d_line") or a TMDL stream with an agricultural related pollutant (GIS layer "2016_AL_approved_TMDLs_lines") ?	50 Point(s)
4. Will the offered acres benefit T&E aquatic species within a Strategic Habitat Unit (GIS polygon layer "SHUs" or within 1 mile upstream of Critical Habitat (GIS layer "crithab_line")? (8 points)	50 Point(s)
Final Ranking Score	

This ranking report is for your information. It does not in any way guarantee funding. When funding becomes available, you will be notified if your application is selected for funding. Some changes to the application may be required before a final contract is awarded.

Appendix H: FF-CCIP Management Recommendations (Example from F36)

Cover Crops Incentive Program: Cover Crop Recommendations

[redacted]: Cover Crop Recommendations

Cover crop specie(s) recommended: Small Grain / Legume mixture

Consider planting early maturing cover crop varieties before corn. Examples of early maturing small grains include FL401 rye, FL104 rye, or Legend oat. An example of an early maturing legume is AU sunrise crimson clover. For a list of local seed suppliers, see page 3.

Seeding rate: Drilled—20 lbs small grain per acre + 10 lbs crimson clover per acre
Broadcast—40 lbs small grain per acre + 15 lbs crimson clover per acre

Rye has the highest likelihood of broadcast seeding success of any of the small grains.

Planting date: October 15 - November 15

If environmental conditions prevent planting before November 15, please contact the Future of Farming Team.

Seeding depth (if drilled): 1 to 2 in.

Fertility requirements: NA

Termination: Chemical termination 2-3 weeks ahead of plant is recommended. Cover crops may be terminated *no earlier than 4 weeks* ahead of cash crop planting.

*Note: If possible, rolling of cover crops is recommended to create a thick, uniform mat of residue to aid with weed suppression and soil moisture retention.

General Expectations and Criteria for Management of Cover Crops

- Conservation tillage must be utilized (at least 30% residue remaining after cover crop termination).
- Cover crop cannot be burned.
- Cover crop cannot be harvested.
- Grazing is allowed after a prescription grazing plan is developed by the Future of Farming Team.
- If specific rhizobium bacteria for selected legumes are not present in the soil, treat seed with appropriate inoculum at time of planting.
- Must keep records according to the ***Cover Crop Documentation Guidelines*** (next page).

For questions about cover crop management, contact the Future of Farming Team at:

email: covercrop@auburn.edu
phone: (334) 703-7901

1

Cover Crop Documentation

Cover Crop Incentive Program - CIG

County	[redacted]
Participant	[redacted]

Site specific cover crop management information.

Tract/Field	Cash Crop Before and After Cover Crop	Cover Crop Species (list varieties if possible)	Seeding Rate (lb/ac) & depth (in)	Seeding Date	Method D=Drill B=Broadcast A=Aerial (list any tillage)	Cover Crop Termination Date/Stage	Cover Crop Height at Termination and (estimated biomass)	Fertilizer type and rate (if applied)	Seed tags/receipts and photo documentation attached*

*- Seed tags are needed to document species/varieties. Receipts are only needed to document the quantity of seed purchased to verify seeding rates.

Appendix J: FF Project Stakeholder Events

Table J.1. FF project stakeholder events (O'Connor 2024). Data from attendance sheets and participant observation.

Event	Date	Participants (total)	Participants[1] (types)	Length	Description
S AL Focus Group Meeting	9/24/20	*n*=21	EA=2, ER=3, F=9, R=7	2:05:49	Discussion about barriers and limitations to adopting conservation strategies
N AL Focus Group Meeting	12/7/20	*n*=21	CC=2, EA=4, ER=3, F=3, G=4, R=5	1:41:00	Discussion about barriers and limitations to adopting conservation strategies
C AL Focus Group Meeting	12/9/20	*n*=17	CC=1, EA=1, ER=3, F=5, G=1, R=6	4:00:00	Discussion about barriers and limitations to adopting conservation strategies
C AL Cover Crop Field Day	2/17/21	*n*=25	CC=3, EA=2, ER=3, F=10, G=2, R=5	4:00:00	Introductions and explored cover crop demo sites
S AL Cover Crop Field Day	3/3/21	*n*=23	EA=3, ER=5, F=8, G=2, R=5	4:00:00	Introductions and explored cover crop demo sites
N AL Cover Crop Field Day	3/8/21	*n*=20	CC=2, EA=3, ER=4, F=5, G=1, R=5	4:00:00	Introductions and explored cover crop demo sites
C AL Irrigation Field Day	6/3/21	*n*=25	EA=3, ER=1, F=4, G=3, R=14	4:15:00	Introductions and small groups discussed irrigation scenarios, followed by a debrief
S AL Irrigation Field Day	6/15/21	*n*=22	EA=3, ER=4 F=3, G=3, R=9	3:30:00	Introductions and small groups discussed irrigation scenarios, followed by a debrief
N AL Irrigation Field Day	7/15/21	*n*=27	CC=1, EA=3, ER=4, F=8, G=3, R=8	3:30:00	Introductions and small groups discussed irrigation scenarios, followed by a debrief
C AL Nutrient Mgt Field Day	12/2/21	*n*=31	CC=4, EA=3, ER=7, F=7, G=2, R=8	4:00:00	Presentations from CCs and ERs and observations and ratings of chicken litter samples.
S AL Nutrient Mgt Field Day	12/9/21	*n*=45	CC=3, EA=6, ER=3, F=24, G=2, R=7	4:00:00	Panel discussion with CCs and EAs
C AL Cover Crop Producers meeting	3/1/22	*n*=15	CC=2, EA=1, ER=3, F=3, R=6	1:10:00	Explored cover crops, discussions among participants in fields

Event	Date	Participants (total)	Participants[1] (types)	Length	Description
S AL Cover Crop Producers meeting	3/16/22	*n*=13	CC=2, EA=1, ER=3, F=3, R=6	2:00:00	Explored cover crops, discussions among participants in fields
N AL Irrigation Field Day	7/12/22	*n*=36	CC=4, EA=2, ER=2, F=4, G=5, R=17, O=1	3:00:00	Explored producers' fields, discussion of irrigation strategies at each site
S AL Irrigation Field Day	8/10/22	*n*=25	C=1, EA=2, ER=2, F=11, G=1, R=8	1:30:00	Expert presentation, discussions among participants
S AL Nutrient Mgt Field Day	11/16/22	*n*=35	CC=3, EA=5, ER=2, F=12, G=1, R=8, O=6	1:32:00	Discussions among participants
C AL Nutrient Mgt Field Day	12/6/22	*n*=14	ER=2, F=2, G=1, R=8, O=1	1:57:07	Discussions among participants
S AL Cover Crop Producers meeting	3/10/23	*n*=36	F+R=1, EA=3, ER=2, F=8, G=4, R=11, O=6	3:45:00	Explored cover crop demo sites, farmer led discussions
S AL Irrigation Field Day	6/26/23	*n*=56	CC=5, R+O=1. F+G=2, F+O=2, EA=4, ER=2, F=9, G=9, R=10, O=10	4:00:00	Sustainability indicators game, discussions among participants
C AL Irrigation Field Day	7/19/23	*n*=47	ER+G=1, F+EA=1, F+R=1, EA=1, ER=2, F=10, G=9, R=13, O=9	3:30:00	Sustainability indicators game, discussions among participants
N AL Nutrient Management Field Day	11/27/23	*n*=40	ER=3, O=3, R=6, EA=6, G=6, CC=6, F=9, CC+G=1	2:30:00	Stakeholder nutrient management panel, discussions among participants
C AL Nutrient Management Field Day	12/7/23	*n*=19	ER=2, O=1, R=6, EA=2, G=2, CC=2, F=2, F+R=2	2:15:00	Stakeholder nutrient management panel, discussions among participants
S AL Nutrient Management Field Day	12/11/23	*n*=44	EA=2, ER=3, F=15, G=1, R=12, CC+F=1, F+G=1, CC=3, O=6	2:00:00	Stakeholder nutrient management panel, discussions among participants
S AL Cover Crop Field Day	3/15/24	*n*=63	EA=5, EA+F=1, ER=2, R=23, G=13, CC=2, CC+F=1, O=10, F=5, G+O=1	5:00:00	Explored cover crop demo sites, expert presentations, stakeholder cover crop incentive programs panel
S AL Irrigation Field Day	8/30/24	*n*=53	R=12, G=16, O=8, F=1, ER=2, EA=4, R+O=1, G+O=1, F=G=2, F+O=1	4:30:00	Expert presentations, discussions among participants

Event	Date	Participants (total)	Participants[1] (types)	Length	Description
FF Project Symposium	9/13/24	*n*=62	F=3, O=15, F+R=1, G=4, R=31, EA=1, ER=3	6:45:00	Expert presentations, discussions among participants
C AL Nutrient Management Field Day	12/4/24	*n*=24	R=9, ER=4, EA=6, O=2, G=3	2:15:00	Expert presentations, discussions among participants
N AL Nutrient Management Field Day	12/5/24	*n*=30	EA=9, ER=3, G=3, R=5, F=6, CC= 3, O=1	2:30:00	Expert presentations, discussions among participants
S AL Nutrient Management Field Day	12/16/24	*n*=29	ER=3, R=8, O=3, F=5, G=4, CC= 1, EA=2, F+O=2, CC+O=1	2:12:00	Expert presentations, discussions among participants
[1]*Crop Consultant = CC; Extension Field Agent = EA, Farmer = F, Government = G, Researchers = R, Extension Specialists = ER, Other = O*					

Appendix K: FF Project Description

The Future of Farming (FF) project is funded through a USDA-NRCS Conservation Innovation Grant (CIG) which began in 2020 and will end in 2026. The FF project is administered through Auburn University and is focused on the implementation of three areas of conservation practices on medium- and large-scale Alabama row crop farms. These areas are (1) cover crops, (2) smart irrigation technologies (i.e., variable-rate irrigation, soil moisture sensors), and (3) nutrient management strategies (i.e, nutrient budgets, edge-of-field monitoring). Three of the principal investigators (PIs) are members of the Crop, Soil, and Environmental Science department at Auburn University (two are Extension specialists and one is a researcher), and another PI is a researcher in the Department of Agricultural Economics and Rural Sociology, also at Auburn University. The team also includes an agricultural economist who is an external consultant and serves as a PI. Also involved in the project are farmers, Extension agents, USDA-NRCS affiliates, graduate students, postdoctoral fellows, and agriculture industry professionals (Prasad et al. 2019).

The FF project has three main components: (1) demonstration plots (n=3) on cooperating farmer's fields in north, central, and south Alabama, where the different conservation technologies are tested, (2) stakeholder-involved events (i.e., meetings, field days), and (3) a cover crop incentive program (FF-CCIP). A primary requirement in the CIG Request for Proposals was that grantees "stimulate the adoption and evaluation of innovative conservation approaches *in partnership with agricultural producers*" (emphasis added) (NRCS and CCC 2019:1). This requirement has been operationalized through numerous workshops, field days, meetings, symposia, and interviews with all stakeholder groups (Appendix J).

Appendix L: FF-CCIP Background

Component 3 of the Future of Farming project is the cover crop incentive program (FF-CCIP), in which participating farmers receive a payment for planting cover crops on their fields during the non-harvest season. Cover crop mixes are tailored specifically to the farmers' stated interests (e.g., moisture retention, weed suppression, erosion prevention), and farmers receive a payment of $50 per acre for up to four years (minimum 25 acres; maximum 100 acres). Farmers' plots must have in rotation one or more of corn, cotton, peanuts, and soybeans. The program has secondary requirements for participating as well, such as "Plant and manage cover crops according to methods recommended by the Future of Farming Team" and "Cover crop cannot be burned."

There are currently 33 farms enrolled in the FF-CCIP. Three others were accepted into the program but ultimately withdrew their applications because they were unwilling to follow the management practices recommended by the FF project team. Two others (F99, F100) withdrew from the program after a year of participating and were unresponsive to requests to participate in this study. Among the 33 enrolled farms, there are four instances in which multiple enrolled farms are managed by the same individual: F94 manages the applications of two enrolled farms; F96 manages the applications of four enrolled farms; F97 manages the applications of two enrolled farms; and O10 manages the applications of six enrolled farms. Thus, while there are 33 enrolled farms, only 23 interviews with FF-CCIP enrollees were conducted for this study (Table A.1).

L.1 FF-CCIP ADMINISTRATION

Funding for the FF-CCIP is allocated through the USDA-NRCS Conservation Innovation Grant (CIG) program, although the administration of the program uses existing NRCS application, enrollment, verification, and coordination processes. In particular, the FF-CCIP uses processes also used to administer the NRCS Environmental Quality Incentives Program (EQIP). To

determine application priority, FF-CCIP applicants were required to fill out a ranking document (Appendix G), which requests information related to certain NRCS conservation priorities—these questions were taken directly from NRCS's Application Evaluation Ranking Tool (AERT) that is used in EQIP enrollment (USDA-NRCS 2016). Applicants were also required to fill out the NRCS Conservation Program Application (NRCS CPA 1200), another document used in the EQIP enrollment process (USDA-NRCS 2019). NRCS assisted in the development of the FF-CCIP verification document, as well (Appendix I).

NRCS also plays a significant role in the coordination of the FF-CCIP. ER1, the Co-PI who directs the FF-CCIP, gave a presentation on 5/14/21 to FF project team members, NRCS representatives, and Alabama Soil & Water Conservation Committee (ASWCC) representatives; in the presentation, ER1 identified the role of each relevant party (Figure L.1).

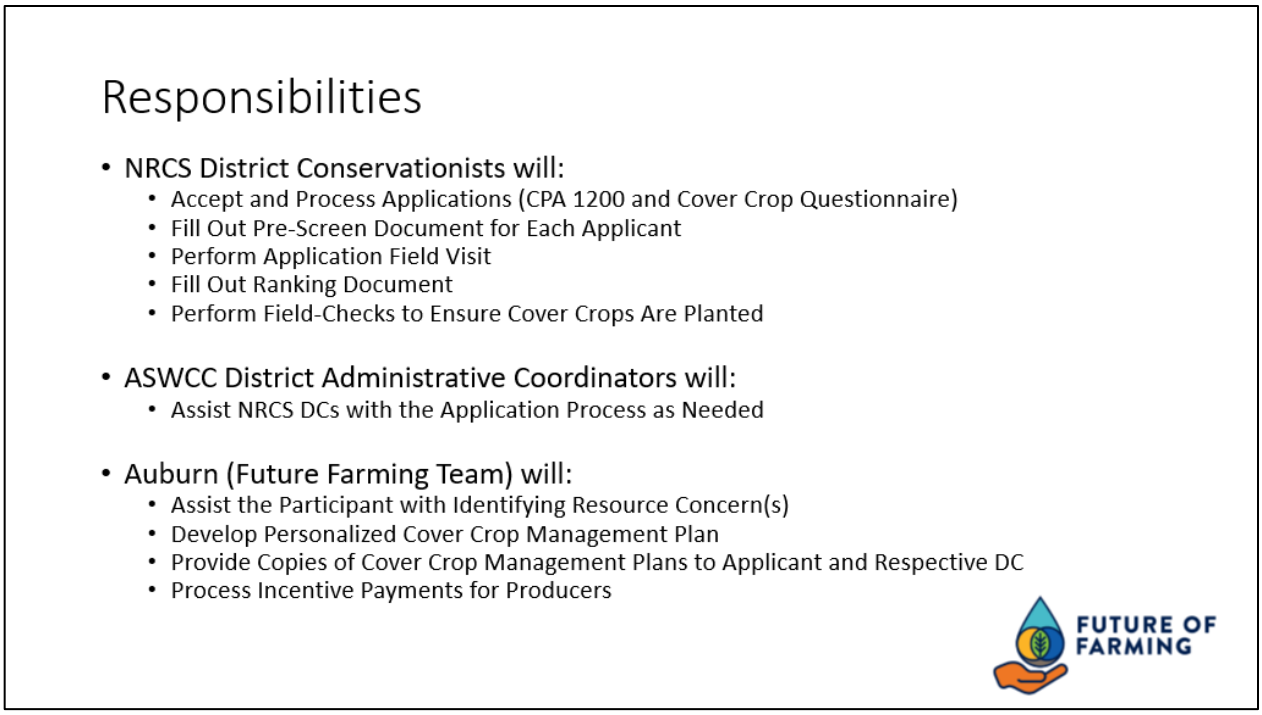

Figure L.1. Slide from ER1's presentation describing the administrative structure and design of the FF-CCIP.

Because the FF-CCIP spans the entire state (Appendix C), and the members of the FF project team devoted to the FF-CCIP are few, assistance from NRCS in the coordination of the program has been instrumental. NRCS District Conservationists (DCs) especially, have done significant work to inform farmers in their networks about the program, assist farmers throughout the enrollment process, and verify their eligibility. The Alabama Cooperative Extension Service (ACES) has also played an important role in promoting the FF project, and many ACES affiliates have attended FF project events (Appendix J).

L.2 FF-CCIP DESIGN PROCESS

There are a number of important considerations regarding the initial design of the FF-CCIP which must be addressed in order to offer informed interpretations of the data and informed conclusions related the overall effectiveness of the FF-CCIP to increase cover crop adoption.

L.2.1 FUNDING

The total budget of the FF-CCIP is $472,500 and was originally intended to support an equal number of farms (n=63) in north, south, and central Alabama. Each region was allocated $157,000 to support twenty-one enrollees, with each enrollee receiving a maximum of $7,500 over the course of the three-year program (the FF-CCIP has since provided enrollees a one-year extension). In the hypothetical scenario is which these numbers were calculated, each enrollee would receive payments on the maximum number of acres possible, which is 50 acres. If some farmers chose not to enroll 50 acres, then there would be surplus funds to potentially support another applicant. Also, if one of the regions did not enroll the maximum number of applicants (n=21), there would be surplus funds which could then go to support additional applicants in the other regions. The funding was divided up evenly among the three regions but was done so with

the expectation that it would likely need to be reallocated depending on the number of eligible applicants.

Also, within each region, funding ($157,500) was set aside to support applicants which qualified as "historically underserved," applicants who had never used cover crops, and applicants who sought funding for a higher level of cover crop management (e.g., increasing the number of species in their cover crop seed mix) (USDA-NRCS 2019). As with the overall program, the expectation was that each region's funds would likely need to be reallocated depending on the number and eligibility of the applicants. Enrollment was well under the expected number, as there are only 33 participant farms, which left a significant amount of unused funds. Because many enrollees requested the maximum acreage be raised, and because there were funds available, the FF project team agreed to raise the maximum number of enrolled acres from 50 to 100 in the second year of the program.

L.2.2 ADDITIONAL FACTORS FOR FF-CCIP ELIGIBILITY

There were multiple factors involved in determining Alabama counties eligible for FF-CCIP enrollment (Appendix C). These counties were chosen for three primary reasons. First, the FF project team wanted FF-CCIP enrollees to have access to the learning networks created by the field days and meetings (Prasad et al. 2019:10). These meetings are held at or near cooperating farmers' fields (n=3), in counties in north, central, and south Alabama. As a result, these and neighboring counties were included as eligible for FF-CCIP enrollment. Second, the number of acres in cover crops as a percentage of total cropland played a factor. Because of funding and coordination constraints, the FF project team elected to exclude counties that already had high rates of cover crop adoption or had low row crop acreage overall. Third, past data on county EQIP programs demonstrated the high variability of applications and enrollment among counties. For

example, in fiscal year 2020, only 29 counties (43%) received EQIP applications, and only 8 counties (12%) funded one or more applications (USDA-NRCS 2020). This further validated the FF project team's reasoning to include counties that demonstrated the highest potential to increase cover crop adoption, and to exclude counties that demonstrated the lowest potential.

Related to the three previous factors, enrollment numbers in each county depended heavily on how active local DCs were in promoting the program and helping farmers through the application process. Alabama's natural resource base is highly diverse, and because NRCS works across the range of the state's environmental concerns, responsibilities and priorities of individual DCs can vary dramatically. It is difficult to assess and measure how much of a priority promoting the FF-CCIP was to each participating DC. Also, the FF-CCIP qualifies, effectively, as an EQIP program, and EQIP programs have restrictions on how many years individual farmers can enroll. In the case of the FF-CCIP, if applicants had already exhausted their eligibility for a separate EQIP program, they were considered ineligible for the FF-CCIP program, as well. These criteria may have further limited the number of farmers eligible to enroll.

The last factor of FF-CCIP eligibility, which requires explanation, relates to two expectations of FF-CCIP participants: (1) they "must be willing to share your experience with the Future of Farming Team and other participating producers" and (2) they "must be willing to attend Cover Crop Workshops organized by the Future of Farming Team" (Appendices D and J). During the process of designing and conducting this study, questions arose as to why enrollees were required to "be willing" to meet these expectations, rather than simply being required to meet them—especially considering that there are other concrete requirements of the program (e.g., that cover crop management practices be verified; see Appendix I). ER1, a Co-PI, explained that it would be difficult to fully require enrollees to meet these expectations, as farmers' schedules tend

to be highly unpredictable. It was considered preferable to require that they are willing to meet these expectations, rather than have their eligibility contingent on meeting them.

L.2.3 FF-CCIP APPLICATION DOCUMENTS

FF-CCIP participants were required to read and/or fill out several documents as a part of their applications and throughout their enrollment in the FF-CCIP. These documents are listed and described in Table L.1 below.

Table L.1. FF-CCIP application and enrollment documents.

FF-CCIP Document	**Description**	**Location**
FF-CCIP Program Description	Included in application; describes the FF project, its objectives, and the FF-CCIP "Contract Duration and Payment" details	Appendix C
Expectations and Criteria Document	Included in application; lists requirements for eligibility, expectations of participants and their cover crop management methods, and expectations participants can have of how the FF project team will assist them	Appendix D
USDA-NRCS Conservation Program Application	Included in application; primarily requests legal information on the land being enrolled and basic information on its management	(USDA-NRCS 2019)
Applicant Questionnaire	Included in application; requests information related to applicants' past and current cover crop usage and the benefits of cover crops most relevant to them	Appendix E
Programmatic Screening Document	Included in application; requires applicants agree (by checking boxes) to the FF-CCIP "eligibility determinants;" each document is approved (by signature) by the applicant's local NRCS District Conservationist	Appendix F
Ranking Document	Included in application; requires applicants identify whether the land they are enrolling in the FF-CCIP has certain physical characteristics relevant to the NRCS's conservation priorities; applicants are given a ranking score based on the presence of these characteristics on their land	Appendix G

FF-CCIP Document	Description	Location
Recommendations Document	Developed after successful application and enrollment; describes cover crops species and management techniques to which participants are required to adhere; reiterates several expectations of participants found in the "expectations and criteria" document	Appendix H
Verification Document	Filled out after each year of enrollment; participants record their cover crop management practices for the year and attach photos of seed tags/receipts	Appendix I

Appendix M: FF Project Documents

Table M.1. Information on the FF project documents collected.

Document Title	Data Analysis Code	Document Developer	Description of Document	Citation
FF project abstract	FF_1	FF project PIs	Brief description of FF project	Prasad et al. 2019
FF project description	FF_2	FF project PIs	Detailed description of FF project	Prasad et al. 2019
FF project budget narrative	FF_3	FF project PIs	Detailed budget for FF project	Prasad et al. 2019
FF-CCIP program description	FF-CCIP_1	FF project PIs; NRCS	Detailed description of FF-CCIP	Appendix C
FF-CCIP "expectations and criteria" document	FF-CCIP_2	FF project PIs; NRCS	Listed expectations of FF-CCIP farmers and criteria for FF-CCIP eligibility	Appendix D
CIG request for proposals	CIG_1	NRCS	Detailed description of 2019 CIG grant and criteria for eligibility	NRCS and CCC 2019
CIG grantee communication materials	CIG_2	NRCS	CIG information to be used for public communication and promotional materials	NRCS 2019