A MIXED METHOD APPROACH TO EXPLORING LANDOWNER INTEREST IN WOODY PLANTINGS TO INTEGRATE CONSERVATION AND PRODUCTION ON MISSOURI FARMS

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RAELIN KRONENBERG

Dr. Sarah Lovell, Thesis Supervisor

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

A MIXED METHOD APPROACH TO EXPLORING LANDOWNER INTEREST IN WOODY PLANTINGS TO INTEGRATE CONSERVATION AND PRODUCTION ON MISSOURI FARMS

Presented by Raelin Kronenberg,

a candidate for the degree of Master of Science

and hereby certify that, in their opinion, it is worthy of acceptance.

Professor Sarah Lovell

Professor Mike Gold

Professor Corinne Valdivia

DEDICATION

I dedicate this thesis to my parents, who always believed in me and pushed me to do my best, and to my partner for being there through the tough days and celebrating the good ones. I could not have done this without all your unending love and support. Thank you.

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LIST OF ABBREVIATIONS AND DEFINITIONS

Agroforestry - the intentional planting and management of trees with crops and/or livestock (Raedeke et al*.* 2003, Wilson and Lovell 2016, Schoeneberger et al*.,* 2017).

Conservation Reserve Program (CRP) - a federal conservation program that pays farmers to set aside vulnerable or marginal pieces for 10 to 15-years (Hellerstein, 2017).

Conservation Stewardship Program (CSP) – a federal conservation program that provides payments to farmers for working towards whole-farm resource goals (Stanek and Lovell, 2019).

Environmental Quality Incentives Program (EQIP) – a federal conservation program that provides funding to support agricultural production, forest management, and environmental quality as simultaneously compatible goals. (Stubbs, 2011).

Farmer – We define farmer as the person actively farming the land. They may either lease, rent, or own the land they work.

Habitus and Field Framework – a framework for understanding human behavior that considers both the influences on the decision maker and the Bourdieu's habitus, or the deposition to act as influenced by the socialization and interactions they experience (Valdivia et al., 2009).

Landowner – We refer to landowner as the person who legally owns the land. For this research, we focus on landowning farmers or those that both own and work the land.

Land sparing conservation – an approach to conservation where an area of land is set aside with the sole purpose of conservation. (Fischer et al., 2014, Kremen, 2015).

Land sharing conservation – this approach strives to integrate conservation into human-dominated landscapes, such as agriculture, for the benefit of both people and wildlife (Phalan et al., 2011).

Multifunctionality Analytic Framework – a framework that explores the multiple economic, social, and environmental services a landscape provides (Lovell and Johnston, 2009b, Barbieri and Valdivia, 2010b, Valdivia et al*.,* 2012).

National Agricultural Statistics Service (NASS) – a branch of the Department of Agriculture that conducts yearly surveys and prepares reports covering virtually every aspect of U.S. agriculture.

National Wild Turkey Federation (NWTF) – a national organization with the mission of conserving wildlife habitat and preserving hunting heritage.

Natural Resource Conservation Service (NRCS) – a part of the United States Department of Agriculture that provides farmers and ranchers with financial and technical assistance to establish conservation practices on their farm/ranch.

Natural Resource Professional – refers to staff employed by natural resource and conservation-oriented agencies who routinely work with landowners to assist them with their land management.

United States Department of Agriculture (USDA) – a government organization made up of 29 agencies and offices that provides leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy.

University of Missouri Center for Agroforestry (UMCA) - a research-oriented academic center that furthers the scientific understanding of agroforestry practices and adoption within a global context (https://centerforagroforestry.org/).

University of Missouri Extension (MU Extension) - a collection of statewide offices in every county of Missouri that provide publications, web-based services, and extension faculty to distribute the knowledge of MU research throughout the entire state.

ABSTRACT

Agroforestry plantings can provide multiple benefits such as reduced soil erosion, decreased nutrient runoff, increased biodiversity, and greater farm income stability. This array of benefits makes them a promising ecologically based model for agricultural production that simultaneously achieves conservation goals. Despite the benefits conservation programs can provide, many landowners are hesitant to enroll and take land out of agricultural production. This study explores the potential to use food producing tree and shrub species, and/or incorporating cultural benefits like recreation and improved visual quality of the landscape, to increase the likelihood landowners in Missouri would commit to a conservation program. Conservation professionals across the state were interviewed to gather in-depth knowledge on the types of conservation planting designs that include trees and shrubs, conservation agency knowledge and promotion of agroforestry practices, and the relationships between landowners and conservation agencies. The interviews provided direction for a statewide survey to collect landowner perspectives and preferences for different planting plans for their farm and captured their interest in participating in conservation programs to assist in the planting of trees and shrubs on their land. Together, this information helps highlight the opportunities for incorporating agroforestry plantings in conservation programs.

Keywords: Agroforestry, Adoption, Conservation, Multifunctional

CHAPTER 1: AN INTRODUCTION TO AGROFORESTRY

Multifunctional perennial polycultures, also known as agroforestry, are synergistic plantings of trees, shrubs, and herbaceous species that provide multiple goods and services (Lassoie et al. 2009). Agroforestry, simply defined as the intentional planting and management of trees with crops and/or livestock (Raedeke et al. 2003, Wilson and Lovell 2016), has a rich history in the tropical climates and was common practice prior to the Middle Ages in Europe (Nair 1993, MacFarland et al. 2017). Indigenous tribes employed and adapted traditional management practices to provide important food, fiber, and medicinal resources for millennia (MacFarland et al. 2017). The more recent recognition of opportunities for agroforestry in temperate regions reflects an academic awakening to the history of agroforestry in North American and the potential of an old practice to influence new farming systems (Nair 2007, Lassoie et al. 2009). Agroforestry practices bring with them a suite of potential economic and ecological benefits that would improve many acres of farmland (Jordan and Warner 2010, Stanek and Lovell 2019). The realization of multiple benefits from a singular area of land use is achieved through the intentional integration of various perennial species, with the ability to include annuals as well. Since these systems address multiple goals at once, there are considered multifunctional. Multifunctionality provides for the production of commodity and non-commodity (ecological and cultural) products (Lovell et al. 2010, Haaland et al. 2011). Agroforestry systems offer many environmental benefits including decreasing soil erosion, reducing pollution from runoff, stabilizing streambanks, improving drainage and infiltration of soil, and enhancing wildlife habitat and travel corridors (Lovell and Sullivan 2006, Barbieri and Valdivia 2010a, Trozzo et al.

2014a). Agroforestry also improves the environment around the farm, providing shelter for birds and other animals and aiding in plant and wildlife conservation (Rois-Díaz et al. 2018).

Due to the contributions to soil health and the longer lifespans of woody species, agroforestry systems can be highly productive over a long period of time when properly managed (McGinty et al. 2008). The high level of productivity is due to the increased diversity of plant species that occupy different niches, canopy layers, and below-ground rooting zones (Lovell et al. 2018). Agroforestry plantings add additional layers of diversity to agricultural production through vertical integration and species diversification when compared with the traditional practices of crop-rotation or intercropping. The degree of system productivity is heavily influenced by the specific interactions of various species, which can provide complementary resource capture (Lovell et al. 2018). Due to perennial vegetation's ability to make use of a spectrum of resources and their soil stabilizing effect, these systems offer a way to sustainably grow crops on environmentally sensitive lands such as riparian areas (Jordan and Warner 2010). This practice would allow vulnerable land area to continue to provide harvestable products while simultaneously being protected.

Agroforestry systems can produce valuable products while also boosting the productivity of adjacent crops. A row of trees bordering a field, commonly referred to as windbreaks, can be designed to provide enhanced crop protection by reduced wind erosion and soil surfaced runoff, which in turn, increases crop production (Schoeneberger 2009). Woody perennial species, such as nut and fruit trees, have the advantage of producing marketable products while also altering the micro-environment to be more favorable for row crops. Agroforestry can provide a variety of products, such as timber, nuts, forage, and meat, which contributes to the profitability of farm by maximizing revenue and reducing some costs (Rois-Díaz et al. 2018). If one crop or market fails, there are several other sources of revenue the farmer can rely on.

Perennial woody species can also be used to improve the health and livelihood of farm livestock. Silvopasture, one of the specific forms of agroforestry, is the practice of integrating trees, forages, and livestock in a pastured system (Schoeneberger 2009, Barbieri and Valdivia 2010b, Wilson and Lovell 2016). Trees provide shade and shelter to the animals. The protection from the sun and wind decreases the impact of these environmental stresses and supports animal performance, evident in greater weight gains (Hamilton 2008, Mayerfeld et al. 2016). Skillful design of the silvopasture system can result in a micro-climate to produce quality green forage for an extended period of time (Garret 2009). This offers an abundance of a nutritious food sources for livestock with less of an expense to the farmer for supplemental feed.

In addition to the environmental and economic benefits, agriculture has traditionally offered recreational opportunities to the farm household and to the public (Barbieri and Valdivia 2010b). The integration of trees into agricultural landscapes provides many benefits to rural residents including leisure activities and improved aesthetics. On-farm recreational opportunities, such as farm tours and other rural experiences, increase the value within the farm household economy as these activities aid in promoting sales of other farm specialties including value-added products and services (Barbieri and Valdivia 2010a, Barbieri and Valdivia 2010b). There are eight common recreational activities provided by agricultural land including hunting, fishing, gathering wild edibles such as berries and mushrooms, enjoying natural space for contemplation, walking and hiking, using off-road recreational vehicles, horseback riding, and camping (Barbieri and Valdivia 2010b). The potential to expand the recreation options available from their land can help motivate farmers to shift to perennial production practices.

Aesthetics are highly ranked among landowners when asked about agroforestry benefits (Workman et al. 2003). Due to their layered components, many farmers consider agroforestry plantings as a desirable landscape form and part of their cultural heritage (Rois-Díaz et al. 2018). Farmers are interested in agroforestry practices that can complement recreational activities and promote their aesthetic values, which ultimately contribute to a better quality of life (Strong and Jacobson 2006). Outdoor recreation and land preservation offer the benefits of visually appealing landscapes which are linked to stress relief (Barbieri and Valdivia 2010b). For example, the planting of riparian buffers in the Midwest can improve the aesthetic of the landscape by bringing spatial definition to the vast areas of agricultural fields (Sullivan et al. 2004). The addition of a variety of colorful, textured plants provide an interesting and beautiful rural environment (Sullivan et al. 2004). Farmers are drawn to agroforestry practices, such as multifunctional buffers and windbreaks, that serve to both add beauty to their land and provide them with direct economic and personal benefits.

Agroforestry practices have potential to diversity farms, boost farm income, and improve rural livelihoods (Jordan and Warner 2010, Lovell et al. 2010, Stutter et al. 2012). Despite these promises, adoption of agroforestry has been slow (Mattia et al. 2018b). A potential solution for supporting greater agroforestry adoption is through established federally funded conservation programs. These programs provide both technical on-farm guidance to farmers and landowners as well as cost-shares for planting stock and other materials needed to successfully establish tree plantings and maintain conservation practices (Arbuckle 2013, Stanek and Lovell 2019). For this research, we focus specially on the state of Missouri to better understand the factors that influence the diffusion of agroforestry practices through natural resource conservation agencies.

We also explore agricultural landowners' perceptions of agroforestry plantings and their interest in participating in conservation programs.

The objectives of this research are to:

1.) Interview natural resource professionals to discern their level of agroforestry knowledge and their communication networks with landowners/farmers.
2.) Survey landowners/farmers to characterize their preferences for planting plans, perceptions of multifunctional perennial agroforestry systems, and interest in conservation program participation.
3.) Synthesize information from the interviews and surveys to better understand landowner interest in establishing agroforestry plantings using federal conservation program funding.

CHAPTER 2. MISSOURI NATURAL RESOURCE PROFESSIONALS SHARE KEY INSIGHTS FOR INCLUDING AGROFORESTRY PRACTICES IN CONSERVATION PROGRAMS

2.1 Introduction to Agriculture in the United States

The United States has about 896,600,000 acres of agricultural land as of 2019 (National Agricultural Statistics Service, 2020), which is just over 10% of the total land base of the county. While agricultural land is important for the provision of food and fiber, it also provides ecological and cultural services for rural communities (Barbieri and Valdivia 2010b). Agricultural production methods have a substantial impact on both natural and built environments. At local, regional, and national scales, agricultural land effects water quality, nutrient cycling, appearance of the landscape, and micro-climate. Globally, agriculture impacts the water cycle, biodiversity, and process of carbon sequestration (Lovell et al. 2018). Intensive production methods with continual soil disturbance and an extensive use of petroleum-based chemical inputs are estimated to contribute 23% of the total anthropogenic greenhouse gas emissions (IPCC 2019). While the negative impacts of agricultural activities on natural resources and ecosystem functions are most often emphasized, opportunities exist for alternative production methods that result in beneficial outcomes for humans and natural ecosystems.

2.2 Background for Research

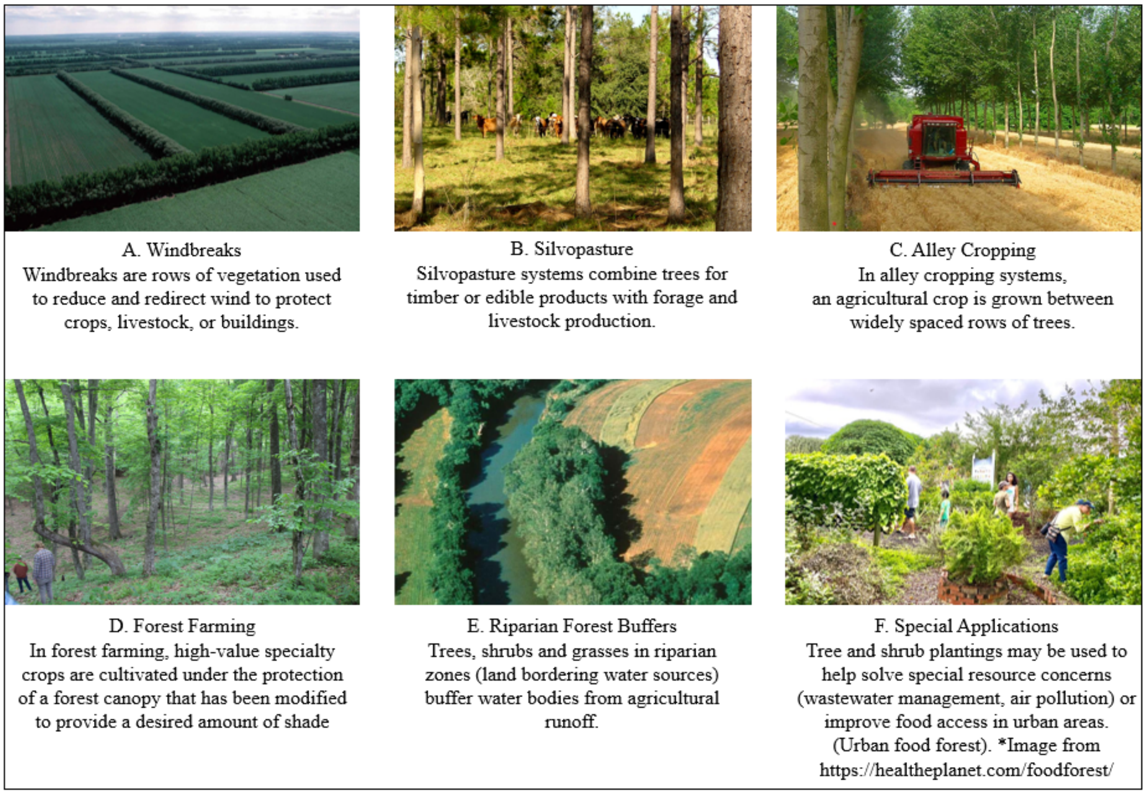
Conservation Programs: Land Sparing vs Land Sharing

The land sparing and land sharing debate is not new (Fischer et al. 2014). The intent of this research is not to add to this discussion directly, as there are many analyses of this framework (Phalan et al. 2011; Fischer et al. 2014; Kremen 2015), but to use this debate to further explore how to integrate conservation practices into agricultural landscapes. In short, the land sparing versus land sharing framework is an economic lens with the goal to most efficiently allocate the scare resource of land to maximize its production potential and conservation benefits (Fischer et al. 2014). Typically, land sparing refers to setting aside an area of land with the sole purpose of conservation. These areas are to remain as free from human influence as possible to protect ecologically important habitat for wildlife and biodiversity conservation while other areas are intensively managed for human needs such as agricultural production (Phalan et al. 2011). The land sharing approach, on the other hand, strives to integrate conservation into human-dominated landscapes for the benefit of both people and wildlife (Phalan et al. 2011). This approach uses wildlife friendly farming techniques to lessen the intensity of agricultural production and support dual land use (Kremen 2015). The debate between the land sharing and land sparing approach to land management has held a prominent place throughout conservation focused literature and is helpful for exploring how to manage landscapes for multiple goals (Kremen 2015).

In response to agricultural resource concerns (e.g., soil erosion, nutrient depletion, water pollution), the United States government has established multiple programs along the land sparing and land sharing management spectrum. The 1985 Farm Bill initiated several programs that targeted conservation practices on agricultural land, the most notable being the Conservation Reserve Program (CRP) (Stanek et al. 2018). Agricultural land enrolled in CRP is planted to trees, grass, wildlife cover, or other environmentally beneficial vegetation for 10 to 15-year contracts with the goal to retire sensitive areas from production (Hellerstein 2017). Land in CRP cannot be planted with row crops, grazed, hayed, or put into production until the contract is up or special provisions are made due to extreme circumstances like drought (Volk et al. 2006, Stanek et al. 2018, Bigelow et al. 2020). CRP policy mirrors a land sparing approach to conservation which encourages landowners to set aside their most vulnerable or marginal pieces of land while being free to continue intensively farming the remaining acreage.

Roughly a decade later, the Environmental Quality Incentives Program (EQIP) was authorized by the 1996 farm bill with the goal to promote agricultural production, forest management, and environmental quality as simultaneously compatible goals (Stubbs 2011). This program uses a land sharing approach to conservation and agricultural production by encouraging landowners to adopt more environmentally friendly production methods and land management practices. A further addition to federal conservation programing was made in the 2002 Farm Bill with the establishment of the Conservation Stewardship Program (CSP) in which landowners receive payments for working towards whole-farm resource goals instead of implementing individual practices (Stanek and Lovell 2018). These initiatives demonstrate a government recognition of the importance of integrating ecologically focused land management into agricultural landscapes.

While many of the above conservation programs are admirable on paper, they have been frequently criticized for being too inflexible, complex, and outdated in comparison to new approaches that encourage multifunctionality of agriculture (Stanek and Lovell 2018). Multifunctional landscapes provide numerous environmental, economic, and social functions within the same area of land (Lovell and Johnston 2009a). This integrated approach to land management is valuable for reducing biodiversity loss and restoring degraded areas while uniting local economic, social, and conservation goals (McGinty et al., 2008). Agroforestry, simply defined as the intentional planting and management of trees with crops and/or livestock (Raedeke et al. 2003; Wilson and Lovell 2016; Schoeneberger et al. 2017), is a different approach to the production of food, fiber, and fuel that supports multiple land-use goals. There are six formally recognized practices that fall under the umbrella term agroforestry (figure 2.1). All offer unique opportunities to address resource concerns while providing additional social and economic benefits.



A. Windbreaks
Windbreaks are rows of vegetation used to reduce and redirect wind to protect crops, livestock, or buildings.

B. Silvopasture
Silvopasture systems combine trees for timber or edible products with forage and livestock production.

C. Alley Cropping
In alley cropping systems, an agricultural crop is grown between widely spaced rows of trees.

D. Forest Farming
In forest farming, high-value specialty crops are cultivated under the protection of a forest canopy that has been modified to provide a desired amount of shade

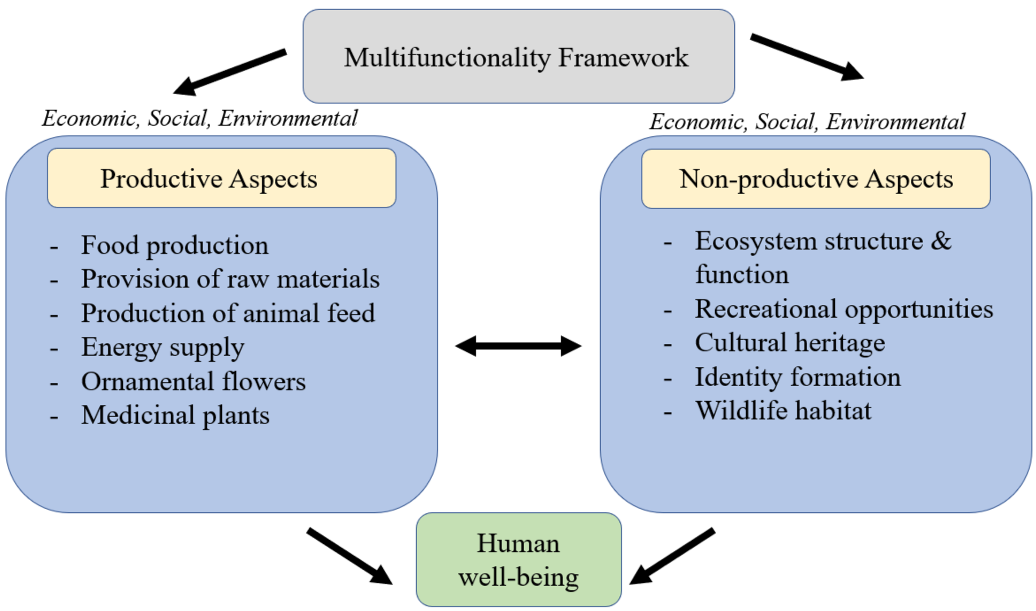
E. Riparian Forest Buffers
Trees, shrubs and grasses in riparian zones (land bordering water sources) buffer water bodies from agricultural runoff.

F. Special Applications
Tree and shrub plantings may be used to help solve special resource concerns (wastewater management, air pollution) or improve food access in urban areas. (Urban food forest). *Image from https://healtheplanet.com/foodforest/

Figure 2.1 An overview of agroforestry practices. Adapted from USDA National Agroforestry Center "Working Trees for Agriculture."

Agroforestry's multifunctionally is best explored through a framework that provides a robust and multi-faceted analysis. For this research, we use the Landscape Multifunctionality Framework (Lovell and Johnston 2009b; Valdivia et al. 2009; Barbieri and Valdivia 2010b) which allows us to explore the multiple economic, social, and environmental services of agroforestry and how these factors relate to agroforestry knowledge and promotion (figure 2.2). This framework helps identify and emphasize the many economic, environmental, and social benefits of the landscape (Valdivia et al. 2012), which are all important factors when considering agroforestry practices in conservation programs. Using this framework helps us recognize the multitude of influences agricultural practices have on the landscape and associated rural communities. We will then integrate the emergent themes from this framework analysis into the broader discussion of agroforestry adoption.

Figure 2.2 The Landscape Multifunctionality Framework as applied to agroecosystem benefits from a human perspective



Agroforestry Adoption: Rate and Key Factors

If agroforestry has the potential to address major environmental concerns while helping farms and communities adapt to and mitigate climate change (Jordan and Warner 2010; Lovell et al. 2010; Stutter et al. 2012), why do we not see more of these practices throughout agricultural landscapes? Studies across the globe have worked to narrow and clarify the variables that effect farmers' decision to adopt agroforestry practices on their land, but none have identified a clear answer. Some of the common and broadly applicable themes for agroforestry adoption include capacity, or the ability for farmers to adopt agroforestry, farmer/landowner attitudes, awareness of agroforestry practices, and farm characteristics such as acreage and income (Strong and Jacobson 2006, Valdivia and Poulos 2009, Prokopy et al. 2019). Education levels, income, acreage, available capital, farm diversity, labor, product markets and access to information, including social networks, are important factors that generally lead to better adoption rates (Prokopy et al. 2008, McGinty et al. 2008). In all, information has been found to be the most limiting factor for increasing adoption of agroforestry practices (Strong and Jacobson, 2006, Mattia et al., 2018b) making it an important focus of our research. While publications, including newspapers, journals, and books, have their place in dispersing farming-related knowledge, farmers are highly influenced by their peer networks and family members (Salamon et al. 1997; McGinty et al. 2008; Kumar and Nair 2011). Beyond these close-knit social circles, farmers' land management choices are shaped by contact with natural resource conservation agencies and personnel (Kumar and Nair 2011; Wilson and Lovell 2016; Stanek et al. 2019). Extension agents, private land conservationists, and professional foresters all serve an important role in supporting the use of conservation practices, including agroforestry adoption, on working farms.

A Look at Missouri: The Show Me State

The United States contains a diverse array of agricultural landscapes, which means that any approach to integrating agroforestry systems into conservation programs must be targeted to the features of a specific area. The state of Missouri offers a unique sociopolitical context for the application of agroforestry tree plantings due to the recent establishment of the Environmental Quality Incentives Program (EQIP) dedicated agroforestry and woody crop establishment fund pool (Cartwright et al. 2017). The state's largest land grant university, the University of Missouri, houses The Center for Agroforestry, a research-oriented academic center that furthers the scientific understanding of agroforestry practices and adoption within a global context (https://centerforagroforestry.org/).

The Center also hosts many outreach and educational events including the Agroforestry Academy, a comprehensive agroforestry training program that focuses on a "train the trainer" model where natural resource professionals attend to gain a better understanding of agroforestry practices and how to support landowners interested in establishing agroforestry on their land (Mendelson et al. 2021). The Center for Agroforestry also offers graduate programs and hosts a wide range of research activities on the scientific processes underlying agroforestry. Despite the presence of this robust knowledge base of agroforestry, barriers to adoption still exist. To better understand how to support landowners in their transition to more sustainable land management, it is important to explore the level of knowledge of integrating trees and shrubs into agricultural landscapes among the "front line workers" of agroforestry adoption, the natural resource professionals.

To determine if landowner preferences, natural resource professional knowledge, and conservation program requirements align to promote tree and shrub plantings, we focus on the following questions:

i. How are trees and shrubs planted for multifunctional uses (those that produce edible crops, fodder, or raw materials) understood by landowners and natural resources professionals s as part of conservation programs?
ii. How are natural resource professionals connecting with landowners who are considering placing their land under conservation programs?
iii. To what extend do natural resource agencies understand and promote agroforestry practices in Missouri conservation programs?

2.3 Methods for Interviews

We used semi-structured interviews of a targeted audience of natural resource professionals to gather their free-flowing perspectives and knowledge of conservation programs. This approach provided us with the flexibility to inquire about new topics as they arose during conversation (Young et al. 2017). Seven representative professionals from major federal and private conservation organizations were invited to participate in interviews (table 2.1). These professionals were chosen based on their active roles in conservation agencies that use federally funded programs to provide financial and technical assistance to agricultural landowners. Initial contact with each professional was made by email and participants were recruited via snowball sampling during the interview process (Young et al. 2017). The inclusion of an array of natural resource personnel from agencies across Missouri provides a sample of the conservation work throughout the state.

Table 2.1 Representation of Natural Resource Conservation Agencies in Interviews

Agency	Number of Participants
Natural Resource Conservation Service (NRCS)	4
National Wild Turkey Federation (NWTF)	2
University of Missouri Extension (MU Extension)	1

Note: This table show the number of research participants from each of natural resource organizations who participated in the interviews. Snowball sampling was used to recruit participants meaning it is unlikely a representative sample

Interviews were conducted using a combination of Zoom video-chat and telephone calls that lasted from 30 minutes to one hour. All dialog was audio recorded with participant consent for later transcription. All interview processes and questions received full Institutional Review Board (IRB) exemption prior to engaging in interviews. During the interviews, participants were asked to provide descriptions of programs that allowed or supported the planting of trees and shrubs on agricultural lands (see supplemental materials). Interviewees were also asked about landowner enrollment in conservation programs and what objectives the landowners have for planting trees. Questions focused on determining if landowners have shown interest in additional benefits from their trees including harvestable products, recreational opportunities, conservation of resources, and agritourism opportunities. Interviews concluded by asking professionals about their basic knowledge of agroforestry practices and if their agency encourages the use of conservation programs to support landowner adoption of them.

The recorded interviews were transcribed verbatim for analysis following the methods described in Stanek and Lovell (2018) and Stanek et al. (2019). A deductive qualitive content-analysis process was used to organize information. Early themes for guiding the coding of interviews were based on previous research studies consulted in the literature review (Matilainen et al. 2017) (table 2.2). A code was established using NVivo software to further analyze the interview responses to understand perceptions of multifunctional agroforestry plantings and how conservation agencies are supporting the use these plantings in federally funded conservation programs.

Table 2.2 Key themes from literature review on agroforestry and conservation programs

Number	Theme Summary	References
1.	The requirements and restrictions of the conservation program	Crampton et al., 2019, Hellerstein, 2017
2.	How conservation and land management agencies connect with landowners	Raedeke et al., 2009, Barbieri and Valdivia, 2010, Mayfield et al., 2016, Stutzman et al., 2018
3.	Landowner interest in planting trees for the potential to harvest products, such as fruit or nuts	Frey et al., 2010, Stanek and Lovell, 2019
4.	Recreational opportunities, such as hunting, on private land	Barbieri and Valdivia, 2010, Haaland et al., 2011
5.	Improved landscape aesthetics	Workman et al., 2003, Garcia de Jalon et al., 2018, Rois-Díaz et al., 2018
6.	Reduced chemical drift	Traore et al., 1991
7.	Protection/conservation of the environment and natural resources	Stanek and Lovell, 2019, Workman et al., 2003, Garcia de Jalon et al., 2018
8.	Generate some other type of profit, such as from conservation program payments	Workman et al., 2003

Note: This table lists the eight key themes from the literature on agroforestry and conservation practice adoption used for developing the code in NVivo to analyze interview content

2.4 Results and Discussion

Trees in Conservation: Great potential, Misunderstandings, & Room to Grow

Trees and other woody perennial plants have long been an important aspect of conservation programs, but their acceptance in agricultural settings has been slow (Valdivia et al. 2012; Trozzo et al, 2014b; Lovell et al. 2018). Natural resource professionals agree there is potential to integrate trees in agricultural land, but it must be the right species, in the right place, and for the right reason. Even with the many recognized benefits of trees and other woody perennials for improving soil quality and wildlife habit, the natural resource professionals are cautious when discussing planting trees on farms.

I use the term woody plants because I don't want to say trees necessarily but shrubs and small trees and stuff like that could fill in these areas without really having big negative impact on crop production.

This interviewee explains how trees and shrubs could be integrated into agricultural land. The careful choice of words demonstrates how this individual has a deep understanding of the tension between farmers and the presence of trees within row crop fields. Trees were once common across agricultural landscapes, but the use of intensive production methods led to their widespread removal (Raedeke et al. 2003). This marks a cultural shift away from having trees in and around fields. Many farmers remember the efforts of past generations to clear the land for agricultural production, and they see planting trees now as erasing this history (Raedeke et al. 2003). Despite the reluctance of some farmers to plant tree, this forester sees potential in promoting these types of practices and is careful to distinguish the words used to describe the plantings by purposefully using the term "woody plants" instead of trees.

While many professionals agreed conservation practices using trees and shrubs would be beneficial, they were hesitant to embrace all five organized agroforestry practices. Alley cropping and forest farming garnered far less interest as the interviewees explained these practices often did not align with many of the landowner's goals they worked with. When asked about landowner interest in these practices, one of the foresters responded,

…the one that we get really the least interest in is alley cropping. And I think there are multiple reasons for that… You know, I would like to see that [alley cropping] *explored more on a large farm scale. And the likelihood of that happening is pretty slim just because most large farm operations don't want to have to operate around trees.*

The concern over “working around trees” was brought up in a couple of the interviews as a reason that landowners are hesitant or simply not willing to participate in conservation programs with tree planting aspects. As one forester explained, *“Most people like to get rid of trees and farm it* [the land]. *”* Farmers have come to rely on the simplicity of open fields and pastures that allow for the mechanization and large-scale production needed to earn enough income in commodity markets.

When professionals were asked about the potential of forest farming - the cultivation of herbs, mushrooms -or other products under an existing forest canopy - most responded they unfamiliar with the practice. This may be due to the small number of existing forest farming activities, which occur mainly in the southern part of the state. One forester explained,

> *“…not that* [forest farming] *is super popular anywhere. In southern Missouri there are some people that actually do forest farming for shitake and stuff like that, but as far as in my area and what I’ve dealt with I have never personally dealt with anyone who has interest in that.”*

The lack of information and experience with agroforestry is one of, if not the primary limiting factor for supporting farmers establishment of these practices (Workman et al. 2003). Another major contributor to the unfamiliarity of agroforestry practices such as forest farming are the limited demonstration opportunities for natural resource professionals interested in expanding their knowledge (Jacobson and Kar 2013).

Beyond the concerns about landowners’ willingness to plant and manage trees, particularly in novel systems such as in alley cropping and forest farming, the professionals mentioned several misconceptions about what activities are allowed on land placed under conservation programs.

Interestingly, misconceptions about the management practices allowed are shared both by landowners and natural resource staff. One common misconception addressed by one of the professionals interviewed is what species or types of trees can be planted using conservation funds. The professional explained,

> *… There are some misconceptions* [about using] *EQIP money for these tree plantings when the side benefit of the tree plantings is food production. For some reason there is a lot of folks out with this misconception that you can't use EQIP money for that. I mean you can plant an oak tree or a hickory tree, but you can't plant a chestnut tree for nut production. That's something that's really hard to address when you are a state person. You need somebody at the national level speaking out and saying oh no no no that's ok.*

Another challenge natural resource professionals face is keeping up-to-date information on the program specifications and requirements. Stutzman et al. found many natural resource professionals had a strong misconception about the requirements of silvopasture establishment including the species allowed and in what type of arrangements (Stutzman et al. 2019). Many professionals also do not know the costs of establishment (Lawrence and Hardesty 1992) and hesitate to suggest these practices to landowners. While conservation programs are funded at the federal level, individual states often have slightly different fund pools and ranking categories to address the natural resource concerns specific to the state and region. The above quote demonstrates the need for a national stance on practice requirements to address these misconceptions while working towards more consistent practice standards across states.

In addition to concerns over what species can be planted, many of the professionals interviewed mentioned concerns about restrictions on harvesting products, such as fruits and nuts, from trees established under the EQIP program. This confusion was expressed by several of the natural resource professionals interviewed and mentioned as a common challenge when working with landowners. One interviewee who works with MU Extension explained,

> *… One of my natural resource friends said something about NRCS funding that establishes trees and shrubs can't be used for trees and shrubs that have an economic value? So maybe some information on what you can and can't use cost-share for would be informational.*

This misinformation and confusion around practice standards prevents natural resource professionals from confidently talking about tree planting under conservation programs. It is especially a challenge for establishing agroforestry practices using federal funding. When asked about any limitations on harvesting from trees with edible products, one forester mentioned "*I don't know what, there shouldn't be any of them that they can't harvest nuts. There might be, I mean I might be wrong here."* This interviewee is correct in acknowledging conservation program participants cannot sell products from the trees planted while the land in under contract. The forester, while having the right information, is still uncertain on the specific limitations.

The lingering uncertainty of program rules, specifically the harvesting limitations, is a significant finding that has not been extensively studied. The uncertainty many natural resource professionals have about the program requirements is concerning as these professionals are an important information source for many landowners interested in establishing conservation practices on their land (Stutzman et al. 2019). The more contact landowners have with conservation professionals, the greater their interest is in agroforestry practices (Arbuckle et al. 2009). The impact professionals have on the landowners' management choices highlights how important it is to provide natural resource professionals working with landowners the most up-to-date information on conservation program guidelines and regulations.

One NRCS employee who has worked closely with agroforestry practices for conservation was able to clarify NRCS's position on planting food-producing tree and shrub species.

> *When we talk about the agroforestry under EQIP, we always have to remember that it's not primarily for the purposes of planting a food crop for the producer. Its primarily for the purpose of addressing a resource concern and it [*agroforestry*] just makes a really good fit.*

The important piece of getting cost-share for trees and shrubs that do produce edible products is that conservation funding is meant to address a resource concern, something many of the fruit and nut producing species can do very well. Planting fruit and nut bearing trees and shrubs offers additional benefits when integrated into conservation programs, particularly the opportunity for landowners to make some additional money from the land after their contract expires when enrolled in CRP or EQIP or as part of the whole farm management plan in CSP. A MU Extension agent commented "*it also would help make the case for folks entering those cost-share agreements if they could come up with some other additional funding from it."* This is ultimately the goal of supporting agroforestry practices through conservation funding – to help landowners implement more conservation activities on their land that can simultaneously support their own economic and recreational goals.

The Challenge of Building Long-term Relationships for Long-Term Conservation

An important component of conservation programming is the relationship between the natural resource conservation agencies and the landowners. Conservation agencies, including NRCS, are forefront in disseminating federal conservation program information such as available funding and sign-up periods while also providing the technical assistance landowners need to establish and manage conservation practices on their land. When asked how they approach building relationships with landowners, many of the professionals interviewed did not have a process for recruiting and networking to connect with landowners interested in conservation. They generally are handed a list of names that had previously contacted their main office and rely on farmers and landowners to initiate the dialogue around conservation. This appears to be typical across agencies. One of the field staff with the National Wild Turkey Federation explained how connections are made with landowners,

> *So most of the time when I am working with landowners, they have already been in contact with another resource management professional that has referred them to me and they are already interesting in utilizing some sort of assistance program.*

At the NRCS office, field staff also relied on landowners taking the initiative to reach out to them. One professional explained,

> *…A lot of times for me with landowners it tends to be a fleeting discussion because they will reach out to me… I do the initial education for them about what our programs have to offer and how they can participate and then I usually send them to whoever their local personnel is in the county.*

While many interviewees could explain how they maintained relationships and built upon connections that were established by landowners or other conservation staff, none could provide concrete steps they took for recruiting landowners to participate in conservation programs. For most, recruiting is a major challenge they acknowledge. This was pointed out by a professional who said, "*It's probably why it's actually a problem, because it's* [recruitment] *hard. Hard to figure out.*"

Since active recruitment is not a focus of these agencies, there may be landowners who are not receiving the information they need to be engaged in conservation practices. This prompts the consideration of what else agencies may be doing to try and reach out to landowners. Many farms are in rural areas with lower rates of internet access. In Missouri, only about 71% of rural residents have access to broadband internet (Quinn et al. 2020). Additionally, most farmers seek out printed information sources such as magazines (Barbieri and Valdivia 2010b) and input from peer and family networks (MacFarland et al. 2017). Despite these preferred avenues for information, the main outlet for details about conservation programing is turning increasingly digital. When asked about outreach, an agent from MU extension shared,

> *"Social media has been really good… Every county extension office has a Facebook page and usually some other social media. And so that's been a good way to establish relationships and give the information of where they can find me at. And then they kind of, we kind of go from there as far as establishing [a relationship]."*

The NRCS office also relies on media outlets and engaging with landowners through online platforms. One professional explains their variety of approaches.

"…we do a lot of Twitter and press releases. We have the ability for producers to go in and sign up for reminders of or information to identify what information they are interested in and it gets automatically emailed to them. We are still publishing newspapers and do press releases…"

Generally, most recruitment and information sharing are facilitated through online interactions or through the mail, ultimately requiring the landowner to take the initiative in seeking out and forming the initial connection. It seems likely that the struggle to actively dialogue with landowners on a one-to-one basis comes from little knowledge on how to form the initial connection. This is a great opportunity for natural resource and conservation agencies to personalize their outreach efforts to work to maximize their connectivity with farmers and landowners.

It is also important to note that most landowners meet with a member of the field staff only a handful of times during the establishment of a conservation practice (mentioned during interviews). This suggest that the information shared during these short periods of connection is extremely important in influencing a landowner's decision to plant trees and shrubs on their land through participating in a conservation program. Stanek et al. found farmers valued personalized one on one planning time with professionals to help design agroforestry plantings and that without this assistance, the establishment of these practices would be too overwhelming (Stanek et al. 2019). Ultimately, the knowledge that an agent has about the practices of tree planting, and agroforestry specifically, and the time they spend working with landowners to provide technical assistance are significant factors in the adoption of these practices (Hand et al. 2019).

Natural Resource Agencies Wish for Greater Agroforestry Knowledge and Promotion

All the natural resource professionals had some familiarity with the term agroforestry prior to being interviewed, but there was great variation in their depth of knowledge on these complex systems. When asked to rate their understanding of agroforestry practices: silvopasture, riparian forest buffers, windbreaks, alley cropping, and forest farming, some professionals were familiar with all five while others admitted they had little information or experience with certain practices (figure 2.3). The two that were recognized by all seven interviewees, riparian forest buffers and windbreaks, are prominent in current conservation programing. Of all the practices, forest farming was the only one where some professionals had never heard of the term. These findings reflect the novelty of forest farming practices and helps to explain why the natural resource professionals showed less interest in promoting this practice to landowners.

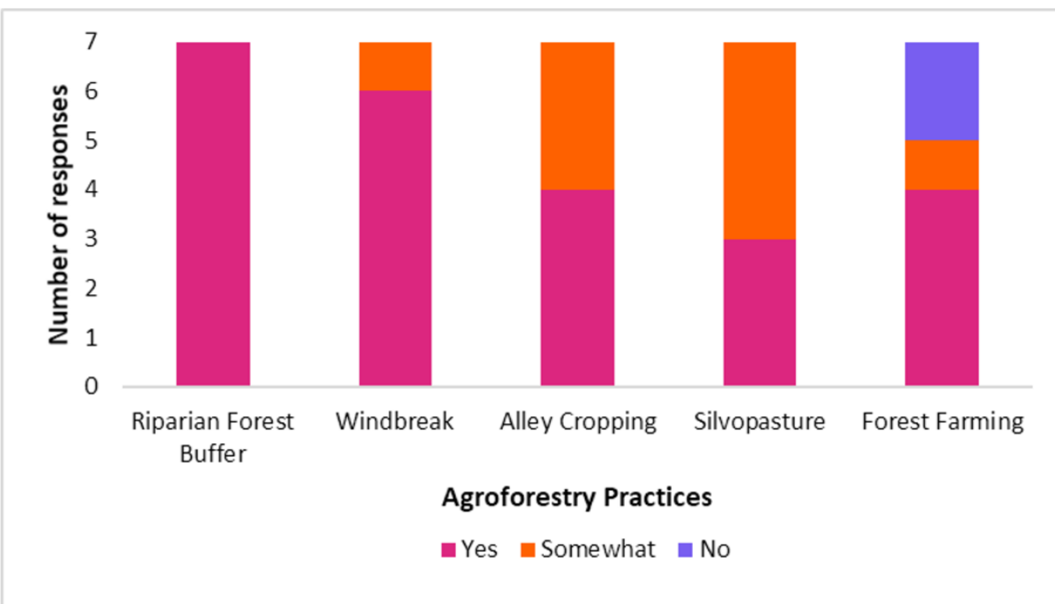


Figure 2.3 Overview of natural resource professionals' familiarity with agroforestry practices. Answers capture the professionals' responses to questions about familiarity with each of the five practices: riparian forest buffers, windbreak, alley cropping, silvopasture, and forest farming. Source: Natural Resource Professional Interviews, 2020

Interviewees were encouraged to share about their agency's promotion of agroforestry and how often they discuss agroforestry with the landowners they work with. Overall, the professionals concluded they did a fair job of exploring opportunities for agroforestry with landowners and that their agency presented a positive picture of agroforestry practices, but they could do more to discuss agroforestry practices with landowners. In general, research has shown many natural resource professionals lack knowledge of agroforestry and rarely promote it (Workman et al. 2003; Stutzman et al. 2019). Workman et al. found professionals responding to an opinion survey ranked lack of familiarity and lack of demonstrations as major obstacles to establishing agroforestry practices (Workman et al. 2003). Workman also found 30% to 35% of the professionals thought agroforestry had moderate to high potential in their work area and many were interested in learning more about agroforestry practices and building programs for their landowner clientele (Workman et al. 2003). One insight from the professionals interviewed is the need to send out the "right" message to the "right" landowner. One forester commented on how the NRCS does a good job of supporting agroforestry adoption saying,

> *"I think we do; we have done a good job of promoting agroforestry in Missouri. We can definitely do better. We just need to make sure we are sending out the right message."*

This concern with the right message to the right landowners was a common dialogue among several of the professionals interviewed.

While the general assertion was that conservation focused agencies, including NRCS and NWTF, are working to promote agroforestry, it is contrasted with an admission by many professionals that they are not doing enough in the field to engage with landowners on agroforestry practices.

> *"I'm probably guilty of not pushing it as much as I should sometimes, but I just, you got to have the right landowner to talk to. Because a lot of my landowners are typical stubborn old farmers that want to do things their way. I bring up planting trees in their grass they are going to just look at me like I'm crazy."*

This quote clearly shows the limited integration of agroforestry into conservation programs is even more complex than a shortage of knowledge and exposure, the acceptance of agroforestry must come from a shift in farming culture. Agroforestry practices, while by no means a completely new set of principles (MacFarland et al. 2017), are drastically different than most agricultural production methods widely used. These "typical stubborn old farmers" often resist the idea of planting trees in and around their fields. For some farmers and landowners, such as the one referenced in the quote above, even mentioning the idea of planting trees begins to discredit the work of the natural resource professional. In these instances, the message must be focused on the outcomes of tree planting and tailored to the receptiveness of the landowner. Different farmers have different farm goals, backgrounds, and social influences (Arbuckle et al. 2009; Prokopy et al. 2019). As noted above, the relationships between conservation agencies and farmers are built upon the initiative of the farmer. Educators, natural resource agencies, and researchers must take care when speaking about agroforestry practices and focus on the needs and concerns of the landowners and farmers they are working with (Mendelson et al. 2021). As of now, research neither determined the single best message for landowners nor any universal factor that influences adoption (Prokopy et al. 2019). The key to greater use of agroforestry practices is supporting natural resource professionals to connect with farmers to know their concerns, land goals, and farming practices to provide the information to address questions about agroforestry and conservation more broadly.

2.5 Conclusion

Agroforestry practices that include trees and shrubs with edible products are a promising component of conservation programs. The Landscape Multifunctionality framework helps provide context to explore the factors influencing agroforestry adoption. We also examined how the relationships between natural resource professionals and landowners can support or prevent wider adoption of agroforestry practices. We were able to identify several of the beliefs and social factors that limit or support agroforestry in conservation programs. Despite the promise of agroforestry for conservation, there is a need for stronger information networks to ensure greater access to agroforestry knowledge for farmers, landowners, and natural resource professionals. It will be crucial to dispel the common misconceptions surrounding tree planting in conservation programs. Of particular importance is strengthening natural resource and conservation agencies role as educators and facilitators of agroforestry adoption. Additional research to further refine the specific adoption factors and farmer profiles throughout the different regions of the state will help determine which messages to send to whom. Working to expand the educational opportunities for natural resource professionals on how to establish, fund, and manage integrated tree-crop-livestock systems will be an important step for expanding the use of agroforestry practices in conservation programs and agricultural production.

CHAPTER 3. SURVEY OF MISSOURI LANDOWNERS TO EXPLORE THE POTENTIAL OF WOODY PERENNIALS TO INTEGRATE CONSERVATION AND PRODUCTION

3.1 Introduction to Conservation and Agriculture

The intensification of agricultural production methods has directly contributed to decreased soil productivity, water pollution, drought, and the loss of wildlife habitat (Lovell et al. 2010; Arbuckle 2013; Wilson and Lovell 2016; Wolz and DeLucia 2018). These effects grew to catastrophic levels in the United States during the 1933 Dust Bowl where widespread drought and severe topsoil erosion from strong winds decimated farms across the western portion of the county. In response to the unprecedented soil erosion that occurred during this time, the United States government initiated the great plains forestry project to support the planting of 220 million trees across the contiguous United States (Chenyang et al. 2021). Despite the success of this program to reduce wind erosion across the plains, farm resource concerns continued to grow and were worsened during the U.S. farm financial crisis of the 1980s. Farm incomes fell drastically due to the inflammatory trade policies initiated by the administration during this time, ultimately leading farmers to shift to larger-scale, more intense production methods in an attempt to maintain their income (Barnett 2000). The United States Government later responded to these economic and resource concerns by establishing conservation programs under farm bill funding (Lassoie et al. 2009) (table 3.1). The 1985 Farm Bill initiated several programs that targeted conservation practices on agricultural land, the most notable being the Conservation Reserve Program (CRP) (Stanek and Lovell 2018). CRP policy encourages landowners to retire vulnerable or marginal pieces of land by planting a grasses or trees to support conservation and address resource concerns, namely soil erosion.

Roughly a decade after the CRP was established, the Environmental Quality Incentives Program (EQIP) was authorized by the 1996 farm bill with the goal to promote agricultural production, forest management, and environmental quality as simultaneously compatible goals (Stubbs 2011). This program encourages landowners to integrate more environmentally friendly production methods and land management practices on their farm. A further addition to federal conservation programing was made in the 2002 Farm Bill with the establishment of the Conservation Services Program (CSP) in which landowners receive payments for working towards whole-farm resource goals instead of implementing individual practices (Stanek and Lovell 2018). A variety of additional smaller and more specialized programs, such as the Regional Conservation Partnership Program, Grazing Lands Conservation Initiative, and the Wetlands Reserve Program have also been incorporated into the arsenal of conservation efforts with some success. Taken together, these initiatives demonstrate a government recognition of the importance of integrating ecologically focused land management into agricultural landscapes.

Table 3.1 Timeline of important events leading to the establishment of federal conservation programs

Year	Event	Outcome
1933	Dust Bowl	Severe soil erosion, abandoned farms
1934	Great Plains Shelterbelt Project	Planting of 220 million trees in windbreaks across the U.S. to address soil erosion from the Dust Bowl era
1935	Soil Conservation Service Established	Program to provide funding to farmers for soil conservation practices
1975	Secretary of Agriculture encourages farmers to plant 'fencerow to fencerow'	Reversal of previous conservation gains, leading to unsustainable farming practices
1980s	U.S Farm Financial Crisis	Falling farm income leads to shift to intense production practices on larger areas of land
1985	CRP Funded	Program to retire ecological sensitive/marginal land from agricultural production
1994	Soil Conservation Service Renamed Natural Resources Conservation Service	Shift in government support for conservation beyond soil and crop productivity
1996	EQIP Funded	Program to promote agricultural production, forest management, and environmental quality as simultaneously compatible goals
2002	CSP Funded	Program to encourage conservation practices that support whole-farm resource goals

While federal conservation programs have had some success in addressing both financial and resource concerns (Her et al. 2016; Wallander et al. 2019), shifts in political support, agricultural markets, and land management preferences have left many vulnerable acres of land in intensive production (Featherstone and Goo 1993; Bigelow et al. 2020). Inflexible management requirements, low program payments, and a complex sign up process leave some landowners with little interest in enrolling in conservation programs (Ryan et al. 2003; Stanek and Lovell 2018). These programs also have issues with backlogs of unfunded applications and budget pressures that prevent some landowners who are interested from successfully enrolling (Stubbs 2011). Collectively, the amount of land enrolled in CRP is steadily decreasing from a peak of 36.8 million acres in 2007 (Morefield et al. 2016) to 20.6 million acres in 2021 (USDA FSA, 2021). Increasingly, land that was enrolled in a conservation program is being returned to production once contracts expire (Morefield et al. 2016; Bigelow et al. 2020). Shifts in commodity prices and renewed land production capacity post CRP enrollment are reasons landowners decide to resume planting commodity row crops such as corn and soy (Bigelow et al. 2020).

3.2 Agroforestry Adoption

An alternative to the conservation versus production dichotomy is to integrate these goals within the same area of land (Phalan et al. 2011). The benefits of land management that integrates both conservation goals and produces marketable goods are many, including improved soil health, wildlife habitat, and income generation for landowners (Jordan and Warner 2010; Lovell et al. 2010). Agroforestry, or the intentional planting and management of trees with crops and/or livestock (Raedeke et al. 2003; Wilson and Lovell 2016; Schoeneberger et al. 2017) is a practice that can support both the conservation and production goals of farms. Agroforestry has great potential to address major environmental challenges while helping landowners, communities, and regions adapt to and mitigate climate change, yet we do not see broad adoption of agroforestry in agricultural landscapes. Researchers have studied the process of landowner decision making and agroforestry adoption factors, but clear patterns have not been identified (Prokopy et al. 2019). Some of the common variables shown to influence agroforestry adoption include capacity, or the ability for landowners to adopt agroforestry, landowner/landowner attitudes, awareness of agroforestry practices, and farm characteristics such as acreage and income (Strong and Jacobson 2006; Valdivia and Poulos 2009; Prokopy et al. 2019). Higher education levels, greater income, more acres of land, access to capital, available labor, access to information, and being integrated into social networks are important factors that generally lead to better adoption rates (Pattanayak et al. 2003; McGinty et al. 2008; Prokopy et al. 2008). Older farmers and those focused on production agriculture as their primary source of income have been found to be less likely to adopt agroforestry (McGinty et al. 2008; Mattia et al. 2018b). Overall, the lack of information on agroforestry available to farmers and landowners is generally the most limiting factor for increasing adoption of agroforestry practices (Strong and Jacobson 2006; Mattia et al. 2018b).

Despite increases in awareness of adoption factors and the growing support for agroforestry, barriers to adoption of these practices still exist. To help build an understanding of how to direct long-term conservation initiatives for multipurpose plantings of trees and shrubs, we consider the values and opinions of landowners in Missouri, a state in which agroforestry practices have been promoted and supported. We use a state-wide survey to gather information about farm goals, practices, and interest in planting trees through conservation program funding. This information will help determine landowner interest in agroforestry, their interest in conservation programs more broadly, and their willingness to plant agroforestry using conservation program resources. Our work will provide new insights into landowners' acceptance of productive conservation by exploring the following research questions:

1.) What are landowners' perceptions of and preferences for different planting plans that include agroforestry for their farm?

2.) To what extent do landowners show interest in participating in conservation programs to assist in the planting of trees and shrubs on their land?

3.) How do landowner characteristics and their land use goals influence their decision to plant agroforestry on their farm?

3.3 Survey Methods

Study Site

The approach to understanding how agroforestry systems can be integrated into conservation programs must be targeted to the features of a specific geographic area due to the great diversity of climates and geography throughout the world. The state of Missouri is part of the southern Midwest area of the United States and offers a unique sociopolitical context for the application of agroforestry tree plantings. The state's geography ranges from prairie land in the north to the Ozark highlands in the south. A lowland area in the southernmost region of Missouri, known as the bootheel, is the state's most intensively row cropped area. There are 95,000 farms across Missouri covering 27.8 million acres of land, roughly two thirds of the state (Missouri Department of Agriculture, 2021). The agricultural industry contributes $88 billion to the state's economy and employs over 400,000 people (Missouri Department of Agriculture, 2021). The importance of agricultural activities, as well as the diversity of different enterprises (e.g., row crops, livestock, and specialty crops), for the state of Missouri presents an interesting case study on how conservation and production can be integrated throughout agricultural landscapes to further support economic and social goals.

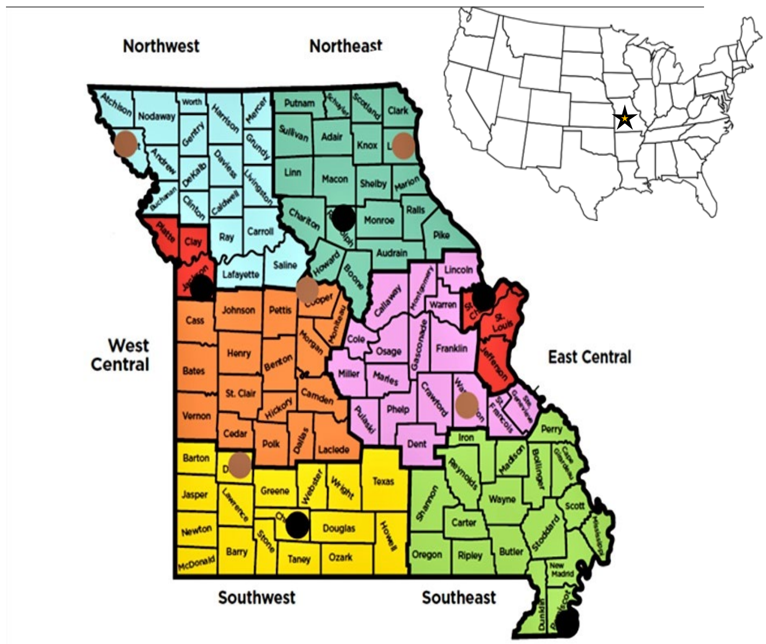


Figure 3.1 The six regions of Missouri as divided by MU Extension used to compare planting design preferences for landowner survey. Counties included in the sample are indicated by dots on the map. Brown dots mark the rural counties, black dots represent urban counties

A strategic approach to proportional sampling of Missouri landowners was used to ensure a representative sample was included in the survey research. For this process, Missouri was divided into the six geographic regions used by the University of Missouri Extension offices (figure 3.1). This accounts for any differences in landowners' agroforestry preferences due to their farms' geographic location and climate. All counties were designated either rural or urban using county rurality data from the 2010 Census Data (United States Census Bureau, 2010). A rural and an urban county from each of the six regions was randomly sampled to be included in the survey. Twelve representative counties were randomly selected from the emergent classification schemes. These counties were chosen to represent the variety of Missouri's landscape ecology, economic activities, and population. A two-step process was used to determine the sample size of each county. Sample data was mined using minimum sample size estimation and sample size with finite population formulas (Cochren, 1963).

Proportional sampling was then completed based on the total population of farms in each of the regions being sampled. A minimum sample size of 50 landowners from each county was chosen to ensure enough survey responses for statistical analysis. Due to difficulty in getting addresses from all the counties selected to be included in the survey, two of the geographic regions, southeast and west central, relied on samples from a single county. Following a similar protocol as Barbieri & Valdivia (2010) and Mattia et al. (2018b), lists of all agricultural land parcels with the landowner contact information was procured from each county's tax assessor office. These contact lists were sorted to remove absentee landowners, businesses, and county land. A proportional sample from each address list was randomly selected for mailing the surveys.

Survey Instrument and Timeline

The first page of the survey asked a series of screening questions, including if the recipient was the primary decision maker for their land, to help ensure our sample population both owned and farmed their land. The main body of the survey instrument contained four sections (table 3.2). The first collected information about the farm including its location by county, acreage, presence of marginal land, and landowner goals. The second section included detailed planting plans and perspective-view digital renderings of a field, pasture, riparian zone, and forest scene used to capture landowners' preferences for the different landscapes (Wang et al. 2016; Häfner et al. 2018). Each of the planting plans varied in complexity from a landscape under typical management (open row crop field, open cattle pasture, grass filter strip, and forest) to a simple agroforestry or timber production design (conifer windbreak in a field, hardwood silvopasture with cattle, basic riparian buffer, timber stand) to lastly the multifunctional agroforestry plantings (multifunctional food producing windbreak in a field, pecan silvopasture with cattle, multifunctional food producing riparian buffer, and a forest farm) (figure 3.2). All planting designs adhere to NRCS conservation practice standards for species selection and spacing. Likert scale ratings for each design allowed participants to rate their preference for the different planting plans. The survey also asked landowners to indicate their agreement/disagreement with several statements including the profitability of the planting, the challenge of maintenance, and the conservation benefits for each of the multifunctional agroforestry designs. After the design ratings, questions on conservation program participation and land use were included. Participants were able to freely explain their choice to enroll or not enroll a conservation program. The final section collected basic demographic information allowing us to cross-reference respondents with census data to check representativeness of the sample for landowners statewide.

Table 3.2 Overview of survey sections sent to landowners

Section	Question Summary
1.) Farm information	Farm location, acres owned, acres leased, farm experience, presence of marginal land, farm goals
2.) Planting Plan Ratings	Rate the desirability of each plan, indicate agree/disagree to comments on planting plans
3.) Land use	Land use/management activities, conservation program enrollment, interest in conservation program – free response
4.) Demographic Information	Age, occupation, education, income

Note: This table is an overview of the sections included in landowner survey. There were four main parts with the second section on planting plan ratings being the focus of the survey and analysis.

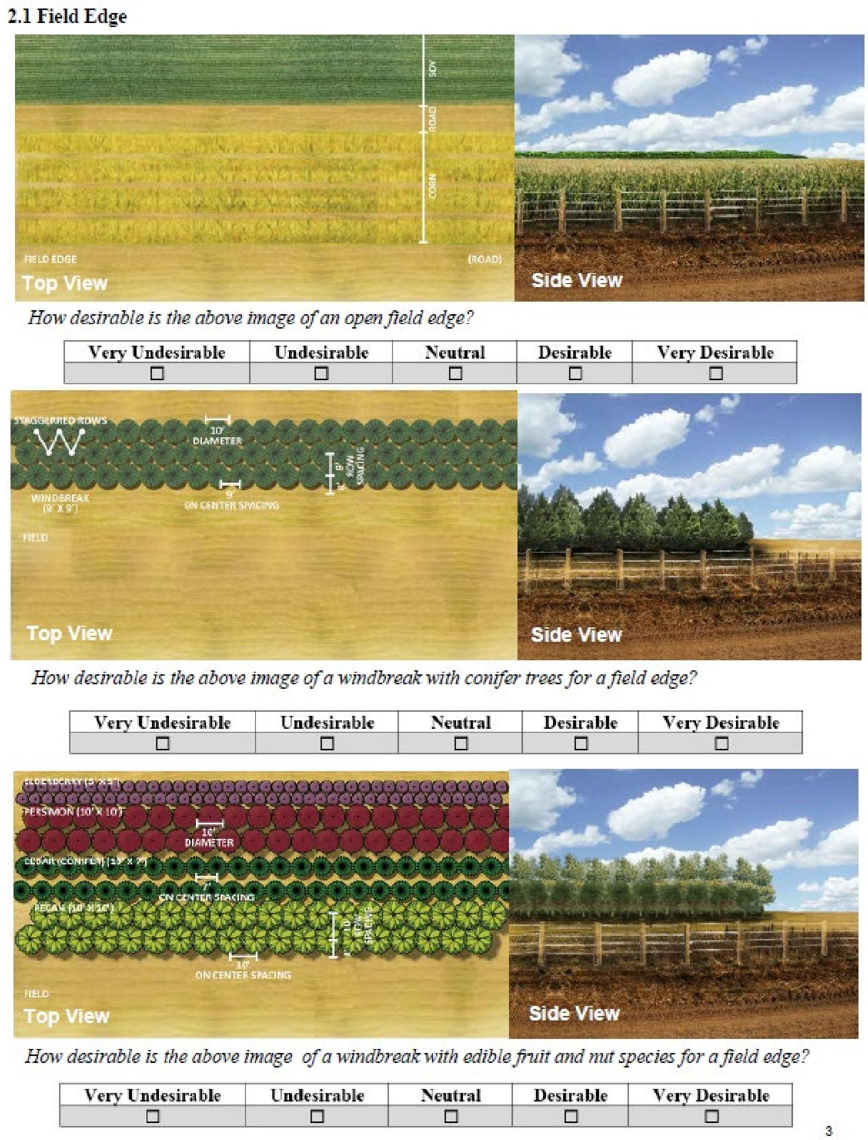


Figure 3.2 Sample of planting plan images from survey showing open field, conifer windbreak, and multifunctional windbreak. This same layout was used to ask participants about the desirability of silvopasture, riparian forest buffers, and a forest farm scene

Surveys were sent out using a modified Dillman method (Dillman et al., 2009) via mail on April 30, 2021 and May 21, 2021. Participants had the option to return the survey via mail or complete it online using the Qualtrics survey platform. A link to the online survey was included on the paper copies mailed directly to participants. The participants were offered the opportunity to be entered into a drawing to win a $25 gift card by completing the survey early. They could choose to remain anonymous or share their contact information for the gift card drawing. A total of 3,673 surveys were sent out between April and May. Due to an initially low response rate of less than 3%, we send out 3,035 additional surveys on July 26th, 2021 to help increase the number of responses (figure 3.3). Reminder postcards were mailed on July 26th to the first two rounds of survey. Reminders for the additional round of addresses were mailed on August 16th.

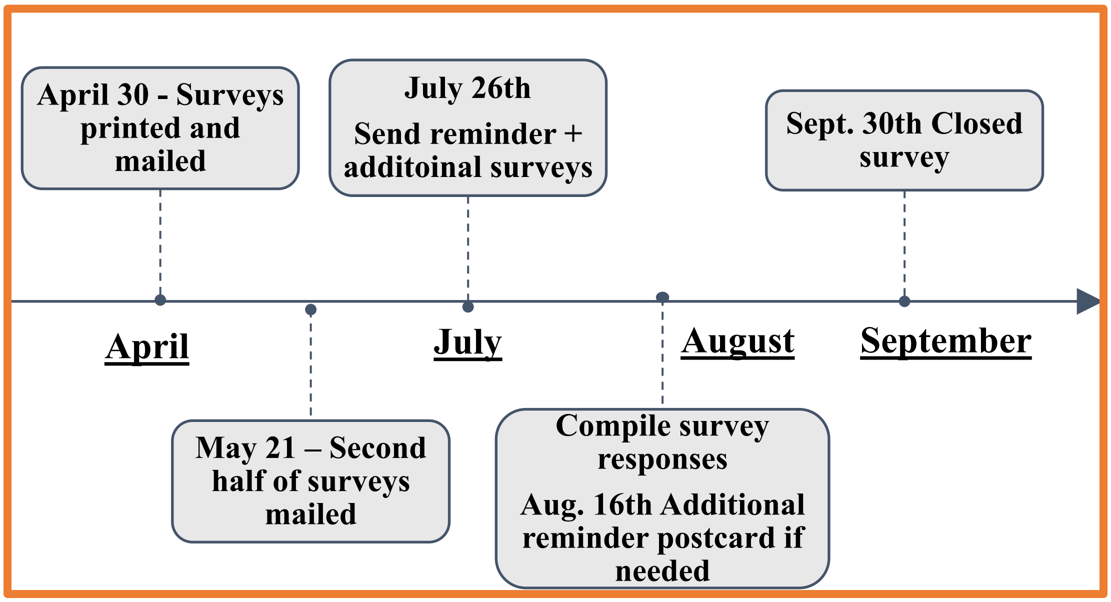


Figure 3.3 Timeline for mailing out the survey, collecting responses, and sending reminders

Statistical Analysis

Descriptive statistics were performed in SAS software version 9.4 (SAS Institute, Cary NC) to quantify the characteristics of those who responded to the survey and to determine the average ratings of the planting plans. The desirability ratings for each of the planting designs were predicted using two-way analysis of variance (ANOVA) based upon each of the designs and the survey respondent. A one-way ANOVA in SAS proc General Linear Model (GLM) was used to predict the landowners' willingness to plant each agroforestry design based upon a single predictor, first using each demographic as an independent factor (age, gender, farming as primary occupation) and again in separate models using each of the farm goals (income, conservation, recreation, education, agritourism, and lifestyle) as the independent factor. Future interest to participate in a conservation program was also measured and used to predict willingness to plant agroforestry. Post-hoc testing was performed using Fisher's Least Significant Difference to examine significant differences between agroforestry design ratings. Free response questions and comments about the planting designs and conservation programs were sorted and explored separately using NVivio software (version 12). Summaries of these responses are included in the discussion to enrich the quantitative findings of the survey.

3.4 Survey Results and Discussion

Survey Response

Of the combined 6,708 surveys sent out, 366 responses were collected. After accounting for undeliverable addresses, we had a response rate of about 6%, which is lower than expected for survey research (Pennings et al. 2002). This is likely due to the over-surveying of landowner populations (Coon et al. 2019). We also acknowledge the timeframe when the survey was sent out during April and May is overlaps with the active planting months for Missouri farms. The average age of survey respondents was 61 years old and the majority self-identified as male (71.6%) and white (96.5%). Approximately 75% had some level of education above a high school diploma with 45% earning a college degree. The majority are not full-time farmers (73%) and when asked what their primary occupation was, "retired" was the most written in answer with 60 responses. Working in healthcare (7), education (9), finance (8) and in local county government positions (7) were other listed primary occupations. The net income of farms was generally none ($0) to less than $20,000 a year. Using data collected through the 2017 National Agricultural Statistics Service (NASS), we compare how representative our sample is to the whole farmer population of Missouri (table 3.3). The survey sample is comparable to the state averages for farmer age, race, and income with slight differences in gender breakdown, farming as a primary occupation, and average farm size.

Table 3.3 Missouri Farmer population statistics compared to survey sample

Population	Average Age	Gender Male	White	Primary Farmer	Average Farm Size	Average Income & Income Range
State	57.4	63.8%	98.4%	39%	291	$12,649
Survey Sample	61.2	71.6%	96.5%	27%	197	< $20,000

Note: This table shows the comparison of the survey participants sample to Missouri farmer population. Note the differences in farm size, gender, and farming occupation

Planting Plan Preferences

When comparing the mean ratings of the three planting plan levels in each scene, multifunctional agroforestry designs were always preferred over the plans that represented typical agricultural land management practices (figure 3.4). For the field setting, the multifunctional windbreak was rated higher than the open field, but the two windbreaks were not rated significantly different. The basic windbreak was also not rated significantly different than the open field. These ratings suggest landowners view the multifunctional windbreak more favorably than the open field, but they also see both windbreaks as equally desirable along with the basic windbreak and open field as equally desirable. For the pasture scene, both options for silvopasture plantings (pecan/nut tree and the hardwood) received statistically higher average ratings compared to the open pasture without trees. Both riparian forest buffers received higher desirability ratings than the grass filter strip, once again suggesting the landowners view the agroforestry plantings as desirable but the addition of the food producing trees did not make the multifunctional plantings more advantageous in the eyes of the participants. For the last set of images of a forest scene, the forest farm was rated significantly more desirable than a natural forest or timber stand. Interestingly, of all the plantings, forest farm had the highest mean desirability rating of 3.87, which would translate to “desirable” on the 1-5 Likert scale.

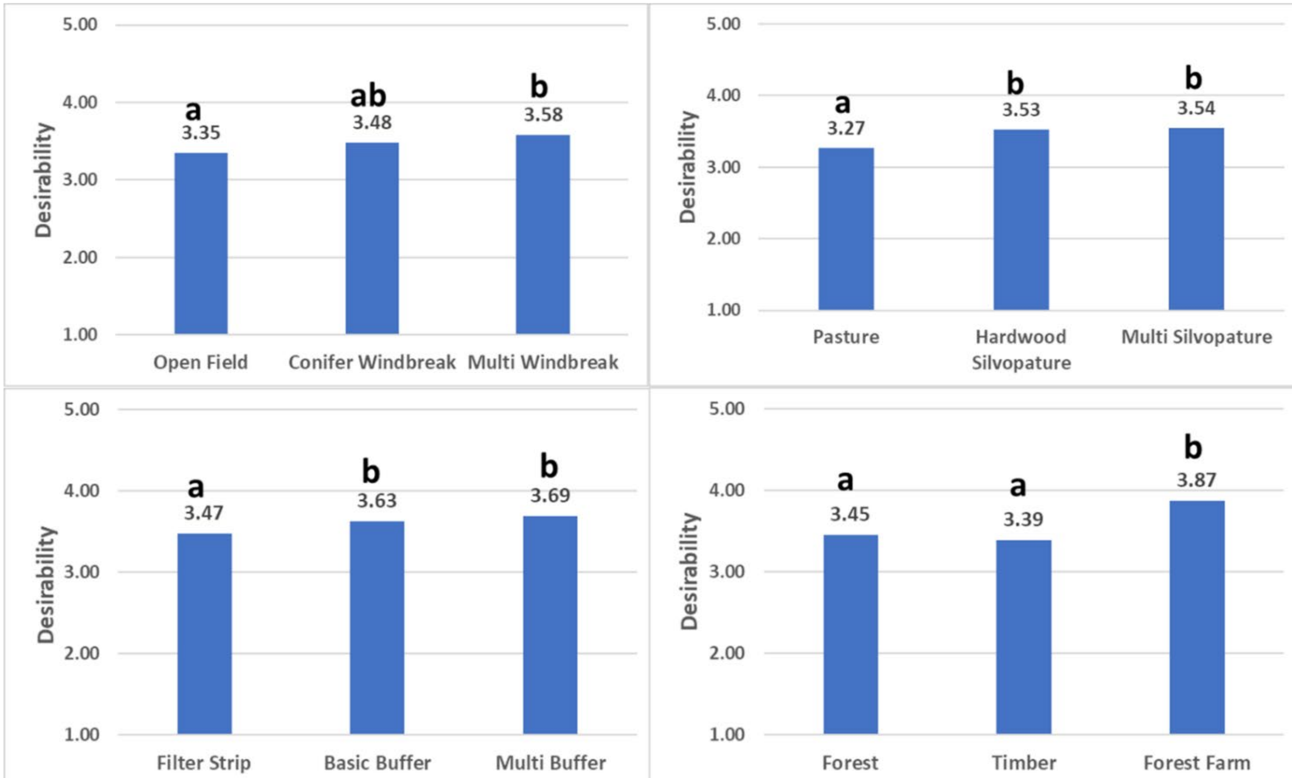


Figure 3.4 Comparison of mean desirability ratings between planting plan images in section two of the survey using a two-way analysis of variance (ANOVA) based upon each of the designs and the survey respondent. Different letters indicate means that are statistically significantly different. 1= Very Undesirable, 3= Neutral, and 5= Very Desirable on Likert Scale shown to participants. Source: Landowner Survey, 2021

These findings emulate other survey and interview work that concluded landowners are generally supportive of multifunctional agroforestry planting designs (Trozzo et al. 2014a; Mattia et al. 2018b). Our survey responses mirror a wider shift in landowner preferences towards multifunctional land management that can include agroforestry, which is especially promising compared to earlier adoption studies that found farmers had little to no interest in agroforestry (Arbuckle et al. 2009; Barbieri and Valdivia 2010a). Despite a growing preference for multifunctional planting designs, when asked about their willingness to plant each of the agroforestry plantings, landowners indicated they are unsure whether they would plant the designs on their farm. In other adoption studies, farmers also indicated they were hesitant to establish agroforestry practices including alley cropping and riparian forest buffers with fruit and nut trees (Barbieri and Valdivia 2010a; Trozzo 2014b).

While the landowners responded that there are benefits from agroforestry practices, especially for supporting conservation including wildlife habitat, protecting natural resources, and reducing soil erosion, they also expressed concerns over the costs to establish and maintain these plantings. Comments on the multifunctional agroforestry designs highlighted concerns over lack of knowledge on how to manage the agroforestry plantings. This need for more technical knowledge and the lack of management skills needed to successfully adopt agroforestry is a reoccurring theme throughout the agroforestry adoption literature (Workman et al. 2003; Trozzo et al. 2014a; Mattia et al. 2018b; Ranjan et al. 2019). Many landowners also indicated the agroforestry practices would not be profitable. They expressed concerns about the cost to establish and maintain agroforestry plantings along with the lack of developed markets for fruit, nuts, and other specialty products produced by species in these plantings. As other researchers have found, there is a recognized need for more developed markets and infrastructure to support agroforestry adoption (Valdivia and Poulos 2009; Mattia et al. 2018b).

In addition to general concerns over financial returns and management requirements, landowners commented on the large area of land that several of the designs would take up. Participants explained the riparian forest buffer and multifunctional windbreak require a lot of space in and along fields, meaning only larger farms would have the land available to plant these designs. Available acres is an important factor for agroforestry adoption, as landowners with more land or land they would transition to alternative management are more willing to plant agroforestry (Pattanayak et al. 2003; Strong and Jacobson 2006; Valdivia and Poulos 2009;

Prokopy et al. 2019). Other comments from respondents indicated the designs are not applicable to their land – several landowners did not have a stream, field, forest, or pasture on their property and therefore were unable to consider planting the design in question.

After examining the desirability ratings of the planting designs across all responses, we explored if there are any differences in the ratings between urban and rural counties and across the six regions. For nearly all planting designs, there was not a statistically significant difference between their average ratings of desirability in urban versus rural counties. Only one planting plan, the conifer windbreak, had a slightly higher desirability rating by landowners in urban counties compared to rural (see table 3.4). This could be due to the benefits windbreaks provide to urban areas such as visual screening, wind protection, and odor control (Sullivan et al. 2004; Jose et al. 2012). Comparing the different regions of Missouri, planting plans also had similar desirability ratings (table 3.5). The forest farm design was the only plan to have significantly different ratings between the various regions. Forest farms were rated higher in the east central (EC) and northeast (NE) regions of the state compared to the others. We did not gather information in the survey to directly determine the reason, but it could potentially be because of the major metropolitan area in these regions. The city of St. Louis and its surrounding communities make up a large portion of the EC region. The proximity of farms in the EC region to St. Louis likely increases their connections to diverse markets in urban areas, therefore providing opportunities to grow and sell specialty forest products (Valdivia and Poulos 2009; Prokopy et al. 2019). The higher ratings of forest farm for this area are something to explore with additional surveys or landowner interviews to better understand the potential of forest farming for this area.

Table 3.4 Mean Desirability Ratings of Planting Designs between Urban and Rural Counties

Design	Urban	Rural	P-value
Field	3.19	3.42	0.1006
Conifer Windbreak	3.68	3.41	0.0433*
Multi Windbreak	3.77	3.51	0.1146
Pasture	3.08	3.35	0.1006
Hardwood Silvopasture	3.62	3.49	0.3508
Multi Silvopasture	3.65	3.49	0.2773
Filter Strip	3.46	3.5	0.7744
Basic Riparian Buffer	3.65	3.64	0.9491
Multi Buffer	3.71	3.69	0.9129
Forest	3.49	3.43	0.7039
Timber	3.33	3.41	0.5879
Forest Farm	3.90	3.86	0.749

Note: Table shows comparison of mean desirability ratings of planting designs between urban and rural counties using a two-way analysis of variance (ANOVA) based upon each of the designs and the survey respondent. Source: Landowner Survey, 2021

1= very undesirable, 3=neutral, 5= very desirable on a Likert Scale

* indicates a significant difference between the mean desirability rating between counties

Table 3.5 Mean Desirability Ratings of Planting Designs Between Regions of Missouri

Design	NW	NE	EC	WC	SW	SE	P-value
Field	3.49	3.19	3.33	3.66	3.20	3.86	0.2072
Conifer Windbreak	3.36	3.64	3.63	3.36	3.33	3.29	0.3541
Multi Windbreak	3.50	3.56	3.85	3.55	3.46	3.43	0.6647
Pasture	3.35	2.97	3.37	3.52	3.43	3.50	0.1083
Hardwood Silvopasture	3.57	3.68	3.59	3.52	3.22	3.43	0.2541
Multi Silvopasture	3.54	3.45	3.70	3.67	3.38	3.71	0.6212
Filter Strip	3.47	3.54	3.20	3.86	3.38	3.57	0.0787
Basic Riparian Buffer	3.53	3.74	3.51	3.86	3.57	3.29	0.4376
Multi Buffer	3.50	3.89	3.77	3.76	3.49	3.29	0.218
Forest	3.39	3.44	3.57	3.44	3.44	3.14	0.907
Timber	3.33	3.58	3.30	3.53	3.10	3.43	0.1818
Forest Farm	3.46	3.99	4.21	3.88	3.81	3.29	0.006*

Note: Table shows comparison of mean desirability of planting designs between the MU extension regions of Missouri using a two-way analysis of variance (ANOVA) based upon each of the designs and the survey respondent. NW= Northwest, NE = Northeast, EC = East Central, WC= West Central, SW= Southwest, SE= Southeast. Ratings of 1= very undesirable, 3=neutral, 5= very desirable on a Likert Scale. Source: Landowner Survey, 2021

* indicates a significant difference between the mean desirability ratings

Conservation Program Interest and Participation

To understand landowners' interest in conservation programs, they were encouraged to share why or why they did not participate in any of the programs. Most of the landowners who returned the survey were not currently enrolled in any conservation program. When explaining why they chose not to participate, the primary reason was due to a lack of knowledge about the conservation programs available in their county. Broadly, landowners have a little awareness of the programs available to them, how to enroll, what the management activities entail, and ultimately knowing if they can provide the management required to establish the conservation practices and maintain enrollment. Earlier studies on landowner participation in conservation programs made similar conclusions (Mattia et al. 2018; Rhodes et al. 2018). Other landowners had some sense of what conservation programs entailed, but they preferred their current management practices and saw no need to integrate new approaches into their production systems. Some landowners mentioned not owning enough acres to qualify for enrollment or indicated that their current land management practices were supportive of conservation already. Other participants had recently bought the farm and any conservation contracts associated with the property were simply inherited and they were not looking to enroll in additional programs. Several landowners noted they prefer to make their own decisions about how to manage their land based on their current knowledge (table 3.6). Others explicitly stated they did not want any government involvement on their land or farm. This distrust of the government has been highlighted in other research as a significant reason landowners chose not to participate in conservation programs (Atwell et al. 2009; Stanek and Lovell 2018; Chapman et al. 2019).

Table 3.6 Frequency of comments by landowners on why they do not want to participate in conservation programs

Comment Theme	Number of Comments
Lack of knowledge of programs	66
Programs not applicable to farm	26
Content with current management	19
Don't like the conservation program requirements	12
Independent decision maker	12
Cost too much to participate	10
Did not qualify for program assistance	10
Participation takes too much time	8
Age and health prevent participation	5
Unprofitable to participate	3
Never thought about conservation programs	2
No help to establish conservation practices	2
Program contracts too long	1

Note: Table quantifies the number of comments on why landowners did not or would not participate in conservation programs. These comments are not exact matches to those made by participants but used as categories to group and quantify similar themes in the landowners' responses. Source: Landowner Survey, 2021

Other participants simply did not like the conservation programs currently available to them. Comments about the difficulty to enroll in conservation programs focused on the amount and complexity of the paperwork needed along with the time it would take to implement the program practices. The financial cost to participate and fund the establishment of conservation practices were other barriers for landowners to enroll in conservation programs. This cost of time and money, along with some practices being seen as a reversal of productive agriculture, led to landowners resisting the idea of planting trees (Atweel et al. 2010). A handful of respondents also mentioned they either did not qualify for conservation program assistance, or they had applied to a program but did not receive funding. Lastly, old age and health concerns also kept some participants from enrolling their land in conservation programs as they worried they would be unable to do the work needed to implement and maintain the conservation practices. Other studies have also shown that age can influence willingness to invest in long-term conservation (Featherstone and Goo 1993; McGinty et al. 2008; Mattia et al. 2018b).

Table 3.7 Frequency of comments by landowners on why they want to participate in conservation programs

Comment Theme	Number of Comments
Want to participate to support conservation	13
Want to create wildlife habitat	6
Want to participate to address resource concern	5
Want to participate for financial benefits	2
Want more knowledge of conservation	1

Note: Table quantifies the number of comments on why landowners chose to or would participate in a conservation program These comments are not exact matches to those made by participants but used as categories to group and quantify similar themes in the landowners' responses. Source: Landowner Survey, 2021

Despite these reasons landowners chose not to participate in conservation programs, the majority (69%) indicated they are interested in enrolling in the future. We found landowners who are interested in enrolling in a conservation program have a strong conservation ethic. Other studies drew similar conclusions on the importance of landowners' conservation and stewardship values in their decision to enroll in conservation programs (Ryan et al. 2003; Mattia et al. 2018b). Some of the primary reasons landowners had chosen to enroll previously or wish to enroll in the future are to conserve natural resources on their farm, address a resource concern such as erosion, and to provide wildlife habitat and hunting opportunities. These reasons were also common in other studies of conservation program participation (Workman et al. 2003; Mattia et al. 2018b). A few participants commented they purchased farms that already had conservation contracts in place and will continue to maintain the practices even after their contract ends due the benefits these programs provide (table 3.7).

Factors for Agroforestry Adoption

Focusing on the factors for landowners' willingness to plant multifunctional agroforestry plantings can help guide future outreach initiatives as well as direct the work of conservation and natural resource professionals in the field. Age was found to be a significant factor in predicting willingness to plant the agroforestry designs with older landowners (67+) being less willing than younger (under 35) and middle-aged landowners (36 to 66) to plant agroforestry. This contradicts findings from other researchers who found age had no effect on interest in planting riparian buffers (Trozzo et al. 2014a). Pattanayak et al. (2003), however, found age to be a factor in adopting agroforestry, but it is not always significant. A reason older landowners may be hesitant to plant trees is due to the long returns for perennial conservation practices, making older landowners more hesitant to commit time and money for plantings they are unlikely to be able to harvest and enjoy during their lifetime (Strong and Jacobson 2006, Mattia et al. 2018b). The aging farmer population presents a challenge to widespread adoption of long-term conservation and agroforestry practices.

Other positive factors for predicting greater willingness to plant agroforestry are the presence of marginal land on the farm and the landowner's interest in participating in a conservation program. Landowners with marginal land were more willing to plant the agroforestry designs than those without. This is consistent with previous research that found the presence of marginal land was a motivator for landowners to enroll in conservation program (Mattia et al. 2018b). For the survey, marginal land was defined as land that is less productive than the average farmland in the participant's area. Marginal land presents resource concerns and is a management challenge due to erosion, poor soil productivity, and/or flooding (Mattia et al. 2018a, Stanek and Lovell 2019). We found many landowners have some amount of marginal land that included uneven, rocky ground prone to flooding or is shaded. Addressing these concerns while producing additional benefits provides an excellent starting point for expanding conservation efforts while maintaining production (Jose et al. 2012).

We found respondents who indicated a future interest in participating in conservation programs are also more willing to plant the multifunctional agroforestry designs compared to those who are not interested in conservation programing. This aligns with other research findings (Trozzo et al. 2014b, Atweel et al. 2010). We found the number of acres the landowner owned, being a beginning farmer (having farmed for less than 10 years), one's primary occupation as farmer, and gender were not significant factors in predicting willingness to plant agroforestry (table 3.8).

Table 3.8 Demographic factors influencing landowner's willingness to plant agroforestry, where designs refer to each of the multifunctional agroforestry planting plans shown to participants of the survey.

Design	Independent Factor[1]	P-value	Model Fit	Variable Type[2]	Relationship[3]
Multi Windbreak	Age	0.0029**	r2 = 0.0498	Categorical	Negative
	Gender	0.065		Categorical	
	Primary Farmer	0.3058		Categorical	
	Conservation Program Interest	<.0001**	r2 = 0.0904	Categorical	Positive
	Farm Income	0.0799		Categorical	
	Marginal Land	0.1011		Categorical	
	Acres	0.3123		Continuous	
	Beginning Farmer	0.7897		Categorical	
Multi Riparian Buffer	Age	0.0009**	r2 = 0.0590	Categorical	Negative
	Gender	0.2589		Categorical	
	Primary Farmer	0.1813		Categorical	
	Conservation Program Interest	<.0001**	r2 = 0.1084	Categorical	Positive
	Farm Income	0.2443		Categorical	
	Marginal Land	0.0153*	r2 = 0.0312	Categorical	Positive
	Acres	0.578		Continuous	
	Beginning Farmer	0.3193		Categorical	
Multi Silvopasture	Age	0.0018**	r2 = 0.0550	Categorical	Negative
	Gender	0.9665		Categorical	
	Primary Farmer	0.0651		Categorical	
	Conservation Program Interest	<0.0001**	r2 = 0.0718	Categorical	Positive
	Farm Income	0.0749		Categorical	
	Marginal Land	0.3528		Categorical	
	Acres	0.2515		Continuous	
	Beginning Farmer	1		Categorical	
Forest Farm	Age	<.0001**	r2 = 0.0819	Categorical	Negative
	Gender	0.0823		Categorical	
	Primary Farmer	0.042*	r2 = 0.0159	Categorical	Negative
	Conservation Program Interest	<.0001**	r2 = 0.1620	Categorical	Positive
	Farm Income	0.0438*	r2 = 0.0523	Categorical	Negative
	Marginal Land	0.0573		Categorical	
	Acres	0.0219*	r2 = 0.0193	Continuous	Positive
	Beginning Farmer	0.807		Categorical	

Results in table are from one-way ANOVA in SAS proc General Linear Model (GLM). Source: Landowner Survey, 2021

[1]Independent factors are demographic information of the farmer and his/her farm. Dependent factors include "would plant the agroforestry design," "would plant the agroforestry design with conservation program funding," and "would plant the design with technical assistance. "Age (<35, 35-66, 67+). Gender (Male, Female, Other). Primary Farmer (Yes/No). Conservation Program Interest (Yes/No). Farm Income (<$1,000, $1,000 - $19,999, $20,000 - $39,999, $40,000 - $69,999, $70,000 - $99,000, $100,000+). Marginal Land (Yes/Unsure/No). Acres owned. Beginning Farmer (Yes/No)

[2]Classification of independent factor used to predict willingness to plant agroforestry designs, either categorical or continuous

[3]Relationship between independent variable and its influence on dependent variable willingness to plant agroforestry design for significant variables

* Indicates significant p-value

** Indicates highly significant p-value.

Model fit (r^2) is shown for only significant variables

The goals landowners have for their farm also factor into their management choices (Walter 1997; Barbieri and Valdivia 2010a). We asked landowners to rate the importance of several common agricultural land goals as found in the literature including production for generating income, supporting natural resource conservation, providing recreational opportunities, education and experimental plantings, supporting agritourism, and providing a rural lifestyle (Traore et al. 1991; Raedeke et al. 2003; Workman et al. 2003; Barbieri and Valdivia 2010a; Frey and Comer 2018; Garcia de Jalon et al. 2018; Stanek and Lovell 2019). The top three most important farm goals found in this study were providing a rural lifestyle for self/family, providing conservation, and production for income (figure 3.5). Providing for educational experiences or agritourism opportunities were less important while recreational opportunities was equally split in importance among respondents.

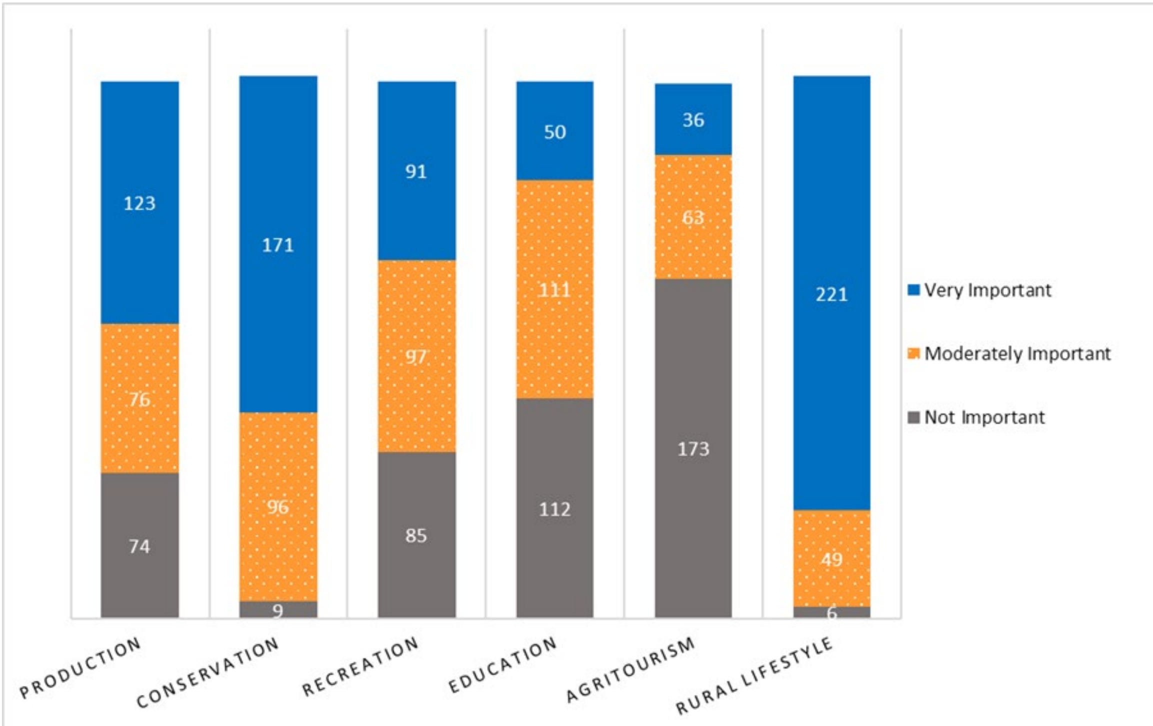


Figure 3.5 Summary of landowners' ranking of important farm goals. Providing a rural lifestyle for themselves or their family was the goal listed as very important by most (221) of the respondents. Providing agritourism opportunities was listed as least important among nearly half of participants (173). Source: Landowner Survey, 2021

Table 3.9 Landowner goals for their farm influence on willingness to plant different multifunctional agroforestry designs, where designs refer to each of the multifunctional agroforestry planting plans shown to participants of the survey.

Design	Independent Factor[1]	P-value	Model Fit	Variable Type[2]	Relationship[3]
Multi Windbreak	Goal of Income	0.1181		Categorical	
	Goal of Conservation	<.0001**	r2 = 0.0954	Categorical	Positive
	Goal of Recreation	0.0007**	r2 = 0.0540	Categorical	Positive
	Goal of Education	<0.0001**	r2 = 0.1097	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0853	Categorical	Positive
	Goal of Lifestyle	0.0528		Categorical	
Multi Riparian Buffer	Goal of Income	0.5839		Categorical	
	Goal of Conservation	0.0083**	r2 = 0.0357	Categorical	Positive
	Goal of Recreation	0.022*	r2 = 0.0288	Categorical	Positive
	Goal of Education	<0.0001**	r2 = 0.0708	Categorical	Positive
	Goal of Agritourism	0.0003**	r2 = 0.0594	Categorical	Positive
	Goal of Lifestyle	0.0334*	r2 = 0.0255	Categorical	Positive
Multi Silvopasture	Goal of Income	0.12		Categorical	
	Goal of Conservation	0.0029**	r2 = 0.0438	Categorical	Positive
	Goal of Recreation	0.0473*	r2 = 0.0234	Categorical	Positive
	Goal of Education	<.0001**	r2 = 0.0895	Categorical	Positive
	Goal of Agritourism	0.0019**	r2 = 0.0476	Categorical	Positive
	Goal of Lifestyle	0.0072**	r2 = 0.0372	Categorical	
Forest Farm	Goal of Income	0.02*	r2 = 0.0294	Categorical	Negative
	Goal of Conservation	<.0001**	r2 = 0.0693	Categorical	Positive
	Goal of Recreation	0.0006**	r2 = 0.0546	Categorical	Positive
	Goal of Education	0.005**	r2 = 0.0397	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0706	Categorical	Positive
	Goal of Lifestyle	0.0006**	r2 = 0.0546	Categorical	Positive

Results in table are from one-way ANOVA in SAS proc General Linear Model (GLM). Source: Landowner Survey, 2021

[1]Independent variable is each of the goals analyzed separately for their influence on the dependent variable, "Would Plant Design," Would Plant with Funding," and "Would Plant with Technical Assistance."

[2]Classification of independent factor used to predict willingness to plant agroforestry designs, either categorical or continuous

[3]Relationship between independent variable and its influence on dependent variable - willingness to plant agroforestry design for significant variables

* Indicates significant p-value

** Indicates highly significant p-value

Model fit (r^2) is shown for only significant variables

In addition to influencing their land management practices, we found landowners goals for their farm influence their willingness to plant agroforestry on the land they own. Previous research noted similar relationships between landowner goals and their farm practices (Walter

1997, Jordan and Warner 2010). Our findings mirror the conclusions of Barbieri and Valdivia (2010b) who found landowners with land enjoyment oriented goals (including conservation, recreation, education, and agritourism) had greater willingness to plant agroforestry (table 3.9). This relationship was not consistent between all goals, suggesting other factors are important in the decision-making process for land management. For income and lifestyle goals, landowners who ranked these as important had higher willingness to plant agroforestry compared to the moderately important groups. Interestingly, landowners who rated income and lifestyle as not important were statistically equally likely to be willing to plant agroforestry as those that rated these goals as important. Agritourism has the lowest importance for all landowners who responded to the survey, and it had little significance in determining willingness to adopt agroforestry for most of the planting designs. This is likely due to the low agritourism development for farms across the state (Gao et al. 2014).

Landowners that expressed conservation is an important goal were more willing to plant agroforestry than those who rated it as a low priority. The conservation ethic is an important piece of adoption that has emerged in several other studies (McGinty et al. 2008; Arbuckle et al. 2009; Arbuckle 2013). In many cases, it is more influential to a landowner or farmer's decision to adopt agroforestry than the financial benefits of conservation program payments or market opportunities (Ryan et al. 2003). Perhaps most notably, across all planting types, the addition of conservation program funding or technical assistance increased landowners' willingness to plant the multifunctional agroforestry designs. This suggests providing the benefits of either financial help or technical knowledge to landowners would make them more willing to plant agroforestry compared to them establishing the plantings on their own (Workman et al. 2003).

Program benefits and support are important in increasing agroforestry adoption and ensuring the successful management of these practices on the ground. Agroforestry development programs that provide access to resources while building farmers capacity by learning from other skilled agroforestry practitioners and professionals can positively affect farmers' self-efficacy to manage their own agroforestry systems (McGinty et al. 2008). Landowners' value personalized assistance in managing their land (Stanek et al. 2019), and having access to agroforestry knowledge and funding would address barriers to planting agroforestry. Considering all the factors we explored in the survey, younger landowners with marginal land and an existing interest in conservation are most willing to plant agroforestry. Other studies also found young, educated landowners with known marginal land would consider planting agroforestry for improved soil and water quality conservation (McGinty et al. 2008; Frey et al. 2010; Mattia et al. 2018b; Stanek et al. 2019)

Interestingly, some of the factors we explored that had no significant influence on willingness to plant agroforestry were found to be important in other adoption studies. While we observed the number of acres owned had no significance influence on the landowners willingness to plant agroforestry, other researchers have found larger farms to be more willing to invest in conservation and plant agroforestry as they have more land and capital available to invest (Featherstone and Goo 1993; Strong and Jacobson 2006; Valdivia and Poulos 2009; Prokopy et al. 2019). Income was another variable that did not show any significant relationship with willingness to plant agroforestry. This contrasts other studies that noted farm income influenced adoption (Strong and Jacobson 2006; Valdivia and Poulos 2009; Prokopy et al. 2019). We may have observed this difference due our sample being mostly retired farmers who are no longer earning money by farming their land directly. Farming as a primary occupation and farming experience did not have any significant effect on landowners' willingness to plant agroforestry. This result is interesting, as other research has noted full time farmers who relied on their farm as a primary source of income were less interested in agroforestry (Prokopy et al. 2008).

Limitations

While we can draw important conclusions from this survey data, there are limitations to this research. We had a low survey response rate making our sample size (n = 366) much smaller than the 1,000 responses needed to make confident assumptions about the whole farming population of Missouri. Our low response rate reflects the growing challenge of low survey response rates for rural populations, primarily due to historic oversampling of this group (Pennings et al. 2002). As with any survey work, it is also important to consider nonresponse bias (Coon et al. 2019). Landowners who are extremely unfavorable to multifunctional plantings may not have taken the time to complete the survey. Another reason that may have impacted who responded is a distrust of the university and government organizations in general (Chapman et al. 2019; Coon et al. 2019). Also, our method of sampling using county tax assessors' lists means some surveys were unintentionally sent to people who either no longer farmed, are deceased, or moved without updating their primary address. We also must remember we are trying to quantify preferences, determine future behavior based on current reported opinions, and make broad statements about a population. These findings are only a snapshot of the landowner views in the counties we sampled from, and care must be taken when generalizing.

While we aimed to focus on landowners who both owned and operated their land, it is important to note an increasing amount of agricultural land is either leased or cash rented and managed by farmers who are not the owner (Ulrich-Schad et al. 2016; Keeley et al. 2019). Often, farm management decisions are left to the tenant (Ulrich-Schad et al. 2016; Mattia et al. 2018b). Some of our survey respondents indicated they are not actively farming and allowed their tenants to have control over management choices. Tenant farmers are generally less willing to invest in long-term plantings such as agroforestry due to their short-term leases (Ranjan et al. 2019). In other instances, tenants may not have the ability to plant trees or enroll in conservation programs without the permission of the landowner or would need the support of the landowner to feel confident investing in long-term conservation (Ulrich-Schad et al. 2016). Land tenure and ownership are important considerations when exploring the adoption of perennial agriculture as they impact how land is managed long-term. Given our focus, we can only apply our conclusions to landowners who both own and farm their land.

Future Research

Moving forward it will be important to explore how to best connect with the young landowners who are more open to implementing agroforestry practices on their farm. The process of increasing connections will include educational programming targeted to younger audiences (Barbieri et al. 2019). Additionally, establishing landowners' preferred information sources will be essential to developing the education and outreach programs needed to support productive conservation (Murakami et al. 2017; Stutzman et al. 2019). Beyond individual behavior change, we need to work to shift government policy to be more supportive of conservation and provide the long-term funding needed to establish and maintain perennial conservation practices (Chenyang et al. 2021). Policy change stems from civilian action (Wekerle 2004; Ranjan et al. 2019). It will be equally important to deepen and expand community support for targeted conservation on agricultural land to build the financial incentives required to motivate landowners to change their management approaches (Barbieri et al. 2019).

In addition to policy, expanding market research and development will be required to build confidence for farmers to invest in tree and shrub crops (Strong and Jacobson 2006; Prokopy et al. 2019). Funding will also need to be allocated for building demonstration farm sites and support the training of agroforestry professionals to provide the education farmers need to successfully adopt agroforestry practices (Chenyang et al. 2021).

3.5 Conclusion

Landowners are receptive to agroforestry plantings, rating them higher, on average, than traditional agricultural land management practices. The inclusion of technical assistance or funding was found to increase the willingness of landowners to plant the multifunctional agroforestry designs. Landowners who are conservation oriented, those that rate conservation as an important farm goal, or are willing to participate in a conservation program, are statistically significantly more willing to plant agroforestry. Taken together, this is a promising sign that supporting agroforestry through federal conservation programs will both encourage landowners to apply to these programs and help landowners interested in conservation plant designs that adhere to not only their conservation goals, but also their recreation, education, and lifestyle interests.

These findings prove helpful for guiding outreach efforts for conservation work and agroforestry adoption. The knowledge that landowners who are already interested in enrolling in a conservation program are also more willing to plant agroforestry while working with a natural resource professional is a good indication that agroforestry can and should be talked about more by natural resource agencies. As knowledge of conservation programs and agroforestry is still a barrier for landowners to plant these practices, continual educational programming is essential. This project also warrants additional work on agroforestry adoption. It will be important to replicate similar surveys in other states to gather localized information on landowner goals, interest in conservation programs, and perceptions of agroforestry planting designs relevant to the local farming communities.

CHAPTER 4. FINAL CONCLUSIONS FOR WORKING TOWARDS PRODUCTIVE CONSERVATION

For this research, we worked to understand the factors that influence the diffusion of agroforestry practices through natural resource conservation agencies. We explored natural resource professionals' knowledge of these practices and quantified landowner perceptions of agroforestry plantings and their interest in participating in conservation programs. We conclude that while there is work to be done to build support for productive conservation on agricultural land, the interest in agroforestry is there. Both natural resource professionals and agricultural landowners share support for agroforestry plantings and wish to learn more about these practices.

Moving forward, we must continue to strengthen the agroforestry knowledge network and provide training and education opportunities for farmers, landowners, and natural resource professionals to support the transition to perennial agriculture for both conservation and production. This includes expanding and personalizing the agroforestry curriculum and training programs available to natural resource professionals and landowners to support the establishment of agroforestry on agricultural land (Mendelson et al. 2021). Empowering natural resource professionals with improved agroforestry knowledge will allow them to work with and educate landowners about opportunities for productive conservation and funding through conservation programs. Educating landowners directly will provide them with the information needed to establish agroforestry on their own land while expanding peer-to-peer agroforestry knowledge networks.

Perhaps most important for furthering productive conservation is garnering greater community interest and support for conservation in agriculture landscapes. Community engagement will be required to advocate for policy that directs spending for conservation and provides the resources farmers need to manage their farms for perennial production. A consumer driven demand for healthier food, safe environments, and protection of wildlife habitat are promising trends for greater support of agroforestry practices by the general public (Valdivia et al. 2012). Political support for agroforestry practices will provide additional opportunities for landowners to adopt these practices. Policy that supplies additional cost share funding for landowners to establish and maintain trees plantings would help bridge the gap in investments and return for perennial crop investments (Wilson and Lovell 2016; Chenyang et al. 2021). Chenyan et al. explores in detail several policy pathways that will be essential to supporting agroforestry including crop insurance changes and tax exemptions that allow farmers to transition to perennial agriculture (2021). In addition to federal funding directly to landowners, grants that support agroforestry research to refine management practices and improve production will be pivotal in improving perennial agriculture, sustainable crop production, and performance (Chenyang et al. 2021).

Building effective messages for rural and urban communities, natural resource professionals, researchers, landowners, and farmers will be needed to increase the appreciation and adoption of agroforestry practices. The mode and type of message will vary depending on the audience. In our survey population, younger landowners under the retirement age of 67 with an existing interest in conservation and marginal land are more willing to plant agroforestry to support their land use goals. Older landowners, who often showed interest in managing their land to pass on to their children or grandchildren, appreciate the investment for future generations that tree planting entails. We found many natural resource professionals wish to support their clients and are receptive to technical knowledge on how to properly design and fund agroforestry plantings. Each of these audiences would benefit from messages tailored to their individual goals and work. Taken together, building supportive policy, expanding agroforestry education, and building outreach programs will accumulate in the connection of natural resource professionals, researchers, agroforestry practitioners, and future agroforestry farmers needed to shift our agricultural paradigm from production versus conservation to productive conservation.

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APPENDIX

Interview of Administrators of Conservation Programs

Target audience: Administrators of conservation programs, including those working for agencies such as USDA Farm Service Agency and Natural Resources Conservation Service.

Format: Interviews via phone or in-person meetings

Purpose: Gather information on their recommendations to growers regarding planting plans for specific conservation programs that include trees and shrubs. Included in the questions will be plant spacing (within and between rows), plant type per row (evergreen trees, deciduous trees, shrubs, or herbaceous plants), and specific species recommended. This information will help inform the design of the planting plans for future surveys to assess landowner preferences.

AGENCY INFORMATION

Your Name (or skip, for confidentiality): _______

Name of agency you work for: ____ ______________________________

Length of time working for the agency __________ (years)

Your current title: ____

Your role in developing and/or administering conservation activities:

CONSERVATION PROGRAM TYPES

What conservation programs are you familiar with that encourage **planting of trees and/or shrubs** on or adjacent to agricultural land? What is the primary focus of the program (e.g., protecting water, conserving soil, enhancing wildlife habitat)? Does the program provide financial assistance to the landowner for the establishment of trees and/shrubs?

- In recent years, has enrollment in the program been: increasing, decreasing, stable?
- In recent years, has landowner interest been: increasing, decreasing, stable?

PLANTING DESIGN (complete one section for each program)

Program Name _____________________________________

Given your experience, please describe the typical planting design for trees and shrubs used in this program. Please fill out each line to the best of your ability, even if they are only estimates or generalities:

- Requirements for previous land use:
- Total number of rows of trees/shrubs and overall width of the planting:
- Recommended/Required (circle one) planting spacing (distance between rows, distance between trees within rows):
- Type of trees/shrubs in each row (e.g., deciduous, evergreens, shrubs, fruit, nut):
- Specific species (trees, shrubs, ground cover) recommended by you (include lists, if available):
- Specific species preferred by landowners (include lists, if available):
- Limitations on management activities (mowing, pruning, etc):
- Restrictions of harvesting products from the trees/shrubs (nuts, berries, cuttings, etc.):
- What assistance do you provide to landowners in developing their planting plans?
- (If applicable) What is the payment structure for landowners participating in the program?

SURVEY PLANNING (assistance in developing landowner survey)

- What method do you recommend for recruiting, connecting, and maintaining relationships with landowners who might be interested in conservation programs?

Social media, one on one conservations, invitations to programs, connect with nurseries.

- What approach works best for administering surveys to landowners (online versus mail)?

Hybrid – Qualtrics and paper

- Are there any specific types of planting designs/systems you would like to explore with landowners that are not currently offered by programs administered by your agency?
- To what extent have landowners expressed interest in conservation programs that support/allow the following (please describe):
    - Harvesting of nuts or berries
    - Recreational activity, including hunting, hiking, foraging

- Improved aesthetics/visual quality of landscape
- Reducing potential damage from chemical drift (herbicides, pesticides)
- Protecting soil, water, and biodiversity
- Generating some other form of profit not listed above (excluding conservation payments), if so, what activities

AGROFORESTRY PRACTICES

- Are you familiar with Agroforestry practices? (No/Yes – which ones)
  - Silvopasture: No___ Somewhat___ Yes___
  - Riparian Forest Buffer: No___ Somewhat___ Yes___
  - Windbreak: No___ Somewhat___ Yes___
  - Alley Cropping: No___ Somewhat___ Yes__
  - Forest Farming: No___ Somewhat___ Yes___
- To what level does your agency promote or assist with agroforestry adoption?

ADDITIONAL NOTES/COMMENTS:

Appendix Table 1. Landowner Demographic factors and their willingness to plant agroforestry with conservation program funding

Design	Independent Factor[1]	P-Value	Model Fit	Variable Type[2]	Relationship[3]
Multi Windbreak	Age	0.0004**	r2 = 0.0663	Categorical	Negative
	Gender	0.6107		Categorical	
	Primary Farmer	0.8951		Categorical	
	Conservation Program Interest	<0.0001**	r2 = 0.1291	Categorical	Positive
	Farm Income	0.1656		Categorical	
	Marginal Land	0.0506*	r2 = 0.0223	Categorical	Positive
	Acres	0.2042		Continuous	
	Beginning Farmer	0.6768		Categorical	
Multi Riparian Buffer	Age	0.0451*	r2 = 0.0267	Categorical	Negative
	Gender	0.5035		Categorical	
	Primary Farmer	0.4023		Categorical	
	Conservation Program Interest	<.0001**	r2 = 0.1141	Categorical	Positive
	Farm Income	0.9153		Categorical	
	Marginal Land	0.0453*	r2 = 0.0232	Categorical	Positive
	Acres	0.6419		Continuous	
	Beginning Farmer	0.3466		Categorical	
Multi Silvopasture	Age	0.0803		Categorical	
	Gender	0.9942		Categorical	
	Primary Farmer	0.3321		Categorical	
	Conservation Program Interest	<.0001**	r2 = 0.0911	Categorical	Positive
	Farm Income	0.7426		Categorical	
	Marginal Land	0.5085		Categorical	
	Acres	0.4103		Continuous	
	Beginning Farmer	0.8574		Categorical	
Forest Farm	Age	0.0009**	r2 = 0.0595	Categorical	Negative
	Gender	0.6002		Categorical	
	Primary Farmer	0.1491		Categorical	
	Conservation Program Interest	<.0001**	r2 = 0.2070	Categorical	Positive
	Farm Income	0.5286		Categorical	
	Marginal Land	0.1714		Categorical	
	Acres	0.1041		Continuous	
	Beginning Farmer	0.2084		Categorical	

Results in table are from one-way ANOVA in SAS proc General Linear Model (GLM). Source: Landowner Survey, 2021

[1]Independent factors are demographic information of the farmer and his/her farm. Dependent factors include "would plant the agroforestry design," "would plant the agroforestry design with conservation program funding," and "would plant the design with technical assistance." Age (<35, 35-66, 67+). Gender (Male, Female, Other). Primary Farmer (Yes/No). Conservation Program Interest (Yes/No). Farm Income (<$1,000, $1,000 - $19,999, $20,000 - $39,999, $40,000 - $69,999, $70,000 - $99,000, $100,000+). Marginal Land (Yes/Unsure/No). Acres owned. Beginning Farmer (Yes/No)

[2]Classification of independent factor used to predict willingness to plant agroforestry designs, either categorical or continuous

[3]Relationship between independent variable and its influence on dependent variable willingness to plant agroforestry design for significant variables

* Indicates significant p-value. ** Indicates highly significant p-value. Model fit (r^2) is shown for only significant variables

Appendix Table 2. Landowner demographic factors and their willingness to plant agroforestry with technical assistance

Design	Independent Factor[1]	P-Value	Model Fit	Variable Type[2]	Relationship[3]
Multi Windbreak	Age	0.0091**	r2 = 0.0402	Categorical	Negative
	Gender	0.4206		Categorical	
	Primary Farmer	0.6925		Categorical	
	Conservation Program Interest	<.0001**	r2 = 0.1322	Categorical	Positive
	Farm Income	0.1298		Categorical	
	Marginal Land	0.0354*	r2 = 0.0249	Categorical	Positive
	Acres	0.2271		Continuous	
	Beginning Farmer	0.6666		Categorical	
Multi Riparian Buffer	Age	0.0402*	r2 = 0.0278	Categorical	Negative
	Gender	0.5332		Categorical	
	Primary Farmer	0.5273		Categorical	
	Conservation Program Interest	<0.0001**	r2 = 0.1010	Categorical	Positive
	Farm Income	0.8145		Categorical	
	Marginal Land	0.0225*	r2 = 0.0284	Categorical	Positive
	Acres	0.776		Continuous	
	Beginning Farmer	0.4083		Categorical	
Multi Silvopasture	Age	0.0304*	r2 = 0.0305	Categorical	Negative
	Gender	0.9973		Categorical	
	Primary Farmer	0.1497		Categorical	
	Conservation Program Interest	<0.0001**	r2 = 0.0857	Categorical	Positive
	Farm Income	0.8292		Categorical	
	Marginal Land	0.2832		Categorical	
	Acres	0.2945		Continuous	
	Beginning Farmer	0.946		Categorical	
Forest Farm	Age	0.0006**	r2 = 0.0628	Categorical	Negative
	Gender	0.1861		Categorical	
	Primary Farmer	0.1099		Categorical	
	Conservation Program Interest	<0.0001**	r2 = 0.1807	Categorical	Positive
	Farm Income	0.6321		Categorical	
	Marginal Land	0.1577		Categorical	
	Acres	0.1054		Continuous	
	Beginning Farmer	0.3185		Categorical	

Results in table are from one-way ANOVA in SAS proc General Linear Model (GLM). Source: Landowner Survey, 2021

[1]Independent factors are demographic information of the farmer and his/her farm. Dependent factors include “would plant the agroforestry design,” “would plant the agroforestry design with conservation program funding,” and “would plant the design with technical assistance.” Age (<35, 35-66, 67+). Gender (Male, Female, Other). Primary Farmer (Yes/No). Conservation Program Interest (Yes/No). Farm Income (<$1,000, $1,000 - $19,999, $20,000 - $39,999, $40,000 - $69,999, $70,000 - $99,000, $100,000+). Marginal Land (Yes/Unsure/No). Acres owned. Beginning Farmer (Yes/No)

[2]Classification of independent factor used to predict willingness to plant agroforestry designs, either categorical or continuous

[3]Relationship between independent variable and its influence on dependent variable willingness to plant agroforestry design for significant variables

* Indicates significant p-value

** Indicates highly significant p-value.

Model fit (r^2) is shown for only significant variables

Appendix Table 3. Landowner farm goals and their influence on landowner willingness to plant agroforestry with conservation program funding

Design	Independent Factor[1]	P-value	Model Fit	Variable Type[2]	Relationship[3]
Multi Windbreak	Goal of Income	0.0248*	r2 = 0.0278	Categorical	Neuatral
	Goal of Conservation	0.0026**	r2 = 0.0441	Categorical	Positive
	Goal of Recreation	0.0177*	r2 = 0.0303	Categorical	Positive
	Goal of Education	<.0001**	r2 = 0.0907	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0978	Categorical	Positive
	Goal of Lifestyle	0.0833		Categorical	
Multi Riparian Buffer	Goal of Income	0.3651		Categorical	
	Goal of Conservation	0.0637		Categorical	
	Goal of Recreation	0.0198*	r2 = 0.0296	Categorical	Positive
	Goal of Education	0.0018**	r2 = 0.0471	Categorical	Positive
	Goal of Agritourism	0.0014**	r2 = 0.0491	Categorical	Positive
	Goal of Lifestyle	0.1657		Categorical	
Multi Silvopasture	Goal of Income	0.7567		Categorical	
	Goal of Conservation	0.0027**	r2 = 0.0440	Categorical	Positive
	Goal of Recreation	0.0279*	r2 = 0.0272	Categorical	Positive
	Goal of Education	<.0001**	r2 = 0.0924	Categorical	Positive
	Goal of Agritourism	0.0001**	r2 = 0.0672	Categorical	Positive
	Goal of Lifestyle	0.1179		Categorical	
Forest Farm	Goal of Income	0.3346		Categorical	
	Goal of Conservation	0.0024**	r2 = 0.0450	Categorical	Positive
	Goal of Recreation	0.0009**	r2 = 0.0531	Categorical	Positive
	Goal of Education	0.003**	r2 = 0.0438	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0939	Categorical	Positive
	Goal of Lifestyle	0.0046**	r2 = 0.0402	Categorical	Positive

Results in table are from one-way ANOVA in SAS proc General Linear Model (GLM). Source: Landowner Survey, 2021

[1]Independent variable is each of the goals analyzed separately for their influence on the dependent variable, "Would Plant Design," Would Plant with Funding," and "Would Plant with Technical Assistance."

[2]Classification of independent factor used to predict willingness to plant agroforestry designs, either categorical or continuous

[3]Relationship between independent variable and its influence on dependent variable - willingness to plant agroforestry design for significant variables

* Indicates significant p-value

** Indicates highly significant p-value

Model fit (r^2) is shown for only significant variables

Appendix table 4. Landowner farm goals and their influence on landowner willingness to plant agroforestry with technical assistance

Design	Independent Factor[1]	P-vale	Model Fit	Variable Type[2]	Relationship[3]
Multi Windbreak	Goal of Income	0.0555		Categorical	
	Goal of Conservation	0.0086**	r2 = 0.0352	Categorical	Positive
	Goal of Recreation	0.0206*	r2 = 0.0292	Categorical	Positive
	Goal of Education	<.0001**	r2 = 0.0898	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0966	Categorical	Positive
	Goal of Lifestyle	0.2434		Categorical	
Multi Riparian Buffer	Goal of Income	0.6617		Categorical	
	Goal of Conservation	0.0718		Categorical	
	Goal of Recreation	0.0388*	r2 = 0.0247	Categorical	Positive
	Goal of Education	0.0028**	r2 = 0.0443	Categorical	Positive
	Goal of Agritourism	0.0002**	r2 = 0.0644	Categorical	Positive
	Goal of Lifestyle	0.072		Categorical	
Multi Silvopasture	Goal of Income	0.5104		Categorical	
	Goal of Conservation	0.0105*	r2 = 0.0342	Categorical	Positive
	Goal of Recreation	0.0491*	r2 = 0.0230	Categorical	Positive
	Goal of Education	0.0002**	r2 = 0.0635	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0733	Categorical	Positive
	Goal of Lifestyle	0.0533		Categorical	
Forest Farm	Goal of Income	0.4385		Categorical	
	Goal of Conservation	0.001**	r2 = 0.0499	Categorical	Positive
	Goal of Recreation	0.0022**	r2 = 0.0464	Categorical	Positive
	Goal of Education	0.0067**	r2 = 0.0380	Categorical	Positive
	Goal of Agritourism	<.0001**	r2 = 0.0966	Categorical	Positive
	Goal of Lifestyle	0.0004**	r2 = 0.0574	Categorical	Positive

Results in table are from one-way ANOVA in SAS proc General Linear Model (GLM). Source: Landowner Survey, 2021

[1]Independent variable is each of the goals analyzed separately for their influence on the dependent variable, "Would Plant Design," Would Plant with Funding," and "Would Plant with Technical Assistance." Goal of income means landowner focuses on using land to generate a source of income.

[2]Classification of independent factor used to predict willingness to plant agroforestry designs, either categorical or continuous

[3]Relationship between independent variable and its influence on dependent variable - willingness to plant agroforestry design for significant variables

* Indicates significant p-value

** Indicates highly significant p-value

Model fit (r^2) is shown for only significant variables

Preferences for Agricultural Land Use, Conservation Practices, and Tree Planting

You are invited to participate in a survey conducted by the University of Missouri, Center for Agroforestry. The questions focus on your perspectives of agricultural land use, tree planting, and conservation practices and should be completed by the person who has the main responsibility for making farm management decisions. Your responses will help researchers, policymakers, and other landowners understand the opportunities and challenges of developing conservation tree plantings on agricultural land for your region. Your participation is completely voluntary, and your responses will remain anonymous. The survey takes around 20 - 30 minutes to complete. For additional information, please contact Raelin Kronenberg, Graduate Student Researcher (rlk5hp@mail.missouri.edu) or Sarah Lovell, Professor and Director of the Center for Agroforestry (slovell@missouri.edu). Questions about your rights as a research participant can be directed to the University of Missouri Institutional Review Board (IRB) by calling 573.882.3181 or email irb@missouri.edu. To take the survey online go to: https://tinyurl.com/qualtricsagsurvey

We appreciate your participation!

LUCKY DRAW FOR $25 GIFT CARD

Be one of the first 100 surveys completed and returned by August 31st, 2021 for a chance to win one of twenty $25 gift cards. Please provide your contact information at the end of the survey. Your responses will remain anonymous unless you chose to leave your contact information for the gift card drawing. All personal information collected by this survey will be kept confidential.

Please confirm you are at least 18 years old: ☐ Yes – continue with survey ☐ No – thank you for your consideration!

Are you the primary person who makes the land use decisions for your property?

☐ Yes – continue survey ☐ No – survey complete, please return packet

By continuing with the survey, you indicate your consent to participate in this research

Part 1: Farm Information *Please answer the following questions based on your current farm.*

1.1 Which Missouri county is your primary farm located in?____________________

1.2 Do you live on the farm? ☐Yes ☐No

→ If no, which county is your primary home residence in? ____________

1.3 What year did you begin **THIS** farm operation? _______

1.4 What year did you begin farming? ________

1.5 During 2020, how many total acres on this operation

	Mark "x" if none	Number of Acres
1.5a Were owned …………………………………….....................	☐	
1.5b Where rented or leased from others ……………....................	☐	
1.5c Were rented or leased to others ………………....................…	☐	

1.6 Do you have land you consider marginal, less productive than the typical agricultural land in your area?

☐ Yes
☐ No
☐ I'm not sure

→ If yes, how many acres? ________

→ Are these areas less productive because they are (*check all that apply*)

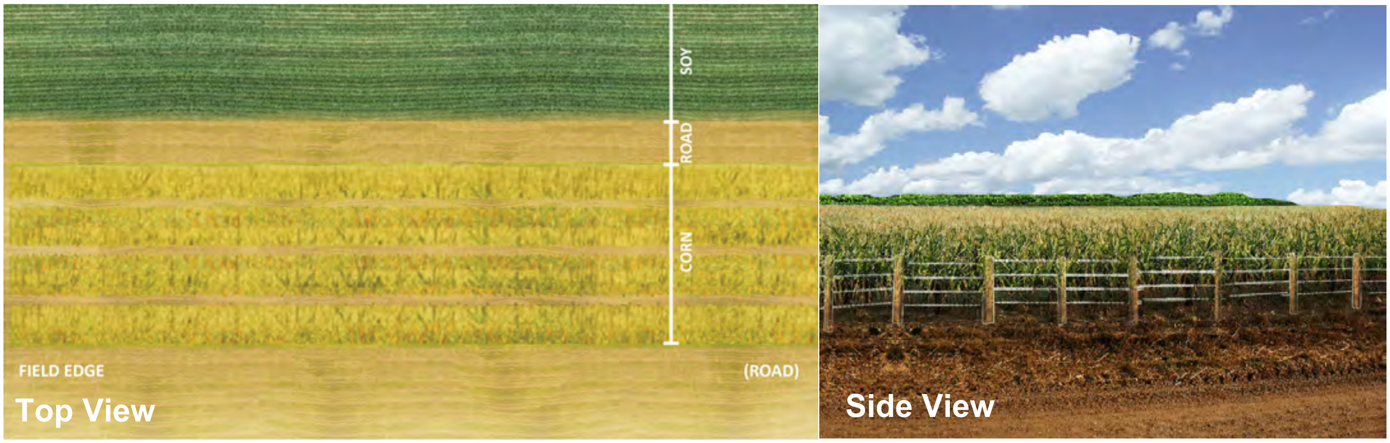
☐ Along a tree line
☐ Poorly drained or wet areas
☐ Shaded areas
☐ Along a river or creek
☐ Steeply sloped areas
☐ Have unproductive soil
☐ Other: ______________

1.7 Indicate the importance of the following statements for your farm.

	Not Important	**Moderately Important**	**Very Important**
To provide income from the production of crops, livestock, and/or timber.	☐	☐	☐
To conserve natural resources by providing wildlife habitat, protecting soil, and improving water quality	☐	☐	☐
To offer recreational opportunities such as hunting, hiking, and photography.	☐	☐	☐
To provide educational experiences by trying different planting systems and management plans.	☐	☐	☐
To engage people in the rural lifestyle experience through agritourism opportunities.	☐	☐	☐
To provide a rural lifestyle for myself and/or my family.	☐	☐	☐
Other:	☐	☐	☐

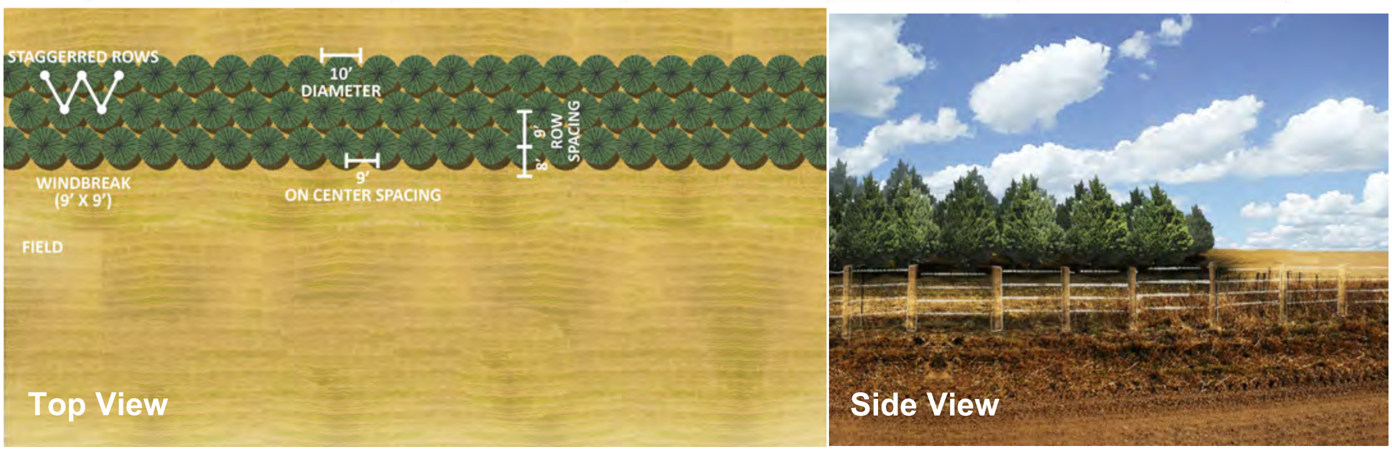
Part 2: Agricultural Landscape Preferences *Below are several planting plans and images of rural landscapes. These images serve as examples of different land management practices. Indicate the desirability of the scenes in these images considering that plant varieties and spacing can be changed to fit land management goals.*

2.1 Field Edge



How desirable is the above image of an open field edge?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐



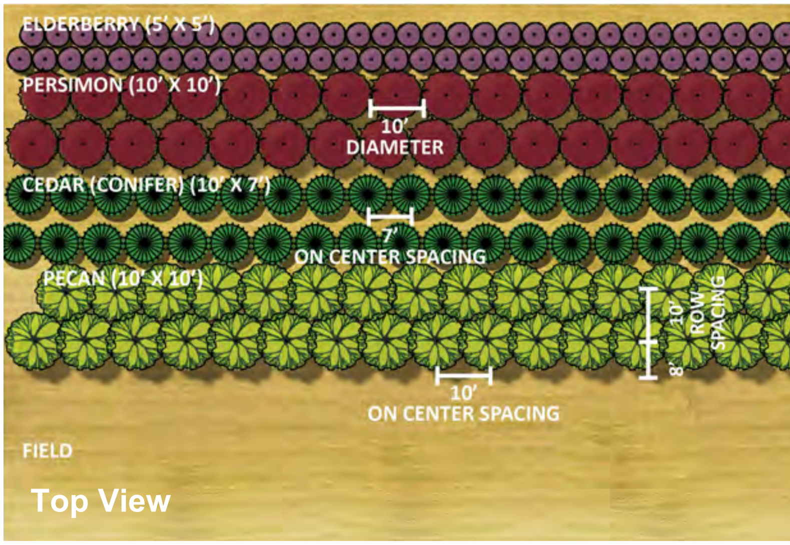
How desirable is the above image of a windbreak with conifer trees for a field edge?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

How desirable is the above image of a windbreak with edible fruit and nut species for a field edge?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

2.2 Windbreak with Edible Species *Below are more detailed questions about the same design you rated on the previous page.*



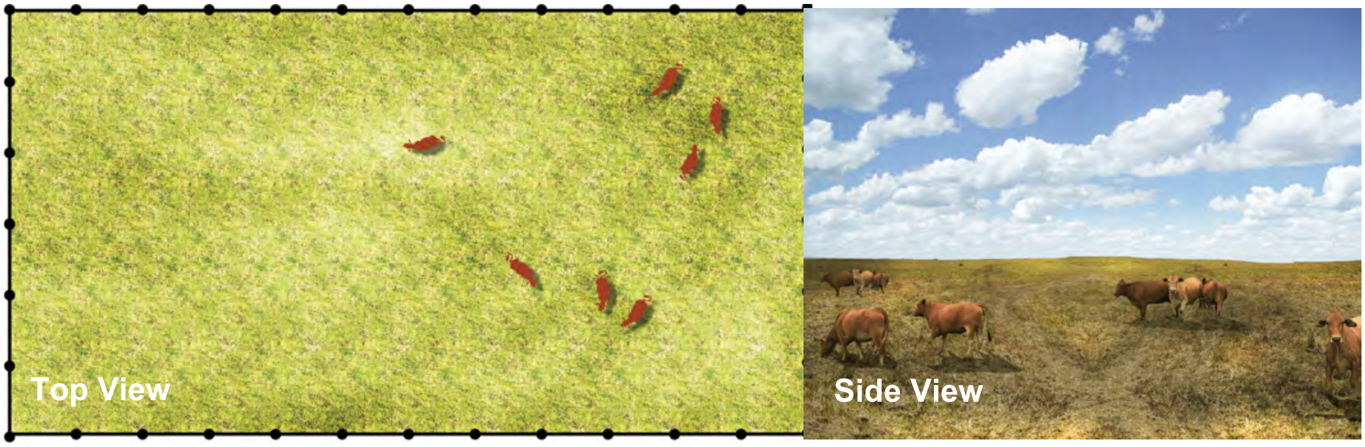
Indicate to what level you agree or disagree with the following statements regarding the above planting plan for a windbreak with edible fruit and nut species. *Since different spacing and plant varieties may be better suited for your land management goals, rate the images based on the design as a whole knowing it could be adjusted to your preferences.*

	Strongly Disagree	**Disagree**	**Unsure**	**Agree**	**Strongly Agree**
It would be a productive use of land.	☐	☐	☐	☐	☐
It would be difficult to manage.	☐	☐	☐	☐	☐
It would provide conservation of natural resources (soil, water, etc.)	☐	☐	☐	☐	☐
It would provide recreational opportunities (hunting, hiking, photography etc.)	☐	☐	☐	☐	☐
It would provide products for my own use (nuts, berries, wood etc.)	☐	☐	☐	☐	☐
It would increase wildlife habitat and biodiversity.	☐	☐	☐	☐	☐
It would attract unwanted wildlife.	☐	☐	☐	☐	☐
It would improve soil health and provide erosion control.	☐	☐	☐	☐	☐
It would mitigate chemical drift (pesticides, herbicides, fertilizer).	☐	☐	☐	☐	☐
It would be financially profitable.	☐	☐	☐	☐	☐
It would be expensive to plant and care for.	☐	☐	☐	☐	☐
Other benefits or concerns **Please specify:**	☐	☐	☐	☐	☐

In regards to the windbreak planted with edible fruit and nut species...

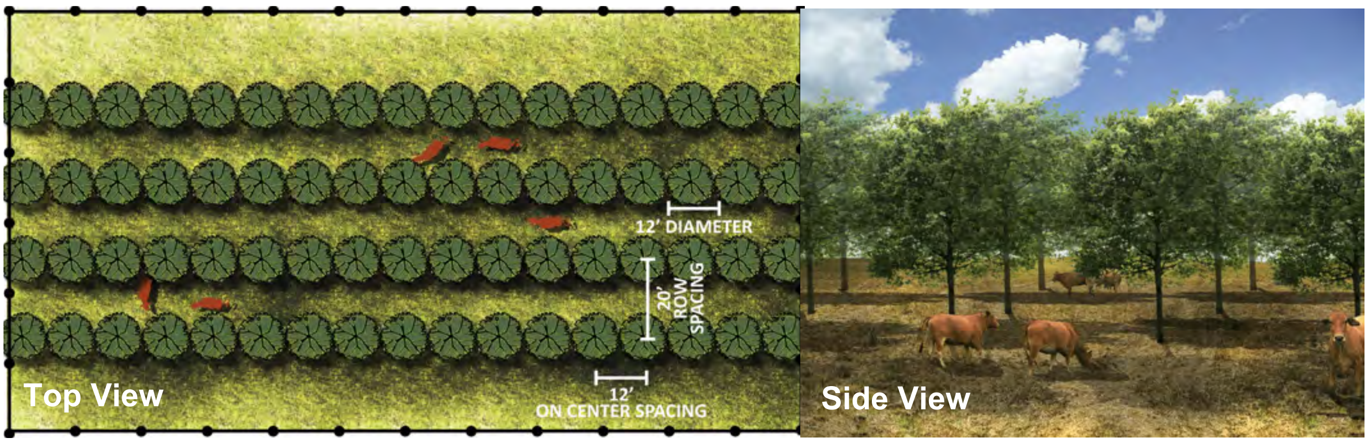
	Yes	**No**	**Unsure**
I am interested in planting this design on my farm.	☐	☐	☐
I would plant this design if I received conservation funding	☐	☐	☐
I would plant this design if I received technical assistance.	☐	☐	☐

`2.3 Pasture *Below are several planting plans and images of livestock pastures. Indicate the desirability of the scenes in these images considering that plant varieties and spacing can be changed to fit land management goals.*



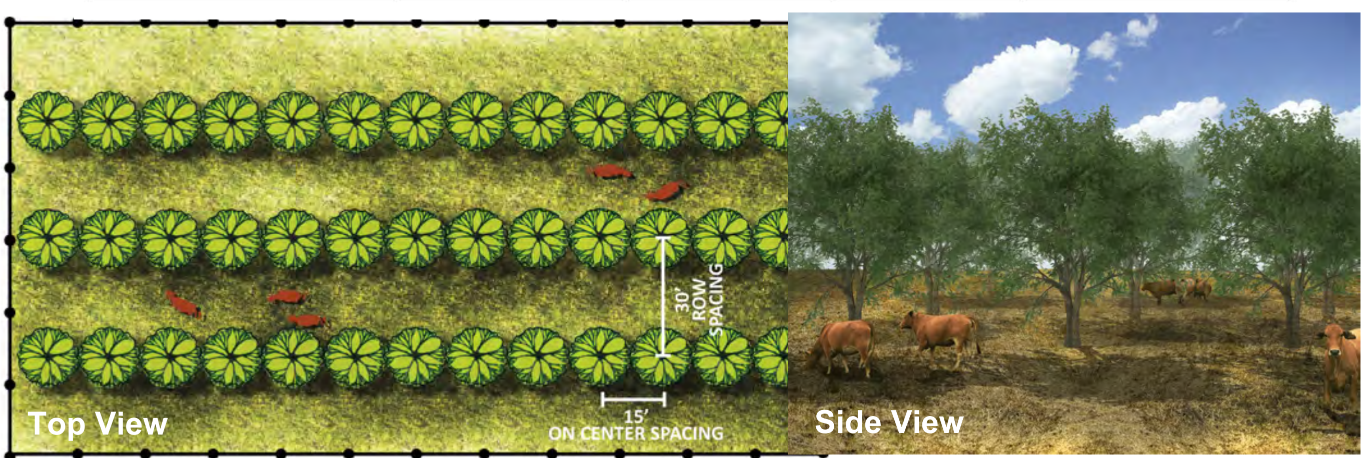
How desirable is the above image of an open pasture?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐



How desirable is the above image of a hardwood silvopasture?

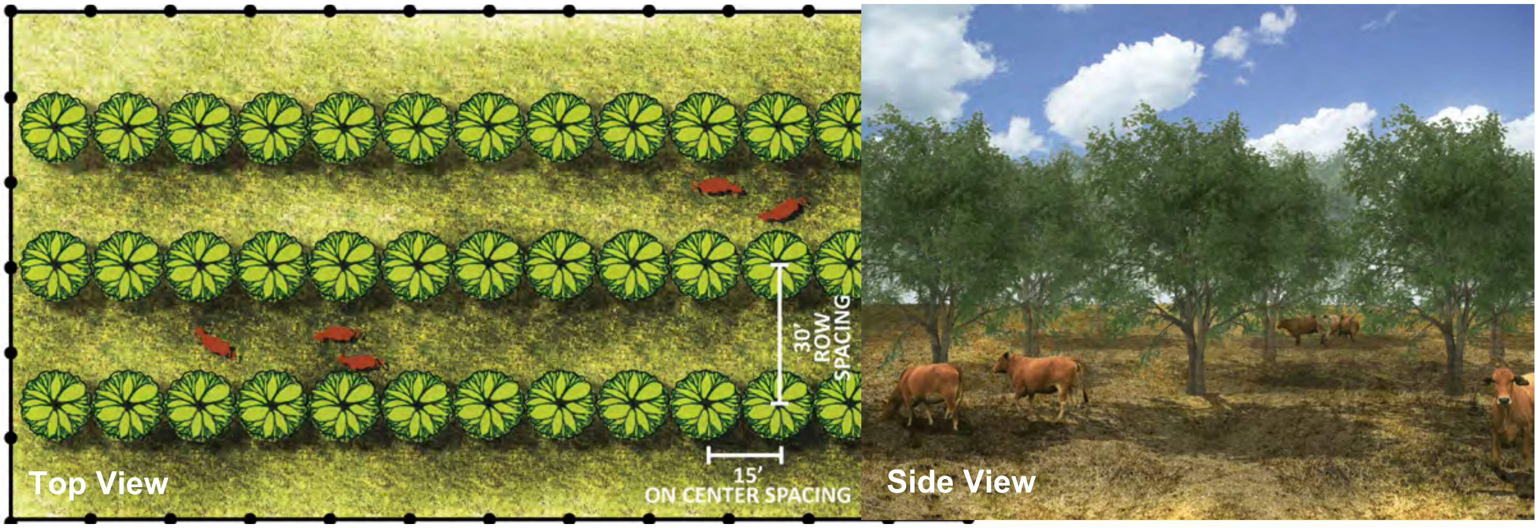
Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐



How desirable is the above image of a nut tree silvopasture?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

2.4 Pasture with Edible Tree Species *Below are more detailed questions about the same design you rated on the previous page.*



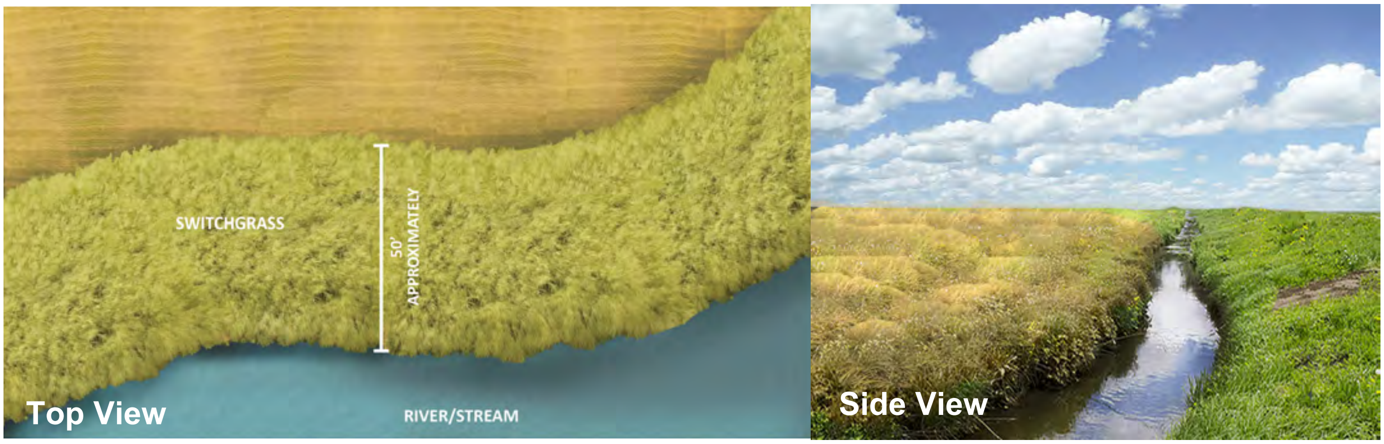
Indicate to what level your agree or disagree with the following statements regarding the above planting plan of a pecan silvopasture. *Reminder - this design could be adjusted to your preferences.*

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
It would be a productive use of land.	☐	☐	☐	☐	☐
It would be difficult to manage.	☐	☐	☐	☐	☐
It would provide conservation of natural resources (soil, water, etc.)	☐	☐	☐	☐	☐
It would provide recreational opportunities (hunting, hiking, photography etc.)	☐	☐	☐	☐	☐
It would provide products for my own use (nuts, berries, wood etc.)	☐	☐	☐	☐	☐
It would increase wildlife habitat and biodiversity.	☐	☐	☐	☐	☐
It would attract unwanted wildlife.	☐	☐	☐	☐	☐
It would improve soil health and provide erosion control.	☐	☐	☐	☐	☐
It would mitigate chemical drift (pesticides, herbicides, fertilizer).	☐	☐	☐	☐	☐
It would be financially profitable.	☐	☐	☐	☐	☐
It would be expensive to plant and care for.	☐	☐	☐	☐	☐
Other benefits or concerns **Please specify:**	☐	☐	☐	☐	☐

In regards to the pasture planted with nut producing trees...

	Yes	No	Unsure
I am interested in planting this design on my farm.	☐	☐	☐
I would plant this design if I received conservation funding	☐	☐	☐
I would plant this design if I received technical assistance.	☐	☐	☐

`**2.5 Riparian Areas** *Below are several planting plans and images of stream areas. Indicate the desirability of the scenes in these images considering that plant varieties and spacing can be changed to fit land management goals.*

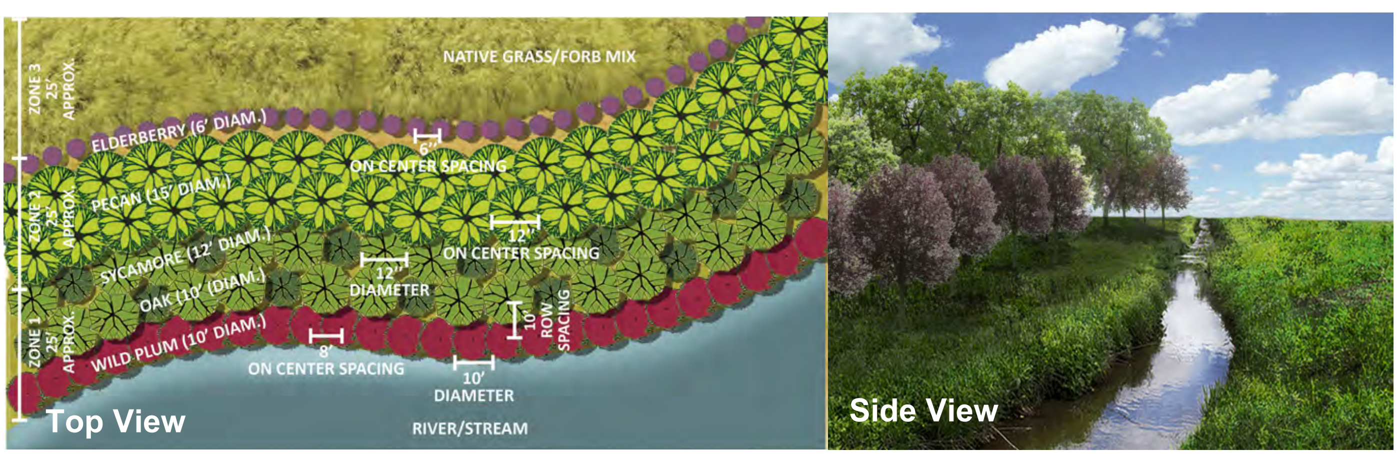


How desirable is the above image of a grass filter strip?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

How desirable is the above image of a riparian forest buffer?

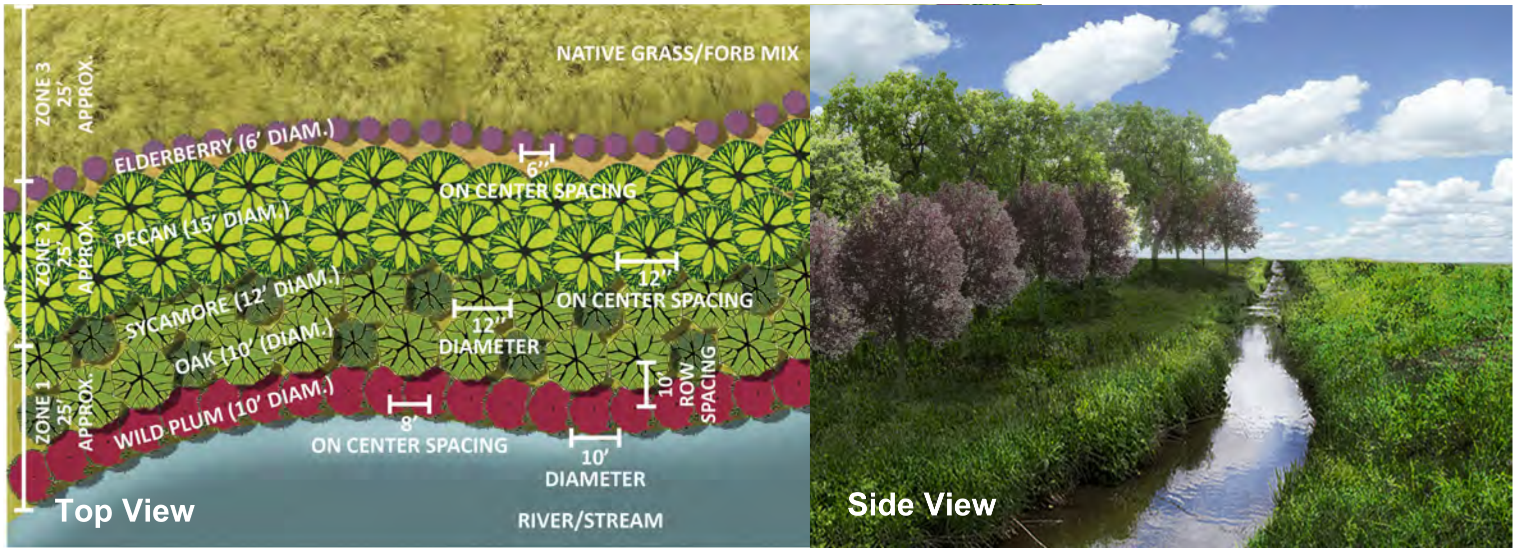
Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐



How desirable is the above image of a riparian forest buffer with edible fruit and nut species?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

2.6 Riparian Buffer with Edible Species *Below are more detailed questions about the same design you rated on the previous page.*



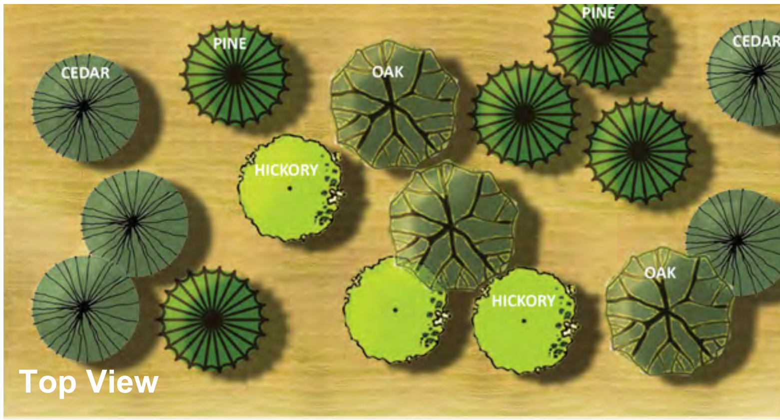
Indicate to what level your agree or disagree with the following statements regarding the above planting plan of a riparian forest buffer with edible fruit and nut species. *Reminder - this design could be adjusted to your preferences.*

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
It would be a productive use of land.	☐	☐	☐	☐	☐
It would be difficult to manage.	☐	☐	☐	☐	☐
It would provide conservation of natural resources (soil, water, etc.)	☐	☐	☐	☐	☐
It would provide recreational opportunities (hunting, hiking, photography etc.)	☐	☐	☐	☐	☐
It would provide products for my own use (nuts, berries, wood etc.)	☐	☐	☐	☐	☐
It would increase wildlife habitat and biodiversity.	☐	☐	☐	☐	☐
It would attract unwanted wildlife.	☐	☐	☐	☐	☐
It would improve soil health and provide erosion control.	☐	☐	☐	☐	☐
It would mitigate chemical drift (pesticides, herbicides, fertilizer).	☐	☐	☐	☐	☐
It would be financially profitable.	☐	☐	☐	☐	☐
It would be expensive to plant and care for.	☐	☐	☐	☐	☐
Other benefits or concerns **Please specify:**	☐	☐	☐	☐	☐

In regards to the riparian forest buffer planted with edible fruit and nut species...

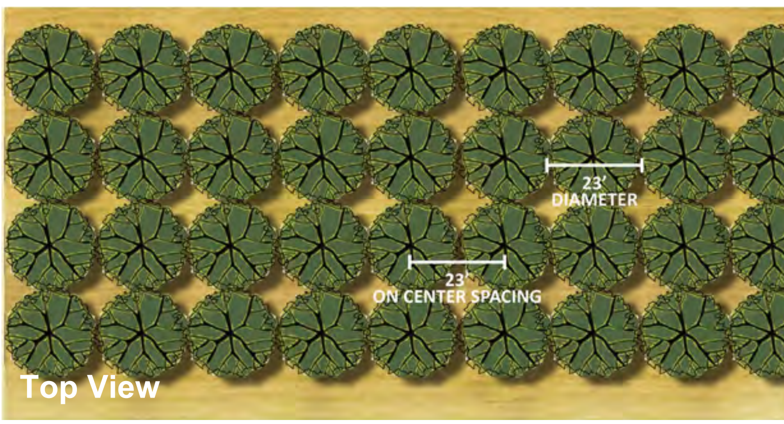
	Yes	No	Unsure
I am interested in planting this design on my farm.	☐	☐	☐
I would plant this design if I received conservation funding	☐	☐	☐
I would plant this design if I received technical assistance.	☐	☐	☐

`**2.7 Forest** *Below are several planting plans and images of forests. Indicate the desirability of the scenes in these images considering that plant varieties and spacing can be changed to fit land management goals.*



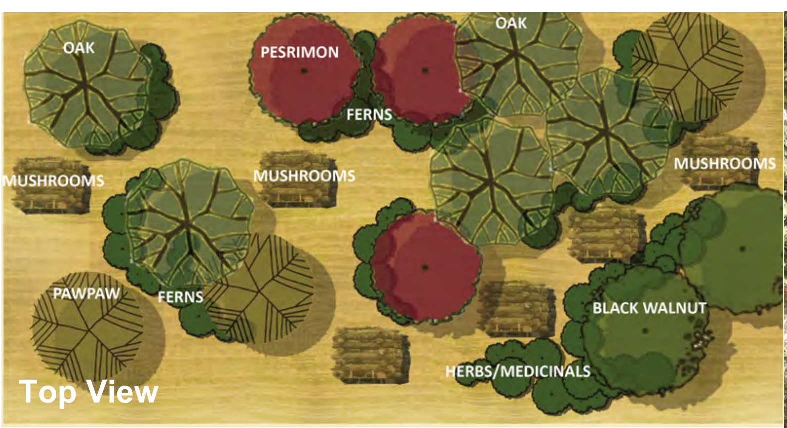
How desirable is the above image of an unmanaged forest?

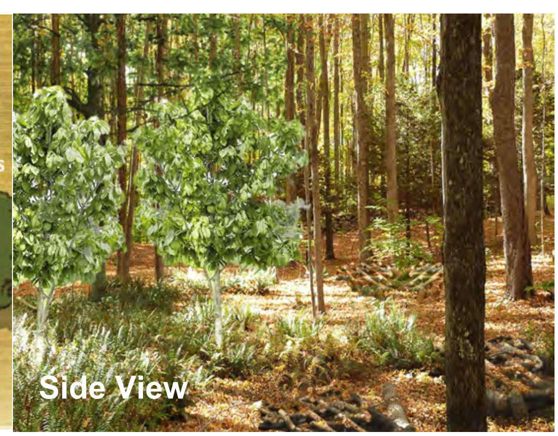
Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐



How desirable is the above image of a hardwood timber stand?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

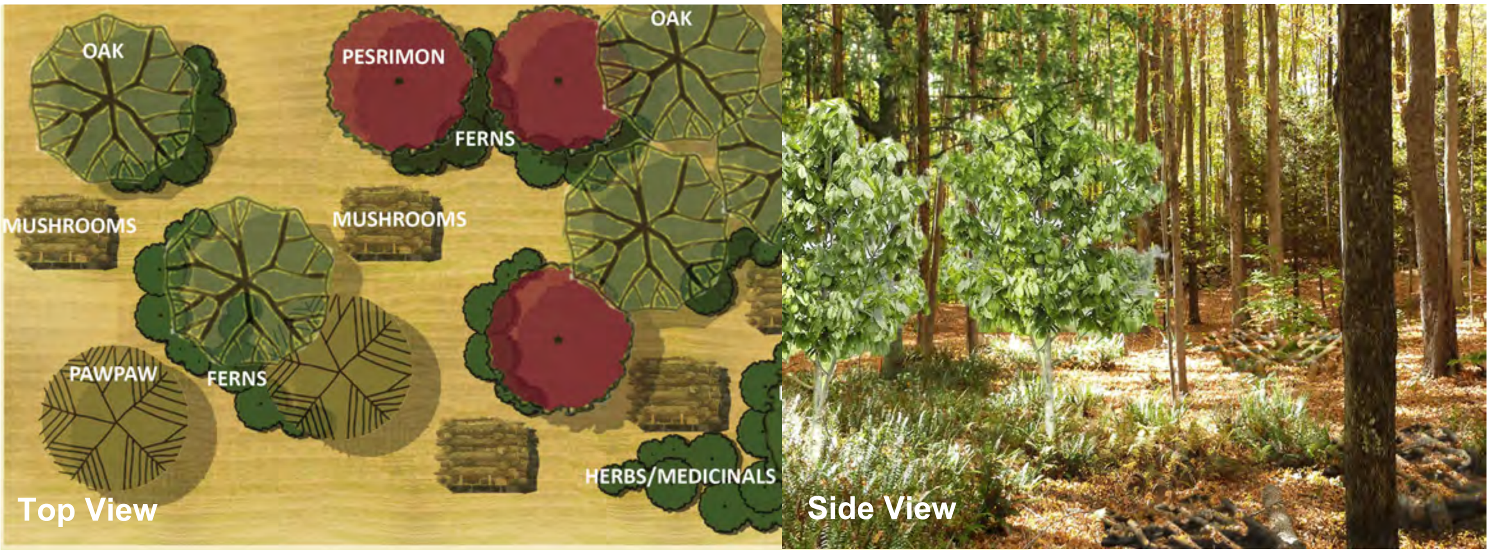




How desirable is the above image of a forest farm?

Very Undesirable	Undesirable	Neutral	Desirable	Very Desirable
☐	☐	☐	☐	☐

2.8 Forest Farming *Below are more detailed questions about the same design you rated on the previous page.*



Indicate to what level you agree or disagree with the following statements regarding the above planting plan of a forest farm. *Reminder - this design could be adjusted to your preferences.*

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
It would be a productive use of land.	☐	☐	☐	☐	☐
It would be difficult to manage.	☐	☐	☐	☐	☐
It would provide conservation of natural resources (soil, water, etc.)	☐	☐	☐	☐	☐
It would provide recreational opportunities (hunting, hiking, photography etc.)	☐	☐	☐	☐	☐
It would provide products for my own use (nuts, berries, wood etc.)	☐	☐	☐	☐	☐
It would increase wildlife habitat and biodiversity.	☐	☐	☐	☐	☐
It would attract unwanted wildlife.	☐	☐	☐	☐	☐
It would improve soil health and provide erosion control.	☐	☐	☐	☐	☐
It would mitigate chemical drift (pesticides, herbicides, fertilizer).	☐	☐	☐	☐	☐
It would be financially profitable.	☐	☐	☐	☐	☐
It would be expensive to plant and care for.	☐	☐	☐	☐	☐
Other benefits or concerns **Please specify:**	☐	☐	☐	☐	☐

In regards to a forest farm planted with edible fruit and nut species....

	Yes	No	Unsure
I am interested in planting this design on my farm.	☐	☐	☐
I would plant this design if I received conservation funding	☐	☐	☐
I would plant this design if I received technical assistance.	☐	☐	☐

Part 3: Land Characteristics and Management Practices on Your Farm

3.1 During 2020, what was the total number of acres under each land use *(uses may overlap, acres do not have to add up to total owned)*

	Mark "x" if none	Number of Acres
3.1a Harvested cropland (Include annual row crops)…………….		
3.1b Abandoned/failed cropland (Crops planted but not harvested)		
3.1c Fallow cropland (Fields left unplanted)……………………..		
3.1d Idle cropland (Field planted with cover crops).......................		
3.1e Permanent pasture or rangeland …………………………….		
3.1f Wooded pasture (Land used as pasture with tree cover)……		
3.1g Non-pastured woodland (Woodlots, maple trees/sugarbush)..		
3.1h Orchard crop (Fruit, nut) …………………………………..…		
3.1i Enrolled in a conservation program (Such as CRP or EQIP) …		

3.2 Did you use any of the following land management practices during the year 2020? (*Check all that apply*)

- ☐ Conventional tillage (Any tillage or seeding system that maintains less than 15% residue cover on the soil surface after planting).
- ☐ Conservation tillage (Any tillage or seeding system that maintains a minimum of 30% residue cover on the soil surface after planting to reduce soil erosion).
- ☐ Cover cropping (Grasses, legumes, and forbs planted for seasonal vegetative cover to reduce erosion, manage pests, and maintain soil fertility).
- ☐ Organic practices (A set of cultural, biological, and mechanical practices that support the cycling of on-farm resources, promote ecological balance, and conserve biodiversity).
- ☐ Timber/forest management (Planting trees, thinning, or harvesting to improve forest stands for timber, forest health, and/or wildlife habitat).
- ☐ Under land-use restricted easement [Including the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Farmable Wetlands Program (FWP), or Conservation Reserve Enhancement Program (CREP)].
- ☐ Agroforestry (The intentional integration and management of trees in an agricultural system with crops and/or livestock).

→ You checked agroforestry. Which of the following practices did you use in 2020? (*Select all used*)

- ☐ Silvopasture – grazing livestock among trees in a highly managed system to maximize production of forage, tree products such as timber or nuts, and livestock
- ☐ Alley Cropping – growing a crop between rows of managed trees
- ☐ Forest Farming – managing a forest stand for products such as mushrooms, herbs, and honey
- ☐ Riparian Forest Buffers – plantings of trees and/or shrubs within the riparian zone of a stream that are managed to reduce bank erosion and improve water quality
- ☐ Windbreaks – rows of tree plantings managed to reduce soil erosion from wind, protect livestock, and improve building energy efficiency
- ☐ Other Woody Crop Establishment - planting of other food producing tree or shrub crops

3.3 What conservation programs, if any, were you enrolled in during the year 2020?

	Mark "x" if none	Number of Acres
3.3a Conservation reserve program (CRP)		
3.3b Environmental Quality Incentives Program (EQIP)		
3.3c Conservation Stewardship Program (CSP)		
3.3d Other (*Please list*)__________________		

3.4 Why did/didn't you choose to enroll in a conservation program?

____

____

3.5 Are you interested in participating in a conservation program in the future?

☐ No

→ If no, explain the reasons why you would not want to participate.

____

____

____

☐ Yes

→ If yes, explain the reasons why you want to participate.

____

____

____

Part 5: Demographic Information

5.1 What is your gender identity?

☐ Male
☐ Female
☐ Non-binary
☐ Prefer not to say

5.2 What is your age? _______years

5.3 Racial identity: *Please select all that apply*

☐ White
☐ Black or African American
☐ Hispanic, Latino, or Spanish
☐ American Indian or Alaska Native
☐ Asian
☐ Native Hawaiian or Pacific Islander

5.4 What is the highest level of education you have received?

☐ No schooling
☐ Some high school
☐ High school graduate (or equivalent)
☐ Trade or vocational degree
☐ Some college (1-4 years, associate degree)
☐ Bachelor (BA, BS, AB)
☐ Masters & higher (MS, MA, MD, JD, PhD, EdD)

5.5 Did farming make up the majority (50% or more) of your worktime in 2020?

☐ Yes
☐ No

⟶ If no, please specify primary occupation _________________________

5.6 What is your approximate net income from your farming operation?

☐ Net loss/no income
☐ <$1,000
☐ $1,000 to $19,999
☐ $20,000 to $39,999
☐ $40,000 to $69,999
☐ $70,000 to $99,000
☐ $100,000 or more

Thank you for your response!

The information you shared will help guide future education and outreach programs with the goal to design planting systems and conservation practices that promote the sustainability and profitability of Missouri farms.

Center for Agroforestry
University of Missouri

If you would like to participate in the drawing for the gift cards and/or receive more information about this research and related projects, please indicate so below. Your contact information will not be distributed to third parties or included in additional research without your consent.

Contact Information (optional, include to join drawing for gift card and/or receive more info)

Name:____

Address: ____

Email: ____

Phone: ____

☐ Check box if you are interested in working further with us on multifunctional perennial cropping systems in Missouri.

4.3 Please share any additional comments you have concerning this survey or its contents.

____

____

____

```
libname xl xlsx "H:\Kronenberg_SurveyData.xlsx";

data work.raelin;
set xl.Analysis;
if Buffer_WouldPlant = 2 then BufferWPRecode = 3; else if
Buffer_WouldPlant = 3 then BufferWPRecode = 2; else BufferWPRecode =
Buffer_WouldPlant;
if Buffer_PlantFunded = 2 then BufferPFRecode = 3; else if
Buffer_PlantFunded = 3 then BufferPFRecode = 2; else BufferPFRecode =
Buffer_PlantFunded;
if Buffer_PlantTechAssist = 2 then BufferPTRecode = 3; else if
Buffer_PlantTechAssist = 3 then BufferPTRecode = 2; else
BufferPTRecode = Buffer_PlantTechAssist;
if Windbreak_WouldPlant = 2 then WindbreakWPRecode = 3; else if
Windbreak_WouldPlant = 3 then WindbreakWPRecode = 2; else
WindbreakWPRecode = Windbreak_WouldPlant;
if Windbreak_PlantFunded = 2 then WindbreakPFRecode = 3; else if
Windbreak_PlantFunded = 3 then WindbreakPFRecode = 2; else
WindbreakPFRecode = Windbreak_PlantFunded;
if Windbreak_PlantTechAssist = 2 then WindbreakPTRecode = 3; else if
Windbreak_PlantTechAssist = 3 then WindbreakPTRecode = 2; else
WindbreakPTRecode = Windbreak_PlantTechAssist;
if Silvo_WouldPlant = 2 then SilvoWPRecode = 3; else if
Silvo_WouldPlant = 3 then SilvoWPRecode = 2; else SilvoWPRecode =
Silvo_WouldPlant;
if Silvo_PlantFunded = 2 then SilvoPFRecode = 3; else if
Silvo_PlantFunded = 3 then SilvoPFRecode = 2; else SilvoPFRecode =
Silvo_PlantFunded;
if Silvo_PlantTechAssist = 2 then SilvoPTRecode = 3; else if
Silvo_PlantTechAssist = 3 then SilvoPTRecode = 2; else SilvoPTRecode =
Silvo_PlantTechAssist;
if Forest_WouldPlant = 2 then ForestWPRecode = 3; else if
Forest_WouldPlant = 3 then ForestWPRecode = 2; else ForestWPRecode =
Forest_WouldPlant;
if Forest_PlantedFunded = 2 then ForestPFRecode = 3; else if
Forest_PlantedFunded = 3 then ForestPFRecode = 2; else ForestPFRecode
= Forest_PlantedFunded;
if Forest_PlantTechAssist = 2 then ForestPTRecode = 3; else if
Forest_PlantTechAssist = 3 then ForestPTRecode = 2; else
ForestPTRecode = Forest_PlantTechAssist;
run;

ods pdf file="H:\Kronenberg_SurveyData_20211116.pdf";

proc means data=work.raelin mean n stddev stderr;
run;

proc sort data=work.raelin;
by SurveyID;
run;

proc transpose data=work.raelin out=work.raelin2 label=Trt;
```

```
by SurveyID;
var Open_Field Multi_Windbreak Windbreak_conifers;
run;

proc transpose data=work.raelin out=work.raelin3 label=Trt;
by SurveyID;
var Pasture Silvo_Hardwoods Multi_Silvo;
run;

proc transpose data=work.raelin out=work.raelin4 label=Trt;
by SurveyID;
var FilterStrip Basic_RipBuffer Multi_RipBuffer;
run;

proc transpose data=work.raelin out=work.raelin5 label=Trt;
by SurveyID;
var Forest Timber Forest_farm;
run;

proc transpose data=work.raelin out=work.raelin6 label=Trt;
by SurveyID;
var BufferWPRecode BufferPFRecode BufferPTRecode;
run;

proc transpose data=work.raelin out=work.raelin7 label=Trt;
by SurveyID;
var WindbreakWPRecode WindbreakPFRecode WindbreakPTRecode;
run;

proc transpose data=work.raelin out=work.raelin8 label=Trt;
by SurveyID;
var SilvoWPRecode SilvoPFRecode SilvoPTRecode;
run;

proc transpose data=work.raelin out=work.raelin9 label=Trt;
by SurveyID;
var ForestWPRecode ForestPFRecode ForestPTRecode;
run;

proc glm data=work.raelin2;
class trt SurveyID;
model col1 = trt surveyID;
lsmeans trt/pdiff lines;
run;

proc glm data=work.raelin3;
class trt SurveyID;
model col1 = trt surveyID;
lsmeans trt/pdiff lines;
run;

proc glm data=work.raelin4;
```

```
class trt SurveyID;
model col1 = trt surveyID;
lsmeans trt/pdiff lines;
run;

proc glm data=work.raelin5;
class trt SurveyID;
model col1 = trt surveyID;
lsmeans trt/pdiff lines;
run;

proc glm data=work.raelin;
class Urban_RuraTEXT;
model Open_Field Multi_Windbreak Windbreak_conifers Pasture
   Silvo_Hardwoods Multi_Silvo FilterStrip Basic_RipBuffer
   Multi_RipBuffer Forest Timber Forest_farm = Urban_RuraTEXT;
lsmeans Urban_RuraTEXT/pdiff lines;
run;

proc glm data=work.raelin;
class RegionTEXT;
model Open_Field Multi_Windbreak Windbreak_conifers Pasture
   Silvo_Hardwoods Multi_Silvo FilterStrip Basic_RipBuffer
   Multi_RipBuffer Forest Timber Forest_farm = RegionTEXT;
lsmeans RegionTEXT/pdiff lines;
run;

proc glm data=work.raelin6;
class _NAME_ SurveyID;
model col1 = _NAME_ surveyID;
lsmeans _NAME_/pdiff lines;
run;

proc glm data=work.raelin7;
class _NAME_ SurveyID;
model col1 = _NAME_ surveyID;
lsmeans _NAME_/pdiff lines;
run;

proc glm data=work.raelin8;
class _NAME_ SurveyID;
model col1 = _NAME_ surveyID;
lsmeans _NAME_/pdiff lines;
run;

proc glm data=work.raelin9;
class _NAME_ SurveyID;
model col1 = _NAME_ surveyID;
lsmeans _NAME_/pdiff lines;
run;

/*Maybe want to switch to the recoded values, as they make
```

```
more sense numerically in that order*/

proc glm data=work.raelin;
class AgeGroups;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
AgeGroups;
lsmeans AgeGroups/pdiff lines;
run;

proc glm data=work.raelin;
class Gender;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
Gender;
lsmeans Gender/pdiff lines;
run;

proc glm data=work.raelin;
class Primary_Farmer;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
Primary_Farmer;
lsmeans Primary_Farmer/pdiff lines;
run;

proc glm data=work.raelin;
class Income;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
Income;
lsmeans Income/pdiff lines;
run;

proc glm data=work.raelin;
class Marginal_land;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
Marginal_land;
lsmeans Marginal_land/pdiff lines;
run;

proc glm data=work.raelin;
class Participate_ConsProgram;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
```

```
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
Participate_ConsProgram;
lsmeans Participate_ConsProgram/pdiff lines;
run;

proc glm data=work.raelin;
*class Acres;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
Acres;
*lsmeans Acres/pdiff lines;
run;

proc glm data=work.raelin;
class AcresGroup;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
AcresGroup;
lsmeans AcresGroup/pdiff lines;
run;

proc glm data=work.raelin;
class BeginningFarmer;
model BufferWPRecode WindbreakWPRecode SilvoWPRecode ForestWPRecode
   BufferPFRecode WindbreakPFRecode SilvoPFRecode ForestPFRecode
   BufferPTRecode WindbreakPTRecode SilvoPTRecode ForestPTRecode=
BeginningFarmer;
lsmeans BeginningFarmer/pdiff lines;
run;

ods pdf close;
```