Between Forestry and Farming: Policy and Environmental Implications of the Barriers to Agroforestry Adoption

Corinne Valdivia,[1] Carla Barbieri[2] and Michael A. Gold[3]

[1]*Associate Professor, Department of Agricultural and Applied Economics, University of Missouri, 210 Mumford Hall, Columbia, MO 65211 (corresponding author: phone: 573-882-4020; fax: 573-882-3958; e-mail: valdiviac@missouri.edu).*
[2]*Assistant Professor, Department of Parks Recreation and Tourism, School of Natural Resources, University of Missouri, 105C Anheuser-Busch, Natural Resources Building, Columbia, MO 65211 (phone: 573-882-9516; fax: 573-882-9526; e-mail: barbieric@missouri.edu).*
[3]*Research Professor, Center for Agroforestry, 203f Anheuser Busch Natural Resources Bldg., University of Missouri, Columbia, MO 65211 (phone: 573-884-1448; fax: 573-882-1977; e-mail: goldm@missouri.edu).*

Farming and forestry are practices with clearly defined institutions, markets, and policies. These are not as clearly defined for agroforestry, a practice experiencing increased interest in the USA. This study examined the barriers preventing the adoption of agroforestry within a household level theoretical framework informed by transaction costs and multifunctionality, using survey data from 353 Missouri (USA) landowners. Costs of establishing or managing trees, the time required to manage, and the lack of tree management experience are perceived as the most influential barriers limiting implementation of agroforestry on the farm. A principal component factor analysis of the perceived barriers identified two factors: the first, labeled Transaction Costs, related to information access and perceived establishment costs; the second factor, labeled Profitability Concerns, was associated with perceptions of the effects of agroforestry on farm profitability and agricultural production. Overall, Transaction Costs appears to be a greater barrier to implementation of agroforestry. Cluster analysis yielded three types of landowners: environmentalists, agriculturalists, and disengaged, who differ in their perceptions of these barriers. Statistical tests revealed differences among clusters on their farmland attributes, multifunctionality indicators, and their resources for adopting agroforestry. Environmentalists appear as more likely to adopt agroforestry, followed by the agriculturalists. Policy implications are also discussed.

Les secteurs de l'agriculture et de la foresterie possèdent des institutions, des marchés et des politiques clairement définis. Ces éléments ne sont pas aussi clairement définis dans le cas du secteur de l'agroforesterie, qui recueille un intérêt croissant aux États-Unis. Dans la présente étude, nous avons examiné les obstacles à l'adoption de l'agroforesterie à l'aide d'un cadre théorique au niveau des ménages comprenant des données sur les coûts de transaction et la multifonctionnalité issues d'un sondage réalisé auprès de 353 propriétaires fonciers dans l'État du Missouri, aux États-Unis. Les coûts de plantation, le temps nécessaire à la gestion et le manque d'expérience en gestion arboricole sont perçus comme étant les principaux obstacles à l'implantation de l'agroforesterie sur la ferme. Une analyse en composantes principales a permis de déterminer deux facteurs: le premier, appelé Coûts de transaction (Transaction Costs), était lié à l'accès à l'information et aux coûts de plantation perçus; le deuxième, appelé Inquiétudes sur la rentabilité (Profitability Concerns), était lié à la perception des conséquences de l'agroforesterie sur la rentabilité et la production de la ferme. De manière générale, les Coûts de transaction semblent constituer le plus important obstacle à l'implantation de l'agroforesterie. Une analyse de grappes a fait ressortir trois types de propriétaires fonciers: les

Canadian Journal of Agricultural Economics 60 (2012) 155–175
DOI: 10.1111/j.1744-7976.2012.01248.x

environnementalistes, les agriculturalistes et les désengagés, qui ont une perception bien différente de ces obstacles. Des tests statistiques ont révélé des différences parmi les grappes quant aux attributs de leurs terres agricoles, aux indicateurs de multifonctionnalité et à leurs ressources pour adopter l'agroforesterie. Les Environnementalistes semblent plus enclins à adopter l'agroforesterie, suivis des Agriculturalistes. Nous avons aussi abordé l'incidence sur les politiques.

INTRODUCTION

Understanding change is key to developing knowledge and information that can foster sustainability in the North American rural landscape. Landowners, our current stewards of the land, are changing as a result of structural changes in farming. Today, over 90% of the landowners in the USA and Canada own small farms, and control a high proportion of the land (Valdivia et al 2009). Farming is no longer the main source of revenue for many rural households. Farming and forestry are two distinct practices with institutions, policies, and markets that are clearly defined. Agroforestry does not neatly fit into either practice. Agroforestry practices deliberately integrate trees or shrubs, and crops or livestock, yielding both economic production and environmental protection. These include windbreaks, silvopasture, riparian buffers, alley cropping, and forest farming. However, the markets, institutions, and policies in support of agroforestry in the USA are still under active development (Godsey et al 2009).

The purpose of this study is to examine the barriers preventing landowner adoption of agroforestry practices using a household level adoption theoretical framework, informed by transaction costs and multifunctionality. In this framework, transaction costs encompass costs related to market access such as information and inputs that support establishment of agroforestry, and to costs associated with access to research, extension, and legal institutions that enable adoption of this practice (McCann et al 2005; Khaledi et al 2010). Multifunctionality is defined as the several functions that the farm resources (e.g., farmland, household members) provide to society (Wilson 2008). This study has three objectives: (1) to examine the influence of different types of barriers to the adoption of agroforestry; (2) to cluster responding landowners based on their perceptions of these barriers; and (3) to identify differences between clusters regarding their relationship to the land, their level of multifunctionality, and their resources and disposition to adopt agroforestry. By addressing these objectives, this study provides information to assist technology transfer more efficiently, given that different types of landowners could be addressed based on their more relevant barriers to adopt agroforestry. Results can also assist in the development of policies to support agroforestry practices responding to the barriers perceived by the different landowners groups identified.

THEORETICAL BACKGROUND

Agriculture is multifunctional as it provides multiple services to society besides the production of food and fiber, including environmental services, preservation of biodiversity, and a setting for recreation, among many others (Ploeg et al 2000; Dobbs and Pretty 2004; Marsden and Sonnino 2008). In this context, agricultural multifunctionality can be viewed as diverse perennial agricultural systems supported by social and human capital (Boody et al 2005), or as a paradigm of sustainable rural communities (Wilson 2008).

Multifunctionality gains importance when the majority of landowners and stewards of the land are in small farms, because it acknowledges positive functions beyond production. Forests and small farms provide several functions to society, some of which are provided without an economic return, producing a positive externality (Alavalapati et al 2004; Mann and Wüstermann 2007). However, when such externalities are internalized in the form of payments for environmental services, or revenues from recreation and tourism, a missed market opportunity is corrected (Vanslembrouck and Van Huylenbroeck 2005; Barbieri and Valdivia 2010b). In this sense, a multifunctionality framework identifies and raises awareness about the economic, environmental, and social benefits of the landscape.

Agroforestry within the Multifunctionality Framework

Agroforestry has the capacity to be a sustainable landuse management strategy (Lassoie et al 2009) because it may increase the multifunctionality of the landscape among small landowners (Barbieri and Valdivia 2010a), thus fostering sustainable rural communities (Wilson 2008). For example, agroforestry practices help control wind erosion, protect marginal land, and increase the scenic beauty of rural landscapes, and can diversify aquatic and terrestrial habitats while providing other economic, social, and environmental benefits (Buck 1995; Williams et al 1997; Gold and Garrett 2009; Valdivia and Poulos 2009).

While trees were once a common sight in the farm landscape of North America, post-WWII agricultural intensification led to their large-scale removal. In the Midwest and other regions of the USA where cropping land values are high, trees are removed from the landscape (Raedeke et al 2003). U.S. farm policies were initially developed to support agricultural commodities (Gardner 2000; Valdivia et al 2009) but the farm crisis of the 1980s motivated the U.S. Congress to pass funding programs to support small family, farms, especially facilitating payment transfers for conservation (Boody et al 2005; Lassoie et al 2009). At that time, a cultural appreciation of the roles trees play in the landscape was lacking among most rural landowners (Raedeke et al 2003), as well as a support system and institutions to promote adoption of trees, similar to those supporting the practice of farming (Raedeke et al 2003; Valdivia et al 2009).

The multifunctional framework is conducive to identifying the motives that landowners place on their land, because it recognizes that they may have a diversity of awareness and interests in the various functions of agriculture. Wilson (2008) argued that the level of time commitment a farmer puts toward the farm will often inform the transition from weak to strong multifunctionality; part-time farmers are often moderately multifunctional due to their reduced time commitment, while lifestyle or hobby farms tend to approach the strong end of the multifunctionality spectrum because they do not depend on farming as a production asset. As landowners are not homogeneous on the roles that farming plays in their income stream, it is expected that the barriers to adopt agricultural practices will also be diverse (Dobbs and Pretty 2004). As a case in point, Barbieri and Valdivia (2010a) found that landowners have different levels of understanding and willingness to adopt agroforestry practices.

Existing literature highlights the lack of understanding of the factors influencing farm-level decisions to adopt practices that do not fit within the practice of farming or forestry (Raedeke et al 2003; Boon and Meilby 2007; Valdivia et al 2009), and therefore have focused on understanding of the various types of decision makers. This is critical because the actions and behavior of farm households are not only driven by their structural situation but also by their values and motivations (Shucksmith 1993; Shucksmith and Herrmann 2002; Boon and Meilby 2007). For example, Raedeke et al (2003) found that farmers emphasized the importance of economic, family, and rental relations in the field of farming. Different types of motivations, including economic (e.g., increased revenues), social (e.g., the need to socialize), family related (e.g., keep the farm in the family), and even personal (e.g., capitalize on a hobby) were found to be important in the decision to diversify the entrepreneurial portfolio of U.S. and Canadian farms (Barbieri and Mahoney 2009). In forestry Boon and Meilby (2007) identified four types of owners according to their forest management attitudes and practice in Denmark. Given the overall low uptake of agroforestry in North America, its strong multifunctionality, and the reduced understanding of the social factors associated with its adoption and practice (Rule et al 2000; Raedeke et al 2003; Gold et al 2009; Barbieri and Valdivia 2010b) it is necessary to understand the types of barriers preventing its adoption.

Barriers Influencing the Adoption of Agricultural and Conservation Practices

It is difficult to implement new practices in areas where farming is complex, and probably more so in areas where simple farming systems (e.g., cattle raising) are practiced. To adopt a new farming practice, farmers must be aware of the innovation, acknowledge its feasibility and worthiness, and believe that it promotes their objectives (Prokopy et al 2008). In developed countries, the new practice often must also be more profitable than the current practice, and problems of uncertainty (e.g., known production, harvest and market information) must be overcome, otherwise farmers will continue using their existing practices even if these do not meet their goals (Pannell 1999).

Previous studies have identified several variables that influence the decision to adopt a conservation practice or to participate in conservation programs, including the level of incentive payments and the time required to make profits, the age of the decision-maker, the importance of farming as a share of income, soil erosion rates, and how permanent is the change in the landscape (e.g., does it involve trees?) (Konyar and Osborn 1990; Skaggs et al 1994; Cooper and Keim 1996). In a recent review of the literature on the adoption of best management practices networks—interacting with neighboring farmers, networking capacity with agribusiness, and familiarity with agency personnel—were significant factors in adoption of best management practices (Prokopy et al 2008). The study also found that access and quality of the information had a positive impact. Both these factors are elements in transaction costs. Land tenure and rental agreements also have an impact in decision making because leasees are less likely to adopt practices that require a long time to return profits (Soule et al 2000; Raedeke et al 2003). Isik and Yang (2004) found that option values, land benefits and attributes, and farmer characteristics influence farmer's decision to participate in the Conservation Reserve Program (CRP). Uncertainty and irreversibility were also found to play a major role in deciding on CRP adoption, which is especially relevant in that enrollment in this program requires fixed participation periods of 10–15 years (Isik and Yang 2004).

Specific to agroforestry, Strong and Jacobsen (2005) found that different types of landowners in Pennsylvania, including farmers, were generally unaware of agroforestry practices mainly because the limited information available created uncertainty as to the feasibility and profitability of these practices. They also found that information was more valuable than financial support in adoption of agroforestry in this state. While examining perceptions about agroforestry among landowners and extension workers in the southeastern USA, Workman et al (2003) found that extension workers considered improved water quality the most important benefit, while landowners placed more importance on aesthetics, shade, wildlife habitat, and soil conservation. In other studies, important variables influencing adoption of riparian buffers were whether the decision-maker was an owner-operator or absentee owner (Skelton et al 2004), and the perceived upfront costs of buffer installation (Lynch and Brown 2000).

The age and gender of the decision-maker, current agricultural production, reasons for owning land, and land management concerns have been found to be useful for identifying farmers with agroforestry adoption potential (Pattanayak et al 2003; Valdivia et al 2009). Attitudes toward risk are also important in the adoption of agroforestry. Diversification is a strategy used to reduce risk (Skees et al 1998). Diversification also takes place to maximize use of resources (e.g., labor, soil types) in smallholder farming, and has been a policy recommendation for small farms in the USA to increase income by including high-value products (Valdivia and Konduru 2003). Physical conditions, such as bank erosion problems or existence of trees in forest farming (Pattanayak et al 2003; Valdivia and Poulos 2009), as well as attitudes (e.g., value placed on the environment) and knowledge of agroforestry (Matthews et al 1993; Flower et al 2005; Valdivia and Poulos 2009; Barbieri and Valdivia 2010b) also influence decisions to adopt. While knowledge is a strong factor in interest of agroforestry practices, actual adoption may depend on cost sharing (Ervin and Ervin 1982; Cooper and Keim 1996) or other incentives.

Given that a diversity of landowners with different purposes and needs are involved in agriculture in the USA, such as rural life-style, traditional farmers, and accumulators (Valdivia et al 2000; Hoppe and MacDonald 2001; Strong and Jacobson 2004), it is expected that these landowners will adopt agroforestry for different reasons. While financial motivations may not be important for landowners who do not depend on land for their livelihood, monetary and nonmonetary motivations are important for those who do (Koontz 2001; Barbieri and Valdivia 2010a). For example, farm operators who are concerned about bank erosion problems are more likely to be interested in the practice of agroforestry (Valdivia and Poulos 2009), while other agroforestry practices may be more suitable for landowners with knowledge of emerging markets (Raedeke et al 2003). Similarly, landowners concerned with future generations and their environment are more likely to plant trees (Valdivia and Poulos 2009). For practices that are not perceived as commercial or not perceived as a sole or important income source, nonmonetary motivations can be a driving force (Koontz 2001).

Limited information on social and economic aspects of agroforestry in the USA (Raedeke et al 2003) points to understanding transaction costs as a key element in examining and identifying barriers to adoption. Transaction costs have been defined according to the context and the nature of the problem (McCann et al 2005). In Kenya, Omamo (1998) defined transaction costs as costs of participating in markets to explain why farm household that produced for consumption or markets were diversified. Key et al (2000) focused on two types of transaction costs in Mexico, fixed costs as barriers precluding participation, and proportional costs that relate to the degree of participation. They included institutions, a marketing cooperative, and providing access to information that reduced fixed transaction costs. McCann et al (2005) consider also market and legal institutions in transaction costs. Khaledi et al (2010) studied transaction costs in the adoption of organic farming practice, which included information, negotiation, and monitoring costs as well as market characteristics, using a combination of perceptions about satisfactions and problems and quantitative measures. Distance to market and marketing problems were major barriers, while size of the operation (smaller), internet use, and satisfaction with the market were positive (Khaledi et al 2010). Transaction costs included searching for partners to exchange, trust and bargaining ability, monitoring, and enforcement of exchange agreements (Khaledi et al 2010). The nature of the market is an element that impacts transaction costs and the adoption of organic practices. Thus, knowledge of markets for agroforestry products, access to information about the technologies, as well as programs and networks of support, make transaction costs a key aspect in understanding barriers to adoption. Furthermore, as both profits and noneconomic motives have been shown to influence the adoption of agroforestry (Lynch and Brown 2000; Koontz 2001; Workman et al 2003; Barbieri and Valdivia 2010a), they can conversely become adoption barriers.

RESEARCH METHOD

Sampling and Survey Procedures

In 2006, a survey was conducted in Boone, Howard, Crawford, and Phelps counties, in the Central and Ozark agricultural regions of Missouri (USA). Tax Assessor's lists were used to identify landowners owning at least 10 acres; 13,431 landowners were identified, excluding those who were development companies and federal or state owners. Landowners with multiple parcels were counted only once. A random sample with replacement from such list resulted in 728 landowners fitting the above criteria and who had complete contact information.

Based on the literature, a draft survey was developed and distributed for review among different people working with private landowners. Drawing from reviewers' feedback, survey content was modified and then tested among landowners for readability and content validity. The 10-section survey instrument included 93 close-ended questions. Specifically, the survey collected information on the landowner involvement with farming and conservation agencies, land resources and use, perceptions toward trees, agroforestry and environmental problems and personal background information. The survey also asked about barriers constraining planting trees on their lands. A group of 20 people that included semi-retired or retired extension agents, farm spouses, part-time workers, and students, were trained in face-to-face data collection methods. Visual images were used to elicit responses regarding different agroforestry practices. A combination of mail and phone survey was used to collect data from landowners who were not reached in person. The study yielded 353 completed survey forms (48.5% response rate).

Analysis

Descriptive analyses were initially performed to examine characteristics of the farmland and their operators. Ten barriers to the incorporation of trees on farms were measured on a five-point Likert scale ranging from one (no influence at all) to five (very large influence). A principal component factor analyses with varimax rotation was used to reduce the data to their underlying dimensions and attain a better understanding of the nature of the barriers. An examination of the scree-plot, as well as eigenvalues over one and factor loadings over 0.5 were used as thresholds for factor identification. Three methods were evaluated for handling missing data: listwise deletion, pairwise deletion, and mean imputation. These methods resulted in the same factors in terms of number and composition, showing small differences in the factor loadings. Listwise deletion method was used because it showed better factor loadings. Cronbach's alpha was calculated to test for internal factor reliability; $\alpha \geq 0.6$ was the minimum value expected to retain items as suggested by Nunnally and Bernstein (1994).

Barrier composite means (M_{F1}; M_{F2}) were obtained by averaging the influence ranking of the items included in each barrier factor. In turn, these factor scores were used to classify respondents through a K-means cluster analysis. Since there is not a standard classification rule for this analysis (Hair et al 1998; Arimond and Elfessi 2001), two to six clusters solutions were tested. The three-cluster solution was the best fit because clusters showed an optimal distribution of respondents with reduced sub-fragmentations and it also captured greater differences. Finally, a series of analysis of variance (ANOVA) and chi-square tests ($p < 0.05$) were used to analyze differences between identified clusters. Statistical Package for the Social Sciences (SPSS, Chicago, IL) software was used to conduct all statistical analysis, including factor and cluster analysis.

STUDY RESULTS

Seventy-two percent of the respondents were male landowners, and 50% in the sample were landowners from counties with an urban center. The socio-economic and farming characteristics of these respondents are presented in Table 1. There is a low incidence of adoption of agroforestry practices; only 30.9% reported having adopted at least one of the five practices promoted in temperate regions of North American (i.e., alley cropping; windbreaks; riparian or stream bank plantings; forest farming; and silvopasture). Windbreaks and riparian or stream bank plantings were more frequently adopted.

Perceived Barriers for Planting Trees in the Farmland

The perceived costs of establishing and managing trees, time required to manage, and lack of tree management experience were the most important barriers to planting trees on the farm (Table 2). Barriers related to potential damage to crops and to tenants' interest were perceived as least influential. The rotated principal component factor analysis of the perceived barriers to incorporate trees on the farm resulted in two factors. The underlying themes were used to label the factors as *Transaction Costs* (M_{F1}) and *Profitability Concerns* (M_{F2}). The transaction costs label was given because the factor comprised items related to information and perceptions of the costs to establish trees. While these costs are known in forestry, this is not necessarily the case with landowners in farming. The profitability concerns label addresses not only the concerns with the new practice, but the impact on existing enterprises. The "Tenants' interest" item did not load in any factor, thus it was dropped from further analysis.

The *Transaction Costs* factor is comprised of five obstacles associated with the perceived farm expenses of establishing the new practice and access to information required to implement new practices on the farm: lack of tree management experience; costs of

Table 1. Landowner socio-economic characteristics and practices in the sample

Landowner attributes	*N*	%
Landowner's age Mean (in years)		(57.7)
Less than 40 years old	27	8.0%
40–49 years old	65	19.3%
50–59 years old	100	29.6%
60–69 years old	86	25.6%
70 years or older	59	17.5%
Landowner's education[a] Mean (in years)		(14.1)
Less than 12 years	23	6.6%
12 years	135	38.4%
13–16 years	127	36.2%
17 years or more	66	18.8%
Farm household assets estimate (in US dollars)		
Less than $100,000	18	6.3%
$100,000–$199,999	54	19.0%
$200,000–$299,999	65	22.9%
$300,000–$499,999	53	18.7%
$500,000–$999,999	52	18.3%
$1,000,000 or more	42	14.8%
Type of landowner ($n = 347$)		
Full-time farmers	29	8.4%
Part-time farmers	89	25.6%
Nonfarmers living on the farm	177	51.0%
Nonfarmers living away the farm	52	15.0%
Number of years farming ($n = 347$) Mean (in years)		(17.7)
Less than 1 year	100	28.8%
1–10 years	67	19.3%
11–25 years	73	21.0%
26 – 40 years	55	15.9%
41 years or more	52	15.0%
Agroforestry practices ($n = 353$) *Overall* (*adopting at least one practice*)	(30.9%)	
Windbreaks	17.3%	
Riparian or stream bank plantings	15.9%	
Silvopasture	4.8%	
Forest farming	1.4%	
Tree planting in front of levees	0.6%	
Alley cropping	0.6%	

[a] 12 years corresponds to high school graduate and 16 years usually represents a college graduate.

establishing and managing the trees; lack of technical information; time required to manage trees; and too much effort needed for clearing the land. Resources include expenses associated with access to the technology (e.g., lack of knowledge and experience), constraints to hiring new personnel (e.g., time and effort requirements), and expenses associated with the actual purchase or maintenance of the trees (e.g., missing input markets), where the costs preclude market participation.

Table 2. Mean and rotated factor matrix of the perceived barriers for implementing agroforestry practices

Barriers for agroforestry adoption: Factors and items[a]	Mean[b]	Factor loadings	Explained variance (%)	Eigenvalue
Transaction costs ($\alpha = 0.849$)[c]			34.52	4.53
Lack of tree management experience	2.39	0.845		
Costs of establishing/managing the trees	2.54	0.815		
Lack of technical information	2.13	0.758		
Time required to manage trees	2.44	0.758		
Too much effort needed for clearing the land	2.04	0.541		
Barrier factor mean score 1 (M_{F1})	(2.36)			
Profitability concerns ($\alpha = 0.777$)			29.72	1.25
Trees being an obstacle for farm equipment	1.87	0.856		
Long return on the investment	2.08	0.789		
Negative effects on crops	1.85	0.701		
Inadequate market prices for timber	2.00	0.674		
Barrier factor mean score 2 (M_{F2})	(1.99)			
Total variance explained			64.24	

[a]Lack of tenants interest (mean = 1.37) did not load in any factor.
[b]Measured using a five-point Likert-type scale from 1 (no influence at all) to 5 (very large influence).
[c]Cronbach's alpha reliability coefficients for domains. Overall reliability ($\alpha = 0.876$).

The *Profitability Concerns* factor includes four barriers associated with low profitability perceived from growing trees: trees as obstacles for farm equipment; returns on investments take a long time; negative effects on crops; and inadequate market prices for timber. This second factor also relates to the perception that trees can reduce farm agriculture profits because trees can negatively affect crops (e.g., encourage weeds and pest propagation, reduced crop growth due to competition for light, water, and nutrients) or create the need to purchase additional farm equipment. The composite mean of each barrier factor shows that overall, barriers associated with *Transaction Costs* appear to be a greater concern in the implementation of agroforestry ($M_{F1} = 2.36$) than those associated with *Profitability Concerns* ($M_{F2} = 1.99$). However, *Transaction Costs* are easier to address through programs aimed to reduce initial establishment costs of agroforestry.

The types of landowners were identified with K-means cluster analysis. The analysis resulted in three clusters. Final cluster sizes were 133 (Cluster 1), 88 (Cluster 2), and 120 (Cluster 3) cases, representing 39.5%, 24.9%, and 35.6% of the respondents, respectively. As expected, all clusters had significantly different perceptions of the barriers of planting trees associated with *Transaction Costs* ($F = 295.194$; $p < 0.001$) and *Profitability Concerns* ($F = 510.672$; $p < 0.001$). Cluster 1 was labeled "environmentalist" because their members perceived that both types of barriers have a moderate influence on their decision to plant trees on their farmlands, although they are much more concerned with *Transaction Costs* ($M_{F1} = 2.83$) than *Profitability Concerns* ($M_{F2} = 1.81$). Cluster 2 was named "agriculturalist" because their members have greater transaction costs ($M_{F1} = 3.00$) and profitability concerns ($M_{F2} = 3.30$) for the incorporation of trees as compared to the other two clusters; they also perceive that both types of barriers are almost equally influential. Cluster 3, named "disengaged" did not perceive any of those barrier dimensions as influential to plant trees on their land ($M_{F1} = 1.37$; $M_{F2} = 1.27$), which can be an audience easier to reach for the adoption of new agricultural practices including agroforestry.

Economic Indicators of the Farmland Use across Clusters

ANOVA and chi-square tests revealed significant differences among clusters on several indicators of their relation to the farmland (Table 3). A significantly larger proportion of agriculturalists farm their land either full or part-time as compared to environmentalists and disengaged. While agriculturalists owned the largest farms, this group also had the largest number of individuals who decreased their farm acreage. Conversely, the disengaged had the smallest farms and had the lowest proportion of landowners who have decreased their farmed acreage in the last five years. There were no significant differences in the acres rented to others, nor the percentage of nonfarming assets landowners held among the three clusters. The number of years the land belonged to the family was significantly greater among agriculturalists as compared to environmentalists. Agriculturalists also reported the highest likelihood of passing the land on to the next generation as compared to the other clusters. Overall these results suggest that, although agriculturalists are more rooted in agriculture in terms of proportion of active farmers, farm size, number of years involved in farming as well as likelihood of passing their farms on to the next generation, this group also experienced the largest reduction in farmed acres in the past five years.

Significant differences were found in the extent of multifunctionality across clusters in terms of their farming functions (i.e., number of acres farmed, crop and livestock diversity, and number of agroforestry practices) and farmland services (i.e., recreational use, leases, and conservation set-asides); however, no differences were found on the pluriactivity indicators of the farm household members (Table 4). As for the farming function, the differences between clusters varied. Agriculturalists had significantly more acres farmed than disengaged. On average, agriculturalists grew 2.8 types of crops and livestock, reflecting greater production diversity than the other two clusters. Those results are consistent with the higher agricultural involvement of landowners in Cluster 2. As for the uptake of agroforestry, agriculturalists are employing significantly more practices than the disengaged.

The disengaged cluster is less multifunctional in terms of the number of recreational activities they provide compared to the other two clusters. Although the agricultural cluster farms more acres, this cluster also leases significantly more land than the other two clusters. No significant differences were found in the number of acres set aside for conservation programs across clusters. Although levels of household pluriactivity were high in all clusters, with off-farm employment of the head of household and the spouse close to or exceeding 50% no significant differences were found across clusters. The large proportion of landowners and their spouses employed off-farm across all three clusters, along with the large amount of land leased to others in the agricultural cluster may be associated with the overall decline in agricultural profitability that is forcing many farmers to find other forms of incomes to supplement their agricultural revenues.

Table 3. A comparison among environmentalists (ENV), agriculturalists (AGR), and disengaged (DIS) on their relation to the land attributes

Attributes	ENV (39%)	AGR (25%)	DIS (36%)	Statistical values	
Type of landowner					
Full-time farmers	6.1%	15.5%	6.0%	$x^2 = 27.186$	$p < 0.001$[b]
Part-time farmers	19.8%	39.3%	19.7%		
Nonfarmers living on the farm	61.8%	35.7%	54.7%		
Nonfarmers living away	12.2%	9.5%	19.7%		
Relation to the land					
Years in the family (mean)	28.9	40.8	31.9	$F = 3.697$	$p = 0.026$[c]
Likelihood to pass it to next generation (mean)[a]	2.8	3.5	2.7	$F = 7.069$	$p = 0.001$[b]
On-farm work—hrs/yr (mean)	785.5	953.2	928.6	$F = 0.569$	$p = 0.567$
Farmed acres change—last 5 years (in percentage)					
Farm acreage increased	22.0%	21.7%	13.6%	$x^2 = 14.844$	$p = 0.005$[d]
Farm acreage didn't change	68.2%	63.9%	83.9%		
Farm acreage decreased	9.8%	14.5%	2.5%		
Economic indicators					
Acres owned (mean)	132.4	229.5	103.9	$F = 6.152$	$p = 0.002$[d]
Acres rented from others (mean)	63.9	90.8	28.3	$F = 1.124$	$p = 0.327$
Percentage of household value of nonfarm assets (mean)	37.9	27.9	34.6	$F = 1.818$	$p = 0.164$

[a]Measured using a five-point Likert-type scale from 1 (very unlikely) to 5 (very likely).
[b]Pairwise shows no differences between the environmentalists and the disengaged.
[c]Pairwise only shows differences between the environmentalists and the agriculturalists.
[d]Pairwise shows that the disengaged is different from the other clusters.

Comparing Attributes for Agroforestry Adoption across Clusters

Significant differences were found across clusters in the physical farmland (i.e., number of acres available for planting trees, projected farmland growth in the next five years), internal (i.e., environmental concerns, perceived benefits of planting trees) and external (i.e., preferred incentives for planting trees) factors that can serve as supporting attributes for adopting agroforestry (Table 5). In terms of physical farmland opportunities, environmentalists appeared to have the greatest competitive advantage because they have a greater number of acres available for adopting agroforestry as compared to the agriculturalists and the disengaged, although significant differences were only found between environmentalists and disengaged. However, no significant differences were found across clusters in the projected farmland growth for the next five years.

Table 4. A comparison of agricultural multifunctionality and household pluriactivity among environmentalists (ENV), agriculturalists (AGR), and disengaged (DIS)

Farm land and household functions	ENV (39%)	AGR (25%)	DIS (36%)	Statistical values	
Farming function					
Number of acres farmed	158.2	291.6	121.4	$F = 4.404$	$p = 0.013$[a]
Crops and livestock diversity	2.3	2.8	2.1	$F = 15.539$	$p < 0.001$[b]
Number of agroforestry practices	0.5	0.4	0.3	$F = 5.095$	$p = 0.007$[c]
Other farmland services					
Number or recreational activities	4.1	4.2	3.3	$F = 6.336$	$p = 0.002$[d]
Number of acres leased to others	12.5	54.9	15.5	$F = 5.787$	$p = 0.003$[b]
Number of acres enrolled in conservation programs	12.6	12.2	2.3	$F = 1.521$	$p = 0.220$
Household pluriactivity					
Landowner off-farm employment	65.8%	62.5%	55.9%	$x^2 = 1.386$	$p = 0.500$
Spouse off-farm employment	66.7%	56.9%	47.1%	$x^2 = 4.556$	$p = 0.102$
Children off-farm employment	30.3%	31.0%	14.3%	$x^2 = 2.718$	$p = 0.257$

[a]Pairwise only shows differences between the disengaged and the agriculturalists.
[b]Pairwise shows that the agriculturalist cluster is different from the others.
[c]Pairwise only shows differences between the environmentalists and the disengaged.
[d]Pairwise shows that the disengaged are different from the other clusters.

Regarding internal factors, the disengaged have the lowest environmental concerns and the lowest perceptions of the benefits of planting trees, which suggest either reduced knowledge or interest in environmental issues. Measured on a four-point Likert scale (1 = not a problem; 4 = very serious problem), environmentalists and agriculturalists had concerns with soil erosion caused by rain and snow, stream bank erosion, and unwanted woody growth, which were not shared by the disengaged. Although concerns related to surface water quality, loss of trees, agricultural run-off, and wind erosion were very low across the board, they were significantly lower among the disengaged.

With respect to the perceived benefits of planting trees, respondents perceived that planting trees creates several positive environmental, wellbeing and economic dimensions (1 = unimportant; 4 = very important). Pairwise comparisons showed that wildlife conservation and scenic beauty were significantly more important for the environmentalist cluster as compared to the other clusters; and carbon sequestration was significantly more important for the agriculturalists than for the disengaged. Similar to environmental concerns, the disengaged perceived lower benefits for planting tree in all categories when compared to the other clusters, suggesting that the disengaged place a low value on the

Table 5. A cluster-based comparison of attributes for adoption of agroforestry

Advantageous attributes	ENV (39%)	AGR (25%)	DIS (36%)	Statistical values	
Farmland opportunities					
Number of acres available for agroforestry adoption	24.5	11.5	6.2	$F = 3.875$	$p = 0.022$[c]
Projected farmland growth (next five years)					
Farm acreage will increase	6.1%	8.5%	6.8%	$x^2 = 4.890$	$p = 0.299$
Farm acreage will not change	71.8%	74.4%	81.2%		
Farm acreage will decrease	22.1%	17.1%	12.0%		
Environmental concerns[a]					
Soil erosion caused by rain/snow	2.3	2.6	1.8	$F = 15.271$	$p < 0.001$[d]
Unwanted woody growth	2.3	2.5	1.8	$F = 11.476$	$p < 0.001$[d]
Stream bank erosion	2.2	2.1	1.7	$F = 5.178$	$p = 0.006$[d]
Loss of wildlife habitat	1.9	1.9	1.6	$F = 1.935$	$p = 0.146$
Surface water quality	1.8	1.9	1.4	$F = 6.980$	$p = 0.001$[d]
Loss of trees	1.8	1.6	1.5	$F = 3.146$	$p = 0.004$[c]
Agricultural run-off	1.6	1.9	1.4	$F = 8.094$	$p < 0.001$[e]
Flooding	1.6	1.6	1.4	$F = 1.171$	$p = 0.311$
Soil erosion caused by wind	1.6	1.6	1.3	$F = 5.751$	$p = 0.004$[d]
Perceived benefits for planting trees[b]					
For future generations	3.4	3.3	2.6	$F = 17.776$	$p < 0.001$[d]
Wildlife conservation	3.3	2.9	2.6	$F = 13.739$	$p < 0.001$[f]
Erosion control/prevention	3.2	3.2	2.3	$F = 23.886$	$p < 0.001$[d]
Water quality protection	3.1	3.0	2.3	$F = 17.411$	$p < 0.001$[d]
Scenic beauty	3.2	2.7	2.4	$F = 18.940$	$p < 0.001$[f]
Economic benefits	2.4	2.7	1.8	$F = 14.321$	$p < 0.001$[d]
Carbon sequestration	2.6	2.2	2.0	$F = 7.322$	$p = 0.001$[c]
Wind protection	2.4	2.5	1.8	$F = 9.421$	$p < 0.001$[d]
Tax benefits	2.4	2.5	1.8	$F = 13.757$	$p < 0.001$[d]
Flood protection	2.4	2.4	1.8	$F = 9.147$	$p < 0.001$[d]
Preferred incentives for planting trees					
Cost-share	56.8%	42.3%	39.5%	$x^2 = 11.536$	$p = 0.021$[f]
Tax incentives	36.9%	39.4%	40.7%		
Rental/incentive programs	6.3%	18.3%	19.8%		

[a]Measured using a four-point Likert-type scale from 1 (not a problem) to 4 (very serious problem).
[b]Measured using a four-point Likert-type scale from 1 (unimportant) to 4 (very important).
[c]Pairwise only shows differences between the environmentalists and the disengaged.
[d]Pairwise shows that the disengaged are different from the other clusters.
[e]Pairwise only shows differences between the agriculturalists and the disengaged.
[f]Pairwise shows that the environmentalists are different from the other clusters.

economic benefits of incorporating trees on the farmland. Finally, significant differences were found in the preferred type of incentives for planting trees; environmentalists reported a larger preference percentage-wise for cost share and the lowest preference for rental and incentive programs as compared to the agriculturalists and the disengaged. It could be argued that high interest in cost share programs relates to a high interest in the establishment of conservation practices (e.g., Environmental Quality Incentive Program [EQIP], and Wildlife Habitat Incentive Program [WHIP]) to diversify wildlife habitat and enhance the environmental quality on the farm.

Preferred Communication Elements for Agroforestry Promotion among Clusters

An examination of the established networks, institutions, and business factors facilitating information access produced important results that may help to reduce transaction costs and capitalize on the values that are important to each cluster for the adoption of agroforestry (Table 6). The disengaged cluster has had significantly less contact with conservation agencies in the past five years. Landowners in this cluster had significantly less established contacts with U.S. agricultural agencies—namely the Natural Resources Conservation Service (NRCS) and the Soil and Water Conservation District (SWCD)—less networking with other farmers, or visited another farmer to discuss agricultural issues as compared to the environmentalists and agriculturalists. Similarly, a significantly smaller proportion of disengaged participated in agribusiness field days as compared to environmentalists and agriculturalists. Finally, the disengaged indicated the highest interest among all clusters in rental and incentive programs, which implies a strong interest in passive use of land (i.e., being paid to take land out of production).

When electing a market place, all the business factors that reduce transaction costs or increase profitability were perceived at least moderately important. For the agriculturalist all attributes were important, and significantly higher in five out of six attributes (i.e., high prices for the products, established good relationships, trust in and established reputation of the buyer, and good service) as compared to the disengaged. For the agriculturalists, all attributes were moderately important, but with no significant differences as compared to the other two groups. In terms of social values when selecting a market place, the support of local community is moderately important for environmentalists and agriculturalists. The disengaged are less likely to participate in a cooperative than the other two groups.

Environmental landowners have different preferred information sources for learning about planting and managing trees from the other clusters. University Extension and State agencies were more important for environmentalists while forestry and farming-related agencies were the least important. Agriculturalists preferred to learn from Federal Agencies and other farmers more than other clusters. The disengaged expressed the lowest interest in contacting agencies to learn about planting or managing trees and the lowest interest in seeking out other farmers to obtain information about managing trees. Although a high percentage of landowners in all three clusters would seek University Extension to learn about innovations in agriculture, pairwise comparisons show significant differences between agriculturalists and disengaged in the distribution of their preferred agencies. Agriculturalists were the most likely to seek agency advice to learn about innovative agricultural practices as only 2.5% of landowners indicated that they would not consult anyone consistent with their high level of involvement in agriculture.

Table 6. A cluster-based comparison of communication elements for the promotion of agroforestry

Communication elements	ENV (39%)	AGR (25%)	DIS (36%)	Statistical values	
Established relationships with agencies (last five years)					
Times consulted with NRCS	2.1	2.4	0.3	$F = 4.259$	$p = 0.015$[b]
Times consulted with SWCD	0.7	1.2	0.2	$F = 4.991$	$p = 0.007$[c]
Times consulted with MDC	1.1	2.8	0.7	$F = 2.720$	$p = 0.067$
Farmer/agricultural networking (last two years)					
Attended extension demonstrations	12.1%	26.2%	11.8%	$x^2 = 9.736$	$p = 0.008$[d]
Attended agribusiness field days	18.2%	22.6%	7.6%	$x^2 = 9.687$	$p = 0.008$[b]
Received advice on-farm from other farmer	42.4%	46.4%	27.1%	$x^2 = 9.557$	$p = 0.008$[b]
Visited other farm for discussion	33.3%	44.0%	21.2%	$x^2 = 12.094$	$p = 0.002$[b]
Economic/business factors influencing selection of market place[a]					
Highest price	3.4	3.8	3.3	$F = 4.479$	$p = 0.013$[c]
Established good relationship	3.5	3.6	3.1	$F = 3.486$	$p = 0.033$[c]
Trustworthy buyer	3.4	3.6	3.0	$F = 4.750$	$p = 0.010$[c]
Buyer with an established reputation	3.4	3.5	2.9	$F = 4.023$	$p = 0.020$[c]
Good customer service	3.2	3.5	2.8	$F = 5.521$	$p = 0.005$[c]
Reduced travel distance	3.1	3.1	2.9	$F = 0.142$	$p = 0.460$
Social factors influencing selection of market place[a]					
Support the local community	3.1	3.0	2.6	$F = 4.080$	$p = 0.019$[e]
Participate in a co-op	2.2	2.4	1.6	$F = 8.142$	$p < 0.001$[b]
Agencies to learn about planting/managing trees					
University extension	35.9%	22.6%	31.7%	$x^2 = 30.585$	$p = 0.001$[f]
State agency	37.4%	28.6%	24.2%		
Other farmers/landowners	13.7%	19.0%	10.0%		
Federal agency	8.4%	14.3%	9.2%		
Forestry/farming related agencies	3.8%	7.1%	12.5%		
Nobody	0.8%	8.3%	12.5%		
Agencies to learn about innovative agricultural practices					
University extension	53.5%	41.3%	45.4%	$x^2 = 17.410$	$p = 0.026$[c]
Other farmers/landowners	14.2%	22.5%	19.3%		
Federal agency	15.7%	20.0%	9.0%		
State agency	10.2%	13.8%	11.8%		
Nobody	6.3%	2.5%	14.3%		

[a]Measured using a four-point Likert-type scale from 1 (unimportant) to 4 (very important).
[b]Pairwise shows that the disengaged are different from the other clusters.
[c]Pairwise only shows differences between the agriculturalists and the disengaged.
[d]Pairwise shows that the agriculturalists are different from the other clusters.
[e]Pairwise only shows differences between the environmentalists and the disengaged.
[f]Pairwise shows that the environmentalist cluster is different from the others.

CONCLUSION AND IMPLICATIONS FOR POLICY

Typologies have been found to be effective in identifying differences that can inform development of targeted extension programs and policies (Shucksmith and Herrmann 2002; Strong andJacobsen 2005; Boon and Meilky 2007). This study identified three distinct groups of landowners using factor analysis with ten potential obstacles that may reduce landowner's interest in planting trees. Two overarching factors were identified, one related to transaction costs in establishment of trees, and a second related to profitability concerns. These factors were used to identify three groups of landowners with differing concerns regarding transaction costs related to the establishment of trees, and profitability concerns. Agriculturalists, environmentalists, and disengaged varied in the importance of these factors. Boon and Meilky (2007) found that clusters with a production logic required different policies than those who were interested in environment values in their study of private forest owners. While environmentalists were more concerned about establishment costs, agriculturalists were concerned about both costs and profitability. Environmentalists were more multifunctional, involved in the farming (e.g., agroforestry adoption) and services (e.g., recreational activities) functions. The disengaged appeared to have no concerns, had less land available for adopting practices, and perceived lower environmental concerns and benefits of planting trees. Low perceptions of barriers to plant trees among disengaged may be associated with landowners' lower labor commitments, and lower concerns with profitability of their land because they are not as involved in farm operations, and may benefit from passive management solutions (Boon and Meilky 2007).

Previous studies found that knowledge and information are significant factors to support new technologies (Khaledi et al 2010), conservation programs (Prokopy et al 2008), and in the adoption of agroforestry practices (Raedeke et al 2003; Workman et al. 2003; Strong and Jacobsen 2006; Valdivia and Poulos 2009). Transaction costs exist due to the weakness of institutions that facilitate access to information, in this case regarding agroforestry practices and policies that can support implementation. Windbreaks and riparian buffers are the most commonly adopted practices, consistent with environmental perceptions (e.g., loss of trees, wildlife conservation) and federal government programs that have supported them in the practice of farming (Raedeke et al 2003; Valdivia et al 2009).

Environmentalists and agriculturalists share similar environmental concerns. Strong environmental concerns have been suggested as instrumental in adopting conservation practices (Alavalapati et al 2004; Valdivia and Poulos 2009), while shared values, perceptions and networks are key to developing and supporting new commercial agroforestry practices like alley cropping or forest farming (Raedeke et al 2003; Prokopy et al 2008; Valdivia et al 2009).

Environmentalists and agriculturalists also share values that reduce transaction costs in market participation (i.e., trustworthy buyer, established relationship, reputation, and highest price). These two clusters also value support of the local community, and have more established relationships with public conservation and education agencies and social networking. Notably, the environmentalists trust not only horizontal (farmer-to-farmer) but also vertical (organizations) information sources, to learn about innovations and technologies related to trees. Horizontal and vertical relationships in social networks, rather than information, have been suggested to contribute to the decision of adoption of innovations and management practices (Prokopy et al 2008), which points to the importance of investing in programs that foster connections with others.

In sum, the socio-economic characteristics of environmentalists and agriculturalists in terms of farm size and acres farmed, portfolio diversity, overall awareness of environmental problems, and their horizontal and vertical social networks, suggest that policies fostering agroforestry adoption should target both groups in the short term (Prokopy et al 2008). It is also necessary to recognize differences between types of landowners in diffusion efforts as it has been suggested (Barbieri and Valdivia 2010a). For example, although environmentalists and agriculturalist landowners are well networked and share values related to the benefits of trees and their concerns about conservation, it is imperative to recognize that more landowners in the agriculturalist cluster are actively farming as compared to their counterpart.

The results of this study have policy implications for the practice of agroforestry. Incentive structures and information are powerful motivators for changing practices (Alavalapati et al 2004; Strong and Jacobsen 2005, 2006; Valdivia and Poulos 2009; Valdivia et al 2009). Incentives not only refer to economic, but also other motivations, such as preferences and values (Pattanayak et al 2003; Chouinard et al 2008). According to the findings, access to information and cost share programs would reduce the barriers to adoption of practices that incorporate trees on the landscape, by reducing transaction costs of establishing the practice. Incentives need to include reduction of costs and increased profitability to be appealing to those more engaged in farming (the agriculturalists), although studies like Strong and Jacobsen (2006) in Pennsylvania found that landowners would be willing to invest themselves.

Widespread adoption and use of agroforestry will require multiple, integrated, deliberate and opportunistic approaches including: market driven and targeted funding, top down (government) and bottom up (landowners) efforts, high tech (research breakthroughs) and high touch (one-on-one tech transfer) efforts, and active partnerships (Raedeke et al 2003; Fléchard et al 2007). Over the past decade, the European Union has engaged in active discussions and put forth specific policies to support the growth of agroforestry (Lawson et al 2005. There are a number of promising trends in support of the growth of agroforestry including consumer driven demand for healthier food and a healthier environment, national efforts to reduce nonpoint source pollution and increase wildlife habitat, the reality of climate change and the cost, and insecurity due to dependence on fossil fuels. Nationwide efforts to reduce nonpoint source pollution and increase wildlife habitat are supported by national policy through Farm Bill programs (e.g., CRP, EQIP, WHIP) that support the use of agroforestry practices like riparian forest buffers (Schoeneberger 2009). Climate change is causing a shift in interest toward long-term carbon storage, increased use of perennials and agroecosystem resilience, and high fossil fuel costs are driving renewed interest in ligno-cellulosic biomass and bioenergy as alternative energy sources (Eaglesham 2007; USDA-ERS 2008; Jordan and Warner 2010). The Federal Biomass Crop Assistance Program incentive scheme is intended to jump-start the nation's push toward a new ligno-cellulosic based biomass and bioenergy industry. All these programs have elements that can benefit the different types of landowners identified in this study. Agriculturalists will access information through extension and other farmers and the practice of farming institutions that are well established. To learn about planting and managing trees, environmentalists are well connected and rely on many types of agencies. Agriculturalists rely on the agencies that support farming as well as other farmers. These agencies have a key role to play in informing about these changes in consumer behavior, environmental policies, and new opportunities.

Finally, policy changes are needed in future U.S. Farm Bill programs to further stimulate landowner adoption of agroforestry through market-based incentives. The USDA Agroforestry Strategic Framework (USDA 2011) reveals three strategic goals for supporting agroforestry (i.e., Adoption, Science, and Integration). Integration, strategic goal number three, seeks to "incorporate agroforestry into an all-lands approach to conservation and economic development."(USDA 2011, p. 11). Strategies to achieve this goal include the development of a USDA Agroforestry Policy Statement and, through Farm Bill legislation, to define agroforestry and specifically authorize its application in conservation and natural resources.

A "new generation" of incentive programs is needed in the USA that allows landowners to pursue alternative market opportunities when establishing agroforestry practices. Policies that support establishment, and encourage landowners to generate income from the trees, shrubs, or alternative crops, as incentive payments are reduced accordingly, can address the profitability concerns that matter to agriculturalists. Increased attractiveness to landowners seeking to earn on-farm income are programs that reduce up front establishment costs, provide income while alternative crops come into production, and reduce long-term costs to federal government as landowners are weaned off cost share programs.

ACKNOWLEDGMENTS

Our appreciation to Dr. Laura McCann (University of Missouri) and to the two anonymous reviewers for their valuable comments and helpful insights on earlier versions of this paper. The authors acknowledge the assistance of Jason Holderieath, graduate student in the Department of Agricultural and Applied Economics of the University of Missouri, Columbia, USA. Partial funding for this study was provided through the University of Missouri Center for Agroforestry under cooperative agreements 58-6227-1-004 with the ARS and CR 826704-01-2 with the US EPA. The results presented are the sole responsibility of the authors and may not represent the policies or positions of the Agriculture Research Service or Environmental Protection Agency of the United States of America. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the United States Department of Agriculture (USDA).

REFERENCES

Alavalapati, **J. R. R.**, **R. K. Shrestha**, **G. A. Stainback and J. R. Matta**. **2004**. Agroforestry development: An environmental economic perspective. *Agroforestry Systems* 61: 299–310.

Arimond, **G. and A. Elfessi**. **2001.** A clustering method for categorical data in tourism market segmentation research. *Journal of Travel Research* 39: 391–97.

Barbieri, **C. and E. Mahoney**. **2009.** Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers. *Journal of Rural Studies* 25 (1): 58–66.

Barbieri, **C. and C. Valdivia**. **2010a.** Recreational multifunctionality and its implications for agroforestry diffusion. *Agroforestry Systems* 79 (1): 5–18.

Barbieri, **C. and C. Valdivia**. **2010b.** Recreation and agroforestry: Examining new dimensions of multifunctionality in family farms. *Journal of Rural Studies* 26 (4): 465–73.

Boody, G., B. Vondracek, D. A. Andow, M. Krinke, J. Westra, J. Zimmernan and P. Welle. 2005. Multifunctional agriculture in the United States. *BioScience* 55 (1): 27–38.

Boon, T. E. and H. Meilby. 2007. Describing management attitudes to guide forest policy implementation. *Small-Scale Forestry* 6: 79–92.

Buck, L. E. 1995. Agroforestry policy issues and research directions in the US and less developed countries: insights and challenges from recent experience. *Agroforestry Systems* 30 (1-2): 57–73.

Chouinard, H. H., T. Paterson, P. R. Wandschneider and A. M. Ohler. 2008. Will farmers trade profits for stewardship? Heterogeneous motivations for farm practice selection. *Land Economics* 84 (1): 66–82.

Cooper, J. C. and R. W. Keim. 1996. Incentive payments to encourage farmer adoption of water quality protection practices. *American Journal of Agricultural Economics* 78 (1): 54–64.

Dobbs, T. L. and J. N. Pretty. 2004. Agri-environmental stewardship schemes and "multifunctionality." *Review of Agricultural Economics* 26 (2): 220–37.

Eaglesham, A. (ed.). 2007. Fourth Annual World Congress on Industrial Biotechnology and Bioprocessing Linking Biotechnology, Chemistry and Agriculture to Create New Value Chains. Summary Proceedings. Orlando, FL, March 21–24. http://nabc.cals.cornell.edu/pubs/WCIBB2007_proc.pdf (accessed Oct. 15, 2011).

Ervin, C. A. and D. E. Ervin. 1982. Factors affecting the use of soil conservation practices: Hypothesis, evidence, and policy implications. *Land Economics* 58 (3): 277–92.

Fléchard, M., M. S. Carroll, P. J. Cohn and A. N. Dhubháin. 2007. The changing relationships between forestry and the local community in rural northwestern Ireland. *Canadian Journal of Forestry Research* 37: 1999–2009.

Flower, T., C. Valdivia and H. Dorr. 2005. Habitus and interest in agroforestry practices in Missouri. Selected Paper, American Agricultural Economics Association Annual Meeting, Providence, RI, July 24–27. http://ageconsearch.umn.edu/bitstream/19279/1/sp05fl03.pdf (accessed February 28, 2012).

Gardner, B. L. 2000. Economic growth and low incomes in agriculture. *American Journal of Agricultural Economics* 82 (5): 1059–74.

Godsey, L. D., D. E. Mercer, R. K. Grala, S. C. Grado and J. R. R. Alavalapati. 2009. Agroforestry economics and policy. In *North American Agroforestry: An Integrated Science and Practice*, 2nd. ed., edited by H. E. Garret, pp. 315–37. Madison, WI: American Society of Agronomy Inc.

Gold, M. A., M. M. Cernusca and L. D. Godsey. 2009. Agroforestry product markets and marketing. In *North American Agroforestry: An Integrated Science and Practice*, 2nd ed., edited by H. E. Garret, pp. 287–314. Madison, WI: American Society of Agronomy Inc.

Gold, M. A. and H. E. Garrett. 2009. Agroforestry nomenclature, concepts and practices. In *North American Agroforestry: An Integrated Science and Practice*, 2nd. ed., edited by H. E. Garret, pp. 45–56. Madison, WI: American Society of Agronomy Inc.

Hair, J., B. Black, B. Babin, R. Anderson and R. Tatham. 1998. *Multivariate Data Analysis*, 5th ed. NJ: Prentice Hall.

Hoppe, R. A. and J. M. MacDonald. 2001. America's diverse family farms: Assorted sizes, types, and situations. ERS Agriculture Information Bulletin No. 769. Washington, DC: Economic Research Service, May.

Isik, M. and W. Yang. 2004. An analysis of the effects of uncertainty and irreversibility on farmer participation in the conservation reserve program. *Journal of Agricultural and Resource Economics* 29 (2): 242–59.

Jordan, N. and K. D. Warner. 2010. Enhancing the multifunctionality of US agriculture. *BioScience* 60 (1): 60–66.

Key, N., E. Sadoulet and A. de Janvry. 2000. Transaction costs and agricultural household supply response. *American Journal Agricultural Economics* 82 (May): 245–59.

Khaledi, **M.**, **S. Weseen**, **E. Sawyer**, **S. Ferguson and R. Gray**. **2010**. Factors influencing partial and complete adoption of organic farming practices in Saskatchewan, Canada. *Canadian Journal of Agricultural Economics* 58: 37–56.

Konyar, **K. and C. T. Osborn**. **1990**. A national level economic analysis of conservation reserve program participation: A discrete choice approach. *Journal of Agricultural Economic Research* 42 (2): 5–12.

Koontz, **T. M. 2001**. Money talks-but to whom? Financial versus nonmonetary motivations in land use decisions. *Society and Natural Resources* 14: 51–65.

Lassoie, **J. P.**, **L. E. Buck**, **and D. Current**. **2009**. In *North American Agroforestry: An Integrated Science and Practice,* 2nd ed., edited by H. E. Garret, pp. 1–24. Madison, WI: American Society of Agronomy Inc.

Lawson, **G.**, **C. Dupraz**, **F. Liagre**, **G. Moreno**, **P. Paris and V. Papanastasis**. **2005**. Options for agroforestry policy in the European Union. www1.montpellier.inra.fr/safe/english/results/final-report/D9–3.pdf (accessed Oct. 15, 2011).

Lynch, **L. and C. Brown. 2000**. Landowner decision making about riparian buffers. *Journal of Agricultural and Applied Economics* 32: 585–96.

Mann, **S. and H. Wüstemann**. **2007**. Multifunctionality and a new focus on externalities. *Journal of Socio-Economics* 37 (1): 293–307.

Marsden, **T. and R. Sonnino**. **2008**. Rural development and the regional state: Denying multifunctional agriculture in the UK. *Journal of Rural Studies* 24: 422–31.

Matthews, **S.**, **S. M. Pease**, **A. M. Gordon and P. A. Williams**. **1993**. Landowner perceptions and the adoption of agroforestry practices in Southern Ontario, Canada. *Agroforestry Systems* 21: 159–68.

McCann, **L.**, **B. Colby**, **K. W. Easter**, **A. Kasterine and K. V. Kuperan**. **2005**. Transaction cost measurement for evaluating environmental policies. *Ecological Economics* 53 (4): 527–42.

Nunnally, **J. and I. Bernstein**. **1994**. *Psychometric Theory*. New York: McGraw-Hill.

Omamo, **S. W. 1998**. Farm-to-market transaction costs and specialization in small-scale agriculture: Explorations with a non-separable household model. *Journal of Development Studies* 35: 152–63.

Pannell, **D. J. 1999**. Social and economic challenges in the development of complex farming systems. *Agroforestry Systems* 45: 393–409.

Pattanayak, **S. K.**, **D. E. Mercer**, **E. Sills and J. Yang**. **2003**. Taking stock of agroforestry adoption studies. *Agroforestry Systems* 57: 173–86.

Ploeg, **J. D.**, **H. Renking**, **G. Brunori**, **K. Knick**, **J. Mannion**, **T. Mardsen**, **K. Roest**, **E. Sevilla-Guzman and F. Ventura**. **2000**. Rural development: From practices and policies towards theory. *Sociologia Ruralis* 40: 391–408.

Prokopy, **L. S.**, **K. Floress**, **D. Klotthor-Weinkauf and A. Baumgart-Getz**. **2008**. Determinants of agricultural bet management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation* 63 (5): 300–11.

Raedeke, **A. H.**, **J. J. Green**, **S. S. Hodge and C. Valdivia**. **2003**. Farmers, the practice of farming and the future of agroforestry: An application of Bourdieu's concepts of field and habitus. *Rural Sociology* 68 (1): 64–86.

Rule, **L. C.**, **C. B. Flora and S. S. Hodge**. **2000**. Social dimensions of agroforestry. In *North American Agroforestry: An Integrated Science and Practice*, 1st ed., edited by H. E. Garrett, W. J. Rietveld and R. F. Fisher., pp. 361–86. Madison, WI: American Society of Agronomy Inc.

Schoeneberger, **M. M. 2009**. Agroforestry: Working trees for sequestering carbon on agricultural lands. *Agroforestry Systems* 75: 27–37.

Shucksmith, **M. 1993**. Farm household behavior and the transition to post-productivism. *Journal of Agricultural Economics* 44 (3): 466–79.

Shucksmith, **M. and V. Herrmann**. **2002**. Future changes in British agriculture: Projecting divergent farm household behaviour. *Journal of Agricultural Economics* 53 (1): 37–50.

Skaggs, **R. K.**, **R. E. Kirskey and W. M. Harper**. **1994**. Determinants and implications of POST-CRP land use decisions. *Journal of Agricultural and Resource Economics* 19: 299–312.

Skees, **J. R.**, **J. Harwood**, **A. Somwaru and J. Perry**. **1998**. The potential for revenue insurance policies in the South. *Journal of Agricultural and Applied Economics* 30 (1): 47–61.

Skelton, **P.**, **S. J. Josiah and J. Brandle**. **2004**. Adoption of riparian forest buffers on private lands: Factors affecting their use in two Nebraska, USA watersheds. 1st World Congress of Agroforestry. Working Together for Sustainable Land Use Systems, p. 90, Orlando, FL, June 27–July 2.

Soule, **M. J.**, **A. Tegene and K. D. Wiebe**. **2000**. Land tenure and the adoption of conservation practices. *American Journal of Agricultural Economics* 82 (4): 993–1005.

Strong, **N. A. and M. G. Jacobson**. **2004**. An agroforestry for every reason: Adoption potential in changing rural Pennsylvania. 1st World Congress of Agroforestry. Working Together for Sustainable Land Use Systems, p. 91, Orlando, FL, June 27–July 2.

Strong, **N. A. and M. G. Jacobson**. **2005**. Assessing agroforestry adoption potential utilising market segmentation: A case study in Pennsylvania. *Small-Scale Forest Economics, Management and Policy* 4 (2): 215–28.

Strong, **N. A. and M. G. Jacobson**. **2006**. A case for consumer-driven extension programming: Agroforestry adoption potential in Pennsylvania. *Agroforestry Systems* 68: 43–52.

USDA. **2011**. USDA Agroforestry strategic framework, fiscal year 2011–2016. United States Department of Agriculture, June. http://www.unl.edu/nac/iat.htm (accessed Oct. 15, 2011).

USDA-ERS. **2008**. 2008 Farm Bill side-by-side. http://www.ers.usda.gov/FarmBill/2008/ (accessed Oct. 15, 2011).

Valdivia, **C.**, **M. Gold**, **L. Zabek**, **J. Arbuckle and C. Flora**. **2009**. Human and institutional dimensions of agroforestry. In *North American Agroforestry: An Integrated Science and Practice*, 2nd ed., edited by H. E. Garret, pp. 339–67. Madison, WI: American Society of Agronomy Inc.

Valdivia, **C. and K. Konduru. 2003.** Interest in agroforestry practices, farmer diversification strategies and government transfers in Missouri's northeast and southeast. In *Proceedings 8th Biennial Conference on Agroforestry in North America* [CD-ROM], edited by S. Sharrow, Corvallis, OR, June 22–25.

Valdivia, **C. and C. Poulos. 2009.** Factors affecting farm operators' interest in incorporating riparian buffers and forest farming practices in northeast and southeast Missouri. *Agroforestry Systems* 75: 61–71.

Valdivia, **C.**, **A. Raedeke**, **S. Hodge**, **J. Green and L. Godsey. 2000.** The economic and social value of floodplain agroforestry to rural development: A baseline economic and social profile of producers in northeast and southeast Missouri. Agricultural Economics Working Papers 2000-4, University of Missouri, Columbia, MO. http://dass.missouri.edu/agecon/research/workingpapers/aewp2000-4.pdf (accessed February 28, 2012).

Vanslembrouck, **I. and G. Van Huylenbroeck**. **2005**. *Landscape Amenities: Economic Assessment of Agricultural Landscapes*. New York: Springer.

Williams, **P. A.**, **A. M. Gordon**, **H. E. Garrett and L. E. Buck. 1997.** Agroforestry in North America and its role in farming systems. In: *Temperate Agroforestry Systems,* edited by A. M. Gordon and S. M. Newman, pp. 9–84. Wallingford, UK: CAB International.

Wilson, **G. A. 2008**. From 'weak' to 'strong' multifunctionality: Conceptualizing farm-level multifunctional transitional pathways. *Journal of Rural Studies* 24 (3): 367–83.

Workman, **S. W.**, **M. E. Bannister and P. K. R. Nair**. **2003.** Agroforestry potential in the southeastern United States: Perceptions of landowners and extension professionals. *Agroforestry Systems* 59: 73–83.