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Landowner interest in multifunctional agroforestry Riparian buffers

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Abstract Adoption of temperate agroforestry practices generally remains limited despite considerable advances in basic science. This study builds on temperate agroforestry adoption research by empirically testing a statistical model of interest in native fruit and nut tree riparian buffers using technology and agroforestry adoption theory. Data were collected in three watersheds in Virginia's ridge and valley region and used to test hypothesized predictors of interest in planting these buffers. Confirmatory factor analysis was used to verify independence of underlying latent measures. Multiple linear regression was used to model interest using the Universal Theory of Acceptance and Use of Technology (UTAUT). A second model that added agroforestry-specific predictors from Pattanayak et al. (Agrofor Syst 57:173–186, 2003) to UTAUT was tested and compared with the first. The first model was robust (Adj $R^2 = 0.49$) but was improved by adding agroforestry specific predictors (Adj $R^2 = 0.57$). Model generalizability was confirmed using double cross validation and normality indices. *Social influence, risk expectancy, planting experience, performance expectancy, parcel size,* and the interaction of gender and risk were significant in the final model. In addition, socioeconomic variables were used to characterize landowners according to their level of interest. Respondents with greater interest were newer owners that have higher incomes and are less active in farming. The result implies that future agroforesters may in large part consist of owners that have recently acquired land and manage their property more extensively with higher discretionary income and multiple objectives in mind.

Keywords Adoption · Agroforestry · Native fruit and nut trees · Riparian forest buffer · Universal theory of acceptance and use of technology

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Introduction

Advances in agroforestry application require a complement of adoption-focused research (Mercer and Miller 1998; Montambault and Alavalapati 2005). Studies of agroforestry adoption have increased in recent years (Arbuckle et al. 2009; Valdivia and Poulos 2009), yet the breadth of adoption research does not parallel that amassed in terms of basic science. Several studies over the past decade have helped shape contemporary perspectives regarding adoption (e.g., Pattanayak et al. 2003; Workman et al.

2003; Mercer 2004; Strong and Jacobson 2005; Arbuckle et al. 2009; Cooper and Jacobson 2009; Valdivia and Poulos 2009). Continuing the trajectory is necessary if agroforestry is to become common land use (Montambault and Alavalapati 2005).

Agroforestry adoption frequently has been studied in terms of socioeconomic variables such as age, gender, education, income, social interaction, land characteristics, and length of ownership. For instance, researchers found that younger landowners appear to be more interested in agroforestry (Konyar and Osborn 1990; Hagan 1996; Strong and Jacobson 2005; Valdivia and Poulos 2009). Others found gender does not correlate with interest (Matthews et al. 1993; McGinty et al. 2008), though women may be more involved in practices consistent with agroforestry strategies such as specialty crop production (Strong and Jacobson 2005). In an international context, studies found that more men per household can relate to greater agroforestry adoption (Pattanayak et al. 2003). Results from previous studies also suggest that landowners with higher levels of education are more likely to be interested in and adopt agroforestry (Traore et al. 1998; Cooper and Jacobson 2009; Arbuckle et al. 2009). Likewise, income was found to correlate positively with agroforestry adoption (Featherstone and Goodwin 1993; Pattanayak et al. 2003).

More broadly, interest is thought to increase with membership in community organizations (Pattanayak et al. 2003) and decisions to adopt often are influenced by family (Salamon et al. 1997; Raedeke et al. 2003). Social interactions such as face-to-face communication, local networks, norms, and support structures may be important in the adoption process as well (Atwell et al. 2009). Some studies found that interest in agroforestry among landowners depends on the size of their land (Konyar and Osborn 1990; Featherstone and Goodwin 1993; Pattanayak et al. 2003; Strong and Jacobson 2005), whereas other studies report no relationship to size (Matthews et al. 1993; Valdivia and Poulos 2009). Length of ownership has not been found to predict adoption of agroforestry but may relate to landowner age, which is known to be influential (Arbuckle et al. 2009).

Factors studied less often though related to agroforestry adoption include farming status and management intensity. Land use appears to be an important antecedent of interest in temperate agroforestry systems. For example, several studies found that farmers (e.g., those who intensively manage their land for production and financial objectives) are less interested in agroforestry (Arbuckle et al. 2009; Barbieri and Valdivia 2010). Nevertheless land use intensity does not preempt adoption; rather it acts to shape different paths of interest (Strong and Jacobson 2005; Trozzo et al. 2014).

Overall, results from these and other studies suggest that agroforestry adoption is driven by factors such as risk perception and expected benefits, which vary across landowner types. Pattanayak et al. (2003) argue that perceived risk is a prominent driver of interest in agroforestry systems and several studies indicate that viewpoints differ (Scherr 2000; Franzel and Scherr 2002). Expected benefits of adoption beyond economics, such as ecological impacts, also are related and can influence the nature of landowner interest and intention (Arbuckle et al. 2009; Valdivia and Poulos 2009).

In this study, we focused on landowner interest in multifunctional agroforestry riparian buffers composed of fruit and nut trees native to Virginia's ridge and valley. This agroforestry buffer merges conservation and production in riparian areas using edible trees and shrubs. Our objective was to build on previous adoption research in temperate regions by developing and testing models using the validated Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) and the agroforestry interest framework developed by Pattanayak et al. (2003). Also, we used socioeconomic variables drawn from the literature to characterize landowners based on their interest in native fruit and nut tree buffers.

Three hypotheses were tested: (1) independent variables in UTAUT predict owner interest; (2) adding agroforestry-specific independent variables from Pattanayak et al.'s (2003) framework improves upon the first model; and (3) socioeconomic characteristics differ across landowner interest. Creekside owners in three watersheds in western Virginia were sampled and mailed a survey. The survey data were used to model interest in planting native fruit and nut tree agroforestry riparian buffers and characterize owner interest.

Confirmatory factor analysis (CFA) was used to verify underlying latent survey measures. Multiple linear regression was used to test and compare the baseline UTAUT model to a second model with UTAUT and agroforestry adoption predictors. Model generalizability was tested and confirmed using double cross validation. Non-parametric tests were used to examine whether socioeconomic variables significantly differ across landowner interest.

Theoretical framework

Venkatesh et al.'s (2003) UTAUT model is a validated and unified model of technology adoption. It was developed using eight behavioral models: theory of reasoned action (Fishbein and Ajzen 1975), technology acceptance model (TAM) (Davis 1989), motivational model (Davis et al. 1992), theory of planned behavior (TPB) (Ajzen 1991), combined model of TAM and TPB (Taylor and Todd 1995), model of personal computer utilization (Thompson et al. 1991), innovation diffusion theory (Rogers 2003), and social cognitive theory (Compeau and Higgins 1995). The UTAUT model was developed and tested within the information technology field; however, its unified structure makes it useful for studying adoption of other technologies (Venkatesh et al. 2003).

The UTAUT model uses expected performance, expected effort, and social influence as predictors of behavioral intention and facilitating conditions as antecedents of actual behavior. Gender, age, experience, and voluntariness of use moderate the different predictors. For this research, it was used to conceptualize and study landowner interest in a multifunctional agroforestry land use technology. The application of UTAUT measures to a native fruit and nut tree agroforestry riparian buffer are described below.

Performance expectancy is how well a landowner expects the buffer to perform in terms of survival, production, and conservation services. *Effort expectancy* is the expected effort required to plan, plant, and manage the buffer. *Social influence* is the extent to which groups or individuals such as family, neighbors, and other landowners support use of the buffer and affect landowner interest. *Facilitating conditions* are the help and support a landowner believes is available for implementing the buffer. Examples of *facilitating conditions* include educational materials, outreach, and financial assistance (Venkatesh et al. 2003). Age, gender, and experience using a buffer were measured to account for hypothesized UTAUT interactions. Voluntariness of use was not included as an interaction term because agricultural riparian management practices are voluntary in Virginia.

Table 1 Indicators for the dependent variable and hypothesized predictors developed from UTAUT and the agroforestry interest framework

	Indicator
Dependent variable	
Interest	I am interested in planting native fruit and nut trees on my creekside in the next 3 years
Predictors	
Performance expectancy	The trees that live would grow lots of food
	Water quality in the creek would significantly improve
	The amount of wildlife would dramatically increase
Effort expectancy	Planning for a creek side planting of fruit and nut trees
	Planting a creek side with fruit and nut trees
	Managing a creek side of fruit and nut trees
Social influence	People who are important to me would strongly favor creek side plantings on my land
	Fellow landowners think creek side plantings are very beneficial
	Folks that live near my land are generally not interested in creek side plantings
Risk expectancy	Putting money into it would be very risky
	I am not certain how I would benefit
	The planting would not be worth my time
Biophysical factors	Buffer area to nearest road
	Plantable riparian area
	Percent highly erodible soil
	Parcel size

Pattanayak et al. (2003) identified five factors that influence *interest* in agroforestry. *Preferences* are landowner characteristics such as age, gender, and education that affect adoption of agroforestry plantings. *Resource endowments* are assets that landowners can access to implement agroforestry practices. *Market incentives* are economic factors that either lower the cost and/or increase benefits of adoption. *Biophysical factors* are influential land characteristics such as slope, soil, and parcel size. Finally, there is *risk and uncertainty* associated with implementing agroforestry practices, which often includes issues of tenure and experience.

The UTAUT model was adapted to account for predictors of adoption presented by Pattanayak et al. (2003) (Table 1). We found that *preferences, resource endowments*, and *market incentives* were accounted for in the UTAUT model either as moderators, independent predictors, or antecedents of adoption (Pattanayak et al. 2003). To adapt the model, we added *risk* and *biophysical* measures because they were not present in UTAUT. Additional adaptation included using *interest* as the dependent variable to account for expected variation in familiarity with the native fruit and nut tree agroforestry buffer. The adapted model was statistically compared to the UTAUT-only model.

Methods

We gathered data from three watersheds in western Virginia with similar land use composition in terms of farms, forest, and livestock management (Fig. 1). Qualified properties were identified using 2011 aerial imagery, the National Hydrography Dataset (NHD), and county tax parcel data using geospatial analysis software (ArcMap 9.3). The study population included owners of 1,729 parcels larger than 2 ha having 1st–4th order streams passing through the property. These criteria focused the study on larger land holdings with greater potential to impact water quality. We drew a random sample of 1,121 landowners from the population after removing duplicate owners using 95 % confidence assuming a 0.03 margin of error (after Dillman et al. 2009). Owners with properties that had non-forested creek sides at least 0.03 hectares in size were included in the study.

The 0.03 hectare minimum is the lowest acreage that can be enrolled in the Conservation Reserve Enhancement Program (CREP), which is a government program that provides support to plant streamsides to conserve soil and protect water quality (USDA FSA 2012). Including streamsides with non-forested sections of 0.03 hectares and greater ensured that data were collected from landowners who have riparian areas that may qualify for CREP. Four hundred and sixty-nine parcels (42 %) from the study met our definition of non-forested creek sides, with a contiguous strip of at least 18 m in stream length and 23 lateral meters (0.03 ha) with less than 10 % canopy cover.

The tailored design method (Dillman et al. 2009) was used to survey qualified landowners. A letter notified landowners of the study and that they should expect a questionnaire. This was followed a week later by a cover letter and the questionnaire. A post card was delivered the next week as a reminder. A cover letter and replacement questionnaire were mailed 3 weeks later. To account for potential inaccuracy in the NHD

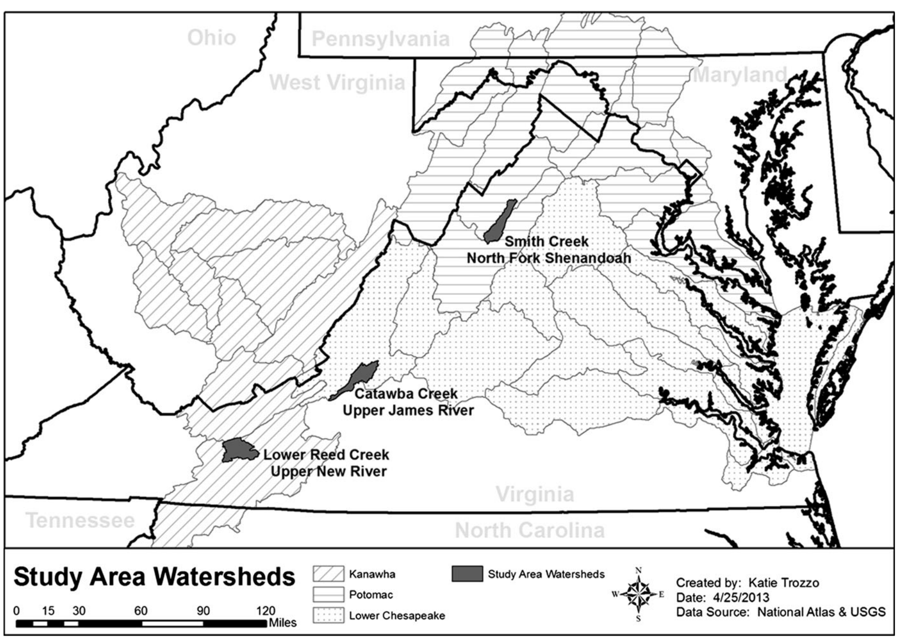

Fig. 1 Study area watersheds in western Virginia: Smith Creek, Catawba Creek, and Lower Reed Creek

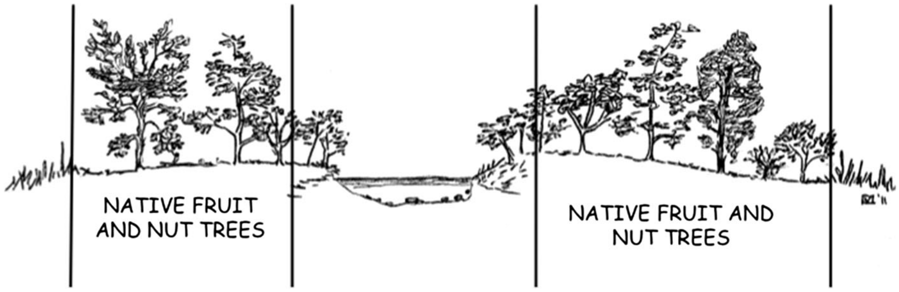

Fig. 2 Image of a native fruit and nut tree riparian buffer shown before asking respondents about their interest in planting native fruit and nut trees in the next 3 years

dataset, owners were asked to return their questionnaire with "no creek" written in the comments section if they did not have a stream on their property. The questionnaire listed potential native fruit and nut tree and shrub species and provided images of an agroforestry riparian buffer to familiarize respondents (Fig. 2).

Owner demographics and characteristics including age, gender, education, income, and years of property ownership were collected. Owners were asked if they considered themselves a farmer and if they had previously planted woody vegetation along their creek sides. Demographic data and land characteristics among early and late respondents were compared to check for non-response bias (after Groves et al. 2002).

We used Pattanayak et al.'s (2003) agroforestry interest framework, Venkatesh et al.'s (2003) UTAUT, and agroforestry adoption literature to identify and develop survey measures (Table 1). A pilot survey with 33 creek side owners outside the study area was conducted to strengthen internal consistency. CFA was used to test the reliability and validity of the *performance expectancy*, *effort expectancy*, *social influence*, and *risk expectancy* variables. χ^2 significance, χ^2/df (CMIN/DF) which accounts for the sensitivity of χ^2 to sample size, comparative fit index (CFI), root mean square error of approximation (RMSEA), and the alternate hypothesis that RMSEA is greater than 0.05 (PCLOSE) were used to confirm the fit of hypothesized latent constructs. In general, significant χ^2, CMIN/DF less than 3.0, CFI above 0.95, RMSEA of 0.05 and below and PCLOSE of greater than 0.05 indicate a good fit.

Indicators for the dependent variable along with independent hypothesized predictors were measured using summated Likert scales and modeled using multiple linear regression (Table 1). The first model included UTAUT-only predictors (*performance expectancy*, *effort expectancy*, *social influence*) and interaction terms (age, gender, planting experience) regressed on *interest*. The second model included predictors and interaction terms in the first model plus *risk expectancy* and *biophysical variables*.

Interest was measured with a single 5-point Likert-type response scale where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. *Performance expectancy* was measured with a summated 5-point scale where 1 = extremely unlikely, 2 = unlikely, 3 = somewhat unlikely, 4 = likely, and 5 = extremely likely. *Effort expectancy* was likewise measured with a summated 5-point scale with 1 = none, 2 = not much, 3 = some, 4 = quite a bit, and 5 = a lot. *Social influence* and *risk expectancy* were measured with the same 5-point scale as *interest*, but multiple measures were summated.

ArcGIS 9.3 was used to collect biophysical variables included in the second model. These included distance of the center of the *buffer area to the nearest road, plantable riparian area, percent highly erodible soil* in the parcel's plantable riparian area, and *parcel size*. *Buffer area to the nearest road* was measured using NHD and Virginia Department of Transportation road network data. *Plantable riparian area* was measured using NHD, county tax parcels, and aerial imagery to identify non-forested sections of the riparian buffer considered plantable space. Percent highly erodible soil was measured with Natural Resource Conservation Service SURRGO soil data overlaid with the plantable riparian area in each parcel. *Parcel size* was measured in hectares using geospatial county tax parcel data.

Categorical dummy variables included age, gender, and riparian planting experience. "Younger" respondents were less than 49 years old, "middle age" respondents were between 50 and 69, and "older" respondents were greater than 70 years old. "Older" served as the reference category. Gender and riparian planting experience are binary dummy variables and coded as 1 = female, 0 = male and 1 = planted, 0 = not planted.

Each categorical variable was multiplied by *performance expectancy*, *effort expectancy*, *social influence*, and *risk expectancy* to create unique interaction terms and were also included individually in the models. Interaction significance was based on whether the R^2 value changed significantly when the interaction term was added to model predictors and controls. When addition of the interaction term led to high multicollinearity with an original variable, deviation scores of the continuous predictors were used to recalculate the interaction term with the dummy variables and the model was rerun. Model fit was evaluated using kurtosis, skewness, and Shapiro–Wilk statistics of studentized residuals. Multicollinearity, outliers, autocorrelation, and non-linearity also were evaluated.

Double cross validation of the second model was performed using four steps to determine generalizability (Guan et al. 2004). The sample was randomly split into two subsamples (Subsample 1 $n = 69$ and Subsample 2 $n = 68$) and regression analysis was applied separately to both samples to obtain beta-weights and z-scores for all predictor variables. Four predicted standard scores for the criterion variable $\hat{y}$ were calculated (A, B, C, D) using beta-weights and z-scores from the subsamples.

A = z-scores from subsample 1 and beta-weights from subsample 1.

B = z-scores from subsample 1 and beta-weights from subsample 2.

C = z-scores from subsample 2 and beta-weights from subsample 1.

D = z-scores from subsample 2 and beta-weights from subsample 2.

To determine confidence in model generalizability, invariance coefficients for A to B and C to D were generated using Spearman-rank correlation because of the ordinal dependent variable (*interest*). Invariance coefficients closer to one indicate the model would perform similarly if a different sample were selected from the study population.

To segment respondents according to their *interest*, the dependent variable was collapsed from a 5-point Likert-type scale into three categories: uninterested (1 = strongly disagree, 2 = disagree), neutral (3 = neutral), and interested (4 = agree, 5 = strongly agree). χ^2 and ANOVA were used to analyze the relationship between independent socioeconomic variables and *interest*. The six socioeconomic variables measured and analyzed were: age, gender, education, income, whether the landowner considered themselves farmers, and the length of land ownership.

Results

Four hundred and sixty questionnaires were successfully delivered and 277 were returned for an adjusted response rate of 60 %. Fifty-five (19.8 %) parcels did not have stream flow at least part of the year. One hundred and fifty surveys (32.6 % of those delivered) contained complete data. One hundred and thirty

Table 2 Socioeconomic variables measured on respondents from which survey data were collected

Variables	All Respondents
Age (years)	
<49	14 % ($n = 22$)
50–69	56 % ($n = 88$)
>70	30 % ($n = 46$)
Gender	
Male	68 % ($n = 104$)
Female	32 % ($n = 49$)
Education	
Some high school or high school degree	30 % ($n = 46$)
Some college or associate degree	23 % ($n = 35$)
Bachelors or graduate degree	47 % ($n = 73$)
Income	
Less than $25,000	14 % ($n = 18$)
$25,000–50,000	22 % ($n = 29$)
$50,000–$100,000	42 % ($n = 56$)
Greater than $100,000	23 % ($n = 25$)
Farmer	
Yes	17 % ($n = 26$)
No	83 % ($n = 128$)
Length of ownership	
Average years	22 ($n = 145$)

seven respondents provided sufficient data to test the models. No differences were observed between late and early respondents.

Respondents were mainly between the ages of 50 and 69 (56 %) and about two-thirds were male (68 %; Table 2). Owners with college degrees (Bachelors or Graduate) made up nearly half of the respondents (47 %). Forty-two percent had incomes between $50,000 and $100,000 per year. Only 17 % of respondents considered themselves farmers.

χ^2 for the latent structure was less than 3.0, CFI was above 0.95, RMSEA below 0.05, and PCLOSE surpassed 0.05, indicating all latent measures in the models were independent (Table 3). The first model (UTAUT-only) explained 0.49 of the variance in *interest* with *social influence*, *planting experience, performance expectancy*, and *effort expectancy* as significant variables (Table 4). The second model (UTAUT with added agroforestry adoption variables) was significant with an Adjusted R^2 of 0.57. S*ocial influence, risk expectancy, planting experience, performance expectancy*, *risk expectancy * female* interaction term, *parcel size,* and *buffer area to the nearest road* were significant (Table 5). *Effort expectancy, plantable riparian area,* and *percent highly erodible soil* were not significant in the second model.

Unstandardized coefficients in the first model indicated that *interest* increases substantially as *social influence* increases (Table 4). *Planting experience* and *performance expectancy* also related to an increase in *interest.* Conversely, as *effort expectancy* increased, *interest* noticeably decreased. Unstandardized coefficients in the second model showed effects similar to those of the first model for *social influence, planting experience,* and *performance expectancy* on *interest* (Table 5). However, with the addition of agroforestry measures, *effort expectancy* was insignificant.

Both *risk expectancy* and *parcel size* exhibited an inverse relationship with *interest.* As *risk expectancy* increased, *interest* decreased and for each acre increased in *parcel size, interest* decreased. *Parcel size* corresponded to a negligible decrease in *interest* for a respondent owning 4 ha, a moderate decrease in *interest* for a respondent owning 40 ha, and a substantial decrease in *interest* for an owner of 120 ha. Additionally, the *risk expectancy * female* interaction term caused a significant change in R^2 indicating that the effect of *risk expectancy* on *interest* is magnified considerably for males. The biophysical

Table 3 Confirmatory factor analyses goodness-of-fit indices for hypothesized latent predictors *performance expectancy*, *effort expectancy*, *social influence* and *risk expectancy*

χ^2	*p*	df	CMIN/DF	CFI	RMSEA	PCLOSE
101.83	0.06	80	1.26	0.97	0.04	0.62

CMIN/DF χ^2/df; *CFI* comparative fit Index, *RMSEA* root mean square error of approximation, *PCLOSE p* value for hypothesis that RMSEA is greater than 0.05

Table 4 Multiple linear regression results of the first model based on UTAUT predictors, controls and interaction terms on interest in planting native fruit and nut tree riparian buffers

Variable	*b*	β	SE	*p* value
Social Influence	0.92	0.50	0.13	<0.01**
Planting Experience	0.44	0.14	0.20	<0.01**
Performance Expectancy	0.30	0.22	0.09	<0.01**
Effort Expectancy	−0.30	−0.21	0.09	<0.01**

Only significant interaction terms are reported

$n = 137$; Adj $R^2 = 0.49$; $F = 19.34$; *p* value = <0.01; Shapiro–Wilk = 0.99 ($p = 0.68$)

** Significant at α = 0.05

Table 5 Multiple linear regression results of the second model that used predictors, controls and interactions based on UTAUT with additional agroforestry measures of risk expectancy and biophysical variables from Pattanayak et al. (2003) to predict interest in planting native fruit and nut tree riparian buffers

Variable	*b*	β	SE	*p* value
Social Influence	0.88	0.48	0.13	<0.01**
Risk Expectancy	−0.62	0.40	0.13	<0.01**
Planting Experience	0.36	0.12	0.18	0.04**
Performance Expectancy	0.17	0.12	0.09	0.07*
*Risk Expectancy * Female Interaction Term*	−0.46	−0.17	0.20	0.02**
Parcel Size	−0.003	−0.16	0.00	0.05**
Buffer to Nearest Road	0.00	0.16	0.00	0.01**

Only significant interaction terms are reported

$n = 137$; Adj $R^2 = 0.57$; $F = 14.96$; *p* value = <0.01; Shapiro–Wilk = 0.99 ($p = 0.40$)

* Significant at α = 0.1; ** Significant at α = 0.05

Table 6 Landowner characterizations by interest in planting native fruit and nut tree riparian buffers

Variables	Owner segments			*p* value
	Uninterested	Neutral	Interested	
Age				0.86
<49 years	13 % ($n = 7$)	14 % ($n = 7$)	19 % ($n = 8$)	
50–69 years	58 % ($n = 32$)	62 % ($n = 31$)	52 % ($n = 22$)	
>70 years	29 % ($n = 16$)	24 % ($n = 12$)	29 % ($n = 12$)	
Gender				0.67
Male	70 % ($n = 37$)	72 % ($n = 36$)	63 % ($n = 26$)	
Female	30 % ($n = 16$)	28 % ($n = 14$)	37 % ($n = 15$)	
Education				0.11
Some high school or high school degree	40 % ($n = 21$)	16 % ($n = 8$)	31 % ($n = 13$)	
Some college or associate degree	20 % ($n = 11$)	24 % ($n = 12$)	24 % ($n = 10$)	
Bachelors or graduate degree	40 % ($n = 21$)	60 % ($n = 30$)	45 % ($n = 19$)	
Income				0.08*
Less than $25,000	20 % ($n = 9$)	6 % ($n = 3$)	6 % ($n = 2$)	
$25,000-$50,000	14 % ($n = 6$)	20 % ($n = 9$)	33 % ($n = 12$)	
$50,000–$100,000	52 % ($n = 23$)	46 % ($n = 21$)	33 % ($n = 12$)	
Greater than $100,000	14 % ($n = 6$)	28 % ($n = 13$)	28 % ($n = 10$)	
Farmer				<0.01*
Yes	31 % ($n = 17$)	8 % ($n = 4$)	7 % ($n = 3$)	
No	69 % ($n = 37$)	92 % ($n = 45$)	93 % ($n = 39$)	
Length of ownership				0.05*
Average years	26 ($n = 52$)	19 ($n = 48$)	18 ($n = 39$)	

χ^2 and ANOVA test results indicate differences among the three categories based on *interest* (uninterested, neutral and interested landowners)

* Significant at $\alpha = 0.10$

variable of *roadside distance to buffer* was significant but did not have a noticeable effect on *interest*.

Shapiro–Wilk statistics for studentized residuals were not significant for the first and second model and kurtosis and skewness for both were within an acceptable range. Neither model exhibited multicollinearity, outliers, autocorrelation, or non-linearity. Spearman's rho invariance coefficients derived from double cross validation for the second model were close to one for the bivariate correlations of A to B ($r_s = 0.90$) and C to D ($r_s = 0.88$), indicating results are replicable and generalizable to the population.

Income, whether the landowner considered herself or himself a farmer, and length of ownership were significantly different across respondent interest ($\alpha = 0.10$) (Table 6). The uninterested group had a higher proportion of landowners making less than $25,000 and fewer making more than $100,000, yet the greatest percentage that make between $50,000 and $100,000. This group also had the largest proportion of landowners who considered themselves farmers. On average, uninterested landowners owned their land longer than those that were neutral or interested. Age, gender, education, and plantable riparian area did not differ.

Discussion

The objective of this study was to develop and empirically test two models of landowner interest in agroforestry in the context of native fruit and nut tree riparian buffers. We also studied whether socioeconomic characteristics differ across landowners based on interest in these buffers. We found the second model including both UTAUT and the agroforestry interest framework variables best predicts *interest*. Interested landowners generally had higher incomes, did not consider themselves to be farmers, and were newer owners of land.

It was a combination of theoretical constructs from UTAUT and the agroforestry interest framework that resulted in a more powerful empirical model. The second model explained 57 % of the variance compared to 49 % in the first model. This result likely relates to the use of validated, cross-technological adoption variables and theoretical compatibility between UTAUT and the interest framework. Overall, the second model explained two to three times the variance in landowner interest when compared to other temperate agroforestry adoption models (Arbuckle et al. 2009; Valdivia and Poulos 2009). Validation tests suggest the second model is generalizable and replicable. The model indicates that influence of others, risk perceptions, experience planting, expectations about performance, size of the parcel, and gender influence landowner *interest* in planting native fruit and nut tree riparian buffers.

Social influence had the greatest effect in the second model, signifying that landowner interest in native fruit and nut tree agroforestry buffers is impacted by beliefs about what family members, other landowners, and neighbors think. Salamon et al. (1997) and Raedeke et al. (2003) found family support affected decisions to implement sustainable farming practices, while Atwell et al. (2009) observed that community networks and norms affected adoption of perennial agricultural systems. The significance and strength of *social influence* indicates that interest in agroforestry generally may be higher when family members, neighbors, and peers are supportive of associated practices and land use principles.

Pattanayak et al. (2003) proposed that landowners may be more likely to adopt practices that offer greater certainty with respect to benefits and/or means to absorb potential losses. In the second model, *effort expectancy* was no longer significant with the addition of *risk expectancy* and other predictors. This indicates that it is not necessarily the effort one expects to be associated with agroforestry but their beliefs about the cost and benefits that more acutely affects *interest*. The implication is that beliefs about the effort required to plan for, plant, and manage agroforestry systems may affect interest but perceptions of risk also are important.

Planting experience and *performance expectancy* also were significant in the second model. The result is similar to findings in Ryan et al. (2003) where farmers with greater conservation experience were more likely to adopt agroforestry plantings. Familiarity and favorable expectations related to management, production, environmental services, and wildlife benefits of agroforestry systems all appear to positively affect landowner *interest*.

Similar to other findings (Matthews et al. 1993; McGinty et al. 2008), gender and age did not directly affect *interest*. However, gender significantly moderated the effect of *risk expectancy*. In other words, the effect of *risk expectancy* on *interest* is less for females than males. This aligns with Strong and Jacobson (2005) in that women often are more likely to be involved in specialty crops production, which inherently manifests greater uncertainty. Interestingly though, the result is contrary to findings in an international context where a greater number of males in a household generally leads to higher rates of adoption (Pattanayak et al. 2003). Our finding implies that while there is not a direct relationship between gender and interest in agroforestry, women are less affected by risk perceptions than men.

Several studies have reported that age correlates with adoption (Hagan 1996; Valdivia and Poulos 2009), but in this case *interest* resonated across various age classes of owners. On the other hand, the relationship between *parcel size* and *interest* was significant. Landowners with smaller parcels were more interested than owners of larger parcels.

Overall, landowners that were more interested in these systems generally had higher income, did not consider themselves to be farmers, and were newer owners. On the other hand, age, gender, and plantable creek side area did not differ when factored by landowner interest. Results correspond to those reported by Matthews et al. (1993) and Valdivia and Poulos (2009). However, education was not significant which differs from previous findings (e.g., Traore et al. 1998; Cooper and Jacobson 2009; Arbuckle et al. 2009).

Less interested landowners tended to have a larger proportion of lower-income respondents yet they also occupied the greatest share of the upper middle-income class compared to neutral and more interested landowners. Previous findings suggest interest in agroforestry and income often are related (Pattanayak et al. 2003), but this result indicates agroforestry adoption may follow the Cancian dip proposed by

Frank Cancian in 1976 and described in Rogers (2003). In this case, adoption generally rises from low to high income but dips at the point of higher middle-income and then continues rising again. Landowners with higher income may be more interested in agroforestry, but the relationship between interest and income is not necessarily linear.

Most farmers were not interested in native fruit and nut tree agroforestry buffers, which reflects results reported in Arbuckle et al. (2009) and Barbieri and Valdivia (2010). Results of this study and others (e.g., Trozzo et al. 2014) indicate that non-farmers may be more inclined to adopt agroforestry practices. This implies that they should not be discounted as they may play an increasingly influential role in the adoption process, especially in light of the effect of social influence on interest.

Results also suggest that many of those that are interested may be newer to land ownership and part of the ongoing largest intergenerational transfer of land the US has ever experienced. Multifunctional perspectives identified among the emerging class of landowners often are underpinned by a combination of intensive and extensive objectives and the means to pursue them (Butler and Leatherby 2004). Newer owners may be more inclined and in a better position to implement agroforestry.

Conclusions

This study focused on landowner interest in agroforestry within the context of native fruit and nut tree riparian buffers in western Virginia. UTAUT and agroforestry interest theory were used to develop and compare two models. Results imply that landowner interest in agroforestry hinges on perceptions of family members and peers, risk beliefs, previous experience with agroforestry practices, expectations about system performance, parcel size, and gender as it related to risk beliefs. Interest in native fruit and nut tree riparian buffers among landowners was related to income, length of ownership, and farming enterprise. Newer, non-farming landowners with higher income were more interested, which suggests that non-traditional segments of landowners are likely more interested in and capable of merging conservation and production through agroforestry systems.

Generally speaking, newer landowners with higher income who do not intensively farm were more interested in native fruit and nut tree agroforestry buffers. These landowners are so perhaps for the very reason that they often have multifunctional objectives, greater potential discretionary income, and are not intensively invested in farming (Trozzo et al. 2014). In a larger sense, they reflect a class of landowners defined by social and family networks more supportive of multifunctional land use and a potential to embrace risk in the name of preferred land management practices (Jones et al. 1995; Erickson et al. 2002; Butler and Leatherby 2004; Kendra and Hull 2005). They also tend to have more experience with conservation practices, better expectations of system performance, greater participation by women, and smaller properties. Outreach, education, and technical support efforts focused on these landowners could help increase adoption, which may then precipitate use among others that are presently less interested.

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