IDENTIFYING BARRIERS AND GATEWAYS FOR AGROFORESTRY ADOPTION IN THE U.S. CORN BELT

Chloe M. Mattia 1* & Sarah Taylor Lovell 1

Correspondence author: mattia2@illinois.edu

(1) Department of Crop Sciences, University of Illinois at Urbana-Champaign, Urbana, United States

Introduction

The Multifunctional Perennial Cropping systems (MPCs) research project surveyed cropland landowners to explore how their socio-demographics and attitudes influence their willingness to implement new perennial cropping systems, specifically on marginal cropland. The land considered marginal, poor yield and high environmental degradation, for conventional Corn Belt agriculture but suitable for supporting perennial production is opportunity land for MPCs. MPCs are designed to be an agroforestry-esque system that includes a perennial production system that also improves the sustainability of agriculture through conservation and rural development.

An appropriate target for implementation efforts could be small or medium sized farms. Based on the U.S. Department of Agriculture 2012 Census, small farms of less than 180 acres make up 20% of agricultural land area and 85% of the number of farms in the U.S. In addition, small farms are the recipients of most of the conservation program payments from U.S. government (Hoppe et al. 2010). The addition of a production component can elevate the conservation acreages to be multifunctional perennial cropping systems with economic, social, and environmental benefits (Alavalapati et al. 2004; Rosset and Martínez-Torres 2012; Liebman et al. 2013). Due to the large number of small farms and their contribution to rural communities, targeted efforts for implementing new agriculture land-use strategies can benefit both the environmental and rural development goals in a new MPCs agricultural paradigm.

Agroforestry and technology adoption theory (Trozzo et al. 2014, Venkatesh et al. 2003) have been used to test models of landowner interest in productive riparian buffers. Using an agroforestry interest framework by Pattanayak et al. 2003, key variables were identified that could predict interest in agroforestry adoption. The planting experience of the landowners and their perceived risk of the system influenced their degree of interest (Trozzo et al. 2014). Thus measuring the adoption potential of marginal cropland would rely on the status of the farm management decision maker, whether an absentee landowner, owner operator, or tenant farmer (Daloğlu et al. 2014).

The study area for the MPCs project was the Upper Sangamon River Watershed (USRW) located in Central Illinois. This project worked in conjunction with additional research projects at the University of Illinois at Urbana-Champaign, including studies on the specific benefits of agroforestry systems in the U.S. Corn Belt. To address the low adoption of agroforestry-esque systems, the MPCs project aimed to explore landowner characteristics and attitudes to classify into groups of landowner typologies, and to identify the highest potential adopters.

Material and methods

A farmer survey was developed following the guidelines set in Dillman 2009 for mixed-mode mail and online surveys. Survey materials were mailed out to landowners in the study region within Central Illinois: the Upper Sangamon River Watershed (USRW). Farmers were given the option to complete the survey online (surveymonkey.com). Two focus group meetings were held after the initial analysis of the survey data to fill in gaps.

The survey included questions regarding demographic information, valuation of ecosystems services, and motivators for adopting new cropping systems, including Likert scale questions (Dunlap et al. 2000; Villamil et al. 2012). The demographic questions mirrored the Agricultural Census 2012 format so the results could be compared to the general agricultural population. As demonstrated in other studies, tenancy is an important factor influencing implementation of perennial systems. The most common classification of lease arrangements are cash rent (the tenant pays the landlord a cash sum for the rights to use the land and farm resources) and crop share (the tenant pays the landowner a percentage of harvested crops and the landowner pays a portion of the costs).

Exploration of the survey data and summary statistics were calculated using the "R" Statistics programme. Focus groups were held following initial analysis of the survey data to provide a more in-depth discussion of adoption preferences and barriers with landowners and other agricultural

stakeholders. Multivariate statistical procedures were employed to determine landowner typologies for agroforestry adoption interest using Hierarchical Cluster Analysis (HCA) and discriminant analysis.

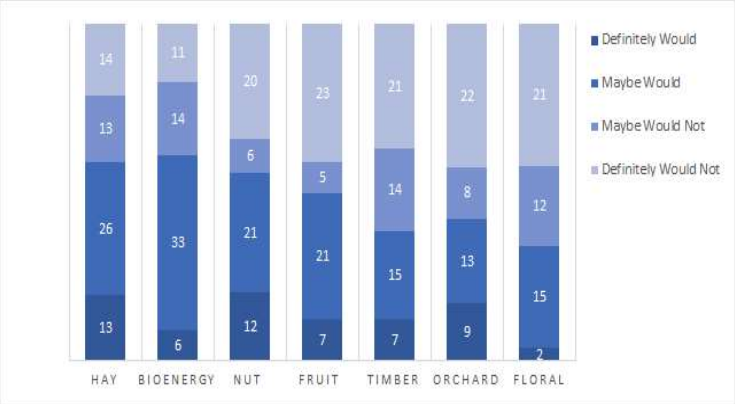
Results

Our sample included 99 surveys that were returned and met all criteria for statistical use. Demographic characteristics of the sample population show similar trends to those seen in the 2012 Census of Agriculture (USDA NASS 2012). The operator landowners in the response group reported smaller acreage farms. In terms of land tenancy, 36.2% respondents rent out over 90% of their cropland (n=94), indicative of absentee landowners. There was a high rate of renting and leasing acres in the study region with the majority of the landowners not being the farm operator.

Potential land conversion to MPCs

Of the respondents, 62.5% stated they have some degree of marginal land (n=96). They reported an average of 32.2 acres (SD= 72.9, n=56) of marginal land, with a range of 0.5-500 acres. The most popular use for marginal land was to have it enrolled in conservation programs, an average of 40 acres (SD= 72.2, n=20) and ranging from 2-250 acres in CRP. Over half of respondents, 65.5% (n=58), would convert their marginal acres to MPCs. Respondents that did not report marginal acres were still likely to give their preferences for MPCs systems (n=84) (Figure 1).

Figure 1. *The Likert scale questions asked for the likelihood a respondent would participate in the given MPCS system (n=84). On the Likert Scale, 1 = not applicable, 2= definitely would not participate, 3= maybe would not participate, 4= maybe would participate, 5= definitely would participate. The frequency of importance rankings of the interest of respondents in adopting varying types of perennial cropping systems: hay or forage crop, bioenergy crops such as switchgrass, tree/shrub nut crops such as hazelnut, tree/shrub fruit crops such as currants, forestry for timber, orchards, and woody floral crops.*



Multivariate Analysis

Hierarchical Cluster Analysis (HCA) was used to classify the respondents into landowner typologies for the purpose of identifying high potential adopters. The selection of number of clusters is based on reducing to the fewest number while maintaining homogeneity within using Ward's method. Criteria used in this were an R Squared >0.80 and a low magnitude of change in the between cluster sum of squares relative to later cluster joins (Figure 2).

The R squared criteria was met at 6 clusters. The 0.80 guideline was met at 7 clusters. The reduction from 7 to 6 clusters resulted in a very low reduction in the R squared (0.01) and the largest jump in BSS observed up until that point in the Cluster Analysis 31.43). The next change in magnitude occurred at the reduction from 5 to 4 clusters. With all the criteria considered, 6 clusters suggested satisfactory homogeneity within the clusters in terms of classifying landowner types.

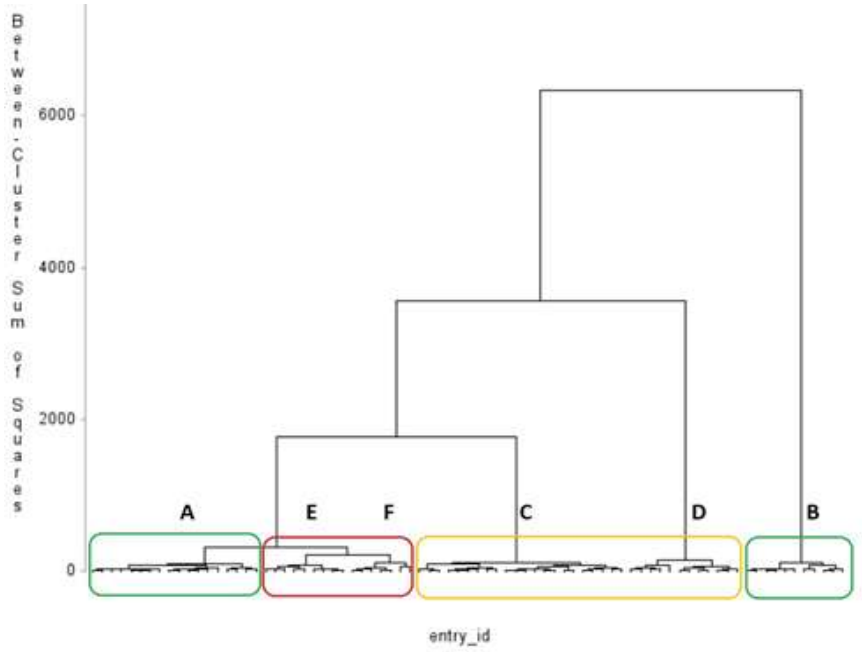
With the farmer typologies classified (Table 1), discriminant analysis used the response variables to model whether or not a respondent was a high or low potential adopter. The error rate for misclassification was found using cross validation. The discriminant function correctly classified potential adopters 88.46% of the time and correctly classified non-potential adopters 69% of the time. Stepwise selection was used to find the best variables for creating the discriminant function to discriminate whether a respondent is a potential adopter. The significance level for entry was 0.3 and the significance level for staying was 0.15. The most important characteristics about a respondent were: how they valued the conservation of plant diversity, their future involvement in

farm management decisions, whether farming was a primary or secondary occupation, and their interest in harvesting land under conservation program contracts.

Table 1: *Typologies of Farmers in the study area*

Name	Potential	Group	*n*	Characteristics
Educated	High	A	18	Highest education and smallest farm size owned. Highest ES valuation for regulating services. Indicated highest involvement in farm management decisions.
Young	High	B	11	Youngest. Most likely to have income come from farming. Prefers shorter leases. Most interested in MPCropping systems. Indicated higher involvement in farm management decisions, more so in the future.
Small conventional	Medium	C	22	Lowest education score. Prefers CROP SHARE leasing agreements. Moderate interest in MPCropping systems and ES valuation.
Large conventional	Medium	D	12	Oldest. Most likely to have income come from off farm. Not very interested in MPCropping systems. Low valuation for ES except for soil and pest insect control.
Money motivated	Low	E	9	Prefers cash rent and long lease arrangements. Most women respondents. Highest ES valuation for provisioning services and low value for ES recreation
Absentee	Low	F	7	More likely to own farmland and lease out. Lowest score for market importance. Not interested in MPCropping systems and lowest ES valuation.

Figure 2: *Dendrogram of the cluster analysis solution showing individual cases grouped hierarchically into six clusters, with three levels of adoption potential. Green is high, yellow is medium, red is low potential.*



Discussion

The focus group and the survey free response questions provided additional information for the interpretation of the landowner typology clusters. There is interest in MPCs and they were believed to have potential given several caveats. One, there needs to be developed markets and infrastructure to support the production of MPCs crops. In the survey data, the motivation and incentives most important to respondents were the existence of an established market for the perennial products and tax exemption. Secondly, the HCA showed that high potential adopters of MPCs are young and educated landowners. Efforts should be focused on identifying this labor force willing to learn and manage MPC systems. Participants in the focus group concluded that educating and involving the next generation of farmers could be a solution.

Overall, survey respondents were not interested in working with neighbors or a product cooperative, and the focus group highlighted issues with landowner-tenant relationships. However, the use of perennial networks would greatly benefit the stability and viability of the product markets and demand, so further work in this area is recommended.

The next step in this project is to identify marginal land suitable for MPCs in the USRW, taking into account land characteristics and the socio-economic data collected from the survey. The RUSLE soil loss equation will be implemented in ArcGIS software using spatial data layers pertaining to land use, soil type, slope, and field size.

References

Daloğlu I, Nassauer JI, Riolo RL, Scavia D (2014) Development of a farmer typology of agricultural conservation behavior in the American Corn Belt. Agricultural Systems 129:93–102. doi: 10.1016/j.agsy.2014.05.007

Dillman DA, Smyth JD, Christian LM. (2009). Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method.3rd ed. Hoboken, NJ: Wiley & Sons.

Hoppe RA and DE Banker (2010) Structure and Finances of U.S. Farms: Family Farm Report,
in EIB-66, eds E.R.S. U.S. Department of Agriculture.

Pattanayak SK, Mercer DE, Sills E, Yang J-C (2003) Taking stock of agroforestry adoption studies. Agroforestry systems 57:173–186.

Trozzo KE, Munsell JF, Chamberlain JL (2014) Landowner interest in multifunctional agroforestry Riparian buffers. Agroforestry Systems 88:619–629. doi: 10.1007/s10457-014-9678-5

Udawatta RP, Jose S (2012) Agroforestry strategies to sequester carbon in temperate North America. Agroforestry Systems 86:225–242. doi: 10.1007/s10457-012-9561-1

United States Department of Agriculture, National Agricultural Statistical Services, Census of Agriculture. Available from:
http://www.agcensus.usda.gov/Publications/2007/Full Report/index.asp; 2007 [accessed 02.09.16].

Villamil MB, Alexander M, Silvis AH, Gray ME (2012) Producer perceptions and information needs regarding their adoption of bioenergy crops. Renewable and Sustainable Energy Reviews 16:3604–3612. doi: 10.1016/j.rser.2012.03.033

Venkatesh V, Morris MG, Davis GB, Davis FD (2003) User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly.27(3): 425-478 Published by: Management Information Systems Research Center, University of Minnesota