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Afforestation Adoption by Eastern U.S. Cattle Producers

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Background

- Agriculture is responsible for about 6% of total US GHG emissions and is the largest contributor to US nitrous oxide and methane emissions.
- Livestock are the largest source of methane emissions in the agricultural sector.
- Cattle account for about 75% of these emissions.
- Beef cattle production is responsible for approximately 2.2% of all US GHG emissions.

One means by which GHG emissions from farmlands can be reduced is through the conversion of bare or cultivated land into forest. Research suggests that afforestation can be an important component of a broader portfolio designed to offset carbon emissions from agriculture. In some agroecosystems, afforestation has the potential to sequester more carbon than other pasture and rangeland management practices.



What is afforestation?

Afforestation is the conversion of bare or cultivated land into forest. For example, afforestation can occur by converting marginal pasture or cropland to fast growing trees or to native species. There are a variety of programs that pay landowners to convert pasture or cropland to forest to remove carbon, a greenhouse gas, from the atmosphere. These programs typically prohibit landowners from harvesting the trees, including thinning, for a certain period of time. While these programs allow trees to be sustainably harvested at the end of the program period, they may discourage the forest product that is harvested from being burned or turned into fuel to prevent the release of the carbon stored in trees back into the environment.

How might afforestation benefit landowners?

- By enhancing potential wildlife habitat which could provide hunting and wildlife viewing opportunities,
- Providing a buffer from surrounding landscapes, and
- Producing fast-growing trees on marginal lands.

Study Objectives

This research examines the factors, including an annual incentive, that influence the adoption or expansion of afforestation on beef cattle farms east of the 100th meridian. The research also examines differences in attitudes and expectations about afforestation across respondents' interest in adopting an afforestation program.

The hypothetical afforestation program examined here requires stand maintenance, replanting, periodic monitoring by a third party, record keeping, and the use of sustainable harvest methods at the end of the proposed program. Land owners are offered an upfront cost share to cover establishment costs (75%), as well as annual payments (\$60, \$90, \$120, \$150, or \$180 per acre) over 10 years.

Research Methods

- 2013 mail survey of cattle farmers east of the 100th meridian.
- A total of 8,875 farmers were randomly surveyed.
- Response rate was 28%.

Acres afforested under the program is modeled as a sequence of decisions:

- Interest in participating in the hypothetical program (INTEREST).
- Willingness to afforest land by accepting the cost share/annual payment (ACCEPT) (75% installation cost share and annual incentive payment of \$60, \$90, \$120, \$150, or \$180 per acre over 10 years), and
- Number of acres the respondent is willing to enroll in the program (ACRES) given the hypothetical offer.

A triple hurdle model linking INTEREST, ACCEPT, and ACRES is estimated using the CMP program in STATA.

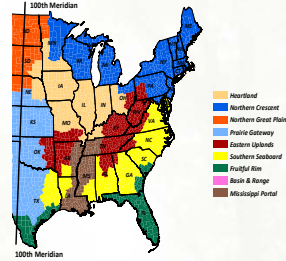


Figure 1. Area Surveyed East of the 100th Meridian

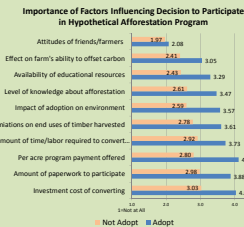
Estimated Model

Variables	1. INTEREST		2. ACCEPT		3. ACRES	
	Est. Coeff.	Std. Err.	Est. Coeff.	Std. Err.	Est. Coeff.	Std. Err.
INTERCEPT	-1.471	0.389***	0.486	0.644	90.378	57.910
INCENTIVE	0.000	0.000	0.003	0.001**	0.558	0.271**
ACRES FARM	0.000	0.000	0.000	0.000	0.260	0.128**
ACRES*INCENT					-0.001	0.001**
HEARTLAND	0.461	0.258**	-0.120	0.411	-102.809	49.213**
NORTHERNCRESCENT	0.769	0.284***	-0.258	0.438	-142.557	48.673**
NORTHERN-GREATPLAINS	0.614	0.326**	0.311	0.523	-276.648	95.296***
PRAIRIEGATEWAY	0.547	0.258**	-0.261	0.415	-30.789	59.230
EASTERNUPLANDS	0.420	0.252**	-0.153	0.406	-102.155	48.465**
SOUTHERNSEABOARD	0.803	0.263***	-0.105	0.420	-33.517	60.311
MISSISSIPPIPORTAL	0.631	0.287**	0.081	0.452	-79.167	49.287
INCENT30K	-0.311	0.130**	0.717	0.211***		
INCENT60K	0.015	0.116	0.185	0.163		
INCENT90K	0.113	0.093	0.030	0.137		
STOCKING RATE	-0.015	0.056				
SHR ACS RENTED	-0.167	0.177				
SHR AC WOODLAND	0.960	0.225***				
GOVERNMENT PAY	0.176	0.033***				
FARMING LIFESTYLE	0.036	0.047				
WAIT AND SEE	-0.088	0.033***				
CLIMATE CONCERN	-0.007	0.027				
AGE	-0.009	0.003***				
COLLEGE	0.390	0.075***				
PASS FARM ON	0.121	0.072**				
σ ₁	176.743	52.869**				
ρ ₁₂	0.071	0.111				
ρ ₁₃	-0.196	0.128				
ρ ₂₃	-0.781	0.203**				

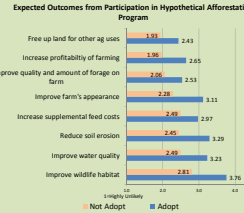
- INCENTIVE positively influenced both probability of accepting the incentive (ACCEPT) and number of acres to enroll (ACRES). The incentive level had a positive effect on conditional acres enrolled up to 381 acres farmed (ACRES) (all else constant).
- Farm size (ACRES FARM) had a significant positive effect on acres enrolled (ACRES).
- Positive regional effects were found for INTEREST (base FRUITFUL RIM). Also HEARTLAND, NORTHERN GREAT PLAINS, and EASTERNUPLANDS had negative effects on ACRES compared with FRUITFUL RIM. The largest of these negative effects was for NORTHERN GREAT PLAINS.
- Being in the lowest income category (less than \$30K) had a negative effect on ACRES, but a positive effect on INTEREST, suggesting that lower income farmers may be less interested in participating, but if they are, they are more likely to accept an incentive based program.

- Farmer/farm characteristics and attitudes influenced interest in adoption (INTEREST): (+) share of farm acres in woodlands (SHR AC WOODLAND), college graduate (COLLEGE), planning to pass the farm on (PASS FARM ON), and agreement that the government should pay farmers to adopt environmental incentives (GOVERNMENT PAY)
- (-) farmer age (AGE), and taking a wait and see approach when adopting new technologies or practices (WAIT AND SEE).

Attitudes About Afforestation



- Most important influences on decision to participate:
- Investment cost
 - Paperwork
 - Per acre payment
 - Labor time
 - Limitations on end use of timber harvested.
- In each case those interested in an afforestation program had a statistically higher importance rating than those not interested, except for attitudes of friends/farmers toward afforestation.



- Expected outcomes from afforestation included:
- Improved wildlife habitat
 - Improved water quality
 - Reduced soil erosion
 - Increased supplemental feed costs.
- For each outcome those who were interested in adopting afforestation believed the outcome to be more likely than those not willing to adopt.

What would landowners need to do to afforest their land?

Before afforestation:

- Prepare the site (remove competing vegetation, prepare seedbed-mowing, till, and apply herbicide application).
- Plant the trees (plants, labor for plant, shelters and mats, shipping and handling, hand planting vs. mechanical planting).

Afforestation maintenance:

- Maintain the stand (weeding, mowing, herbicide application, tilling, herbivore control).
- Replant trees (account for minimum survival rate in trees per area).
- Have tree growth monitored periodically.
- Keep records of forest maintenance.
- At the end of the program, either maintain the stand or limit harvest to sustainable methods.

Cost Estimates (by region) for the Establishment and Maintenance of Afforested Land^a

Region	Establishment Costs/Acre (Year 1) ^b	Maintenance Costs/Acre (Year 2)	Maintenance Costs/Acre (Avg. in Years 3-10)
Appalachia	\$300	84	49
Corn Belt	\$304	87	49
Delta	\$300	84	49
Lake	\$303	87	49
Northeast	\$300	84	49
Northern Plains	\$303	86	49
Southeast	\$260	116	49
Southern Plains	\$302	82	49

^aThe example fast growing woody crop is hybrid poplar for all regions but the Southeast which is pine. Based on US Billion Ton Update (Oak Ridge National Laboratory 2011).

^b Forest establishment costs include cuttings, plantings, machinery, fertilizer, and chemicals; Maintenance costs in year 2 include cultivation, fertilizer, and herbicide; Maintenance costs in years 3 to 10 include cultivation and fertilizer.

$$(1) \text{INTEREST}_{it}^* = \beta' X_{it} + u_i$$

$$\text{INTEREST}_{it}^* = \begin{cases} 1, & \text{INTEREST}_{it}^* > 0 \\ 0, & \text{INTEREST}_{it}^* \leq 0 \end{cases}$$

$$(2) \text{ACCEPT}_{it}^* = \gamma' X_{2it} + v_i$$

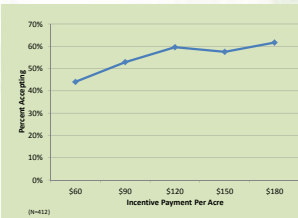
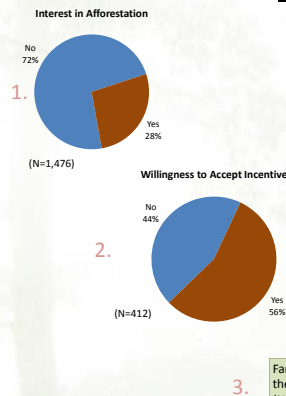
$$\text{ACCEPT}_{it}^* = \begin{cases} 1, & \text{ACCEPT}_{it}^* > 0 \text{ and } \text{INTEREST}_{it}^* > 0 \\ 0, & \text{ACCEPT}_{it}^* \leq 0 \text{ and } \text{INTEREST}_{it}^* > 0 \end{cases}$$

$$(3) \text{ACRES}_{it}^* = \eta' X_{3it} + e_i$$

$$\text{ACRES}_{it}^* = \begin{cases} \text{ACRES}_{it}^*, & \text{ACCEPT}_{it}^* > 0 \\ -, & \text{ACCEPT}_{it}^* \leq 0 \end{cases}$$

$$\ln L = \sum_{\text{INTEREST}_{it}^* > 0} \ln(\Phi(-\beta' X_{it})) + \sum_{\text{INTEREST}_{it}^* > 0, \text{ACCEPT}_{it}^* > 0} \ln(\Phi_2(\beta' X_{1it}, -\gamma' X_{2it}, -\rho_{12})) + \sum_{\text{INTEREST}_{it}^* > 0, \text{ACCEPT}_{it}^* > 0} \ln(\Phi_3(\beta' X_{1it}, \gamma' X_{2it}, \eta' X_{3it}, \rho_{12}, \rho_{13}, \rho_{23}, \sigma^2))$$

Results



Farmers who were interested in adopting and would accept the incentive offer, would convert, on average, 80.29 acres (N=229). The median acres to be converted is 31 acres.

Conclusions

Findings suggest that just under 16% of farmers would be interested in adopting afforestation and enrolling an average of about 80 acres per farm. Respondents operating larger farms tended to be more interested in adoption and were more willing to accept the incentive offered than those with smaller farms. Acceptance rates also varied across geographic regions. An incentive would have a positive influence on likelihood of participating and a positive influence on acreage converted among smaller farms. Interestingly, farmers planning to pass the farm on to family members or others were more likely to adopt. This finding could indicate that farmers may view planting land in an afforestation program as a way to increase the value of land over time for the next generation.

Results also reveal that farmers viewed afforestation as environmentally beneficial, but potentially adding to their need for supplemental feed for the cattle they continue to graze. Upfront investment costs, paperwork involved, the payment level, labor required and limitations on end use of timber harvested were all concerns. Our findings suggest that upfront cost share and payment levels are important in terms of adopting afforestation. However, educational programs about how to afforest land in labor efficient ways and potential markets for carbon neutral uses of timber could be of use to farmers in making the decision of whether to participate in such a program.

