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Kathryn G. Arano

Ian A. Munn

John E. Gunter

Steven H. Bullard
Stephen F. Austin State University, Arthur Temple College of Forestry and Agriculture, bullardsh@sfasu.edu

Max L. Doolittle

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Kathryn G. Arano, *Division of Forestry, West Virginia University, 322 Percival Hall, Box 6125, Morgantown, WV 26506-6125;* **Ian A. Munn, John E. Gunter,** *and* **Steven H. Bullard,** *Department of Forestry, Forest and Wildlife Research Center, Mississippi State University, Box 9681, Mississippi State, MS 39762; and* **Max L. Doolittle,** *Social Science Research Center, Mississippi State University, Box 5287, Mississippi State, MS 39762.*

ABSTRACT: *Nonindustrial private forestland (NIPF) landowners in Mississippi who recently harvested timber were surveyed to examine their regeneration behavior. Differences between regenerators and nonregenerators were investigated by looking at the different factors affecting reforestation decisions. A discriminant analysis was used to identify factors that were useful in differentiating between regenerators and nonregenerators. Ownership size; sociodemographic characteristics such as income, education, place of residence, and age; awareness of existing government incentive/assistance programs; and participation in educational programs were significant variables in differentiating between regenerators and nonregenerators. Landowners who own larger timberlands had a higher propensity to engage in regeneration activities after harvests. This also was true for landowners who had higher income levels and educational attainment, and were younger, city resident, and white. Landowners who were aware of existing government incentive/assistance programs and those who participated in educational programs also were more likely to participate in pine regeneration. Landowners in Mississippi considered both ecological and economic reasons as highly important considerations in their decision to regenerate. The belief that the land would reforest itself to pine naturally, the high cost of reforestation, and lack of information on reforestation options were top reasons cited by landowners for their decision not to regenerate. South. J. Appl. For. 28(4):189–195.*

Key Words: NIPF landowners, regenerators, nonregenerators, discriminant analysis, reforestation decision.

Nonindustrial private forest landowners are an important category of forest ownership in the South, as they control the majority of timberlands. Forest management decisions of landowners play an important role in the long-term sustainability of timber. The trend in ownership management of private timberlands is one of the key determinants of timber supply (Haynes and Adams 1992). Therefore, it is important to know who these landowners are and to learn about their behavioral characteristics.

A typical landowner is usually faced with an important managerial decision: whether or not to invest time, managerial competence, labor, and capital in growing timber (Clawson 1979). When landowners harvest their timberlands, they are faced with the decision of whether to regenerate after harvest. This decision is perhaps the most critical one a forest landowner has to make (Nodine 1993).

In the South, most forestry investment opportunities involve regenerating harvested timberlands with pine. Consequently, pine regeneration on private timberlands is an important factor affecting future timber supplies. However, evidence suggests that NIPF landowners have not been very active in regenerating their timberlands after harvest (Adams and Haynes 1991). Softwood growth in most of the large softwood-producing states in the South has been less than softwood removals (Powell et al. 1993). This shortfall in regeneration efforts is occurring despite the presence of a variety of government programs designed to assist NIPF landowners. Some landowners willingly invest in timber production while others do not. This behavior has been a major concern of the forestry community and policy makers. Identifying different characteristics associated with the decision to regenerate may provide useful information in

NOTE: Kathryn Arano can be reached at (304) 293-2941 ext. 2423; Fax: (304) 293-2441; kathryn.arano@mail.wvu.edu. This work was approved for publication as Journal Article No. FO-259 of the Forest and Wildlife Research Center, Mississippi State University.

understanding landowner behavior. Moreover, identifying specific reasons for regenerating and not regenerating is important in developing policies and programs that address the most important reforestation issues faced by NIPF landowners.

A number of studies already have looked into the reforestation behavior of NIPF landowners (e.g., Royer and Kaiser 1983, Doolittle and Straka 1987, Royer 1987, Hyberg and Holthausen 1989), but few actually have investigated differences between landowners who regenerate and those who do not, nor have they examined the specific reasons for their decision. This article investigates how regenerators differ from nonregenerators by looking at the different factors affecting landowners' reforestation decisions. It is an extension of a study reported earlier in Gunter et al. (2001). Specifically, the study objectives were: (1) to identify factors that are useful in differentiating between regenerators and nonregenerators using discriminant analysis; and (2) to examine the specific reasons for landowner decisions, as well as the degree of importance of these reasons.

Methods

Data

The data set used in this study was collected by the Social Science Research Center (SSRC) at Mississippi State University in a telephone survey conducted in spring of 2000 (Mar. 15 through May 30). Mississippi landowners who owned at least 20 acres of uncultivated land and who harvested timber between Jan. 1994 and Dec. 1998 were included in the survey. A modified Dillman's (1978) Total Design Method for survey procedures was followed. A simple random sample of approximately 22% of landowners was drawn from 62 of the 82 counties in Mississippi. The sample size was designed to achieve a 5% sampling error at a 95% confidence level. Landowners living in Mississippi Delta counties were excluded because most of their forestland consists of hardwood timber types. Some non-Delta counties also were excluded because NIPF landowner records were not available at the time of the survey. Names and addresses were matched with telephone records. Landowners were screened and interviewed in the same call. A total of 7,392 landowners were initially contacted. Of those contacted, 340 refused to be interviewed, 6,223 were screened (i.e., telephone screening) but did not meet the criteria for tract size and harvest activity, and 829 completed the interview, resulting in two different subgroups: 427 regenerators and 402 nonregenerators. It should be noted that the survey was initially collected for a different study, the purpose of which is to interview the same number of regenerators and nonregenerators. Thus, although the initial sample of landowners was randomly drawn, the nature of the interview process resulted in a nonrandom final sample because it is not a representative of the actual number of regenerators and nonregenerators in Mississippi. However, the sample of landowners included within each group is random. Because of the nature of the data collection, the resulting samples for regenerators and nonregenerators were treated as independent samples.

An interview schedule was constructed and used to collect necessary information from landowners. Specifically, the survey provided information on ownership characteristics, landowner sociodemographic characteristics, landowner participation in assistance/incentive/educational programs, and landowner decisions about reforestation. Landowners were asked attitudinal questions such as their perception about timberland investment (i.e., whether it is a risky investment or not), and their perception regarding the degree of importance of the different reasons presented to them for regenerating and not regenerating.

Analysis

Although logistic regression is the more common model used in similar studies (e.g., Royer 1987, Jamnick and Beckett 1988), discriminant analysis was used in this study because of the nonrandom nature of the final sample collected. As mentioned in the previous section, the final sample resulted in two distinct samples of regenerators and nonregenerators that are not necessarily representative of their distribution in Mississippi. Thus, given the nature of the sample and the study objective of examining differences between regenerators and nonregenerators on the basis of landowner characteristics and other factors, discriminant analysis was more appropriate.

Discriminant analysis is a multivariate procedure that can be used to study differences between two or more groups of objects simultaneously with respect to several variables (Klecka 1980). This procedure also can be used to predict group membership on the basis of response variable measures. Discriminant analysis is an appropriate procedure to use when groups of units are known in advance and the purpose of the research is either to describe group differences or to predict group membership (Huberty 1994).

The nature of group differences can be expressed in the form of a canonical discriminant function. This is a linear combination of the discriminating (independent) variables and can be expressed mathematically as (Klecka 1980):

$$f_{km} = u_0 + u_1 X_{1km} + u_2 X_{2km} + \ldots + u_p X_{pkm} \quad (1)$$

where:

f_{km} = the value on the canonical discriminant function for case m in group k,
X_{ikm} = the value on the discriminating variable X_i for case m in group k; and
u_i = coefficients which produce the desired characteristics in the function.

The discriminating variables (X_is), also called predictors, are the independent variables in the model. The criterion variable (f) is the dependent variable and considered as the object of classification efforts. Discriminant analysis results in two sets of coefficients for the model: unstandardized coefficients and standardized coefficients. The unstandardized coefficients are used to construct the actual prediction

equation that can be used to classify new cases. Unstandardized coefficients are used for calculating the actual discriminant scores. Because the size of these coefficients is a function of the scaling of the variables, standardizing is necessary to compare the variables. Standardizing puts the variables on the same scale. Standardized coefficients indicate the relative importance of the independent variables in predicting the dependent variable. Variables with the largest standardized coefficients contribute the most to the prediction of group membership (StatSoft, Inc. 2003). That is, contributions of variables to the discriminant score are directly related to the size of the coefficient. As the discriminant score increases, the observation is more likely to be associated with the group that has a higher value of its centroid. The population centroid is the mean value for the discriminant scores for a given group of the dependent variable. An observation that results in a lower discriminant score is more likely associated with the group that has a lower value of its centroid.

Variables investigated in the model include ownership characteristics, socio-demographic characteristics, and landowner awareness/participation in assistance/incentive and educational programs. Previous studies have shown an association between these variables and timber management (e.g., Greene and Blatner 1986, Royer 1987, Hyberg and Holthausen 1989, Kluender and Walkingstick 2000). These factors also are expected to provide a means of differentiating between regenerators and nonregenerators. Specifically, the following variables were used in the study.

Criterion Variable (Dependent Variable)

Landowners in the survey were asked whether they have regenerated their timberlands after harvest. Landowners who regenerated were classified as regenerators, and those who did not as nonregenerators. This grouping then was used as the criterion variable in the model:

Discriminating Variables

Ownership Characteristics.—Variables representing ownership characteristics include ownership size (ACRE), which measures the timberland owned by landowners in acres, and ownership type (TYPE), which describes the nature of timberland ownership (e.g., sole ownership, corporation).

Landowner Characteristics.—Variables representing landowner sociodemographic characteristics include household income (INC), age (AGE), gender (SEX), race (RACE), place of residence (RESI), number of household members (HOUS), and educational level (EDUC).

Attitude toward Timber Investment.—Attitude toward timber investment (INVT) is the landowner's perception of the riskiness of timber investments. Specifically, landowners were asked whether they consider investing in pine plantations more risky than other investments.

Awareness of Assistance/Incentive Programs.—A measure of landowners' awareness of assistance/incentive programs was included to account for the influence of such programs on landowners' decision to regenerate. Specifically, landowners were asked if they were aware of the Conservation Reserve Program (AWARE1), Forestry Incentive Program (AWARE2), Mississippi Forest Resource Development Program (AWARE3), Federal Income Tax Incentives (AWARE4), and Mississippi Reforestation Tax Credit (AWARE5).

Attendance in Educational Programs.—Landowner attendance in educational programs (EDPR) also was included as a discriminating variable. Landowners were asked whether they have attended any educational program related to timber management.

A summary of the definition and coding of the variables are presented in Table 1.

In examining the different reasons for landowners' decisions regarding reforestation, landowners who regenerated were presented with a list of possible reasons for regenerating (Doolittle and Straka 1987) and were asked to rank these reasons by level of importance: high, moderate, low, no importance, not sure/don't know. Landowners who did not regenerate also were provided a list of potential reasons for their reforestation decision and were asked to rank the importance of these reasons in their decision.

The Statistical Packages for the Social Sciences (SPSS) was used to estimate the model.

Results

Differentiating Between Regenerators and Nonregenerators

Summary statistics of the variables used in discriminant analysis are presented in Table 2 and the results are presented in Table 3. Due to missing values, (i.e., nonresponse in some of the survey questions) only 538 observations (278 regenerators and 260 nonregenerators) were included in the analysis. In light of the high percentage of missing observations, we were concerned of the potential bias that might be introduced as a result of the listwise deletion (LD) of the missing observations. Thus, missing data analysis was performed for the variables with missing cases (i.e., ACRE, TYPE, INC, SEX, RESI, EDUC, INVT, and EDUC) by examining the number of cases missing per variable and evaluating whether the observations are missing at random. Because none of the variables have missing data for more than half of the cases and the resulting final sample still large, there should be no concern for potential bias. Moreover, most of the variables had only few missing cases with the exception of the income variable (INC), which had 246 (out of 829) missing cases. However, the result of the hypothesis test indicates that the nonrespondents for the income variable are not significantly different from the respondents in terms of their decision to regenerate after harvest ($F = 0.33$, $P = 0.56$), suggesting that the observations are missing at random. Since, the observations are missing at random, the listwise deletion approach to treating missing observations leads to unbiased parameter estimates (Howell 2002).

Because some of the variables in the model appear to be highly correlated (e.g., education, income, race), we were

Table 1. Variable definitions and coding of the discriminating variables used in discriminant analysis model for NIPF regenerators and nonregenerators in Mississippi who harvested timber between 1994 and 1998.

Variable name	Definition and coding
ACRE	Ownership size in acres
TYPE	Ownership type, dummy variable Coded 1 = sole ownership/co-own, 0 = partnership/corporation/estate/trust/other types
INC	Annual household income, dummy variable Coded 1 = >$50,000, 0 = <$50,000
AGE	Age in years
SEX	Gender, dummy variable Coded 1 = male, 0 = female
RACE	Race, dummy variable Coded 1 = black, 0 = white
RESI	Place of residence, dummy variable Coded 1 = farm/town, 0 = city
HOUS	Number of household members
EDUC	Highest educational attainment, dummy variable Coded 1 = college/advanced degree, 0 = elementary/high school
INVT	Riskiness of timber investment, dummy variable Coded 1 = yes, 0 = no
AWARE1	Conservation Reserve Program awareness, dummy variable Coded 1 = yes, 0 = no
AWARE2	Forestry Incentive Program awareness, dummy variable Coded 1 = yes, 0 = no
AWARE3	MS Forest Resource Development Program awareness, dummy variable Coded 1 = yes, 0 = no
AWARE4	Federal Income Tax Incentives awareness, dummy variable Coded 1 = yes, 0 = no
AWARE5	MS Reforestation Tax Credit awareness, dummy variable Coded 1 = yes, 0 = no
EDPR	Attendance in educational programs, dummy variable Coded 1 = yes, 0 = no

Table 2. Summary statistics of the variables used in discriminant analysis model for NIPF regenerators and nonregenerators in Mississippi who harvested timber between 1994 and 1998.

	Regenerators (n = 278)		Nonregenerators (n = 260)	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
ACRE	1,406.42	7,642.78	162.37	337.11
TYPE	0.95	0.23	0.97	0.18
INC	0.54	0.50	0.40	0.49
AGE	52.12	16.61	58.85	13.50
SEX	0.81	0.39	0.80	0.40
RACE	0.99	0.10	0.90	0.31
RESI	0.82	0.39	0.88	0.32
HOUS	2.45	1.08	2.50	1.09
EDUC	0.76	0.43	0.52	0.50
INVT	0.17	0.38	0.21	0.41
AWARE1	0.64	0.48	0.48	0.50
AWARE2	0.51	0.50	0.28	0.45
AWARE3	0.34	0.48	0.16	0.37
AWARE4	0.40	0.49	0.16	0.37
AWARE5	0.45	0.50	0.16	0.37
EDPR	0.40	0.49	0.15	0.35

concerned about multicollinearity. However, multicollinearity diagnostics found no significant multicollinearity among the independent variables. The model was significant at α = 0.01 and correctly classified 71% of the landowners included in the sample. Specifically, the model correctly classified 66.2% of regenerators and 76.2% of nonregenerators. The population centroid is 0.53 for regenerators and −0.56 for nonregenerators. Thus, the higher the discriminant score, the more likely that a particular observation be classified as a regenerator since this group has a positive

Table 3. Results of discriminant analysis that models factors that differentiate between NIPF regenerators and nonregenerators in Mississippi who harvested timber between 1994 and 1998 (n = 538).

Variables	Unstandardized coefficients	Standardized coefficients
Constant	−3.02	–
ACRE**	0.00	0.11
TYPE	0.16	0.03
INC**	0.04	0.02
AGE**	−0.03	−0.46
SEX	−0.14	−0.06
RACE**	1.62	0.36
RESI**	−0.36	−0.13
HOUS	−0.13	−0.14
EDUC**	0.73	0.34
INVT	−0.24	−0.09
AWARE1**	0.04	0.02
AWARE2**	0.02	0.01
AWARE3**	0.40	0.17
AWARE4**	0.13	0.06
AWARE5**	0.66	0.29
EDPR**	0.71	0.30

Model's Wilk's λ = 0.77; χ^2 = 137.09.
Population Centroids: Regenerators = 0.53; Nonregenerators = −0.56.
Predictive Power: Overall = 71%; Regenerators = 66.2%; Nonregenerators = 76.2%.
**Significant at α = 0.01

centroid. In direct contrast, lower discriminant scores are associated with the nonregenerator group.

Except for ownership type (TYPE), gender (SEX), number of household members (HOUS), and perception about riskiness of timberland investments (INVT), all model variables were significant. Based on the magnitude of the standardized coefficients, age (AGE), educational level

(EDUC), race (RACE), and attendance in educational programs (EDPR) made the largest contribution when discriminating between regenerators and nonregenerators.

Ownership size (ACRE) was a significant factor in discriminating between regenerators and nonregenerators. The positive sign of the coefficient indicates that larger ownership sizes will be associated with higher discriminant scores, increasing the likelihood that a landowner is a regenerator. Thus, landowners owning larger timberlands were more likely to be classified as regenerators while those with smaller ownerships were more likely to be nonregenerators.

Among the sociodemographic characteristics examined, income (INC), age (AGE), race (RACE), place of residence (RESI), and educational level (EDUC) were significant in discriminating between regenerators and nonregenerators. The income (INC) variable was positive indicating that more affluent landowners were more likely to be regenerators. Age was negatively associated with the decision to regenerate. An increase in age would result to a decrease in the discriminant score, increasing the likelihood that a landowner will be classified as a nonregenerator. That is, younger landowners were more likely to regenerate after harvest. Landowners belonging to the white race and those who lived in cities were more likely to be regenerators. Landowners who attained higher education were more likely to be regenerators than landowners with lower educational attainment.

Landowner awareness to the different programs identified in the study (AWARE1, AWARE2, AWARE3, AWARE4, and AWARE 5) was significant in discriminating between regenerator and nonregenerators. The positive signs of the coefficients indicate that landowners aware of these programs were more likely to be regenerators. Attendance in educational programs was also significant in differentiating between regenerators and nonregenerators. Landowners who attended educational programs about forest management were more likely to regenerate their timberland after harvest.

Reasons for Landowners Reforestation Decisions

In general, regenerators considered most of the reasons presented to them to be highly important in their regeneration decision (Table 4), including both the ecological and monetary benefits of timber production. For instance, the three reasons that ranked highest in terms of level of importance were: (1) the desire to keep the land in timber production; (2) the desire to be good stewards of the natural environment; and (3) an economic decision in anticipation of future profits from forest production. On the other hand, the availability of cost-sharing funds from public agencies was not an important consideration in the decision of landowners to regenerate. Most of the regenerators considered the availability of cost shares to be of low importance or no importance relative to the other reasons.

The majority of the nonregenerators considered each reason presented to them to be of low importance or no importance (Table 5). Only a small percentage of the landowners considered these reasons to be of high or moderate importance in their decision not to regenerate. However, the belief that the land would reforest itself to pine naturally, the high cost of reforestation, and the lack of information on reforestation options were considered to be more important relative to the other reasons. On the other hand, the preference for growing hardwood on the tract and the belief that reforestation investment is too risky ranked the lowest in terms of level of importance.

Discussion

Reforestation activities of NIPF landowners in the South continue to be a major concern of the forestry community and policy makers, especially with evidence of declining softwood inventories. It is particularly worrisome whether the South can continue to meet future softwood demands. Studying landowner characteristics and behavior is important in understanding which factors are most useful in predicting forest management activity or the lack thereof. This research investigated factors that are important in differentiating between regenerators and nonregenerators. It demonstrated the use of discriminant analysis in identifying ownership and landowner characteristics associated with landowners' reforestation decisions. Although the main objective of the model presented in this study is to identify factors that are significant in differentiating between regenerators and nonregenerators, the discriminant analysis model can also be used for predictive purposes. A landowner's classification (e.g., whether regenerator or nonregenerator) can be predicted using the model, given the ownership and landowner characteristics. Therefore this model

Table 4. The relative importance of reasons for regenerating for NIPF respondents who regenerated to pine ($n = 427$) after harvesting timber in Mississippi between 1994 and 1998.[1]

Reasons for Regenerating	Importance				
	High (%)	Moderate (%)	Low (%)	No importance (%)	Not sure/don't know (%)
Had revenues from timber sale to finance reforestation	49.2	15.5	10.1	23.4	1.9
Availability of cost-sharing from public agencies	27.9	15.9	9.8	45.4	0.9
Economic decision in anticipation of future profits from forest production	72.8	11.2	6.3	8.4	1.2
Advice of professional forester	54.8	15.0	5.6	23.9	0.7
Availability of tax credits and tax deductions	33.5	17.1	12.4	32.8	4.2
Felt the land should be kept in timber production	90.2	5.9	1.9	2.1	0.0
Conserve the natural environment and provide for future generations	90.2	6.1	0.2	3.0	0.1

[1] Abstracted from Table 8 of Gunter et al. (2001).

Table 5. The relative importance of reasons for not regenerating for NIPF respondents who have not regenerated to pine (n = 402) after harvesting timber in Mississippi between 1994 and 1998.[1]

Reasons for not regenerating	Importance				
	High (%)	Moderate (%)	Low (%)	No importance (%)	Not sure/ don't know (%)
Could not get the government cost-sharing	22.1	6.0	3.2	66.7	2.0
Could not borrow money to reforest at a reasonable interest rate	10.7	5.0	4.5	78.6	1.2
Land is not suitable for pine	16.4	4.5	4.0	73.9	0.2
It takes too long to get the money back from a reforestation investment	13.7	9.7	4.7	67.9	4.0
Rate of return on reforestation investment is too low	12.4	7.7	5.0	70.1	4.7
Have not yet decided the future use of the land	21.9	10.0	2.5	62.7	3.0
Investment in reforestation is too risky	8.2	6.0	6.0	78.1	1.7
Had other uses for sale revenues	20.6	5.2	2.7	68.4	3.0
Reforestation costs too much	27.4	6.5	3.7	58.5	4.0
Too much red-tape in obtaining technical or cost-sharing assistance	22.1	5.5	2.7	63.7	6.0
Felt the site would reforest itself to pine naturally	31.8	14.9	9.7	41.0	2.5
Logging left site in such poor condition that it made reforestation with pine difficult	14.7	9.2	7.0	66.9	2.2
Wanted to grow hardwood on the tract	5.7	4.7	3.5	83.6	2.5
Adequate stocking of pine after harvest	14.4	8.0	8.2	64.2	5.2
Didn't have information on reforestation options	24.6	6.5	8.0	58.7	2.2

[1] Abstracted from Table 9 of Gunter et al. (2001).

can be used to identify landowner intentions toward timber management and can serve as a guide in developing policies that encourage reforestation among private landowners.

Ownership size was a significant variable in differentiating between regenerators and nonregenerators. Landowners who own larger timberlands have a higher propensity to engage in regeneration activities after harvests compared to landowners with smaller timberlands. This result is expected, as it is more practical to invest on larger ownerships. Moreover, larger ownership allows for greater economies of scale. Royer and Kaiser (1983) also found a positive association between active reforestation and large holdings.

The results also indicated that sociodemographic characteristics of landowners could be useful in predicting their management activities. Specifically, income, education, place of residence, age, and race, were significant in differentiating between regenerators and nonregenerators. Regenerators generally had more income and education. These landowners also tend to live in cities, are younger, and are white.

There also is evidence that landowners who are aware of existing government incentive/assistance programs and those who participate in educational programs are more likely to participate in pine regeneration. These findings highlight the role of incentive and educational programs in encouraging landowners to be active in forest management. Therefore, landowners should be made aware of the existence and availability of incentive/assistance programs. They also should be encouraged to attend educational programs so they will be well-informed about the different reforestation options available to them. Previous studies also have reported the significance of incentive and educational programs in influencing landowner decisions related to forest management (e.g., Royer 1987, Royer and Moulton 1997). Landowner awareness of these different incentive and educational programs may help them better understand different timberland investment opportunities and available alternatives, which can positively influence their reforestation decisions.

Landowners in Mississippi consider both economic and ecological factors highly important in their decision to regenerate pine following a harvest. The desire to keep the land in timber production, the desire to be good stewards of the natural environment, and an economic decision in anticipation of future profits from forest production were considered the three most important reasons for regenerating. Although the majority of the landowners considered all of the reasons for not regenerating to be of low or no importance, the belief that the land would reforest itself to pine naturally, the high cost of reforestation, and the lack of information on reforestation options ranked the highest in importance. These findings are similar to the findings of previous studies (Royer and Kaiser 1983, Palmer et al. 1985) of NIPF landowners in the South, indicating that landowners still face the same problems they did more than a decade ago. Although efforts have been made to address these problems, our findings indicated that there is a need to re-evaluate existing policies to determine if new, expanded, or redirected programs are needed to encourage landowners to regenerate following a harvest.

Why certain landowners are motivated to engage actively in reforestation activities whereas others are not is shaped by their sociodemographic characteristics, the nature of their timberland holdings, and the availability of forestry assistance/incentive programs. Although the findings of this study do not provide specific solutions in promoting nonregenerators to regenerate, it provides useful information on where policy efforts should be focused to encourage regeneration. For example, although it may be best to focus efforts on relatively large landowners who are proactive (i.e., landowners who fit the regenerator profile) from the standpoint of program efficiency, the nonregenerators are also an important group that should be given considerable

attention by policy makers and forestry professionals. Understanding the needs and interests of this group is important in developing programs that aim to encourage reforestation investments among these landowners. Specifically, policy efforts should focus on reaching landowners who have smaller timberland ownerships, less affluent, older, less educated, black, farm or rural residents, and "underserved" landowners or those outside the loop on information, education, communication, and networking (i.e., those who are generally unaware of government incentive programs or those who are not reached by educational or assistance programs).

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