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Forest tenure systems and sustainable forest management: the case of Ghana

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Abstract

Adoption and implementation of sustainable forestry practices are essential for sustaining forest resources, yet development of effective policies and strategies to achieve them are problematic. Part of the difficulty stems from a limited understanding of the interaction between obtrusive forest policies and indigenous tenure systems and how this affects sustainable forest management. This study uses a market framework to analyze the relationships between individual components of forest tenure and sustainable forestry practices. Data from 21 rural communities in the forest belt of Ghana are used to evaluate theoretical propositions. Logistic regression models are used to predict willingness to engage in the preservation of indigenous, economically valuable trees, conservation of natural forests, and establishment of forest plantations. The number of farmers engaged in sustainable forestry practices is small. While most tenure variables behaved as expected, security of tenure and exclusiveness are less important to the practice of sustainable forestry. Farmers, in their role as potential producers, perceive preservation of indigenous, economically valuable trees and conservation of forests as having a net cost to them, especially if compensation is not paid for damage to crops resulting from logging operations of concessionaires. Current statutes in Ghana provide few incentives for farmers to engage in sustainable practices. The study also provides recommendations for forest tenure systems to function effectively. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

The world's forests continue to dwindle rapidly in terms of both area and quality, but the problem is more pronounced in developing countries. It is estimated that 65.1 million ha of forests were destroyed in developing countries between 1990 and 1995, while forest cover increased by 8.8 million ha in developed countries during the same period (FAO, 1999). This results in a net loss of 56.3 million ha of forests worldwide over the 5-year period. The irony is that destruction of forests continues to occur in spite of many global and regional initiatives aimed at arresting the trend, and at a time when sustainable development is a key objective in many national forest policy frameworks.

The most comprehensive global initiative to combat deforestation was FAO's Tropical Forestry Action Programme developed in the early 1980s. It was followed by the World Bank's Forestry Sector Policy

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in 1991. Since 1992, there have been regional efforts at defining criteria and indicators for measuring sustainable forest management including the International Tropical Timber Organization Process, Helsinki Process, Montreal Process, Amazonian Process, and Center for International Forestry Research Process. Undoubtedly, these initiatives have had some impact on reducing deforestation, yet the on-going alarming rates of forest destruction raises the issue of the extent to which the initiatives have influenced national forest policies.

More importantly, it raises the issue of how effective the policies have been in terms of restructuring institutions to provide incentives for sustainable forest management. In this regard, a quote from a former chief of Kofikrom in the Sefwi Wiawso, Ghana, study area is of consequence:

> "Government does not reward any farmer who conserves his forest, rather it promotes forest destruction through the National Best Farmer Award, because the underlying criterion for the award is the extent of one's cultivated farm. Why can't there be an award for farmers who are conservation-minded, or at least incorporate conservation into the criteria for the National Best Farmer Award?"

The quotation suggests that there are no incentives for farmers to conserve forests in Ghana. Yet, the importance of incentives to adoption of sustainable practices has been underscored in many studies. For example, market incentives have been shown to increase adoption of agroforestry practices in Kenya (Scherr, 1995) and Java (Suryanata, 1994).

2. Changing perceptions of forests

Changes in meanings and perceptions of forests over the last century have suggested that there is a dynamic relationship between humankind and forests. In the past, forests were generally viewed as obstacles to agricultural growth and development. Later, forests were viewed as means of production of timber to support increased demand for wood products. The advent of environmentalism in developed countries, coupled with changing social values, and increased scientific understanding of human impacts on forest ecosystems have altered this perception dramatically. Today, forests are seen by some as objects to view and use non-consumptively (Yaffee, 1994). To others, forests provide a linkage with gods and spiritual powers (Schmithüsen, 1995).

These latter perceptions have influenced forest management to the extent that even those who believe in the productive aspects of forests do not accept the massive clear cutting that characterized forest management decades ago. For example, in 1998 MacMillan Bloedel, a giant forest products firm in Canada, announced phasing out clearcutting in British Columbia. A year later, another Canadian firm, TimberWest Forest Corporation, is following suit (Society of American Foresters, 1999).

The question for this study is whether perceptions of forests among forest-dependent communities have also changed. We argue that bundles of rights governing use and management of forests are at the core of these perceptions. These rights, hereafter referred to as forest tenure, are largely functions of local institutions and national forest policies.

Adoption and implementation of sustainable forestry practices are essential for a continuous supply of commodity and non-commodity resources from forests; however, development of effective policies and strategies to achieve them are problematic. Part of the difficulty stems from limited understanding of the effect of the interaction between forest policies and indigenous tenure systems and how this affects sustainable forest management. This is particularly true for Africa (see Dommen, 1994; Place and Hazell, 1993; Migot-Adholla et al., 1991; Kasanga, 1988; Okoth-Ogendo, 1989). While the disproportionate focus of research on land tenure and agricultural productivity may be important, it often de-emphasizes the important relationship between humankind and forests.

An understanding of the integration of forest tenure and forest policy can be used to influence the behavior of tenure holders towards desired social goals. An emerging body of research addressing tree and forest tenure include Pasicolan et al. (1997), Zhang and Pearse (1997), Dewees (1995), Place and Otsuka (1997a,b), Fortmann and Bruce (1988). This study adds to the emerging body of research by assessing the relationships between components of tenure and sustainable forestry practices through a market framework. It uses primary data from 21 rural communities

in the forest belt of Ghana. The data were collected between September 1997 and March 1998.

Many studies on land tenure have focused on the relationship between security and investment (Hayes et al., 1997; Sjaastad and Bromley, 1996; Roth et al., 1994; Feder and Onchan, 1987). While the importance of tenure security is recognized, its generalization as a panacea for all tenure issues diminishes the importance of other tenure components. Security is only one of the 'sticks' in the bundle of rights to land. By testing for the relative importance of tenure variables, this study focuses attention on other important components of tenure and helps to prescribe changes in tenure systems that are likely to increase adoption and implementation of sustainable forestry practices.

3. Deforestation and ownership of forests in Ghana

In pre-colonial Ghana (then called Gold Coast), forests were owned in common by communities (families, clans and 'stools'). A 'stool' refers to a community governance or administrative structure similar to dynasties (Kasanga et al., 1996). However, the country's Forest Ordinance of 1927 gave authority to the colonial government to reserve parts of the country's forests. Although the bill did not alter ownership of the forest reserves, it vested them in the government of Ghana and prescribed that they should be held in trust for the communities.

Today, there are 279 forest reserves in Ghana (Kasanga, 1994). While the forest reserves are relatively intact, there is conflict over ownership, exacerbated by scarcity of afforestable land for cocoa cultivation. It is estimated that about 50–70% of the total area of forest reserves in parts of the western region of the country have been illegally encroached (England, 1993). On a broader scale, of a total of 16,340 km^2 of forest reserves in the tropical high forest zone of the country, only 9000 km^2 are in stable condition. The rest are either degraded or significantly depleted (Hawthorne and Abu Juam, 1993).

More disturbing is the increased level of deforestation occurring on off-reserve forests owned and managed by individuals and local communities. In many respects, degradation of off-reserve forests indirectly increases pressure on forest reserves. About a third to two-thirds of the timber harvested annually in Ghana comes from off-reserve forests (Mayers et al., 1996). The destruction has serious implications for forestry, yet changes in national forest policy and statutes on forests have not adequately addressed high rates of deforestation. Indeed, some of the statutes provide a disincentive for the protection of valuable, indigenous tree species.

Theoretically, merchantable tree species in off-reserve forests belong to communities, but in practice the trees belong to the government because it is an offense for an individual or community to cut or sell merchantable trees species without permission from the Forestry Department. There are cumbersome processes involved in requesting and being granted permission to cut merchantable trees. Loggers are required by law to compensate farmers for damage to food and cash crops resulting from logging operations on their land, but rarely comply. This, in addition to frustrations in claims processes, has resulted in some farmers illegally destroying valuable tree species on their farms before concessionaires have access to the trees. The frequency of such conflicts casts doubt about the effectiveness of forest tenure systems in Ghana regarding adoption and implementation of sustainable forestry practices.

4. Methodology

4.1. The model

This study postulates that forest tenure structure determines the conduct of the tenure holder, which, in turn, determines tenure performance. The theoretical model is a modified version of Bain (1959) 'structure-conduct-performance' framework in industrial organization. Bain's model relates to how sets of attributes influence economic performance defined broadly as production and allocative efficiency, in terms of incorporation of science and technology into production processes to increase output per unit of input (Scherer and Ross, 1990). It is modified in this study to relate components of tenure systems to tenure performance. In this study, tenure performance relates to the extent to which one's tenure arrangement affects sustainable forestry practices defined as (a) preservation of indigenous, economically valuable trees, (b) conservation

of natural forest, and (c) establishment of forest plantations.

The above criteria for measuring sustainable forestry practices were chosen because they generally conform to the criteria for the measurement of sustainable tropical forest management developed by the International Tropical Timber Organization in 1992. The following reasons further explain the choice of the sustainable forestry practices. Silvicultural systems in Ghana and other tropical countries have been relatively unsuccessful in replenishing degraded tropical forests with indigenous, economically valuable tree species. As a result, preserving and tending naturally regenerated trees, such as *Khaya ivorensis, Entandrophragma angolense, Pericopsis elata*, etc. on farm and fallow lands, is one of the limited options for ensuring a continuous supply of such species in the future. Moreover, moderate disturbance, such as those on fallow lands appear to benefit regeneration of certain tree species (Thadani and Ashton, 1995). Furthermore, conservation of natural forests and establishment of forest plantations indeed distinguishes between farmers who have tenure arrangements that are conducive to sustainable forestry practices and those without.

4.2. Conceptual framework

Conservation of a forest is a form of investment. A farmer's willingness to conserve a forest is largely influenced by the value attached to the forest. While the value of a forest is a reflection of its meaning to the society where it is found, its value today arises from the contemplation of its value tomorrow. If the farmer's perception of the future value of the forest is high, the forest will most likely be conserved. In other words, the farmer's option value for the forest is positive, suggesting that he or she would be willing to pay for the conservation of the forest for its use in the future. Nonetheless, the decision to conserve forest land will not be finalized until an affirmative answer can be given to the fundamental question, 'will the benefit stream reaped by the farmer and the farmer's family outweigh the benefit stream from alternative uses?' The answer to this question is buried in the structure of tenure arrangement. It follows from above that an individual's willingness to engage in sustainable forestry practices (SFP) would be determined by given forest tenure practices and by other household characteristics, or

$$\text{SFP} = f(\text{forest tenure, household characteristics}),$$

The three sustainable forestry practices-namely preservation of indigenous, economically valuable trees, conservation of natural forests, and establishment of forest plantations-are the dependent variables in this study. Responses to all three dependent variables are binary. For example, farmers were asked whether they do or do not preserve indigenous, economically valuable tree species on their lands. A similar approach was used for conservation of natural forests, except that a 'yes' response represents those who have actually conserved forests or those who wish to allow part of their fallow lands to turn into forests for future use, and 'no' otherwise. Similarly, a 'yes' response represents those who have established teak plantations, or those who wish to do so in the future, and 'no' otherwise.

4.3. Components of forest tenure

This paper breaks down forest tenure into six core components-comprehensiveness, exclusiveness, duration, transferability, security, and right to economic benefits. These components are based on Luckert and Haley (1994) description of characteristics of property rights as they relate to forest resources. Two exogenous variables, level of education and number of farms (i.e. discrete areas cultivated by each household), are also used as explanatory variables in exploring the relationship between forest tenure and sustainable forestry practices.

The level of education is an explanatory variable because value of a resource is also a function of what one knows about the resource Smith (1990). Because education is a vehicle for learning about a resource, a farmer's level of education may influence one's willingness to engage in sustainable practices. Also, in the Ghanaian setting, mode of land acquisition influences one's rights to land. Number of farms is selected as an explanatory variable to capture the different tenure arrangements that characterize each mode of land acquisition. Table 1 provides a description of all the explanatory variables.

The term security is broad and has many definitions. It is noteworthy that security has a legal meaning in

Table 1
Description of explanatory variables

Variable name	Description
Comprehensiveness (Comprehe)	Number of use rights that a tenure holder has according to his tenure arrangement. Each use right the tenure holder has is equivalent to one point. All points are added to provide a score for the respondent
Duration	Period during which a tenure holder can exercise rights to the forest, Duration (1) = bad for forestry (1–9 years), Duration (2) = good for forestry (10–49 years), Standard is Duration (3) = very good for forestry (50 > years)
Economic compensation (Econ)	It is used as a proxy for economic benefits, i.e. the extent to which a tenure holder can retain benefits from forests. Tenure holders do not have a right to retain monetary benefits from merchantable tree species but have a right to be compensated for damage to their crops resulting from logging operations. Economic compensation describes whether externalities resulting from logging operations on a farmer's land are internalized. Econ (1) = no compensation for damage to crops, Econ (2) = compensation for damage to crops, Econ (3) = no damage to crops; therefore, no compensation, Standard is Econ (4) = no experience of logging on land
Security	Confidence tenure holders have in their rights to the forest measured by capability to register a piece of land in a farmer's name without constraints. It is a binary variable; 1 is secure rights, 0 otherwise
Exclusiveness (Exclusive)	Extent to which a tenure holder can prevent others from infringing on his rights regarding use of non-timber forest products. Scores range from 0 (least exclusive) to 7 (most exclusive)
Transfer	Freedom given to a tenure holder to exchange rights to the forest measured as capability to bequeath land to family members (defined as wife/husband and children), rent, sell, pledge, give any part to a friend, or stranger. Scores range from 0 (least transferable) to 6 (most transferable)
Education (Educ)	Level of education of farmer. Educ (1) = no formal education, Educ (2) = up to junior secondary school, Standard is Educ (3) = those who have higher education defined as technical and commercial schools, training college, and university
Farms	Number of farms per farmer

this study; and although it is defined narrowly, it facilitates the breaking down of forest tenure into its core components. Bruce (1993) describes three definitions of tenure security. The legal profession uses the term to imply confidence in the legal system to protect tenure holders' rights in land. On the other hand, economists use the term to include not only the confidence implied above, but also to describe the duration of tenure. In this usage, Bruce (1993) explains that adequacy of security of tenure is "examined in relation to the time needed to recover the cost of a particular investment. But when tenure is too short or too uncertain for most investments, economists will say generally that the land holder lacks security of tenure". Another usage of security of tenure combines confidence and long duration, in addition to a third element of full rights to land. This usage of the term simply means full private ownership of land. As explained by Bruce (1993), tenure would be considered insecure if land cannot be freely bought or sold. This definition by default includes duration, transferability and exclusiveness.

The following reasons explain why duration, economic compensation, and level of education are categorical variables. Economically valuable tropical trees tend to have long production periods. Teak (*Tectona grandis*) is one of the fastest growing tree species in Ghana, yet the minimum production period provided by the farmers interviewed is 10 years. The categories for duration are therefore based on this minimum production period, explaining why tenure duration less than 10 years is considered bad for forestry. In addition, many tenancies fall within this range of duration (<10 years). Duration 10–49 years is good for forestry because teak and many other tree species would reach merchantable sizes with this period. Duration of 50 years and more is considered by farmers interviewed as very good for forestry not only because most economically valuable tropical tree species would reach merchantable sizes within this

period, but also farmers who had duration of 50 years and more either owned the land or could farm it over a very long time period.

Regarding economic compensation, the interesting issue from the standpoint of this study is whether compensation significantly affects one's willingness to engage in sustainable practices. A description of the explanatory variables is provided in Table 1. High illiteracy rates among farmers interviewed made it difficult for them to state the exact number of years spent in school. The categories for level of education were therefore devised to facilitate the analysis.

5. Study areas and data collection methods

Four forest districts within the forest belt of Ghana-Assin Fosu, Sefwi Wiawso, Goaso, and Asante-Akim Juaso were randomly selected as study areas. Actual study sites consisted of five to six communities in each forest district. The data collection method consisted of personal interviews of 354 randomly selected heads of farming households. Socio-economic data by household, land acquisition methods, and data on sustainable forestry practices were gathered from each respondent. Perceptions of forest management practices were captured in relation to the components of forest tenure. Each interview lasted 60–90 min.

6. Empirical model

The empirical model for predicting participation in sustainable forestry practices is:

$$\begin{aligned} \text{SFP} = & \beta_0 + \beta_1\text{Comprehe} + \beta_2\text{Duration} + \beta_3\text{Econ} \\ & + \beta_4\text{Security} + \beta_5\text{Exclusive} + \beta_5\text{Transfer} \\ & + \beta_7\text{Educe} + \beta_8\text{Farms} + \mu_i \end{aligned}$$

where Comprehe, Duration, Econ, Security, Exclusiveness, Transfer, Educ, and Farms are as defined in Table 1. The responses to the three sustainable forestry practices were modeled using backward stepwise logistic regression models of the form:

$$P_i = \frac{1}{1 + e^{XB}}$$

where P_i is the probability of the sustainable forestry practice occurring, X a vector of explanatory variables and B a vector of regression coefficients.

There is one model for each for the three sustainable forestry practices, and each of them is estimated separately. Once estimated, the probability enables the prediction of the likelihood of a farmer's involvement in a particular sustainable forestry practice, given a combination of his tenure arrangement.

Many ethnic groups occupy the forest belt of Ghana, yet they have similar forest tenure systems. This similarity, in addition to the fact that one survey instrument was used throughout the study, allowed for pooling the data and testing for different study areas. Dummy variables are used to test for the four area effects, again Assin Fosu, Sefwi Wiawso, Goaso, and Asante-Akim Juaso.

7. Results and discussion

Fig. 1 shows the frequencies of the three sustainable forestry practices. Only about 45% of the respondents preserve indigenous, economically valuable trees on their farms, yet this performance is better than the other two sustainable forestry practices. The worst performance is shown by conservation of natural forests where only 36 farmers (10%) out of a total of 354 responded 'yes' to conserving natural forests. Only 14 out of the 36 farmers have actually conserved forests; the rest wish to allow part of their fallow lands to turn into forests for future use (Fig. 2). This performance has serious consequences for forestry and economic growth in Ghana because as Mayers

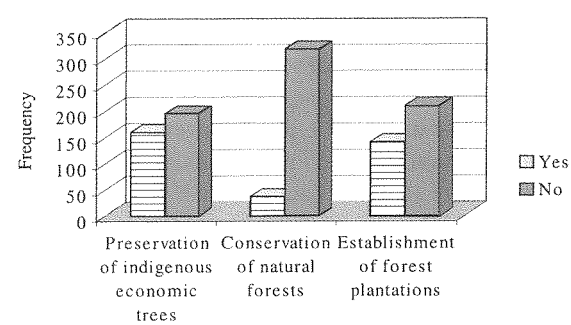

Fig. 1. Frequencies of respondents involved in sustainable forestry practices.

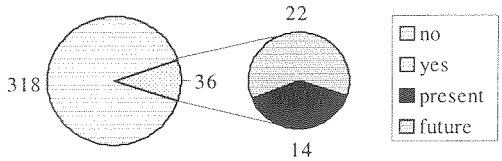

Fig. 2. Relative occurrence of conservation of natural forest among respondents.

et al. (1996) have predicted, based on current conditions that the harvest of current commercial tree species will be reduced by 65% within 20 years. Based on such a prediction, there would be a collapse of tree harvests in off-reserves forests, suggesting a high probability of extinction of many tree species.

Establishment of forest plantations is similar to conservation of natural forests. One hundred and forty farmers (about 40%) responded 'yes' to establishing forest plantations, but only 24 of this number have actually done so (Fig. 3). This is not surprising because the major objective of many farmers in subsistence economies is to plant food and cash crops to sustain their livelihoods. In addition, there are genuine constraints to establishing forest plantations. In Costa Rica, for example, Howard and Valerio (1996) report that other factors, apart from financial returns, influence farmers' land-use allocations. Factors, such as nearness of one's land to access road, availability of seedlings, and the relatively long gestation period for even a fast growing species, such as teak, are likely to affect the willingness of farmers to establish forest plantations. Lack of technical know-how for planting and tending trees among farmers also reduces willingness to establish forest plantations. On the other hand, the poor performance is an indication of the general disinterest in private forestry. Unlike the US government which provides technical and financial

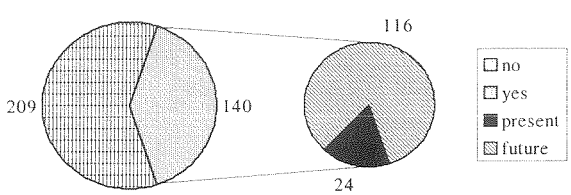

Fig. 3. Relative occurrence of establishment of forest plantations among respondents.

Table 2
Variables influencing decision to preserve indigenous economically valuable trees in Ghana[a]

Variable	Coefficient	Standard error	Odds ratio (exp. b)	t-Statistic
Econ (1)	−1.2072	0.3275	0.2990	−369
Econ (2)	2.5007	0.4673	12.1913	5.35
Econ (3)	1.0202	0.4171	2.7736	2.45
Duration (1)	−1.3086	0.4330	0.2702	−3.02
Duration (2)	−1.0018	0.5721	0.3672	−1.75
Transfer	0.2584	0.0633	2.4652	4.08
Farms	0.3790	0.1276	1.4608	2.97
Goaso	0.1137	0.4054	1.1204	0.28
Wiawso	−1.0315	0.4057	0.3565	−2.54
Juaso	0.9023	0.3931	2.4652	2.30
Constant	−1.4025	0.4554		−3.08

[a] Nagelkerke $R^2 = 0.44$, −2 log likelihood = 345.66, c statistic = 0.84, $N = 354$.

assistance to forest landowners, Ghana does little, if any, to promote private forestry.

Three responses are inherent in Figs. 2 and 3. First, there are those who responded 'no' to the specified sustainable forestry practice. Second, there are those who are actually engaged in the sustainable practices, labeled as 'present'. Third, there are those who have plans to be involved in those practices, labeled as 'future'. These responses suggest the use of multinomial logistic regression model. However, the disproportionate number of 'no' responses meant little variation in the data, and as a result, the multinomial logistic model performed poorly. An alternative binomial logistic model consisting of 'no' versus 'yes' defined as 'present' and 'future' yielding a 'yes' response worked well. Results shown in Tables 2–4 are based on the binomial logistic models.

8. Preservation of indigenous economic trees

The results shown in Table 2 indicate four important variables regarding preservation of indigenous, economically valuable trees on farmlands-economic compensation, duration, transferability and number of farms. All these variables are statistically significant at the 5% level. The variables economic compensation and duration have more than one category and have therefore been treated as indicator variables. Inferences about any of the categories are made with

Table 3
Variables influencing decision to conserve forests in the forest belt of Ghana[a]

Variable	Coefficient	Standard error	Odds ratio (exp. b)	t-Statistic
Econ (1)	0.1869	0.5232	1.2056	0.36
Econ (2)	1.3877	0.5322	4.0057	2.61
Econ (3)	−0.3463	0.8559	0.7073	−0.40
Comprehe	0.6237	0.1942	1.8659	3.21
Educ (1)	−1.6432	0.6241	0.1934	−2.63
Educ (2)	−1.1242	0.5560	0.3249	−2.02
Transfer	0.2828	0.1007	1.3269	2.81
Goaso	−1.2468	0.6331	0.2874	−1.97
Wiawso	−1.2812	0.5427	0.2777	−2.36
Juaso	−0.2828	0.5190	0.7537	−0.54
Constant	−6.0202	1.4904		−4.04

[a] Nagelkerke $R^2 = 0.32$, $-2LL = -2$ log likelihood $= 174.82$, c statistic $= 0.85$, $N = 354$.

reference to a standard category (Table 1), which is assumed to have a coefficient of zero.

The sign of the coefficient of Econ (1) indicates that the odds of preserving indigenous trees decrease if farmers are not compensated for damage to crops resulting from logging operations. Farmers perceive preservation of indigenous, economically valuable trees as having a net cost to them, especially if compensation is not paid for damage to crops resulting from logging operations of concessionaires. This is consistent with the argument advanced by Fortmann and Bruce (1988) that "people will not preserve, protect or plant trees nor allow others to, if doing so is costly to them personally". Dewees (1995) also shows that in Malawi, investments in tree planting tend to be most encouraging among farmers when there are low costs and low risks.

Table 4
Variables that influence decision to establish forest plantations in the forest belt of Ghana[a]

Variable	Coefficient (b)	Standard error	Exp. b	t-Statistic
Econ (1)	0.4476	0.2969	1.5645	1.51
Econ (2)	1.1698	0.3444	3.2213	3.40
Econ (3)	1.0652	0.3935	2.9014	2.71
Educ (1)	−1.0962	0.4489	0.3341	−2.44
Educ (2)	−0.2141	0.4097	0.8073	−0.52
Comprehe	0.2177	0.0654	1.2433	3.33
Farms	0.2532	0.1149	1.2881	2.20
Goaso	0.7352	0.3469	2.0859	2.12
Wiawso	−0.1481	0.3556	0.8623	0.42
Juaso	0.0379	0.3441	1.0387	0.11
Constant	−2.4737	0.6525		3.79

[a] Nagelkerke $R^2 = 0.19$, -2 log likelihood $= 416.362$, c statistic $= 0.72$, $N = 349$.

On the other hand, the odds of preserving trees increase when farmers are either compensated (Econ (2)) or when there is no damage to their crops (Econ (3)). However, the odds increase by a factor of 12 (exp. b of Econ (2)) when farmers are compensated compared with an increase of 2.7 when farmers do not experience damage to crops. The coefficient of Econ (3) has a positive sign because in addition to farmers experiencing no destruction to crops during logging, some of the trees had become nuisance and those farmers were happy to see these trees cut.

As suggested by the sign of the coefficients of Duration (1) and (2), tenure duration of less than 50 years decreases the odds of preserving indigenous, economically valuable trees. Tropical hardwood tree species are slow growing so farmers with short tenure duration may not be motivated to preserve them. Moreover, farmers do not derive direct economic benefits from such trees, serving as a disincentive for their protection. Also, both Transfer and Farms have positive effects on preserving indigenous, economically valuable trees, but based on their odds ratios, Transfer shows a higher positive effect than Farms. As theoretically predicted, increased transfer rights is essential for such long-term investments as preservation of tropical hardwood trees on farmlands.

Regarding the study area variables, Wiawso is the only one that shows a negative effect on the odds of preserving valuable trees. This result can be linked to on-going disputes between the government of Ghana and farmers in this region regarding ownership of forests. It clearly demonstrates the effect of conflicting ownership of forests on sustainable forestry practices.

9. Conservation of natural forests

The effect of economic compensation on conservation of natural forests is similar to its effect on preservation of indigenous, economically valuable trees. Based on the odds ratio of Econ (2) in Table 3,

compensating farmers for damage to crops is key to motivating farmers to conserve natural forests. In spite of the positive sign of the coefficient of Econ (1), the magnitude of its odds ratio suggest that it does not have a significant effect on conserving natural forests, compared with Econ (2).

The results presented in Table 3 also suggest that farmers who have had no formal education and those with education up to junior secondary school level are unlikely to conserve natural forests. Additionally, having several use rights to the forest, (Comprehe), and being able to freely exchange those rights (Transfer), increases the odds of conserving natural forests. Comparing across study areas, all study areas, except Fosu, have negative signs for their coefficients. This reflects the poor performance of tenure systems regarding conservation of natural forests as indicated in Fig. 1. In view of current statutes on ownership of trees, conservation of forests seems to have high opportunity costs for farmers. As argued by Lawry (1990), communities are likely to neglect conservation of resources that are of low value, especially if their conservation conflicts with resources of higher value. It appears that farmers are better off converting forests to agricultural crops, not only to support their subsistence livelihoods, but also where profits received can be kept in interest bearing accounts, as implied by Hotelling (1931).

10. Establishment of forest plantations

Table 4 shows the estimated coefficients and statistical properties that affect the decision to establish forest plantations. The results show that payment of compensation for damage to food and cash crops (Econ (2)) is crucial to motivating farmers toward sustainable forestry practices. Also, education at or below the junior secondary school level decreased the odds of establishing forest plantations. In addition, farmers who have comprehensive rights to their land have a higher probability of establishing forest plantations than those who do not. This clearly makes land acquisition methods, such as tenancy and borrowing, which inherently carry with them limited rights, less favorable toward establishment of forest plantations.

The inclusion of Farms among the selected variables in Table 4 indicates that those who have more than one farm are more likely to establish forest plantations than those who do not. Two inferences may be drawn from this. First, it suggests that farmers tend to satisfy their food needs before getting involved in forest plantations, implying that provision of alternative methods of sustaining livelihoods, such as thorough establishment of village industries, holds promise in terms of individuals allocating more land to forest plantations. Second, those who have more than one farm are more likely to have tenure arrangements that allow for the establishment of plantations compared with those having only one farm.

In comparing study areas for all three sustainable forestry practices, Wiawso consistently emerged as the study area least interested in the adoption and implementation of the practices. It is possible that tenure systems in Wiawso are less conducive to the sustainable practices compared with the other areas. In addition, the on-going dispute over ownership of forests in that area between the Government of Ghana and the farmers may have had negative impacts on farmers' willingness to engage in those practices. Also, Kasanga (1994) reports that the Western Region of which Wiawso is part, is the latest area in Ghana to experience an influx of migrant farmers seeking forestland to establish cocoa plantations. It is possible that this reason and the relative abundance of forests in that region have made farmers in the Wiawso study area less interested in sustainable forestry practices.

It is noteworthy that security of tenure and exclusiveness are the only two tenure variables that do not significantly affect farmers' decision regarding sustainable forestry practices. This finding is not consistent with theoretical predictions on land tenure. This result may be due, in part, to differences in the interpretation by the survey respondents for the terms security and exclusiveness.

Security of tenure is generally perceived as key to investment in land, while affecting productivity at the same time. The absence of security from the selected variables indicates that in the Ghanaian setting there is no correlation between land registration and sustainable forestry practices. A similar finding is reported in Kenya where formal title does not increase agricultural productivity (Migot-Adholla et al., 1994). These findings caution generalizations about security of tenure and suggest clarification of the contexts within which the term is used.

Exclusiveness also deviated from theoretical expectations because it was revealed during interviews that farmers consider many of the forest benefits as public goods. In addition, there is a sense of community among farmers in the study areas. This is explained by access to land, which is usually through families, clans, tribes, and 'stool'. Indeed, many of the inhabitants living in villages in rural sections of Ghana are related somehow. Therefore, some communities consider excluding others in the enjoyment of non-timber forest products from one's forest as unacceptable.

11. Conclusions

The basic model for predicting the probability of a farmer engaging in sustainable forestry practices is applicable to Ghana and may be applicable to similarly situated countries. Our results indicate that the number of farmers engaged in sustainable forestry practices in the study areas is small, suggesting that a majority of farmers still perceive forests as places to increase agricultural productivity to support subsistence living. The most likely reason is lack of incentives, which is largely the result of forest tenure and policy.

If sustainable management of private and communal forests is a desired social goal, then our results suggest that incremental changes in tenure variables-transferability, comprehensiveness, economic compensation, and duration would facilitate its achievement. Economic compensation is the most significant tenure variable affecting adoption and implementation of sustainable forestry practices. In addition to its relatively high odds ratios, it is the only variable that was consistently significant in all three models. Transferability and comprehensiveness are the next most significant tenure variables-each was significant in two of the three models. However, where both variables are significant, comprehensiveness tended to have a larger effect than transferability.

Our results also suggest that laxity in the enforcement of compensation to farmers when their crops are destroyed during logging operations is having significant negative effects on sustainable forestry practices. Compliance of the law could be improved by making regulations 'road block' statutes similar to the Endangered Species Act. Additionally, the regulations may also provide for a framework that allows local communities to re-evaluate periodically, applications of concessionaires operating in their communities.

Duration of tenure is not as significant as expected a priori. The difference in the coefficient of duration (1) versus duration (2) is an indication of how short-term tenancy arrangements in particular can reduce sustainable forest management. Also, exclusiveness, and land registration as a proxy for tenure security, are not as significant as expected theoretically.

Two exogenous variables, level of education and number of farms also affect willingness to engage in sustainable forestry practices. Improvement in the literacy rates among farmers would have significant positive effects on sustainable forestry practices. Likewise, increased access to land, and provision of alternative sources of livelihoods are likely to have positive effects on sustainable practices.

Changes in tenure systems are possible because contrary to long-held beliefs regarding rigidity of customary tenure in Africa, recent studies have proved otherwise. African farmers reacted positively and spontaneously to market incentives in the production of new crops during the early years of colonial rule (Bruce and Migot-Adholla, 1994). Farmers in Ghana can similarly adopt sustainable forestry practices if tenure systems are made more conducive to market forces. For example, improved transfer rights is likely to stimulate investment and transaction in trees and forests.

Similarly, rights to forestland could be made as comprehensive as possible, including rights to dispose of economically valuable trees. Implementation of such a change could begin with an amendment to Ghana's Trees and Timber Decree of 1974, which vests all timber species in the government. In this regard, it may be important to treat trees as commodities just as cocoa and coffee, and credit facilities and technical assistance extended to tree farmers. As an incentive, farmers could be given a percentage of the value of merchantable trees logged from their lands, and the amendment could provide for a periodic review of the formula for paying benefits.

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