How to Restore Forest Areas in a Smallholder Agriculture-Dominated Country?

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Abstract

This study deals with ways of addressing more effectively the problems of forest restoration in a smallholder agriculture-dominated area like the southwest Côte d'Ivoire. An empirical estimation based on a probit model is used to analyze the farmer decisions concerning their eventual participation to the national program of forest development based on a policy of large-scale reforestation.

The results show that the main explicative variables of smallholders' adhesion to this project are agricultural training, ethnic group, access to credit, the age of the head of household and the household's residence area. Contrary to all expectations, some variables such as literacy, out-farm income, and the status of landowner and whole-time farmer do not explain the decision of smallholder.

Keywords: Côte d'Ivoire, forest management, probit model

1. Introduction

In Côte d'Ivoire, forest degradation is alarming. Indeed, forest area has shrunk from 12 million hectares in 1960 to nearly 2.8 million hectares nowadays. During this period, forests were disappearing at the average rate of 3000 00 hectares per annum. And it is roughly estimated that about three-quarters of Ivorian forest cover was lost. Côte d'Ivoire has also one of the highest rates of deforestation in Sub-Saharan Africa driven mainly by an extensive agriculture and a great commercial logging (Sangaré, 2014; FAO, 2012; Ministry of Planning and Development, 2012; Ehui & Hertel, 1989).

As most of African countries, Côte d'Ivoire is widely based on agriculture which represents on average 27% of Gross Domestic Product, 60% of national export revenues and employs about 60% of labor force (Ministry of Planning and Development, op. cit.). This country has known a high agricultural growth rate (nearly 5% per year) during two decades 1960-1980 (Ehui & Hertel, op. cit.). Côte d'Ivoire's principal agricultural export crops are cocoa, coffee, wood and rubber. This country is the leading global cocoa producer, responsible for 40% of world output. Cocoa represents its main export crop with 40% of national export revenues, 10% of Gross Domestic Product, and nearly 600,000 growers that provide food and shelter to about 6 million persons (Tano, 2012). As per 2014 census, more than half (nearly 50.3%) of Côte d'Ivoire's inhabitants continue to live in rural areas where agriculture is the main source of livelihoods (Ministry of Planning and Development, 2014). The high rate of deforestation and the agricultural performance of Ivorian economy highlight clearly the plight of forest resources, and call attention to the problem of optimal restoration of forest land.

In reviewing the studies on deforestation and agriculture in Côte d'Ivoire since 1960s, the most interesting question is not, what did the agriculture contribute to the deforestation, but rather, how does this latter constrain the first and how is it able today to stop or restrain this phenomenon of deforestation? Henceforth, the studies on deforestation, as it has been aptly remarked in several previous studies (see Sangaré, 2014), should focus on the social and economic consequences of forest depletion, particularly in the densely populated rural areas.

Among the most important challenges facing Ivorian authorities, there is the task of identifying development strategies of agriculture that can simultaneously preserve forest areas, increase agricultural production, generate income opportunities, and reduce the frequent penuries of foodstuffs on the market. As a whole, these challenges could be attained if only the agricultural productivity and food supply of Ivorian cities are noticeably improved (Stessens & Dao, 2006; Ehui, Hertel, & Preckel, 1990; Ehui & Hertel, 1989).

Besides, Ivorian authorities had foreseen the increase of forest area from 14% in the decade 2000 to 20% (nearly 6.45 million hectares) of land area on the horizon 2015 through a large-scale reforestation. Even if it seems unlikely in the foreseeable future, this objective should allow later the preservation of rural landscape and rural goods and services (Ministry of Planning and Development, op. cit.). Elsewhere, this policy should exacerbate the pressure on the farmers, particularly the smallholders, which are forced to diversify their income sources to maintain their standard of living. In presage to these events, it is important firstly to assess the extent of forest depletion and secondly to estimate the adhesion of farmers to the policy of forest restoration. Nevertheless, only a few studies have investigated these issues in the context of today's African countries and mainly Ivorian economy.

To our knowledge, this paper represents one of the first efforts to fill this gap by identifying and measuring the impacts of socio-demographic, economic and environmental characteristics associated with the acceptance of the project of forest restoration in Côte d'Ivoire. The present study would like to shed light on the next questions.

For national program of forest development to be viable, the key issue is whether growers would be willing to assign a part of their parcel to allow the reconstitution of forest areas without a major damage for their agricultural production. Will farmers be able to diversify their crop choices toward timber culture which is a high-value crop? In other words, the adoption of the teak cultivation is it an optimal strategy of the diversification of farm incomes? The other next issues of this study are the following items. Have the farmers been worried by forest resources depletion? Do the status of landowner or out-farm income opportunities influence the decision of the farmers to participate to the restoration of forest resources?

The aim of this study is to provide policy-makers with answers to these questions and offer a richer insight into the role of social, cultural and economic factors in explaining farmers' adhesion to the reforestation policy. This study analyzes these issues in depth by outlining a theoretical framework and a conceptual model deeply inspired from models of choice.

The paper is organized as follows. The next section provides an overview of literature. Section 3 describes the methodology of the study. In section 4, the results of the econometric analysis are reported and discussed. Section 5 presents some concluding remarks.

2. Literature Review

In spite of the widespread concern about deforestation in Côte d'Ivoire (Sangaré, 2014; Djézou, 2010; Sylla, 1999; Coulibaly, 1998; Ehui & Hertel, 1989), few empirical studies analyzed the determinants of reforestation. Nonetheless, to our knowledge, only two studies (Wasikama, 1998; Sangaré, 2017) analyzed the adhesion of populations to any project of reforestation in this country. By using the contingent valuation method, these studies have analyzed the behavior of the tourists for the one and of the farmers for the second. Yet, elsewhere in the world, some studies attempted this type of reasoning.

Westerberg et al. (2010) offer insight into public preferences over the range of possible future landscape configurations for the Marais des Baux wetland in southern France. To attain this objective, the authors use a random parameter logit model by taking account of unobserved and observed preference heterogeneity. In their study, these authors reveal that the demand for a high level of biodiversity is conditional on respondents expressing a high level of environmental concern, and that parenthood raises the willingness-to-pay for any future management alternative different from the current situation. Further, they find that mosquito control or attachment to the area is essential for support of large-scale wetland restoration. From the perspective of maximising the compensating surplus, they recommend the restoration of the wetland to one third of its original size in conjunction with biological control of mosquitoes, more tree hedgerows and recreational facilities, while increasing efforts to induce higher levels of biodiversity.

In order to take account not only for the private benefits to forest landowners but also for the ecological, environmental and economic benefits valued by society, Madureira et al. (2011) attempt to assess a best alternative management strategy for a forest area in Central Portugal by implementing a contingent valuation experiment where an advanced landscape visualisation technique is employed to generate the visual information conveyed in the valuation scenarios. Then, several econometric model specifications are considered as well as alternative approaches to handle zero willingness to pay values and protest responses. The results obtained suggest that there is a willingness-to-pay landowners for the amenities their forests may provide. Around 75% of the respondents would support programs funding adequate forest management by landowners. The variable AGE exhibits a negative impact on willingness to pay (WTP) for both strategies.

With consumer survey data, collected in former West and East Berlin after the unification of Germany, Moon et al. (2002) analyze the issue of WTP for foods produced with techniques consistent with environmental

stewardship. The main result of this study reveals some differences in the WTP between residents of the two former German states attributed to area of residence. Also, with respect to the effect of city administrative district, these authors find that consumers residing in the former West Berlin were more willing to pay a premium than those who were living in the former East Berlin. Besides, younger respondents were found to be more willing to pay a premium for agricultural products produced with environmentally sound practices. Contrary to all expectations, education was found to be insignificant in consumer valuation of agricultural products produced with environmentally benign techniques. The authors explain this situation by the fact that respondents with higher education may be more aware of environmental problems attributable to nonagricultural sources whereas considering agriculture itself as an insignificant source of environmental degradation. This study shows that household income did not have statistically significant effects on the WTP for environmentally sound agricultural practices. Higher-income respondents were not willing to pay more than lower-income respondents.

Lera-López et al. (2012) examine the willingness-to-pay of people living in a number of villages in Navarre, in the Spanish Pyrenees to reduce noise and air pollution. These authors use several models based on contingent valuation. They find that those living near roads are willing to pay more to reduce air and noise pollution. In addition, younger people, the better educated, and the more environmentally aware individuals are also willing to pay more to reduce those externalities.

A study by Wasikama (1998), based on a sample of 212 tourists, discusses the rationality of the preservation of National Park of Taï by comparing this option with the others possible alternative in land uses. By using a financial analysis, the author assesses the net present value of NPT to about 366 billion CFA francs. Also, the economic analysis of Wasikama's study, based on the contingent valuation method, allowed identifying the main explicative variables of willingness-to-pay of tourists for the preservation of NPT. Thus the author proceeded with two estimates: a logit model and a semi-log model. The results of two models show that the variable age contributes to explain the WTP of the tourists surveyed.

Sangaré (2017) analyzed the determinants of the willingness-to-accept of the smallholders for the restoration of National Park of Taï. By using the contingent valuation method, this author described the smallholders' attitudes, which are settled in the south-west Côte d'Ivoire, towards the forest resources. The aim of this study is to assess the amount that the smallholders could accept as compensation for the cession of a part or a whole of their cultivated land areas to Ivorian state in order to preserve the National Park of Taï. The statistical and econometrical analyses reveal that only few farmers would accept to adhere to the project. The results of Sangaré's study allow also identifying the educational attainment, the part-time farming practice, the membership in support group, the experience in farming, the environmental characteristic of residence area, the farm-home distance and the environmental sensitivity of the individual like the main determinants of the willingness to accept (WTA) of the farmers settled in the vicinity of NPT.

3. Methodology

In order to understand the decisions of the farmers about their participation or not to the policy of forest restoration, it is possible to resort to the models of choice to conduct the analysis. Among the available models of choice, a model seems emerged and outclasses the others models. Indeed, probit model is recognized as one of the best quantitative techniques and tools for the analysis of the questions of choice since a long time.

The Probit models are used to model a relationship between a dependent variable Y and one or more independent variables X. In these models, the dependent variables are discrete variables that represent a choice or category from a set of mutually exclusive choices or categories. The independent variables could be discrete variables as well as continuous variables.

3.1 Study Area, Questionnaire design and Data Collection

Until the mid-1960s, the south-west area had the lowest density of population (2 inhabitants per kilometer-square). But with the building of several economic infrastructures (the Port of San Pedro, the dam of Buyo, several logging units, the bridge of Soubré (on Sassandra river)) and the war of Liberia, a massive influx of population has been observed for some time past. Today, the percentage of native people, Krou ethnic group, is fewer than 10 % of population. Thus the density of population has been increased from 25 inhabitants per km-square in 1965 to 40 inhabitants per km-square in 1995 (OIPR, 2006).

In south-west Côte d'Ivoire, the population rose to 1912 876 inhabitants in 2008 from 6476 96 inhabitants in 1988. Today, this region represents one of the most densely populated rural areas of the country; and it has been chosen as study area for three main reasons: firstly it will shelter about 10% of Ivorian population (i.e., nearly 2839 736 inhabitants) on the horizon 2020. Secondly, most of those inhabitants will continue to practice agriculture like their main income-generating activities. Thirdly, the remaining forest areas are mainly located in

this region where large populations of rural people live near forests under state control and depend on them for subsistence and, sometimes, for commercial purposes. For these reasons, there is justification in giving to this study a particular attention in national program of forest conservation.

Agriculture and its connected activities form the backbone of the economy of the south-west Côte d'Ivoire. This agriculture is dominated by cash crops (cocoa, coffee, rubber, palm tree, etc.). Unfortunately, agricultural yield is on the wane. It is equivalent to 200 kilograms per hectare for cocoa culture in this region against 500 kilograms per hectare at national level (OIPR, 2006). However, cocoa production of this region, which represents nearly 34% of national production, i.e., 15% of world output, is greater than the Cameroon's cocoa production (5th world cocoa producer) (Tano, 2012).

In this region, the production of food crops is very dynamic also. When the first non-indigenous people arrived and settled in the south-west area, the food crop productions have noticeably increased. These people grew commonly crops that they are used to consuming. A major part of national foodstuffs production, estimated to 8.9 million tons in 1999, is realized in the south-west Côte d'Ivoire (Sangaré, 2014).

Data collection took place through personal interviews conducted by research assistants. In these interviews, respondents give some information to fill in the questionnaire. This questionnaire was structured into four parts. The first elicited information concerning the individuals' social, economic and demographic characteristics. It further obtained information about household composition. The second part elicited information about the characteristics of farms. The third part elicited information to assess individual attitudes towards forest conservation and their sensitive to the variations of food price. The fourth part consisted of a description of the elicitation of individual's valuation of alternative management strategies through the construction of a contingent market. This method consists to elicit values that individuals assign to unpriced goods and services. This part also includes questions to determine why people decided to yield ground or not for forest conservation. It also provided information to identify protest responses. Finally, interviewers completed this part with information about the interview characteristics as well as their evaluation of the plausibility of the valuation scenarios for the individuals. This study used a two-stage random sampling technique. The first stage was the purposive selection of the villages in the southwest Côte d'Ivoire. The agglomerations located in the outlying areas of the National Park of Taï, have been regrouped in two categories: the first concerns the villages located in the west area of NPT in the department of Guiglo and the second includes those that are located in the east area of NPT in the department of Soubré. The second stage involved selection of investigated households by using a well-known sampling method. We tried to have a representative sampling by covering the maximum of the various rural communities living in this study area.

The sample has been selected among households settled in the vicinity of National Park of Taï. This park is a public forest area with about 5,364 km-square which became world-wide patrimony of UNESCO in 1988. Some localities, such as Taï and Daobly, are nearest the boundary of Liberia. The interviews were conducted by approaching respondents in their farms and their homes in September 2010 and June 2011; and, because it involved face-to-face interviews the response rate was nearby 95%. Thus, two departments and eight villages have been visited during this survey. The choice of the visited localities and any given individual as respondent was random. The heads of households who have been selected are 508 in number by reason of 331 in the department of Soubré and 177 in the department of Guiglo (see Appendix A1). Because the population is not evenly distributed in the surroundings of NPT of course, we have chosen to select most of respondents among people living in the east of NPT (65.16% of the sample), while less respondents among those living in the west of this park (34.84%). This discrepancy in farmer number by visited region is explained by the divergence of forest cover ratio. Indeed this ratio equals 36.5% in west area of NPT against 14% in east area of this park (OIPR, 2006).

3.2 The Empirical Model

For a sample of 508 respondents settled in the south-west Côte d'Ivoire (see Appendix A1), we try to model the farmer behavior through the probability that a farmer decides to adhere to the reforestation project. So we use a binary-choice model in which the response variable is coded as 1 or 0. We assume that the response of the farmer characterized by a dependent variable y takes one of two values. Let us assume that:

$$y = \begin{cases} 1 & \text{with probability} & p_i \\ 0 & \text{with probability} & 1 - p_i \end{cases}$$

We consider U_{i1} as utility of individual i if the latter chooses to adhere to the project and U_{i0} his utility otherwise. These utility levels are not directly observed, they depend on socio-economic characteristics such as gender, age, occupation, residence, cultivated land, ethnic group and some specific characteristics of each

alternative. To simplify, we assume that the utility levels U_{i1} and U_{i0} are explained by a linear model where causal factors are gathered in a set of variables called X.

$$U_{i1} = a_1 + a_{11}x_{i1} + a_{12}x_{i2} + \cdots + \varepsilon_{i1}$$
$$U_{i0} = a_0 + a_{10}x_{i1} + a_{20}x_{i2} + \cdots + \varepsilon_{i0}$$

where ε_{i1} and ε_{i0} are the error terms.

The utility levels are not the observable variables, and the gap between U_{i1} and U_{i0} is a latent variable. The decision rule is as follows: individual chose to participate to the project if $U_{i1} > U_{i0}$. Assume that P_i the probability that the individual i chooses to participate to the forest restoration.

$$P_i = \Pr(y_i = 1) = \Pr(U_{i0} < U_{i1})$$
$$= \Pr[\varepsilon_{i0} - \varepsilon_{i1} < (a_1 - a_0) + x_{i1}(a_{11} - a_{10}) + x_{i2}(a_{21} - a_{20}) + \cdots + x_{in}(a_{n1} - a_{n0})]$$
$$P_i = \Pr(\varepsilon_i \leq x_i'\beta) = F(x_i'\beta)$$

with F represents the distribution function, $x_i' = (1 \; x_{i1} \; x_{i2} \; \dots \; x_{in})$ the vector of explanatory variables, ε_i is a random effect equal to $\varepsilon_{i0} - \varepsilon_{i1}$, and β the vector of estimate parameters:

$$\beta = \begin{pmatrix} a_1 - a_0 \\ a_{11} - a_{10} \\ \dots \\ a_{n1} - a_{n0} \end{pmatrix} = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \dots \\ \beta_n \end{pmatrix}$$

As a general principle in a binary choice model, the individuals are supposed to have the choice between two possibilities. We attempt to model the probability of choice among these alternatives. Thus, the farmer decision represented by the variable could take two values 0 or 1. By noting P_i the probability that y_i equal to 1, we note:

$$P_i = \Pr(y_i = 1) = F(x_i'\beta)$$

The fact that the probability is included between 0 and 1, consequently the model must verify the two following conditions:

$$\lim_{x_i'\beta \to +\infty} \Pr(y_i = 1) = 1$$

$$\lim_{x_i'\beta \to -\infty} \Pr(y_i = 1) = 0$$

3.3 Analytical Method

An OLS regression of y_i on the vector X cannot be used because this method ignores the discreteness of the dependent variable and does not constrain predicted probabilities to be between zero and one (Cameron & Trivedi, 2005). Probit model is one of more appropriate models for binary outcomes. Using discrete dependent variable which cannot be modeled by linear regression, this model requires more computational effort to fit and is harder to interpret (Baum, 2006). And the best analytical method is the maximum likelihood estimation (MLE) [for mathematical demonstrations see Caderot et al. (2009, pp. 408-413) or Fomby (2010)].

Taking account these considerations, we formulate the following empirical model:

$$decis_i = \alpha_0 + \alpha_1 age_i + \alpha_2 liter_i + \alpha_3 ethngr_i + \alpha_4 marsta_i + \alpha_5 landow_i + \alpha_6 wtfarm_i + \alpha_7 credit_i + \alpha_8 agritra_i + \alpha_9 ofincome_i + \alpha_{10} resarea_i + \varepsilon_i$$

where the indicator variable *decis* is set to zero for the farmer against the project of reforestation and to one for those reporting their adhesion to this project.

3.4 Description and Justification of the Used Variables, Expected Signs of Their Coefficients

The used variables in the estimation of Probit model are described and justified individually. Indeed, the results of the studies quoted in previous section allowed listing a set of explicative variables being able to affect the decision of farmers. The expected signs of the coefficients of these variables and their potential impacts on farmer decisions are presented in the next table.

Table 1. Description of used variables

Variables	Description
decis	The dependent variable reflects a situation of binary choice by representing the decision of household head (HH) concerning the project of forest restoration. It equals to 1 if the response is yes and 0 otherwise.
literacy	This represents the educational level attained by the household head (HH). It takes the value 1 if HH is a well-read man (a well-read woman) and 0 otherwise. The fact that the HH is illiterate decreases the probability to accept of the reforestation project.
ethnic group	This variable describes two ethnic groups: the indigenous group and the non-indigenous group. This dummy variable takes the value 1 if HH belongs effectively to the native population and 0 otherwise.
marsta	This is a dummy variable which reflects the marital status of respondent. It takes the value 1 if HH is married or common-law and 0 otherwise. The fact that the interviewee is married or a common-law decreases the probability to accept of this latter.
Age	The age of the respondents is measured in years. This variable is categorized in two age-groups: 17-to-45-year-old and 45-to-85-year-old. The individuals, belonging to the 17-to-45-year-old group, are supposed to have some probabilities higher relative to the individuals of the other age-group. This category of persons thinks they could fit into others sectors of economic activity by reason of their youth. As to the age-group of 45-to-88-year-old, these persons have family and social responsibilities such as they are unable to yield ground in a proportion higher than the one of the previous age-group.
landow	This describes the status of landowner of the household head. It is a dummy variable which takes the value 1 if HH is landowner and 0 otherwise. The status of landowner is supposed to affect positively the decision of the HH.
wtfarm	This is a dummy variable which measures the worker status of the respondent. It takes the value 1 if the household head is a whole-time farmer and 0 otherwise. The whole-time farmer are supposed to have a weak probability to accept the forest restoration project relative to the others peasants.
credit	This dummy variable captures the access to credit. It takes the value 1 if the farmer has access to credit and 0 otherwise. The farmers, who have access to loan, have a probability to yield ground higher than the one of others.
agritra	This is a dummy variable which takes the value 1 if the household head has benefited of an agricultural training supplied by one of the technical services of Ministry of agriculture and 0 otherwise. Agricultural formation is supposed to improve the productivity of farmers and could increase the probability to yield ground.
out-farm income	This dummy variable gives information about the out-farm income of the household head. It takes the value 1 if this one (or another member of family) receives an income from another economic activity and 0 otherwise. The household heads receiving this type of income are supposed to have a higher probability to yield ground comparatively to the others household heads.
resarea	This is a dummy variable which indicates the household's residence area relative to National Park of Taï (NPT). It takes the value 1 if the household inhabits in east area of NPT and 0 if the household inhabits in west area of this park. The fact that the household lives in east area is assumed to affect positively the decision of the grower.

Source: Author's description.

4. Results and Discussion

Traditionally, any farmer with land sizes ≤ 2 ha is considered as a smallholder. These farmers belonging to this category have low endowments of land as well as other factors such as capital but tend to be well endowed with labor (Birthal et al., 2013). But, according to survey data, the average cultivated land reaches 5.88 ha in export agriculture and 1.15 ha in food-crop agriculture. The agricultural activities practiced in the South-West are dominated by the crop of cocoa and the family production units. The survey results revealed only 15% of the respondents are farmers with land sizes ≤ 2 ha. While if we consider as small farmer each landowner with land size ≤ 5 ha because of the characteristics of export agriculture which is practiced generally on large land, the percentage of small farmers becomes 50.40%. These results show that Ivorian agriculture is widely dominated by smallholders. It is observed that a high proportion of respondents (89.96%) are landowners of their land areas cultivated.

The average size of households is about 10 individuals. Male-headed households are numerous in the sample than female-headed counterpart. Indeed, the first represent about 94.29% and the last 5.71% of the sample. Respondents are respectively at 60.63%, 22.24%, 16.14% and 0.98% of no education, primary, secondary and university education levels. As to ethnicity, it is remarked that the foreigners represent the largest ethnic group accounting for about 42.91% of the surveyed farmers. This was followed by the non-indigenous group (41.73%) and the indigenous group (15.35%).

Numerous are the farmers who practice the double-cropping. This category of farmers represents about 75.59% of the respondents. And a large part of the respondents practice the agricultural activity as a whole-time work. Also, diversification by farmers is observed toward high-value crops (cocoa, coffee, palm grove and particularly rubber) with a view to raise their farm incomes significantly. Consequently, it leads a detrimental decrease of

food crops production.

Elsewhere, survey data reveal that about 58.66% of household heads belong to the 17-to-45-year-old group. Thus there are 31.10% and 10.24% of the surveyed individuals respectively in the 45-to-65-year-old group and the 65-to-88-year-old group. The average age of surveyed farmers is estimated to be 43 years, while that the median age is 42 years. Most of the agricultural activities require a lot of strength and energy. With more than half of the surveyed persons belonging to the 17-to-45-year-old group, we can suppose evidently that the phenomenon of deforestation will continue to accelerate. Indeed, these farmers are likely to possess the necessary strength to carry out these operations. Survey data have also shown that the membership to the farm co-ops explains the decision of household head regarding the acceptance of the forest restoration policy. Estimates have indicated that more than half of the surveyed reported be members of these co-ops.

Moreover, as regards contacts with agricultural development agencies, it is observed that about 83.66% of surveyed farmers are in relation with the agricultural management structures on the one hand, and that nearly 34.25% of these farmers have received agricultural training on the other hand. Only 23.62% of farmers have previously had access to credit. Despite the proliferation of mutual aid group in almost totality of Ivorian communities, particularly in those who live in rural areas, it is observed that only few household heads are members of these groups.

Also, survey data reveal that nearly 70.08% of the respondents are opposed in a foreseeable future to the extension of the forest areas to the detriment of their cultivated areas. To understand the farmers' perception concerning the forest preservation, it is necessary to analyze the main reasons put forward in order not to yield ground (see next Table).

The answers to the attitudinal questions, which were included to assess the individual's perceptions regarding the necessity of the forest restoration, reveal that they perceived the harsh lack of farmland in the studied area and the significant contribution of forest resources to agricultural productivity. But only 29.92% of the respondents are willing to yield a parcel of their cropland for the forest restoration. As to the others respondents who are opposed to the project, they give several reasons to justify their decisions (see Table 2).

Table 2. Main causes of the refusal to contribute to the forest restoration

Main reasons	Responses	Percentage
There is a harsh lack of farmland in the region	264	74
I am not the owner of my croplands	21	06
I have nothing to do outside of agriculture	47	13
The croplands are the property of my family and must be left to our descendants	18	05
Other reasons	06	02
Total	**356**	**100**

Source: Author's calculation from field data.

Of all reasons described in the previous table, the rarefaction of forest area is mainly advanced by the farmers to explain their refusal of the reforestation policy. Then, there are respectively the incapability to find another job outside agriculture, the absence of property rights on the cultivated areas and the reason for leave a legacy to the descendants.

In order to understand the reasons for this discrepancy in the willingness to accept of farmers, an empirical estimate is conducted through a simple probit model. The estimation results allow identifying the main explanatory variables of farmer participation to the restoration of the forest. Thus, we notice that the farmer decision is affected by the age, the ethnic group, the fact to have benefit of an agricultural training, the access to credit and the residence area of his household. The values and the signs of coefficients of the explanatory variables are presented in the next table.

Table 3. Empirical results of the simple probit model

Variables	Coefficients	P-value	Marginal effects
Literacy	.119	0.381	.040
Marital status	.134	0.480	.047
Age	.276	0.026**	.094**
Whole-time farmer	.062	0.632	.021
Out-farm income	.262	0.262	.083
Ethnic group	.494	0.018**	.150**
Agricultural training	.270	0.045**	.089**
landow	.063	0.752	.021
Credit	.307	0.042**	.099**
Residence area	.420	0.006***	.147***
Constant	-.379	0.182	
Number of observations = 508; LR chi2(14) = 32.61; Prob > chi = 0.000			
Log likelihood = -293.674; Pseudo R2 = 0.052			

Note. ***significant at 1%; **significant at 5%; *significant at 10%.

Source: Author's calculation.

The estimate results allow making some remarks. Indeed, estimates reveal that only five of the explicative variables, age, ethnic origin, agricultural training, access to credit and household's residence area, are significant. These variables are positively associated with the acceptance of forest restoration. Also, the improvements in farmer productivity and agricultural performance appear to reduce the demand for more forest clearance. Elsewhere, estimate results indicate that, in the farmers' community, the young people are more willing to adhere to the project of forest restoration relative to the others. Indeed, the fact to be a young farmer (i.e., being from the group of 17-to-45-year-old) increases the probability of acceptance of the project of forest restoration by 0.0932. As mentioned in the study of Moon et al. (2002), it is observed that age affects the willingness to pay of the respondents towards the environmental goods. Similarly, the fact of being from non-indigenous group decreases the probability to accept the project by 0.1528 529. Indeed, with regard to ethnic membership, the project of forest restoration was found to be slightly more accepted by the household whose the head is native from the southwest comparatively to the households whose the head is foreigner to the region (see Appendix A2). As to the fact to have access to credit, we remark that it has significant effect on the probability of acceptance. The farmers which have access to credit are more fitted to adhere to the forest restoration project than the others with a probability of 0.0998 133. Elsewhere, the fact to benefit an agricultural training increases the probability of adhesion to the project of the forest restoration by 0.0898 182. Finally, the results showed that the forest depletion increases the probability of acceptance by 0.1501 68. This result shows the farmers settled in the study area where forest area is plentiful are more willing to adhere to the project of forest restoration relative to those which are living in the region weakly endowed with forest resource. As shown in the study of Lera-López et al. (2012) with populations living near roads who are willing to pay more to reduce air and noise pollution, we found in this study that the respondents living in the eastern area of the park (who are more affected by the environmental problem), are those who are willing to accept the reforestation policy.

Besides, the empirical results show that the farmers' decision is not explained by the following variables: marital status, literacy, whole-time farmer, out-farm income, and landowner. Concerning the out-farm income, we note that this one did not have statistically significant effects on the probability to accept the project of forest restoration. Thus, respondents which receive an income obtained outside agriculture are not more willing to accept than those deprived of this type of income. While this result is contrary to what we expected, a considerable number of studies on contingent valuation of environmental goods, and particularly the study of Moon et al. (2002), have reported the insignificant effect of income on WTP.

To justify the insignificant effect of landowner's status on the decision of farmer, we could put forward the unlawful occupation of state forests (classified forests, national reserves and parks) that is in vogue in the southwest Côte d'Ivoire. The forest areas located in this part of the country are seriously degraded. It is estimated that about 25% of the national production of cocoa is realized in the protected areas (parks, reserves, and classified forests), in large part in those that are located in the southwest Côte d'Ivoire (Sangaré, 2017).

Against all expectations, it is observed that the schooling of the household heads do not contribute significantly to explain their decisions of participation to the policy of forest restoration. One plausible explanation is that the educated farmers may be more aware of environmental problems comparatively to the others farmers. Indeed, the uneducated farmers don't evaluate exactly the risks related to the forests degradation.

Besides, empirical estimates have highlighted some discrepancies between the probabilities to contribute to forest restoration across the western and eastern peripheries of National Park of Taï. This fact could offer useful insights into understanding environmental differences between the two areas. For these reasons, a useful comparison must be made between these areas. A selection of socioeconomic characteristics of the farmers was examined and their variations between the two visited districts under considerations established. On the whole, we observe the results described in Table 4.

Table 4. Comparison between the west area and the east area of the study area

Variables	West area	East area	t-test
Average age (years)	42.59	43.58	-0.809
Household size (persons)	9.06	10.46	-2.485[***]
Farming experience (years)	11.30	20.54	-9.880[***]
Average farm size (ha)	7.12	7.49	-0.464
Average size of food-crop farms (ha)	1.63	1.26	2.305[**]
Average size of cash-crop farms (ha)	5.49	6.22	-0.969
Average length of residence (years)	26.26	23.34	2.630[***]

Source: computed from field data 2010/2011.

Comparative analysis of the socioeconomic characteristics between the two groups of smallholders indicates that there are significant differences in the estimated means for several variables. According to the student's test (T-test), two means are statistically different if the T-statistic is significant at the 5% level. Thus, the results of the T-test for equality of means displayed in Table 4 indicate that the variation between the two areas was not significant only for the variables such as average age, average farm size and average size of cash-crop farms. The contrary result is observed for the others variables (household size, farming experience, average size of food-crop farms; average length of residence) (see results of T-tests in Appendixes). As observed in the results of the T-test for equality of the means, we can consider that there is a significant difference between west and east areas.

As shortcomings to the estimates conducted in this paper, we can highlight the fact the probability of acceptance of the farmers might have been accounted for by some economic and environmental factors that are not or insufficiently captured in the model. These factors include education, contact with the agricultural development agencies, previous activity, household size, land quality, labour quality, disease, mutual aid group, and so on. In developing countries, it is commonly recognized that household size plays a significant role in farming, particularly in subsistence farming, where farmers rely on household members for the supply of the farm labour. So, household size might evidently explain the behavior of household head regarding the forest restoration.

Four of the variables, out-farm income, whole-time farmer, landowner, and literacy, were correctly signed. Also, it will be necessarily interesting to include in the analysis the variables regarding experience and traditional/improved technology used by the farmers and their perception of the deforestation. Indeed, Lera-López et al. (2012) observed in their study that the more environmentally aware individuals are willing to pay more to reduce some externalities. We can also suppose that the perception of individuals on deforestation could explain positively their adhesion to the large-scale reforestation.

5. Conclusion and Policy Implications

In Côte d'Ivoire, the issue of deforestation has come to centre stage. The economic consequences of deforestation and recent trends toward sustainable development have increased the pressure on policymakers to adhere to standards of sustainable agriculture in their duties.

This paper does not suggest that the reforestation policies are easy, nor does it suggest that Côte d'Ivoire has found an ideal model to limit deforestation, nor that such a model even exists. It aims to analyze the explanatory factors of the farmers' adhesion to the national program of forest development.

Our study site, the South-West Côte d'Ivoire, is an agriculture-dominated area, with the highest proportions of growers settled in this country. Thus, it is an excellent site to investigate the determinants of farmers' participation to any project of the restoration of forest areas. Our data, which were collected during September 2010 and June 2011, allow us to study the impact of socio-demographic and economic characteristics and geographic regions on their decision to contribute to this project and to explore implications of these findings for the reconstitution of Ivorian forest resources.

Descriptive statistics show that a larger part of farmers in this region is opposed to forest restoration policy.

Nevertheless the findings highlight the need for the conservation and restoration of degraded forests. Most of farmers surveyed recognize that forest resources contribute significantly to grow their harvest. Also the farmers highlight the need to preserve the forest resources. But, only 29.92 percent of the investigated farmers accept, for a reason or another, to participate to forest rehabilitation.

This study found singularly that agricultural training, ethnic group, access to credit, the age of the head of household and the household's residence area play a very significant role in farmer's acceptance. The findings prove that agricultural training and access to credit are the main channels through which we might educate farmers on the reforestation project. Also, it is important to lead some policies for improving the farmer adhesion to the restoration of forest areas as well as fighting against deforestation. Indeed, restoring the degraded forest areas will bring numerous benefits to the economy of Côte d'Ivoire. Moreover, the carbon credit revenues could also be earned, bringing additional funds for forest conservation and livelihood improvement.

The problems of the forest restoration can be tackled in a variety of ways. Among them, a great importance might be given to a stronger policy framework which is imperative in bringing about improved farmer performance. These guidelines would include:

- Continuing to promote the adoption of best techniques of agricultural production. Particularly, the policymakers would promote the development and diffusion of modern high-yielding varieties of crops. This leads to the increase of farmers' productivity and the sensitive decrease of the forest degradation also. The co-ops might play an important role in this context.

- Strengthening the policy of employment creation in the sectors with low intensity in land. This allows to turn away young people from agricultural activities toward others activities less dangerous for the forest.

- Increasing the access of farmers to the improved seed. This action will decrease assuredly the quantities of cropland. Also Ivorian authorities must develop the changes in technology that would permit the double-cropping to replace the single-cropping.

This short survey of the literature on the deforestation in Côte d'Ivoire presented earlier in this study suggests several issues for further research. The further research should be conducted with data of a large-scale national survey.

Acknowledgements

References

Barbier, E. B. (2010). Poverty, Development, and Environment. *Environment and Development Economics*, 1-26. https://doi.org/10.1017/s1355770x1000032x

Baum, C. F. (2006). *An Introduction to modern Econometrics Using Stata*. A Stata Press Publication, United States of America.

Birthal, P. S., Joshi, P. K., Roy, D., & Thorat, A. (2013). Diversification in Indian Agriculture toward High-Value Crops: The Role of Small Farmers. *Canadian Journal of Agricultural Economics, 61*, 61-91. https://doi.org/10.1111/j.1744-7976.2012.01258.x

Cadoret, I., Benjamin, C., Martin, F., Herrard, N., & Tanguy, S. (2009). *Econométrie appliquée, Méthode—Applications—Corrigés* (2eme édition). Edition de Boeck Université, Belgique.

Cameron, A. C., & Trivedi, P. K. (2005). *Microeconometrics, Methods and Applications*. New York: Cambridge University Press. https://doi.org/10.1017/CBO9780511811241

Ehui, S. K., & Hertel, T. W. (1989). Deforestation and Agricultural Productivity in the Côte d'Ivoire. *American Journal of Agricultural Economics, 71*(3), 703-711. https://doi.org/10.2307/1242026

Ehui, S.K., Hertel, T.W., & Preckel, P.V. (1990). Forest Resource Depletion, Soil dynamics, and Agricultural Productivity in the Tropics. *Journal of Environmental Economics and Management, 18*, 136-154. https://doi.org/10.1016/0095-0696(90)90044-Y

FAO. (2012). *State of the World's Forests*. Rome.

Fomby, T. B. (2010). *Lecture Notes on Binary Choice Models: Logit and Probit, Maximum Likelihood Estimation of Logit and Probit Models, Department of Economic SMU March, 2010*. Retrieved from http://faculty.smu.edu/tfomby/eco5385/lecture/Logit%20and%20Probit%20Notes.pdf

Lamb, D., & Gilmour, D. (2003). Rehabilitation and Restoration of Degraded Forests. *Scientific Reports, 6*(2), 773-776.

Lera-López, F., Faulin, J., & Sánchez, M. (2012). Determinants of the willingness-to-pay for reducing the environmental impacts of road transportation. *Transportation Research Part D, 17*, 215-220. https://doi.org/10.1016/j.trd.2011.11.002

Madureira, L., Nunes, L. C., Borges, J. G., & Falcão, A. O. (2011). Assessing forest management strategies using a contingent valuation approach and advanced visualisation techniques: A Portuguese case study. *Journal of Forest Economics, 17*, 399-414. https://doi.org/10.1016/j.jfe.2011.04.001

Ministry of Planning and Development. (2012). Plan National du Développement 2012-2015. République de Côte d'Ivoire.

Ministry of Planning and Development. (2014). Preliminary results of 2014 Census, République de Côte d'Ivoire.

Moon, W., Florkowski, W. J., Brückner, B., & Schonhof, I. (2002). Willingness to Pay for Environmental Practices: Implications for Eco-Labeling. *Land Economics, 78*(1), 88-102. https://doi.org/10.2307/3146925

OIPR. (2006). Plan d'aménagement et de gestion du Parc national de Taï, Office Ivoirien des Parcs et Réserves, l'environnement, Ministère des Eaux et Forêts.

Raboteur, J., & Rodes, M. F. (2006). Application de la Méthode d'Evaluation Contingente aux récifs coralliens dans la Caraïbe: Etude appliquée à la zone de Pigeon de la Guadeloupe. *La Revue électronique en Sciences de l'Environnement VertigO, 7*(1), 1-17. Retrieved from http://www.guadeloupe.developpement-durable.gouv.fr/IMG/pdf/vertigovol7no1_Raboteur_et_Rodes.pdf

Sangaré, M. (2011). *Effets de la raréfaction des espaces cultivables sur les niveaux de productions agricoles dans le Sud-Ouest de la Côte d'Ivoire.* Document de recherche.

Sangaré, M. (2014). *Déforestation et Agriculture en milieu rural ivoirien* (Thèse unique, Université Félix Houphouët-Boigny de Cocody-Abidjan).

Sangaré, M. (2017). Analyse économique de la Restauration des Aires Protégées en Côte d'Ivoire: Cas du Parc National de Taï. *European Scientific Journal, 13*(1, 2 & 3).

Shechter, M. (2000). Valuing the environment. In H. Folmer & H. L. Gabel (Eds.), *Principles of Environmental and Resource Economics, New Horizons in Environmental Economics* (2nd ed., pp. 72-103). Cheltenham, UK: Edward Elgar Publishing Limited.

Stessens, J., & Dao, D. (2006). *Côte d'Ivoire: Profil des marchés pour les évaluations d'urgence de la sécurité alimentaire*. Katholieke Universiteit Leuven, Programme Alimentaire Mondial, Service de l'Evaluation des besoins d'urgence (ODAN).

Tano, A. M. (2012). *Crise cacaoyère et Stratégies des producteurs de la Sous-Préfecture de Méadji au Sud-Ouest ivoirien*. Thèse en vue de l'obtention du Doctorat de l'Université Toulouse 2 Le Mirail (UT2 Le Mirail).

Wasikama, T. M. C. (1998). *Utilisation alternative des terres: une analyse économique de la préservation des forêts tropicales primaires (cas du parc national de TAÏ, SUD-OUEST de la Côte d'Ivoire)*. (Thèse de Doctorat 3eme Cycle, Université de Cocody-Abidjan, CIRES).

Westerberg, V. H., Lifran, R., & Olsen, S. B. (2010). To restore or not? A valuation of social and ecological functions of the Marais des Baux wetland in Southern France, *Ecological Economics, 69*, 2383-2393. https://doi.org/10.1016/j.ecolecon.2010.07.005

Appendix A1

The Distribution of Respondents according to Visited Localities

DISTRICTS	SUB-PREFECTURES	VILLAGES	RESPONDENTS	TOTAL
SOUBRE	Buyo	Buyo	131	331
		Konédougou	59	
	Oupoyo	Walèbo	65	
	Meagui	Kragui	14	
		Pogréagui	62	
GUIGLO		Taï	77	177
	Taï	Daobly	41	
		Zagné	59	
TOTAL	4	8	508	508

Source: Survey Data.

Appendix A2

Description of the Explicative Variables

Variables	Description
Decis	=1 if the response of HH is yes and 0 otherwise
Socio-demographic variables	
Age	=1 if the HH belongs to the class [17-45[and 0 otherwise
Literacy	Academic standard of the HH (1: well-read and 0 otherwise)
Marital status	Marital status of household head (1: married and 0: no)
Ethnic group	=1 if the HH is indigenous and 0 otherwise
Landow	=1 if the HH is landowner and 0 otherwise
Economic variables	
wtfarm	=1if the HH is a whole-time farmer and 0 otherwise
Credit	=1 if the Household has access to credit and 0 otherwise
Agritra	=1 if the HH is payee of an agricultural training and 0 otherwise
Out-farm income	=1 if the household receives an out-farm income and 0 otherwise
Environmental variables	
resarea	=1 if the household lives in east area of NPT and 0 in west area

Source: Author's description.

Appendix A3

General Statistics

Variables	Mean	Standard-error	Minimum	Maximum
Decis	.7007874	.4583645	0	1
Socio-demographic variables				
Age	43.24	13.1724	17	88
Literacy	.3897638	.4881773	0	1
Marital status	.8818898	.3230567	0	1
Ethnic group	.1535433	.3608658	0	1
Landow	.8996063	.3008204	0	1
Economic variables				
wtfarm	.3562992	.4793771	0	1
Credit	.2362205	.4251779	0	1
Agritra	.3425197	.4750201	0	1
Out-farm income	.0905512	.2872527	0	1
Environmental variables				
resarea	.6515748	.4769411	0	1

Source: Author's calculation from field data.

Appendix A4

Analysis of Correlations between the Different Variables

```
          |  decis   marsta   wtfarm    ofinc     ag_1     eth_1   landow literacy agritra    loan   resarea
   decis |  1.0000
  marsta |  0.0139   1.0000
  wtfarm |  0.0373  -0.0079   1.0000
   ofinc |  0.0414  -0.0333   0.2379   1.0000
    ag_1 |  0.0984  -0.1681   0.0540  -0.0212   1.0000
   eth_1 |  0.0756  -0.0979   0.0480   0.2271   0.0187   1.0000
  landow |  0.0535   0.0604   0.0160   0.0826  -0.1277   0.0878   1.0000
 literacy|  0.0903  -0.0702   0.1808   0.1276   0.1388   0.3426   0.0521   1.0000
 agritra |  0.1274   0.0713   0.0260  -0.0109  -0.0216  -0.0082   0.1721   0.0781   1.0000
    loan |  0.1205   0.0168   0.0411   0.0345   0.0036  -0.0569   0.0470   0.0497   0.1455   1.0000
 resarea |  0.0816   0.0524  -0.1547  -0.3739  -0.0062  -0.5022   0.0719  -0.2119   0.1447   0.1343   1.0000
```

Source: Author's calculation.

. ttest aneprai1_1, by (loca) 1

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	11.30508	.6833632	9.091556	9.956444	12.65373
1	331	20.54381	.5778584	10.51321	19.40706	21.68056
combined	508	17.3248	.4861267	10.95674	16.36973	18.27987
diff		-9.238722	.9350464		-11.07577	-7.40167

diff = mean(0) - mean(1); t = -9.8805
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) = 0.0000; Pr(|T| > |t|) = 0.0000; Pr(T > t) = 1.0000

. ttest supv, by (loca)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	42.59322	1.010581	13.4449	40.5988	44.58764
1	331	43.5861	.7162869	13.0317	42.17704	44.99517
combined	508	43.24016	.5844309	13.1724	42.09195	44.38836
diff		-.9928824	1.226999		-3.403522	1.417757

diff = mean(0) - mean(1); t = -0.8092
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) =0.2094; Pr(|T| > |t|) = 0.4188; Pr(T > t) = 0.7906

. ttest supi, by (loca)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	163.0282	13.54627	180.2213	136.2942	189.7623
1	331	126.4502	9.062759	164.8825	108.6221	144.2782
combined	508	139.1949	7.591248	171.098	124.2807	154.1091
diff		36.5781	15.86484		5.409034	67.74716

diff = mean(0) - mean(1); t = 2.3056
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) =0.9892; Pr(|T| > |t|) =0.0215; Pr(T > t) = 0.0108

. ttest totmena, by (loca)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	549.7175	78.21858	1040.631	395.3505	704.0846
1	331	622.568	35.69135	649.3471	552.3567	692.7792
combined	508	597.185	35.81386	807.2033	526.8232	667.5469
diff		-72.85046	75.16924		-220.5327	74.83179

diff = mean(0) - mean(1); t = -0.9692
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) =0.1665; Pr(|T| > |t|) =0.3329; Pr(T > t) = 0.8335

. ttest sup, by(site)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	9.067797	.3773227	5.019952	8.323137	9.812456
1	331	10.46828	.3591625	6.534389	9.761741	11.17481
combined	508	9.980315	.2698272	6.081596	9.450198	10.51043
diff		-1.400481	.5634328		-2.507437	-.2935255

diff = mean(0) - mean(1); t = -2.4856
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) =0.0066; Pr(|T| > |t|) =0.0133; Pr(T > t) =0.9934

. ttest resid, by(site)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	712.7627	79.33695	1055.51	556.1885	869.3369
1	331	749.0181	38.20995	695.1692	673.8523	824.1839
combined	508	736.3858	37.16308	837.6132	663.3732	809.3984
diff		-36.25542	78.05683		-189.6108	117.1

diff = mean(0) - mean(1); t = -0.4645
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) =0.3213; Pr(|T| > |t|) =0.6425; Pr(T > t) =0.6787

. ttest resid, by(site)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	26.26554	1.155208	15.36904	23.98569	28.54538
1	331	23.34139	.5286831	9.618546	22.30138	24.3814
combined	508	24.36024	.5327095	12.00666	23.31365	25.40683
diff		2.924147	1.111559		.7403081	5.107986

diff = mean(0) - mean(1); t = 2.6307
Ho: diff = 0; degrees of freedom = 506
Ha: diff < 0; Ha: diff != 0; Ha: diff > 0
Pr(T < t) = 0.9956; Pr(|T| > |t|) = 0.0088; Pr(T > t) = 0.0044

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