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Linear Panel Data and Farming Cash Flow Analyses to Assess the Causes of Deforestation in the Upper Guinean Forest: Data and Evidence from the Prefectures of the Central Region in Togo

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Abstract

We present a careful quantitative description of land use in central Togo, by constructing farm budgets and analyzing time series data on agricultural production in four prefectures over the time period from 1996 to 2015. One key finding is that higher prices for chemical inputs are associated with more deforestation (as proxied by area in yam production), and correspondingly, greater quantities of chemical inputs applied are associated with less deforestation. This confirms that chemical fertilizers and forest clearing are substitutes and suggests that one path to reducing deforestation is to increase agricultural productivity, and to provide farmer with agricultural risk assistance that covers the farming negative externality costs. This risk assistance may include the coverage for the environmental deterioration costs, and the subsidies to compensate for investments' cost.

Keywords

Panel Data, Deforestation Factors, Farming Cost-Benefit Analysis, Agriculture Productivity, Agriculture Risks

1. Introduction

Both deforestation and rural poverty have become issues at a stake due to more and more demand for agricultural products associated to increasing world pop-

ulations. The concern is that forestry and agriculture are both important sectors for the human survival, and one cannot pretend to promote one sector without negatively affecting the other [1]. The expansion of agriculture land associated to increasing demand in food, fodder, and biofuel produced by tropical ecosystems, has raised concerns [2]. Prior to the recent decades, the cash crops or commodities have been limited to some few conventional crops including coffee, cocoa, tea, palm oil, cotton and some other textiles like kapok and silk, and were produced for exportation towards just some few western countries. But nowadays, the demand has internationalized and the practice has targeted a greater number of tropical agricultural goods. As example, the soybean was introduced in Togo just in recent years [3]. Bassan [4] found that, in 2003, the household surveying's year, 50% of the soybeans produced at the surveyed zone in Togo, and 88.5% in Benin aimed at producing the fermented spice (e.g., a food ingredient locally called *dawa-dawa*). Today, the soybeans production has supplanted any other conventional cash crop, because its uses have diversified to many other foods importantly the cheese and soymilk; in addition, it can be exported to many more countries. Other cash crops of the same consideration are peanut, cashew, pineapple, and many uncountable vegetables. This situation has become a great challenge for tropical countries for two major reasons. First, as would state Lambin and Meyfroldt [1], the land has become an increasing scarce resource in the tropics because most of these crops are tropical ecosystems site specific. Consequently, this agriculture land expansion is threatening for both the forest ecosystems as well as for the conservation policies built to protect them. Second, the practice of producing agricultural, forest or any other land based products abroad, usually called land use displacement, creates environmental costs (to the host country) which are not immediately perceptible to most project analysts. We still need to know the efficiency of our conservation policies, however.

To be able to assess the efficiency of various policies on conservation such as carbon storage (e.g., the Reduction of Deforestation and Forest Degradation+),, the wild life conservation and the conservation of water quantity and quality, it has become imperative to provide adequate understanding of the process of the agriculture expansion [2]. This understanding is equally important as we seek to improve these policies. There have been plethora studies of the causes of tropical deforestation, but very few have been concerned with West Africa. Some of these studies have undertaken the analysis at the national level [5], but as would say Geist and Lambin [6], most of them have been based on cross-country data, whose findings raise concerns as they are to be checked at the local levels. Further, none or rare of these has interested in the specific impact of land use displacement abroad. Thus, while seeking to add to the existing literature on the empirical analysis of tropical deforestation causes the study intends to know to what extent the farmer producer benefits from the farming to be able to account for environmental reparation following the agricultural practices. Thus in this article we identified the major causes of the deforestation in West Africa, particularly in Central Togo, and quantified their effects. Then through cost-benefit

analysis, we assessed the farming returns to the famer producer and finally question the effectiveness of our current policies in addressing the conservation issue.

2. The Conceptual Framework

The hypotheses in this study of deforestation in Togo are guided by the economic models. Most farm household models have been examined, but to ease the discussions we simply assume that the farmer producer concern is to maximize the total profit. This assumes a perfect labor market where farmers can hire workers and in return they can find employment themselves [5]. Barrowed principally from Angelsen [5], Sills [7], Nicholson [8], and Bassan [4] the profit maximization function is presented as in Equation (1):

$$R = PA\int\left(L,F,H\right) - qF - w\left(L + h\left(H\right)\right) \tag{1}$$

where:

R is the profit function, P is the unit price of the outputs, A is the level of the technology input, L is on -the-field labor input, H is the total land area, F is the quantity of the fertilizer input, q is the fertilizer unit price, w is the wage in the farm (or the existing opportunity wage in the country).

The FOC is presented in Equation (2)

$$PA = \frac{q}{f_F} = \frac{w}{f_L} = \frac{w_{h(H)}}{f_H} \tag{2}$$

According to Equation (1), an increase in the farm profit would necessitate an increase in the agriculture outputs which consequently would increase deforestation in the condition of Central Togo where the farming is in a great part extensive. Thus, we hypothesized that,

- an increase in any farming outputs (e.g., the selected crops' farming outputs) will increase the deforestation.

Considering all together Equation (1) and Equation (2), the production output depends on the level of inputs (e.g., labor, capital and land) used. This increase on the production resulting from the increase in the factor of production would necessary conflict with the forest land. Thus it can be hypothesized that:

- the increase in labor (e.g., the number of the farmer producers) would increase the deforestation,
- the increase on agricultural land would obviously increase the deforestation.

An increase in the capital investment would lead to intensification (e.g., an increase in the output per unit of land area), thus would help to conserve the forest lands. We therefore hypothesize that:

- an increase on capital quantity (e.g., fertilizer and pesticide quantities) would alleviate the pressure on the forest land.

The production increase may result also from increasing output price. This increase in the output price would produce two types of effects resulting from the driving of the labor into the concerned sector. Two options are therefore available.

1) If the sector is conflicting to the forestry development as in the case of yam cultivation, then

- the increase in the output prices would increase the deforestation

2) As the sector does not conflict with the forestry practice, the increase in the output price may drive the labor to the sector, therefore easing the conservation. Another consequence may be that the revenue from the promoted sector helps to initiate other enterprises importantly the non-land based economic enterprises. In both cases, the increase in the output prices will favor the conservation. Thus the hypothesis is:

- An increase in the output prices would decrease the deforestation.

Considering now the investment side, the effects of the input price will depend on the type of the input. The agriculture wage increase will affect the vegetation cover depending on whether the farmer is the labor buyer (case of the food crops), or the labor provider (case of the cash crops). Thus the hypotheses are:

- An increase in food crop wage related variables will increase deforestation.
- An increase in cash crops (e.g., cotton) wage related variables will reduce deforestation.

Elevated agriculture land price will force the farmer to forestry practices, importantly through illegal cutting. Also the land availability (free costs) will drive farmers to agriculture practice (even immigrants), thus will increase vegetation cover loss. Thus the hypothesis is:

- An increase in the land price related variables is expect to increase the vegetation cover loss.

Finally, if the farmer does not have access to capital input because of the high price, he will shift to forestry practices. Thus the hypothesis is:

- An increase in the agriculture capital related input price's variables (e.g., fertilizer cost, and pesticides cost) will increase deforestation and forest degradation.

The next issue is which farming crop is favored, or is more likely to contribute to forest loss. As raised by Bassan [4], the crop that benefits the most incentive from the corporates, or other institutions (e.g., state institutions, international institutions) is likely to be more cultivated. Thus the hypothesis is:

- Any cash crop (e.g., cotton) farming is more likely to increase deforestation than food crops farming.

3. Materials and Method

3.1. The Study Area (Figure 1)

The study concerns the Central region of Togo. The coordinates recorded in Sokodé, the major city are 09 degrees North latitude and 01.09 degrees East longitude. It is a part of the vegetation cover type that stretches from the savanna-forests of the Upper Ivory Coast [9], into the Dahomean Gap in Togo. The area is limited in the South by the Plateaus region, and to the North by the Kara

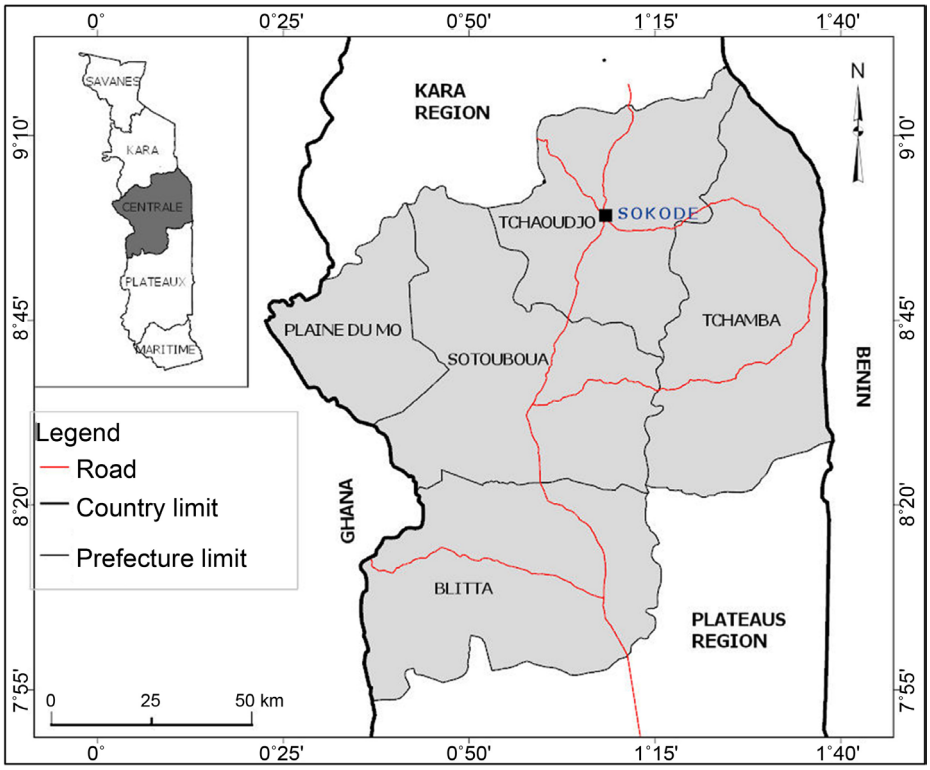

Figure 1. A map of the central Togo.

region. It makes frontiers with Ghana in the West and with Benin in the East. Administratively, as shown in **Figure 3**, it is originally divided into five prefectures which are Blitta, the Plain of Mô River, Sotouboua, Tchamba, and Tchaoudjo. The Togo forest service is represented in each prefecture. These offices are coordinated by the regional office located in Sokodé. Each regional office, a total of five in the country, operates under the national forest and environmental office of the Ministry of the Environment and the Forest Resources of Togo. The climatic characteristics in Sokodé, with the annual rainfall minima of 964.5 mm, the maxima of 1645.1 mm, and the averages of 1270.49 mm, do not favor the occurrence of the dense forests. According to Chevalier [9] the dense forest occurrence requires a minimum annual rainfall of 1500 mm distributed all over the year, and a dry season less than three months [9]. However, the dense forest occurs in patches within the savanna ecosystem. This dense forest predominate the savannas in the lower latitude like in the Prefecture of Blitta, as well as at the rivers and water streams' banks.

The area presents a great potential for ecological biodiversity. In fact, an inventory of protected areas in 1993 [10], recorded 14 protected areas covering a total of 252,087 ha. In addition, the region hosts two of the major protected areas of the country including the protected area of Fazao and that of Aboudlye. At the economic stand points, the Central region along with the Plateaus region of the country supply wood to satisfy the national demand and for exportation. The agriculture is the major economic activity. This small holding agriculture is

practiced in shifting cultivation, and in rotation of crops from one year to another. Yam is the sole crop that performs very well on a forest land or on dense wooded savanna newly converted to agriculture. Thus, the farmer starts the farm by cropping yam in the first year. The other food crops (e.g., cereals, tubers, and beans), and the cash crops, are cultivated either in the second, third, or forth year after the land is set to farm. For these reasons, the land area allocated annually for yam planting has constituted the proxy in this study of deforestation. Another consideration is that the vegetation includes both the wooded savanna and the forest and because these two vegetation cover types may coexist in the region, as largely discussed above, the land conversion to agriculture may include also the wooded savanna. At the national level and according the 2011 Agriculture census [11], the population in agriculture in rural area is of 97.3% in average. The farms of 0.5 ha in size represent 76%, 0.5 - 1 ha 18%, 1 - 2 ha 5%, and finally, the farms of more than 10 ha, 1%.

3.2. Method

For this analysis our major reference is Wooldridge [12]. Data from the four prefectures of interest collected over 20 years, 1996-2015, were pooled in a sectional data across time, a total of 4 × 20 observations. The general Ordinary Least Square model could be presented as in Equation (3) below. The variables are specified in Table 1.

$$\begin{aligned} VCAloss = {} & \delta_0 + \delta_1 Dblit + \delta_2 Dtchb + \delta_3 Dtchd + \beta_0 + \beta_1 popTog + \beta_2 gdp\_B\_D \\ & + \beta_3 mwage + \beta_4 permCV + \beta_5 fuelW + \beta_6 amand + \beta_7 pcproT \\ & + \beta_8 cproN + \beta_9 cproAN + \beta_{10} Ncprice + \beta_{11} Rcfertq + \beta_{12} NcfertC \\ & + \beta_{13} Rcpestq + \beta_{14} NcpestC + \beta_{15} pyproT + \beta_{16} fertq\_t \\ & + \beta_{17} fert\_cost + \beta_{18} casproT + \beta_{19} pbeaproT + \beta_{20} ppeaproT \\ & + \beta_{21} pmproT + \beta_{22} psproT + \beta_{23} prproT + w_{it} \end{aligned} \quad (3)$$

where:

VCAloss the dependent variable is the vegetation Cover Area loss is the area converted annually to agricultural land (the yam cultivated land area), in hectare; *pop Tog,* is the population of Togo from 1996 to 2015; *gdp_B_D*, the country annual Gross Domestic Product, in Billions of dollars; *mwage*, the minimum wage, in the country currency per month of 22 days; *permCV,* the volume of the wood, in cubic meter, to which a receipt was issued following a payment required by the legal authority; *fuelW*, the biomass to which a cut license is issued by the legal authority, it includes the wood for charcoal and fire wood; *amand,* the annual illegal wood harvested, in cubic meter, to which a fine was issued; *pcproT,* in tons, is the cotton produced annually in the prefecture; *cproN*, the cotton producer number for the entire Central Region; *cproAN*, the number of cotton producers' association for the entire Central Region; *Ncprice*, the national cotton price in local currency for the year; *Rcfertq*, the quantity of fertilizer, in tons, used in cotton production in the Region per the year; *NcfertC,* the national unit price of fertilizer, in the local currency per bag of 5 kg, used in cotton pro-

duction; *Rcpestq*, the quantity of pesticide in liters, used in cotton production in the Region per the year; *NcpestC*, the national unit price of pesticide, the local currency per liter, used in cotton production; *pyproT*, the annual yam produced, in tons, per year in the prefecture; *fertq_t*, the quantity of fertilizer, in tons, used in food crops production per year in the Region; *fert_cost*, the unit price of fertilizer, in the local currency per KG, in Togo; *casproT*, the annual cassava quantity, in tons, of legumes produced in the prefecture; *pbeaproT*, the annual beans quantity, in tons, produced in the prefecture; *ppeaproT*, the annual peanut quantity, in tons, produced in the prefecture; *pmproT*, the annual maize quantity, in tons, produced in the prefecture; *psproT*, the annual sorghum quantity, in tons, produced in the prefecture; *prproT*, the annual rice quantity, in tons, produced in the prefecture; *Year*, the year from, 1996 to 2015, in which the data are collected; *Prefect*, the Central Region Prefecture in which the data are collected; *W*, the error terms or the residuals.

Table 1. The variables data and their sources.

Factors	Variables	Source
Food production	Area	DSID
	Cereal quantity (maize, sorghum, and rice)	
	Pulses quantity (beans and peanut)	
	Tuber quantity (yam and cassava)	
	Annual Pesticide used (quantity)	
	Pesticide cost	
	Annual fertilizer used (quantity)	
	Fertilizer cost	
Commodities (Cotton)	Area	NSCT
	Cotton Quantity	
	Cotton price	
	Annual pesticide used quantity	
	Pesticide cost	
	Annual fertilizer used (quantity)	
	Fertilizer cost	
Forestry practices	Number of cotton associations	DSID
	Population in production in central region	
	Fines from illegal forestry practices	DR Centrale
	Lumber produced	
	Fire wood and charcoal	
	Wood price	
Socio economic data	Country Population	Internet, INSEED
	Gross Domestic Product (GDP)	

NSCT: the French acronym the Cotton Society of Togo; DSID: the French acronym for the Agriculture's Office of Statistics Information and Documentation: INSEED: the French acronym for the National Institute for the Statistics, and the Economics and Demographic Studies; DR Centrale is the Central Region Regional Environmental Office.

3.3. The Panel Data Model for the Entire Region

The test for homoskasticity (equal effects or equal variances) among the prefectures rejected the null hypothesis. The test for equal effects among the years failed to reject the null hypothesis.

The Ordinary Least Square model that allows controlling for the heterogeneity among the individual prefectures is presented in the Equation (4) below barrowed from Wooldridge [12]:

$$Y_{it} = \delta_1 + \delta_2 d_2 + \delta_3 d_3 + \cdots + \delta_T d_T + \beta_1 x_{1it} + \cdots + \beta_k x_{kit} + a_i + \mu_{it} \tag{4}$$

where:

Y is the dependent variable, the d's are the dummy variable created to capture the time period ($t = 1, 2, \cdots, 20$), specific effects, the it's are the individual observation i in the time period T ($i = 1, 2, \cdots, N$), k's are the index for the different independent variable, x's are the independent variables, a is the individual fixed effects which could be the unobserved variables specific to each prefecture, and the μ's are the error terms and constitute the residuals in the expression of each individual i, δ's and β's are the slope for the dummies and the independent variable, respectively.

To get rid of the fixed effects of an individual prefecture, we need to decide on the First Difference estimation or the Fixed Effect estimation. To be able to compare the effects of the cooperativity between the two models we have reported both of them. It is also important to report that the variables *popTOG* and *dgp_B_D* are dropped from the model because of high collinearity among themselves and with the *mwage*. The First Difference estimation tests for the difference in Y_{it}'s for two consecutive time periods as described in Equation (5):

$$\begin{aligned} \Delta Y_{it} &= Y_{it} - Y_{i(t-1)} \\ &= \beta_1 \Delta X_{1it} + \cdots + \beta_k \Delta X_{kit} + \Delta \mu_{it} \end{aligned} \tag{5}$$

In the Fixed Effect estimation the dependent variables Y_{it}'s are averaged over time to get the mean of the Y_{it}'s as in Equation (6):

$$\overline{Y}_i = \beta_1 \overline{X}_1 + \cdots + \beta_k \overline{X}_k + a_i + \mu_i \tag{6}$$

Then the regression is made on the difference between Y_{it}'s and $\overline{Y}_i$'s. Thus Equation (4) becomes Equation (7) below:

$$\begin{aligned} \ddot{Y}_{it} &= Y_{it} - \overline{Y}_i \\ &= \beta_1 \ddot{X}_{1it} + \cdots + \beta_k \ddot{X}_{kit} + \ddot{u}_{it} \end{aligned} \tag{7}$$

3.4. The Data

The variables data or the proxies (**Table 1**) necessary for the study were collected in panel for the time period from 1995 to 2015, and from the prefectures in the Central region of Togo. There are four prefectures retained for the study which are Blitta, Sotouboua, Tchamba, and Tchaoudjo. The fifth prefecture, the Plain of the Mô River, is newly created and there are no data available for the whole study time period. These data are mainly the forest data, agricultural food crop

data, the cash crop data, and the socio-economic data.

The forest data are secondary data compiled in a monthly basis by the prefectures. The annual reports which constitute the major sources of the data collection are normally available either in the Regional Forest Office in Sokodé, or at the General Secretary of the Ministry in charge of the environmental and forest resources. The variables of interest here are the wood biomass which may be categorized as fuelwood, charcoal and industrial wood production. Data on the receipts collected from various forestry activities including transport permit, cutting certificates, and also from the fines for illegal forestry operations, are available in these annual reports.

Data on crop production are also secondary data made available in most cases by the Office of Agriculture Statistics, Information and Documentation (DSID) of the Ministry of Agriculture. These data are the results of periodical agricultural census. But each year the census data are updated to make available data in the yearly basis. The variables considered here are the production and the output prices, the fertilizer quantity and price, and the pesticide quantity and price for each year. As announced above, the concerned food crops are cereals, tuber and pulses. The major important cash crop produced in the Region is the cotton, but coffee and cocoa are also cultivated under the dense forests in Blitta (e.g., mount Adele), the prefecture at the south most of the region. The historical data were made available for this study by New Office of Cotton Society (NSCT), formally called SOTOCO. The data include the cotton production, the price, cotton pesticides used, cotton fertilizer used and their prices. Some of the national figures are provided by the DSID.

The socio-economic data are provided either by the National Institute of Statistics, and Economics and Demographic Studies (Inseed), or from the websites. Besides the panel data, single point data such as data on agriculture systems (e.g., the agricultural field establishment, mix cropping practice, and the rotational practices) were obtained by question and answer with the Institute of Counseling and Support (ICAT)'s agents and with individual farmer producers implicated in major crops and cotton production. This information concerns the recent years from 2011 to 2016.

3.5. The Computing and Statistical Analysis Tools

The data were created in the MS **Excel** spreadsheet software and exported into the **R-2.5.1 statistical software for Windows**, using the "**read.table**" command for analysis. The R statistical software packages are the **plm** and **zoo** in the p**lm**, **sandwich, coeftest, and lmtest libraries**. The Panel Hausman Test (phtest) permitted to retain the First Difference model as the best fit to address the issue.

4. Analyses Results

4.1. The Results from Panel Data Analysis

The common farming practice in the area is the mix cropping, and yam is the

crop that starts the rotation. Therefore we decide the annual area converted to yam planting constitutes the proxy for the vegetation loss. The analysis results are compiled in Table 2 the full model, where are reported the 20 independence variables included in the model, their Fixed models and First Difference coefficient estimates, and the resulting probabilities. We are not able to report the reduced model outputs (made of the four underlying independent variables, the national cotton fertilizer cost (NcfertC), the national cotton pesticide cost (NcpestC), the national cotton price (Ncprice) and the national minimum wage (mwage), because these independent variables do not quite explain by themselves the vegetation cover area loss (very low coefficient of determination R^2). Furthermore, including the time dummy's to capture the time effect results in

Table 2. Vegetation cover area loss linear panel model.

variable	Fixed effect estimates				First difference estimates			
	Estimate	**Std. Error**	**Robust stdE**	**Pr (>|t|)**	**Estimate**	**Std. Error**	**Robust STD error**	**Pr (>|t|)**
x4mwage	6.9629e−02	9.2500e−02	5.4195e−02	0.206257	0.04575837	0.08357681	0.04780257	0.344198
x4fuelW	3.9084e−04	4.2705e−03	1.2448e−03	0.755177	−0.00090186	0.00465068	0.00136366	0.512181
x4pcproT	−7.9061e−02	2.0287e−01	1.1174^{e}−01	0.483319	0.05297004	0.21094800	0.11645392	0.651670
x4cproN	**7.1133e−02**	**6.0755e−02**	**3.2984e−02**	**0.037105***	**0.07505823**	**0.05034743**	**0.03181295**	**0.023276***
x4cproAN	3.1033e+00	8.6318e+00	5.7100e+00	0.589807	−0.62983081	6.86620396	5.17097862	0.903666
x4Ncprice	−1.0468e+01	1.2630e+01	7.4972e+00	0.170324	−5.32711092	13.48743525	9.12651419	0.562702
x4Rcfertq	**−1.9763e−01**	**7.1914e−02**	**6.6301e−02**	**0.004874****	**−0.25192327**	**0.07759634**	**0.07159199**	**0.001097****
x4NcfertC	**8.5609e+00**	**9.0929e+00**	**4.1607e+00**	**0.046190***	**12.37716474**	**8.53468251**	**3.62820844**	**0.001490****
x4Rcpestq	**1.2216e−02**	**4.0104e−03**	**4.1740e−03**	**0.005625****	**0.01497277**	**0.00426332**	**0.00440342**	**0.001538****
x4NcpestC	**3.1811e+00**	**1.6441e+00**	**1.2326e+00**	**0.013636***	**4.72821844**	**1.72263058**	**1.43368774**	**0.002051****
x4Rfertq_t	−8.9807e−01	5.1134e−01	4.5081e−01 &	0.053212.	**−0.96146749**	**0.44427226**	**0.42087823**	**0.027728***
x4permCV	−1.7585e+00	6.5551e+00	4.8402e+00	0.718287	−4.57396888	6.95058234	5.90463680	0.443107
x4amand	−2.7234e+00	9.4071e+00	7.6238e+00	0.722802	−1.96224153	8.33402850	5.21645554	0.708783
x4pmproT	5.8174e−02	3.4482e−02	3.1848e−02	0.075230.	**0.07492936**	**0.03034442**	**0.02705182**	**0.008463****
x4psproT	2.8921e−03	3.4261e−02	2.7338e−02	0.916277	−0.02490590	0.03888238	0.03427687	0.471696
x4prproT	3.8027e−02	8.9765e−02	6.6368e−02	0.569874	0.00091690	0.09143739	0.08990411	0.991914
x4pbeaproT	3.1465e−01	1.6630e−01	1.6075e−01	0.057307.	0.18003438	0.16931574	0.16765939	0.289343
x4ppeaproT	−9.1673e−02	2.1009e−01	1.7672e−01	0.606792	−0.05505650	0.20257389	0.18410084	0.766445
x4pyproT	**2.0807e−02**	**5.9723e−03**	**9.3667e−03**	**0.032049***	**0.02343749**	**0.00508494**	**0.00718131**	**0.002256****
x4pcasproT	1.0175e−02	9.7267e−03	8.0824e−03	0.215373	0.01242709	0.00882272	0.00664911	0.068959.
	Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1 " " 1				Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1 " " 1			
	SST:	92,774,000			SST:	181,460,000		
	SSR:	37,556,000			SSR:	59,367,000		
	R^2:	0.59519			R2:	0.68803		
	Adj.R:	0.2005			Adj. R2:	0.53984		
	F-statistic: 2.94057 on 20 and 40 DF, p-value: 0.001811				F-statistic: 4.32964 on 19 and 40 DF, p-value: 4.7286e−05			

the drop of eight variable coefficients from the model, and significant statistical effect for all the fifteen non-dropped independent variables. Even though the pFtest for individual time effect is significant (p-value = 0.00089), we are not able to provide a Robust Standard Error of the time fixed effect for the full model either. A bunch of variable coefficients are also dropped from the model. Removing these independent variables to eliminate or reduce the serial correlation among them creates other drops. We attribute the drops primarily to data limitation (degree of freedom deficiency, 40 predictors if fixed estimation or 36 if first difference estimation, for a samples size of eighty or seventy-six, respectively). The multicollinearity among independent variables is the other cause as reported by Serban Scrieciu (2006) to which evidence is provide here. In fact, the model formulation itself leads to suspect serial correlations among independent variables which is confirmed by the Breusch Pagan lmtest (p-value = 0.002), and the Breusch-Godfrey/Wooldridge test (p-value = 5.618e−05 for the Chisq). This presence of multicollinearity can be created by the data quality; however the process of differentiation and demeaning which characterize fixed effect and first difference models respectively, might constitute the causes.

The numbers of Individual observations, the coefficients of determination, R^2, and F statistics are also indicated at the bottom of the Table 2. The stars accompanying the probabilities indicate the level of significance of each predictor. The adjusted coefficients of determination (R^2's) indicate that 20.05 percent for the Fixed effect estimation, and 53.98 percent for the First Difference estimate explain the Vegetation Cover Area loss and suggest that the First Difference model constitutes the best regression fit for this study. However, the First Difference estimation has poorly estimated the vegetation cover area loss in the reduced model. The test for heteroskedasticity rejects the null hypothesis. Thus, the robust standard errors that control for this heteroskedasticity were constructed and included along with the related probabilities in Table 2.

The significance effects of the independence variables depend on which of the models (whether the fixed effect model or the First Difference model) is used. As a general observation, comparing to Fixed Effect model, the First difference estimation increases the level of the statistical significance. The evidence to this are its higher coefficient of determination (R^2) observed in all the empirical analyses outputs presented throughout this study and its higher p-values from the analyses. Table 2 reveals that eight independent variables have significant effects for the First Difference estimates among which six, *NcproN* the national cotton producer number, *NcfertC* the national cotton fertilizer cost, *Rcpestq* the regional cotton quantity, *NcpestC* national cotton pesticide cost, *pmproT* maize production in the prefecture, and *pyproT* yam production in the prefecture, increase significantly the deforestation. Just two independent variables, *Ncfertq* National cotton fertilizer quantity, and *Rfertq-t* Regional fertilizer quantity, decrease the deforestation. When using the Fixed Effect estimation a total of six independence variables have significant effects. Five of them including *NcproN,*

NcfertC, *Rcpestq*, *NcpestC pyproT*, have positive significant effects. Just one independent variable, *Ncfertq* has negative significant effect.

4.2. Results from Cost-Benefit Analysis

Tables 3-5 below present the cash flow analysis of the farming in the region which includes the different activities with the related annual investment costs, the sales, and the net revenues, of the selected food crops (e.g., maize and yam), and the cotton, the major cash crops of the region, for the year 2011. Specifically, Table 3 estimates the maize farming total investment costs to 256,000 F cfa (Line 13), the sales to 209,400 Fcfa at the harvest time or at the market surplus, and to 279,200 F cfa for the late season sales (Lines 14 and 15), and finally the net revenues to −46,600 F cfa for the harvest time sales and 32200 F cfa for the late season sales (Lines 16 and 17).

Table 4 estimates the yam farming total investment costs to 389,000 F cfa (Line 11), the sales to 1,916,250 Fcfa at the harvest time or at the market surplus, and to 4,471,250 F cfa for the late season sales (Lines 12 and 13), and finally the net revenues to 1,527,250 F cfa for the harvest time sales and 4,082,250 F cfa for the late season sales (Lines 14 and 15). Table 5 estimates the cotton farming total

Table 3. Maize farming cash flow's table for the year 2011.

Year	Lines	The activities	2011	2012
		Labor		
	1	land clearing	12,000	
	2	Tillage	25,000	
	3	seed sowing	10,000	
	4	fertilizer application (3 hj)	14,000	
	5	weeding (8 hj)	12,000	
	6	Second tillage	12,000	
Investment (Fcfa)	7	ginning	19,000	
	8	Transport	12,000	
		equipment and inputs purchase		
	9	fertilizer (6 sacks, 11,000 each)	66,000	
	10	Post-harvest conservation Product	9000	
	11	Land	15,000	
	12	Small equipment (hoes, cutlass, sacks)	50,000	
	13	**Cash in total**	256,000	
Sales Yield = 1396 kg per ha	14	At harvest time (unit price = 150 F per kg)		209,400
	15	Late in the year (unit price = 200 F per kg)		279,200
Net revenues	**16**	**At the harvest time (Fcfa)**		**−46,600**
	17	**Late in the season (Fcfa)**		**23,200**

The analysis is by a hectare basis.

Table 4. Yam farming cash flow's table for the year 2011.

Year		Activities	2011	2012
		Labor		
	1	land clearing	14,000	
	2	Making mound (16 hj)	100,000	
	3	planting the seed (12 hj)	30,000	
	4	fuming the trees	20,000	
	5	Implanting post (8 hj)	12,000	
Investment	6	Weeding	48,000	
	7	harvest (16 hj)	45,000	
	8	Transport	55,000	
		Small equipment		
	9	hoes, cutlass, knife	50,000	
	10	Land rent	15,000	
	11	**Total cash in flow (Fcfa)**	**389,000**	
Sales yield = 12,775 kg per ha	12	At the harvest (unit price = 150 F per kg)		1,916,250
	13	late season (unit price = 350 F per kg)		4,471,250
Net revenues	**14**	**At the harvest time sales (Fcfa)**		**1,527,250**
	15	**For the late season sales (Fcfa)**		**4,082,250**

The analysis is on Hectare basis.

Table 5. Cotton farming cash flow's table for the year 2011.

Year		Activities	2011	2012
		Labor		
	1	land clearing	12,000	
	2	Tillage	25,000	
	3	seed sowing	10,000	
	4	fertilizer application	14,000	
	5	Pesticide application	10,000	
	6	Weeding	12,000	
Investment (Fcfa)	7	Second tillage	12,000	
	8	Harvesting	12,000	
	8	Transport	12,000	
		Equipment and inputs purchase		
	9	fertilizer (200 kg per ha at 250 F/kg)	50,000	
	10	Pesticides cost for the five treatments	19,600	
	11	Land (by default)	15,000	
	12	Small equipment (hoes, cutlass, container)	50,000	
	13	**Cash in total**	**253,600**	
Sales (Yield = 1150 kg per ha)	14	sale unit price in 2011 = 204,78 Fcfa per kg		235,497
Net revenue (Fcfa)	**15**			**−18,103**

The analysis is on a hectare basis.

investment costs to 253,600 F cfa (Line 13), the sales to 235497 Fcfa (Line 14) and finally the net revenue to −18,103 F cfa (Line 15).

5. The Finding Discussions

5.1. The Empirical Data Analysis

The report has considered separately the cases of the proximate factors and that of the underlying variables.

The proximate factors' effects

The results from the analysis are consistent to the hypotheses and to the results from previous works undertaken in the West African sub-region, the Sub-Saharan countries, or at the global level, where the proximate factors are found to be responsible of the forest lost. For instance, Geist and Lambin [6] found that permanent agriculture as well as shifting cultivation, and commercial logging and fuel wood supply induce deforestation across countries and continents. Lambin and Meyfrodt [1] raised the point that it appears difficult to reconcile the land uses, specifically forestry and agriculture and called for new sound policies to address the conservation issues.

The agricultural outputs' effects

The conflicts among forestry and agriculture are very perceptible in the study area as the analyses reveal. Table 6 shows that food crops' farming (e.g., maize and the yam farming), has positive significant effects on vegetation cover area loss. The cotton farming, and that of the other crops including the beans, sorghum, rice, and peanut, and cassava have little effect on deforestation, but the positive estimates of the slope coefficients for all, help to understand that they all contribute to the deforestation. These findings make sense because the maize and the yam are the major staple food crops in the area. The beans, sorghum, the rice and the peanuts have secondary uses in Togo's food diet. For instance, the rice has become widely consumed in the country lately, but an important part of this crop is imported from abroad. The sorghum is produced for local beers. The peanut is used in the artisanal production of oils and as food ingredient. The Cotton has constituted the major cash crop even if other crops like soybeans are becoming more and more widespread used. Clearly, the agriculture land expansion constitutes the major threat for land conservation because the maize and yam farming has relied on extensive practice than in intensification,

Another concern in this study is the effect of land use displacement abroad. We have understood from Lambin and Meyfrodt [1] that the countries have increased their forest land area and their food production at the expenses of countries from where they import the agricultural goods and forest products, This situation can also be observed in central Togo where the cotton farming despite its negative returns to the farmer producer, as we will demonstrate later in our cost-benefit analysis of the farming, appears the most important constraint to the land conservation. Our two models present the effect of cotton farming in Central Togo, Table 2 and Table 6, in a contradictory ways with negligible impacts.

Table 6. First difference estimates and probabilities for various explanatory variables.

	Fixed effect model		First Difference model	
Independent variables	Statistical significance	economic significance	Statistical significance	economic significance
	Proximate factors			
Fuel Wood supply in the prefecture	not significant	0.0004	not significant	−0.0009
Quantity of cotton produced in the prefecture	not significant	−0.08	not significant	0.05
Volume of wood allowed to cut	not significant	−1.76	not significant	−4.57
Quantity of maize produced in the prefecture	not significant	5.82	**Increase**	**0.075**
Quantity of sorghum produced in the prefecture	not significant	2.82	not significant	−0.025
Quantity of rice produced in the prefecture	not significant	3.81	not significant	0.0009
Quantity of beans produced in the prefecture	not significant	0.06	not significant	0.18
Quantity of peanut produced in the prefecture	not significant	0.61	not significant	0.06
Quantity of yam produced in the prefecture	**Increase**	**0.03**	**Increase**	**0.023**
Quantity of cassava produced in the prefecture	not significant	0.22	not significant	0.01
	Underlying factors			
Minimum wage	not significant	0.069	not significant	0.046
The price of cotton in Togo	not significant	−1.05	not significant	−5.33
Regional fertilizer supply in cotton production	**Decrease**	**−1.98**	**Decrease**	**−0.25**
National fertilizer cost	**Increase**	**8.56**	**Increase**	**12.37**
Regional pesticide supply in cotton production n	**Increase**	**1.22**	**Increase**	**0.01**
National pesticide cost	**Increase**	**3.18**	**Increase**	**4.73**
Fertilizer used in food production in Togo	not significant	−6.96	Significant	−0.96
Fines from illegal wood cutting	not significant	−2.72	not significant	−1.96
	Socio economic factors			
Regional number of cotton producers	**Increase**	**0.08**	**Increase**	**0.05**
Regional number of cotton producer associations	not significant	3.1	not significant	0.63

While the Fixed Effect estimation reveals a decreasing effect of cotton farming (a ton of cotton produced in the area leads to 0.08 ha decrease in deforestation), the First Difference estimation shows an increasing effect (a ton of cotton grain leading to 0.05 ha of forest land loss). Whether for the Fixed Effect or for the First Difference model, the effect is very little. In reality, the cotton as the second or third year crop in the area farming rotation pattern, does not directly interact with the forest land, rather it's beneficial to conservation as it will be discussed later. But it constitutes a threat because of the long run effects of the intensification which is the permanent land exhaustion [13].

As shown in our original hypotheses crops that benefit incentives from corporates or from any other institutions contribute more to forest land loss. However, the cash crop farming constitutes high threats to tropical ecosystems in a

long run. Because, first, the populations are increasing and the needs for tropical goods including both forest products and agricultural goods. As Gibbs *et al.* [6] also raise it, the agriculture practice is very demanding for land because of the emerging and increasing demand for foods, animal feeds, and the biofuel as alternatives for fossils' energy. Consequently, we should expect the agriculture land to expand in the future, particularly in tropical countries. Second, to compensate for the land scarcity, the future trend will consist of stabilizing and intensifying the agriculture practices which policy options are not without social and environmental risks. Some of these risks are the deforestation, which is tangible here in Central Togo, and others experienced in other situations such as permanent lands' exhaustion and the inability of the farmer producer to pay back the investment costs, associated to the past American and Russian agriculture [13]. To achieve the conservation objectives, Boucher *et al.* [14] simply suggest a reduction of the demand for these international commodities. But how this suggestion can be implemented?

The wood supply in the region

Concerning the wood supply in the study area, whether for the fuel wood or the industrial wood, the empirical analysis does not show a clear correlation pattern with the deforestation. The reason may be multiple but the essential ones are that the forestry practice in Togo is a selective cutting which does not lead directly to deforestation, but to forest degradation [15] and [16]. Another reason is the wood data sources. Indeed, the control posts for wood shipping, from where most data originate, do not record data from the sole prefecture of its jurisdiction, but from many other sources, even data on wood shipped from beyond the country's borders. However, all the models display negative effects of the payoff from illegal cutting, *amand*, on land conservation. Average annual fines are estimated to about 7 million Fcfa (14,000US$) in the Central Region. Likewise, the whole stand cutting is also becoming a common practice. Individuals would approach the forest offices pretending to establish a farm on a particular land, which moves owe them the right to cut permit. There are many other twisted ways as such that allow getting around the regulations that cannot be revealed by statistical empirical analyses. Overall, these findings do not express the reality of the field simply due to the reasons discussed throughout the paragraph and many others we cannot enumerate in the context of the study.

The Underlying factors

The agricultural inputs' quantity

The fertilizer quantity supply in the Central Togo for cotton farming significantly decreases the annual area allocated to yam cultivation (the deforestation proxy variable). The quantity of fertilizer used in food farming does not show a significant effect but the negative sign of the slope estimator shows a decrease in land allocated to yam production as the fertilizer quantity increases. This result apparently confirms our original hypothesis that an intensification of agriculture increases the agriculture yield and thereby lessens the deforestation. But our data

have not shown any increase in the cotton yield in the Central Togo during our study time period. As presented in Figure 2 below, it has remained relatively stable between 0.8 tons and 1.2 tons per hectare with just two peaks of 1.9 tons per hectare in 1998 and 2009.

Another explanation may be that the fertilizer supply has a motivation effect, meaning that its supply has led more and more farmers into cotton farming. This interpretation is not relevant either because in such case the fertilizer would have had an increasing effect on forest land loss [5] and [17]. The most relevant explanation of the decreasing effect of the fertilizer input on deforestation is that it has helped the reuse of abandoned farm lands for cropping instead of starting new farms from scratch according to the farm establishment process which consists of cutting down forests, planting yam in the first year, and then cropping other crops the following years, a process described above. This reuse of old farm lands for cropping is true for cotton as well as for any other crops like maize whose farming relies on fertilizer input. Indeed, under the traditional farming practice (e.g., under no fertilizer inputs), the shifting cultivation is linear because the soil could sustain no more than three years of cultivation. But the introduction of the intensive cotton farming in Togo has allowed the reuse of the abandoned land for both cotton and maize cultivation. The maize has been favored because the farmer has discreetly used the fertilizer for maize cultivation before its official introduction in recent years. Indeed, the farmer would receive an amount of fertilizer supposing to destine it for cotton farming, but he diverts an important part of the fertilizer supplied by the cotton society (SOTOCO) to maize farming. Not only such twisted practice has extended the time period of cropping on the same land, but also has it raised the maize yield from less than or equal to 750 kg per hectare during the years prior to 1980, to more than one ton an hectare after.

The weak effect of fertilizer quantity used in the food crop farming traduces the low level of its farming intensification. In fact, our data reveal that 0.029 tons

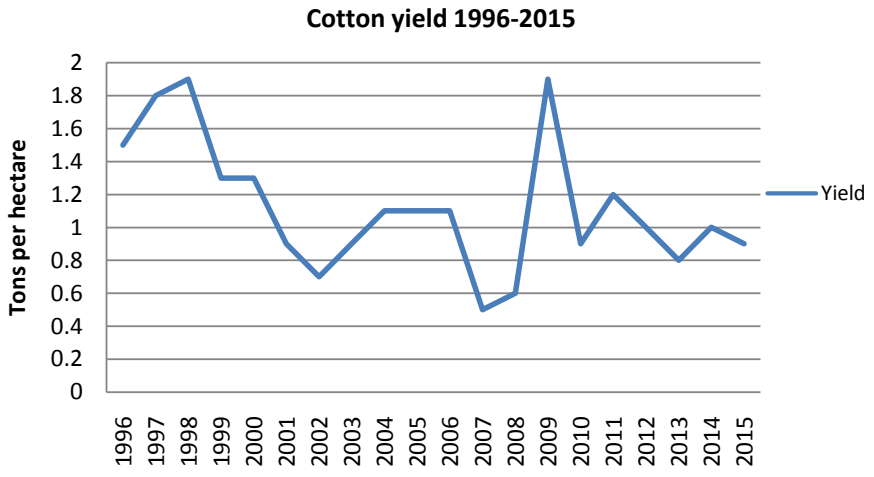

Figure 2. Evolution of the cotton yield in the central Togo 1996-2015.

per hectare of fertilizer in average are supplied annually for maize farming in the region, while three tons per hectare are supplied for cotton farming in central Togo. Further, a cross-country comparison of the yield also confirms that the food crops have been discriminated against in terms of the fertilizer used. For instance, while the cotton yield in the central Togo has reached the international level's (e.g., 971 tons of seed cotton per hectare), the average maize yields is 1.23 tons, the tenth that of the North American countries (e.g., 11 tons per hectare), according to the FAO Statistics [18]. In fact, from the time of its introduction in Togo, the cotton production has relied heavily on input such as labor, land, fertilizer and pesticide. An international research center on Cotton and textile (IRCT) was even created in 1949 [19], to accompany the cotton production. On the other hand, the results confirm what was said previously about the reliance of maize and other food crops' production on agricultural land's area expansion rather than on the practice intensification.

Else, our two models show an increasing effect of labor input on deforestation, which does not necessarily, indicates low labor marginal productivity leading to land/labor inputs substitution. Ellis [20], Sills [11], and Rankow [21] pointed out that the farmer may provide more than one combination of inputs to produce a given level of an output. However, a holding of 0.5 hectare for most farmers in the country (76 percent) constitutes an indicator of high unemployment and underemployment. This is an important constraint to the conservation because unemployed or underemployed farmer would necessarily encroach into the forest land as he has the opportunity to do so.

Agricultural input price

The analysis results in **Table 6** show that an increase in both fertilizer and pesticides' cost increases the deforestation. These results are also consistent to the hypothesis that an increase in any capital input cost discourages the farmer producer from farming, which in consequence forces him to forestry practices resulting in forest land loss. But cautions need to be made regarding the effect of the rising in input cost. Even though his analysis of the effect of the fertilizer input price on deforestation was not conclusive, Angelsen [17] predicted that an increase in the fertilizer price would decrease the land area under cultivation. This is not a contradiction because the Angelsen situation would happen if there are other job opportunities (non-land based economic activities) that are available to the farmer, which is not the case in Central Togo. In fact, the national fertilizer cost had increased from 181 Fcfa per kg in 1997 to 250 Fcfa in 2012, and the pesticides' from 3520 to 4500 Fcfa per liter. The rise in the fertilizer cost has had different effects depending on type of the crops and on the type of inputs. The inaccessibility to the fertilizer, due to price increase leads the farmer to resign from cotton production to yam cultivation, consequently leading to deforestation. When the fertilizer is inaccessible the maize farming practice becomes more extensive, which is detrimental to conservation, because as raised previously the cotton fertilizer supply has expanded the maize cropping's time pe-

riod beyond three years necessary for cropping the same land under the traditional agricultural practice. Likewise, the inaccessibility to pesticide due to price increase has the same effect on cotton production, the resign of the farmer, but does not affect the maize cultivation. However, this inaccessibility to pesticide discourages the farmer for the beans cultivation and shifts him to yam production because the cotton pesticides were also discreetly used in beans farming.

The effect of the change in output price

In Table 2 and Table 6 we may realize that the cotton price change has not had a significant statistical effect on forest land area, but by checking in economic significance we find that an increase in the cotton price by one Fcfa reduces the area of land allocated to yam cultivation 1.05 ha for the Fixed Effect model and by 5.33 ha for the First Difference model. These findings are consistent to the original hypothesis that a rise in the output price diverts the farmer from other crops farming including the yam cultivation (the deforestation proxy). Three explanations are available here. The first one is that the rise in cotton output price drives farmers to resign from the yam production for cotton farming which is not the case because rather the number of cotton producer had fallen over time in the region, as shown in Figure 3. The second explanation concerns the economic activities diversification effect, which means that the revenue accumulated from the cotton farming due to the rise in cotton output price, has served to create other rural economic sectors which had necessitated labor, also labor from yam cultivation. This also is not obvious because such diversification had not been conspicuous in Central Togo. The explanation that fits the most is the third one which is that the wealth issued from the rise in cotton price has helped to invest more in cotton production, importantly, in the purchase of inputs. Therefore, the rise in cotton price will have the same effect as that of the increase in the fertilizer supply, which is, to lessen the deforestation through the extension of the farming time period and the increase in maize yield, a subject discussed above.

The model limitations

The running of the model violates some of the six Gauss-Markov's multiple linear regression assumptions such as the non-serial correlation and the non-perfect correlation assumptions. From the formulation, Equation (13), including the production factors F, H, and L all as independent variables together with the production output variable q, also an independent variables in the same multilinear regression model (Equation (5)) would obviously lead to the correlation among the factors of production and the output variable, thus violating the non-perfect correlation assumption and that of the serial correlation. However, the correlation matrix shows weak correlation coefficients between these factors of production and the production output.

$$q = \int (L, F, H, \cdots) \tag{13}$$

where:

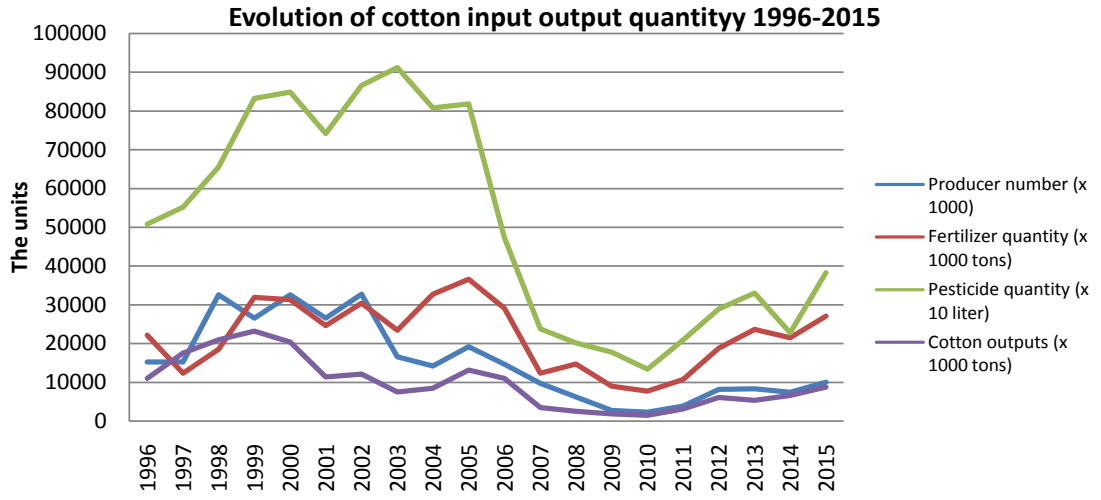

Figure 3. Comparison of the evolution of the cotton outputs and the input quantity.

q is the production function; the variables L, F, H, represent the production factors, already defined in Equation (1).

The presence of the multicollinearity would make it harder to reject the null hypothesis that β_j, the slope estimator for the variable j, in the multiple regression model, as being equal to zero [12]. As shown in Equation (14), high R_j^2 due to the multicollinearity among independent variables would lead to large slope estimator of x_j, thus small value for the t-statistics.

$$var\left(\hat{\beta}_j\right) = \sigma^2 \Big/ \left(SST_j\left(1-R_j^2\right)\right) \tag{14}$$

where:

$\hat{\beta}_j$ is the predicted slope estimator for the independent variable j, SST_j is the total variation of x_j, and R_j^2 is the R-squared from the regression of x_j on the other independent variables.

Another question relative to the regression model limitation is the choice of the proxy for the quantity of inputs used in the farm. The input variables are proxied by the quantity of the input supplied to the prefecture and to the region, which is not quite right because as mentioned above the input supplied to a particular crop may be diverted to other uses (e.g., the fertilizer supplied for cotton cultivation being used for maize and or for vegetable cultivation, the cotton pesticide being diverted to beans cultivation). Furthermore, the input supplied for a particular year may serve in farming the next years because it has not been completely used in the year it was supplied.

5.2. Regarding the Cost Benefit Analysis

We examine here the farming returns to the farmer, and the choice of the deforestation model.

The farming returns to the farmer

As discussed above, the farming of the major crops, whether cash or food crops, had been detrimental to the forest land. The next concern is to know the

farming returns to the farmer producer. The results from the cash flow analysis presented in Tables 3-5 are converted to kilograms to permit the comparability with the figures that already exist in the literature. Tables 3-5 show that the sole crop for which the farming activities yield positive financial returns is the yam, the net revenues being 119.55 Fcfa (0.239 $US) per kilogram when sold at the harvest time, or 319.55 Fcfa (0.639 $US) for the late season sales, without accounting however for the post-harvest losses. The maize and cotton yielded in 2011 negative financial returns, −33.38 Fcfa (−0.067 $US) per kg of maize sold at the harvest time, and 16.62 Fcfa (0.034 $US) per kg of maize sold late in the season; the seed cotton was sold with a loss of 15.74 F cfa (0.031 $US) per kg. Extending the analysis beyond 2011 (e.g., up to 2016) the maize sold at the harvest time, the moment when most farmers sell their farm goods and cotton, produces still negative financial returns each year.

In reality according to FAO [22], the agriculture sector particularly the smallholding one has always suffered from bad or poor performance in most Sub-Saharan African countries. The same author provides three reasons for this poor performance. First, prior to the Structural Adjustment Programs in 1980s the countries adopted the cheap food policy to keep the urban workers' wages low. For example in Togo, a National office for Food Products created in 1971 for the storage of grains has progressively changed to TOGOGRAIN, and recently to the National Agency for Food Security in Togo (ANSAT). These agencies purchase the grains at the harvest time, thus permit to keep the agriculture goods' price very low. Second, investments on public goods which constitute one of the major foundations of the structural adjustment of the 1980s, very expensive to support, had led the states to withdraw the agriculture subsidies. Finally, there also have been problems inherent to agriculture itself, the market failure. According to Poulton *et al.* [23] this market failure or the transaction risks pose serious difficulties in making investments in poor rural area. The various risks, principally, the rent-seeking risks apply in the Togo farming condition as well. For instance, in addition to the governmental agencies discussed above, private enterprises or individuals are implicated in the transaction of the goods from the farm gates to the markets. Usually they also purchase the goods from the farmer producers at low price, during the harvest time.

The profit maximization approach versus the subsistence approach

Here we are then raising the question of how the farmer continues to produce farm goods as the farming does not pay off considering both the forest land conservation and the enhancement the local people life.

Answering this question helps to confirm our study framework assumptions. Is the farmer producer profit maximization or subsistence oriented? The answer is "it depends on whether he produces commodities" goods or food crops, as it may be understood from Figure 4. As presented above, the two types of crops (e.g., the maize and cotton) farming had undergone negative financial returns. However, as the maize production increased from one year to another, the seed cotton production had fallen progressively from 23,186.3 tons in 1999 to reach

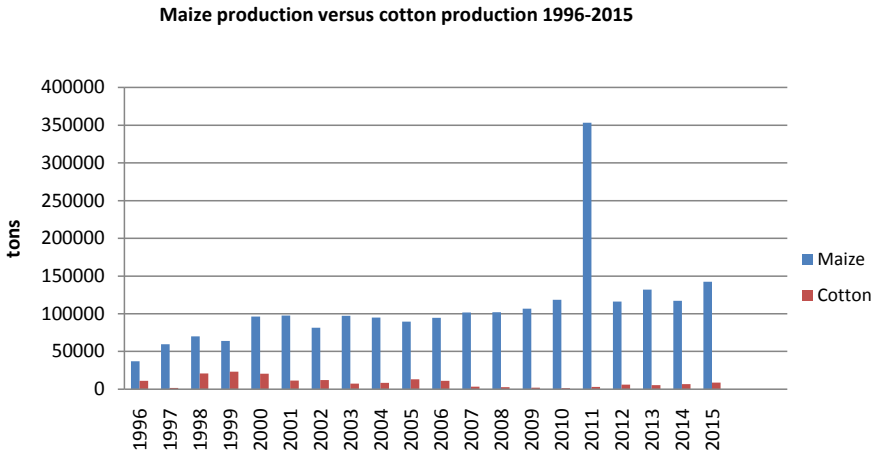

Figure 4. Maize, Cotton productions 1996-2015.

an annual production of 1488.6 tons in 2010 due to the drop in the cotton output price from 175 Fcfa (0.35 $US) to 150 Fcfa (0.30 $US) during that period of time, from where the cotton production has barely resumed. The immediate explanation to this is that as the commodities' cropping is financial return motivated, in the food crop farming case the farmer producer is motivated by both financial returns and the household consumption. The evidence to this is that he could not give up cropping maize even though its farming does not pay off. We may deduce that both subsistence and profit maximization are applied in the farmer condition, which is not right. Not being able to sell at the production price is a matter of distortion created, as explained above by the government's interventions in keeping the food prices low, and the removal of the subsidies, and by the private enterprises and or individuals that serve as intermediaries between the farmer and the markets. Thus we remain consistent to the beginning assumption that the deforestation is a matter of profit maximization. Any subsistence oriented practice must be induced by distortions (e.g., public, private as well as individuals').

5.3. The Forest Conservation Challenges

Conservation has become a challenging issue in West Africa, first because as clearly outlined in this study the agriculture has remained extensive and thus the agriculture land expansion will increase in the future, and as many other current or looming factors continue to play or will play for the conversion of forest lands into other land uses. Second, the local people do not have any motive to appropriate the conservation policies [24] because their basic needs [25] are not yet satisfied (e.g., the farming does not pay off). Finally, the concern about tropical ecosystems of West Africa is that the use of the resources does not initiate or at least trigger the local development which, according to the Environmental Kuznets Curve [26], could initiate or trigger the land conservation or protection. Rather the resources depletion, the environmental degradation, and poverty are increasing. All these imply that the actual conservation measures including reg-

ulations and policing are inefficient policy instruments in solving the deforestation issues, new measures that effectively integrate the local development and conservation issues are required. For example, we urgently need to increase agriculture productivity. At the same time we should be able to cope with negative externalities associated to agriculture intensification which are the environmental deterioration and the failure of the revenues to compensate for the investment costs.

6. Conclusion

Our study on the causes of deforestation is motivated by the economic profit maximization models. The statistical Panel data model and the farming economic cost/benefit studies have served for the analyses. The panel data analysis results reveal that both cash crop farming (e.g., the cotton farming) and the staple food crops' farming have all constrained the conservation. From the literature, we could understand that agricultural land will continue to expand at the expenses of the forest land as long as more and more new crops are to be cultivated. The findings from the cost-benefit analysis reveal that besides for the yam, the farming, not only induces the forest loss but also does not provide positive financial returns for the farmer producers. This confirms the existing discrimination against agriculture sector, mainly, the smallholding agriculture, a subject wildly documented in the literature. It is recognized that small holding farming has suffered from agriculture goods' cheap price policy in the era prior to the Structural Adjustment Programs. In the recent two or three decades, the agriculture in Africa has suffered from the removal of public investments in favor of infrastructural construction, education and research, and health. The last problem undergone by the sector is the transaction risks or the market failure. We could explain from these facts how efforts undertaken so far to save tropical forest land in West Africa have not yielded real impacts. It is important to notice that the future of tropical forest ecosystem is ominous because more and more land will be needed for agriculture expansion. Another reason is that, the resources are not or cannot be used to initiate the local development. Most theories including Maslow pyramids of needs as well as the Environmental Kuznets Curve are consistent that the basic needs must be satisfied before any others. A community must reach a certain level of economic development before getting evolved in protection. We therefore are in need of new and efficient measures including increasing agriculture productivity, and providing agriculture risks' coverage to farmers, to save these forest ecosystems.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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