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Forest Management, Gender, and Food Security of the Rural Poor in Africa

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Abstract

This paper addresses the economic impact of forest management on gender and food security of rural poor in Africa. The analyses reveal that deforestation places major demands on women and children's time, limiting their opportunities to obtain an education or undertake income-generating activities. It also impairs the capacity of forests to contribute to food security. The econometric evidence applied in Cameroon taken as an accurate picture of Africa suggests that the producer prices of coffee, and cocoa, timber prices, and food crop prices influence at various degrees the decision to deforest. The agricultural value added per hectare positively affects forest cover. The fertilizer price index, the credit to farmers and the per capita GNP have no effect on the activities of deforestation. Food security is negatively correlated to forest depletion. Finally, the oil boom, the structural adjustment policies and the devaluation of the CFA franc have seriously increased the speed of forest depletion in Cameroon. A critical lesson from these results is that policy measures outside of the formal forest sector are a key part of the problem – and therefore of the solution – of forest conversion in Cameroon.

Keywords: deforestation, gender, food security, Africa, Cameroon

JEL classification: Q23, Q18, C22

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1 Introduction

Food security defined as physical and economic reliable access to food in sufficient quantity and quality, for all people, at all times is of increasing concern and remains one of Africa's most fundamental challenges for human welfare and economic growth. An estimated 200 million of people on the continent are unable to acquire and effectively utilize the food they need for a healthy life and their numbers have increased by almost 20 per cent since the early 1990s (Benson 2004). Undernutrition is the major risk factor underlying over 28 per cent of all deaths in Africa (2.9 million deaths annually) (Idem). Without concerted efforts to reverse this trend, the continent will continuously experience increasing undernutrition and food insecurity on a yet unknown scale in times of periodic drought or crop failure. The management of forests is an integral part of these efforts.

Forests play an important role in ensuring that hundreds of millions of people in the developing world do not go to bed hungry. In fact, food security is very much dependent on environmentally responsible and sustainable use of the world's forests. The people who are most affected by food insecurity are the world's poor, particularly the forest dwellers, subsistence farmers, landless families and livestock herders. Forests are very important to these people because they are one of the most accessible productive resources available to them. In sub-Saharan Africa, where the depth and severity of poverty is at its worst (Dorward et al. 2004), people have historically had relatively unrestricted access to forests. Poorer people have thus been able to exploit the forests for food, fuel and marketable products. Where forest gathering activities are not restricted to the poor, they depend on these activities to a greater extent. Poorer women, often dominate forest product gathering and processing activities, both for household products and income. According to Sène (2000), almost one third of the population in Africa is chronically undernourished, and rural populations in many areas are compelled by socioeconomic stresses to use all the natural resources available. Therefore, foods from forests in this continent constitute an important component of household food supply. They include a wide variety of products ranging from termite larvae, roots, tubers, rhizomes, nuts to mushrooms and leaves. They are most extensively used to help meet dietary shortfalls and to supplement household income during particular seasons in the year. These seasons commonly occur at the time of year when stored food supplies have dwindled and new crops are only just beginning. Forest and farm tree products are also valued during the peak agricultural labour period, when less time is available for cooking and people consume more snack foods. During these periods the consumption of forest and tree foods increases. Well-known examples of leaves consumed include the Cameroonian ndole (bitter leaf), baobab (Adansonia) and many types of tree leaves used for making beverages. Wild animals and fish are also important forest food products. In many villages and small towns, the contribution of forests to food supply is essential for food security, as they provide a number of important dietary elements that the normal agricultural produce does not provide adequately. Forests and trees also provide critical support to agricultural production. They help maintain favourable and stable conditions needed for sustained agricultural productivity. Trees prevent soil erosion, enhance soil fertility and maintain soil moisture. In Algeria, for example, trees are used to stabilize sand dunes and arrest desertification. Deep-reaching tree roots can help mobilize nutrients far below ground level for use by food crops. Finally, forests provide insurance against drought and crop failure. In some cases the availability of forest foods may allow farmers to market a greater share of their agricultural produce. It can therefore be said that both directly and indirectly, many forestry activities have an

impact on rural people's food situation. Women are often more reliant than men on forest products, obtaining from them income needed to feed and clothe the family, as well as fuel for cooking. In some villages in the west region in Cameroon, for example, poorer women rely on year-round fuelwood gathering as a major source of supplementary income. They also spend several hours a day collecting mushrooms during the early rainy season. Women are therefore the principal users of forest products.

2 Gender, forest-based activities and Food Security

Nutrition-related activities have an important gender dimension. For instance, improvements in child nutrition are closely linked to increased social access of women to the resources that they can use to improve care for children. Women are directly involved in the processing and preparation of food and the care and feeding of dependents within the households. They play an essential role in agricultural production. Their specific roles and tasks may vary from region to region, but as the figures in Table 1 indicate, their contribution is significant. Therefore, an analysis of food security with more attention to gender is particularly appropriate in the context of developing countries.

Table 1: Females as percentage of the total agricultural labour force (mean % by region)

Region	Per cent
East Africa	45.2
Middle East	33.2
North Africa	26.3
Southern Africa	47.8
West Africa	46.6

Source: Dixon (1983).

Women are also extensively involved in many forest-based gathering and processing enterprises. Contrary to the common belief that they are only concerned with subsistence activities, they make important contributions to the household's cash income. As they often have little access to land and capital resources, forests provide a source of raw materials and products for cash sale. In addition, they often combine cash earning activities with forest based subsistence activities such as food and medicine collection. Many forest-based activities can be undertaken near the homestead, thus allowing them to combine these activities with domestic chores.

The fuelwood trade provides another source of cash income for many rural agriculturalists, especially women. In a detailed study of the production, marketing and household use of fuelwood in three rural and urban areas of Sierra Leone, Kamara (1986) found that the majority of fuelwood collectors and sellers are women both in the rural and urban areas, although rural men provide about 20 per cent of the marketed fuelwood. The cash income earned from fuelwood collection plays an important role in the agricultural cycle. It provides the first cash income from land cleared for rice production; subsequently, fuelwood collection for the market is concentrated during the

off-peak agriculture period, providing cash income in a period when food supplies are generally at their lowest.

Table 2 indicates that the majority of women's labour is devoted to cash earning activities, though this, too, varies considerably. In Ghana for instance, women in a fishing village spend 6.3 hours/day earning cash income compared with 2 hours/day in agricultural production and 3.6 hours/day for fuel collection and cooking (Cecelski 1987). While there are a number of possible factors contributing to the amount of time women spend in cash-earning activities, in Mozambique (where only 0.1 hours/day was spent in non-agricultural income earning activities) there were simply fewer opportunities for women in the study area to engage in cash earning enterprises (Cecelski 1987). Ardayfío (1985) reported that in Ghana, there are opportunities for women to earn cash. In all of the households surveyed, women were the major contributors to household income, both in terms of time spent and money earned. They were involved in a wide range of activities including agricultural production, food processing, and artisanry (two important activities were charcoal production and fish smoking). He noted that cash income is an important component of household food security in Ghana, as more than 75 per cent of the weekly household expenditures are on food. He also mentioned that in the study area, deforestation has brought with it negative consequences for food security; either more time must be spent gathering or more money spent purchasing increasingly scarce fuelwood. The increased time spent gathering fuelwood leaves less time for cash earning activities, while more expensive purchased fuelwood leaves less money for buying food. Furthermore, many income-earning activities, such as fish-smoking and beer-making, depend on fuelwood. Consequently, as the price of fuelwood increases (either in labour or cash), the profitability of the enterprise diminishes. The author concludes that the constraints placed on women's income earning potential by fuelwood scarcity may have the most harmful impact on food security for the household. Therefore, fuelwood supply can influence the amount of food supplied or cooked.

Table 2: A rural woman's work (hours per day)

Country	Agricultural work[1]	Non-agricultural work[2]	Fuel collection and cooking	Other[3]	Total hours worked
Ghana					
Savannah village	1.3	2.7	5.0	5.0	14.0
Fishing village	2.0	6.3	3.6	2.1	14.0
Forest village	3.8	0.3	4.1	5.8	14.0
Mozambique					
Average of four villages	3.1	0.1	1.8	9.0	14.0

Notes:

1 Family subsistence, space wage employment and livestock raising.

2 Crafts, food processing and trade.

3 Cleaning, child care, social, community and religious activities; for Ghana, travel time is also included here.

Source: Cecelski (1987).

Cecelski (1984) reported that, in Somalia, refugees fed their bean rations to their livestock or discarded them because they could not afford the fuelwood to cook them. While this is an extreme case, it serves to illustrate the fact that grains and legumes are inedible without cooking.

In another fuelwood study in Ghana, Ardayfio (1986) found that, over a year's survey period, the proportion of the household budget taken up by fuelwood purchases rose from 1 per cent to 16.3 per cent in one village. Thus, money that should have otherwise been spent on food had to be spent on fuelwood. Many authors report a reduction in the number of meals cooked (Agarwal 1986; Alcantara et al. 1985; Cecelski 1984). It is not clear whether the total amount of food consumed is reduced. Nor is it clear that fuelwood scarcity is the cause for this decline. Generally fuelwood scarcity is associated with other problems such as food scarcity, increased workloads, commercialization and the availability of processed foods. In Rwanda, 62 per cent of all families cook only once a day. Thirty three per cent cook even less (Lidju and Bamuhiga 1982). In Sudan, Hammer (1982) reports that food is cooked once a day instead of the customary three times because of fuelwood shortages. The reduction in cooked meals has a negative effect on children's nutritional status. If the staple foods are starchy, a child cannot digest adequate calories in one meal alone (Cecelski 1984). Undercooking and reheating leftovers can have a serious impact on disease incidence. This is especially true of meats (because of parasites), tubers, and legumes (because of toxic substances lost in cooking).

Also associated with fuelwood shortages are changes in the diet. In particular, several authors have noted that an increase in consumption of fast foods and purchased snack foods is a reaction to increasing fuelwood shortages (Cecelskí 1984; Agarwal 1986). Generally, it is assumed that these foods are of lower nutritional quality than traditional foods, though little has been said to support this claim. There are many factors associated with the dietary changes discussed above, including income, labour demands, and changing cultural values. However, it is also clear from these observations that fuelwood supply is linked to nutritional needs and problems.

Food processing also depends on fuelwood availability and is of central importance to nutritional stability, as it serves to extend the supply of a food resource into a non-productive period. Traditionally, products are smoked, dried or cooked. In a study on fuelwood use in Sierra Leone, Kamara (1986) found that 13.4 per cent of the household firewood energy was expended on processing farm produce. Mascarenhas et al. (1983) found that 90 per cent of the fish catch from Lake Victoria (Tanzania) was smoked. The fuelwood scarcity in the region has meant that the cost of processing has gone up and has been passed on to the consumers. In other fishing regions, lower percentages of fish were smoked. In Arusha, 35 per cent of the catch was smoked, in Dodoma 50 per cent was smoked, and in Singida 57 per cent was smoked. These authors also found that 80 per cent of the households brewed beer using firewood. In another study of Lake Victoria fisheries, Mnzava (1981) reports that 59,000 tonnes (of a total 65,415 tonne catch) of fish were smoked in 1977. It is also assumed that an additional 30 per cent were consumed and were not recorded. Of these, some were smoked. The author also estimated that between 1975 and 1981 an estimated 152,000 m^3 of wood was used to cure 759,000 tonnes of fish.

The constraint of time is another major factor limiting women's further involvement in income generation. Several authors have suggested that there is a limited amount of

time women can afford to spend on fuelwood collection and cooking. As fuelwood gathering takes increasing amounts of time, it leaves less time for cooking. In Peru, an average of five hours was spent daily on cooking and fuelwood gathering. As the amount of time spent gathering fuelwood increased (from 10 per cent to 33 per cent), the amount of time spent cooking was reduced (from 90 per cent to 67 per cent), (Alcantara et al. 1985).

It comes from the development that precedes that the role of women in meeting the household's basic food needs is very important and varies from society to society. Generally, men have greater access to the cash economy and often generate cash as their primary activity. Women's activities revolve more around the subsistence needs of the household, most particularly food production and child care. Yet, it is frequently the case that women also make important contributions to the household's cash income and that they are often involved in forest-based income earning activities. Some studies try to establish a direct link between women's income and child nutrition. Furthermore they found differences between women's and men's spending patterns. Women characteristically spend money on food supply and thus, nutritional status is more directly dependent on women's income than men's (Cecelski 1987).

However, there are also certain general restrictions and patterns to women's cash earning activities. Though a woman's cash earning may be substantial, it is usually not undertaken in lieu of traditional women's responsibilities, which often means that it must be undertaken at home, and not on a 'full-time' basis. For example, the processing of many forest products can be performed at or near the home, thus allowing women to combine income-earning activities with other household chores such as childcare. Similarly, women and especially poorer women often combine forest product gathering activities with their household's traditional responsibilities. An excellent example of this is found in Usambara, Tanzania, where Fleuret (1979) found that young unmarried women commonly relied on the sale of wild leaves. She concluded that this trade is a significant source of income for single (or widowed) women in difficult economic circumstances. In the same line, Fisseha and Milimo (1986) showed that many forest-based processing enterprises in Zambia involve women. For instance, they own (48 per cent) and work for (39 per cent) a significant share of the broom making, bamboo/cane processing and twine/rope making ('other') enterprises. In addition, they are commonly involved with vending forest processed products. Women also sell great quantities of processed forest foods such as traditional beers made from forest fruits. Always in Zambia, Fisseha (1987) found that 36 per cent of rural small enterprise employment is in traditional beer brewing. In addition, most food processing activities depend on fuelwood energies. In Sierra Leone, women dominate the fuelwood trade. Almost, 80 per cent of the urban fuelwood sellers are women while in rural Bo, 67 per cent of the marketed fuelwood is collected by women, and in rural Makeni they collect 72 per cent of the marketed wood (Kamara 1986). Most of the cash income is then used for buying food provisions.

As fuelwood collection and marketing becomes more complicated, men also enter into the trade. Since donkeys, cars, or mechanized means of transportation are often available only to men, they tend to dominate when transportation distances grow. In addition, because women generally have less access to land than men, where ownership of the trees is important the trade may also be dominated by men. Where the vast majority of fuelwood is collected from privately owned land rather than common forests, Hyman (1983) found that the fuelwood trade was dominated by men. Kgathi

(1984) also found that the fuelwood trade was dominated by men in Botswana. In Sierra Leone, Kamara (1986) found that of the fuelwood collected by men, the greater portion is sold rather than consumed in the household. The net result of the growing participation of men in fuelwood production and trade is uncertain. On the one hand, it may free women from one of their most tiresome chores, though alternatively, it may deprive them of an important source of income.

In general, the evidence suggests that the gathering and processing of forest products may be favoured by women because of ease of access to forest resources, possibility of combining 'subsistence' gathering with income earning activities, flexibility of location of enterprise (i.e. near home), and finally their knowledge about forest products through subsistence use. In this respect, it is safe to say that tropical deforestation places major demands on women and children's time, limiting their opportunities to obtain an education or undertake income-generating activities. It impairs the capacity of forests to contribute to food security and other needs. In Africa, between three and five million hectares of tropical forests disappear each year (FAO 1996). Compared to other regions, Africa has been the most affected with an annual deforestation rate of 0.7 per cent (Marcoux 2000). In terms of household food security, this trend implies diminishing availability and use of forest food resources, fewer income earning opportunities for the rural poor, and increased burdens on women in their efforts to meet their basic needs. Deforestation is therefore a threat to sustainable food security of poor rural populations in Africa. This is why the identification of factors leading to the halting of forest disappearance has become a priority, and one of the main components of the overall strategy to alleviate poverty in this continent. In the face of forest depletion, fuelwood and water become scarcer, and considering women's traditional productive roles in the household, they bear the brunt of this deforestation-induced scarcity. Shortage of wood fuel imposes time and financial costs on poor households, putting a particular burden on those that are short of labour and making it harder for children to attend school.[1]

This paper focuses on tropical forests, because they are located in the areas of the world with the highest concentration of the food insecure, and they are home to approximately 300 million people who depend on hunting and gathering to survive (FAO 1996). Many are at risk of not consuming enough food to meet their daily energy requirement on a chronic, transitory or seasonal basis. The analysis in the paper puts elements of economic policies that attempt to render the contribution of forests to food security of poor more sustainable at the disposal of policy makers. The main research questions are therefore, what are the immediate determinants of tropical forest depletion in Africa? What is the nature of the relationship between forest depletion and food security? Thus, the general objective is to investigate the immediate causes of tropical deforestation and the nature of the relationship between deforestation and food security in Cameroon taken as an accurate picture of Africa. Specifically the paper identifies the factors that shape agents' decision to deforest, the correlation between forest depletion and food security and singles out the appropriate economic and environmental policies to mitigate, if not halt the effects of unsustainable conversion of forests.

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1 Studies from Burkina Faso, Uganda and Zambia show that women and girls can save hundreds of hours a year if walking time to sources of fuels and potable water was reduced to 30 minutes or less (Balakrishna and Warner 2003).

3 Literature review

A direct connection between deforestation and food security is rarely made in the economic literature. However, it is clear that when forests are cut down to provide land for shifting agriculture, pasture or for other uses, it is not conducive to sustainable development neither for agricultural practices nor for natural resource conservation. Much biodiversity is lost at the same time and the world's genetic storehouse becomes impoverished. With the forests gone, foods that normally supplement diets or add valuable nutrients during times of need vanish and the available fuelwood is reduced. This leads to a number of possible consequences that negatively impact on food security of poor. Therefore, reducing or halting the process of forest clearing has a linkage with food supply and food entitlement of poorer populations.

The literature on the causes of accelerated depletion of tropical forests for agricultural activities relies principally on two different approaches, namely the population (subsistence) approach and the open economy (market or profit-maximizing) approach[2] These two approaches are useful to explore the range of hypotheses for the effect on deforestation of changes in economic variables.

The population and open economy approaches refer to different assumptions made about household behaviour and the labour market, the latter being the most important (Angelsen et al. 1999). In the population approach (PA), no labour market exists, whereas a perfect labour market is assumed in the market approach (MA) where any amount of labour can be sold and hired at a fixed wage. In our paper, the MA seems to be more appropriate because of the long-term effects of the study and also because migration became very important in Cameroon after the oil-boom in 1978 (Ndoye and Kaimowitz 2000). In addition the population in Cameroon no longer relies on subsistence farming activities.

Compared to the subsistence approach, the open economy approach has a different way of reasoning although the key change in the underlying model assumptions is only the introduction of a labour market where labour can be sold at a fixed wage (w). This wage rate gives the opportunity costs of labour used in agriculture (Angelsen et al. 1999). The forest clearing decisions can then be examined as a profit-maximizing problem. However, this does mean that the household's overall objective is to maximize profit. The perfect labour market assumption implies that production decisions can be separated from the consumption and labour supply of the household (Angelsen et al. 1999). Thus, the production decisions of a utility-maximizing household can be analysed as a profit-maximizing problem. The open economy approach does not need to introduce any particular behavioural assumption for the farm household. The production problem is now to maximize total profit or land rent.

$$X = pAf(L,H,F) - qF - w[L + h(H)] \qquad (1)$$

Where X is production, A represents the technological level, L is labour input, H is total land area (assumed to be of homogeneous quality), and F is fertilizer input. The labour

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2 However, other approaches such as the Chayanovian or the general equilibrium approach can yield hypotheses, which are consistent with both approaches mentioned above.

used to cultivate the land, in addition to the costs related to the clearing of new land and also costs from having a large area to cultivate are represented by a convex function $h(H)$. p and q are output and fertilizer prices respectively.

The first order condition is summarized as follows:

$$pA = \frac{w}{f_l} = \frac{wh_H}{f_H} = \frac{q}{f_F} \qquad (2)$$

The main difference between the two versions of the model (PA and MA) is that whereas the wage rate (w) is exogenous in the MA the shadow wage is endogenous in the PA. Population on the other hand is endogenous in this model whereas it is exogenous in the subsistence model. All this makes a fundamental difference to the response of exogenous changes. Within the MA agricultural production and land use are determined by the relative profitability of agriculture, and not by any population requirement.

3.1 Empirical review

The causes of forest depletion have been attributed to several factors. The most important categories are the immediate and the underlying causes.

In Sudan, Stryker et al. (1989) found that increased producer prices of export crops encouraged woodland clearing for crop cultivation and this resulted in significant deforestation. Based on the market theoretical approach, Angelsen et al. (1999) statistical analysis in Tanzania showed that the increase of agricultural output prices, in particular annual crops is a major factor behind deforestation. The results of these authors were confirmed in Ivory Coast where the effects of price increase of export goods contributed to deforestation but to a lesser extent than the lack of a consistent and secure land tenure system (Reed 1992). Osei Asare and Obeng-Asiedu (2000) found in Ghana a long-run equilibrium relationship between the producer prices of cocoa and coffee, fertilizer prices, food crop prices, agricultural wages, timber prices and agricultural credit on the one hand and deforestation on the other hand. According to the findings of these authors, higher levels of fertilizer prices, food crop prices and coffee producer prices stimulate in the long-run higher levels of deforestation whereas higher levels of agricultural wages precipitates lower levels of deforestation. Other empirical works reveal that devaluations undertaken in Ghana at the beginning of 1980s motivated forestry exploiters to intensify tree felling for more exploitation of timber and woodwork. This ended up accelerating deforestation (World Bank 1994; Pimentel et al. 1991). These results were confirmed in Malawi (Cromwell and Winpenny 1991), and in Botswana (Perrings et al. 1988).

In Africa, quantitative studies on the determinants of forest depletion are very scarce. Ndoye and Kaimowitz (2000) look at the influence of macroeconomic and agricultural policies, market fluctuations and demographic changes on the humid forest zone of Cameroon between 1967 and 1997. To capture deforestation, they use increases in perennial crop area and in the combined area of annual crops. The results indicate that after the oil boom, the Structural Adjustment Programme (SAP) and the devaluation of

the CFA franc in 1994, the net effect of cocoa, coffee and food production increased the pressure on forest areas. This paper is basically descriptive.

A study of deforestation in the area around Ndélélé in the East Province based on remote-sensing analysis points to a marked increase in deforestation after the economic crisis in the mid-1980s (Mertens et al. 1999). This paper uses the same proxy to capture forest clearing as in Ndoye and Kaimowitz (2000). It investigated the role of the main driving forces of deforestation at the village-level through bivariate regression analyses. However, it concentrated on the underlying factors of deforestation and covered a very small part of the country territory.

The impact of SAP on forests is also addressed by Kaimowitz et al. (1998) using a comparative analysis between Cameroon, Bolivia and Indonesia. The results indicate that forest clearing for food crops increased under SAP Nkamleu et al. (2002) examined fuelwood consumption in households of forest zones in Cameroon. The results confirmed the importance of fuelwood as a source of energy, and the econometric analysis showed a negative correlation between income levels and fuelwood consumption. Finally, a series of papers focusing on the underlying, and social causes of deforestation confirmed the high rate of forest clearing in Cameroon and concluded to the necessity of some well-elaborated protection policies (Cleaver 1992; Besong 1992; Toornstra et al. 1994).

Compared to the studies reviewed above, our paper has three special novelties. First, it explores the linkages between socio-economic variables and forest depletion using long-run statistical analysis, which is the first attempt in Cameroon taken as an accurate picture of Africa. The need for quantitative analysis of the immediate factors behind deforestation in Cameroon became necessary in order to determine the net effects of policies and provide more concrete policy guidelines. Second, data on annual forest cover is used as a proxy for deforestation. This proxy seems to craft better to the deforestation process in Africa than the increases in perennial crop area combined with area of annual crops used in previous papers. Although agricultural land expansion is a major source of deforestation, the proxy is not good at the national level for two main reasons:

1. It does not cover all sources of forest conversion.

2. Some agricultural expansion may not be into forest, but, for example, grasslands and Savannah.

Third, our study uses the agricultural value added per hectare instead of the approximate monthly revenue of farmers used in various papers (Osei Asare and Obeng-Asiedu 2000).

3.2 Structural shifts in Cameroon

It is worth mentioning the structural shifts that occurred in the Cameroon economy during the period under consideration. Between 1970 and 2002, three main structural shifts can be underlined in Cameroon, namely the oil boom, the SAP and the devaluation of the CFA franc.

During the oil boom, high international coffee and cocoa prices and more favourable producer price policies encouraged forest clearing to plant coffee and cocoa. Furthermore, government investment of oil revenues in parastatal oil palm (SOCAPALM) and rubber plantations (HEVECAM) fuelled deforestation. Wood harvest rose from 1.2 million cubic meters in 1977 to 2.1 million cubic meters in 1985 (Ndoye and Kaimowitz 2000). Timber exports grew as well, but stagnated as companies sold more timber domestically (Foteu 1995; World Bank 1988). The oil boom stimulated construction, and this generated greater domestic demand for timber. However, food crop production apparently grew slowly during the oil boom due to promotion of rapid rural to urban migration (Ndoye and Kaimowitz 2000).

Contrary to the oil boom, the structural adjustment policies induced a reduction of cocoa and coffee producer prices by 40 per cent and 60 per cent respectively in Cameroon (Blanford et al. 1994; Gbetnkom and Khan 2002). Consequently, about 45 per cent of cocoa farmers in the East province abandoned their cocoa area in 1993 (Toornsta et al. 1994). With respect to food crop sector, its growing importance severely affected deforestation compared to cocoa and coffee. As rural households found their incomes from cocoa and coffee collapsing, many compensated for those losses by increasing food production.

In January 1994, the CFA franc was finally devalued by 50 per cent. The new exchange rate greatly stimulated timber production, and this negatively affected large areas of forest. The devaluation doubled the prices timber companies received for their logs, but only increased their production costs by 34 per cent (Ndoye and Kaimowitz 2000). This induced logging companies to increase their production. On average, log exports from Douala were almost twice as high in 1994-96 as between 1987 and 1993. Concerning cocoa and coffee, producer prices for these two crops rose, and farmers responded to the increases by expanding their productions. With respect to food crops, Sunderlin and Pokam (1998) reported that 48 per cent of plantain producers increased their cultivated areas between 1993 and 1997, as did 47 per cent of producers of other food crops. This is because urban dwellers consumed fewer imported foodstuffs, since the devaluation greatly raised their price. Meanwhile, the total number of urban consumers continued to grow.

In general, it is obvious from the reviewed studies that prices paid to the producers of coffee, cocoa, and food crops, the export price index of timber, the fertilizer price index, the monthly average revenue of farmers, the gross national product per capita, the credit to agriculture, and the changing economic conditions (oil boom, structural adjustment policies, and the devaluation of the CFA franc) are important immediate causes of deforestation in Cameroon.

4 Methodology

The theoretical approach that guides the analysis in this paper is the open economy (market or profit-maximizing) approach. It is useful to explore the range of hypotheses for the effect on deforestation of changes in economic variables.

4.1 Model specification

From the theoretical framework presented above, we draw a linear model for empirical analysis of the form:

$$FOR = \alpha_0 + \alpha_1 coffeep + \alpha_2 cocoap + \alpha_3 timberp + \alpha_4 vaah + \alpha_5 GNPPC + \alpha_6 credit + \alpha_7 foodp + \alpha_8 fertp + \alpha_9 oilb + \alpha_{10} sap + \alpha_{11} dev + \alpha_{12} ra\inf + \mu_t$$

α_i represents the respective coefficients of the independent variables, and μ is the error term associated to the regression of the equation. *FOR* stands for annual data on the forest area used to capture deforestation. The variables *coffeep*, *cocoap*, and *foodp*, are the prices paid to the producers of coffee, cocoa, and food crops respectively. *timberp* is the export price index of timber. The higher these prices, the more the forest area diminish because of conversion of new forest portions and export of timber. A negative relationship is therefore expected between these variables and FOR ($\alpha_1 \prec 0, \alpha_2 \prec 0, \alpha_3 \prec 0, \alpha_7 \prec 0$). *fertp* is the fertilizer price index. Assuming complementarity between fertilizer and land area, increased fertilizer prices will expand the area of cultivation. A negative relationship is expected ($\alpha_8 \prec 0$). *Vaah* is the agricultural value added per hectare. It has a direct influence on deforestation. Its increase indicates an intensive agriculture; therefore the populations have no more interest in the extension of farmland and thus deforestation. This variable seems better attached to our preoccupation than the approximate monthly revenue of farmers used by the authors mentioned above, which is even very difficult to evaluate. The higher this variable, the less the supplementary destruction of forest area. Thus the expected relationship is positive ($\alpha_4 \succ 0$). *GNPPC* represents the gross national product per capita, which can be interpreted as a proxy for alternative employment opportunities. The higher it is, the less the dependence of the populations on the export of cash crops and forestry products. Thus a positive relationship is expected ($\alpha_5 \succ 0$). *Credit* is the volume of credit destined for agriculture. It is one of the critical inputs necessary for small and large-scale production. The inadequacy of formal credit to farmers or the lack of it in farming operations may hinder farmers from undertaking investments in land improvements and better farm management practices to intensify production. An increase of this variable favours forest protection. The expected relationship is positive **(**$\alpha_6 \succ 0$**)**. *Oilb, Sap* and *Dev* are dummy variables designed to capture the effects of the oil boom, the structural adjustment policies and the devaluation of the CFA franc on deforestation respectively. Each of these dummies takes 0 before the corresponding structural shift and 1 after. The expected relationship for the three is negative ($\alpha_9 \prec 0, \alpha_{10} \prec 0, \alpha_{11} \prec 0$). *Rainf* stands for rainfall and is a proxy for food security. Throughout the Sahel and the Horn of Africa, agricultural production is strongly influenced by climatic factors, especially rainfall. Rainfall is an appropriate indicator in the case of Cameroon as acute food shortages often result from drought. The use of this variable reflects the conventional emphasis on supply determinants of food security. A negative relationship is expected ($\alpha_{11} \prec 0$).

The above linear empirical model is a variant of the model of Osei Asare and Obeng-Asiedu (2000). However, it has originality for using two new variables, *Vaah* and *Rainf.*

4.2 Sources of data

The main data source was the Department of Statistics and National Accounts where the following documents were consulted: Cameroon in Figures, Annual Statistical Reports, and National Accounts documents. Other consulted sources include various reports from the World Bank, the Bank of Central African States, and the FAO. All prices were deflated by the GDP deflator. Annual data on forest cover in hectare (ha) were collected from various FAO and World Bank reports. Producer prices of cocoa and coffee, timber price index, GNPPC expressed in CFA franc and rainfall were taken from various issues of Cameroon in figures, and Annual Statistical Reports. The average producer prices for food crops in CFA franc per kg was calculated from the prices of four main food crops in Cameroon (maize, millet, cassava and plantains) from various issues of African Developments Indicators. The fertilizer prices in CFA franc per tonne were obtained from some issues of 'Fertilizer's Statistic Yearbook' of the FAO. Credit to agriculture is used as a proxy for credit availability to farmers. It was collected from various reports of the Bank of Central African States (BEAC). The agricultural value added per hectare is obtained from the World Bank's Economic and Social database (BESD).

4.3 Estimation technique

We examine the time-series characteristics of the variables, testing for stationarity and cointegration of the variables in the equation under consideration.

4.3.1 Unit root tests

We need to know the underlying process that generates our time-series variables. That is, whether the variables are stationary or non-stationary. Non-stationary variables might lead to spurious regressions. We use the Augmented Dickey-Fuller (ADF) and the Phillips Perron (PP) tests.

4.3.2 Cointegration analysis

To test for co-integration we run our regressions and use the ADF and the PP unit root tests to test for the stationarity of the residuals. If the residuals are stationary, then we conclude for co-integration of series used in the model (Adam 1993; Perman 1989).

5 Empirical results

5.1 Unit root tests results

Appendix Table A1 reports the results of the ADF and the PP tests for the order of integration of our variables. After comparing the ADF and PP statistics in Table A1 with the Mackinnon critical values provided by the Eviews econometric package, we came up with the following conclusions concerning the unit root tests. Most of the variables are not stationary in their levels, implying the non-rejection of the null hypothesis of non-stationarity. But they all become stationary in their first differences. The examination of the correlograms leads to the same conclusions. This means that they all have a single unit root. Only one variable (credit) is stationary in its level. We cannot therefore specify our model in its level without the risk of obtaining spurious

regressions except they are co-integrated. It is therefore necessary to carry out a cointegration test.

5.2 Co-integration test results

As described above, we ran our regressions and tested the residuals for the presence of unit roots. The results as presented in Table A2 in the appendix reject the null hypothesis of no co-integration. The ADF and PP statistics presented in Table A2 are significant at 1 per cent. In addition, the statistics of Durbin-Watson already indicate that the hypothesis of the absence of cointegration between the variables can be rejected (Pindyck and Rubinfeld 1998).

5.3 Regression results

We have used the ordinary least squares estimation procedure to obtain the results in Table A2. These results meet our expectations in terms of their signs except GNPPC and credit, which present contrary signs. This is not the same situation with their levels of significance.

The estimated coefficients of the variables *coffeep*, *cocoap*, *foodp* and *timberp* are statistically significant at 10, 1, and 5 per cent respectively with the expected negative signs. This indicates that the prices paid to farmers of coffee, cocoa, and food crop, and to exporters of timber effectively influence the speed of forest clearing in Cameroon. However, there is a difference in the response for annuals and perennials crops. The results show weak evidence of cocoa and coffee farmers responding in the short run[3] to price increases. This is because very often, farmers of perennials crops respond to price incentives in the short run by intensifying care and improving husbandry for their existing crops. Furthermore, since perennial export crops are less soil erosive, and productivity can be improved from rehabilitating existing plantations, it is obvious that forest clearing would be slower than for annual crops (Angelsen et al. 1999). Food crop farmers can easily respond to price incentives in the short run by expanding the land area. In addition, because most annual crops deplete soil fertility faster than cash crops, they require more new fertile land (Angelsen et al. 1999).

The fertilizer price index has the expected sign but is statistically insignificant. The behaviour of this variable can be explained either by the fact that farmers of perennial crops consume very negligible quantity of fertilizer or by the difficulties to obtain reliable data on the variable. Angelsen et al. (1999) found this variable insignificant in Tanzania.

The agricultural value added per hectare (Vaah) is highly significant (1 per cent) with the expected positive sign. This variable measures what a farmer derives from his agricultural activities as profit per hectare. The higher this profit, the less the attack of the farmer of parcels of forests. This variable can therefore be at the center of a governmental policy aimed at discouraging deforestation.

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3 The results with *cocoap* and *coffeep* lagged for three years, and *foodp* lagged for one year are not reported in the paper. These lagged variables were not significant and deteriorated the performance of the whole model.

Credit to farmers does not have the expected sign, and is not significant. This can be linked to the fact that in Cameroon, access to banking credits by small-scale farmers of rural zones who make up about 90 per cent of farmers is very difficult. Only a minority of farmers possessing modern agricultural tools can obtain credit. To reduce the weight of this problem, the government had established state structures to give small-scale subventions to peasant farmers (FONADER, Credit Agricole dDu Cameroon), unfortunately, all these structures disappeared during the economic reforms. The very negligible effect of bank loans on deforestation can also be the consequence of the absence of reliable data on this variable.

Food security proxied by rainfall has the expected negative relationship with forest depletion and is statistically significant at 5 per cent level. This indicates that forest depletion negatively impacts on the rural poor forest dwellers, subsistence farmers and landless families and livestock herders' basic food needs in Cameroon.

The three dummy variables oilb, sap, and dev designed to capture the three structural breaks that occurred in the Cameroon economy during the period under consideration in this paper have the expected signs, and are significant at 1 per cent, 5 per cent and 1 per cent respectively.

The GNPPC does not have the expected sign and is not significant. Its increase is assumed to reduce the demand of agricultural and forestry products.

As a whole, our model has performed well, because all the coefficients except two have the expected signs. However, in terms of their significance, some of our expectations were not met. The adjusted coefficient of determination ($\overline{R^2}$) shows that the variables included in our model have succeeded to explain at 88 per cent deforestation in Cameroon. Osei Asare and Obeng-Aseidu (2000) had 97 per cent in the case of Ghana. The Fisher Statistics (F-Stat) for the general performance of the model is significant. To test for serial correlation, we have used the Durbin-Watson statistic (DW). As appeared in Table A2, the DW shows that the null hypothesis indicating the presence of a serial correlation has been rejected. All the probabilities of these two statistics are not significantly different from zero.

6 Conclusion

This paper aimed at examining the impact of forest management on gender and food security of poor populations in Africa. The analyses reveal that deforestation places major demands on women and children's time, limiting their opportunities to obtain an education or undertake income-generating activities. Also, managing the remaining forest resource for food security in Cameroon taken as an accurate picture of Africa involves introducing improved forest management and harvesting policies and technologies. This can be accomplished by making investments that minimize the loss of forest area to deforestation, improve tree growth, minimize soil disturbance and ensure quick and satisfactory regeneration of new forests. It could also include ensuring satisfactory natural regeneration of harvested forests and forests damaged by fire, adopting reduced-impact logging practices, and minimizing the negative environmental impact of road construction and maintenance. In short, it means practicing sustainable forest management. However, under current practices, the overwhelming majority of tropical forests are not sustainably managed. In Africa, forests are experiencing the

highest rates of depletion and degradation. The econometric analysis addresses the factors of forest clearing in Cameroon and their magnitudes in the long-run. The empirical evidence suggests that the producer prices of coffee, and cocoa, timber prices, and food crop prices influence at various degrees the decision to cut down more wood for export and to convert forests into farmland. The agricultural value added per hectare positively affects forest cover. This means that its increase rather motivates the conservation of forests. The fertilizer price index, the credit to farmers and the per capita GNP have no effect on the activities of deforestation. Forest depletion negatively impacts on food security of poor rural forest dwellers, subsistence farmers and landless families and livestock herders. Finally, the oil boom, the structural adjustment policies and the devaluation of the CFA franc have seriously increased the speed of deforestation in Cameroon.

The implications of these results are such that all attempts to slow down the speed of forest depletion in Cameroon must take into account the influence of the significant variables in our model on this phenomenon. Meanwhile, the policies aimed at reducing the prices of agricultural products shall hardly get the support of the populations, given that about 75 per cent of them depend on agriculture. In addition, it would be difficult to implement them in the actual context characterized by the liberalization of economies, which put an end to the stabilization of the cash crops prices. The agricultural value added per hectare, which measures what a farmer derives from his agricultural activities as profit per hectare increases the profitability of maintaining forests. This variable can therefore be at the center of governmental policies aimed at discouraging forest depletion. This is possible through the promotion of intensive farming system by increasing the amount of labour, and capital applied per hectare of land. Whether the expansion of markets demands and higher product prices lead to more or less pressure on the forest-agriculture frontier depends on the farmers' choice of technology (that is how much to intensify and how much to expand an area) in response to perceived opportunities.

Another implication of this study is that the new institutional tools for forest management and land-use planning in Cameroon (ONADEF, MINEF) have not yet provided a sustainable response to the problems of the progressive disappearance of forests.

Finally, a critical lesson from this paper is that policy measures outside of the formal forest sector are a key part of the problem of tropical deforestation in Cameroon, and therefore potentially a key part of the solution. This means that, prior to the crisis, and also during the crisis, governmental authorities did not pay sufficient attention to the unintended and the undesirable consequences of, inter alia, structural adjustment policies, urban and public sector employment policies, infrastructure policies, agricultural pricing and import policies, and exchange rate policies (Mertens et al. 1999). In order to protect the remaining forest areas, and render sustainable the contribution of forests to food security of poor populations, attention to these policies should be a first-order priority in the future. It is obvious that governmental authorities will not alter exchange rates to protect forests, but environmental preoccupation should be taken into consideration when determining what macroeconomic policies to implement. It appears therefore that an important challenge is likely to be learning how to manage forests both for growth, and also as a safety net. With this knowledge, better-informed choices of trade-offs involved in forest management can be made.

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Appendix

Table A1: Unit root tests statistics

	Levels		First difference	
	ADF	PP	ADF	PP
Ln (timberp)	- 2.01	- 2.01	-4.65	-5.25
Ln (cocoap)	- 0.78	- 0.69	-4.09	- 4.51
Ln (coffeep)	- 1.85	- 1.71	-3.63	- 4.08
Ln (credit)	- 6.9	- 4.25	……	…...
Ln (For)	- 0.55	- 0.73	-3.31	- 4.85
Ln (GNPPC)	- 0.86	- 0.86	-3.05	- 3.05
Ln (Vaah)	- 1.97	- 1.877	-3.17	- 4.57
Ln (Foodp)	- 0.5	- 0.172	- 3.953	- 4.04
Ln (fertp)	- 2.02	- 1.674	- 3.09	- 3.855
Ln (rainf)	-1.21	-1.99	-4.04	-7.18

The critical values of Mackinon for rejecting the hypothesis of the presence of a unit root at the 1%, 5% and 10% levels are: ADF (-3.7497, -2.9969, -2.6381) and PP (-3.7343, -2.9907, -2.6348).

Table A2: Results of the estimation of the function of determinants of deforestation

Dependent variable log (FOR)

Variables	Coefficients	t-statistic
Ln (Coffeep)	-0.02816	-1.6801***
Ln (Cocoap)	-0.0676	-1.967***
Ln (timberp)	-0.0314	-2.15**
Ln (Vaah)	0.03457	3.14*
Ln (Credit)	-0.00422	-0.8411
Ln (GNPPC)	-0,009611	-0,2334
Ln (foodp)	-0.05816	-2.9402*
Ln (fertp)	-0.0143	-0.996
Ln (rainf)	-0.0284	-2.491**
Oilb	-0.0326	-3.204*
Sap	-0.0275	-2.456**
Dev	-0.0519	-3.35*
C	9.465	60.24*
ADF = -4.43		
PP = -6.493	Durbin-Watson Stat = 2.26	F-statistic = 162.35
R^2 = 0.9018		Prob (F-stat) = 0.0000
$\bar{R^2}$ = 0.8812	S.D dependent Var = 0.00953	S.E. of regression = 0,0253

Note: *, ** and *** imply significance at 1%, 5% and 10% respectively.