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Assessing Shifting Cultivation Trajectories in the Southern Part of Cameroon

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Abstract Good understand of changes in shifting cultivation and factors involved is a way forward in finding appropriate respond to preserve forested landscapes. A study was conducted with the aim of analyzing different pathways that could be taken in shifting cultivation trajectories. A total of 470 households were randomly sampled in the three study sites of the southern part in Cameroon. Data were collected using household survey, focus group discussion, interview of key informants and remote sensing based analysis of land cover. We found that shifting cultivation could migrate from traditional to a relatively modern form. Modern form is characterized by the evolution of objective from consumption to commercialization, a very short fallow, improvement of technique, and introduction of new market crops and diversification of crops produced. It is affected by population density, availability of forest land and accessibly (road and transport). In the site where traditional form is observed, 88 % of respondents revealed that there is still forest land belonging to nobody where they can create new farm. Therefore, a good management of land will constraint shifting cultivators to shift to modern agricultural technique. Moreover, it is advisable to develop policy measures to promote the progressive change of this old practice towards the adoption of appropriate agricultural techniques in the context of preservation of forested landscape.

Keywords: *shifting cultivation, trajectory, drivers of change, traditional to modern form, Cameroon*

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1. Introduction

In the context of reducing emissions from deforestation, agriculture is a major concern for global environmental management. Among drivers of land use change, agriculture has been identified as the main factor of deforestation accounting for around 80 % of deforestation worldwide [13]. In Africa, it accounts for around 1/3 of deforestation [13] and it is dominated by slash-and-burn farming known as shifting cultivation [19,34]. Many studies confirm the persistence of shifting cultivation in the world. The review of 156 cases study by [21] show the extend of shifting cultivation across Central Africa, East Africa, Madagascar, Central America, South America, Latin America, Southeast Asia and Pacific Island. The practice is also found in many parts in Cameroon [34].

Studies related to shifting cultivation were conducted mostly in the central, east and south part of Cameroon. Among these works, [4] conducted an explorative study which has characterized shifting cultivation with the different types of crop farm. [34] has developed the land use dynamic under shifting cultivation system and has assessed the relationship between soil properties and land use dynamics. He came out with five different cycles of shifting cultivation according to fallow length and land use type. [35] analyzed the impact of shifting cultivation practice on plant biodiversity and carbon sequestration. [11] assessed farmers' indigenous knowledge of soil fertility, and their management strategies of natural resources while [14] worked on the dynamic of carbon in slash and burn agriculture.

Indeed, the term shifting cultivation refers to a broad range of land use types [3]. Shifting cultivation has been defined with relatively the same meaning. But there are common features for shifting cultivation, it refers to any temporally and spatially cyclical agricultural system including clearing of land with slash and burn, followed by cultivation phases and the fallow phase during which farmers shift from cropping field to another abandoned fields. Generally, it involves an alternation of cropping for few years on a land parcel followed by a relatively long period of fallow, the lengths of the cropping and fallow phases vary considerably [7,10,14,34].

Historically, some authors blamed shifting cultivation as a principal cause of deforestation [8]; while others considered it to be one of the sustainable agricultural practices [17] due to its long fallow period allowing enough time for forest and soil regeneration [26,35]. Moreover, [1] and [26] mentioned that, in the context of low population density, shifting cultivation has often been described as sustainable and compatible with conservation

of forest. Also, in the absence of the market economy, it is described as environmentally friendly cultivation method that did not cause significant negative consequences [14,26]. However, the key component of this system is fallow, which it is viewed as a vegetation type derived from cropland [35]. Fallow was classified according to age of land and dominant plants species in the land [34,35]. Shifting cultivation is a complex system with different land use types and interaction within.

Nowadays, shifting cultivation has become an unsustainable land use practice contributing considerably to forest deforestation and degradation [26]. Some factors as population density, market forces, roads and transportation net-works have been reported to influence shifting cultivation system in many areas [21]. Consequently, there are changes observed in this practice, whereas shifting cultivation has been viewed as traditional practice which has remained as such over thousands of years [5]. Indeed, studies in shifting cultivation addressed themes as soil fertility, soil degradation, carbon stock, biodiversity, land use land cover change, etc. Much of them mentioned changes observed in the practice without particular attention in studying these changes and possible trajectories taken during the processes of evolution. One of the most common changes mentioned is fallow length. Nonetheless, there are many other changes that occur during the dynamic process of shifting cultivation such as cropping technique, type of crop introduced and the increase in the marketing of agricultural products

In the context of preservation of forest by avoiding deforestation due to this practice, it would be important to closely examine the changes observed in shifting cultivation and the implication of factors involved such as population, road network and availability of land. So, a deep understanding of different trajectories taken by shifting cultivation over time is a way forward in finding appropriate strategies to halt negative aspect of this practice in order to develop sustainable agriculture in forested area. Therefore, the aim of this study is to analyze different pathways that could be taken in shifting cultivation trajectories. Questions one may ask are (i) what are trajectories of shifting cultivation in southern part of Cameroon? (ii) Which factors affect the changes or mutations of shifting cultivation in this area? The knowledge of the trajectories of shifting cultivation will enable the government to reflect on policies and strategies for forest management which incorporate sustainable agriculture according to the specificities of each zone. In addition, lessons learned from areas where changes have been observed could serve as a basis for a new move within and beyond communities practicing the primitive form of shifting cultivation.

2 Materials and Methods

2.1. Description of the Study Area

The study was conducted in EligMfomo-Obala, Ayos and Efoulan councils of the southern part of Cameroon (Figure 1). The climate is bimodal tropical climate with two rainy seasons alternating with two dry seasons. The location are: (i) EligMfomo-Obala (latitude:4°09' 41,40"; longitude:11°27' 29.52") belong to Lekie division in the center region; (ii) Ayos (lattitude:4° 04' 4,80"; longitude: 12°31' 31,44") is a council of Nyong et Mfoumou division in the center region and (iii) Efoulan (lattitude:3° 05' 12,48"; longitude:10° 48' 38,64") is part of Mvila division in south region of Cameroon. The temperature averages of EligMfomo-Obala , Ayos, Efoulan is respectively 24.7°C, 24.6°C, 25.2°C; and the average annual rainfall is 1707mm, 1759 mm and 2423 mm [9]. The population of EligMfomo is 23405 inhabitants (Local administrative record, 2014/ survey of 2016), Olaba is 133014 inhabitants [25], Ayos is 24531 inhabitants [24] and Efoulan is 24999 inhabitants [2].

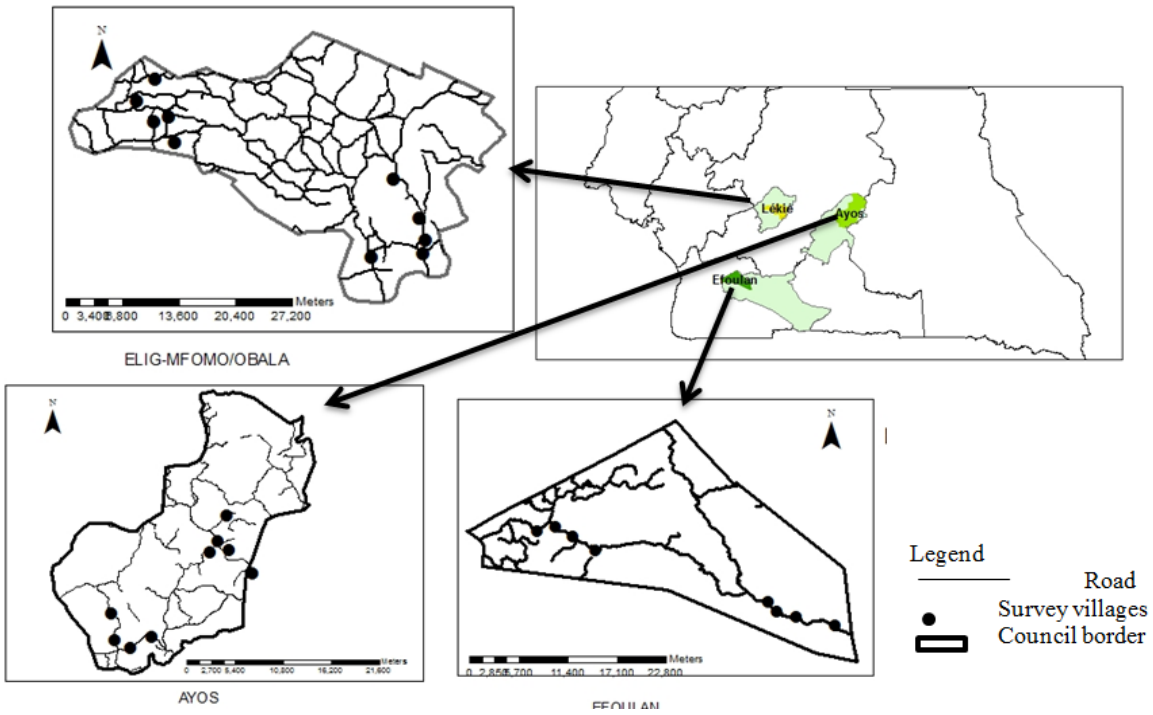


Figure 1. Study area map

The vegetation of the center region of Cameroon is part of the Congo-Guinean domain, covered by semi deciduous forest of Sterculiaceae and Ulmaceae [16]. In EligMfomo-Obala, vegetation is degraded because it has highly cleared for food and industrial crops. The south region of Cameroon vegetation is known as guineo-congolese forest with two districts: the biafra atlantic district made of Cesalpiniaceae and the littoral atlantic district made of Lophira alata (azobé) and Sacoglottis gabonensis (ozouga) [16]. The main activity of the population of these areas is agriculture, made of perennial crop and annual crop.

2.2. Data Collection and Analysis

The study has been carried out in three sites in the southern part of Cameroon from july 2015 to december 2016. These communities are actively engaged in agriculture which represents the principal activity of the household. These areas, in particular Ayos and EligMfomo-Obala-are among the localities that supply urban towns and surrounding countries (as Gabon) with agricultural products. In addition, this selection is based on the abundance of vegetation cover according to Cameroon forest atlas of the Ministry of the Forestry and Wildlife and World Resources Institute (WRI). So, we considered the gradient that move from EligMfomo-Obala with vegetation cover highly degraded to Efoulan with a relatively dense vegetation cover.

Data collection was done by the researcher with the help of locally recruited assistants under supervision. The research methodology was based on literature review, household surveys, focus-groups, and remote sensing based analysis of land cover change. We collected both quantitative and qualitative data. We started with literature review which aimed to gather secondary data from socio-economic and environmental books, local administrative records on population etc. After, household surveys (HHS) were conducted with questionnaires, which were designed, tested and reviewed. A total of 470 households were randomly sampled in 8 villages of each study sites. It represents at least 15 % of the total households of these villages. EligMfomo-Obala, Ayos and Efoulan represented respectively 34.36% (n=161), 36.81% (n=136) and 28.94% (n=136) of the sample. The chief of household was the respondent to the questionnaire who has provided information's of his family.

The information found in HHS aimed first to characterize shifting cultivation through the exploration of interest of practicing shifting cultivation, fallow length, soil fertility and use of inputs, introduction of new crop, demand, materials, availability of agricultural land and land use type and farming technique. Using a four to five-point continuous scale, respondents were asked to rate their level of appreciation of each question and to provide brief explanation to justify their assessment.

Secondly, population, accessibility (road and transport) and availability of land was been found in the literature review as factors influencing shifting cultivation. Considering these factors, HHS questionnaire accessed farmers' perception on road state and cover, transportation price, distance to market, availability of land and trend of household inhabitants change. This was completed by data on population and road density collected through documentations and the analysis of land cover change of forest to non-forest land of 1990 and 2010. Here, we used database of Reducing Emissions from Deforestation and Degradation in Africa Project (REDDAF) which contribute to enhance the operational monitoring of forest cover and biomass changes in Cameroon and Central African Republic. (REDDAF project received funding from the European Community's Seventh Framework Programme (FP7/2011-2013) under grant agreement n° 262775). In Cameroon, GAFAG (the Consortium lead of REDDAF project) worked closely with the Ministry of Environment, Protection of Nature and Sustainable Development (MINEPDED) and the Ministry of Forest and Wildlife (MINFOF) to classify land cover change based on Intergovernmental Panel on Climate Change (IPCC) classification. The information is available for EligMfomo-Obala and Ayos which was used as an example to illustrate the impact of shifting cultivation on forest cover. The data of these areas was extracted from land cover change database produced by the project. In addition, we used the dataset of the Ministry of transport (MINTP) that contains vector files of roads infrastructure. GIS analysis was coupled with the literature review and observation made in the field to demonstrate the impact of shifting cultivation in the forest cover loss. Finally, focus group discussions were conducted to have more information and deep explanation on the observations that was gathered.

Data have been analyzed on Excel and R software. Descriptive statistical analysis as frequency, percentage, sum and mean was used. Satellite images of land cover change database and vectors shapefile were processed using ArcGIS software.

3. Results

3.1. Trajectories of Shifting Cultivation Practice

Traditional, semi-traditional and modern forms of shifting cultivation are the trajectories of shifting cultivation which have been distinguished respectively in Efoulan, Ayos and EligMfomo-Obala (Figure 2). We found that commercialization and consumption level, gradual improvement of agricultural technique, diversification and new crop, and fallow length are the factors characterized the observed change in each trajectory. Population density, road density, transportation price and availability of land are the factors influencing the change from traditional to modern form of shifting cultivation. Intensity of these factors could increase or decrease according to shifting cultivation trajectory.

3.2. Characterization of Shifting Cultivation Trajectories

3.2.1. Objective of Doing Shifting Cultivation

Practicing of shifting cultivation takes its foundation on interest of farmers. Result found indicate that 93.04 % of farmers in EligMfomo-Obala, 92.44 % in Ayos and 80.13% in Efoulan strongly agree that agriculture is firstly done for consumption and secondly for commercialization.

In addition, 95% of in Ayos to 96% in EligMfomo-Obala and Efoulan of shifting cultivator state that agriculture is the main source of household income. Nonetheless, the proportion of product sold as compare to proportion consume shows that, farmers sell an average of 46.55% of the production in EligMfomo-Obala, 37.90% in Ayos and 29.01% Efoulan (Figure 3). Furthermore, 50% of farmers in EligMfomo-Obala sold about 25% to 75% of their production, it is important as compare to the one of Ayos (25% - 50%) and Efoulan (20% - 35%).

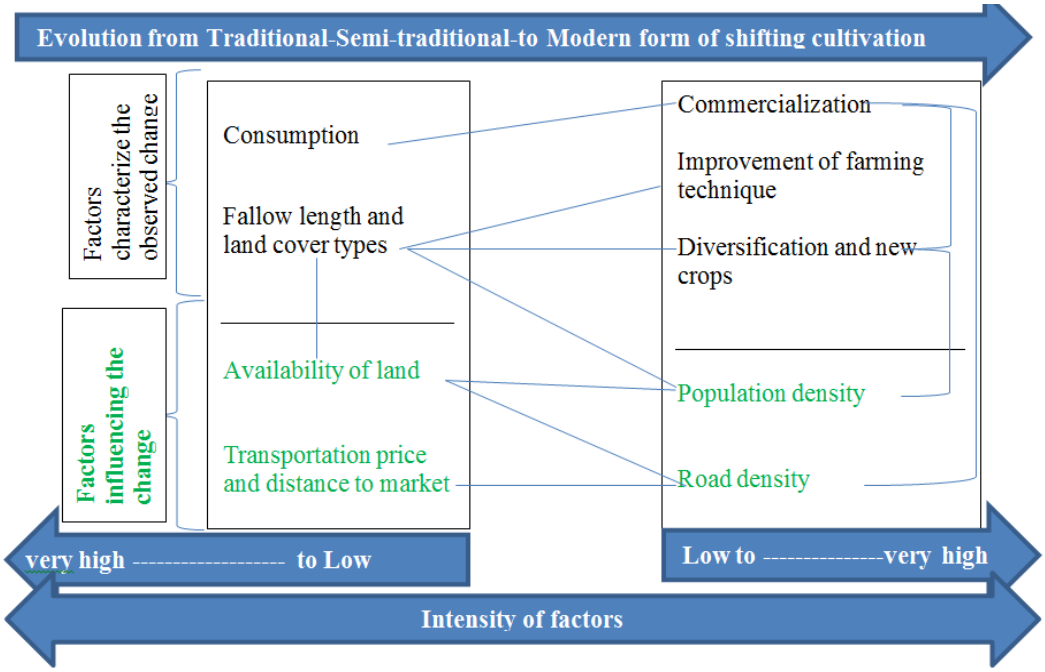


Figure 2. Dynamic of shifting cultivation (relation between factors)

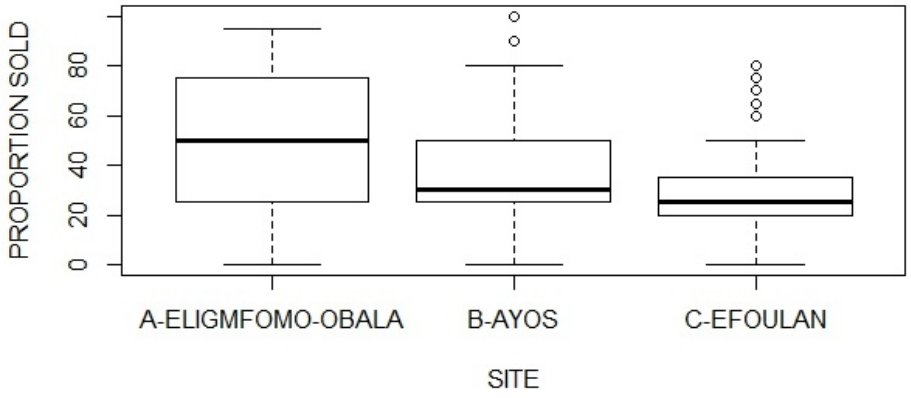


Figure 3. Proportion of agricultural products sold

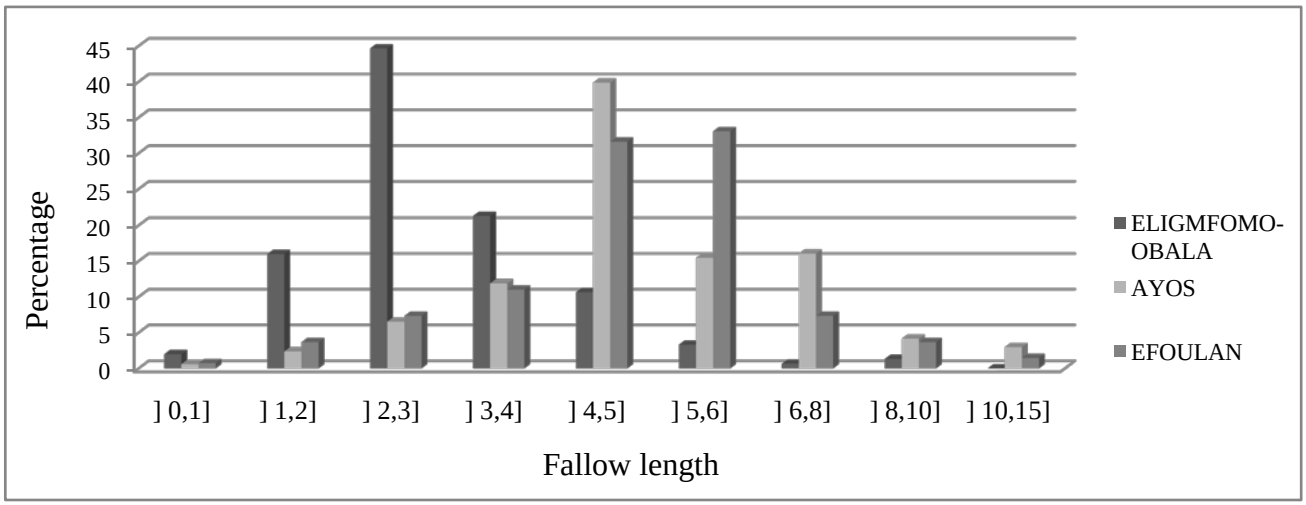


Figure 4. Proportion of fallow length in different ages groups

3.2.2. Land Cover Type and Fallow Length

Land cover type and fallow length express in some way intensity of shifting cultivation and deforestation or availability of forest land. For this purpose, 94.41% of farmers in EligMfomo-Obala, 82.53% in Ayos, and 75.97% in Efoulan have noted that, the fallow period has declined. Although the fallow period has decreased, EligMfomo-Obala has the smallest fallow period. We found that, the highest proportion of fallow length is 3 years (44.67%) in EligMfomo-Obala, 5 years (39.88%) in Ayos and range between 5 years (31.62%) to 6 years (33.09%) in Efoulan (Figure 4).

Moreover, 61.11% of farmers in EligMfomo-Obala, 97.04% in Ayos and 98.46% in Efoulan think that, they have enough land to increase in number and or in surface area their plots. However, the difference lies in the type of vegetation cover where it can be made (Figure 5). We have observed that, household in EligMfomo-Obala mainly own young fallow lands which represent 53.85% of their land. In Ayos and Efoulan, all types of vegetation cover land (i.e. young fallow to very old fallow) are available, and represent respectively 53.66% and 47.76%.

3.2.3. Farming technique

Use of input and type of agricultural material are some indicators of changing observe in shifting cultivation technique. Result found indicated somewhat progressive change in technique of shifting cultivation practice. About 69.08% of respondents in EligMfomo-Obala mentioned that they have changed their technique of doing farm as compare to the past, while in Ayos and Efoulan 63.58% and 80.88% of farmers respectively have declared that they didn't change. This change could be justified by the importance giving to soil fertility and the use of input. To this end, 57.05% of farmers in EligMfomo-Obala are dissatisfied to very dissatisfied about fertility of their land, while 84.97% in Ayos and 77.78% in Efoulan are satisfied to very satisfied (Table 1). We found that 80.92% of farmer in EligMfomo-Obala, 52.07% in Ayos and 50.38% in Efoulan use input. Among the input used, fungicide is the most used in all sites (Table 2). However, the particularity of EligMfomo-Obala, is the importance of soil fertilizer used than other sites.

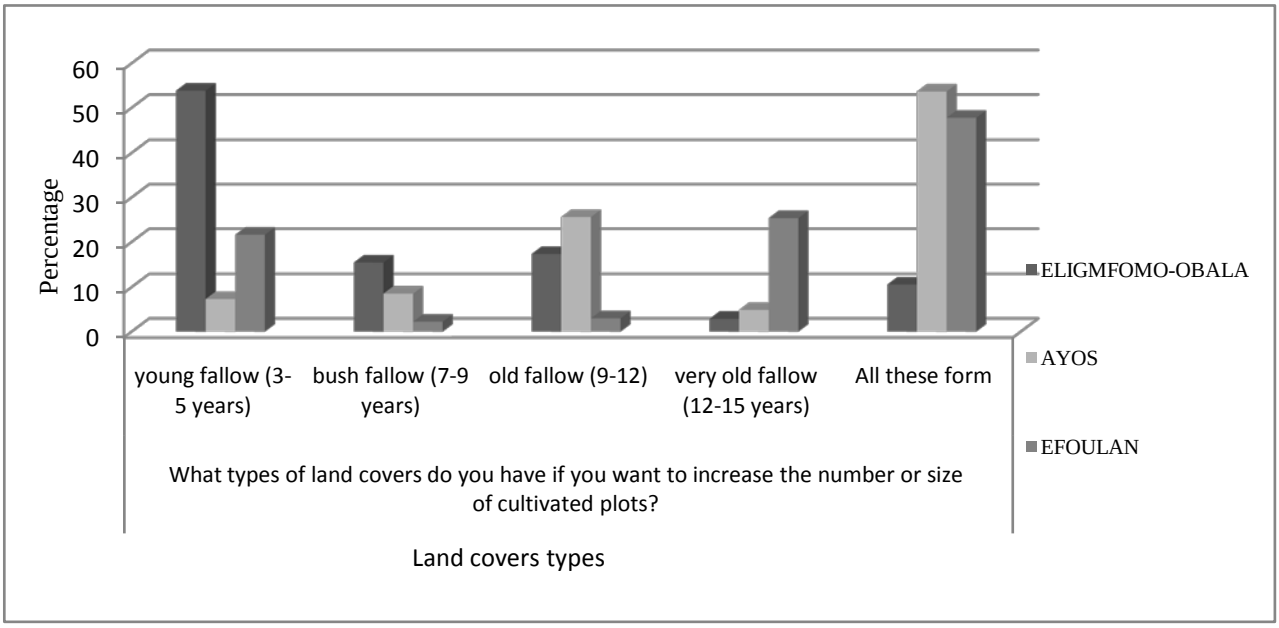


Figure 5. Availability of land covers type in each household

Table 1. Satisfaction level on the fertility of land and use of input

Question	Level of appreciation	ELIGMFOMO-OBALA (%)	AYOS (%)	EFOULAN (%)
Appreciate the overall level of satisfaction of the fertility of your land?	Very dissatisfied	5.77	0.58	0.00
	Dissatisfied	51.28	6.36	8.15
	Neither	20.51	8.09	14.07
	Satisfied	19.87	58.38	57.04
	Very satisfied	2.56	26.59	20.74
Assess the level of the use of inputs	no inputs	18.63	45.09	51.47
	Very Low	6.21	7.51	5.88
	Below Average	13.66	9.25	16.18
	Average	29.81	20.81	22.06
	Above average	15.53	14.45	4.41
	Very High	16.15	2.89	0.00
Type of input use	Fertilizer	33.33	7.88	3.57
	Fungicide	64.26	92.12	94.64
	Herbicide	3.21	2.73	0.89
	Insecticide	8.43	8.48	3.57
	Pesticide	4.02	6.67	7.14

In addition, agricultural equipment goes along with changing of agricultural technique. Classical agricultural equipment such as hoe and machetes are well represented in households of all sites. More than 92% of farmers have these materials (Table 2). It is followed by sharpener, wheelbarrows, rakes, prayers and axes. Nonetheless, we should note the particular presence of motor-pumps in EligMfomo-Obala (10.56 %) than Ayos and Efoulan.

3.2.4. New Crop Introduce and Diversification of Crop Produce

Progress in agriculture could be expressed by new crops introduced and diversification of agricultural production. Thus, result shows that 82.61 % of farmers in EligMfomo-Obala, 70.73% in Ayos 38.84% in Efoulan mention to have introduced new crop. Assessment of the type of new crop introduces reveal that, hybrid cocoa is the most important new crop in all sites. However, we found a great diversity of new crop introduce in EligMfomo-Obala than in Ayos and Efoulan (Table 3).

In addition, demand by type of crop produce is quite diverse in EligMfomo-Obala, vegetable products occupy an important place (Table 4). Plantain, cocoyam, cassava, groundnuts and cocoa are products whose demand is important in all sites. Specifically, plantain and cocoyam are over 54% of requests in Efoulan and 57% in Ayos. Although, the proportion of cucumber demands is negligible compared to the other products in Ayos and Efoulan, it is the peculiarity of areas dominated by forest or very old fallow.

Table 2. Proportion of farmers with materials.

Materials	ELIGMFOMO-OBALA (%)	AYOS (%)	EFOULAN (%)
Machetes	96.89	95.95	98.53
Hoe	92.55	96.53	94.85
sharpener	77.02	72.83	84.56
Sprayer	57.76	38.15	31.62
Rakes	42.24	35.84	46.32
Wheelbarrow	40.37	35.26	35.29
pickaxe	32.92	33.53	40.44
Axes	21.74	31.21	59.56
Motor pump	10.56	1.73	1.47
Chainsaw	6.21	4.62	4.41
Rickshaw	2.48	2.31	1.47
Generator	1.86	5.78	0.74

Table 3. Proportion of the importance of the type new product (varieties) introduced

Product	Eligmfomo-Obala (%)	Ayos (%)	Efoulan (%)
Cocoa Hybrid	46.70	92.11	62.00
Tomato	14.84	1.97	2.00
Maize	12.09	0.00	30.00
Okra	10.44	0.00	2.00
Cassava	7.14	4.61	4.00
Potato	5.49	0.00	0.00
Peanut	1.10	0.00	0.00
Watermelon	1.10	0.00	0.00
Chilli Pepper	1.10	1.32	0.00

Table 4. Farmers perception on the level of demand of agricultural product according to what they produce.

Products	Eligmfomo-Obala (%)	Products	AYOS (%)	Products	Efoulan (%)
Cassava	26.54	Plantain	29.52	Cassava	29.81
Plantain	12.81	Macabo	28.07	Plantin	24.23
Peanut	7.78	Cassava	15.38	Macabo	20.33
Cocoa	7.78	Peanut	14.76	Peanut	5.85
Maize	7.78	Cocoa	4.37	Cocoa	5.57
Tomato	7.09	Cucumber	1.66	Cucumber	4.18
Macabo	6.18	Banana	1.04	Wild Mango	2.51
Okra	5.03	Coffee	1.04	Maize	1.95
Potato	3.89	Njansang	1.04	Banana	1.67
Chilli Pepper	3.20	Yam	0.83	Igniame	1.39
Banana	2.29	Maize	0.62	Vegetable	0.56
Igniame	1.83	Tomato	0.42	Nuts	0.56
Plum	1.83	Chilli Pepper	0.42	Tomato	0.28
Orange	0.92	Vegetable	0.21	Chilli Pepper	0.28
Vegetable	0.69	Okra	0.21	Potato	0.28

3.3. Factors Affecting Shifting Cultivation Trajectories

3.3.1. Population

Population is an important factor in analyzing the change of shifting cultivation practice. Hence, we found that population density of EligMfomo-Obala (252.70 inhabitant/km^2) is the most important than the one of Ayos (19.00 inhabitant/km^2) and Efoulan (15.14 inhabitant/km^2) (Table 5). However, this population is constantly growing, 73.68% in EligMfomo-Obala, 73.23% in Efoulan and 74.12% in Ayos of households have reported an increase in the size of their household over the last 5 years. This is mainly due to births of approximately 82.30% of cases in Efoulan, 76.09% in EligMfomo-Obala and 74.89% in Ayos.

3.3.2. Accessibility to the Site

Accessibility is very important in advancing intensity of shifting cultivation. It was studied by assessing price of transport, distance to market, road state, length and density that covers each sites. For this purpose, appreciation of local population concerning the road cover that cross the village is 53.21% satisfactory in EligMfomo-Obala, and 55.29 % and 57.78% unsatisfactory in Ayos and Efoulan respectively (Table 6). The state of the road is bad to very bad according to 64.12 % and 73.53 % of respondents in Ayos and Efoulan. This is not the case in the locality of EligMfomo-Obala where 43.87 % of farmers think that road is good to very good.

In addition, analysis of road map data of the Ministry of transport (MINTP) reveals that EligMfomo-Obala has 291.08 km of road, Ayos counts 384.32 km of road and Efoulan has 194.24 km of road. The density of road in EligMfomo-Obala represents almost the double as compared to Ayos and more of the triple as compare to Efoulan. The Figure 6 which present spatially the road cover that crosses each council, help to confirm farmers' appreciation and to have a picture of the density of road.

Moreover, type of road that crosses the village helps to give more explanation on road state. 17% of road network in EligMfomo-Obala is tarred, it is the most important compared to Ayos which has only 5% of tarred road and Efoulan which has no tarred road. Track / Path (define by MINTP as unimproved seasonal roads, cleared to be accessible to light vehicles and animal drawn carts) represent the important part of the road network in EligMfomo-Obala and Ayos (73% and 87%), it represents only 25% in Efoulan. Also, trails (which are a narrow road, used by pedestrian and animal, inaccessible to vehicles) make up the majority of road network in Efoulan (49%).

In addition, these observations explain why the price of transport is low in EligMfomo-Obala and particularly high in Efoulan. Indeed, an average of 682 Fcfa and 1003 Fcfa is paid respectively for the transport of persons and for agricultural products in EligMfomo-Obala. This represents 1661 Fcfa and 1985 Fcfa in Ayos, 2019 Fcfa and 1696 Fcfa in Efoulan (Figure 7). Also, accessibility to the area has impact the development of market place where farmers could sell their agricultural product. We found that distance to the market is relatively long for farmers who live in Efoulan area. The average distance to market is about 34.06 km in Efoulan, 21.66 km in Ayos and 11.84 in EligMfomo-Obala.

3.3.3. Availability of Land

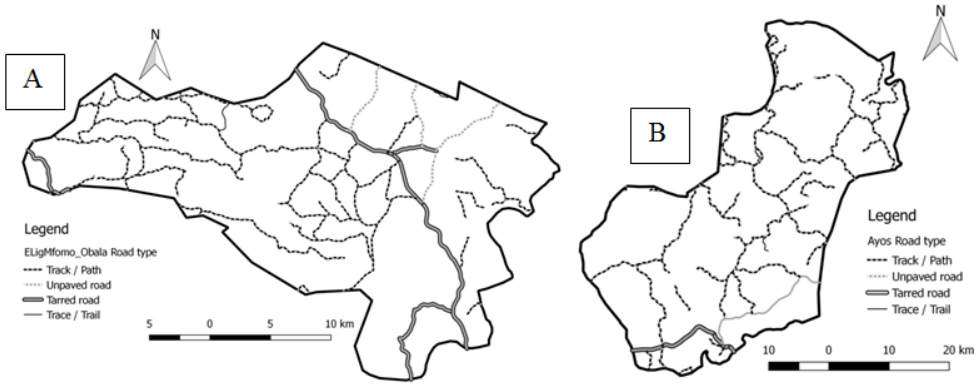
Scarcity of land sometime constraints shifting cultivators to be sedentary and to adopt intensive form of agriculture. In terms of tenure, 94.77% of farmers in EligMfomo-Obala, 97.01 % in Ayos and 97.06 % in Efoulan confirm that it was the customary law through the "axe right" or right of the first occupant that allowed their families to acquire land. However, the pursuit of "axe right" could be limited due to availability of land. Indeed, 84.52 % of households in EligMfomo-Obala believe that there are no more unoccupied forest lands where families could create new plots, while 61.45% and 88.28% of households in Ayos and Efoulan respectively think that, there are unoccupied forest lands for the creation of new plots (Figure 8). It is important to note that the answer is quite frank and precise in Efoulan where 46% of households strongly agree on the availability of land as compared to 28% in Ayos.

Table 5. Population (i) Efoulan: T1 [2] and T2 [33], (ii) Ayos: T1 [27] and T2 [4], (iii) Elig-Mfomo-Obala: Elig-Mfomo T1 [27] and T2 (Local administrative record 2014/ survey of 2016) , Obala T1 [27] and T2 [25].

Sites	Surface (km^2)	Population (T1)	Density (Inhabitant/km^2) (T1)	Population (T2)	Density (Inhabitant/km^2) (T2)
Ayos	1620	22899	14.14	24531	15.14
EFOULAN	1474	24999	16.96	28000	19.00
ELIGMFOMO-OBALA	619	95090	153.62	156419	252.70

Table 6. Appreciation by farmers of length and state of road that cross the village

Questions	Level of appreciation	Eligmfomo-Obala (%)	Ayos (%)	Efoulan (%)
Appreciate the road cover that crosses the village?	Very dissatisfied	5.77	24.12	14.81
	Dissatisfied	29.49	31.18	42.96
	Neither	11.54	12.94	14.81
	Satisfied	17.95	14.71	5.93
	Very satisfied	35.26	17.06	21.48
Qualify the state of the Road covers that crosses the village?	Very bad	7.74	32.35	16.91
	Bad	30.97	31.76	56.62
	Average	17.42	14.71	17.65
	Good	14.84	5.88	7.35
	Very good	29.03	15.29	1.47



D

Site	Road type	Proportion (%)	Total length of road (km)	Density (Km^2)
Elig Mfomo -Obala	Track / Path	72.97	291.08	0.47
	Unpaved road	8.31		
	Tarred road	17.13		
	Trace / Trail	1.60		
Ayos	Track / Path	86.68	384.32	0.24
	Unpaved road	6.39		
	Tarred road	5.27		
	Trace / Trail	1.66		
Efoulan	Track / Path	24.65	194.24	0.13
	Forest trail	0.81		
	Unpaved road	25.16		
	Trace / Trail	49.38		

Figure 6. Spatial representation of the cover that crosses the council of EligMfomo-Obala (A), Ayos (B) and Efoulan (C), table represent road density and proportion of road type (D)

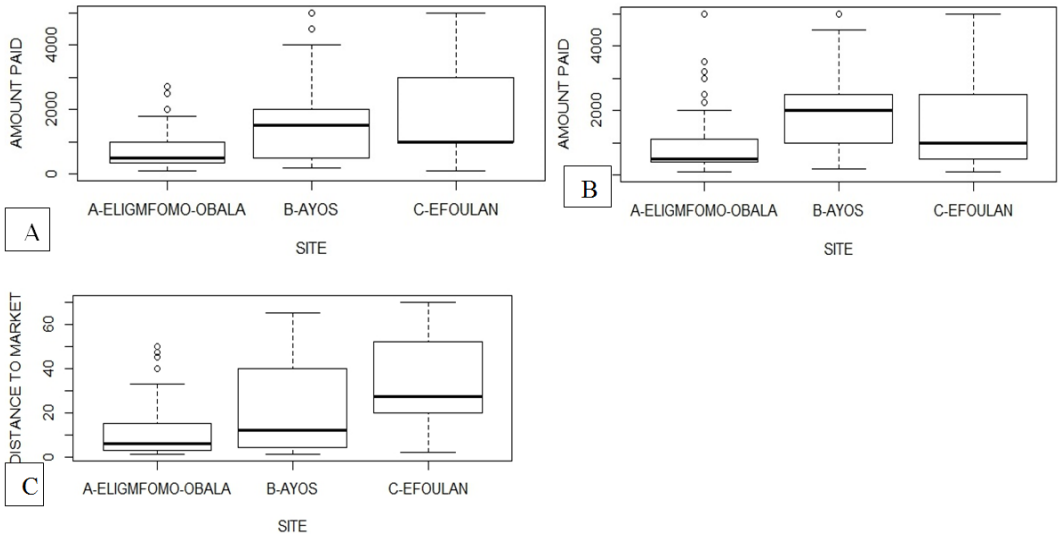


Figure 7. Amount paid in Fcfa for the transport of persons (A), Amount paid in Fcfa for the transport of food (B), and distance to market place where farmers sell their product (in Km) (C)

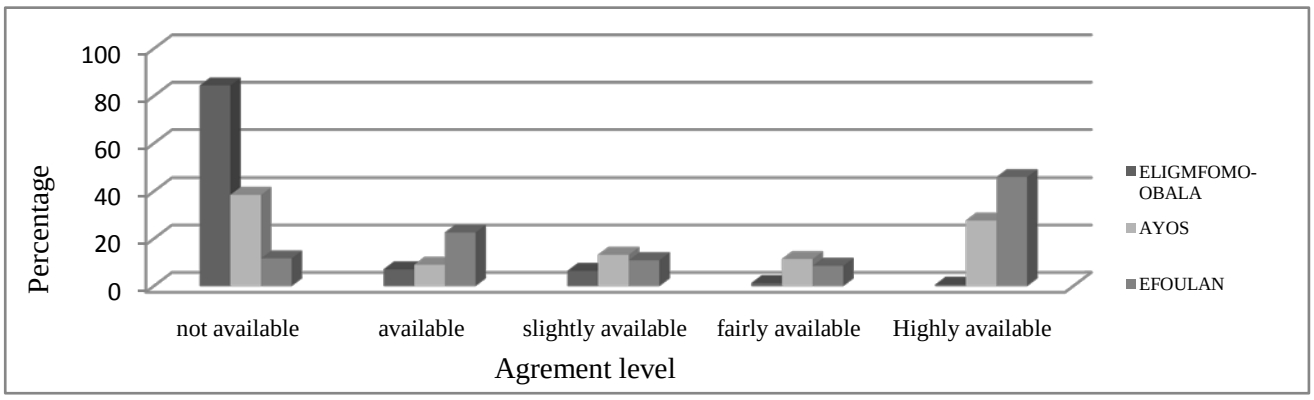


Figure 8. Farmers' appreciation on availability of unoccupied forest land to create new plots

3.4. Impact of Shifting Cultivation on Vegetation-forest Cover

Land cover analysis of EligMfomo-Obala and Ayos was used as an example to illustrate the impact of agriculture in forest cover loss. Result showed that EligMfomo-Obala has a vegetation cover quite degraded as compared to Ayos (Figure 9). In fact, percentage of non-forest was 22.13% in 1990 and 31.75% in 2010, representing 9.62% of forest cover loss to non-forest. In Ayos, it was 6.49 % in 1990 and 10.23% in 2010, a loss of 3.74% forest cover. Land use type classification of vegetation in 2010 showed that cultivated land represent respectively 23.81% and 3.17% of non-forest area in EligMfomo-Obala and Ayos.

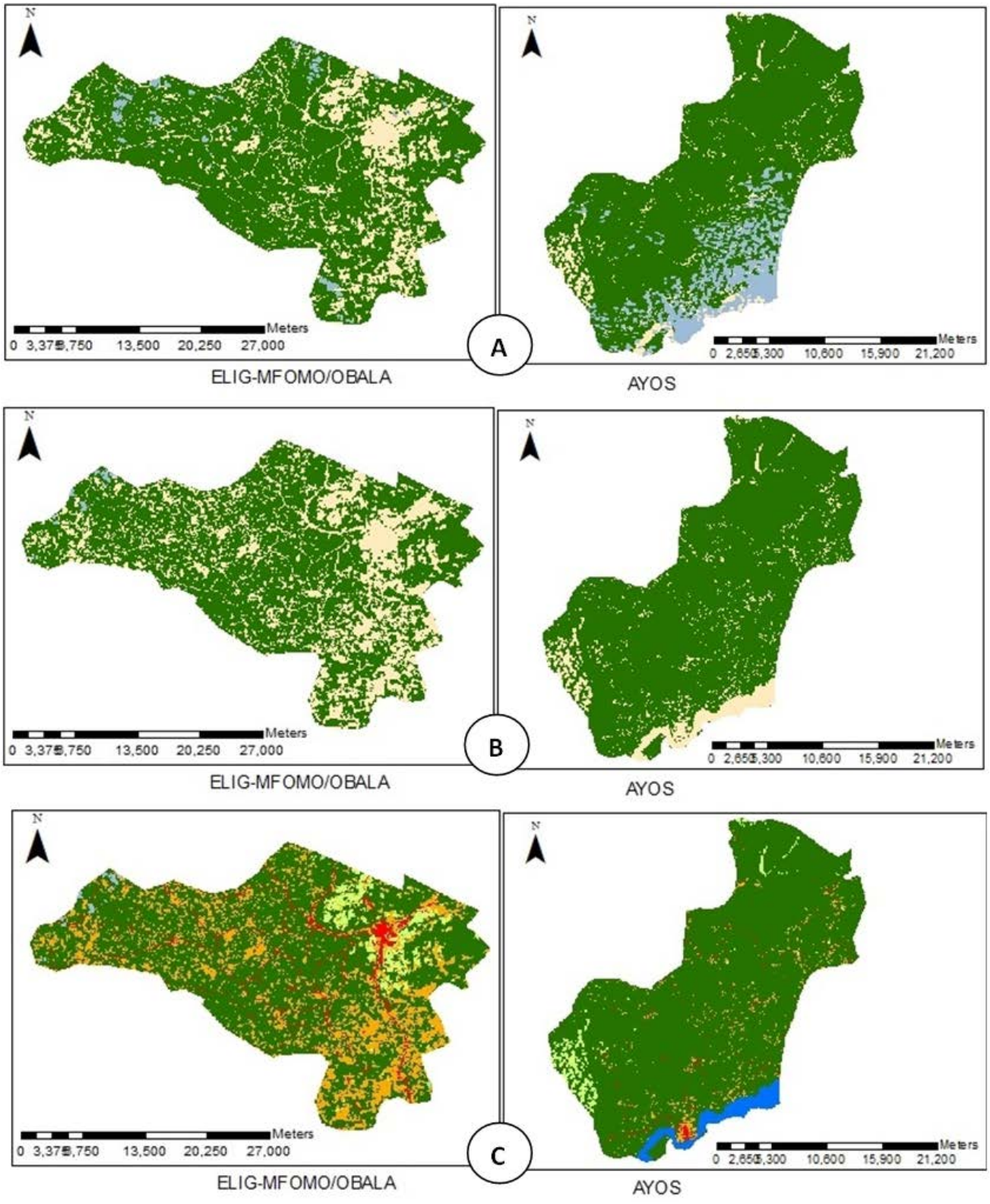


Figure 9. Land cover change Land use change (A- Land covert 1990, B- Land Covert 2010, C- Land Use Change 2010), Database of GAF-AG under the REDDAF Project in Cameroon (2012)

4. Discussion

4.1. Consumption to Commercialization Trajectories

Traditional, semi-traditional and modern forms of shifting cultivation trajectories was been distinguished. The objective of doing shifting cultivation is initially for consumption and secondly for commercialization. This observation is evident since it is the principal activity and the main source of household income. However, we have noted in EligMfomo-Obala that the average quantity consumed is close to 50% of total production. It is also important as compared to others sites. This shows an evolution of the main economic objective from consumption to commercialization.

As EligMfomo-Obala is refers to modern form of shifting cultivation, this observation meet the results found in Uganda by [6] where under evolutionary farming systems, he has noticed that food crops are grown for home consumption and to generate income, and he has observed an increase in food crop production specifically for market. In addition, discussion held with the agricultural extension officers in the area justified this observation by the fact that EligMfomo-Obala feeds the surrounding towns (especially Yaoundé) in food. In addition, importance of population and road density observe in EligMfomo-Obala as compare to Ayos and Efoulan could also explain the present result. Growth of population often leads to increase of crop demand [30] and road transport has a significant impact on distribution of agricultural production [32]. [18] in southern Nigeria found that the movement of agricultural products between area of production and area of consumption is driven by efficient transport system. Thus, the road network plays an important role in the commercialization of agricultural products and this justifies the low level of marketing observed in Efoulan which has a road network in very bad condition. Even if the road network of the EligMfomo-Obala is not satisfactory to meet the expectations of the farmers, it is much better as compared to road network of Ayos and more especially the one of Efoulan. This has a negative impact on the cost on people and agricultural products transport in remote area like Efoulan council.

4.2. Fallow Length and Land Cover Type Trajectories

Afterwards, we found a reduction in the fallow period in all sites. It was found as a result of land scarcity. This finding aligns with those of [12] who have observed in Sierra Leone that reduction of the fallow period was as a result of land scarcity due to competing land uses. Farmers (84.52%) in EligMfomo-Obala face the problem of scarcity of unoccupied lands where they could create new plots, and they (53.85%) have only young fallow as option to extend their plots. In addition, it was been important to observe the presence of cucumber crop in Ayos and Efoulan, farmers used to target very old fallow or forest to growth this crop. Since, it is absent in EligMfomo-Obala, this justifies the predominance of young fallow in this area as compare to Ayos and Efoulan, and therefore highlight the degradation of forest cover. Moreover, this result could also be explained by the impact of population growth which leads land pressure due to increase competition for land [7,15,21,26]. Also, many authors state that, decline of fallow length is the result of transportation net- works, market forces [14], high demand of food [31]. These behaviors have shaped the land use and land cover type observed in each site.

4.3. Farming Technique, New Crop and Diversification of Crop Produce Trajectories

Shortness of fallow length often leads to decrease of soil fertility, it was been notice in many part of the word [21,34]. It is while farmers (53.29%) in EligMfomo-Obala are dissatisfied about the fertility of their land. As we know, fallow length is a key issue of the sustainability of shifting cultivation practice [4]. In this context, the adaptation with low soil fertility is to improve the technique of doing farm. Results show that farmers (69.08%) of EligMfomo-Obala gradually change with cropping technique with the use of fertilizers (33.33%) to improve the fertility of their soil, those of Ayos and Efoulan have preserved the traditional technique of field preparation. The latter still benefit from fertile soil and they use mostly fungicides because of cocoa farming which is one of the main crops of these sites. This could refers to the observation of [6] which has mentioned the use fertilizers in the modern farming.

Aside, the proportion of possession of agricultural equipment by farmers remains more or less similar in all sites. However, farmers of EligMfomo-Obala have more motor pumps (10%) than others (1% to 2%). This shows a certain evolution of farming techniques with the use of materials for the irrigation of crops to manage water availability constraints. It also allows farmers to produce off-season crops. In this line, [23] found that new and improved technology has proven to be the most important driver of agricultural growth.

In addition, improvement of agricultural technique is followed by the diversification of crops and development of new market crops such as vegetable in EligMfomo-Obala. [6] also found introduction of new crop varieties for market in modern farming while studying the evolution of farming system in Uganda. [5] observed in northeast India the introduction of new cash crops as an innovation in shifting cultivation and [6] remark the use of improved seeds in modern farming. Nonetheless, hybrid Cocoa (improve cocoa plant material) was found is all sites as new crop introduced because it is the main cash crop, and one of the oldest crop produced in these communities. Indeed, for the past years, agricultural policy of Cameroon government has been focusing its efforts in cocoa production through support schemes to farmers with provision of improved planting materials.

4.4. Availability of Land in Shifting Cultivation Trajectories

The availability of forest land is an asset for farmers who want to expand their area or increase number of cultivated plots. Due to scarcity of land, acquisition of land through the clearing of new forest lands in accordance

with the "axe right" is limited in Elig-Mfomo-Obala council. From discussion with this community, we found that young farmers wishing to start or expand their agricultural activity are obliged to acquire land in neighboring departments. Nevertheless, this situation is not the case in Ayos and Efoulan councils where the potential for agricultural lands remains more or less available. In fact, the observation made in Ayos and Efoulan regarding their perception of unoccupied land where farmers could create new farm goes in line with the thought of [22], which mentioned that "land law and, in a general sense, the law on natural resources are based on the argument that there is plenty of available land in Cameroon which is based on the assumption that some land is vacant and ownerless". That is why, as long as there are spaces perceived unoccupied by farmers, the clearing of forest under the "right of the first occupant" will continue. Moreover, in the southern part of Cameroon, [28] observe that property rights are ambiguous and depend on formal definitions of the use associated with open land, supporting the clearing of forest to consolidate private ownership. Also, productive use has to be proven in order to be able to seek land titles, and in Cameroonian context, productive use involves the destruction of spaces and resources [29]. This current situation of land management could encourage the creation of new plots in unoccupied forest land and may promote deforestation.

4.5. Implication of Shifting Cultivation Trajectories in Vegetation Cover

We found important forest covers loss in EligMfomo-Obala as compare to Ayos. In addition, proportion of cultivated of land in EligMfomo-Obala is higher than in Ayos. This means that shifting cultivation systems is considered as one of the main causes of deforestation at the expense of forest [20,26]. This could be justify by the fact that population growth leads to expansion of the cropped area [23] and therefore forest loss [20]. In addition, [26] mention that, impact of shifting cultivation in deforestation and degradation forest is the result of shortened of fallow periods, there is not enough time for forest regeneration and young or secondary forest gradually replaces old forest. Moreover, we observed that road networks density impact the accessibility and allow farmers to move in forest land. Consequently, this behavior impacts the forest cover and the level of deforestation under shifting cultivation practice.

5. Conclusion

Traditional, semi-traditional and modern forms of shifting cultivation trajectories are shaped and linked to the importance of the population density, accessibility (road density, state of the road, and transportation price) and availability of land. Enabling condition surrounding these trajectories is population density which impacts the availability of land and fallow length. Indeed, land scarcity performs limit access to new land. Short fallow length leads to decrease of soil fertility, the use of fertilizer and therefore the improvement agricultural technique to a relatively modern form. Modern form of shifting cultivation involves introduction of new crop, development of cash crop, diversification of crop to respond to demand. Moreover, accessibly is vital for the growth of shifting cultivation with commercialization of crops, transport of person and crops, access to farm and forest land. The bad condition of road network didn't allow the development of agricultural activities which remain subsistence practice for consumption. Furthermore In the area with low population density, land is still available and farmers could create new plots under the "axe rights". We conclude that good management of land in forested landscape accompanied with incentive measures will constraint shifting cultivators to shift to modern agricultural technique.

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