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Slash-and-burn agriculture, the major cropping system in the region of Faradje in Democratic Republic of Congo: Ecological and socio-economic consequences

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The present study aims to explore smallholder's household living standard relevant to slash-and-burn agriculture, and determine trend of key crops grown with respect to their production and related generated average gross income in the region of Faradje, in the far northeastern region of the Democratic Republic of Congo (DRC). Surveys were conducted on agronomic and social economic characteristics prevailing in the area, in five localities, involving 50 farming households based on a questionnaire designed. Questions asked were about yield and gross income, considered as dependent variables as well as household size, farmland area, farming systems, crop types, distance between farms and home, farm task allocation, duration of fallowing, types of off-farm activities and number of reared animals taken as independent variables. Graphs were plotted using R statistic package (Version 3.6.1, 2019-07-05) and correlation analysis was conducted using Genstat 12th edition. The results showed that each household produced yearly on average 793.71 kg of paddy rice, 194.96 kg of maize grain, 175 kg of cassava chips, 70.50 kg of groundnut seeds and 8.60 kg of beans on an average of 0.81 ha of cropland in two cropping seasons. The results also showed that the total annual average income earned by one household was US $ 940.60 with individual average income of US $188.90. This was slightly higher than the national average real gross domestic product (GDP) in 2008 estimated at US $171; however, the figure was still unfortunately below the minimum of US $1 per day (0.52 US $/day) suggesting that slash-and–burn agriculture cropping system is far to achieve food security and accordingly improvement of economic situation in Faradje DRC. The household size and number of agricultural workers/households were weakly correlated with the average gross income (respectively, r = 0.29 and r = 0.35) whereas cropland surface area was moderately associated with the average gross income (r = 0.74). This demonstrates the importance of cropland surface in this cropping system in Faradje; suggesting that increasing farmers' gross average income through slash-and-burn cropping system requires cropland expansion. Consequently, much should be undertaken to mitigate adverse effects of the established cropping system over the overall environment.

Key words: Slash-and-burn agriculture, gross income, Faradje, DR Congo.

INTRODUCTION

Slash-and-burn agriculture is the most prevalent system used in the tropics and sub-tropics. It is estimated to be

used by 200 to 500 million people and supports life of billions of people worldwide (Andriesse and Schelhaas, 1987). However, despite enormous potential and large number of farm operators, shifting, swidden or slash-and–burn agriculture which is a current cropping system in poor economy countries is still not in measure to reverse food security and accordingly economic situation prevailing therein (Stefan and Norgrove, 2013).

Researchers are quite alienated as regards the definition to give to the concept and many interpretations are available depending on the number of factors such as physical, ecological, climatic and socioeconomic in which the system is practiced. Generally, whether shifting, swidden or slash-and–burn agriculture, all they refer to land uses where a cropping period is rotated with a fallow period that is long enough to enable the growing of dense, woody vegetation, and where the biomass is eliminated from the plot by cutting, slashing, and burning it, prior to the next cultivation cycle. It is generally considered as an extensive land use, maintained through time by expansion over uncultivated land following population growth (extensification), in contrast with more intensive land uses, where the biomass is incorporated to the soil through plowing or other practices (Stefan and Norgrove, 2013; Pollini, 2014).

Slash-and–burn agriculture is always reported of being associated with poor crop yields and rapid ecological degradation. ICRAF (2000), for instance, indicated that slash and burn agriculture caused 70% deforestation in Africa, 50% in Asia and 30% in America. The same source states that some governments and international organizations looking at themselves responsible for the inconsiderate natural resources destruction of nations attempted to put an end to the practice. Yet, it turned out to be easy to pass laws and adopt policies forbidding cut and incineration of forest, in contrast, stopping shifting agriculture was much less. It is therefore clear that, swidding agriculture is a reality and will continue to be so in the future. In this perspective, the Democratic Republic of Congo (DRC), one of resource rich countries, in order to build up sustainable management of its resources is committed in supporting the implementation of self-development policy based on rational use of natural resources especially the forest while focusing on their planning and sustainable use (Trefon, 2008). Given that shifting cultivation is one of the wide spread cropping systems across the tropics, the DR Congo is not exempted. For example, in the region of Faradje, located in the far northeast of the country, a woody savannah region, this system of agricultural land use is the most accessible and adapted to farm operators (Talaguma, 2013); while at the same time, shifting farmers are the first to be accused worldwide of deforestation in the tropics, raising fears of looming global warming resulting in climatic change (Roper et Robert, 1999; Cheryl et al. 2005; FAO, 2012).

It is then in this context that this study was set up with assumption that, similarly in the forest agricultural regions, slash-and-burn agriculture could also have negative impacts as well as on crop yield (translated into households' income) and on the environment. The hypotheses driving this study were: the balance between agricultural land use method and equipment used by farmers in the study area may not be adapted to optimal production conditions. Secondly, income generated through the practice of slash-and-burn agriculture may be the most important if not the only one, compared to that generated by other economic activities. Finally, this agricultural practice is likely imposed to farmers by socioeconomic conditions prevailing in the region. The purpose of the study was to collect information about slash-and-burn agriculture in this area, which is one of the remotest regions and isolated from the main universities and agricultural research centers in the country. The underlying rationale was to show the contribution of agriculture to the sustainable development of this rural area as well as related constraints and later constitute an actual database about slash-and-burn agriculture for the region. The research also aims at enabling the discovery of other cropping systems used in this area which would eventually help the understanding of local practice of slash-and-burn agriculture and in the choice of suitable production systems for the area. This study furthermore was susceptible to provide a general view to economic developers and policy makers to plan strategic responses to make shifting agriculture an income generating activity while promoting principles of rational and sustainable use of resources. To assess these hypotheses, several specific objectives were focused on namely, the characterization of crop types and reared animals as well as related motivation, the estimate of farmland sizes and the availability of labor force, the determination of key crop trends grown in the region with respect to their yield and total production (income derived) and the assessment of the sustainability of farming system.

MATERIALS AND METHODS

Geographic location of the study area

The study was carried out in the region of Faradje (Figure 1); it is a

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"Territory[1]" with a surface area of 13,138 km^2 and where reside an estimated 576, 861 inhabitants of whom 299,968 are women (52%) and 276,892 are men (48%), with a density average of 26.22 persons/km^2 (CAID, 2016). This area was selected by the fact that it was one of the remotest regions and isolated from the main universities and agricultural research centers in the country.

Faradje's Territory is one of the 124 administrative entities named "territories" that possess the DR Congo. It is situated in the far northeast of the country (Former Eastern province now called Haut-Uele or Upper Uele), at the boundary of South Sudan (in the North) and the neighbouring territory of Aru bordering Ugandan Republic (in the East). The geographic coordinates of the region are: 3° 44' 0'' latitude N, 29° 43' 0'' longitude E; an altitude varying between 700 and 1500 m with some mountain ranges in the eastern part of the Territory (Maps of world.com, 2009).

According to Makondambuta (1997), the climate of Faradje belongs to the AW type according to Koppën-Geiger's classification. It is a climate characterized by two seasons: one dry season (the longest) from November to March and a rainy one, from April to October. However, there exists a short dry period between June and July. The average annual temperature revolves around 23°C, with a precipitation ranging from 900 to 1500 mm. The vegetation ranges from forest galleries to small shrubby savannas (Lisingo, 2009). The main groups of soil found in the region belong to the tropical ferruginous soils rich in iron (ferralsols on rocks undifferentiated), dominated by clay-type 1/1 (kaolinite). However, there may also be found some soils with the fraction of clay-like 2/1 (montmorillonite) and clayey-silt soils mainly in the south part of the territory (Landa et al., 2013). The territory is one of the mining areas of DR Congo (gold mining of Kilo-Moto, Kibali Gold mining) and includes one of the most important nature reserve of the country (Garamba Park) where are kept the last white rhinoceros (*Ceratotherium simum cottoni*) of the world. In contrast, the majority of people are engaged in smallholder agriculture.

Data collection timing and process

The fieldwork covered the period ranging from 20th May to 20th June 2011. It involved a descriptive survey using semi-structural questionnaire containing both open-ended and closed-ended questions, (Kibwika, 2015) and completed by some interviews and observations. In fact, as stated by Shukla in 2007, pragmatism endorses the idea that research questions should guide methods and paradigms that underlie the methods. Consequently, this study mainly followed a quantitative method approach including standardized measurements of data collection even though some data with qualitative characteristics (that are not analyzed in this paper) intervened across the collection process, in order to be more practical and find workable solutions for data collection and analysis. Therefore, due to some on ground practical issues, the study had to do with experimentally accessible samples failing to access theoretically targeted samples (Kyazze, 2016).

The research target population covered farming households of five villages living in one of the eight rural counties that the territory of Faradje encompasses. The units of the study included responsible persons of farming households of all gender. Other analysis units included farmland area, crop types, cropping system, yields, gross income, distance between farms and home, farm task allocation, duration of fallowing, types of off-farm activities as well as rearing types. Surveyed households were selected using combined sampling methods by probability and non-probability, namely by convenience, purposively and also using snow ball technique (Kibwika, 2015; Kyazze, 2016).

[1] Territory: Congolese administrative entity right below the province but above the county according to the new national layout put in place since 2016.

The questions asked were about yield and gross income taken as dependent variables whereas the independent variables comprised household size, farmland area, farming systems, crop types, distance between farms and home, farm task allocation, duration of fallowing, types of off-farm activities as well as number of reared animals. The gross income was evaluated using the most simple formula based on the quantity of production intended to the market, that is, gross income = production times current market price. Given some concerns such as the absence of available sampling frame of farming households and clue on the accurate number of households per surveyed village as well as the insufficiency of resources, the study decided to consider a unique number of ten farming households per each surveyed village (Table 1), instead of using the mathematical formula suggested by Nassiuma (2000). In total, 50 farming households were surveyed in 5 villages. Farmland areas were measured and estimated in ha; the production was weighed and converted in yield terms into ton/ha. Furthermore, the yields were estimated at the local market cost and converted into US $. As for data processing and analysis, mainly descriptive statistics were used to analyze and present results. R statistical package (Version 3.6.1, 2019-07-05) was used to plots the graphs. Pearson's correlation was used between the number of agricultural workers per household, the cultivated surface area in ha, size of surveyed farming households, field surface area/agricultural worker and gross income was carried out using Genstat 12th edition. Means were separated with least significant difference at 5% (Ibanda et al., 2018). Pearson's correlation was given by the formula:

$$\frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2\,]\big[\,N\sum y^2 - (\sum y)^2\,\big]}}$$

Where: N= number of pairs of scores, $\sum xy$ = Sum of the product of paired scores, $\sum x$ = Sum of the x scores, $\sum y$ = Sum of the y scores, $\sum X^2$ = Sum of squared x scores, $\sum y^2$ = Sum of squared y scores.

RESULTS AND DISCUSSION

Opportunities for slash-and-burn agriculture implementation

Households' composition and number of agricultural workers

The results related to household composition showed that the surveyed farming households were composed of 4.1; 6; 5.5; 5 and 4.3 for Awago, Watu, Karisia, Zoro and Angwande respectively (Figure 2a). Numbers of agricultural workers per household were 2.6; 3; 2.9; 2.7 and 2.5 for Awago, Watu, Karisia, Zoro and Angwande respectively (Figure 2b). On average, the surveyed households consisted of 5 persons (4.98 exactly) of whom an average of 3 were agricultural workers (2.74) who constituted familial labor force. In a total of 50 surveyed households (Table 1), there were 137 agricultural workers out of 248 persons making up the whole sample (55.2%). This average household size and the number of familial labor force were slightly lower than the national average, ranging from respectively 5.4 to 7

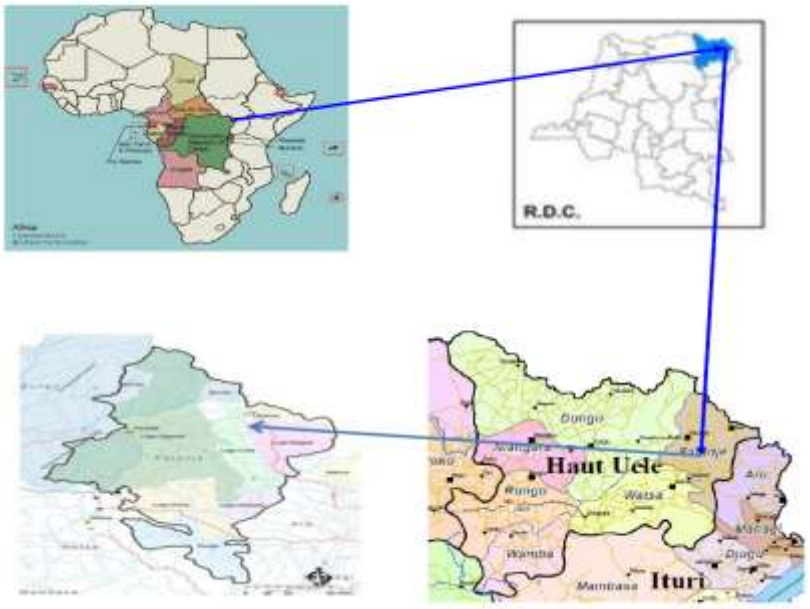

Figure 1. Territory of Faradje in the far Northeast of DR Congo.
Origin: Congo autrement[2] (2017).

Table 1. Number of surveyed farming households per village.

Name of village	Potential number of farming households noticed while surveying	Number of surveyed farming households/village
AWAGO	158	10
WATU	109	10
KARISIA	102	10
ANGWANDI	34	10
ZORO	152	10
TOTAL	**525**	**50**

Source: Authors.

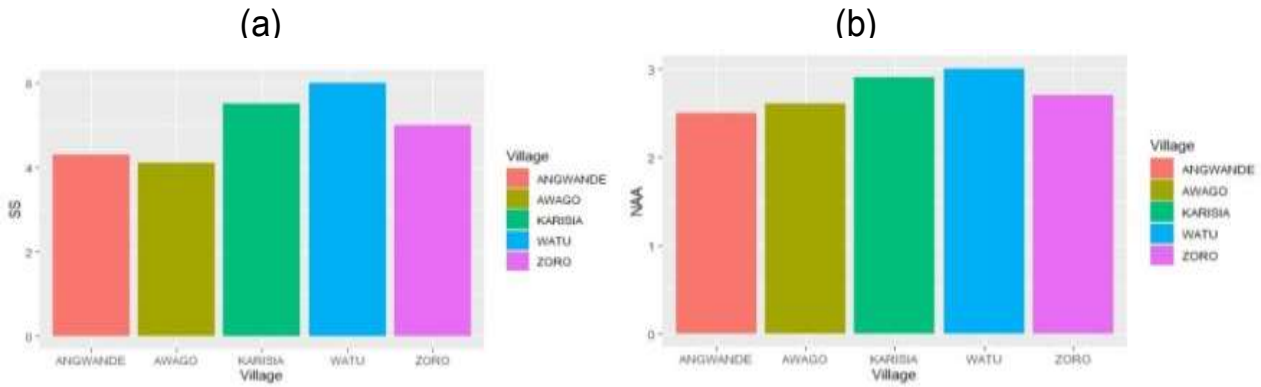

Figure 2. (a) Size of farming households; (b) Number of agricultural workers per household. SS =Size of Surveyed household; NAA = Number of Agricultural Workers.

[2] Congo autrement: Reference website for different view about Economic, Sportive, Cultural, Artistic, Scientific, Technological , Social and Leisure activities in DR Congo. URL: https://www.congo-autrement.com/

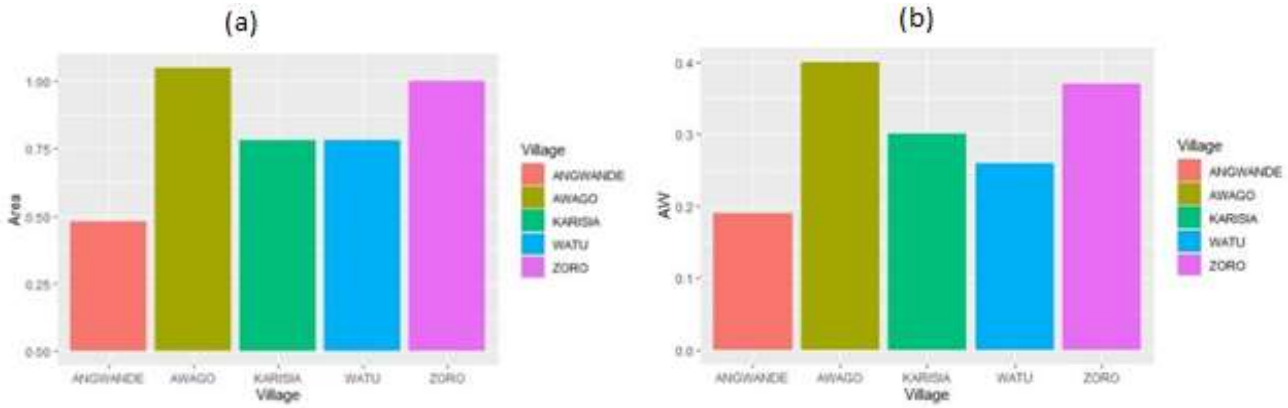

Figure 3. (a) Size of cultivated land/household, (**b)** slash-and-burn agriculture average surface area/agricultural worker in ha.

persons/household and 4 familial farm laborers (Angongolo et al., 2005; Tanzito, 2009; Kamara et al., 2010; Kankwanda et al., 2014). However, the figures found in this study fitted in the average size of sub-Saharan African countries which was reported to range between 4 individuals per household and 9 in Senegal for example (UNDESA, 2017).

Average number of fields per households

These results showed that the average number of fields per household was 3. About 40% of respondents stated to have 3 fields (20 households); 28% had respectively 4 and 2; 2% had respectively 1 and 5. Several factors explained this multiplicity of fields number namely for example, the will of minimizing risks such as pests and other crop enemies, the lack of consolidated land and declining soil fertility. This average number of 3 fields per household was almost similar to that found by Gafsi et al. (2007) in their survey conducted on family farms in western and central African region, who found an average of 3.3 fields / smallholder household.

Average size of cultivated surface area and average surface area/agricultural worker

The results showed that the size of cultivated area was 1.05, 0.78, 0.78, 1 and 0.48 ha for Awago, Watu, Karisia, Zoro and Angwande respectively (Figure 3a). According to these figures, one household cultivates on average 0.81 ha of land for one season. Nevertheless, the village Awago showed more than 1 ha average size of cultivated area (1.05 ha). Lowder et al. (2016) stated that slash-and-burn agriculture land area in sub Saharan Africa ranged from 0.5 to 5 ha per smallholder household with a large number of sizes less than 1 ha (60%). In Cameroon for example, Ntumu people cultivated around 1.5 ha/household (Dounias, 2000).

Besides, assessments made by Hurault (1965); Grenand (1981); Tsayem-Demaze et al. (2002); Tsayem-Demaze acd Fotsing (2005) and Tsayem-Demaze and Manusset (2008) reported an average size of 0.5 ha of slash-and-burn agriculture surface area varying from one community to another: 0.8 ha for instance in Aluku people of upper Maroni (Surinam, Guyana), 0.3 ha in Kali'na and Palikur people in the region of Mana and Oyapock, 0.5 ha in Wayapi people and 0.4 in Wayana people (Guyana). Their results showed that these averages were continuously increased and tended currently towards 1 ha. Gely, 1984 suggested that this surface area variability highlighted diverse agricultural purposes underpinning land clearing depending on communities, while emphasizing that the minimal indispensable surface area to satisfy daily needs for example in cassava flour was 0.6 ha. The cultivated surface area/number of agricultural worker was 0.40 for Awago, 0.26 for Watu, 0.30 for Karisia, 0.37 for Zoro and 0.19 for Angwande as shown in Figure 3b. This suggests that the average cultivated surface area/number of agricultural worker is around 0.3 ha.

Farm activity allocation

The results of farming task allocation and sharing among members of the household in the study area showed that, men were involved in heavy tasks in high percentage, such as land clearing (96%), tree felling (96%) and tillage (96%) (Figure 4).

Contrariwise, women accomplished slight tasks such as collection of lops and weeding in high percentage (94 and 98% respectively), compared to men and children. The results also showed that harvest and sowing were done by females and males at almost the same level. In general, the average of farming task allocation and sharing among members showed that in the studied

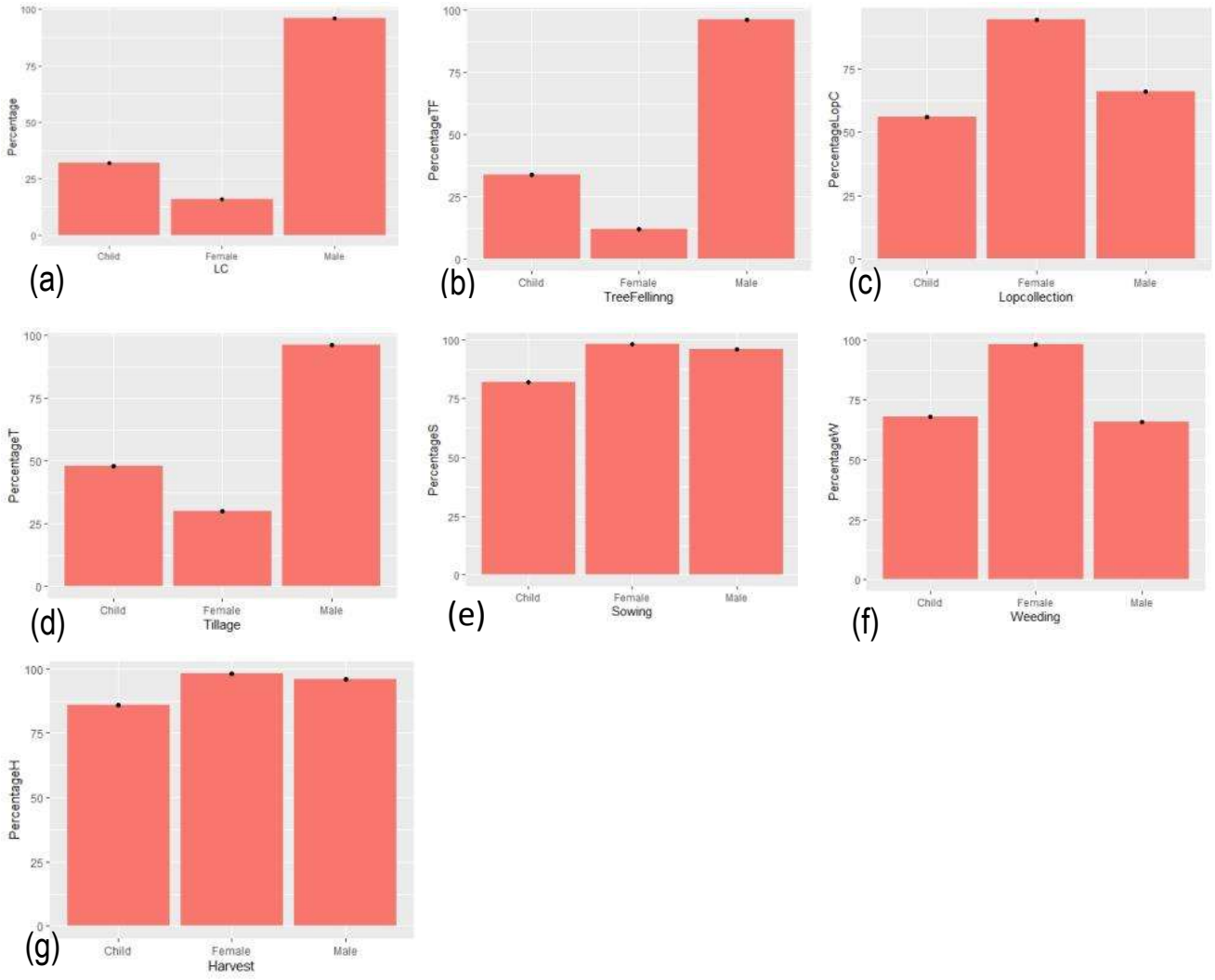

Figure 4. (a) Land clearing or slashing; (b) Tree felling; (c) Lop collection; (d) Tillage; (e) Sowing; (f) Weeding; (g) Harvest.

region, men participated in about 87.48% of the whole farm works, against 63.71% for women and children were involved up to 58% in farm works. These results suggested that there were no strictly speaking gender-based tasks depending on crops, growing periods and work intensity implying that works were almost implemented collectively by the members of households in the region of Faradje. Mushagalusa et al. (2015) reported in contrast that women's participation in farming activities amounted to 48.40% in the southwest of DR Congo, which is quite lower than the rate found in this study area (Figure 5).

In other developing countries women's participation in farming activities ranged from 20% in the Americas, around 35% in south Asia and up to slightly fewer than 50% on average in east and Southeast Asia. In sub Saharan Africa, the average percentage was between 40 and 50% with some exceptions such as Nigeria, Togo, Ethiopia and Niger (with respectively 37, 29 and 24%). Besides, the figures ranged from 67 to 77% in certain regions of Cameroon. However, they varied considerably across the same country, between and within regions and were changing rapidly in many parts of the world, where economic and social forces were transforming the agricultural sector (FAO, 2011; Palacios-Lopez et al., 2015).

Duration of cropland exploitation and fallowing

According to the results of the survey, cropland fallowing was a common practice for the majority of farm operators in the region of Faradje (88% of surveyed households). About 48% of households declared that they set their farms aside for about 3 years against 40% who leave their fields uncultivated for 10 years. 12% of households

Figure 5. (a, b, c, d, e and f): Slash-and-burn agriculture pictures in the region of Faradje.
Source: Authors' survey.

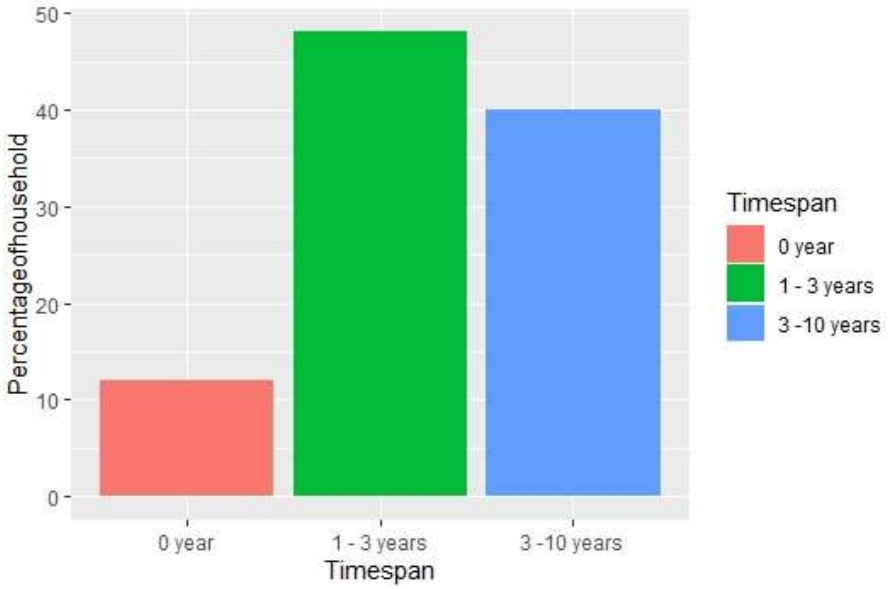

Figure 6. Average timespan of fallowing.

did not resort to fallowing due to land availability issue (Figure 6).

On average, the duration of the continuous running of a given cropland across the surveyed villages approximated almost three years and the average fallowing timespan was shown to be around 3.3 years; despite the low educational level of some farmers in the field of agriculture. This could be explained by the fact that although the technique of crop rotation was not well known by some, several farming households declared that the most common crop succession comprised rice followed by intercropping associating maize with

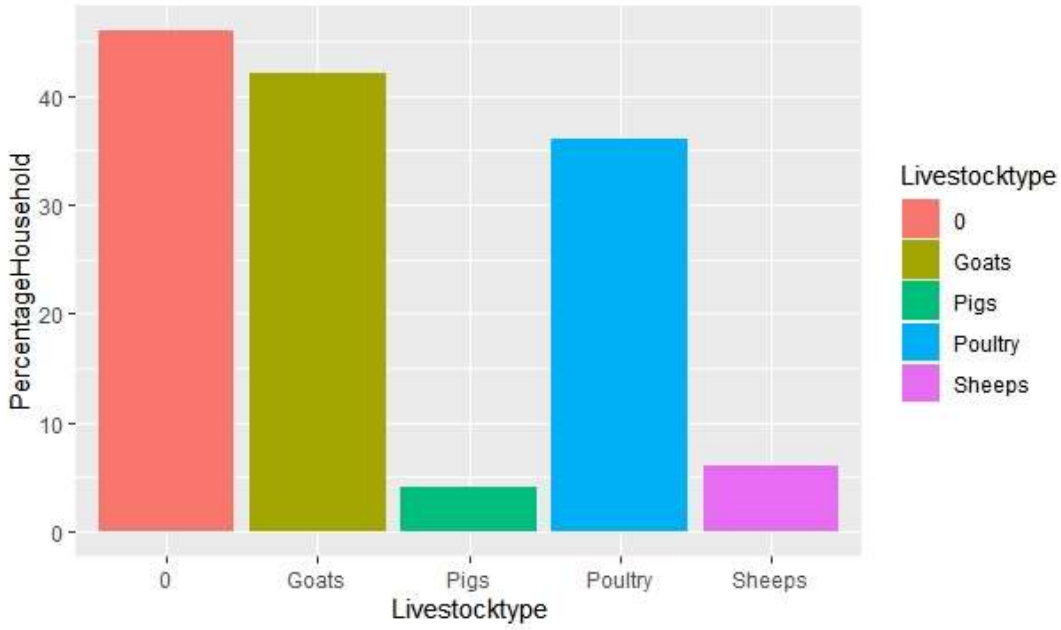

Figure 7. Type of livestock and average number per household.

groundnut or beans and finally cassava. This was quite acceptable from agronomic perspective. It is relevant to notice that, rice, groundnut and beans were sown mainly for the market; whereas, maize and cassava were intended for self-consumption because of their low commercial value. Furthermore, households stated that this fallowing timespan was getting increasingly shorter due to an invasive plant species (*Chromolaena odorata*) which enabled a fast soil fertility recovery. Studies by Hurault (1965); Grandisson (1997); Fleury (2000); Tsayem-Demaze and Manusset (2008) reported that the average timespan of successive land use was about 2 to 3 years (with in-between burn) in Guyana (Central America) and the fallowing period covered from 2 to 5 years which was correspondent to the exploitation of one to two croplands.

Synergism between crop production-livestock

The results showed that the practice of animal rearing in the studied area comprised mainly small livestock namely, goats, pigs, sheeps and poultry (Figure 7). However, this livestock rearing was conducted traditionally, that is small scale (Figure 7) without any zootechnic standards and accordingly was less productive (Kazybayeva et al., 2006). Generally, it was not associated to crop production given that the livestock system was unable to provide enough manure for soil amendment even though animal are usually in kind of stalling.

The results in the Figure 7 indicate that in general, 54% of 50 surveyed households practiced livestock rearing against 46% who did not have livestock. Among 54% of household who had livestock, 42% of surveyed households practiced goat rearing followed by poultry rearing with 36%. Sheep and pigs were reared at 6 and 4% respectively. This figure (46%) of rural households with no livestock was quite higher compared to the prevailing context in other African countries. The range of rural households with livestock varied from 67 to 85% in Senegal (Kazybayeva et al., 2006) and 42.9% on average in South Africa (Lehohla, 2016). The low proportion of farmers keeping animals in the study area indicated that farmers had no livestock keeping culture and remained mainly crop producers (Table 3).

Average distance between households' homes and farms

The results showed that the relative distance separating farmers' residential area from their fields was 1.6 km with a majority of 60% of households (30) who had their farms located between 0 and 1 km. However, 16% had to walk up to 2 to 5 km to find their fields. The neighborhood of fields around the residential areas (around 1 km) could be related to the security issue prevailing in the region (Lord's Resistance Army, from the neighboring Uganda) at the time of the survey that forced the majority of small farm operators to move closer to residential areas. This situation also had an impact on the average fallowing period as well as on the average cultivated surface area which tended to decline (respectively 3.3 years and 0.82

Table 2. Overall average field number/farming household.

Field number	1	2	3	4	5	Overall average	Total Percentage (%)
Number of households	1	14	20	14	1	3	
Percentage against total number of surveyed households (50)	2	28	40	28	2		100

Table 3. Average distance between farms and residences of surveyed households.

Range of distance	0-1 km	1-2 km	2-5 km	Total	Overall estimated average distance
Number of households per range (out of 50)	30	12	8	50	1.6 km
Percentage (%)	60	24	16	100	

ha). On the other hand, the positive impact of this regretful situation was noticed on the general surrounding vegetation which was less and less cleared during the survey period.

Socio-economic aspect of slash-and-burn agriculture system in Faradje

Average gross yield in kg of main crops grown per household and related market values in US$ and total average gross income in US$ per household and per head

The results of Table 4 revealed that one household produced on average 194.96 kg of maize grain, 70.50 kg of groundnut seeds, 793.71 kg of paddy rice, 175 kg of dried cassava chips and 8.62 kg of beans. It is important to remark that the very poor bean production occurring during the investigation time was completely atypical given that the region is traditionally an area producing this commodity. According to the respondents, it was related to unfavorable seasonal conditions (high precipitations) which caused production destruction on field. Besides, the results also showed that the average household income generated by those main crops was US $ 726.62. Paddy rice was the most valuable crop to the households which generated US $ 496.30 against US $ 141.50 for cassava, US $ 42.90 for groundnut, US $ 33.90 for maize and US $ 12.10 for beans. The almost higher value earned from paddy rice was related to the large surface area given to the crop compared to others, because of its market value. Households reported that commonly bean comes after the rice in terms of income generation although its poor production during the specific season is due to seasonal climatic perturbation. The lowest value of the generated income through slash-and-burn agriculture system in this region was US $ 69.47 against US $ 4269.47 which was the highest. However, when adding to this above mentioned average income, those generated through other agricultural commodities such as palm oil (an average of 242.39 Kg of oil that is, 116.40 L / household/year) not shown in table 4 and the income from small livestock rearing, the average annual rises up to US $ 940.60 /household. The total annual average income earned by one household was shown to be US $ 940.60 and the individual average income was US $ 188.90 (Table 4). This figure was slightly higher than the national average real GDP in 2008 (IMF, 2010; WHO, 2010) which was estimated at US $ 171. However, with national average growth rate of around 5% over the period 2009 to 2012 (2.8% in 2009, World Bank), the national average real GDP was projected to reach US $ 188.10 in 2011 against US $ 207.70 in the study area and US $ 256.50 against US $ 283.30 by the end of 2018. It can be seen that slash-and-burn agriculture in Faradje participated consequently in the development of the national real GDP despite its much-maligned ecological impacts. Besides, it is worth noticing that the sector of agriculture contributed up to 40.30% to the national GDP (against 13% for mining industry) and hired the three quarts of active population in 2006 (World Bank, 2010). In contrast, these figures are well below the minimum of US $1 per day (US $ 0.52/day in Faradje in 2011). Hauser and Norgrove (2013) reported that most slash-and-burn farmers are poor. Often the only resource available to them is land. Thus, farming, whether subsistence or market oriented, might be their only option. Therefore, much efforts are required if one needs a fast and durable income growth in the region through diverse supports for example by educating farmers to use conservation agriculture, a more sustainable alternative to slash-and-burn, which could contribute to alleviating food insecurity, and fight poverty while being ecologically sustainable and providing financial supports (Mulimbi et al., 2019).

Correlation analysis of gross income with other parameters

The results of Person's correlation between the number

Table 4. Average gross yield in kg of main crops grown and related market value in US$ and the total average gross income in US$ per household and head.

Village	Maize	Gnut	Rice	Cassava	Beans	Total kg	Gr Total US$
Awago	1487	1104	4963.64	490	88	8132.64	9328.56
Watu	2090	720	8694	560	84	12148	7449.01
Karisia	2219	486	7392	3500	71.80	13668.80	12574.42
Zoro	2736	1044	14064	3920	153	21917	14643.10
Angwande	1216	171	4572	280	34	6273	3033.28
Total	9748	3525	39685.64	8750	430.80	**6470.64**	
Aver./vill.	1949.60	705	7937.13	1750	86.16	12427.89	
Aver./hh	194.96	70.50	793.71	175	8.62	**1242.80**	
Total US$	1694.70	2143.21	24814.10	7073.64	605.23	36330.84	47028.37
Aver./hh $	33.9	42.9	496.30	141.47	12.10	**726.62**	**940.60**
Aver./head	6.81	8.61	99.70	28.41	2.43	**145.32**	**188.90**

Aver. = Average, Gunt = Groundnut, hh= Household, Vill. = Village.

Table 5. Correlation matrix for different factors.

Parameter	FS	HH_size	NAW	S/AW	GTotal_US
FS	-				
HH_size	-0.04	-			
NAW	0.14	0.96*	-		
S/AW	0.98**	-0.25	-0.08	-	
GTotal_US	0.74	0.29	0.35	0.67	-

**, *Significant at P<0.01, 0.05, FS= Field size ha, HH_size= Household size, NAW= Number of agricultural workers per household, S/AW= Surface area/ number of agricultural worker, GTotal_US= gross income.

of agricultural workers per household, the cultivated surface area in ha, size of surveyed farming households, field surface area/agricultural worker and gross income showed that there was significant (P≤0.0104) correlation between the number of agricultural workers per household and the size of farming households. This implies that the increase in the number of agricultural workers per household would inevitably lead to the increased size of farming (Table 5). The cultivated surface area in ha was also significantly (P≤0.0038) correlated to the field surface area/number of agricultural worker indicating linear relationship among them. A very low negative correlation (r= - 0.04) was also found between cultivated surface area and the size of households. This means that the increase in size of households negatively impacts the total cultivated surface area while it could be thought that a bigger size of household is supposed to hold a proportional cultivated area.

This may be related to the financial situation within those smallholder households (average income per head to be invested in agricultural activities) and may eventually impact the living standard of the households in question. In contrast, the average number of agricultural workers had also a very low positive correlation with field expanse (r= 0.14). This means the number of familial laborer is not the only factor in that area susceptible to expand the cultivated surface area. Several parameters such as the quality of work tools (always rudimentary) and other sources of labor force are necessary in order to extend the cultivated area to meet satisfactory threshold of households' needs.

Household size and the number of agricultural workers/households were weakly correlated to the average gross income (respectively, r = 0.29 and r = 0.35) whereas cropland surface area was moderately positively associated with the average gross income (r = 0.74). This demonstrates the importance of cropland surface in this slash-and-burn cropping system in the region. This suggests that the increase in cropland size would inevitably lead to increased farmers' gross average income, confirming the expanding characteristic of the cropping system. However, much should be done, to mitigate associated ecological adverse effects of the cropping system.

Conclusion

The present study aims to explore smallholders' households' living standard relevant to slash-and-burn

agriculture, and determine key crops grown trend with respect to their production (yield) and related generated average gross income in the region of Faradje, far northeast of the D R of Congo. After analysis, results showed that the total annual average income earned by one household was US $ 940.57 with individual average income of US $ 188.87. This was slightly higher than the national average real GDP in 2008 estimated at US $171; however, the figure was still unfortunately far below the minimum of US $ 1 per day. Consequently, this confirmed the whole hypotheses set for this study. This suggests that slash-and-burn agriculture cropping system is a limitation to food security and accordingly improvement of economic situation in this study region. Thus, in view of the above results found, it could be recommended that, policymakers and developers involved in human promotion by the means of agricultural activities need to explore other cropping systems, such as integrated cropping system, in order to achieve the sustainable development goal in this remotest rural region of the DR of the Congo. It is also recommended that policy makers and developers emphasize on providing institutional support to the farmers in the form of financial help.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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