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Paper submission email: JBAH@iiste.org
ISSN (Paper)2224-3208 ISSN (Online)2225-093X
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Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.22, 2015

Farmers' Perceptions on Soil Degradation and Their Socioeconomic Determinants in Three Watersheds of Southern Benin

Kouelo Alladassi Félix[1] Houngnandan Pascal[1] Azontonde Hessou Anastase[2] Dedehouanou Houinsou[3]
Gangnon Sèmèvo Oslo Armel[1]
1 Laboratoire de Microbiologie des Sols et d'Ecologie Microbienne, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi (LMSEM/FSA/UAC) 01 BP 526 R.P. Cotonou
2 Laboratoire Sciences des Sols, Eaux et Environnement, Institut National de Recherches Agricoles du Bénin (LSSEE/INRAB)
3 Département d'Economie, de Sociologie, d'Anthropologie et de Communication, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi (DESAC/FSA/UAC)

Abstract
Soil degradation is one of the most serious ecological and environmental problems in south of Benin. Understanding farmers' perceptions of soil degradation and its causes is important in promoting soil and water conservation practices. The objective was to examine farmers' perceptions, understanding and interpretation of soil degradation factors and socioeconomic characteristics that influence these perceptions. A survey was conducted in Allada, Aplahoué and Djidja districts, which had respectively the watersheds of Govié, Lokogba and Linsinlin in southern Benin. The study was based on the data obtained from 427 sample households heads using pre-tested structured interview schedule. The data were analyzed using simple descriptive statistics and frequencies with the chi-square test. The finding of the study shows that almost all farmers of the study area had good perception on the causes, indicators and problems of soil degradation. Farmers explained soil degradation as soil fertility depletion and soil erosion (soil loss). The main causes of soil erosion perceived by farmers were slope, runoff, rain intensity and duration. According to the farmers, the soil fertility depletion is mainly caused by deforestation, bushfires, continuous cropping, soil type and animal trampling. Several socioeconomic characteristics influence significantly the farmers' perceptions as gender, literacy, agricultural extension and/or membership of farmers' organization. The farmers' perceptions vary significantly according to cropping systems, therefore, from village to village, with their socioeconomic determinants.
Keywords: Farmers' perceptions, soil degradation, soil erosion, soil fertility decline, socioeconomic determinants, southern Benin.

Introduction

In a context of high urbanization and lack of farming systems intensification, agricultural growth model on which the countries of Africa sub-Saharan are based, in more than a generation, is not sustainable over time. It led to a collapse of the soil productivity and accelerated degradation of natural resources (Blein et al., 2008; Simard-Rousseau, 2012). Studies have addressed the problem of natural resource degradation in tropical agro-ecosystems (Taonda et al., 1995; Ouattara, 2006; Abba et al., 2007; Ranaivomanana, 2008; Traoré and Toé, 2008; Ouédraogo et al. 2009). Agriculture in Benin is oriented more towards the satisfaction of market needs. Particularly in southern Benin, population pressure has led to the reduction or elimination of natural shrubby fallow and development of marginal lands. A study in South-Benin region to assess soil degradation showed negative balances (Van der Pool et al., 1993 cited by Adegbola and Arouna, 2004). Indeed, the physical soil productivity assessed through the first maize cycle average yields indicates that the performance decreased by 760 or 280 kg / ha against about 2000 kg / ha of original performance (Floquet et al., 1998). The soil depletion as well as the most important issue for both farmers and research and extension services. But, apparently, the nature and extent of soil degradation are poorly understood.

Many technological and institutional innovations that can solve soil degradation have been developed yet, these innovations do not seem to be generally successful (Wennink et al., 2000; Douthwaite et al., 2002). Indeed, several studies (HOUNDEKON and Gogan, 1996; Alohou and Hounyovi., 1999; Floquet et al, 2001) have highlighted the low level of adoption of these technologies by farmers despite the technical performance of these. Now these technologies are available to farmers with extension methods also designed by researchers or funders. It is this down approach that explains the very poor results they have registered (CT/PIIP, 2003). Everything happens without any reference to the realities of the rural world in which these technologies are intended.

The overall design of agricultural development that prevailed until recently was based on the existence of two distinct worlds: on one side those who know and who produce knowledge (researchers, technicians, politicians, etc.) and the other those who do not know (farmers) who should receive and apply the knowledge

produced by the first.

Whence the down approach that guided the implementation of these technologies. The importance and recognition of knowledge farmers were highlighted by some authors to the already fifty years without it actually be considered by the development partners. De Leener (2002) has compiled the history of farming knowledge in agricultural research, history characterized first by a long period of neglect of this knowledge despite highlighting its richness, diversity and adaptation to requirements economic, technical, social and cultural; then by the recognition of its value and timid reflected in the actions of research. To this end, farmers' practices and indigenous perceptions of environmental issues are critical in the development of solutions to environmental management problems.

The challenge is to listen and learn from the knowledge of farmers. Knowledge of farmers' soils offers a different set of temporal and spatial scales with regard to land use, which has important implications for sustainable agriculture (Brouwers, 1993; Sandor & Furbee, 1996). In Benin, there are very few studies on the perception of farmers' soil degradation and the factors that influence their willingness to engage in conservation practices. This study will reveal the perception of farmers on soil degradation in southern Benin. Control technologies against soil degradation (soil conservation) take these farming knowledge to a high rate of adoption.

Material and methods

Surveyed zones and villages' selection

This survey takes place in three villages: Village of Govié in the districts of Allada (Latitude: 6° 39' 52'' North, Longitude: 2° 9' 35" East), village of Lokogba in Aplahoue (Latitude: 6° 56' 32'' North, Longitude: 1° 40' 25" East) and village of Linsinlin in Djidja (Latitude: 7° 20' 46'' North, Longitude: 1° 56' 8" East). Aplahoue and Djidja are located in the south-western Benin. These sites is characterized by slopping land (watersheds), insecure tenure, land pressure and increasing irregularity rainfall. Allada is located south of Benin and characterized by land pressure and low crop yields. In all these sites, soils are much degraded. Figure 1 shows the location of the study sites. Allada and Aplahoue districts are characterized by a sub-equatorial climate with two (02) rainy seasons and two (02) dry seasons. Annual rainfall ranges from 900 to 1100 mm. But, Djidja district enjoys a climate of sub-equatorial tending to Sudano-Guinean in the northern parts.

Selection of the research units

The research units are the households represented by their heads. They are chosen randomly in order to be a representative sample of the population. According to Dagnelie (1998), the sample size required can be calculated by applying the following formula:

$N = [(U_{1-\alpha/2})^2 \times p(1-p)]/d^2$, with $n \geq 50$ and $p \geq 1/10$ of population, N =sample size required per village of study; $U_{1-\alpha/2}$=confidence level of 95% (typical value of 1.96); p =proportion known or suspected in the parent population; d =margin of error of 5% (typical value of 0.05). To calculate the sample size, we take p =0.1; thus n =139.This is the minimum possible size per site for this survey. For the three watersheds' villages, 417 farm households are surveyed.

Data, collection and tools of analysis

The data used consist of variables such as socio-economic and demographic characteristics and farming perceptions on soil degradation and theirs causes. Data are analyzed using descriptive statistics and frequencies in SPSS version 16. The Chi square test is conducted to verify the significant level of farmer's perceptions and theirs determinants.

Results

Farmers' perceptions on soil degradation

The soil fertility decrease is mentioned by surveyed farmers as perceptions of soil degradation (Figure 2). But the proportions are most important to Linsinlin (96%) than Govié (76%) and Lokogba (64%). This difference according to the study site is significant at the 1% level ($\chi^2 = 45.204$; $P < 0.0001$). Gender, religion and literacy are not determining factors in the perception of soil degradation by farmers in all the three surveyed villages. Agricultural extension determines the perception of farmers in every village. Indeed in the village of Govié, almost all farmers not mentored think about soil fertility decline, while at least 25% of farmers mentored by public institutions evoke the soil loss as perception. This difference is significant at the 5% level. In the village of Lokogba, there is a significant difference at the 10% level that about 15% of not mentored farmers evokes the soil loss while almost all producers mentored by public institutions evoke the soil fertility decline. In the village of Linsinlin, while 100% of mentored farmers (by public or private institutions) mention the soil fertility decline, there are some farmers (7%) of those who not mentored evoke the soil loss. This difference is significant at the 5% level (Table 1). Membership of a farmer organization is a factor of perceived soil degradation in the village of Linsinlin. Indeed, while 100% of the members surveyed mention the soil fertility decline, there are about 7% of non-members think that the soil loss is their perceptions of soil degradation. In other villages, the perception of soil degradation does not vary with membership of a farmer organization.

Farmers' perceptions of soil fertility decline

The three most cited elements to assess soil fertility are: the plant growth rate, crop yield and plant color (Figure 3). However, the proportion of farmers concerning their perception of soil fertility vary significantly by sites (χ^2 = 60.91; P < 0.0001). In village of Govié, the plant growth rate and crop yield are the elements mentioned by the majority of farmers, almost evenly (35 and 33% respectively). But, in Lokogba village, the crop yield was cited by 45% of farmers and plant growth rate by 32%. And in the village of Linsinlin, the plant growth rate is the element most cited (51% of farmers) and crop yield by 28%). Insect's indicators and previous cropping are almost only mentioned in Govié while the plant's indicator are cited in Govié and Lokogba. These differences between villages are significant at 1%. In the villages of Govié and Linsinlin, sex is significantly crucial in appreciation of soil fertility (Table 2). In the village of Govié, the views are very varied in women and include three elements: Plant growth rate, Crop yield and Plant color. But the majority of men (87%) evoke the plant growth rate. In the village of Lokogba, gender has no significant influence on the assessment of soil fertility. In all the villages and whatever religion, plant growth rate is the single most mentioned in the perception of soil fertility. But in the village of Govié, the religion influence significantly, at 10% level, the perception of soil fertility. In addition to the plant growth rate, 26% of Christians evoke other elements, mainly crop yield. The perception of soil fertility is almost the same between the literate and no literate in Govié. The plant growth rate is the main element of perception, followed crop yield. However, literacy has a significant influence at 5% level on the perception of soil fertility in the village of Linsinlin where some literate farmers evoke indicator plants. In the village of Lokogba, there is no literate. In the villages of Lokogba and Linsinlin, agricultural extension is a factor which significantly determines the perception of soil fertility. Indeed, in the village of Lokogba, the majority (87%) of not mentored farmers evoke the plant growth rate, while the majority of mentored farmers (by public institutions, 65%) reported crop yield as element of perception. In the village of Linsinlin, the plant growth rate and crop yield are cited by 53% and 43% of not mentored farmers respectively. While for almost all mentored farmers (by public institutions, 92%), the plant growth rate is the element of perception. Contrariwise, in the village of Govié, agricultural extension does not determine the perception of soil fertility by farmers. In all the villages, membership of a farmer's organization is a significant factor determining the perception of soil fertility. Indeed, in the village of Govié, members perceive soil fertility by the growth rate plant, crop yield and plant color. But, not members of farmer's organization mentioned above the plant growth rate and crop yield. In the village of Lokogba, the majority of no members evoke the plant growth rate, while all members mentioned the performance culture as an element of perception. A Linsinlin, the farmer organization members cited the plant growth rate as an element of perception of soil fertility. In contrast, non-members said that the plant growth rate and crop yield are the perception of soil fertility indicators.

Causes of soil fertility decline

In Govié, continuous cropping, soil type and bushfires are the three cases cited by the farmers justifying the soil degradation. But, in the village of Lokogba, continuous cropping and erosion are the two elements mentioned, while in the village of Linsinlin, continuous cropping and bushfires have been mentioned (Figure 4). The farmers' perceptions on causes of soil fertility decline vary significantly from site to site (χ^2 = 4.349; P < 0.0001). In the village of Linsinlin the causes of declining soil fertility significantly vary by gender of farmers. The majority of women (61%) mention bushfires, while the majority of men (62%) mention the continuous culture as causes of the decline in soil fertility. In other villages, gender does not influence the perception of the causes of declining soil fertility (Table 3).

Religion is a significantly influential factor in the perception of the causes of the soil fertility decline in Govié and Lokogba but not in the village of Linsinlin. In the village of Govié, Christians explained the soil fertility decline by continuous cropping (40%), the type of soil (24%) and bushfires (21%). Muslims explained it by bushfires (100%) and Animists by bushfires (60%) and continuous cropping (20%). In the village of Lokogba, Christians explained the soil fertility decline by continuous cropping (25%) and bushfires (58%) and Animists by deforestation (33%), bushfires (36%) and continuous cropping (30%). Literacy is a key factor in the perception of the causes of declining soil fertility in the village of Linsinlin. Indeed, literate explained the soil fertility decline mainly by continuous cropping while non-literate explained by the bushfires and continuous cropping. In other villages, there is no significant influence between literacy and the causes of soil fertility decline. In all the villages, agricultural extension is a significant determinant of the perceived causes of the soil fertility decline at 1% level. In the village of Govié, the not mentored farmers explained the soil fertility decline by bushfires and continuous cropping. The mentored farmers (by the public institutions) explained it by the bushfires, continuous cropping and soil type. The mentored farmers (by the private institutions) explained it by the devegetation. In the village of Lokogba, the not mentored farmers explained the soil fertility decline by bushfires while the mentored explained by the continuous cropping. In the village of Linsinlin, the not mentored farmers explained the soil fertility decline by bushfires, the mentored (by the public institutions) explained it by the continuous cropping and mentored farmers (by the private institutions) by continuous cropping and animal trampling. Membership of

a farmer organization is a determining factor of the causes of soil fertility in the villages of Lokogba and Linsinlin and is significant at the 1% level. In the village of Lokogba, all members evokes the continuous cropping while non-members explained this phenomenon by deforestation, bushfires and continuous cropping. In the village of Linsinlin, non-members explained the soil fertility decline by bushfires while members explained it by continuous cropping. In the village of Govié, membership of a farmers' organization does not significantly impact the perceptions of farmers on the causes of the soil fertility decline.

Causes of soil erosion

According to the farmers surveyed, the soil loss due to soil degradation. This soil loss or soil erosion is caused by several factors according to these farmers. In the village of Govié, the slope is the main cause of soil erosion (31% of farmers) followed by rain intensity (24%), runoff (16%) and rain duration (15 %). In the village of Lokogba, slope and runoff are the main causes of erosion (32% and 30% respectively). They are followed by the rain intensity (16%) and rain duration (11%). In the village of Linsinlin, causes of erosion are numerous according to farmers: the rain duration (21% of farmers), the type of soil (17%), slope (15%), runoff (14 %) and tillage (11%). Soil permeability, trampling and devegetation are also other causes of soil erosion rarely cited by some farmers of the villages surveyed (Figure 5). The farmers' perceptions on causes of soil erosion vary significantly from site to site ($\chi^2 = 2.347$; $P < 0.0001$). It is only at Govié that gender is a factor that determines the causes of erosion. The men explained soil erosion by the slope while the women explained by the slope, rain intensity and devegetation. Religion and literacy, in all villages, are not factor influencing the perception of the causes of soil erosion. The agricultural extension and membership in a farmers' organization are significant determinant causes of soil erosion in the village Linsinlin and not in the other villages. The main cause of soil erosion is the slope for no mentored farmers, rain duration for the farmers mentored by public institutions and soil permeability for those mentored by private institutions (Table 4). The rain duration is the main cause of soil erosion for members of farmers' organization while for no members, soil erosion is caused by the slope.

Discussion

If farmers perceive soil degradation as problem, the chance that they invest in soil management measures will be enhanced. This study show that soil erosion and soil fertility depletion are the main indicators of soil degradation according to the farmer's perception. These results are similar of those obtained by Adimassu et al., 2013 who showed that Ethiopian farmers perceived water erosion and soil fertility depletion as main indicators of land degradation. Farmers have their own perception in evaluating the problem, causes and consequence of land degradation (soil erosion and soil fertility decline; Kassa and al, 2013). Other studies (Bewket and Sterk, 2002; Bekele and Drake, 2003; Gebremedhin and Swinton, 2003) have also shown that soil degradation is perceived by farmers through soil erosion and soil fertility depletion. Farmers' perceptions of soil degradation vary from place to place and from household to household due to variations in socio-cultural, economic and biophysical conditions (Nederlof and Dangbegnon, 2007). In Osun-State (Nigeria), erosion as the major cause of land degradation and 69% of the farmers experienced a low level of crop loss to land degradation (Awoyinka et al., 2005). Farmer's perception of soil degradation refers to the perception to relationship and processes of soil erosion and fertility of the soil (Belay, 2014).

In the study area, soil fertility depletion is caused mainly by continuous cropping, soil type and bushfires. Findings of Adégbidi and others (1999) in the north of Benin indicate that the main causes of the fall in soil fertility (definition of soil degradation in this study area) are deforestation, over-exploitation (continuous cropping) and bushfires. The farmers of sudanian zone of Benin perceive in the same way soil erosion through deforestation, slope, runoff, wildfire, animal trampling, gap in land cover and inadequate land use practices for agriculture (Avakoudjo et al., 2011). In southern Ethiopia (Moges and Holden, 2007), the most important perceived indicator of soil fertility loss was reduced crop yield, followed by poor crop performance and yellowing of the crop (plant color).

The main causes of soil erosion problems of Dejen district in Ethiopia (Belay, 2014), as of Allada, Aplahoué and Djidja in Benin, perceived by farmers were the slope of the land, deforestation, improper farming practice and high intensity of rainfall and absence of appropriate soil conservation practice. In Kenya (Okoba and De Graaff, 2005), farmers attributed the soil erosion to high rainfall, steep slopes. The major causes of erosion were agricultural settlement and deforestation while slope and run-off were pointed as major factors. Globally, the causes and factors evoked here were previously described in other regions. In Upper East Region of Ghana, the perceptions of farmers on the causes of erosion were: high intensity of rainfall, inadequate vegetative cover, deforestation and lack of proper conservation methods (Fariya and Farida, 2015). But, contrary to these results, Kenyan farmers did not perceive soil erosion as poor soil cover (devegetation) and tillage. Farmer's perception of soil erosion problems refers to the perception to relationship and processes of soil erosion and fertility of the soil (Belay, 2014).

Their level of education and membership of organization raise awareness of the farmers to land

degradation problems (Awoyinka et al., 2005). In Samanalawewa watershed (Sri Lanka), socioeconomic determinants of soil erosion are, inter alia, education, membership of farmer's organization, agricultural extension (training) as this study findings, and contrary, household size, land tenure, farm labor, income, etc., (Udayakumara et al., 2010). Findings of Denboba (2005) showed that household head education, literacy and extension services determine significantly the farmers' perception on soil fertility decline.

Conclusion

This study uses survey data of farmers of three watersheds in southern Benin to know their perception on soil degradation and analyze the socioeconomic determinants of their perceptions. The results indicate that farmers in southern Benin clearly perceive soil degradation, soil fertility depletion, soil erosion and his causes. So, the surveyed farmers have a good understanding about the problems of soil degradation. For these farmers, two main phenomena explain soil degradation: Soil fertility decline and soil fertility. The farmers perceive that the soil fertility depletion is mainly caused by deforestation, bushfires, continuous cropping, soil type and animal trampling. Soil erosion is mainly caused by slope, runoff, rain intensity and duration. Several socioeconomic characteristics influence significantly the farmers' perceptions as gender, literacy, agricultural extension and/or membership of farmers' organization. The farmers' perception vary from village to village with their socioeconomic determinants.

Acknowledgement

This study is funded by the Government of Benin through the training of trainer's scholarship. We thank the government for its financial support.

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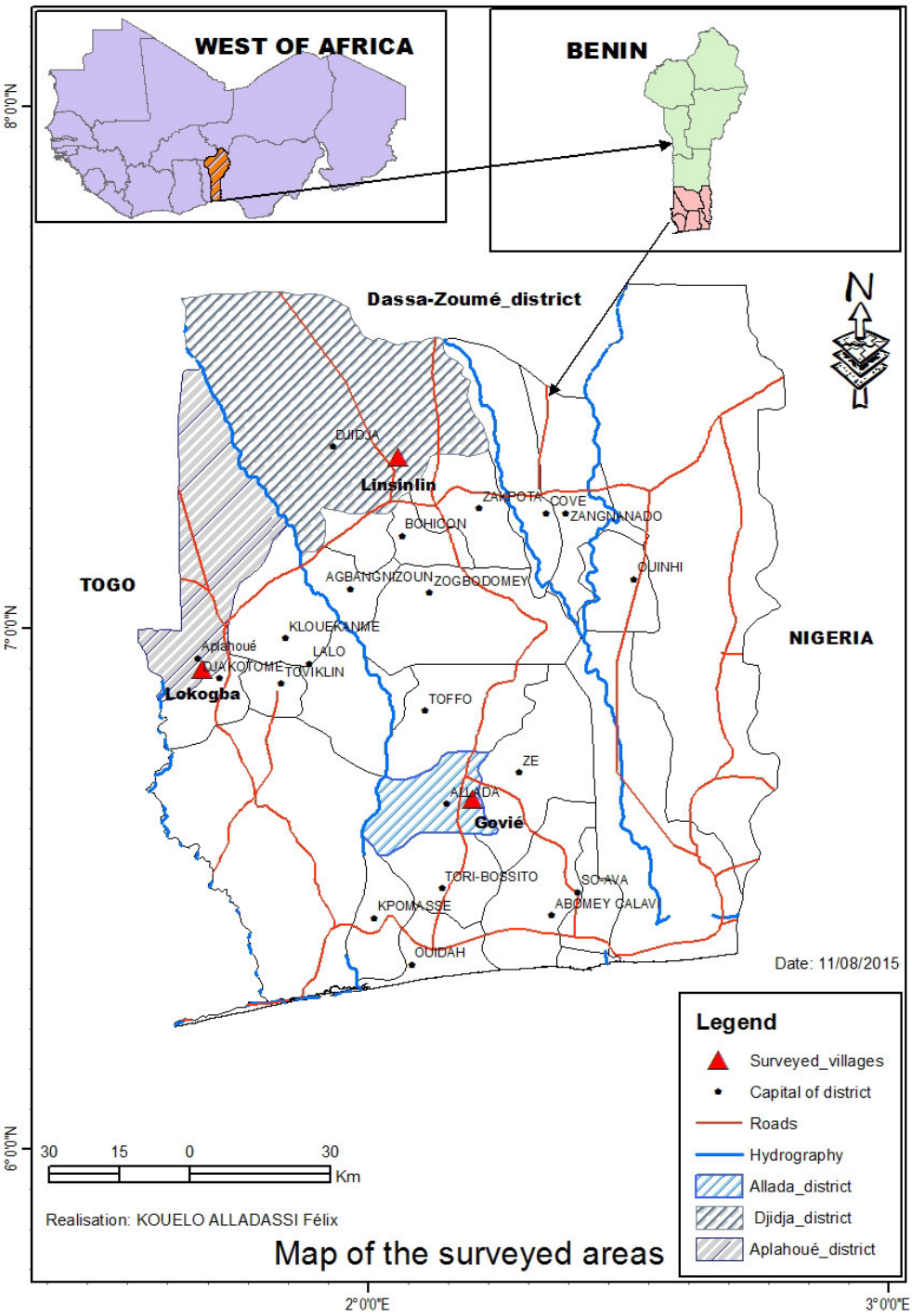

Figure 1: Map of the surveyed areas

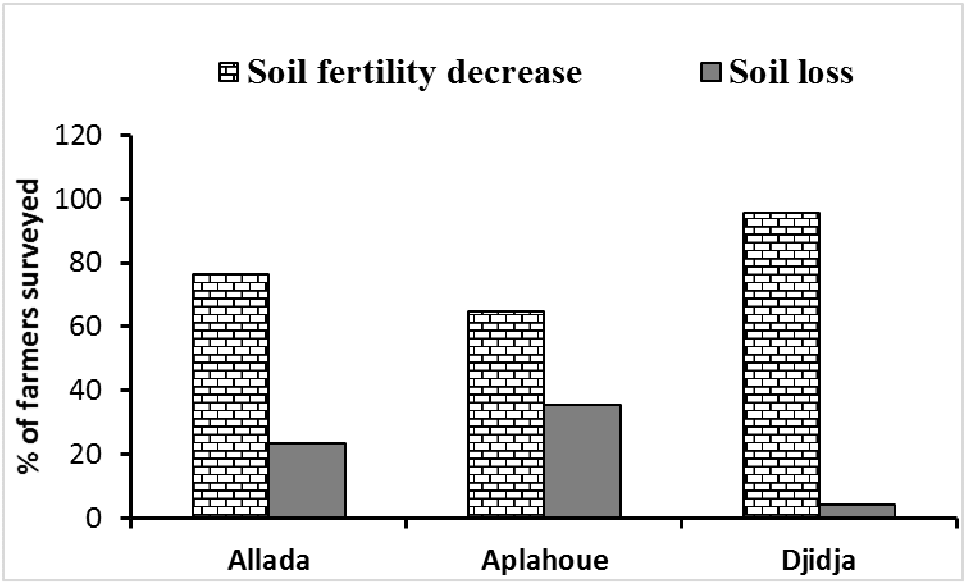

Figure 2: Farmers' perceptions on soil degradation in southern Benin.

Table 1: Significance level of socio-economic determinants of farmers' perceptions on soil degradation.

Site	Socioeconomic determinants	Chi-Square	Probability (α = 0.05)
Allada	Gender	0.003	0.955 ns
	Religion	2.74	0.955 ns
	Literacy	0.508	0.476 ns
	Agricultural extension	7.844	0.02**
	Farmer organization	0.002	0.962 ns
Aplahoue	Gender	1.181	0.277 ns
	Religion	0.192	0.661 ns
	Agricultural extension	4.635	0.063*
	Farmer organization	0.498	0.48 ns
Djidja	Gender	1.439	0.23 ns
	Religion	0.745	0.388 ns
	Literacy	0.774	0.379 ns
	Agricultural extension	6.378	0.041**
	Farmer organization	5.752	0.016**

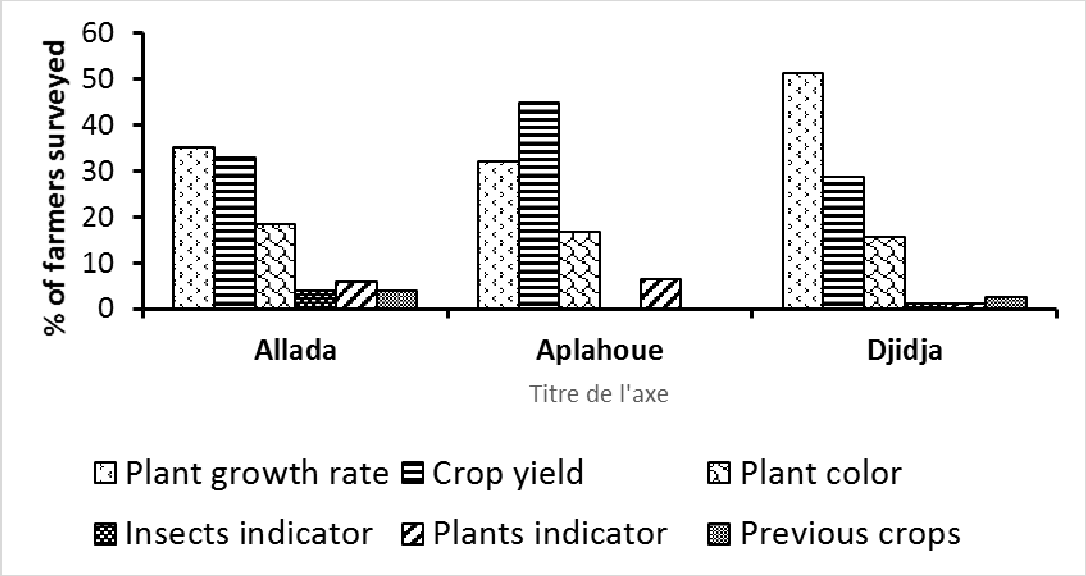

Figure 3: Farmers' perceptions of soil fertility decline

Table 2: Significance level of socio-economic determinants of farmers' perceptions on soil fertility decline.

Site	Socioeconomic determinants	Chi-Square	Probability (α = 0.05)
Allada	Gender	20.990	0.000****
	Religion	11.354	0.078*
	Literacy	5.750	0.124 ns
	Agricultural extension	3.261	0.775 ns
	Farmer organization	12.365	0.006***
Aplahoue	Gender	0.876	0.349 ns
	Religion	0.181	0.671 ns
	Agricultural extension	40.114	0.000****
	Farmer organization	10.193	0.001***
Djidja	Gender	22.678	0.000****
	Religion	5.662	0.129 ns
	Literacy	11.116	0.011**
	Agricultural extension	79.747	0.000****
	Farmer organization	34.091	0.000****

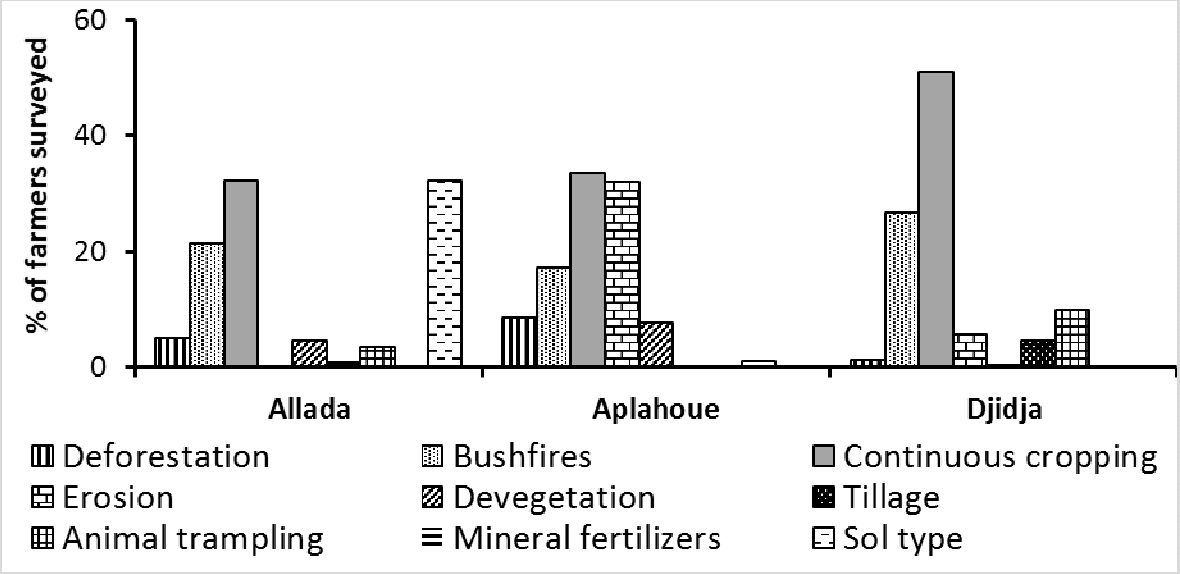

Figure 4: Causes of soil fertility decline according to the surveyed farmers.

Table 3: Significance level of socio-economic determinants of farmers' perceptions on causes of soil fertility decline.

Site	Socioeconomic determinants	Chi-Square	Probability (α = 0.05)
Allada	Gender	5.456	0.363 ns
	Religion	29.067	0.001***
	Literacy	4.254	0.513 ns
	Agricultural extension	70.421	0.000****
	Farmer organization	4.835	0.436 ns
Aplahoue	Gender	3.631	0.163 ns
	Religion	7.313	0.026**
	Agricultural extension	68.486	0.000****
	Farmer organization	10.947	0.004***
Djidja	Gender	7.993	0.018**
	Religion	2.665	0.264 ns
	Literacy	6.476	0.039**
	Agricultural extension	82.997	0.000****
	Farmer organization	39.047	0.000****

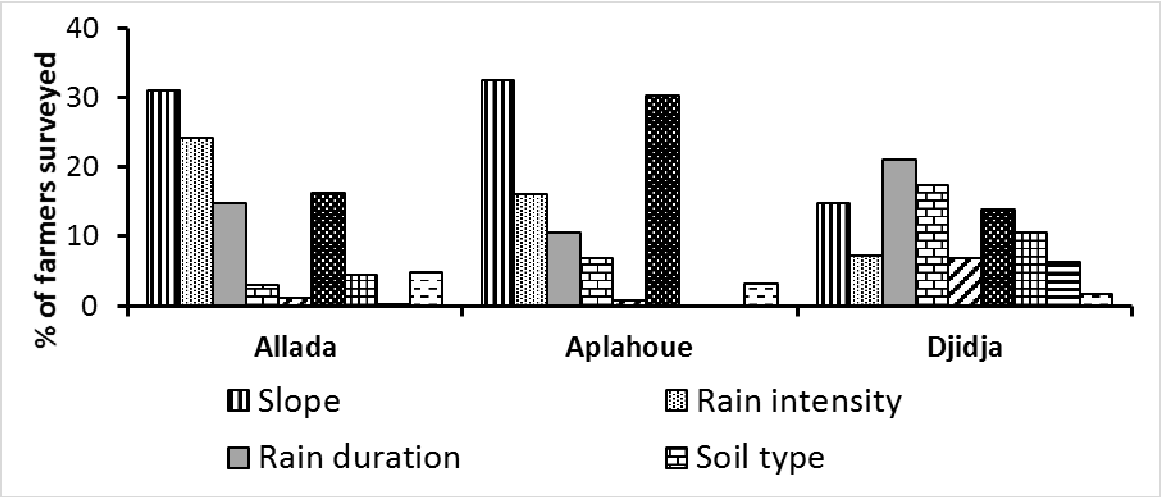

Figure 5: Causes of soil erosion according to the surveyed farmers.

Table 4: Significance level of socio-economic determinants of farmers' perceptions on causes of soil erosion.

Site	Socioeconomic determinants	Chi-Square	Probability (α = 0.05)
Allada	Gender	13.445	0.020**
	Religion	3.606	0.963 ns
	Literacy	6.405	0.269 ns
	Agricultural extension	13.231	0.149 ns
	Farmer organization	4.401	0.493 ns
Aplahoue	Gender	0.289	0.591 ns
	Religion	1.215	0.270 ns
	Agricultural extension	2.249	0.134 ns
	Farmer organization	0.3	0.863 ns
Djidja	Gender	7.34	0.394 ns
	Religion	9.127	0.244 ns
	Literacy	10.763	0.149 ns
	Agricultural extension	48.384	0.000****
	Farmer organization	19.663	0.006***