

## SOCIO-ECONOMIC DETERMINANTS OF BEST LAND MANAGEMENT PRACTICES ADOPTION IN HIGHLY ANTHROPIZED AREAS: CASE STUDY OF DAN SAGA AND TABOFATT VILLAGE CLUSTERS IN NIGER REPUBLIC

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### ABSTRACT

*The objective sought by this study is to highlight the socio-economic determinants that could be helpful in scaling up of best land management practices in high demographics areas. Indeed, a survey was carried out in Dan Saga and Tabofatt two villages' clusters in order to identify the driver factors which explain the high adoption of best land management practices in these areas. The data were collected from 200 farmers (100 from each cluster), randomly chosen. The survey addressed the likelihood of farmer to use agroforestry practices and or erosion control practices, on the basis of four socioeconomic variables: the educational level of farmer (Instr), the distance between their farm and habitation (Prox), the possession of Harnessed Cultivation Unit (HCU) and the land tenure status (Land). Data were subjected to an analysis by statistical modeling of logistic regression. The results show that agroforestry technology is predominated in Dan Saga cluster (90% of citation for agroforestry practices) compare to Tabofatt cluster where people use mostly erosion control practices (76% of citation for erosion control practices). Among the socioeconomic variables, three main factors significantly influenced the adoption of best land management; the educational level of peasants, the modality of land tenure by purchase and by inheritance and the possession of harness unit. In addition, the main land management technologies perform a high profitability compare to state of inaction. These results could serve as a lever for scaling up of greening policy in other degraded areas of Sahel's region.*

**Key words:** appropriation, agroforestry, erosion, land tenure, Sahel

### INTRODUCTION

Since 1970s and 1980s droughts, Niger republic has embarked on a vast soil restoration actions. Major reforestation projects have been carried out. Thus, agroforestry and erosion control practices have been fluently developed with significant greening of degraded landscapes (Boffa, 2000; Larwanou and Saadou, 2006; Tidjani *et al.*, 2016; Seghieri, 2017). These best land management have spread like an "oil stain" effect in certain areas of the Sahel zone (Adam *et al.*, 2006). In some cases, local regulations have played a key role in the appropriation of best land management practices (Amoukou and Yamba, 2008).

In addition, several authors including Herrmann *et al.* (2005), Raynaut (2006) and Bagnian (2014), argue that the greening of the Sahel is more accentuated in areas of high population density. In these areas, despite land saturation, landscape restoration has been successful on a large scale (Mazzucato and Niemeijer, 2001; Raynaut, 2001; Larwanou and Saadou, 2005; Bagnian *et al.*, 2012). From this perspective, anthropization appears to be an essential asset in landscape transformation (Abdoulaye and Ibro, 2006).

Obviously, these examples constitute a textbook case on the reproducibility of best land management practices in a context of anthropogenic concentration and climatic deterioration. The scaling up of these technologies in other contexts should be considered with a view to taking into account the socioeconomic factors which are relevant in the likelihood of best land management adoption's (Yabi *et al.*, 2016; Adebisi *et al.*, 2019). Thus it is crucial to understand what are the socio-economic determinants that underlie the strong appropriation of best land management practices in the case of certain areas of the Sahel? How are these best land management practices spread in these areas? By addressing these questions, the objective of this study is to identify and assess the socio-economic determinants which influence positively the appropriation of best land management practices in certain highly demographic areas of the Sahel. The results provided by this study will amplify the effect of greening program of the Sahel through the initiative of Great Green Wall.

**MATERIALS AND METHODS**

**Study Areas**

The study areas include two village clusters; Dan Saga and Tabofatt located respectively in the departments of Aguié (center-south) and Keita (Ader Douthi Maggia zone). These two localities stand out for their fairly high demographic densities (> 100 inhabitants per km<sup>2</sup>) and set themselves up as a land of strong predilection for the use of best sustainable land management (SLM) practices (Evequoz and Guero, 2000; Adam *et al.*, 2006).

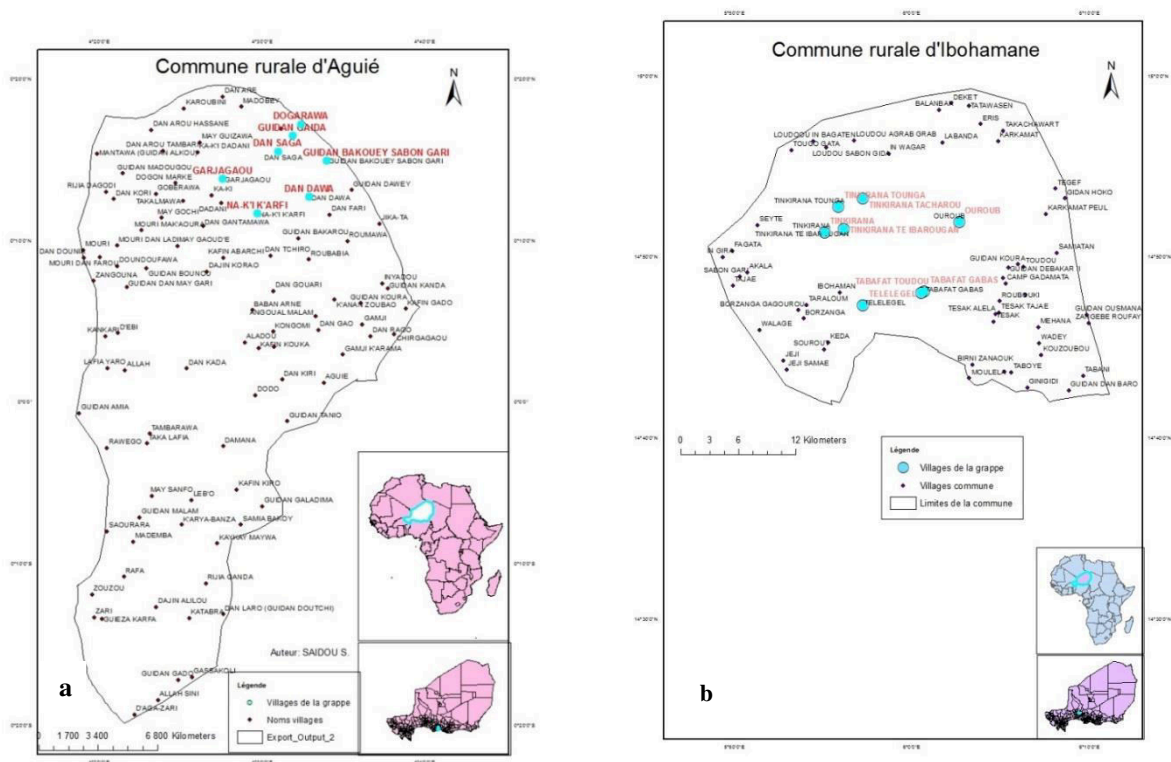
Dan Saga's cluster covers seven villages namely Dan Saga, Gardjagaou, Nakikarfi, Guidan Gaida, Dan Dawa, Dogaraoua, Guidan Bakoye Sabon Gari (Figure 1a). It is located in a semi-arid zone with an average annual rainfall of 457.4 mm (Yamba, 2016). The vegetation is dominated by a combretaceous facies with a remarkable phytodiversity of 54 species (Lawali *et al.*, 2018). The dune soils support rainfed agriculture with the main crops such as millet, sorghum and cowpea. The agricultural practices are characterized by low mechanization and shortening of fallow times due to the over population.

The Tabofatt cluster is located about 65 km northwest of Keita. It brings together six village terroirs namely Tagueléguel, Teguef, Tabofatt, Tinkira Tounga, Tinkirana Tacharou, Tikirana Taibaroug and Ouroub (Figure 1b). The northern-Saharan position places the cluster in a typically arid climate with low annual rainfall, on average 400 mm per year (Martin, 1994). The sub arid brown soils occupy the valley bottoms and support rainfed agriculture on most of the valleys (Gavaud, 1968).

**Data Collection**

In order to understand the logic underlying the high rate of best SLM practices adoption, a survey was carried out from 2 to 23 august 2018, in the two village clusters concerned by the study. For that purpose, an individual questionnaire was developed using Sphinx ++ V5 software. The questionnaire specifically covers three relevant aspects of best SLM practices appropriation. These are the farmers' perception of soil degradation indicators (soil color, crust presence and plants parasite presence), the types of best SLM practices and the broadcasting strategies such as the Peasant School of Demonstration, Incentive Measurements like the "food for work" operation, Community Relay structure and Model-Peasant.

In addition, the questionnaire focused on certain socio-economic aspects which may explain the adoption of best SLM practices. These relate to tenure types of land tenure (inheritance, purchase, pledge and loan), the possession of a harnessed cultivation unit, the proximity of the field to the village according to the halo (established on the basis of the centers of three amplitude classes; 3 km which is near halo, 4.5 km which is intermediate halo, and 7.5 km corresponding to distant halo), and the interviewee's level of education (educated or uneducated). In total, 200 operators were interviewed divided into 100 respondents by cluster. The choice of interviewees is made on the basis of simple randomly sampling method among the farmers. The sampling rates are 32 and 31% respectively in Dan Saga and Tabofatt.



**Figure 1:** Location map of study areas: Dan Saga cluster (a) and Tabofatt cluster (b)

The evaluation of the profitability level of best SLM practices was made on the basis of additional data related to the average annual yields and the average annual agricultural incomes produced on the basis of the production of millet which is the main basic cereal consumed in Niger. These data are available in the document Niger in Figures 2018 (Institut National de la Statistique du Niger, 2018).

### Data Analysis

The socioeconomics determinants underlying the adoption of best SLM practices were highlighted using binary logistic regression modeling with XLSTAT software. The probability function of this model is of the form (Collet, 1999):

$$\text{Log} \left( \frac{Y}{1-Y} \right) = C + \beta_1 X_1 + \dots + \beta_n X_n \text{ (Equation 1)}$$

In this model,  $Y$  is the probability of adoption. It is exponential in shape represented by a sigmoidal curve. The predictive variables are such that  $X_1$  is possession of harnessed cultivation unit (Yes or Not),  $X_2$  is land proximity to inhabitations (Near = 0-1 km, Medium = 1-3 km, Far > 3 km),  $X_3$  is type of land tenure (Purchase, Pledge, Inheritance or Loan), and  $X_4$  is education status of respondents (Instructed or Uninstructed). The  $C$  value represents the marginal effect. The  $\beta_1, \beta_2, \beta_3$  and  $\beta_4$  values estimate the weight of each predictive variable in the explanation of the best SLM practices in use.

The Chi-square was used to test the level of independence between the explicative and predictive variables. The  $H_0$  hypothesis of independence is accepted according to the value of  $P_r$  of Pearson.

The validity of the results was evaluated through the logarithm of the maximum likelihood (LMV) which is measured by the value of the deviance ( $-2LLMV$ ), the Akaike Information Criterion (AIC), the pseudo  $R^2$  and the value of the surface under the ROC curve (AUC). The lower the deviance, the more crucial the predictors are in explaining the probability of adopting best SLM practices. The profitability analysis was done through the internal rate of return (IRR) and the time of return on investment (RT). These parameters are evaluated over a 5-year chronicle from 2014 to 2018. The TR is calculated using the formula:

$$TR = \frac{\text{Initial investment cost}}{\text{Average annual financial flow}} \dots \text{ (Equation 2)}$$

The measurement of the average annual financial flow (AFF) is given according to the net margin by the formula recommended by Penot et al. (2010):

$$AFF = \sum \text{Products} - \sum \text{Charges} \dots \text{ (Equation 3)}$$

The product was got from Ambouta and Amadou (2000), Adam et al. (2006) and CILSS (2008). The charges are established based on the data in the collection of technical sheets in natural resource management and agro-sylvo-pastoral production in Niger (Ministère de Développement Agricole, 2002). The IRR is determined using the TRI function of the EXCEL software with a discount rate of 10% commonly used in the literature.

## RESULTS

### Socioeconomic Profile of the Respondents

Table 1 shows the respondents' socioeconomic data. In both Dan Saga and Tabofatt, they are typically adults aged 18-55 years. Most of them are married (78 and 84%, respectively in Tabofatt and Dan Saga). The rate of instructed respondents is fairly average (52% in Dan Saga and 47% in Tabofatt).

### Peasant Perception of Soil Degradation Indicators

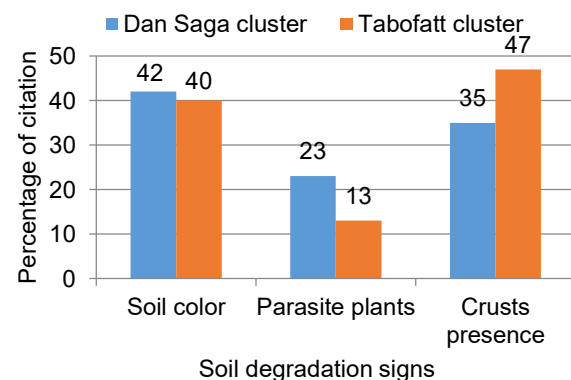
Several signs are useful to justify the use of land management practices. Two signs are mostly targeted by farmers to understand the soil's health (Figure 2). In the two localities, the soil's colour is cited in equal proportion, i.e., 42% of citations in Dan Saga cluster and 40% of citations in Tabofatt cluster. On the other hand, the level of appreciation based on the crust presence on soil surface indicators varies according to the context in which the nature of the lands model plays a key role. The population of the Tabofatt cluster where the morpho-pedological facies is contrasted distinguishes soil degraded by the crusts presence with 47% in Tabofatt against 36% of quotes at Dan Saga where the lands are relatively sandy and homogeneous. The indicators relating to the presence of certain crop parasitic plants in the field is used to a lesser extent in assessing the tendency of soil degradation. Only in Dan Saga cluster with 23% of quotation that the farmers give some credit to that indicator.

### Strategies for disseminating best SLM practices

At the Dan Saga, the field farmer demonstration school strategy recorded 55% of citation in row 1, followed by the means of popularization by community relay structures with 42% of citation in row 2 (Figure 3). At the Tabofatt cluster level, the incentive strategy obtains 53% of quotation preferably at rank 1, followed by the farmer field strategy with 47% citation at rank 2 (Figure 4).

### Adoption Level of Best SLM Practices

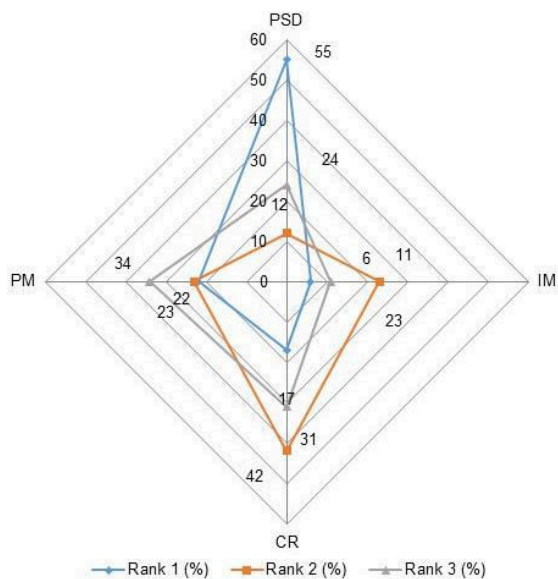
Farmers in two localities have a good understanding of the production constraints they face by referring to some obvious signs of soil degradation. This justifies the fact that they have adopted and adapted a diverse range of best SLM practices.



**Figure 2:** Percentage of citation on three different soil degradation indicators

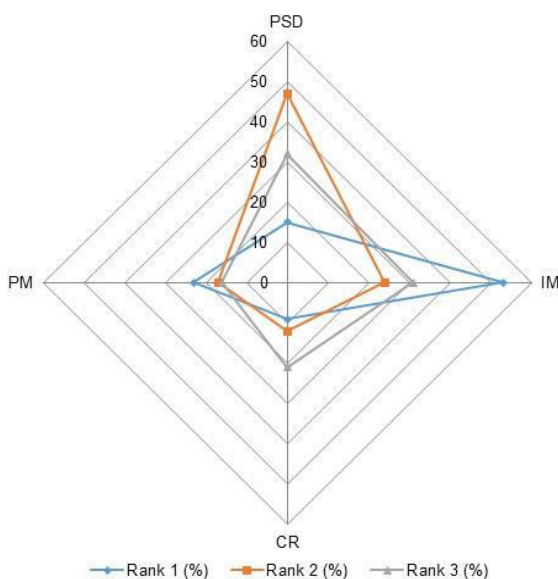
**Table 1:** Socioeconomic characteristics of respondents

Villages cluster	Age			Married	Marital status			Education	
	0-18	18-55	> 55		Single	Divorce	Instructed	Uninstructed	
Dan Saga	17	61	22	84	13	3	52	48	
Tabofatt	14	67	19	78	10	12	47	53	



Legend: PSD: Peasant School of Demonstration, IM: Incentive Measurements, PM: Peasant Model, CR: Community Relay

**Figure 3:** Percentage of sharing strategies in function of rank in Dan Saga cluster



Legend: PSD: Peasant School of Demonstration, IM: Incentive Measurements, PM: Peasant Model, CR: Community Relay

**Figure 4:** Percentage of sharing strategies in function of rank in Dan Saga cluster

In the two clusters, the study identified four main practices that can be classified in the category of cultivation methods (Table 2). Among these practices, organic manuring and crops-leguminous association / rotation practices stand out for their preponderance in the two clusters. By way of illustration, in the case of organic manure, 35% and 49% of citation were recorded respectively in Dan Saga cluster and in Tabofatt.

Regarding agroforestry practices, Assisting Natural Tree Regeneration (ANTR) stands out clearly as being the most used in Dan Saga cluster with 94% of citations. However, this practice is relatively in its infancy in the Tabofatt cluster (Table 2).

In the case of runoff management practices, Zai, half-moons and ridging are practiced specifically on *Guéza* soils in Dan Saga cluster. On this type of soil, 45% and 38% were cited respectively in favor of the practice of Zai and half-moons. At Tabofatt, the use of anti-erosion practices matches perfectly the morpho-pedological units of the landscape. On sandstone plateaus, battleships, peasants mainly use dry stone partitioned micro-bowls which they assimilate to half-moon structures (27% of quotes). At the level of medium slope, they favor stony cords with 28% of quotes. *Zai* are preferred over encrusted glazes (31% of quotes).

**Determinants of Best SLM Practices Utilization**

The LOGIT analysis applied to the probability of adoption of the main practices generated six statistical models. Their parameters are listed in Tables 2, 3 and 4. The evaluation of the level of influence of each explanatory variable on the probability of adopting a category of SLM best practices is based on the weight of the variable which is highlighted by its value located in the second column of the table.

Jointly, in the two clusters, the factors relating to the level of education of the farmer and the possession of a harnessed cultivation unit positively and significantly influence the adoption of practices (Table 3). The probability for an educated farmer to use these technologies is much higher with a weight of 2.69 and 1.83 respectively in Dan Saga and Tabofatt clusters. More specifically in the case of the Dan Saga cluster, land tenure has a significantly positive influence on the adoption of farming practices. In this cluster, the peasants who acquired land by purchase and by inheritance express a high propensity to adopt agricultural practices with  $1.17 \pm 0.32$  and  $1.29 \pm 0.33$ , respectively, in Dan Saga for example.

The results in Table 4 focus attention on the case of the Dan Saga cluster, where we find a highly significant influence of the proximity factor and the possession of a harnessed cultivation unit on the probability of agroforestry practices adoption. In addition, the terms of land tenure play a very significant role in the adoption of these kinds of practices. In the case of the Tabofatt cluster, the effect of the four explanatory variables is not significant on the use of agroforestry practices. However, the level of education plays a role in the tendency to plant and breed trees in the farm either in the form of hedges or forest enclaves producing timber intended for marketing.

**Table 2:** Adoption rates of best SLM practices

AP	Dan Saga	Tabofatt	AFP	Dan Saga	Tabofatt	ECP	Dan Saga	Tabofatt
OM	35	49	ANR	94	11	Zai	45	31
FM	21	13	WF	4	20	HM	38	27
Mulching	16	14	Plant	1	67	SC	0	28
C-LA/R	27	24	IC	1	2	Ridging	17	14
Total	100	100	Total	100	100	Total	100	100

AP - Agricultural Practices, AFP - Agroforestry Practices, ECP - Erosion Control Practices, OM - Organic Manure, Micro - Fertilizer Micro dosing, C-LA/R - Crops-Leguminous Association or Rotation, Plant - Plantation, ANR - Assisting Natural Regeneration, IC - Improved Clearing, HM - Half-moon, SC - Stony Cords

**Table 3:** LOGIT model result applied on the agricultural practices

Villages cluster	Dan Saga		Tabofatt	
Parameter	$\beta$ value	Pr	$\beta$ value	Pr
Marginal Effect	1.73 $\pm$ 0.72	0.015**	0.67 $\pm$ 0.46	0.143
Harnessed Cultivation Unit	0.99 $\pm$ 0.27	0.000***	1.36 $\pm$ 0.31	0.0001***
Proximity	0.14 $\pm$ 0.03	0.0001***	-0.02 $\pm$ 0.05	0.667
Purchase tenure	1.17 $\pm$ 0.32	0.000***	-0.22 $\pm$ 0.12	0.067
Pledge tenure	1.64 $\pm$ 1.52	0.279	0.44 $\pm$ 0.73	0.551
Inheritance tenure	1.29 $\pm$ 0.33	0.0001***	0.16 $\pm$ 0.04	0.0001***
Loan tenure	-1.05 $\pm$ 0.62	0.089*	0.37 $\pm$ 0.86	0.671
Instructed	2.69 $\pm$ 0.57	0.0001***	1.83 $\pm$ 0.43	0.0001***
Uninstructed	-2.69 $\pm$ 0.57	0.0001***	-1.83 $\pm$ 0.43	0.0001***

\*\* - significant at 0.05; \*\*\* - significant at 0.01

**Table 4:** LOGIT model result applied on the agroforestry practices

Villages cluster	Dan Saga		Tabofatt	
Parameter	$\beta$ value	Pr	$\beta$ value	Pr
Marginal Effect	2.02 $\pm$ 0.8	0.009**	0.02 $\pm$ 0.21	0.917
Harnessed Cultivation Unit	0.71 $\pm$ 0.21	0.001**	0.09 $\pm$ 0.13	0.456
Proximity	0.11 $\pm$ 0.03	0.001**	-0.02 $\pm$ 0.03	0.586
Purchase	0.79 $\pm$ 0.30	0.009**	-0.05 $\pm$ 0.09	0.560
Pledge	1.35 $\pm$ 1.08	0.212	0.30 $\pm$ 0.53	0.568
Inheritance	-0.91 $\pm$ 0.25	0.000***	-0.02 $\pm$ 0.03	0.426
Loan	-0.82 $\pm$ 0.45	0.071*	-0.29 $\pm$ 0.62	0.641
Instructed	1.89 $\pm$ 0.53	0.000***	0.13 $\pm$ 0.17	0.468
Uninstructed	-1.89 $\pm$ 0.53	0.000***	-0.13 $\pm$ 0.17	0.468

\*\* - significant at 0.05; \*\*\* - significant at 0.01

The methods of land tenure by pledging and loan stand out quite significantly by their positive influence on the use of erosion controlling practices in the two clusters (Table 5). Values ranging from 1.36 and 0.81 were recorded for the pledging modality and 0.92 and 0.96 for the loan under the Dan Saga cluster and Tabofatt, respectively. Likewise, the frank peasants with a level of education favour the use of these practices in the two localities. In the specific case of the Tabofatt cluster, we note that all the explanatory variables have positively and significantly influenced the probability of using erosion controlling practices with the exception of the factor related to proximity to housing areas.

### Validity Level of the Generated Models

The level of validity of each model is assessed based on four parameters and two statistical tests. The parameters used include deviance, pseudo-R<sup>2</sup>, AIC and AUC. The two tests used are the normality test at 3DL and the Hosmer-Lemes how test at 1 DL.

In light of Table 6, all six models are significant on the normality test (rejection of H<sub>0</sub>). The pseudo-R<sup>2</sup> value is greater than or fairly close to 0.50. AUC values range from 0.67 to 0.98, placing the six models in a fairly reliable range. With a fairly low maximum likelihood value (deviance = 20.95), the result of the model applied to cultural practices at the Dan Saga cluster provides the best validity.

**Table 5:** LOGIT model result applied on the erosion control practices

Villages cluster	Dan Saga		Tabofatt	
Parameter	$\beta$ value	Pr	$\beta$ value	Pr
Marginal Effect	-0.1 $\pm$ 0.23	0.629	0.45 $\pm$ 0.31	0.147
Harnessed Cultivation Unit	0.08 $\pm$ 0.23	0.479	0.39 $\pm$ 0.15	0.008***
Proximity	0.04 $\pm$ 0.12	0.001***	0.06 $\pm$ 0.04	0.135
Purchase	0.45 $\pm$ 0.15	0.003**	0.09 $\pm$ 0.09	0.350
Pledge	-1.11 $\pm$ 0.78	0.157	-0.89 $\pm$ 0.63	0.157
Inheritance	-0.08 $\pm$ 0.11	0.451	-0.01 $\pm$ 0.02	0.503
Loan	0.32 $\pm$ 0.30	0.288	1.27 $\pm$ 0.75	0.089**
Instructed	0.57 $\pm$ 0.20	0.004***	0.55 $\pm$ 0.20	0.007***
Uninstructed	-0.57 $\pm$ 0.20	0.004***	-0.55 $\pm$ 0.20	0.007***

\*\* - significant at 0.05; \*\*\* - significant at 0.01

**Assessment of the Level of Profitability of Best SLM Practices**

The profitability of best SLM practices aims to reinforce the underlying motives behind the strong appropriation of best SLM practices (Table 7). Land management practices guarantee a return on investment in the space of a few months to less than two years. The best offer of profitability is recorded by the practice of ANTR with an IRF of 485%; half-moon and mulching practices show the less value of RIT (Table 7).

**DISCUSSION**

**Farmer Perception of Soil Degradation and Level of Adoption of Best Land Management Practices**

The adoption of a practice is concretized according to (Rogers, 1995) by the combination of five factors namely the relative advantage it provides compared to other alternatives, its compatibility with the socio-economic realities of users, the testability which offers farmers the possibility of verifying by trial the effect of the practice and the observability which is inherent in the visibility of the effects induced by the practice. In this ways, farmers of the two localities manage to situate a soil perfectly according to its state of degradation. In the context of a dune plateau as in the case of the Dan Saga cluster, the color of the surface horizons is commonly used by farmers to assess the level of soil productivity. In fact, it is an indicator of the level of leaching of sandy soil. On this subject Bouzou and Yamba (2008) had reported that the peasants of the Maradi region in Niger distinguish *farin wuri* (cleared ground) and *bakin wuri* or *ban kodo* (literally back of toad) to qualify the level of soil fertility. They explain why *farin wuri* is derived from *bakin wuri* by permanent cultivating without fallow. This fact was also mentioned by Ambouta *et al.* (1998) at the level of the Gakudi terroir where the peasants use certain edaphic and biological traits such as the color of the superficial part of the soil, the abundance and luxuriance of the vegetation to apprehend the state of productivity of a soil. The invasion of the soil by certain parasitic species of crops of the genus *Striga* is also another indication of degradation often used by farmers.

Based on the state of soil degradation, best land management practices have been used since the end of 1980s ecological droughts. This study showed that at present, the more or less judicious choice of a category of these practices is conditioned by certain local specificities as well as the dominant erosive phenomena. At the Dan Saga cluster where probably the wind dynamics were more worrying, the farmers preferred to adopt agroforestry practices, like Assisting Natural Tree Regeneration practices (ANTR). It is an endogenous practice and improved thereafter because it is inspired by the observation made by the peasants that the fields of the emigrants, being abandoned are more wooded and offer the best yields than the fields regularly cultivated (Larwanou *et al.*, 2012; Bagnian *et al.*, 2013; Morou *et al.*, 2016; Lawali *et al.*, 2018). Furthermore, the vigour of ANTR in this context is determined by the strong vegetative reproductive capacity (such as suckering) of the combretaceous species which dominate the landscape of this area (Bationo *et al.*, 2012). For the Tabofatt cluster, the practices for collecting water and sediments have become closely linked to it because they are more appropriate for countering the particularly lively surface hydrodynamics in this context. In areas where practices are applied, awareness campaigns have induced an appropriation of best land management practices. On the other hand, in some areas, the initiation of a real reliability of these practices is appreciably weak (GIZ, 2012). In addition, depending on the context, the adoption of best SLM practices must deal with certain major material and financial constraints (Kohio *et al.*, 2017) and especially land policy (Boffa, 2000; Seghieri, 2017). These challenges require a reconsideration of the terms of the participatory approach which must channel this dynamic.

**Determinants of the Strong Appropriation of Best SLM Practices**

This study highlighted three main determinants that significantly influence the adoption of best SLM practices. First, the level of education of farmers predisposes them to be receptive to innovations. It means that those who are educated in any way are more bound to appropriate best SLM practices.

**Table 6:** Values of the models parameters validity

Model	Agricultural practices		Agroforestry practices		Erosion control practices	
	Dan Saga	Tabofatt	Dan Saga	Tabofatt	Dan Saga	Tabofatt
Deviance	20,958	65,453	49,327	95,723	74,222	92,983
Pseudo $R^2$	0,859	0,525	0,770	0,437	0,472	0,518
AIC	34,958	79,453	63,327	119,723	108,222	106,983
AUC	0,98	0,889	0,916	0,658	0,761	0,742
Test of H0	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
Test of H-L	0,963	0,867	0,000	0,536	0,363	0,0001

AIC - Akaike Information Criterion, Test of H-L - Test of Hosmer-Lemeshow applied on the  $\chi^2$  statistic, AUC - area under curb

**Table 7:** Values of internal rate of profitability and return investment time of 5 mean technologies used in the two clusters

Indicators	ANR	Half-moon	Zai	Stony Cord	Mulching
IRF (%)	485	105	47	78	93
RIT (years)	1.18	0.90	1.76	1.17	0.99

IRF - internal rate of profitability, RIT - return investment time, ANR - assisting natural tree regeneration

This result is in agreement with those obtained by Belem (2017) who showed the strong influence of the level of education and the incentive income on the adoption of cashew growing in Burkina Faso. Similarly, Adebisi *et al.* (2019) reported that the use of organic manure in North Benin is favored significantly by: the peasant's level of education. Akukwe (2020) in their study in the southeastern Nigeria reported that the level of education factor influence the household food security. Meanwhile, Kayode *et al.* (2017) observed that in Kogi State (Nigeria), the influence of years of schooling in the SLM adoption is more important in female than in male. This is to indicate that it's important to reinforce the effort of informal education in rural areas in order to expect a rapid best transformation.

The land tenure, through the acquisition of land by purchase and by inheritance plays a key role in the adoption of best SLM practices. This highlights a major issue related to the right of land using because the peasants who exploit the land they have acquired by pledge or by loan probably consider that this type of investment is not profitable in the short term. In addition, the majority of the land subject to this type of transaction is in fact fields with relatively pedogenetically juvenile. For instance, the leached tropical ferruginous soils locally called *guéza* in Dan Saga cluster and raw mineral soils in the case of the Tabofatt cluster are generally concerned by this kind of land tenure. Elenwa and Emodi (2019) found that in 40% of case land tenure constitutes a constraint of soil conservation practices of arable crop production in Omuma Local Government Area of Rivers State, Nigeria. In the same sense, Lawali *et al.* (2018) indicated that land tenure constitutes the major determinant of ANTR practice in Dan Saga cluster.

The profitability indicators for each of the five main best SLM practices evaluated in this study show that investment in land management technologies is highly profitable. Similarly, a study conducted by CILSS (2012) came to the same conclusion with an internal rate of return of 145% and 93% respectively for an investment in half-moon and *zai* technologies. Subsol *et al.* (2013) found a rate of return on investment for best SLM practices at an average of 84%. These results do not take into account the combination effect of best practices. For example in Burkina Faso Sigue *et al.* (2019) have shown that the profitability performances of anti-erosion practices are amplified when they are combined with fertilizer micro-dosing technology.

## CONCLUSION

The objective of this study was to identify and assess the factors influencing the strong appropriation of best land management practices in certain highly anthropized areas of the Sahel. The

results obtained showed the farmers of the two clusters adopted a varied range of best SLM practices specifically adapted to their context. This dynamic of appropriation of positive technologies is maintained by various sharing approaches which have resulted in the field with a high adoption of agroforestry practices in Dan Saga cluster and a high preponderance of erosion controlling practices in Tabofatt cluster. This large-scale adoption is significantly influenced by three major socio-economic determinants, in particular the level of education of the peasants, the land tenure by purchase and inheritance and the possession of a unit of harnessed culture. In addition, the profitability performance of these best SLM practices helps to justify their strong appropriation. The investment is up to the investment capacity of the farmers. These results indicate that best SLM practices can be scaled up to effectively combat desertification and guarantee food security in highly anthropized areas of the Sahel.

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