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Farm-level adoption of soil and water conservation techniques in northern Burkina Faso

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Abstract

Using a Probit regression model, this study uses data from 230 small farm households in northern Burkina Faso to identify and analyse the determinants for the adoption of two soil and water conservation techniques, the ''zaï'' and the stone strip. The ''zaï'' is a traditional technique for restoring degraded soils by creating a micro-environment favourable for crops by digging and sowing in holes in which manure or compost has already been deposited. In the stone strips, stones are arranged perpendicular to the slope of the land in order to slow down water flow, encourage water infiltration and increase the sedimentation of the materials reconstituting soil.

The Results indicate that the most significant variables for the adoption of both of these conservation adoption are training and small ruminants holding. Variables such as education and perception of soil degradation are determinants only for the adoption of zaï technique. Membership in a farmer's association and area cultivated are positively related only in the case of the stone strips. Although stone strips is a technique suitable for larger areas, the results show that the perception of soil degradation is not positively correlated with this technique. These findings suggest, therefore, that support services for rural development should focus their intervention on making farmers convinced of the problem of soil degradation before training them on soil conservation practices.

JEL classification: Q25

Keywords: Technology adoption; Zaï; Stone strips; Economics; Probit regression

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1. Introduction

Sub-Saharan Africa is faced daily with the phenomenon of erosion which contributes to weakening agro-silvo-pastoral production. According to Swinton and Gebremedhin (2001), soil degradation is one of the basic problems facing states within Sub-Saharan Africa in their efforts to increase production and reduce poverty and food insecurity.

Burkina Faso is 270,000 km^2 Sahelian country in West Africa. According to INERA (2000a), about 24% of the arable lands are highly degraded and this threatens the quality of the natural environment and food security in the medium and long term. Indeed soil degradation is one of the most serious problems of the northern region of Burkina Faso (Rochette, 1990).

The natural environment of the northern provinces of the country is characterized by soils that are poor in organic matter, leading to a more accentuated degradation of the natural vegetation. This part of the country is also characterized by a high population density and important animal resources. The competition between animals and humans in this region with low rainfall and degrade soil has resulted in recurrent cereal deficits. Any intensification of production necessitates of water control. According to INERA (2000a), for example, 31% of the average annual rainfall is lost through run off on unmanaged lands. In area where the lands are managed through the use of stone strips for example, the loss is reduced by to 23%. According to the Ministère de l'Agriculture (1999) the loss of land through erosion is estimated to be 28 t/ha/annum in the northern zone of the country, 8–15 t/ha/annum in the central zone and 3–9 t in the southwestern zone of the country.

Soil conservation methods seem to be effective for reducing poverty in the Sahel, where more than 85% of the population are farmers and herders, as they help to improve soil fertility and yield. In this context, a reducing on soil degradation is imperative in order to boost agricultural production. Several efficient soil and water conservation techniques have been developed through research and the endogenous knowledge of agriculturists.

It is imperative to create favourable conditions so that a greater number of farmers can take advantage of these techniques. One of the most important steps towards this goal is to identify the factors that encourage the adoption of water and soil conservation techniques such as zaï and stone strips.

Zaï involves digging, in the dry season, a pit 30–50 cm in diameter and 10–20 cm deep every 0.8–1.2 m apart and throwing the earth downhill to form crescents. Termites take advantage of the leaves and harvest residues that blown into these hollows by the wind. At the beginning of the rainy season, the farmer deposits dung and compost (200–600 g) in the crescents. He sows 10–15 seeds of millet or sorghum in small holes (during the dry season or after the first rains). During the first rains, the very abundant flow of water is trapped in these pits and permeates the soil deeply through the holes burrowed by the termites and form pockets of water shielded from direct evaporation. The seeds germinate very quickly, finding micro-pores, water and nutrients from deep in the ground and taking advantage of the high concentration of nitrogen (Roose and Rodriguez, 1990).

Stone strips are an anti erosion construction made by the judicious arrangement of stones along a contour line. The aim is to reduce the speed of running water, allowing it to percolate into the soil and at the same time, disperse the excess that cannot permeate the soil.

The potential gain obtainable from adopting these technologies has been examined from various angles, but very few studies have looked into the conditions leading to their adoption in West Africa in general, and the Sahel in particular.

The main objective of this study is to identify and analyse the factors leading to the adoption of soil and water conservation practices, in particular zaï and stone strips. The study objectives are based on several hypotheses. These are: (a) the adoption of the techniques is influenced by the level of human capital such as age, education, training, membership in farmer's organisation and perception of soil degradation; (b) larger farms are more likely than the smaller ones to adopt soil conservation methods; (c) the readiness of farmers to adopt the soil conservation methods is conditioned by the availability of appropriate equipment.

2. Literature review

Quite a large number of studies have been carried out of soil conservation, but very few have examined the factors encouraging the adoption of conservation methods. A number of studies, such as those of Reij et al. (1996), Chleq and Dupriez (1986), Gascon (1987), have been limited to the description of traditional techniques of soil and water conservation in Africa. INERA (1989, 2000b) made an inventory of the major soil conservation activities in the northern zone of the central plateau of Burkina Faso. However, it main concerned was to obtain scientific knowledge about soil conservation methods and it focused more on the purely agronomic aspects.

Kambou et al. (1994), Robins and Sorgho (1994), Ousmane (1995) and Sidibé (2002) have examined aspects connected with the effectiveness or the impact of water conservation and soil fertility restoration technologies on the productivity of arable lands. A number of studies are currently under way at Institut de l'Environnement et de la Recherche Agricole (INERA) which give prominence to the effects of stone strips on the dynamics of organic matter. The socio-economic impact of soil conservation measures has also been examined. Atampugre (1993) has evaluated the socio-economic impacts of stone strips in Yatenga and Yahga, respectively. Brasser and Vlaar (1990) have examined the socio-economic aspects of filtering dykes but without addressing the factors determining their adoption.

Some studies have been made of the adoption of different types of soil conservation methods in other parts of Burkina Faso. Reij et al. (1996) examined the success of these soil conservation methods by dealing with regard to the zaï technique in Yatenga and Niger. However, he did not examine the factors leading to their adoption. Traoré (1985) identified a number of factors that hinder the application of the results of agricultural research in Benin, Burkina Faso, Guinea and Mali. His analysis is based primarily on the institutional approach regarding the promotion of new agricultural techniques. Sands (1986) and Harisson (1991) examined the delay in the application of the technology. They studied the aspects leading to adoption generally laying emphasis on the socio-cultural factors conditioning the viability of the technology. Robins and Sorgho (1994) and INERA (1994) limited their research to the estimation of the rate of adoption and the farmer's perception of an innovation. Lowenberg-DeBoer et al. (1993) proposes the hypothesis that soil conservation methods will be adopted, if the rate of return on investments in the technology is higher than that of other activities in which the farmer may engage. He does not however test the hypothesis.

Always in Burkina Faso, Bonkian (1985) and Kaboré (1988) used the allocation of resources to analyse the management soil fertility. They examined in particular the use of fertilizers and yoke farming to explain soil fertility management. Ouédraogo (1999) has examined the determinants of the adoption of soil conservation methods in Passoré (in the central north of Burkina Faso). He used a Probit model to analyse the impacts of three determinants on the adoption decision.

Adesina and Baidu-Forson (1995) analyse the conditions for the adoption of an improved variety of sorghum taking into account farmers' perceptions as a determining factor. Kang et al. (1991) have examined the economic effects of soil erosion in lane farming systems in south-western Nigeria. They considered a single determinant influencing the adoption of this technique that is the current value of additional revenue generated through investment in the soil conservation methods. In the Philippines, Lapar et al. (1999) have examined economic aspects of the adoption of hedging techniques applied by farmers. They analysed factors affecting the decision to adopt this technique. In Brazil, Nerlove et al. (1996) used the diversification of agricultural speculations to analyse the adoption of new ploughing technologies.

In view of the importance of the subject and the lack of knowledge with regard to the causes of non-adoption of the soil conservation methods, it appears useful to us to undertake a study to understand and explain why certain farmers in the Sahel seem to be indifferent to the use of soil conservation methods. In the case of those who have adopted the technologies, it is important to identify their characteristics. The findings will enable us to make recommendations which will help to better conditions for the adoption of conservation techniques in areas of greatest need.

3. Conceptual framework

3.1. Definition of adoption

There are several definitions and methods for evaluating adoption. (Adesina and Zinnah, 1992; Featherstone et al., 1997; CIMMYT, 1993; Ghadin and Pannel, 1999). According to CIMMYT (1993), the adoption of new techniques can be defined in several ways depending on whether one applies the total application of the technological package or the number of years of application. Like Featherstone et al. (1997), we define adoption as the extent to which a new technology is utilized, balanced with other activities, over a long period of time and supposing that the farmer has full information on the technology and its potential. This definition brings out the fundamental characteristics of adoption such as intensity, time spent in application and the rational choice of the farmer.

3.2. Adoption models

According to Negatu and Parikh (1999) classification, three groups of adoption models exist: (i) the innovation–diffusion model, (ii) the economic constraints model and (iii) user-technique characteristics model. The third group is of interest to us principally because of the difficulties involved in collecting data for the first two, and because of our working hypotheses. According to this model, the characteristics of the technique, within the institutional and socio-economic context of production, play a central role in the adoption process. In the same way, it takes into consideration the diversity of activities that have an influence on adoption (Nerlove et al., 1996). Moreover, this user-technique model integrates the perception of the individual, which has been very seldom studied (Adesina and Zinnah, 1992).

4. Economic approach

4.1. Sampling and collection of data

This study concerns a region of Burkina Faso characterized by a high degree of soil degradation and common practices of soil conservation, i.e. the use of zaï and stone strips. This region is composed of seven provinces of which the Yatenga province, located in the north of the country is one. After several field visits, bibliographic research, and interviews with some local institutions such as NGOs, resource persons and farmer's organization, the Yatenga province has chosen for study because the farmers in this area were open minded and ready to share information. The province is divide into departments and the one selected was the department of Ouahigouya because of its accessibility. Using population census data available at Institut National de Statistique et de la Démographie (INSD), around 57% of households were selected randomly from each of four villages also randomly selected from the total villages in the department. The data were collected for year 2003/2004 cropping year from 230 farmers located in the Barelogo, Mogombouli, Noogo and Solgum. Two investigators were involved in collecting the data and received 15 days training in how to fill in the questionnaire. The information collected using the questionnaires cover nine sections. These are:

- Section 1: Farmer's socio-economic characteristic;
- Section 2: Perception of environment degradation;
- Section 3: Socio-demographic composition of the farm;
- Section 4: Process of conservation practice adoption;
- Section 5: Inventory of farm equipment;
- Section 6: Inventory of farm livestock;
- Section 7: Inputs used in soil conservation practices;
- Section 8: Labour used in soil conservation practices;
- Section 9: Evaluation of production cost.

In addition to this questionnaire, and to facilitate the interpretation of the results we had individual and collective informal discussions with farmers and local institutions such as NGOs and farmer's associations. This helped us to familiarize ourselves with the local farming system and particularly the management of soil fertility.

4.2. Socio-economic theory of adoption

The theory of the maximization of utility is generally used to explain the response of the farmer vis-à-vis a new technique (Adesina and Zinnah, 1992). According to this theory a new technique will be adopted by the farmer, if the utility obtained from the new technique exceeds that of the old one.

We assume that the farmer's response to their situation is consistent with utility-maximizing (Rahm and Huffman, 1984; Adesina and Zinnah, 1993). Let U_{ij} be the utility the farmer obtains from the technique with $j = \{0,1\}$ indicating the adoption or non-adoption of the technique and $i = \{1, 2, \ldots, n\}$ indexing the farmer's characteristics. These characteristics are not all observed, but a linear relationship is postulated for the ith farmer between the utility derived from the jth technology and a vector of observed farmer's personal socio economic characteristics X_i:

$$U_{ij} = X_i\alpha_j + \varepsilon_j \quad j = 0, 1 \text{ and } i = \{1, 2, \ldots, n\}$$

The decision of the farmer is a process of two mutually exclusive alternatives: either he adopts $j = 1$ or does not $j = 0$. We assume that a farmer chooses the option that gives him the largest utility. The ith farmer will adopt the technique j if $U_{i1} \succ U_{i0}$ and the qualitative variable D_i indexes the adoption decision:

$$U_{i1} \leq U_{i0} \quad \text{then } D = 0 \quad \text{and} \quad U_{i1} \succ U_{i0} \quad \text{then } D = 1$$

$$\begin{aligned} P_r &= P_r(D_i = 1) = P_r(U_{i1} \succ U_{i0}) = P_r(X_i\alpha_1 + \varepsilon_{i1} \succ X_i\alpha_{i0} + \varepsilon_{i0}) \\ &= P_r(\varepsilon_{i1} - \varepsilon_{i0} \succ X_i\alpha_0 - X_i\alpha_1) = P_r(\varepsilon_{i1} - \varepsilon_{i0} \succ X_i(\alpha_0 - \alpha_1)) \\ &= P_r(\mu_i \succ X_i\beta) = F(X_i\beta) \end{aligned}$$

where $\mu_i = (\varepsilon_{i1} - \varepsilon_{i0})$ and $F(X_i\beta)$ is the cumulative density function for μ_i. Thus, the probability of the ith farmer to adopt the new technology is the probability that the utility of the new technology is larger than the utility of the old one or the cumulative distribution F evaluated at $X_i\beta$. If μ_i is normal, then F is the cumulative normal density function corresponding to the Probit model which is similar to the Logit model (Amemiya, 1981).

4.3. Empirical model specification

4.3.1. Model specification

The empirical definition of the farm specific variables that are expected to determine the probability of adopting zaï and stone strips are

$$P_i = P_r(D_{ii} = 1) = F\left(\beta_0 + \sum_{j=1}^{10}\beta_j X_{ij}\right)$$

where adoption is a dummy and the dependent variable indicating the decision to adopt or not the technology. The βs are the coefficients of the independent variables X_i (Tables 1 and 2 give the definition and summary statistics of the variables) indicating the influence of these variables on the likelihood of adoption. Hence, if the estimated coefficients for these

Table 1
Definition of variables used in the Probit model of farm-level adoption of soil and water conservation methods in northern Burkina Faso

Symbols in the equation	Variable name	Description	Type of variable
D	Adoption	Dependent variable: adoption of conservation practice	Dummy, 1 if adoption, 0 otherwise
X_1	Age	Age of the farmer	Continuous variable
X_2	Education	Number of years attended at school by the farmer	Continuous variable
X_3	Training	Farmer's training in soil conservation practice	Dummy, 1 if trained, 0 otherwise
X_4	Membership in farm's organization	Membership in farmer's organization of the head of farm	Dummy, 1 if registered, 0 otherwise
X_5	Perception	Farmer's perception of the phenomenon of degradation	Dummy, 1 if the farm has a perception 0 otherwise
X_6	Number of workers	Number of farm workers	Continuous variable
X_7	Area cultivated	Total area of land exploited	Continuous variable
X_8	Agricultural equipment	Value of the agricultural equipment in USD	Continuous variable
X_9	Number of cattle	Number of head of cattle	Continuous variable
X_{10}	Number of small ruminants	Number of head of small ruminants	Continuous variable

variables are positive and significant, we can infer that farmers with a higher value for these variables are more likely to adopt conservation practices.

4.3.2. Expected effects of the variables

In this section, we discuss the expected effects of the variables used in the Probit model of farm level adoption. These expected effects are summarized in Table 3. According to the theory of human capital, young heads of household have a greater chance of being taught new knowledge and, hence, are better prepared for the adoption of technological innovations. Hence, we would expect a negative relationship between age and the adoption of soil conservation practices.

Table 2
Summary statistics of variables used in Probit model of farm-level adoption of soil and water conservation methods in northern Burkina Faso

Variable	N	Minimum	Maximum	Mean	Standard deviation
Adoption of zaï	230	0	1	0.617	0.487
Adoption of stone strips	230	0	1	0.648	0.479
Age	230	4	85	53.487	12.999
Education	229	0	5	0.257	0.793
Training	230	0	1	0.209	0.407
Membership in farmer's organization	230	0	1	0.578	0.495
Perception	229	0	1	0.122	0.328
Number of workers	230	1	13	4.617	2.170
Area cultivated	230	0.5	14	3.297	1.782
Agricultural equipment (USD)	230	0	642	91.768	119.786
Number of cattle	230	0	32	1.470	3.648
Number of small ruminants	230	0	43	11.335	9.886

Table 3
Expected relationship between variables used and the adoption of soil and water conservation methods

Variables	Adoption of zaï	Adoption of stone strips
Human capital		
Age	Negative	Negative
Education	Positive	Positive
Training	Positive	Positive
Membership in farmer's organization	Positive	Positive
Perception	Positive	Positive
Family size		
Number of workers	Negative	Positive
Area cultivated	Negative	Positive
Agricultural equipment	No	Positive
Livestock		
Number of cattle	Positive	Positive
Number of small ruminants	Positive	Positive

In most adoption studies, it has been shown that new technological practices are positively related to education (Ram, 1976; Tassew, 2004; Schultz, 1981). Hence, we would expect a positive relationship between education and the use of both soil conservation practices, zaï and stones strips. Training is similar to education and we would also expect a positive relationship in this case.

In rural areas, there is at least one farmer's organization through which farmers benefited from many kind of support such as access to credit and training from government institutions and NGOs. A farmer is member if he is registered and pays membership fees. Hence, being a member in a farmer's organization should increase the likelihood of the adoption of zaï and stones strip. Perception of soil degradation is also likely to be a determining variable for the adoption zaï and stones strip, as farmers are aware of the negative consequences of soil degradation on poverty and food security. Research findings, for example, from Negatu and Parikh (1999) and Batz et al. (1999) confirm the influence of the perception of technology's characteristics on the adoption process. Shiferaw and Holden (1998) indicate, that theoretically, the perception of soil erosion and its negative impact on yield helps to increase the probability of adopting soil conservation methods. To measure this variable, farmers were asked in a closed-ended questionnaire to estimate the present soil degradation compared to the past level and to assess how it will be in the future and the probable consequences if nothing is done.

According to Feder et al. (1985), farm size is one of the first factors on which empirical studies focus. They indicate that farm size can have different effects on the probability of adoption, depending on the characteristics of the technology and the institutional setting. Biswanger (1978) found, for example, a strong relationship between farm size and the adoption of the tractor in South Asia while Doss et al. (2003) did not find a clear one with the use of improved varieties.

The size of the area cultivated is likely to be negatively correlated with zaï and positively correlated with stone strips. The reason is that both techniques require manure, but zaï needs much larger amounts and it is difficult to find enough to treat larger areas.

Livestock produce manure and the higher the number of livestock is, the more soil conservation practices can and should be adopted.

To carry out zaï and stone strips the equipment needed are for digging and transportation. For zaï, in practice, the digging is done with a short handled hoe. To transport the manure, most of farmers carry it on their heads or borrow a cart from those who have one. This would lead us to expect no relationship between the possession of agricultural equipment and the adoption of zaï. In the case of stone strips, the stones need to be transported and this makes it necessary for the farmer to have the means of transport, hence making transport a critical determinant of the adoption of this technique. However, in practice, stones are always transported collectively and more often with vehicles that are not the property of farmers. These may be put at the farmers' disposal in certain circumstances by for example NGOs, projects or other monitoring and support services. Results may also vary because of ploughing equipment. The stone strips technique requires that the land area to be treated is large, enough to realize advantages of scale. The larger the area land to be treated is, the lesser the suitability agricultural tools like the short handled hoe, locally known as a ‘‘daba‘‘, and therefore the greater the need for more adaptable equipment. Thus, we would expect a positive relationship between agricultural equipment and the adoption of stone strips.

5. Results

In this section, we discuss the validity of the model before presenting the empirical results.

5.1. Model selection and adequacy

The statistical analysis used is binary regression of SPSS 12.0. We used two automated variable selection, a backward and a forward method. They consist of adding or removing step by step from the model, the predictors that contribute the least or the most, until all the predictors in the model are significant. If both methods choose the same variable, one can be fairly confident that the model is well specified. The same variables were chosen by both methods for the zaï and stone strips. The results are displayed in Table 4.

The Hosmer–Lemeshow statistic is used to estimate the goodness-of-fit model. It is known as one of the most reliable tests of model fit for binary regression because it aggregates the observations into groups of similar cases. A P-value value less than 0.05 indicates a poor fit for the model. Our model adequately fits the data because the significant P-values are 0.13 and 0.20 for zaï and stones strip, respectively.

5.2. Empirical results discussion

5.2.1. Variables not in the equation

The variables age, number of workers, membership of farmer's organisation and number of cattle were removed from both the models for the zaï and stone strips by the

Table 4
Probit model regression results of farm-level adoption of soil and water conservation methods in northern Burkina Faso

Variable	Adoption zaï			Adoption stone strips		
	B	S.E.	Exp (*B*)	*B*	S.E.	Exp (*B*)
Constant	−0.924*	0.254	0.397	−1.426*	0.42	0.240
Human capital						
Age	–	–				
Level of education	0.777**	0.403	2.175			
Training	1.709*	0.6	5.523	1.312***	0.571	3.715
Membership of farmer's organization				0.484**	0.317	1.622
Perception	2.912*	1.059	18.402			
Size of the farm						
Number of workers	–	–	–	–	–	–
Area cultivated	–	–	–	0.357***	0.15	1.429
Agricultural equipment	0.000***	0.000	1.000	–	–	–
Livestock						
Number of small ruminants	0.128*	0.028	1.137	0.054***	0.024	1.055
Number of cattle	–	–	–	–	–	–
Hosmer and Lemeshow test[a]		0.133			0.204	
Pseudo R-squared		0.405			0.277	
Prediction statistics		76.3			74.6	

[a] A poor fitness if the significant value is less than 0.05.
* 1% level of significance.
** 10% level of significance.
*** 5% level of significance.

automated method. These results are not consistent with our hypothesis as we were expecting a positive (except age) relationship between these variables and adoption of zaï and stone strips. The results for age variable and the number of cattle, suggest that the adoption of soil conservation methods is neither a matter of age, nor wealth, as wealth in a rural area can be expressed in terms of the number of cattle held.

5.2.2. Variables in the equation

The variables accepted by the zaï adoption model are education, training, perception, agricultural equipment and number of small ruminants, while those included in the adoption of stone strips are only the size of the area cultivated, training, number of small ruminants and membership of a farmer's organisation.

5.2.2.1. Education and training. The results in Table 4 show a positive relationship between the level of education and adoption of zaï. This finding is consistent with our expectation and indicates that one more year of education leads to twice the likelihood of adopting zaï. The same positive relationship is found with regard to the training for which the likelihood to adopt zaï and stone strips by a trained farmer is greatly increased compared with an untrained one.

5.2.2.2. Perception. The coefficient of the perception variable is positive and significant for zaï, but not for the adoption of stone strips adoption. These findings show that there is no relationship between the perception of soil erosion and the adoption of stone strips. Thus suggests that stone strips are build without farmers being convinced of the necessity of their use, possibly because of investments made by sponsors. However, the results show that the perception of soil erosion has a great impact on the decision to adopt zaï. A farmer who has a good perception of soil degradation is much more likely to adopt zaï than one who lacks such a perception.

5.2.2.3. Membership in a farmers' organization. The coefficient of the membership variable is positive and significant for adoption of stone strips. The results show that the likelihood that a member in a farmers' organization will adopt stone strips is greater than for a non-member. This may be explained by the numerous advantages of belonging to an association. For instance, members have easy access to training, information, inputs, credit and borrowing agricultural equipment.

5.2.2.4. Area cultivated. The results related to size of the area cultivated are consistent with our hypothesis for stone strips but not for zaï. According to this hypothesis, farmers with a larger area to cultivate would adopt stone strips while those with smaller area would adopt zaï. The reason is that zaï requires large amounts of manure and it is difficult to find sufficient quantities for a larger area. For stone strips, important investments are required such as a vehicle to transport stones which would not make it profitable when applied on small areas.

5.2.2.5. Agricultural equipment. Despite its significance, the coefficient of the equipment variable is very close to zero making it a non-determining variable for the adoption of zaï and stone strips. These results are consistent with our hypothesis for zaï but not for stone strips. This is because of the larger area involved which requires more modern equipment for ploughing. For zaï, only a short handled hoe is needed to dig the pits and manure to be transported is, in practice, carried on the head or with a cart borrowed from neighbours. Thus, the need for agricultural equipment is not essential, justifying the null coefficient.

5.2.2.6. Livestock. Livestock includes number of small ruminants and cattle. In contrast with our hypothesis, there is no significant relationship between the number of cattle and the adoption of either zaï or stone strips. However, the number of small ruminant was significant for both of these soil conservation practices. The results denote a small impact on the adoption of the two soil conservation methods. Holding one additional small ruminant is expected to slightly increase the likelihood of the adoption of both zaï and stone strips.

6. Conclusion and implications

The analysis of adoption of soil conservation practices leads to the following results. The age, number of workers and number of cattle variables for which we were expecting positive relationship (except on the case of age) with the adoption of soil conservation practices turned out to be not significant and were therefore not included in the models. Variables such as training and the number of small ruminants were positively related to both of zaï and stone strips and were thus consistent with our prediction.

The coefficients of perception and agricultural equipment are only significant in the case of the adoption of zaï. However, possessing agricultural equipment does not have any effect on the adoption of zaï because of its null coefficient. In contrast, perception has a great impact on its adoption.

The size of the area cultivated and member of a farmer's organisation are the variables which influence the adoption of stone strips.

From these findings the main conclusions are as follows:

1. Because there is no relationship between age, agricultural equipment and number of cattle, one can conclude that soil conservation practices are not a matter of increasing age or wealth (symbolized by possessing modern agricultural equipment and cattle).
2. Because training and small ruminants are positively correlated with both of the soil conservation practices, training and manure (symbolized by the small ruminant) are crucial for the adoption of both zaï and stone strips.
3. A non-significance relationship between perception and the adoption of stone strips indicates that stone strips are build without the farmers being convinced of their benefits. The decision to build stone strips is more dependant on support services than on the individual's socio-economics characteristics.

All these results suggest two main recommendations for the attention of the Governments and support services (NGOs and other projects) involved in rural development: (a) support services should work closely with farmers and make sure that they are convinced of benefit of the activities to be undertaken; (b) farmers should be encouraged to join associations through which training and help with access to livestock can be provided. In particular this help can be done through the facilitation of access to small credit.

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