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Restoration of degraded lands and forest landscapes in the Sahel: The case of Tominian District, San Region, Mali

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Abstract
In the Tominian district of south-eastern Mali, the degradation of land and woody cover is undermining a rural economy that depends almost entirely on rain-fed farming. This study examines the experience of the NGO Sahel-Eco, which has for several years been promoting soil and water conservation techniques, farmer-managed natural regeneration and tree planting there through the "Regreening Africa" project. A mixed-methods design was used: a questionnaire administered to 120 members of 21 farmer organisations across 12 villages, supplemented by semi-structured interviews with ten key informants (administration, elected officials, customary authorities and technical services). Awareness of the problem is almost universal (93.33%), and every respondent acknowledged its harmful effects. Shifting cultivation and chemical inputs (35%) and excessive wood cutting (25%) are seen as the main drivers. Sahel-Eco is known to 74.17% of respondents, and 95% consider its techniques useful. Yet actual practice is dominated by the least demanding options, tree planting (60.83%) and fallowing (23.33%), while stone bunds, zaï pits and half-moons, frequently mentioned by local actors, are far less widespread. Access to land, the limited involvement of women and reliance on the NGO's technical support emerge as the main barriers to wider uptake.

Keywords: Land restoration, soil and water conservation, farmer-managed natural regeneration, Sahel-Eco, Tominian

Introduction

Land degradation is today among the environmental problems with the most serious consequences for rural societies. At the global scale, IPBES (2018) [8] estimates that more than 75% of the Earth's land surface has been substantially altered and that the well-being of some 3.2 billion people is directly affected. Nkonya *et al.* (2016) [11], for their part, estimate that nearly 30% of land has experienced a decline in productivity over the past three decades. The costs of this degradation, long underestimated, are now measured in points of gross domestic product (ELD Initiative, 2015) [3], and they weigh most heavily on countries whose economies rely on rain-fed agriculture.

The Sahel offers a particularly clear illustration. The combination of recurrent droughts, sustained population growth and the expansion of cultivated land at the expense of woody vegetation has led, since the 1970s, to rapid soil impoverishment and increased erosion. Mali has acknowledged this situation by committing to the land degradation neutrality target promoted by the United Nations Convention to Combat Desertification, with national targets set for 2030 (UNCCD/SP-NDT Mali, 2020) [18]. This commitment forms part of a broader continental framework, the Great Green Wall Initiative (African Union, 2007) [1], and is put into practice on the ground through programmes run by non-governmental organisations alongside technical services and local authorities, such as the "Regreening Africa" programme (Regreening Africa, 2022) [12].

Several Sahelian experiences have shown that this trend is not irreversible. In Niger and Burkina Faso, the spread of farmer-managed natural regeneration and of improved traditional techniques such as zaï pits and stone bunds has regreened millions of hectares and substantially improved cereal yields (Kaboré and Reij, 2004; Reij *et al.*, 2009; Sendzimir *et al.*, 2011) [9, 13, 16]. These successes, however, owe less to the intrinsic performance of the techniques than to the social conditions of their adoption: land tenure security, producer organisation, close support in the field and the perception of a rapid benefit (Botoni and Reij, 2009; ETFRN, 2021) [2, 4, 13].

In the Tominian cercle (district), San region, these issues are particularly acute. An agro-sylvo-pastoral area, the district suffers from erratic rainfall, a shortening rainy season and strong demand for farmland and fuelwood (Tominian Commune, 2020) [17]. The NGO Sahel-Eco has been working there for several years through the "Regreening Africa" project, promoting soil and water conservation and soil defence and restoration techniques (SWC/SDR), farmer-managed natural regeneration (FMNR) and tree planting (Sahel-Eco, 2022) [15]. While institutional reports regularly highlight the results of such interventions, these are rarely subjected to an independent analysis that gives a voice to the beneficiaries themselves.

This article seeks to help fill this gap. It addresses the following question: to what extent does Sahel-Eco's experience contribute to the restoration of degraded lands and forest landscapes in Tominian district? More specifically, it aims (i) to assess local people's level of awareness of land degradation and of the NGO's intervention, (ii) to identify the restoration techniques promoted and actually practised, and (iii) to analyse the factors that encourage or hinder their adoption. Four hypotheses guide the analysis: local awareness of the phenomenon is still limited (H1); the techniques promoted are diverse but unevenly applied (H2); their adoption depends on socio-economic, land tenure and organisational

factors (H3); and the intervention produces positive effects that are nonetheless limited by persistent constraints (H4).

Materials and methods

1. Study area

Tominian district lies in south-eastern Mali, in the San region, about 500 km from Bamako (Figure 1). It comprises twelve communes and 317 villages. The climate is Sudano-Sahelian, with a cool dry season, a hot dry season and a short, often deficient rainy season. The terrain is flat, soils are predominantly sandy, clayey and lateritic, and the vegetation, dominated by shrub savanna with shea, néré, baobab, balanzan and tamarind trees, has been heavily thinned by drought, erosion and wood cutting.

The population, predominantly Bwa, lives mainly from rain-fed agriculture (millet, sorghum, fonio, groundnut, sesame, cowpea) and from small-scale livestock rearing, which is struggling for lack of pasture. Natural population growth exceeds 3% per year, increasing pressure on cropland and wooded areas. Schooling, long marginal, only expanded from the 1990s onwards, notably thanks to community schools.



Source: GADM, adapted by Touré, 2026

Fig 1: Location of Tominian district in the San region

2. Sampling and survey population

The survey covered the communities targeted by the "Regreening Africa" project. In each of the twelve selected villages, one or more farmer organisations partnering with Sahel-Eco (women's groups, youth associations, cooperatives) were selected, giving a total of 21 organisations. Five to six members were then randomly drawn from each organisation, yielding a sample of 120 respondents (Table 1). This quantitative component was supplemented by a purposive sample of ten key informants, two per category: administration (prefect, sub-prefect), customary authorities, elected municipal officials, technical services and project managers.

Table 1: Distribution of the sample by commune

Commune	Villages surveyed	Organisations	Respondents
Bénéna	Dobwo, Sèguèkuy, Sounèni	10	56
Yasso	Lorokuy, Yasso	4	24
Tominian	Kagnan, Hanékuy, Safienso, Minso	4	24
Mandiakuy	Mandiakuy, Komina	2	11
Dâh (San district)	Dâh	1	5
Total	12 villages	21	120

Source: field survey, 2024

3. Data collection

Two instruments were used. A questionnaire, consisting mostly of closed questions, was administered individually to organisation members. It covered respondents' profiles, their perception of land degradation (existence, causes, consequences), their knowledge of control measures, their involvement in restoration activities and their assessment of Sahel-Eco's intervention. A semi-structured interview guide, organised around the same themes but leaving ample room for open questions, was used with the key informants. Focus groups were also held with some groups, and direct observations were carried out on treated plots to document SWC/SDR structures, tree-planting sites and compost pits.

4. Data processing and analysis

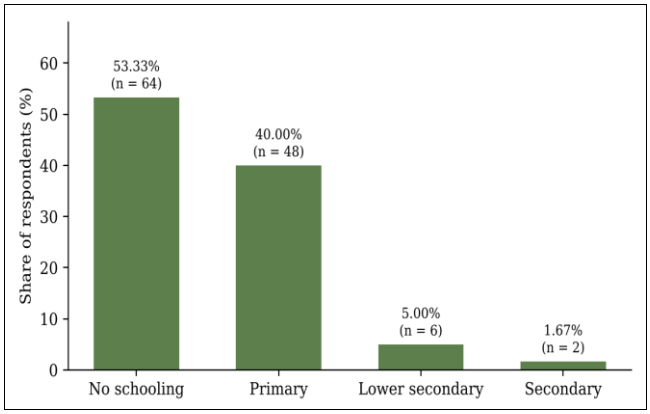
Quantitative data were entered and processed in Excel, then analysed using descriptive statistics (counts and frequencies). Interviews were transcribed and subjected to

thematic content analysis in order to bring out recurring categories of discourse on the causes of degradation, the techniques known and the conditions for their adoption.
Cross-referencing the two sources made it possible to compare what organisation members reported practising with the way institutional actors interpreted it. Data collection took place in a tense security context, which at times limited access to certain households and officials.

Results

1. Respondent profile

The sample is overwhelmingly male: 98 men (81.67%) and 22 women (18.33%). This imbalance reflects the land tenure structure of the area, where land is held and managed by men, who are the heads of farms and the usual counterparts of agricultural projects. Educational attainment is low (Figure 2): more than half of the respondents have never attended school (53.33%) and 40% stopped at primary level. Only 6.67% reached lower secondary (fondamental) or secondary level.



Source: field survey, 2024

Fig 2: Respondents' level of education (n = 120)

2. Perceptions of land degradation

Land and forest landscape degradation is a phenomenon clearly recognised by local people. Of the 120 people interviewed, 112 (93.33%) said they were aware of it, and all of them considered that it has harmful effects on their lives and activities (Table 2).

Table 2: Perceptions of land degradation and respondents' involvement

Question	Yes (n)	Yes (%)	No (n)	No (%)
Awareness of land degradation	112	93.33	8	6.67
Recognition of its negative effects	120	100	0	0
Knowledge of control measures	120	100	0	0
Involvement in control efforts	120	100	0	0
Usefulness of the techniques promoted by the NGO	114	95.00	6	5.00

Source: field survey, 2024

Asked about the main cause of degradation, respondents pointed first to farming practices (Table 3). Shifting cultivation combined with the use of chemical fertilisers and pesticides ranks first (35%), ahead of excessive wood cutting (25%), water and wind erosion (20%) and bushfires (15%). Only 5% were unable to identify a cause.

Table 3: Main cause of land degradation cited by respondents

Cause cited	Count	Percentage (%)
Shifting cultivation and chemical inputs	42	35.00
Excessive wood cutting	30	25.00
Erosion	24	20.00
Bushfires	18	15.00
No specific answer	6	5.00
Total	120	100

Source: field survey, 2024

The consequences highlighted are primarily food-related (Table 4). For 67.50% of respondents, degradation results first and foremost in food insecurity, owing to falling yields. This is followed by the decline of plant and animal species (19.17%) and decreasing rainfall (13.33%), the latter reflecting a local interpretation that links the disappearance of trees to that of rainfall.

Table 4: Main consequence of land degradation according to respondents

Consequence cited	Count	Percentage (%)
Food insecurity	81	67.50
Decline of plant and animal species	23	19.17
Decrease in rainfall	16	13.33
Total	120	100

Source: field survey, 2024

3. Known control measures and techniques practised

All respondents stated that they knew at least one way of combating degradation and said they were involved in this effort, either individually or through their organisation. When asked which measure they considered most effective for restoring soils, they placed fallowing far ahead (58.33%), followed by composting (30%). A minority (11.67%) ranked the creation of non-farm jobs first, arguing that pressure on land and wood will only ease if young people have other sources of income (Table 5).

Table 5: Control measure considered most effective by respondents

Measure cited	Count	Percentage (%)
Fallowing	70	58.33
Composting	36	30.00
Job creation	14	11.67
Total	120	100

Source: field survey, 2024

The practices actually implemented to restore vegetation cover show a different profile (Table 6). Tree planting is by far the most widely practised technique (60.83%). It relies on private nursery operators and on collective planting days, during which holes are dug with an auger. Fallowing comes second (23.33%), well ahead of abandoning chemical products (15.83%).

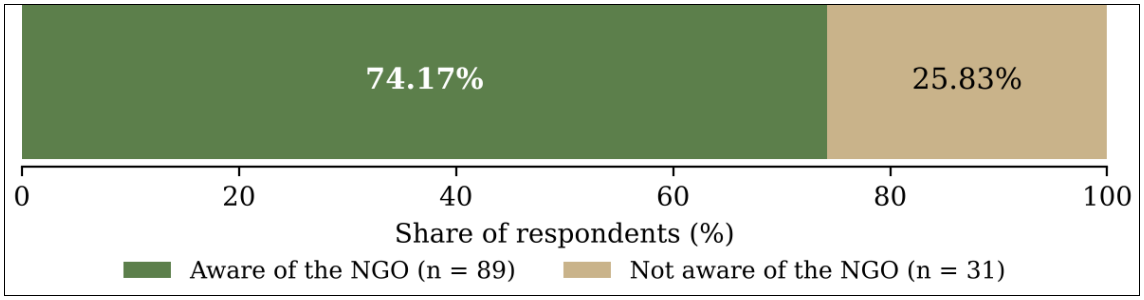
Table 6: Main technique practised to restore vegetation cover

Technique practised	Count	Percentage (%)
Tree planting	73	60.83
Fallowing	28	23.33
Abandoning chemical products	19	15.83
Total	120	100

Source: field survey, 2024.

4. Awareness and assessment of Sahel-Eco's intervention

Sahel-Eco is known to 89 respondents, or 74.17% of the sample (Figure 3). The remaining quarter, although members of the project's partner organisations, did not identify it by name. By contrast, the techniques promoted are viewed very favourably: 95% of respondents consider that they effectively contribute to restoring land, particularly because they help retain moisture, add organic matter and encourage the natural regrowth of woody plants.



Source: field survey, 2024

Fig 3: Respondents' awareness of the NGO Sahel-Eco (n = 120)

Field observations confirm the presence, in several villages, of SWC/SDR structures built with the NGO's support: lines of stone bunds following the contours, plots prepared with zaï pits, and compost heaps placed in the fields at the start of the rainy season (Figure 4). Their presence in the fields, however, contrasts with the modest place they occupy in the practices reported by respondents (Table 6).



Source: field photographs, 2024

Fig 4: SWC/SDR techniques observed in the study area: stone bunds (a), zaï pits (b) and compost heaps (c)

5. The perspective of key informants

Interviews with elected officials, customary authorities and technical staff complement these findings on three points. The first concerns the explanation of degradation. Interviewees offer a broader interpretation than that of farmers, combining climatic factors and human practices. One elected official thus lists "the lack of trees, runoff, soil impoverishment, the shortage of arable land, strong winds, excessive wood cutting, *Striga* invading the fields, overgrazing and the use of chemical inputs". Another stresses "the poor management of woodland and land by the authorities and communities".

The second point concerns techniques. Key informants spontaneously cite a much wider range than farmers do: tree planting, FMNR, stone bunds, zaï, half-moons, small earth bunds, composting, biopesticides and improved fallowing. They consider these techniques effective and often long known in traditional forms, such as mulching with millet stalks. One official sums up the issue as follows: "given the effects of chemical fertilisers and pesticides on soil impoverishment, green manures and biopesticides must be used to ensure sustainable production".

The third point concerns the role of the NGO. For elected officials, Sahel-Eco's involvement is first and foremost a source of information, training and mobilisation. Techniques are disseminated through awareness sessions, village outreach activities, workshops, radio broadcasts and public feedback meetings at the town hall, as well as through district-level consultation frameworks on natural resource management. Finally, interviewees consider that most communities now apply these methods, while calling for stricter enforcement of the rules against excessive tree cutting and for the channelling of runoff.

Discussion

1. Acute awareness of the problem

The first lesson of the study contradicts hypothesis H1. Far from being limited, awareness of land degradation is almost universal among respondents, all of whom perceive its effects. This finding is consistent with other Sahelian studies, in which farmers describe precisely the impoverishment of their soils and the disappearance of trees, sometimes well before scientific measurements document them (Reij *et al*., 2009) [13]. This result should nevertheless be qualified. All respondents are members of the project's partner organisations and have therefore been exposed to awareness sessions; their level of awareness is probably not representative of all households in the district. Moreover, the question asked concerned the recognition of a phenomenon, not an understanding of its mechanisms. The fact that 13.33% of respondents cite declining rainfall as a consequence of degradation shows that local interpretations closely associate vegetation cover with climate, which in fact provides a lever for mobilising people around tree-planting efforts.

The causes identified by farmers converge with those reported in the literature. IPBES (2018) [8] ranks agricultural expansion and the overexploitation of woody resources among the main drivers of degradation worldwide, and FAO (2016) attributes the vast majority of deforestation in tropical countries to agriculture. The rejection of chemical inputs, cited by more than a third of respondents, should nonetheless be interpreted with caution. In the absence of soil measurements, this perception probably reflects, at least in part, the awareness-raising discourse on organic farming and compost widely relayed by the project.

2. A gap between valued and practised techniques

The second lesson confirms hypothesis H2. The techniques promoted by Sahel-Eco are diverse and well known to local actors, but the practices reported by farmers are concentrated on two options: tree planting and fallowing.

The most agronomically effective SWC/SDR structures, such as zaï pits, stone bunds and half-moons, appear only marginally in the questionnaire responses, even though they occupy a central place in the discourse of key informants and in field observations.

This gap is explained first by the labour cost of these techniques. Zaï requires several thousand planting pits per hectare to be dug by hand during the dry season, and stone bunds involve collecting and transporting large quantities of stones (Roose, 1994; Kaboré and Reij, 2004) [9, 14]. For poorly equipped family farms, such an investment is only conceivable if the yield gain is rapid and visible, or if outside support reduces its cost. Tree planting, by contrast, benefits from collective organisation (nurseries, planting days), which reduces the individual burden and gives it high social visibility. Fallowing, finally, is a long-standing practice that farmers value but find increasingly difficult to apply for lack of available land. That 58.33% of respondents consider it the most effective measure, while only 23.33% actually practise it, clearly illustrates this tension between agronomic knowledge and land constraints.

This mismatch is not specific to Tominian. Reviews of the adoption of conservation practices show that no single factor can explain farmers' choices and that adoption depends on a combination of local constraints (Knowler and Bradshaw, 2007) [10]. In Burkina Faso, the spontaneous spread of improved zaï was rapid only where farmers had seen its effect on yields for themselves and where local innovators demonstrated it (Kaboré and Reij, 2004) [9].

3. The social conditions of adoption

The third lesson concerns the factors of adoption (H3). The data collected do not allow these determinants to be tested statistically, since the analysis remained descriptive. Nevertheless, the qualitative results and the very structure of the sample point to three factors.

The first is access to land. The strong predominance of men among the members surveyed reflects men's control over land. Yet SWC/SDR techniques and agroforestry are medium-term investments that only make sense if the farmer is assured of keeping the plot. Women and young people who do not own land therefore have structurally less incentive to adopt them, even though women carry out a large share of farm work (FAO, 2011). ETFRN (2021) [4] stresses that securing land tenure is, in Africa's drylands, one of the most decisive conditions for the success of restoration projects.

The second factor is human capital. With more than half of the respondents having never attended school, the uptake of techniques relies almost entirely on practical demonstration and field support. This explains the central role of the NGO's field facilitators and of the consultation frameworks, but also the fragility of the arrangement. The fact that a quarter of the members of partner organisations do not know Sahel-Eco by name shows that information circulates unevenly even within the groups themselves.

The third factor is organisational. The groups act as relays for awareness-raising, seedling production and the organisation of collective work. Their dynamism therefore largely determines the spread of the techniques. The experience of Niger showed that FMNR only spread on a large scale once communities had made it a collective rule, backed by a clarification of rights over trees (Sendzimir *et al*., 2011) [16]. In Tominian, this shift from individual adoption supervised by the project to an autonomous collective norm does not yet appear to have taken place.

4. Real but fragile gains

Hypothesis H4 is partially confirmed. The very positive assessment of the techniques promoted (95%) and the discourse of key informants point to perceived effects on soil moisture, fertility and the regrowth of woody plants. These results are in line with the conclusions of the Bamako workshop (Regreening Africa, 2022) [12], which stressed the value of inclusive, evidence-based approaches for accelerating land restoration in Mali. They nonetheless remain perceptions: the study measured neither changes in yields, nor changes in vegetation cover, nor the survival of planted seedlings. Yet the survival of planted trees is often low in the Sahel in the absence of follow-up, and it is generally natural regeneration protected by farmers that produces the most lasting gains in tree cover (Garrity *et al*., 2010; Reij *et al*., 2009) [7, 13].

The sustainability of these gains is also threatened by structural pressures that the project cannot counter on its own. Population growth, which shortens fallow periods, continued wood cutting and bushfires, overgrazing and climate variability continue to weigh on restored land. In this context, land restoration appears to be a necessary but insufficient lever for ensuring household food security. It would benefit from being embedded in climate-smart agriculture strategies that combine fertility management, adapted varieties and income diversification (Zougmoré *et al*., 2014) [19], as is also suggested by the 11.67% of respondents who rank job creation as the leading solution.

Finally, this study has limitations that should be emphasised. The sample, restricted to members of partner organisations, introduces a bias in favour of the intervention being evaluated. Single-response questions may have masked the combination of several practices by the same farmer. The absence of biophysical data and of a control group makes it impossible to attribute the observed changes formally to the project. These limitations open the way for further work based on field measurements and on a comparison between beneficiary and non-beneficiary villages.

Conclusion

This study examined the experience of the NGO Sahel-Eco in restoring degraded lands and forest landscapes in Tominian district, based on a survey of 120 members of farmer organisations and ten key informants. It shows that land degradation is a problem clearly recognised by local people, who attribute it to their own farming practices as much as to wood cutting and erosion. The NGO enjoys a very favourable image, and the techniques it promotes are considered useful by almost all respondents.

The transition from knowledge to practice nevertheless remains incomplete. Farmers favour the options that are least labour-intensive and best supported collectively, such as tree planting, while the most effective SWC/SDR structures remain concentrated on a limited number of farms. Access to land, the limited role of women, the level of education and dependence on the NGO's technical support are the main barriers.

Several directions emerge for consolidating these gains. FMNR should be made a priority, given its low cost and durability, and accompanied by local agreements on tree use

and fire control. The cost of SWC/SDR structures should also be reduced through collective work and support for transporting materials, and women and young people should be explicitly targeted through mechanisms that secure their access to land, in conjunction with the land commissions. Finally, setting up a system for monitoring seedlings, vegetation cover and yields would make it possible to measure the real effects of the interventions. Further research covering other districts and incorporating biophysical measurements over several years would allow a more rigorous assessment of the contribution of these approaches to land degradation neutrality in Mali.

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