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Evaluation of the cost of sylvo-pastoral site development operations: The case of a half-moon site in the Ouallam/ Niger department

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Abstract— *In Niger in general, and in its western part in particular, natural ecosystems have been undergoing continuous degradation for decades. In response, unprecedented efforts are being made to reclaim degraded land. This article assesses the cost of creating one hectare of sylvo-pastoral land in the rural communes of Simiri and Tondikiwindi (Ouallam department, Niger). Based on interviews, the cost was assessed by identifying the players involved and the equipment used. Daily remuneration, equipment depreciation, market price and load calculations were used to establish the monetary value of the cost. The people who carry out the work in the field are essentially the beneficiaries, who provide the labour and the technical supervisors. One hectare requires 105 diggers, 2 plotters and equipment. The direct and indirect monetary costs of developing one hectare of sylvo-pastoral half-moon site are estimated at 163,555 and 116,500 CFA francs respectively. The year of implementation covers the essential costs. This work has enabled us to understand the human resources and costs involved in developing a sylvo-pastoral site.*

Keywords— ***Land reclamation, cost, sylvo-pastoral, Ouallam.***

I. INTRODUCTION

As in the Sahel, the people of Niger are essentially rural (Issoufou et *al*., 2011) and are heavily dependent on natural resources to satisfy their needs, including timber and non-timber forest products (Alio et *al*., 2022). This dependence has consequences for landscape dynamics. For several decades now, the country has been experiencing a gradual degradation of its environment. The degradation of forest resources is causing physical, chemical and biological changes to ecosystems, leading to a breakdown in the services they can potentially provide (Ay et *al*., 2020 ; Moussa et *al*., 2023).

Moreover, the factors influencing the dynamics of land degradation are numerous and complex in their interactions (Moussa et *al*., 2022). To deal with this, sustainable land management (SLM) techniques are nowadays strategies for adapting to land degradation and climate change. With this in mind, Niger has embarked on a national policy to protect and restore the environment (GIZ and KFW, 2015 ; Fourera et *al*., 2019). Since then, the State, in collaboration with technical and financial partners, has been carrying out activities to restore degraded land by implementing water and soil conservation (WSC) and soil defence and restoration (SDR) techniques, in order to rehabilitate the vocations of degraded ecosystems.

Activities such as reclaiming degraded land are being carried out in a context of strengthening people's resilience. The Ouallam department has benefited from the construction of anti-erosion works, in particular half-moons. As part of the biological treatment, woody species such as *Eucalyptus camaldulensis* have been planted (Laminou et *al*., 2020 ; Moussa et *al*., 2024). The works are generally carried out on community areas, specifically on plateaux, resulting in the existence of sylvo-pastoral sites with beneficiary populations (Moussa et *al*., 2017 ; Moussa, 2018).

Developing a site therefore requires equipment and human resources, resulting in a cost that depends on the type of work, the actors involved, including the donor, and the objectives of the intervention (GIZ, 2012 ; Hamidou, 2017). The aim of this study is to assess the cost of developing one hectare of half-moon sylvo-pastoral site (DLSP). Specifically, the aim is (i) to identify the human and technical resources mobilised for implementation and (ii) to estimate the monetary cost of creating one hectare.

II. METHODOLOGY

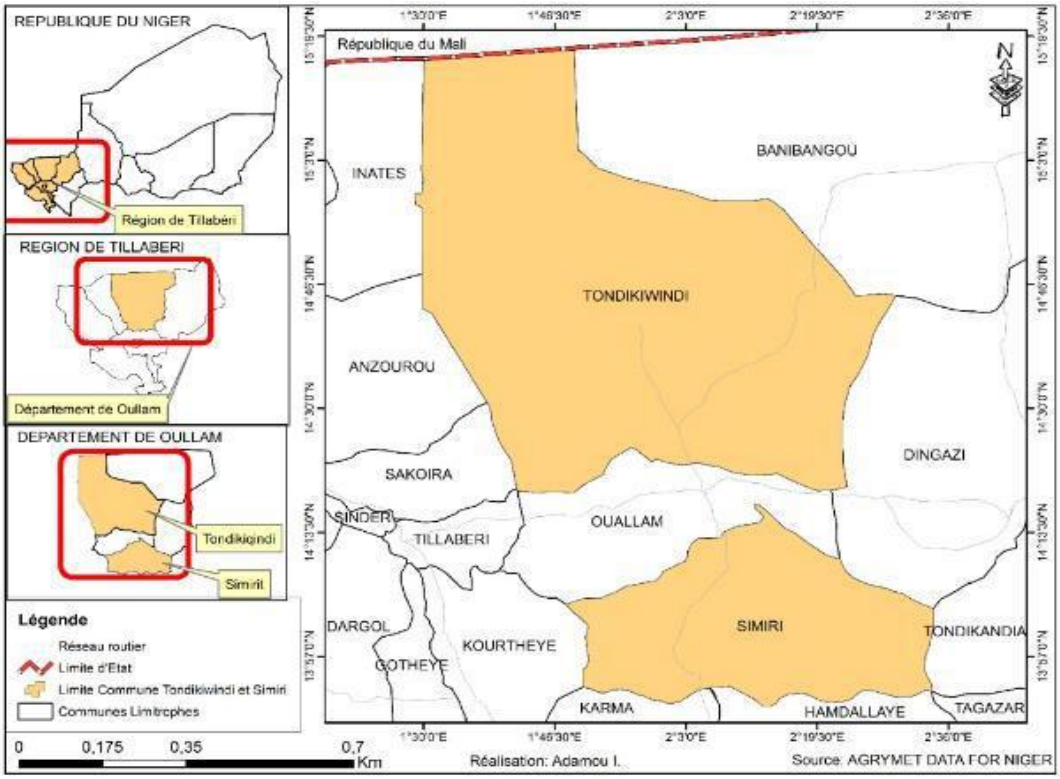

Fig. 1: Location of the communes of Simiri and Tondikiwindi

The cost evaluation was carried out using direct, semi-structured interviews with resource persons (community leaders) among the beneficiary populations, departmental government technical services, agents of the non-governmental organisation (NGO) responsible for implementing the activities and local authorities, particularly village chiefs. Table 1 shows the number of people surveyed by category.

Table 1 : Sample surveyed as part of the cost estimate

Population	**Workforce**
Resource persons	
Village chiefs	3
NGO agents	6
State technical services	3
Other resource persons	6
Beneficiary population	
Focus group	3 focus groups (around 10 people per focus group)

Source: Our surveys

Data was collected in the villages of Satara (Simiri rural district), Darey and Tondibiya (Tondikiwindi rural district). These villages were chosen because of the experience (more than a decade) of the local people in restoring degraded land for silvo-pastoral use. We also note the successes achieved, and the motivation and commitment of these communities to restoring and

preserving their natural resources. Figure 1 shows the location of the communes of Simiri and Tondikiwindi.

The main questions asked of the people surveyed concerned the types of structures built, the role of each actor involved in building the structures and the nature of the remuneration. The evaluation methods adopted to estimate the cost of construction (Table 2) relate to one hectare of sylvo-pastoral half-moons. It should be noted that there are direct and indirect costs. The evaluation focused more on the (direct) costs of building and installing the structures.

Table 2: Parameters and methods for assessing direct cost

Operations/Materials	Valuation methods
Making the work (DLSP)	
Tracing	Daily remuneration
Digging	Daily remuneration
Tailoring equipment	Depreciation and cost of equipment
Biological enhancement	
Seeding of herbaceous plants	Market price or replacement costs
Acquisition of woody plants	Production price by the NGO
Transport of plants to the site	Cost of investment by the NGO
Planting of plants	Remuneration per planted crop

Source: Authors

The various formulas used to determine expenses are as follows:

$$\mathbf{Am} = \frac{\mathbf{Pm}}{\mathbf{Dv}} \ (A) \quad ; \quad \mathbf{Rm} = \frac{\mathbf{Re}}{\mathbf{Nj}} \ (B) \quad ; \quad \mathbf{Ct} = \mathbf{Pu} \times \mathbf{Np} \ (C) \ ; \quad \mathbf{Cp} = \mathbf{Pu'} \times \mathbf{Pp} \ (D)$$

- (A): Am is depreciation, Pm is the price of the equipment and Dv is the lifetime of the equipment;
- (B): Rm is the average daily remuneration, Re is the monthly remuneration and Nj is the number of days in the month;
- (C): Ct is the cost of transport, Pu is the unit price and Np is the number of plants;
- (D): Cp is the cost of planting, Pu' is the unit price at planting and Pp is the number of plants planted.

The basic requirement (direct cost) for creating one hectare of sylvo-pastoral half-moon site is essentially made up of the cost of labour, the materials used to create the half-moon and the biological treatment (Table 3). The standard norm for creating a half-moon per hectare was 313 structures (PAC, 2006). Each beneficiary is required to dig three structures per working day. It therefore takes 105 people to dig one hectare of half-moon in one working day. In practice, the beneficiary population is organised into several teams (e.g. 20 people per team).

Table 3: Requirements for creating a hectare of sylvo-pastoral half-moon site

Headings	Quantities/ha
Number of DL/hectare	313
Plotters	2 men/day
Diggers	105 men/day
Equipment (Compass, pick and shovel, etc.)	1 kit
Herbaceous seed	25 kg
Number of plants	313

Source: Our surveys

Indirect costs have been estimated on an indicative basis, as donors and stakeholders have different rates of reimbursement (a day's mission may be paid at 15,000, 25,000 or 40,000 CFA francs, depending on the organisation).

III. RESULTS

3.1. Stakeholders involved in site development

Several stakeholders are involved in site development. They are interdependent and the role of each is decisive (Table 4).

Table 4: Actors involved in the management of sylvo-pastoral sites on the plateaux

Acteurs	Roles
Beneficiary population	It provides manpower and carries out field activities under the supervision of the implementing NGO.
Implementing NGO	It is responsible for managing all the activities of the project as a whole, under the supervision of the funding body.
State technical services	They are involved in supervising and monitoring.
Funding provider	He is the authorising officer, the instructor and the project manager.

Improving the well-being of the beneficiaries is at the heart of the concerns of all these players. The cost of implementation is therefore estimated on the basis of the activities carried out by those working in the field, who are essentially the beneficiaries, supervised by the NGO's technicians. The emphasis is therefore mainly on the cost of physical activities (Table 5).

Table 5: Players' roles and working tools

Actors	**Tasks**	**Work equipment**
Plotters	They mark out the structure in accordance with the technical standards for construction, including the determination of the slope, the level lines and the excavation component of the structure, represented by a semi-circle for the half-moon.	- Compass, water level; - Stakes and ropes; - Boots and gloves.
Diggers	They scour the earth to obtain the bowl and form the bead.	Pickaxe, shovel and crowbar.
Framers	They supervise the work and ensure that it is carried out properly.	Control tools such as tape measures, plugs, etc.

The work (Figure 2) is carried out before the rainy season, generally between January and April. In most cases, the work is followed by the sowing of herbaceous plants on the ridge. The woody plants are planted during the rainy season (Figure 3).

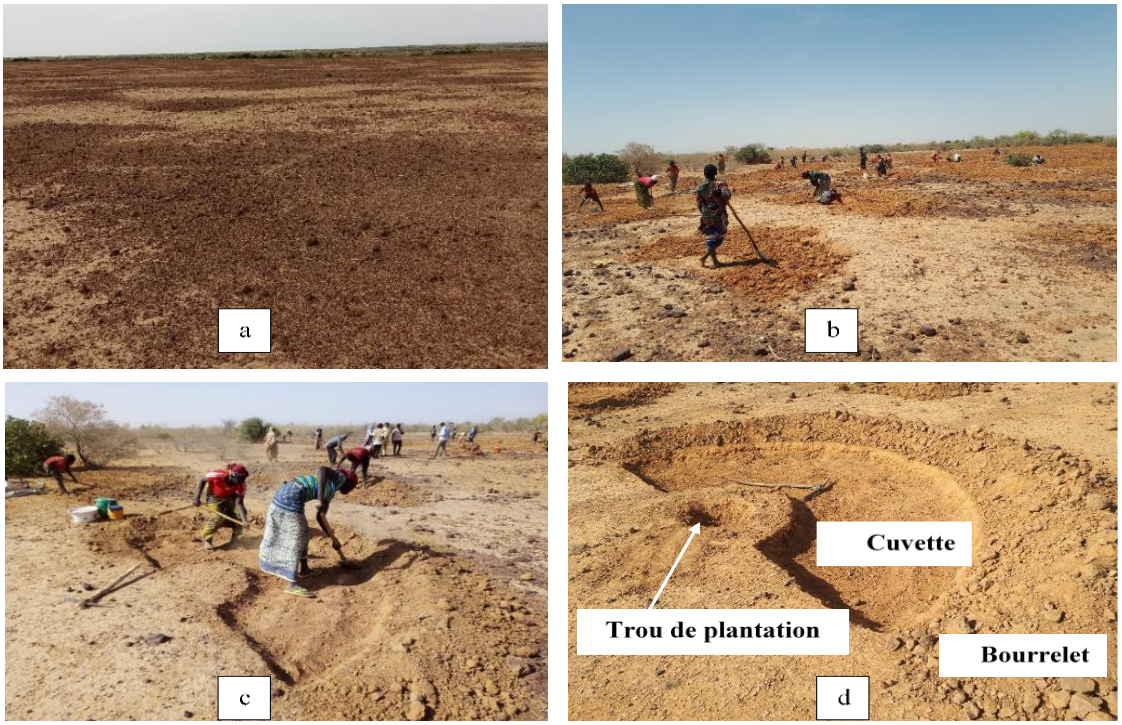

Fig. 2: Construction of the half-pipe: a: Undeveloped area; b: the first diggings following the tracing; c: construction at an advanced level and d: Ready-made half-moon

Fig. 3: Transporting seedlings for a plantation at Simiri

3.2. Monetary cost of activities

The monetary or direct cost of developing a silvo-pastoral site in its year of establishment is 163,555 CFA francs (Table 6). Most of the management work is carried out during the year of installation. The following years are devoted to site maintenance, in particular to repairing damaged structures, replanting and caretaking.

Table 6: Direct monetary cost of creating one hectare of sylvo-pastoral half-moon

Headings	Quantities	Unit amount (CFA francs)	Total amount (CFA francs)
Tracing and levelling	2 men/day	1,300	2,600
Digging	105 men/day	1,200	136,500
Depreciation of equipment	1 kit	3,500	60
Herbaceous seeding	25 kg	400	10,000
Herbaceous seeding	313 plants	25	7,825
Transport of seedlings to site	313 plants	5	1,565
Planting of seedlings	313 plants	5	1,565
Total			**163,555**

However, it should be noted that there are other charges relating to the development of degraded land. These costs vary according to the funding providers. Table 7 gives some indicative values.

Table 7: Additional costs of creating a hectare of sylvo-pastoral half-moon

Headings	Quantities	Unit amount (CFA francs)	Total amount (CFA francs)
Training for plotters and the survey team	2/day	15,000	30,000
Site foreman's duties	1/day	1,500	1,500
Host expenses	1/day	4,000	4,000
Supervisor's duties	1/day	5,000	5,000
Site caretaker expenses	1/day	1,000	1,000

Monitoring and supervision of the funding provider	3/day	15,000	45,000
Monitoring and supervision of government technical services	2/day	15,000	30,000
Total			**116,500**

The sum of the direct cost (Table 6) and the indirect cost (Table 7) gives a monetary cost per hectare of 280,055 CFA francs (163,555 + 116,500). This cost estimate is indicative, as the amounts for the various headings vary according to the donor's financial capacity, mandate and objectives.

In addition, the State of Niger, through the Ministry of the Environment and the Fight against Desertification (ME/LD), has drawn up a compendium of technical sheets on good practice in sustainable land management (SLM). Updating this compendium in 2022 has resulted in a cost per hectare for building the sylvo-pastoral half-moon (Table 8).

Table 8: Cost of producing the sylvo-pastoral half-moon per hectare of the compendium of technical sheets on good sustainable land management (SLM) practices in Niger (ME/LD, 2022)

Headings	**Unit**	**Quantities**	**Price per unit (CFA francs)**	**Amount (CFA francs)**
Labour planning and tracing	M/d	4	2,000	8,000
Labour to make the work	M/d	105	2,000	210,000
Purchase of forestry plants	Plants	313	100	31,300
Transporting plants	Plants	313	100	31,300
Small equipment kit (daba, pickaxe, shovel, compass, level, rope, etc.)	FF[1*]	1	3,500	3,500
Personal protective equipment (PPE): Boots, gloves and masks, etc.	FF[2*]	1	300	300
Herbaceous seeding (seed)	Kg	5	5,000	25,000
Spreading	M/d	1	2,000	2,000
Regarnis in 2nd year: purchase, transport and planting	M/d	104	200	20,800
Security (over 3 years)	M/y	3	20,000	60,000
Management	M/d	1	7,000	7,000
Total investment				**399,200**

NB: These costs are indicative and may vary depending on the context.

1*: This cost is calculated on the basis that a team of 60 people uses an equipment kit (daba, pickaxe, shovel, compass, water level, rope, etc.) costing 350,000 CFA francs and will be amortised over 100 ha in one year.

2*: This cost is calculated on the basis that a team of 60 people uses PPE (boots, gloves and masks, etc.) costing 30,000 CFA francs and will be amortised over 100 ha in one year.

IV. DISCUSSIONS

In practice, the population is organised into teams, the size of which depends on the number of beneficiaries in the sector. Each team has its own players (tracers, diggers and inspectors). A beneficiary household is represented at the work by a member of the household. This member could be a woman or a man, referred to as an able-bodied arm. Nevertheless, there are beneficiary households that do not take part in the physical work. These are referred to as households without able-bodied arms (HWAA). A household without an able-bodied arm is one in which none of its members is fit to take part in the physical work, but was entitled to the same rights as the households with an able-bodied arm (HAA) that carried out the fieldwork. This

consideration of disabled households is the responsibility of a donor with a humanitarian mandate. The humanitarian donor that financed the sites in this study was the World Food Programme (WFP) in collaboration with local NGOs.

The cost of creating a silvo-pastoral site includes the cost of building the structures and biological treatment (François and Souleymane, 2006). During the first years of the project, each beneficiary had to dig three structures per working day. On average, 105 people dug one hectare of half-moon. Seeds for herbaceous plants generally came from the farmers or from reclaimed sites. Woody plants for planting were also produced in village nurseries. Replanting often takes place in the first year or the following year. According to GIZ (2012), creating one hectare of forest half-moon requires a workforce of 100 people per day to mark the contour lines, draw the outline of the half-moons in staggered rows, dig the micro-basins (troughs), create the ridge, dig the planting holes, sow the ridges with herbaceous plants and plant the woody plants. GIZ (2012) estimated the quantity of plant material to be brought in at 15 kg of herbaceous seeds, 625 tree seedlings and 120 seedlings for replanting dead individuals.

In the case of this study, remuneration is generally in kind (food). This is obvious when we know that the lessor is the WFP. However, during the surveys, a few cases of cash payments were recorded, which made it possible to estimate the daily remuneration. The average daily pay for a beneficiary was 1,300 CFA francs. In their work on the socio-economic impact of the creation of sylvo-pastoral sites with half-moons and benches at Satara (Simiri commune), Moussa et *al*. (2017) reported that the production of three half-moons/day was paid at 1,300 CFA francs and planting at 25 CFA francs per plant. These results are in line with those found in the present study. On average, 104 people worked on the construction of one hectare of half-moon forest. According to Particip (2005) in GIZ and KFW (2015), the total direct unit investment cost of one hectare of forest half-moons is 147,577 CFA francs. This result is close to that of the present study, which is estimated at 163,555 CFA francs /ha in the first year (direct cost). In addition, the collection of technical sheets on good practice in sustainable land management (SLM) from the Ministry for the Environment and the Fight against Desertification (ME/LD, 2022) resulted in an indicative cost of 399,200 CFA francs. The indicative nature of the cost and the context of the intervention are at the root of the differences noted between the different costs of creating a hectare of half-moons. The financial backers do not all have the same financial capacity or mandate. For example, the World Food Programme (WFP) and a local NGO do not have the same financial capacity or mandate.

In addition, the agricultural half-moon is relatively less expensive than the sylvo-pastoral half-moon built on the plateaux. Because of the difference in soil types (between plateaux and glacis in agricultural fields), fewer able-bodied workers are needed to make the agricultural half-moon. According to GIZ (2012), 50 people a day can make a hectare of agricultural half-moon, compared with 100 to 105 people for the forest half-moon and sylvo-patorale. One person can carry out just over 6 agricultural half-moons compared with 3 forest half-moons per day. According to Jangorzo et *al*. (2019), the cost of producing one hectare of agricultural half-moon is 114,000 CFA francs, or 364 CFA francs per work.

However, it should be noted that the cost of building a site and the nature of the remuneration of the populations depended on the funding provider and the objectives targeted. In the case of a donor with a humanitarian mandate, the cost is quite high, as the population is assisted beyond their efforts. This is corroborated by the existence of households without valid arms (HWAA) who did not take part in the work, but received the same rewards as those who did. With regard to the nature of the remuneration, depending on the donor and the context, people are paid in cash (Cash For Work) or in food (Food For Asset). In the study by Hamidou (2017) on assessing the impacts of a half-moon site in Ayorou (Tillabéri-Niger), the beneficiaries of the recovery work are paid exclusively in food.

V. CONCLUSION

At the end of the assessment of the investment cost, it emerges that several players are involved in the recovery of degraded land. Each has its own role to play and uses its own means to fulfil it.

Assessing the cost is complex, as it could be estimated at several levels due to the diversity and interdependence of the players involved. The cost of creating a sylvo-pastoral site, as estimated in this study, covers both direct and indirect expenses. The latter vary according to the players involved. The cost obtained is relatively low and bearable for the donors.

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