1. Contestant profile 1. Profil du candidat

Competitor's name:	**AKOUEHOU S. Gaston**
Occupation of the candidate:	**Directeur Général du CERF**
University / Organization	**Centre d'Etudes de Recherches et de Formation Forestières (CERF)**
Number of people in your team:	**Others team members: Richard MAHOUKPO – Romaric LOKOSSOU – Roméo GBAGUIDI**

2. Project overview 2. Apercu du projet

Title:	**Project of Sustainable Restoration and Management of Ecosystems in the quarry of FONGBA**
Competition: (Research / Community)	**Research: Soil and Biodiversity Management**
Name of the quarry:	**Quarry exploitation of Fongba limestone (LOKOSSA) : CALCIM S. A BENIN**

Abstract

The "Project of Restoration and Sustainable Management of the Ecosystems in the “FONGBA" quarry mine carried out, in the context of Quarry Life Award, edition 2018, by the Center of Studies, Research and Training in Forestry (CERF). It aims at contributing to the restoration of the soil and the rehabilitation of the ecosystems of this quarry.

The methodological approach used for this purpose is developed into two axes: one related to the implementation of a research-action on soil fertilization and the other on the reforestation of the site with the help of some indigenous species or exotic. This project implementation strategy allowed us to experiment with three Integrated Soil Fertility Management (ISFM) techniques and seven selected species for the regeneration of the ecosystems of the environment.

The three ISFM techniques tested with a physical soil amendment consist of the cultivation of two fertilizer plants (Mucuna and Cajanus) and conservation agriculture with maize cultivation. The species selected and currently being tested for restoration, ecosystem rehabilitation and several other purposes are: *Senna siamea Acacia auriculiformis*, *Khaya senegalensis, Adansonia digitata*, *Terminalia superba*, *Afzelia africana* and *Milicia excelsa* (Iroko).

The analysis of the results reveals that the adoption of each ISFM technique depends on the objective set and the means available. Experienced exotic species grow faster, however, it is recommended to continue the actions with indigenous species with significant growth and soil enrichment capacity, in order to restore the microclimate that has existed there.

I. Introduction

Limestone mining activities induce land degradation that destroys the ecosystem found there. To face this situation, the company CALCIM SA, in charge of the unit of extraction and crushing of limestone of FONGBA in the region of Mono (district of Lokossa), plan not only the exploitations at the same time as the reversal of the ground, but also its restoration. In this approach, it was found that the level ground is loose but lacking all the arable land.

As part of the implementation of the Sustainable Land and Biodiversity Management Plan that underlies this extraction, the first edition of the Quarry Life Award competition is launched, at which the "Centre d'Etudes de Recherches et de Formation Forestières (CERF)" participated with the "**Project of Restoration and Sustainable Management of Ecosystems in the quarry of FONGBA**".

The overall goal of this project is to contribute to the environmental biological upgrading of the Fongba mining site, which has earned it the indispensable resource of limestone.

Specifically, it aims to:

- **Restore the fertility** of the FONGBA mine site and;
- **Rehabilitating its biodiversity** with the help of species appropriate for the reconstruction of destroyed ecosystems.

To achieve this, test actions were carried out after a participatory diagnosis which made it possible to identify certain techniques of Integrated Management of Soil Fertility and Soil Restorative Species to be tested.

The methodological approach that facilitated the conduct of the various research-actions generated by the animation session organized for this purpose, for the benefit of the representatives of the main actors is as follows.

II. Project implementation Methodology

The strategy chosen for project implementation was based on results-based management. It is declined according to the specific objectives in two axes:

2.1- First Axis of Intervention of the Project: The Reconstruction of the Arable Earth

The first line of intervention consisted in testing, applying and validating sustainable techniques of fertilization of the site prepared for the reconstitution of the arable land. The process of implementing this research-action has tested three **techniques of Integrated Management of Soil Fertility (ISFM)**. These three experienced ISFM techniques are:

- ✓ Localized organic manure per hole + Fertilizer plant: Mucuna ;
- ✓ Organic matter per hole + Fertilizer plant: *Cajanus Caja* ;
- ✓ Organic manure in rows with conservation agriculture + Maize crop.

To accelerate the replenishment of the arable land a physical amendment of the different parcels prepared to receive the tests on ISFM techniques has been planned. These organic manures are intended to facilitate the growth of species that will be planted.
To reduce costs and facilitate testing, the practice of localized organic manure has been selected as a method to test. To do it two tests are put into experimentation. This is the organic manure in pockets to receive the seedlings of fertilizing plants and organic manure lines for conservation agriculture.
All these forecasts and concerns described call for the setting up of an experimental design for the conduct of research action. Which device would be suitable for doing so?

2.1.1- Experimental design

As part of this experiment, the device used is that of **complete random blocks** which has many advantages related to its flexibility, simplicity and adaptability. This experimental set-up refers to the rules governing the distribution of treatments (ISFM techniques) to experimental plots (Gomez, 1972). This device facilitated comparisons of the different tests and controlled the main source of variation in the experiments (soil heterogeneity). In particular, it has been noted that not only the land brought to the surface during the turning and leveling operation of the soil is poor in nutrients, but also the heterogeneity of the topsoil buried in depth and concentrated in places is not homogeneous. Anything that does not facilitate the recovery of biodiversity. The portion of the mine site put into experimentation is subdivided into 3 blocks (repetitions) of 3 equal parcels in each block. The techniques of Integrated Management of Soil Fertility (mucuna-pea farm-conservation agriculture) are randomly distributed on the 9 plots that constitute the three blocks taken together. Then there is the question of why the repetition of the same ISFM technique.

2.1.2- The repetition

The repetition (replication) of each of the ISFM techniques considered, a number of times in the experiment, aims at allowing an estimation of the residual variability (Estimate of error), that is to say the variability that is not related to the techniques put in place. It is necessary in this experiment to provide a measure of the experimental error. Repetition is one of the simplest ways to increase accuracy. Indeed, as part of this experiment we have three (3) repetitions which allowed us to detect on which parcels the arable land is sorely lacking compared to the other. What does the notion of block that is also practiced in this experimental device mean?

2.1.3- The Bloc

The block (Local control) is a planned grouping of experimental units (Dagnelie, 2007). Its purpose as repetition is to increase the accuracy of the experiment. The block makes it possible to considerably reduce the heterogeneity of the soil. Hence a correct blocking should produce large differences between the blocks, leaving the parcels inside a more homogeneous block (Gomez, 1972). This observation was well made at the level of the different blocks installed on behalf of this action research.

The experiment also required a technique for the distribution of plots. The one used in this case is randomisation, which is defined in below.

2.1.4- Randomization

Randomization is a random distribution of the different treatments within the different experimental units (Dagnelie, 2007). It is Fisher's main input and provides unbiased estimates of residual variability and treatment influence (Validity of estimate). The variation observed in the positioning of each of the GIFS experiments at the block level is due to this randomization technique that has been applied.

In addition to this first methodological approach, relating to the reconstitution of the arable land marked a physical amendment of the soil and the putting into experimentation of three techniques GIFS, there was the second axis of intervention of the project devoted to tests actions on the rehabilitation ecosystems of the environment. (***see Annex in Figure 2***).

2.2- Second Axis of Intervention of the Project: the Rehabilitation of the Ecosystem

This second axis related to restoration to contribute to the rehabilitation of the biodiversity of the environment was concretized by activities such as:

i) Evaluate the ecosystem elements of the excavated and developed site; ii) Study and select the suitable species for the reconstitution of the ecosystem of the environment; iii) Develop agroforestry using selected species.

To achieve this, specialists, CERF- certified seed, labor, seedlings produced on a mini-nursery set up for the purpose, pickets and the participation of beneficiary were mobilized.

This methodological approach followed for the execution of this project led us to the results summarized in below:

III. Projet Results

The demonstrative implementation of the Restoration and Sustainable Management of Ecosystems in the Career of FONGBA project yielded two main results:

3. 1- Techniques of Integrated Management of Soil Fertility (ISFM) have been tested and validated for the reconstitution of the destroyed arable land:

For this purpose three ISFM techniques have been realized. It is the cultivation of two fertilizing plants (Mucuna and Cajanus) under conservation agriculture experiment with maize cultivation. At this level, some specific results have been obtained:

- The application of localized organic manures: the nutrients introduced facilitated the development of Mucuna plants, *Cajanus caja* and maize;
- The completion of a Mucuna culture test: it contributed to the fertilization of degraded soil (confers discussion for reconstructed arable land) ;
- The implementation of an action-research on the culture of Cajanus caja: it not only participated in the reconstitution of the soil but also it constitutes a plant food and environmental (even photographs in appendix and heading discussion for various appreciations) ;
- Conducting a trial on conservation agriculture: it directly facilitated soil fertilization and testing of a food crop without going through a stage reserved exclusively for the reconstitution of arable land. Mulching has contributed to soil protection, moisture conservation and the rehabilitation of the animal ecosystem including the snail.

3.2- The implementation of some ecosystem rehabilitation tests with selected soil restoration species:

This experimentation on the reforestation of the site is the second major category of activities that has been conducted as part of this project. The various intermediate results obtained for this purpose are as follows:

- The production of selected plants: A total of seven different species were produced. These are: i) *Senna siamea* (1000 plants); ii) *Acacia auriculiformis* (1100 plants); (iii) *Khaya senegalensis* (1000 plants); iv) *Adansonia digitata* (100 plants); v) *Terminalia superba* (600 plants); vi) *Afzelia africana* (100 plants); vii) and *Milicia excelsa* (Iroko). The average size of these plants at planting is 52.96 cm. The reasons for choosing each of these species are described in the commentary on the results;
- Reforestation of the plants: the planting was carried out in staggered rows at a distance of 2m x 2m for *Senna siamea*, at 6m x 6m for *Acacia auriculiformis* and at 8m x 8m for for the other plants;

- The realization of undergrowth: This undergrowth culture composed Panicum sp, Pénicétum sp, Manihot sp, et Zea maize was carried out on a portion of the Acacia auriculiformis plantation of 2017. It contributed to the rehabilitation of the animal ecosystem at this location . It consisted mainly of grasscutters, hares, squirrels and partridges.

The reconstitution of arable land, agroforestry using soil restorative species and their various intermediate results are all assets of the project that require analyzes and interpretations for their adoption and appropriation by the community.

IV. Discussion: Analysis and Interpretation of Results

The experimentation conducted on the reconstitution of arable land and the tests of rehabilitation of the ecosystems raises hope for the problem of sustainable management of the exploitation quarry of Fongba limestone.

4.1- Experimentation on the Reconstruction of the arable soil

The results obtained in soil fertilization experiments vary from one ISFM to another. So for each of the techniques of Integrated Management of Soil Fertility (ISFM) we observed the following variations:

4.1-1 Mucuna Cultivation Experience: A fast-growing, creeping legume that quickly covers the soil completely after two months. It left on the ground, enough leaves and lianas rich in organic nutrients now in decomposition for the formation of a new layer of arable soil. The complete random block device allowed us to note a difference between the results observed at the level of the mucuna plot located in the different blocks. The thicknesses of dry matter left vary from one plot to another. We have respectively for Bloc1 Mucuna1 = Bloc2 Mucuna2 = Bolc3 Mucuna3 =

4.1-2 The Cajanus Caja Cultivation Experiment: Pea is a fertilizer plant whose leaves and stems are gradually cut and spread on the ground. The dry leaves that have fallen off themselves and those spread during the clearing operations constitute decaying organic matter for their participation in the constitution of the arable land in the plots that shelter them. The observation of Cajanus caja plants during the vegetation makes it possible to note that the earth composed of organic elements that will be built at the end of the experiment will not be the same at all the Blocks. Variations in the height and size of the plants bear witness to this. The measures taken to this end are as follows: $Bloc_1$ *Cajanus caja*$_1$ = 2,34m $Block_2$ *Cajanus caja*$_2$ = 2,50m; $Bolck_3$ *Cajanus caja*$_3$ = 1,90m.These variations are due to the heterogeneity of the soil noted with respect to the different blocks. This heterogeneity results mainly from the presence of surface earth buried in some places while others are totally lacking.
Cajanus caja is a shrub and plays a significant role in the environment. The vegetation that these shrubs constitute now on a soil that was bare three months ago are beautiful illustrations. It is also a very nourishing seeds plant and excellent beans.

4.1-3 Organic Agriculture or conservation agriculture (CA): Conservation agriculture is part of agro-ecological techniques, which also include agroforestry, organic agriculture or integrated disease and pest management. Its main purpose is the integrated management of the soil and its fertility. It is based on three principles: reduction, and even suppression, of tillage, permanent soil cover and diversified rotations of crops (CIRAD, 2011).
In the case at hand, mulching of the soil has resulted in the conservation of moisture from the production of glass and other maggots resulting in the reappearance of snails in the field. It also allowed the test to be conducted until corn emergence without any weeding (maintenance).

The heterogeneity of the soil was also the cause of the variations obtained in the yields of the different plots installed for this purpose. These yields are summarized as follows: Bloc1AC1= 60kg, Bloc2AC2 = 50kg, Bolc3AC3 = 56kg. However the average of 55,33kg per plot corresponding to 2213 kg/ha realized for a first season on such soil also proves the effectiveness of this technique GIFS.
Maintaining or even restoring soil fertility improves the ecological efficiency of agro-ecosystems by optimizing the biogeochemical processes that exist in natural ecosystems, particularly forest ecosystems, and is a major issue to be popularized within the riparian community.

4.1-4 Comparison of Different Experienced GIFS Techniques

The results observed above show that all the methods of Integrated Soil Fertility Management put in experiment all contribute to the satisfactory regeneration of the soil. However, the benefits vary from one ISFM technique to another and the conditions to be met for its application are not the same. The realization of each method depends on the objective set and the elements available to accomplish it. The comparative table produced for this purpose is as follows:

4.1-5 Table of Experiences on Integrated soil fertility management (ISFM)) Techniques

ISFM techniques	Advantages	Challenges : observations
Mucuna	Total ground coverage Soil protection Production of organic matter rich in plant nutrients Easy to make Availability of seeds Interesting raw material for animal feed	Ground cover for at least one season Shelter building for reptiles Impossibility of an association with another culture
Cajanus *caja*	Nutrient production for plants Excellent bean for human nutrition Shrubs for shade and windbreaks Floor fixing Plant associable with other cultures Firewood Medicinal virtues Perennial crops	Need for thinning for its association with other cultures Time of soil reconstitution a little longer than that of others Necessity of weeding during the first 2 months
Agriculture of Conservation under Maize crop	No weeding Glass production and other micro-organisms Soil protection Immediate realization of agroforestry Suitable for mechanical agriculture	Difficulties of looking for straws Difficult to achieve by small farmers Sources of diseases and pest attacks

4.2- Experimentation on the Rehabilitation of the ecosystem

Some intermediate outcomes have facilitated this goal. It is :

4.2-1 Evaluation and Selection of Ecosystem Elements to be reconstituted

The selection of ecosystem elements to be rehabilitated was based on the results of the Environmental Impact Assessment (EIA) carried out before the start of the extraction activities in 2011, the fast-growing fertility restorative species experienced in farming environments. and the few natural regenerations observed on the closed quarry.
According to the results of the EIA, 2011; vegetation, strongly affected by population pressure, is dominated by herbaceous species. The dense forest has given way to an anthropogenic vegetation of palm trees, shrubs and shrubs including iroko (Milicia excelsa), Baobab (Adansonia digitata), Acacia auriculiformis, Senna siamea etc ... The natural regenerations observed on the Closed quarries are mainly dominated by Senna siamea and Acacia auriculiformis.
To this end, Senna siamea and Acacia auriculiformis have been selected as targeted fertility restorers and other native species for ecosystem restoration and soil restoration such as: Milicia excelsa, Adansonia digitata, Terminalia superba, Afzelia africana and Khaya senegalensis.
These two categories of species have been selected for several other reasons:

- **Fertility Restorative Essences: *Senna siamea* and *Acacia auriculiformis***

Senna siamea, a plant up to 18 m tall with an erect stalk, is commonly used as a shade tree, windbreak or hedge. The plant contains **Barakol**, a compound with sedative and anxiolytic effects, which contributes to its medicinal values. It is used against intestinal worms and scabies. The leaves are used as green manure. All parts of the plant can be used for tanning. The wood is used for carpentry, cabinetry, inlay, handles, sticks and other decorative uses. In addition, it can be transformed into charcoal of excellent quality.
Acacia auriculiformis is an easy silviculture product that is now used as both service and work wood. It has a very high capacity for enriching poor soils (CERF, 2010). Over most of the country, it is perceived as a substitute for wood species of works in rarefaction. It is excellent in crafts for turning items, toys, chess pieces and carom (CERF, 2017). In Benin, wood is adopted by communities for multiple purposes and for construction. Its very high calorific value (4,800 to 4,900 kcal / kg) makes it an excellent fuelwood.

- **The Essences of Ecosystem Reconstitution and Soil Restoration**

These species have been selected for their environmental, economic and medicinal value and their scarcity situation.
Afzelia africana and ***Khaya senegalensis*** are two of these threatened species, already on the IUCN Red List and critically endangered in Benin (Adomou et al, 2006). The ***Terminalia superba***, a rare and vulnerable wood, is used as boards, panels, plywood, paper pulp; he deserves to be promoted.
Decoctions and bark macerations are used in traditional medicine to treat wounds, lesions, hemorrhoids, diarrhea, dysentery, malaria, vomiting, edema and ovarian diseases, as expectorant and analgesic. The leaves serve as a diuretic, laxative roots.
Adansonia digitata (Baobab tree) is sought after for its medicinal and nutritional properties. Its leaves are excellent vegetables in some parts of the country and fruits rich in vitamin C are well marketed.
Milicia excelsa (**Iroko tree**) is an oxalogenic plant native to West Africa including Benin. It has an ability to amend the soil. It converts the absorbed CO2 into limestone. Unfortunately, it is part of the list of species, with a high probability of extinction in Benin (Adomou, 2005). The finance law N ° 2017-40

of 29 December 2017 on the law of finance, management 2018 even prohibited the exploitation of *Milicia excelsa* and *Afzelia africana* in Benin.
This ability to enrich the soil of iroko (*Milicia excelsa*) based on a natural mechanism was discovered by a Swiss researcher, Eric Verrechia and published in 2014. According to these Swiss researchers: "A single tree would be enough to stabilize in the form of limestone the concentration of CO2 in the air column above an area of 1,000 m^2. So ten Iroko trees planted spaced apart would be enough to participate in the reconstitution of limestone on an area of one hectare exploited

4.2-2 Reforestation and Undergrowth crop

The plants of the different species produced were reforested on May 20, 2018. Some variations were observed in the growth of the plants at the nursery. Thus, before the planting of the seedlings we recorded on a number of 10 plants taken at random the following average sizes: **Adansonia d. = 63,7cm - Senna = 52,48cm - Terminalia = 54cm - Acacia a. = 47, 64cm - Kaya s. 47cm and Afzelia a = 42cm.** The Baobab tree is the fastest growing species in the nursery. *Afzelia africana* is the one that grows the least. *Senna siamea*, which was sown one month after the others, comes in second place with an average size of 52.48cm.
At the present stage, the heights of the plants recorded in plantations are respectively: **Adansonia d. = 70 cm - Senna s = 92 cm - Terminalia s. = 62 cm - Acacia a. = 82 cm - Kaya s. = 61 cm and Afzelia a. = 50 cm.** The fastest growing species in plantation is *Senna siamea* and *Acacia auriculiformis*
The creation of undergrowth culture has made it possible to notice imprints of the passage precisely at this place of certain animals such as grasscutters, partridges, rats and squirrels which destroyed these cultures and made them a refuge with the presence of some holes of rats and squirrels.

4.3- The added value of the project for science and for career / business

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The "Project of Restoration and Sustainable Management of Ecosystems in the Career of FONGBA" contributes through its results to the revaluation and the protection of the biodiversity of the site. The research-action carried out on the techniques of reconstitution of the arable land and the rehabilitation of the ecosystems, are part of the logic of the Sustainable management of the lands to fight against their degradation. All of these greening career actions contribute to the overall goal of the Quarry Life Award, which is to create added value for nature and science.
The adoption of these ISFM techniques and ecosystem restoration, will improve the knowledge of quarry users and a large number of people about the practical techniques of replenishing arable land and the indigenous or exotic species available to do so.

This project now allows the company CALCIM S.A, not only to know what rehabilitation techniques developed ecosystems, but also to control the role of indigenous species in the environmental and in the process of reforming the deposit of limestone in the field.

As the limestone quarries are already closed, leveled by the company, it will now be enough for this company and the beneficiaries of these abandoned sites to adopt a site development plan, in order to appropriate these ISFM practices. Agroforestry for the restoration of destroyed biodiversity. This appropriation would be a great publicity for the company CALCIM SA that would have successfully recovered a site like the one in Fongba located 5km from Lokossa chief town of the department of Mono thanks to its sustainable land management plan and Biodiversity.

4.4- Recommendations and Tips

The results of this project require a progressive extension of the actions, both on the exploited site and the surrounding areas in order to reach the objective of the plan of restoration and sustainable management of the ecosystems that the group HEIDELBERGCement has fixed through Quarry Life Award. Such an extension of the project would generate both environmental and economic benefits for CALCIM S.A and above all the riparian community. This small-scale experiment evaluated the cost of reconstituting arable land and the rehabilitation of ecosystems over an area of one (01) hectare. These actions are estimated at **370 000 XOF / ha** for soil fertilization with *Mucuna pruriens*, **430 000 XOF / ha** for *Cajanus cajan* and **550 000 XOF / ha** for Conservation Agriculture respectively. Reforestation activities are estimated at **720 000 XOF / ha** for exotic species and **444 900 XOF / ha** for exotic species (confers budgets in appendices). The planning of the various extension activities of the project will depend on their nature. The reconstitution of the arable land should begin in January and spread over a year. Plant production is for December-April and planting activities for May-June. The plantation interviews will cover the first two years.

V. Conclusion

The implementation of the Project of Restoration and Sustainable Management of Ecosystems in the Career of FONGBA made it possible to experiment three techniques of Integrated Management of the soil Fertility and some indigenous and exotic essences for the reconstitution of the arable land and the rehabilitation of ecosystems of the said quarry.

The results of the reconstitution of the arable land show that the cultivation of *Mucuna pruriens* quickly improves the texture of the soil (Thickness 12cm dry matter), protects it, and is easy to realize but occupies the ground for a year. *Cajanus cajan* also improves soil fertility and at a slower rate (dry matter thickness 4cm), but it is useful for nutritional, economic and grow faster than planted restorative species. Conservation Agriculture with the maize yields obtained is also an interesting method of improving soil fertility, however it is more suitable for mechanized crops. The adoption of each of these techniques therefore depends on the objectives and means available.

Observation of the vegetation at the current stage, of the different species tested, shows that exotic species grow faster than native ones. However, not only do native species also have an appreciable increase, they are essential for the reconstitution of the ecosystems of the environment and play an important role, in this case *Milicia excelsa* in the reforming of the limestone deposit in the field.

To do this, it is preferable for the next time, to conduct comparative study on the growth of indigenous species and their capacity for soil enrichment in order to prioritize the latter in the restoration of ecosystems in the area.

To be kept and filled in at the end of your report: À conserver et à completer à la fin de votre rapport

Project tags (select all appropriate):

This will be use to classify your project in the project archive (that is also available online)

Project focus:

- ☐ Beyond quarry borders
- ☒ Biodiversity management
- ☐ Cooperation programmes
- ☐ Connecting with local communities
- ☐ Education and Raising awareness
- ☐ Invasive species
- ☐ Landscape management
- ☐ Pollination
- ☒ Rehabilitation& habitat research
- ☐ Scientific research
- ☒ Soil management
- ☐ Species research
- ☐ Student class project
- ☐ Urban ecology
- ☐ Water management

Flora:

- ☒ Trees & shrubs
- ☐ Ferns
- ☒ Flowering plants
- ☐ Fungi
- ☐ Mosses and liverworts

Fauna:

- ☒ Amphibians
- ☐ Birds
- ☒ Insects
- ☐ Fish
- ☒ Mammals
- ☒ Reptiles
- ☒ Other invertebrates
- ☒ Other insects
- ☒ Other species

Habitat:

- ☐ Artificial / cultivated land
- ☐ Cave
- ☐ Coastal
- ☐ Grassland
- ☐ Human settlement
- ☐ Open areas of rocky grounds
- ☐ Recreational areas
- ☐ Sandy and rocky habitat
- ☐ Screes
- ☐ Shrub & groves
- ☒ Soil
- ☐ Wander biotopes
- ☐ Water bodies (flowing, standing)
- ☐ Wetland
- ☒ Woodland

Stakeholders:

- ☒ Authorities
- ☒ Local community
- ☒ NGOs
- ☐ Schools
- ☐ Universities

Annexes

Implementation of the Restoration and Sustainable Management of Ecosystems Project in the annexes.

1. SCHEMATIC SUMMARY OF THE DIFFERENT STAGES OF PROJECT IMPLEMENTATION

Activity 1: Physical Amendment of the Soil

	
Localized Organic matter on rows	**Localized Organic matter on hole**

Figure 1: Photo of type of physical amendment

Activity 2: Action Research on ISFM Techniques: Cultivation of two fertilizing plants (Mucuna-*Cajanus cajan*) and an experiment on conservation agriculture with maize cultivation

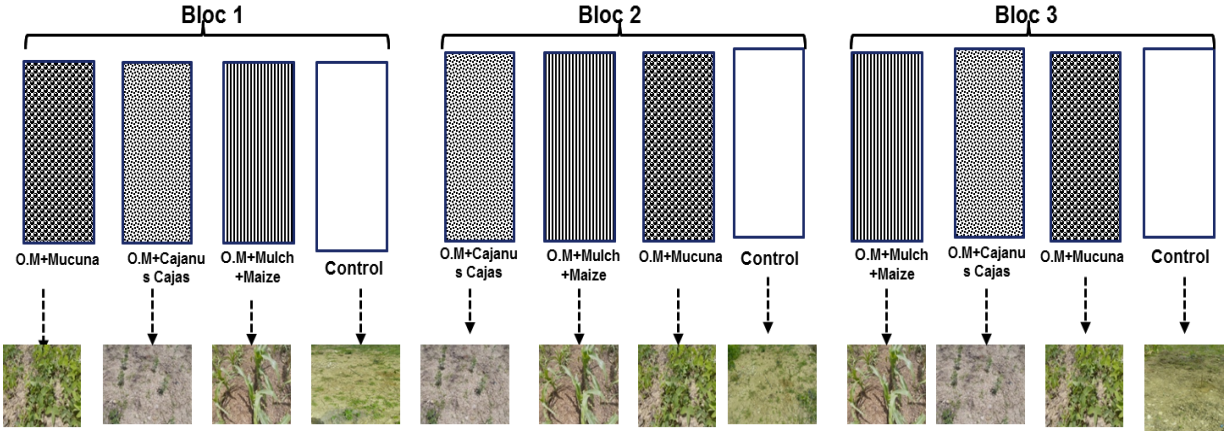
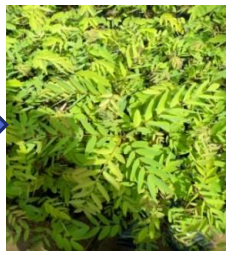


Figure 2: Experimental Design: Complete Random Blocks

Legend: ***O.M + mucuna =*** *Organic matter under the mucuna* ***; O.M + Cajanus Cajas =*** *Organic matter under Cajanus Cajas****; O.M + Mulching + Maize =*** *Organic matter combined with mulching under maize;* ***Control =*** *Maize without organic matter input*

Activity 3: Plant Production

Sowing in pot



Senna siamea **= 1000**

Acacia au. **= 1100**

Khaya senegalensis **= 1000**

Adansonia digitata **=100**

Terminalia superba **= 600**

Afzelia Africana

watering in nursery

Kaya senegalensis

Figures 3. **Tree plant species in nursery**

Activity 4: Reforestation

Figures 4: **Photos of planting**

Treatment 1 Mucuna *pruriens*

Treatment 2 Cajanus *cajan*

Treatment 3 : Organic Agriculture

Figure 5: Photo of National Jury visiting 17 May 2018

2. PHOTOS OF EVOLUTION OF ECOSYSTEM UNDER EXPERIMENTATION

Treatment 1 : Mucuna

Before experimentation	Ongoing and after experimentation

Treatment 2 : Cajanus *cajan*

Before experimentation | Ongoing and after experimentation

Treatment 3: Conservation Agriculture or Organic Agriculture

Before experimentation | Ongoing and after experimentation

Figure 6: Photos of ecosystem under experimentation evolution

3. PROJECT ACTIONS BUDGETING

3.1- Budget of arable soil reconstitution

3.3.1- Budget of arable soil reconstitution for one hectare (01 ha) with *Mucuna pruriens*

LABELS		UNIT	QTITE	UNIT PRICE (XOF)	TOTAL (XOF)
Plot delimitation		Man/day	04	5 000	20 000
Organic matter		Truck (7 m^3)	04	50 000	200 000
Seeds purchase		Kg	20	500	10 000
Localized organic matter	hole	Man/day	15	2000	30 000
	Spreading	Man/day	15	2000	30 000
Sowing		Man/day	15	2000	30 000
Monitoring restauration operation		Man/day	5	10 000	50 000
Total					**370 000**

3.3.2- Budget of arable soil reconstitution for one hectare (01 ha) with *Cajanus cajan*

LABELS		UNIT	QTITE	UNIT PRICE (XOF)	TOTAL (XOF)
Plot delimitation		Man/day	04	5 000	20 000
Organic matter		Truck (7 m3)	04	50 000	200 000
Seeds purchase		Kg	20	500	10 000
Localized organic matter	Man/day	HJ	15	2000	30 000
	Man/day	HJ	15	2000	30 000
Sowing		Man/day	15	2000	30 000
Monitoring restauration operation		Man/day	5	10 000	50 000
Plantations upkeeping		Man/day	(15x2)	2000	60 000
Total					**430 000**

3.3.3- Budget of arable soil reconstitution for one hectare (01 ha) with organic Agriculture

LABELS		UNIT	QTITE	UNIT PRICE (XOF)	TOTAL (XOF)
Plot delimitation		Man/day	04	5 000	20 000
Organic matter		Truck (7 m3)	04	50 000	200 000
Seeds purchase		Kg	20	500	10 000
Mulching		Man/day	60	3000	180 000
Localized organic matter	hole	Man/day	15	2000	30 000
	Spreading	Man/day	15	2000	30 000
Sowing		Man/day	15	2000	30 000
Monitoring restauration operation		Man/day	5	10 000	50 000
Total					**550 000**

3.2- Reforestation Budget: Two categories of plants to be reforested on one hectare: alien species and native species

3.2.1- Alien species: *Acacia auriculiformis Senna siamea*

LABELS	UNIT	QTITE	UNIT PRICE (XOF)	TOTAL (XOF)
Plot delimitation	Man/day	04	5 000	20 000
Picket purchase	unit	2500	15	37 500
Picket	Man/day	10	5 000	50 000
Plant cost	Unit	2500	65	162 500
Seed transport (loading-unloading-distribution)	Unit	2500	20	50 000
Hole	Man/day	2500	25	62 500
Planting	Man/day	2500	25	62 500
Monitoring restauration operation	Man/day	10	10 000	100 000
Plantations upkeeping	Number	05	35000	175 000
Total				**720 000**

3.2.2- Native species :

- ***Khaya senegalensis, Adansonia digitata*, *Terminalia superba, Afzelia africana* and *Milicia excelsa* (Iroko)**

LABELS	UNIT	QTITE	UNIT PRICE (XOF)	TOTAL (XOF)
Délimitation de la parcelle	Man/day	04	5 000	20 000
Picket purchase	Unit	340	15	5 100
Picket	Man/day	4	5 000	20 000
Cost of *Milicia excelsa*	Unit	20	1000	20 000
Cost of others native plants	Unit	320	200	64 000
Seed transport (loading-unloading-distribution)	Unit	340	20	6 800
Hole	Man/day	340	50	17 000
Planting	Man/day	340	50	17 000
Monitoring restauration operation	Man/day	10	10 000	100 000
Plantations upkeeping	Number	5	35 000	175 000
Total				**444 900**