Final Project Report (English Form)

Instructions:

- Document length: maximum 10 pages, excluding this cover page and the last page on project tags.
- Start with an abstract (max 1 page).
- Final report text: Do not forget to mention your methodology; the people involved (who, how many, what organization they are from – if applicable); and the expected added value for biodiversity, society and the company. Finally, state whether the results of your project can be implemented at a later stage, and please mention the ideal timing and estimated costs of implementation.
- Annexes are allowed but will not be taken into account by the jury and must be sent separately.
- Word/PDF Final Report files must be less than 10 MB.
- If you choose to submit your final report in your local language, you are required to also upload your final report in English if you wish to take part in the international competition.
- To be validated, your file must be uploaded to the Quarry Life Award website before **30th September 2016** (midnight, Central European Time). To do so, please log in, click on 'My account'/ 'My Final report'.
- In case of questions, please liaise with your national coordinator.

1. Contestant profile

▪ Contestant name:	**TOUNDOU Outéndé**
▪ Contestant occupation:	Researcher Assistant
▪ University / Organisation	Université de Lomé
▪ E-mail:	
▪ Phone (incl. country code):	
▪ Number of people in your team:	**6**

2. Project overview

Title:	**Wastes-soils-plants-animals: a cooperation to boost Sika-Kondji career biodiversity**
Contest:	Togo
Quarry name:	Tabligbo East quarry (Sika-Kondji)
Prize category: (select all appropriate)	☐ Education and Raising Awareness ☐ Habitat and Species Research ☒ Biodiversity Management ☐ Student Project ☐ Beyond Quarry Borders

Abstract

Mining activities occupy a key place in the economies of developing countries. However, these benefits are often accompanied by many adverse environmental impacts. Among them, the significant ones are deterioration of soil and its biodiversity. In this study, we assessed the possibility of using putrescible and mineral wastes free obtained in plant (SCAN Togo), in the career and city to attract and retain fauna in the career by the composting process. The products of compostage (composts) were analyzed in laboratory to identify their chemical characteristics and their fertilizing potential. So, results of laboratory analyzes were completed by agronomic tests on four plants species, namely *Z. mays* (for the flowers attracting insects and the grains production for food) and *G. max* (for the flowers, the grains production, and the nitrogen recycling) with Fisher bloc Design, *A. esculentus* (for the flowers and fruits production), and *C. citratus* (as its essential oils production could be used to improve local soap and bio-insecticids and deodorants) with an Split plot design. The results show that all composts have attracted insects, arachnids and amphibians. Compost C2 (green waste + food waste) is the best compost which attracted more animals, 43% of total individuals counted on all composts piles. It also appears that composts C1 (green waste) and C2 have more attracted insects while composts C3 (green waste + limestone and clay) and C4 (green waste + food waste + limestone and clay) attracted arachnids and amphibians. The chemical analyzes of composts showed that composts C2 and C4 contain the highest levels of total organic matter (respectively, 15 and 14% dry matter), nitrogen (respectively, 1.20 and 0.75% dry matter) and phosphorus (respectively, 0.45 and 0.38% dry matter). On the other hand, composts C1 and C2 have the highest levels of potassium (0.48 and 0.60% dry matter, respectively). Agronomic tests have confirmed results of chemical analyze and showed that flowers and leaves of maize have more attracted insects. Composts C1, C2 and C4 have allowed the growth parameters (until 583% of improvement compared to control treatment) and yields (until 152% of improvement rate relative to control treatment). In addition, *C. citratus* grown on C1 have presented a high content of essential oil (3.53 mg / g against 1.73 mg / g fresh weight for the control treatment). This work is an experimental study but the consequent results are very encouraging and should be valued for sustainable and harmonious development.

Keywords: wastes, compost, restoration, biodiversity, soil, careers, sustainable development.

INTRODUCTION

Industrial activities are an important source of financial income for developing countries. In Togo, we have more than 120 industrial units spread throughout the country which participate in economic development (MERF, 2010). Mining activities occupy an important place in these actvities especially in the maritime region. Unfortunately, the economic interests related to mining are often accompanied by significant adverse impacts on the environment (Dupon, 1986; Danloux and Laganier 1991; Laroche, 2011).

In many countries, the lack of restoration and rehabilitation of mines sites lead to the drop crop yields and the disturbance of biodiversity (Wild and Wiltshire, 1971; Goodman, 1974; MERF, 2010; MINEO, 2000) increasing poverty of the populations surrounding these mine zones. However, mining sites constitute an important natural value if they are well maintained.

CIMTOGO, SCANTOGO and GRANUTOGO are mining companies of Heidelbergcement installed in Togo. The approach of these companies, and specifically SCANTOGO base on its environmental management plan, is to systematically carry out progressively to the development and rehabilitation of each area at the end of exploitation. The goal is to promote a reconstruction of the ecosystem and an environment suitable to the promotion of biodiversity (ADEME, 2005; Physafimm, 2009). According to our investigations, it appears that SCANTOGO can produce more than 10 tons of putrescible wastes (all categories) that can be developed in the rehabilitation and restoration of the quarry for restoring topsoil fertility and the biodiversity. In this work, we propose to restore ScanTogo soil and biodiversity using free wastes from the plant and the career via the composting process and to guarantee incomes for the community and the company (Solé-Benet *et al.,* 2009; Laroche, 2011).

RESEARCH OBJECTIVES

The main goal of this research is to identify the best types of composts which can restore the fertility of topsoil and the biodiversity of the limestone career of SCANTOGO in Sika-Kondji. To achieve the overall goal, the specifics objectives are to:

- identify the best type of wastes composting heap attracting animals and possessing a high agronomic value;
- evaluate the chemical characteristics and the agronomic fertilizing potential of each compost by chemicals analyses to determine the best types of compost for plants growth on the topsoil;

- assess the effects of composts on growth and production of four food crops commonly grown in the villages around the mine to confirm the agronomic value of the bests types of composts which will be used for the topsoil fertility and restoration.

DESCRIPTION OF STUDY AREA

The experimental site is located in the ecofloristic area V of Togo specifically in a limestone career of SCANTOGO based in Sika-Kondji (8 Km from Tabligbo) at 06 ° 36'48,7 '' North Latitude and 1 ° 34'44,1 '' East Longitude. The initial land state of this area (14 km^2) is characterized by vast farmland fallow around villages, dotted with palm tree plantations and teak. In the mining area, the upper soil layers and thus more recent, are layered of sand and clay. Flora of the study area content mainly forest patches or islands (Ceiba, Milicia, Antiaris etc ...). There are also gallery forests containing big trees. The fauna is characterized by species such as lizards, chameleons, turtles, snakes, mice, cane rats and insects. There are also some birds scattered in the savannah.

MATERIAL AND METHODS

Composting process, attraction of animals by composts piles and compost fertilizer potential

Composted wastes: Four different composts were prepared by mixing two different kinds of putrescible wastes free obtained from SCANTOGO company and one natural additive (mixture of limestone and clay wastes). The putrescible wastes are:

- green wastes from land clearing operation and maintenance of flowerbeds
- food wastes from restaurants and SCANTOGO workers' housing estate.

We have used natural additive (mixture of limestone and clay) free obtained from the quarry and transported to the drain by pumping water. Table 1 shows the different types of composts and quantity of wastes in each compost pile.

Table 1: Composition of the different types of compost produced (m = mass of wastes; P = percentage of the wastes relative to the total mass of the pile)

Composts	Green wastes		Food wastes		Limestones and clay wastes	
	m (kg)	*P (%)*	*m (kg)*	*P (%)*	*m (kg)*	*P (%)*
C1	300	100	0	0	0	0
C2	230	76,7	70	23,3	0	0
C3	200	66,7	0	0	100	33,3
C4	250	83,3	20	6,7	30	10

Composting method and process monitoring*:* The composting method adopted is that of pile. Wastes are mixed and laid in piles of 2 m of diameter by 1 m of height. Piles are turned over periodically 6 days, 2 weeks, 1 month, 2 months and 3 months in order to ensure good ventilation and allow the aerobic degradation of organic matter. Watering is regular and the quantity of water supplied is a function of piles moisture to maintain a rate of 50% up to the compost maturity. The four composts piles are installed on an area of 625 m^2 and distant 7 m from each other.

Monitoring of the composting process consists to measure temperature, moisture and pH. These parameters were used to monitor the composting process until maturation (about 16 weeks). The measure of humidity and pH is carried out on samples at several locations of each piles. Temperature is measured with a temperature sensor every 2 days. Value considered is an average of 6 measurements, on each side and at different depths (0.5, 1, 1.5 and 2 m) (Sandec, 2006; Unmar *et al.* 2008). Pictures of Figure 1 show the different composted wastes. Figure 2 shows composts pile in full watering and temperature monitoring while figure 3 present the four types of composts piles.

Figure 1: Different Wastes (a= Green wastes; b= Food wastes and c= Limestone and clay).

Figure 2: Irrigation and temperature measure of composts piles (a=irrigation and b= temperature measure)

(a) (b) (c) (d)

Figure 3: Composts piles at 2 days of the process (a= C1 ; b= C2 ; c= C3 and d= C4)

Assessment of the impact of composts on animals attraction: The objective of this section is to improve the site attraction and sustainability in the fauna diversity before, during and after mining. Thus, during the composting process 16 data collection were made (8 visits in morning and 8 in evening). Quantitative data collection concerned number of individuals per species or family on each pile during our visits. The qualitative ones (data collection) concerned pictures taking and descriptions of hardly identifiable species. Photos and descriptions were then taken back to laboratory for a better identification of species.

Assessment of composts maturity by germination test: A germination test is carried out in three repetitions using maize (*Zea mays* L.) in order to evaluate the phytotoxicity and maturity of each compost (Compaoré *et al.,* 2010). Seeds (4 grains) are germinated in pots firstly with sand alone (Control), secondly with 50% of sand and 50% of compost, and thirdly with 100% of compost. Tests are carried out in the laboratory at room temperature (25 °C) and substrate humidity is maintained every day with 50 ml of distilled water. Number of germinated seeds is counted after 10 days. Germination rates evaluated in percentage is calculated using the formula: GR (%) = 100 × NGG / NGS (NGG = Number of sprouted grains; NGS = Number of grains sown).

Chemical characteristics and agronomic potential fertilizing of composts*:* Composts and topsoil chemical characteristics and their agronomic fertilizing value was conducted in the laboratory of Management, Treatment, and Development of Wastes (GTVD) and Chemicals Analyzes Laboratory all two from Université de Lomé (UL) and at Togolese Institute for Agronomical Research (ITRA).

Assessment of organic part**:** Total organic matter was determined by calcination according to standard NFU 44-160. 10 g of dry sample calcined at 550° C for 2 hours in an oven Nabertherm Brand Controller P320. The percentage of organic matter is calculated by mass difference of the sample before calcination (Mi) and after calcination (Mf). Total organic content is given by the following formula: MOT (%) = 100 × (Mi-Mf) / Mi. The TOC (Total Organic Carbon) is determined according to the French standard NF ISO 14-235. Principle of this method is based on a hot oxidation (135 ° C for 1h) in an acid medium by potassium dichromate.

Evaluation of chemical parameters: pH and electrical conductivity (Ec) were measured using standardized methods (AFNOR NF ISO 10-390, 2005). 20 g of dry sample were mixed with 100 ml of distilled water. The solution is homogenized for 2 h and then filtered throughcxxted in the maritime region (Togo) and therefore enjoys a Guinean climate with four seasons (two rainy seasons and two dry ones). Topsoil is a sandy clay soil whose physicochemical characteristics are given in Table 2. Three reasons have guided the choice of plant species: their dominance in the farm of peasants, their nutritional value and their potential flowering and animals attracting. They are: corn (*Zea mays* L.), soybean (*Glycine max*), okra (*A. esculentus*) and lemon grass (*C. citratus*). Moreover, the four crops and maize in particular face nowadays issues of land degradation and unexpected seasonal shifts (Adewi *et al.*, 2010), therfore reducing greatly their agronomic performance.

Impact of composts on a species rich on essential oil (*C. citratus*) has also been studied to develop local soap production (jobs for wives), one of Heidelbergcement group of Sika-Kondzi local social duty.

Experimental systems and agro-technical works*:* Two large experimental approaches are used in this study covering a total area of 625 m^2. Corn and soybean were planted using a Fisher block design with 5 treatments (4 composts and one control treatment) with 3 replicates per treatment. Each experimental plot has an area of 6 m^2. A split plot device has been used for Okra and lemon-grass. Research was conducted during 4 months (May to August 2016).

The agro-technical works have focused on land preparation, grains sowing and plants transplanting (Lemon grass),parcel maintenance and harvesting. All composts were applied at a rate of 10 t / ha.

Impacts of composts on plants growth, species productivity, and biodiversity improving: Data collection has concerned the physiological growth parameters such as height of plants and average number of leaves per plot and per treatment. At maturity relative to each species, grain yields, fruits, and biomass dimensions were measured. Extraction of lemongrass essential oil by hydro-distillation was performed in the laboratory of natural products and aromatic extracts of Université de Lomé (UL) to assess the impact of compost on the quality and quantity of essential oil.

To assess the impact of composts on fauna and flora diversity improving, pictures of animals (insects) on each elementary plot were taken as the time goes.

Statistical analysis: Data collected during composting process and agronomic tests are subjected to variance analysis (ANOVA) using MSTATC software (version 2.10). XLSTAT software (2008) was also used to identify correlations between some parameters at a probability threshold of 5%. Figure 4 shows the amounts of rainfall and average temperature during the test period.

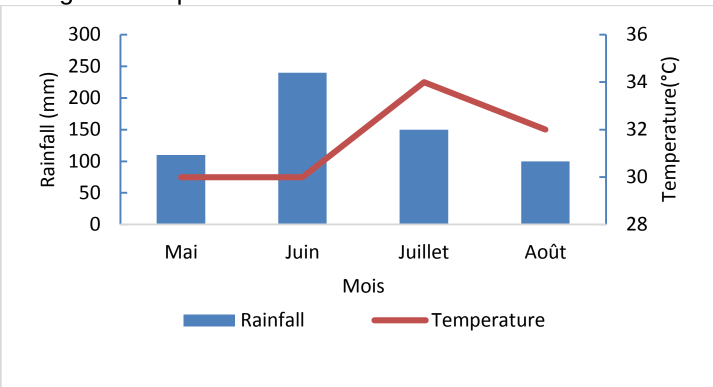

Figure 4: Monthly change in temperature and rainfall during the agronomic test

Table 2: Physical and chemical characteristics of the topsoil SCANTOGO limestone career

pH	6,80
Electrical conductivity (µS/cm)	140,60
MOT (% d.m.)	7,600
COT (%d.m.)	4,410
N (% d.m.)	0,080
P (% d.m.)	0,270
K (% d.m.)	0,022
Ca (% d.m.)	0,202
Clay 2µ (%)	49,50
Fine silt 2 to 20µ (%)	17,50
Coarse silt 20 to 50µ (%)	04,35
Fine sand 50 to 200µ (%)	16,70
Coarse sand 200 to 2000µ (%)	7,80
Elements 2 mm (%)	0,00

RESULTS

Monitoring the composting process and germination test: Figure 5 shows that the temperature of composts piles is the same at the first day of the process (40° C). During the four next days, the temperature increased to reach a maximum value of 58° C. However, the temperature increase is more pronouced in the pile of C4 (green wastes + food + limestone and clay wastes) and less in the pile of C3 (green waste + limestone and clay). Figure 5b shows that composts after 2 months of the process exhibit a dark brown color similar to garden soil.

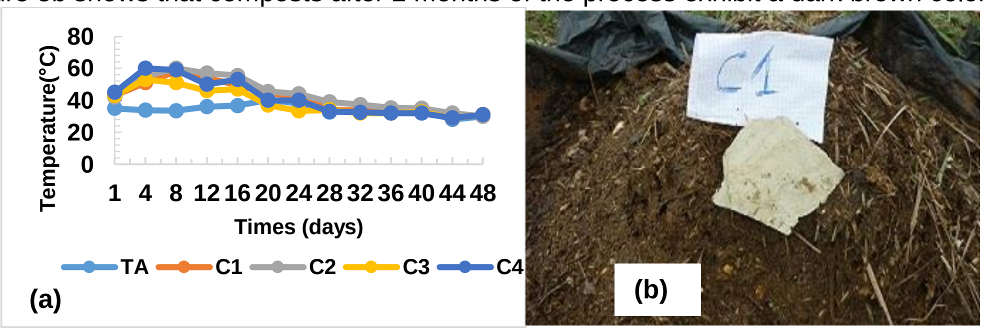

Figure 5: Evolution of composts piles temperature (a) and C1 compost pile after 2 months of process (b) (TA= Ambient Temperature)

Results of germination tests show that regardless of the type and the dose of compost, germination rates are more than 50% (Table 3). However, the rate is higher on a substrate containing 50% of compost (similar to control) compared with that containing 100% of compost.

Table 3: Results of germination test on maize (T= control treatment)

Amendments	C1	C2	C3	C4	T
Germination rates(%) (50% de compost/50% sand)	100	100	100	100	100
Germination rates (%) (100% de compost)	75	75	100	75	100

Impact of composts on the attracting and keeping of animals in the career: C2 compost (green waste + food waste) was most visited by animals (Figure 6a). In addition, all animal families inventoried in this study have visited this compost pile. Animal distribution on the piles of compost is heterogeneous (Figure 6b) as families of frequency index II are dominant. PCA (Principal Component Analysis (Figure 7)) shows that C1 composts (green waste) and C2 (green waste + food waste) well attracted insects while C3 compost (green waste + limestone and clay) and C4 (green waste + food waste + limestone and clay) hosted more arachnids and amphibians.

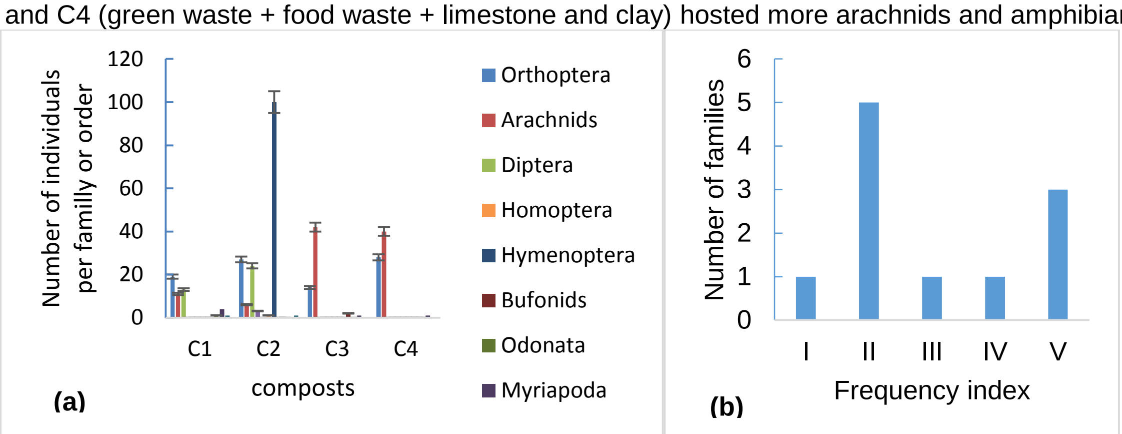

Figure 6: Impacts of composts on animals' attraction (a: total number of individuals by order or family of species; b = Frequency index histogram)

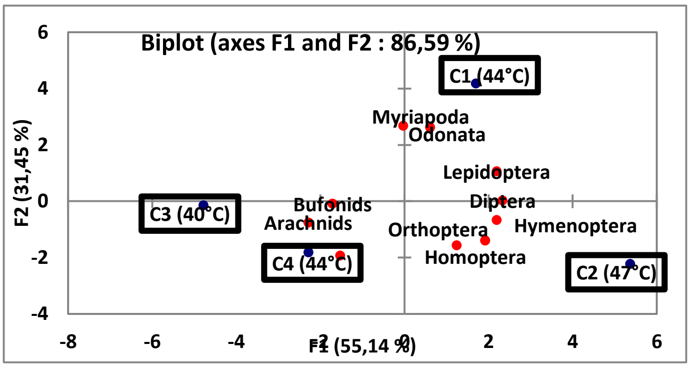

Figure 7: Relations between composts and families or orders of animals encountered on each pile of compost

Figure 8: Some animals on composts heaps

Chemical characteristics and potential fertilizer compost: Compost C2 (green waste + food waste) and C4 (green waste + food waste + limestone and clay) contain the highest organic matter content (14.60 ± 1% d.m.) and total organic carbon (8.49 ± 1.5 % d.m.) (Table 4). Contents of C1 and C3 are similar with an average of 11.10 ± 0.5% d.m.) for total organic matter and a TOC moderately equal to 6.45 ± 0.45% d.m. All compost pH values are greater than 7 and comprise between 7.80 and 8.14 (Table 4). Concerning compost electrical conductivity, composts C2 and C4 are most efficient with respective values of 3080 ± 100 µS / cm and 2450 ± 150 µS / cm. The macronutrient contents (N, P and K) are higher in compost C2 (green waste + food) and C4 (green waste + food + limestone and clay) while composts C1 (green waste) and C3 (green waste + calcareous clays) present the lowest values (Table 4).

Table 4: Contents of macronutrients and chemical characteristics composts (d.m.= dry matter)

Composts	MOT (% d.m.)	COT (% d.m.)	N (% d.m.)	P (% d.m.)	K (% d.m.)	Ca (% d.m.)	pH	Ec (µS/cm)
C1	11,00	6,39	0,64	0,36	0,48	0,92	7,80	1833
C2	15,20	8,83	1,20	0,45	0,60	1,10	8,14	3080
C3	11,20	6,51	0,41	0,26	0,35	1,63	8,11	1297
C4	14,00	8,14	0,75	0,38	0,42	1,28	8,00	2450

Impacts of composts on plants growth, on biodiversity improvement, and agronomic performances: Composts have generally improved plant growth compared to the control (about 113.2 ± 10 cm against 84.75 ± 7 cm for the control for a corn). We can see that plants grown on compost C1 exhibit the highest heights for all species except lemongrass for which C4 compost is the most performant (Figures 9 and 10). For instance, corn and soybean grown on C1 compost have the height of 133 cm and 48.75 cm, respectively. On other hand, citronella and okra grown on C4 present the greatest height (80 ± 5 cm vs 60 ± 3 cm for control). To resume, C1 (green waste), C2 (green + food wastes), and C4 (green waste + food waste + waste limestone and clay) have improved plants growth parameters.

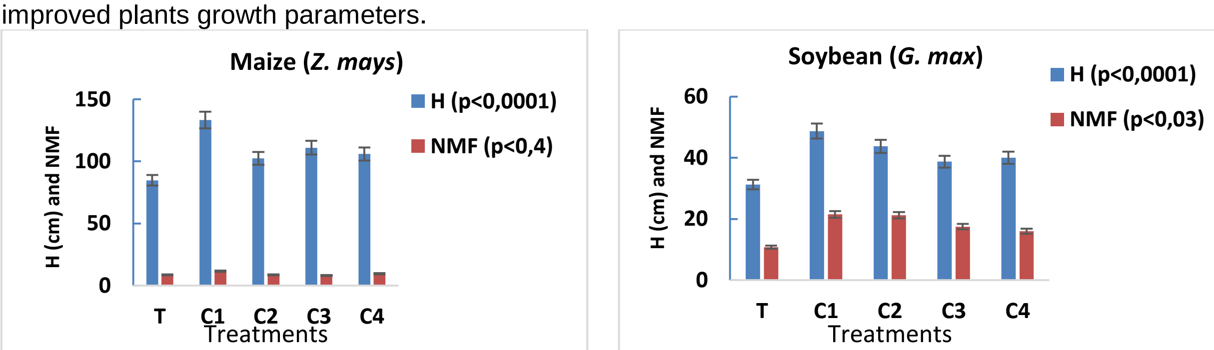

Figure 9: Impact of composts on growth of corn and soybeans at 50th DAS (probabilities of 5% level; H = height; NMF = Number of leaves; DAS=Days After Sowing)

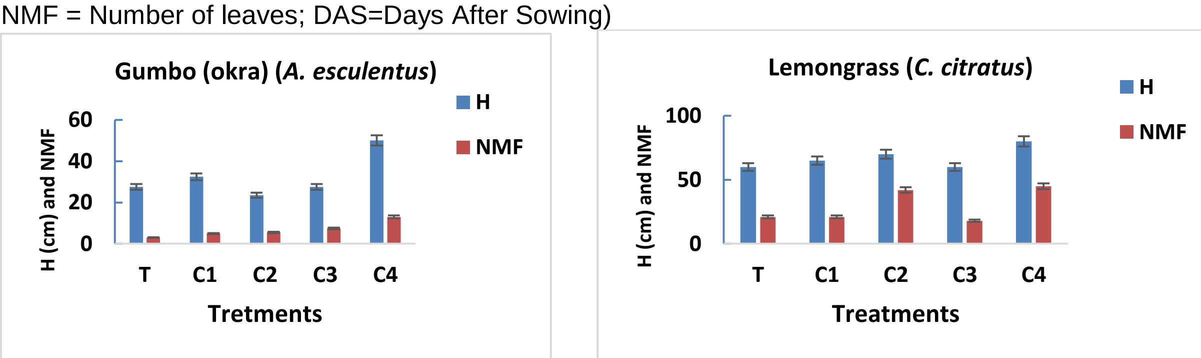

Figure 10: Impact of composts on growth of okra (75th DAS) and lemongrass (50th days after transplanting) (H = height; NMF = Number of leaves; DAS=Days After Sowing)

Observation of experimental plots of each species shows that only corn plants attract insects through and maintain them on their leaves and flowers (Figure 11).

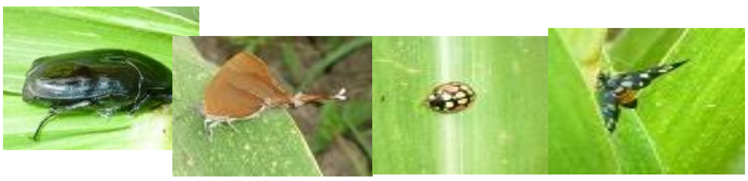

Figure 11: Some insects on the leaves of corn on C1 compost plot

Analysis of agronomic parameters (Figures 12 and 13) show that composts C1, C2 and C4 have allowed plants to improve their yields compared to that of the control (T).

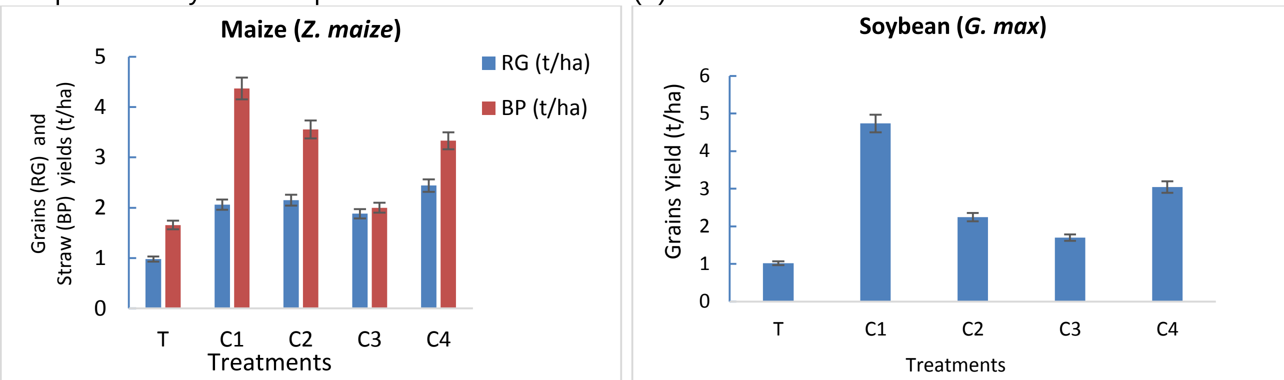

Figure 12: Grains and straw biomass yields of maize (left) and soybean yield (right).

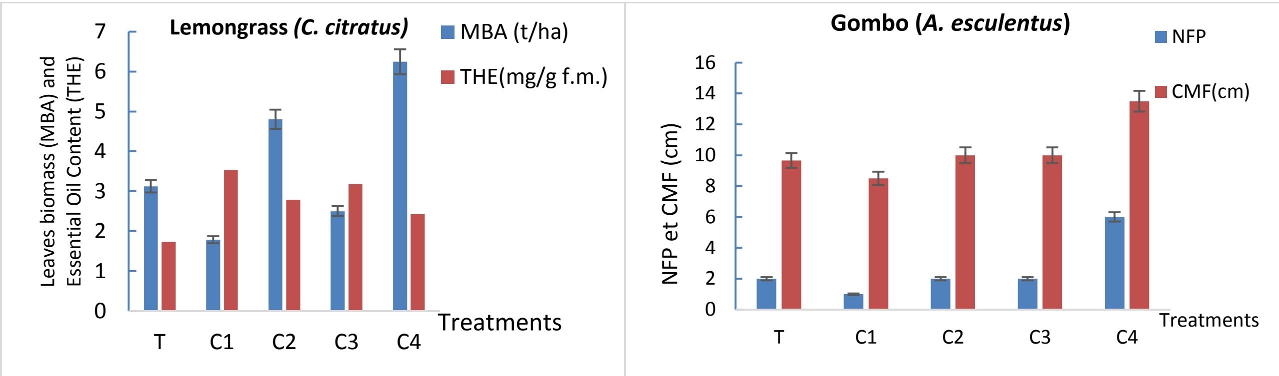

Figure 13: Leaves biomass and quantity of essential oil of *C. citratus* at 85 DAS (left) and number of fruit per plant (NFP) and circumferences of fruits (CMF) of *A. esculentus* at 90 DAS (right) (DAS= Days After Transplanting)

DISCUSSION

Temperature increasing at the beginning of the composting process could be explained by the decomposition of biodegradable matters by microorganisms (Hassan *et al.,* 2001; Attrassi *et al.,* 2005; Compaoré *et al.,* 2010; Koledzi *et al.,* 2011; Toundou, 2016). the subsequent decreasing of the temperature (after 20 days of the process) is explained by the decrease of biodegradable organic matter and the death of microorganisms under effect of the heat (Hassan *et al.,* 2001). These results are in accordance with those of Manios *et al*. (2003), Koledzi *et al.* (2011), and Toundou (2016). Concerning the composts maturity, all are not toxic according to the germination test. Accordingly, they (composts) are favorable to plants growth after 3 months (90 days) (Zuccooni *et al.,* 1981. Koledzi, 2011; Toundou, 2016). Moreover, mature compost exhibits a pH between 7 and 9 (Avnimelech *et al.,* 1996). All pH values obtained in this study are included in this range (7.8-8.14). C/N ratios of the composts are all less than 20. Therfore, the composts of the current study are mature and can be used in agriculture under acceptable dose (Compaoré *et al.,* 2010; Koledzi, 2011; Toundou *et al.,* 2014). Furthermore, composts C2 and C4 (presence of food wastes) have the lowest C/N ratios and the high organic matter contents. These composts present the characteristics which are favorable for their uses in restoration of topsoil fertility, the plants' growth and the career biodiversity improvement. Conductivity values are higher for C2 and C4 indicating that these composts contain high amounts of ions which are important for plants growth on the topsoil (Toundou, 2016). Nitrogen, phosphorus and potassium contents are higher for C2 and C4 (averages of 0.98%, 0.42%, and 0.51%, respectively), due to the presence of food wastes in the piles of these composts. Indeed, food wastes mainly contain fruits, vegetables, fish and flour which have a lot of nutrients for plant growth. C3 compost calcium content is very high (1.63%). This high calcium content can have a depressive effects for plants growth.

The comeback of wildlife on a site is an important step in the restoration of one mining site. Results of our study indicate that insects, arachnids and amphibians can be easily attracted and retained by the composting process especially in compost C2 (green waste + food waste) pile. Indeed, it has been shown that species that quickly colonize a mining site in restoration are those who find the resources they need such as food, shelter and breeding sites (Ghose, 2004). Thus, composts piles are not only shelter for those animals but also food that can keep them in the career during and after the mining activities. Certainly, all around the piles of compost, one can find several families of insects that constitute preys for amphibians and arachnids. Compost piles constitute food chains to keep animals such as arachnids, amphibians and insects in the career. These piles of compost are therefore habitats and place of feeding for these animals.

All composts promoted best nutrition of plants resulting to a high growth parameters of plants compared to those of control treatment (Brahima, 1966, Pirot, 1998 Mako *et al.,* 2013). The best growth performances on the C1 compost (garbage waste) for corn and soybean could be explained by ionic balance of nutrients in the soil amended with this compost. Undeniably, there is an ionic balance necessary for absorption of nutrients by plants. So, a high cations content may for example inhibit potassium and ammonium absorption (Etchebest, 2000), thus reducing the plant growth. This is the cases of plants grown on composts C3 and C4 which contain high levels of calcium (Toundou *et al.,* 2014). Furthermore, the mineral composition of C1 and C2 composts is interesting for the growth of corn and soybean on the topsoil. The best agronomic performance (yields parameters) recorded on the C2 and C4 composts could be explained by their high levels of N, P and K. According to Beech (1990) and Tougma (2006), large applications of nitrogen are required to obtain large leaves of lemongrass (C2 and C4). However, plants grown on composts C2 and C4 yielded less essential oil compared to composts C1 and C3. These results are in agreement with those of Tougma (2006) who has showed that application of N, P and K did not significantly affect the content of essential oils of lemongrass. C1 compost (green waste) is then the most efficient regarding the production of essential oil on the topsoil. Results for *A. esculentus* plants grown on composts and especially C4 are in agreement with those of Adebayo *et al.* (2013) who demonstrated that wastes composts improve the growth and yields of okra fruits. C4 compost (green waste food + limestone and clay) is the most efficient for the production of okra on the topsoil.

It appears in this study that the compost (C2) made with green waste and food waste attracts and keeps insects, arachnids and amphibians in the career. For plants growth on the topsoil, yields and flora improvement, composts C1 (green waste), C2 (green wastes + food wastes), and C4 (green + food wastes + limestone and clay) are the best.

ADDED VALUE OF THE PROJECT FOR BIODIVERSITY, COMMUNITY AND COMPANY

Biodiversity: For the first time in Togo, putrescible wastes are used to improve a career soil fertility and his biodiversity restoration. To the best of our knowledge, this is the first time composting process are used to attract and retain animals in a career. The following results to this study allow to develop permanently a compost C2 pile on the topsoil to attract and retain insects (pollinators), arachnids and amphibians in the career. This study allowed as well to know the best composition of composts (C1, C2 and C4) which ensure growth and good yields of maize and lemongrass (Poaceae), soybean (a leguminosa), and okra (a malvaceae). Extraction and use of essential oil from lemongrass will allow to reduce the utilization of toxic chemical insecticides.

Community (society): Application of waste composts as organic amendment ensures topsoil fertility. Use of composts contributes to reduce chemical fertilizers (expensive and pollutants). Market gardening is the main activity of women of the villages around the career. The use of composts C1 and C2 allow plants growth therefore their profits and ensures a harmonious and good health of populations around the mining site of Sika-Kondji. Essential oil from plant can be used to improve local soap, and profit for the women of surrounding villages.

Company: Implementation of this project in Sika-Kondji mining site make SCANTOGO, the best company among all mining companies in Togo which protect environment, restore soil using his own wastes (the first in Togo). This can help the company to quickly obtain a good certification as well as nationally and internationally awards. With composting process, Scantogo manages, treats and recovers its own wastes according to current environmental standards (also a positive mark for a good corporate visibility). Implementation of our study allows SCANTOGO plant to reduce costs of rehabilitation using free materials obtained in his site. Production of essential oils will allow the company to produce biological insecticides, perfumes, deodorants and detergents, all bearing the company logo. This is not only advertising and promotional strategies but also sources of revenue for SCANTOGO Company.

CONCLUSION AND PERSPECTIVES

The main aim of our project is to restore biodiversity of SCANTOGO mining site using free materials in the site and providing benefits to local community and company. This work proposes simple and relatively inexpensive facilities for a significant improvement of biodiversity on quarry sites. Thus, after analysis of our results, it appears that insects, arachnids and amphibians can be easily attracted and detained on the site by using wastes composting especially green and food wastes compost pile. Concerning the permanent fertilization of the topsoil to ensure the better plant growth, C1 compost (green waste), C2 (green wastes + food wastes), and C4 (green wastes + food waste + limestone and clay) are the outperformed. This work is in an experimental study but the ensuing results are very encouraging and should consequently be valued for sustainable and harmonious development. For this, our future work during the mining activities for the project implementation will include:

Activity 1: permanently installation of compost heaps of type C2 on the topsoil and establishment of a large-scale composting station to produce composts C1 and C4 types.

Activity 2: fertilization of topsoil in restoring areas with composts C1, C2, and C4 and providing these composts to peasants around mining site and to farmers from surrounding villages

Activity 3: training, informing and assisting peasants and women on composting and its positive effects and an installation of essential oils production unit to develop and improve local soaps and biopesticides, perfumes and deodorants.

BUDGET PER ACTIVITY

We estimate the total budget at € 30 000.

Tasks	***Period***	***Cost (€)***
Activity 1	(January to April)	**10000** (Composting Monitoring Process)
Activity 2	(May to November)	**10000** (Farms Monitoring)
Activity 3	(January to December)	**10000** (Material and human resources)

NB: Project will generate profits for the population around the quarry and company (selling of fruits, grains from plant, essential oil, soap and deodorant).

Acknowledgements

We thank SCANTOGO administration for their support in the realization of this work. We Thank too the staff of GTVD, LPBV and ESA labs all from Université de Lomé and the ITRA laboratory of analysis for technical assistance in chemical analysis. Nature is the greatest winner!

REFERENCES

1. Adebayo A. G., Shokalu A. O., Akintoye H. A., 2013. Effect of Compost Mixes on Vegetative Development and Fruit Yield of Okra (*Abelmoscus Esculentus*). *OSR-JAVS*, 3 (1): 42-49.

2. ADEME, 2005. Réhabilitation du site minier. In ADEME, Médiathèque, [En ligne]. http://www2.ademe.fr/servlet/getBin?name=2B78733D583C434161321119BB72BEE

3. Adewui A., Badameli K. M. S., Dubreuil V., 2010. Evolution des saisons de pluies potentiellement utiles au Togo de 1950 à 2000. *Climatologie*, 2: 89-107.

4. Attrasi B., Mrabet L., Douira A., Ounine K., El Haloui N., 2005. Etude de la valorisation agronomique des composts des déchets ménagers. *Biotechnol et Envir*, Atelier "Biotechnologies" au Maroc, Setat du 6 Mai 2005.

5. Avnimelech Y., Bruner M., Ezrony J., Sela R., Kochba M., 1996. Stability indexes for Municipal Solid Compost. *Compost Sci. Util.,* 4: 13-20.

6. Beech D.F., 1990. The effect of carrier and rate of nitrogen application on the growth and oil production of lemongrass (*Cymbopogon citratus*) in the Ord Irrigation Area, Western Australia. *Australian Journal of Expérimental Agriculture*, 30 (2): 243-250.

7. Brahima. G., 1966. Principes fondamentaux d'agriculture générale. Vigot frères éditeurs ; 23, rue de l'école de médecine, Paris VIe

8. Compaoré E., Nanema L.S., Bonkoungou S., Sedogo M.P., 2010. Evaluation de la qualité de composts de déchets urbains solides de la ville de Bobo-Dioulasso, Burkina Faso pour une utilisation efficiente en agriculture. *J Appl Biosci*, 33: 2076-2083.

9. Danloux I., Laganier J., 1991. Classification des phénomènes d'érosion, de transport et de sédimentation sur les bassins touchés par l'exploitation minière en Nouvelle-Calédonie. *Hydml Continent*., 6 (1):15-28.

10. Dupon J. F., 1986. Les effets de l'exploitation minière sur l'environnement des îles hautes: le cas de l'extraction du minerai de nickel en Nouvelle-Calédonie. IRD, Ressources documentaires, http pleins_textes/pleins_textes_5/b_fdi_31-32/34105. E1157124200898.pdf

11. Etchebest S., 2000. Croissance foliaire du maïs (*Zea mays* L.) sous déficience en phosphore. Analyse à l'échelle de la plante et à l'échelle de la feuille. Thèse préparée à l'unité d'agronomie, INRA Bordeaux, 83p.

12. Goodman G. T., 1974. Ecology and the problems of rehabilitating wastes from minéral extraction. *Proceedings of the Royal Society*, 339: 373-387.

13. Hassen A., Belguith K., Jedidi N., Cherif A., Cherif M., Boudabous A., 2001. Microbial characterization during composting of municipal solid waste. *Bioresour Technol*, 80: 217-225.

14. Koledzi K. E., 2011. Valorisation des déchets solides urbains dans les quartiers de Lomé (Togo): Approche méthodologique pour une production durable de compost. Mémoire de Thèse de Doctorat, 224p.

15. Koledzi K. E., Baba G., Tchangbedji G., Agbeko K., Matejka G., Feuillade G., Bowen J., 2011. Experimental study of urbans waste composting and evaluation of it's agricultural valorization in Lomé (Togo). *Asian J. Appl. Sci.*, 4 (4): 378-391.
16. Laroche O., 2011. Révégétalisation de sites miniers et valorisation de boues de stations d'épuration : cas de la Nouvelle-Calédonie. Mémoire de Maîtrise en Environnement, Centre universitaire de formation en environnement, université de Sherbrooke, Canada, 128p.
17. Manios T., Laux D., Manios V., Stentiford E.I., 2003. Cattail plant biomass as a bulking agent in sewage sludge composting; Effect of the compost on plant growth. *Compost Sci. Util.*, 11 (3): 210-219.
18. MERF, 2010. Rapport national du Togo pour la dix-huitième session de la commission de développement durable des nations unies (cdd-18), 44p.
19. MINEO Consortium, 2000. Review of potential environnemental and social impact of mining. http://www.brgm.fr/mineo/UserNeed/IMPACTS.pdf
20. N'Gbesso M.F.D.P., Kouane N'Guessan C., Zohouri G.P., Konate D., 2013. Evaluation finale du rendement et des paramètres phytosanitaires de lignées de soja [*Glycine max* (L.) Merrill] dans deux zones agro-écologiques de savane de Côte d'Ivoire. *Int. J. Biol. Chem. Sci.*, 7(2): 574-583.
21. Physafimm, 2009. La phytostabilisation: la méthodologie applicable aux friches industrielles métallurgiques et minières. In École National Supérieure des Mines http://www.emse.fr.
22. Pirot R., 1998. La motorisation dans les cultures tropicales. 175p
23. Solé-Benet A, Contreras S, Miralles I, Lázaro R., 2009. Organic wastes as amendments for limestone quarry restoration. Advances in Materials Recycling and Eco – Energy (p. 42–44), Madrid, 12–13 november 2009, Madrid.
24. Toundou O., 2016. Evaluation des caractéristiques chimiques et agronomiques de cinq composts de déchets et étude de leurs effets sur les propriétés chimiques du sol, la physiologie et le rendement du maïs (*Zea mays* L. Var. Ikenne) et de la tomate (*Lycopersicum esculentum* L. Var. Tropimech) sous deux régimes hydriques au Togo. Thèse de doctorat de l'Université de Lomé en cotutelle avec l'Université de Limoges, 213p.
25. Toundou O., Tozo K., Amouzouvi K.A.A., Lankondjoa K., Tchangbedji G., Kili K., Gnon B., 2014. Effets de la biomasse et du compost de *Cassia occidentalis* L. sur la croissance en hauteur, le rendement du maïs (*Zea mays* L.) et la teneur en NPK d'un sol dégradé en station expérimentale. *ESJ*, 10 (3): 294-308.
26. Wild H. et G.H. Wiltshire G. H., 1971, The problem of végétation Rhodesian Mines dumps examined. Chamber of Mines Journal, 13 (11): 26-30 et (12): 35-37.
27. Zuccooni F., Forte M., Monaco A., De Bertoldi M., 1981. Biological evaluation of compost maturity. *Biocycle*, 22 (2): 27-29.

Project tags (select all appropriate):

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

Project focus:

- ☒Biodiversity management
- ☐Cooperation programs
- ☒Education and Raising awareness
- ☐Endangered and protected species
- ☐Invasive species
- ☒Landscape management - rehabilitation
- ☒Rehabilitation
- ☒Scientific research
- ☒Soil management
- ☐Urban ecology
- ☐Water management

Flora:

- ☐Conifers and cycads
- ☐Ferns
- ☒Flowering plants
- ☒Fungi
- ☐Mosses and liverworts

Fauna:

- ☒Amphibians
- ☒Birds
- ☐Dragonflies & Butterflies
- ☐Fish
- ☐Mammals
- ☒Reptiles
- ☒Spiders
- ☒Other insects
- ☒Other species

Habitat:

- ☐Cave
- ☐Cliffs
- ☒Fields - crops/culture
- ☐Forest
- ☐Grassland
- ☒Human settlement
- ☐Open areas of rocky grounds
- ☐Recreational areas
- ☐Screes
- ☐Shrubs & groves
- ☒Soil
- ☐Wander biotopes
- ☐Water bodies (flowing, standing)
- ☐Wetland

Stakeholders:

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