A COMPLETE RESEARCH REPORT ON **"THE USE OF VERMICOMPOST FROM ORGANIC FOOD WASTE AS A POTENTIAL TREAT FOR TOPSOIL IN RESTORING BIODIVERSITY AT QUARRY SITE RECLAMATION"** AT BEPOSO

PRESENTED TO THE JURY OF THE QUARRY LIFE AWARD GLOBAL COMPETITION

BY

KWASI BOADU NTIAMOAH, EBENEZER ADJEI-AFFUL & ADU SAFO KANTANKA

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ABSTRACT

Currently, municipal solid waste (MSW) management problem has been an issue of global threat and has baffled authorities in their quest to manage solid waste in a sustained state. Current studies on solid waste characterisation in Ghana gave approximately 60% putrescible waste making large scale vermicomposting very feasible. The main objectives of the research were: (1) To innovatively use African Night Crawlers (*Eudrilus eugeniae*) to recycle organic food waste into vermicompost directly on highly degraded mine laterite using simple in-situ technology. (2) To use vermicompost to amend quarry waste (laterite) into a suitable growth medium to promote biodiversity at some part of an active quarry site. This aim was to find an alternative means to change quarry lateritic overburden into suitable growth medium to restore biodiversity during quarry reclamation activities. (3) To compare the effectiveness of vermicompost, laterite and amended laterite in protecting seeds and promoting seedlings growth in Greenhouse. Initial assessment of biodiversity and physicochemical parameters of the site were done and the site divided into two equal blocks (P1, amended laterite and P2, laterite). It was discovered at the end of the research that there was about 1375% increment in fauna alone (excluding the worms used and microbial organisms) at the experimental plot (shown in Fig 25). Native crops and agroforestry plants that were cultivated in the amended laterite medium and laterite medium recorded 100% and 20% average survival respectively. Using Dilution Plate Techniques, amended laterite was discovered to be a better habitat for plant growth promoter microbes than the laterite. Physicochemical parameters of the amended laterite were within the standard thresholds of FAO but that of laterite were below the standards. The research has practically established a guideline on how to change quarry laterite into growth medium to promote biodiversity after quarry site reclamation activities by using logistically feasible and environmentally friendly simple in-situ technology.

INTRODUCTION, BACKGROUND INFORMATION AND PROBLEM STATEMENT

Based on an estimated population of 18 million in 1994, about 3.0 million tons (2.7 million tonnes) of solid waste were generated annually in Ghana, and that on average, each person generated daily 0.45 kg of solid waste (Mensah and Larbi, 2005). Another study in 2008 suggested that every Ghanaian generates 0.50 kg of solid waste daily (Demedeme, 2008) which estimates 13.32 million tons of waste with current population of 26,652,767. MSW in Ghana is largely dominated by the organic/putrescible component which constitutes about 60% of the average waste stream (Adu and Lohmueller, 2012) but only 10% of waste generated get to landfill sites. The majority of waste gets into drainage systems resulting in periodic floods, cholera outbreak, and financial losses. More than 7,000 people have been affected by cholera this year, with close to 70 of them dying in Accra alone (GhanaWeb.com, August 31, 2014) due to poor waste management. Waste management is the greatest challenge facing Ghana lately. President John Mahama, on Saturday, August 30, 2014, personally immersed himself in the filth of the capital, Accra, to help clean the city (GhanaWeb.com, August 31, 2014).

Mining activities over the years have generated huge sums of money to Ghana. Following its contribution to the socioeconomic transformation in the country, the industry has between 1984 and 1999, attracted about 4 billion dollars of direct foreign investment into the country for mine development, expansion and extraction, which promote poverty reduction and enhancement of living standards (Minerals Commission, 2000).

Despite the various benefits derived from mining activities, the devastating effects left by mining activities on agricultural lands, water bodies, biodiversity and the communities are very appalling. After mining activities, most mining companies lack topsoil for reclamation activities. The most readily available material for reclamation is mine waste (laterite) which has its physicochemical parameters falling below Food and Agricultural Organisation (FAO) standards. Despite the challenges, the application of topsoil is a key element in any successful reclamation project (Stoupe, 1998) to facilitate biodiversity promotion.

Land owners of mine sites, who are mostly peasant farmers, are compelled to adopt NPK fertilization on most reclaimed lands before they support biodiversity. Inorganic fertilizer is not only expensive but also the rampant use of chemical fertilizers contributes largely to the deterioration of soils and aquifers. It leads to loss of soil fertility due to imbalanced use of fertilizers that adversely impacts agricultural productivity and causes soil degradation which gradually endangers biodiversity (Wani *et al.* 1995).

Generally, the biodegradable waste produced in Ghana and the prevalent conditions make it suitable to vermicompost for quarry sites reclamation. Vermicompost when used as amend has the potentials to change quarry laterite into growth medium to support biodiversity. In short, earthworms, through a type of biological alchemy, are capable of transforming garbage into 'gold' (Vermi Co, 2001) which can be used to change quarry laterite into a habitat for fauna and flora but has not been practised.

OBJECTIVES OF THE RESEARCH

The main objectives were:

a. To innovatively use African Night Crawlers (*Eudrilus eugeniae*) to recycle organic food waste into vermicompost directly on highly degraded mine laterite using simple in-situ technology.
b. To use vermicompost to amend quarry waste (laterite) into a suitable growth medium to promote biodiversity at some part of an active quarry site.
c. To compare the effectiveness of vermicompost, laterite and amended laterite in protecting seeds and promoting seedlings growth in Greenhouse.

METHODOLOGY

Description of the study area

The research was conducted at the West Africa Quarries Limited (WAQL), Beposo, which was commissioned on March 7, 2014 to averagely supply 250 tons granite aggregates per hour for road construction and other constructional purposes using a three-stage mobile crusher to facilitate the socioeconomic development of Ghana. The company is located at Atta-ne-Atta near Beposo in the Shama District in the Western Region of Ghana (N5^0 08' 12" -W1^0 36' 42" and N5^0 08' 23" -W1^0 36' 38"). It has a concession size of 16.49 acres with a single operational pit. It is 2.3 km from the Cape Coast-Takoradi road.

The concession area has a moist tropical climate with an average annual temperature of 23-32°C and an annual rainfall ranging between 1200 and 1800mm, with July as the peak month producing 375mm. It experiences two rainfall maxima with a very distinct dry season. Relative humidity is generally high throughout the year ranging from 76% to 85%. The maximum daily temperatures during the hot months may be expected to exceed 35°C while the minimum can fall below 21°C. Biodiversity of the area has rapidly changed due to human activities. The flora is chiefly characterized by *Ceiba pentandra, Alchonea Cordifolia* and oil palm (*Elaies guineensis*). 165 vascular plant species have been recorded with about seven listed on the IUCN Red List as globally threatened. The fauna common at the area are Avi fauna-Birds (Accipitridae, Ardeidae), Dragonflies and Damselflies, Rodentia-Sciuridae, striped ground squirrel, western palm squirrel, Hystricidae-Brush tailed porcupine and Thryonomyidae-Grasscutter/cane rat.

Research Methods: Activities employed during the research

Vermiculture (Earthworm selection and multiplication)

Vermiculture is the process of collecting and rearing of worms. It is a precursory process that seeks to increase the number of worms and also provide mature worms for large scale vermicomposting.

Earthworms are invertebrates. There are nearly 3600 types of earthworms in the world and they are mainly divided into two types: (1) burrowing; and (2) non-burrowing. The burrowing types *Pertima elongate* and *Pertima asiatica* live deep in the soil. On the other hand, the non-burrowing types *Eisenia fetida* and *Eudrilus eugeniae* live in the upper layer of soil surface. The burrowing types are pale, 20 to 30 cm long and can live for 15 years. The non-burrowing types are red or purple and 10 to 15cm long but their life span is only 28 months (Nagavallemma *et al*, 2004). Earthworms may be segmented and bilaterally symmetrical. They are invertebrates and have a clitellum. They also taper at both ends.

Table1: Shows some features of different worms

Name of worm species	Limits and optimal Temperature	Limits and optimal moisture	Colour	Size of adult worm	Time to maturity	Incubation Time
Eudrilus eugeniae	25°C(16°C-30°C)	80% (70%-85%)	Reddish-brown	5–7mm × 80–190mm	40-49 days	12-16 days
Perionyx excavatus	25°C–37°C	70%-85%	Reddish brown	4–5mm × 45–70mm	28-42 days	18 days
Lumbricus rubellus	9°C -10.6°C	50%-80%	Reddish brown	4mm × 70–150mm	74-91 days	35-40 days
Eisenia fetida	25°C (0°C–35°C)	80%85%(70%–90%	Brown with buff bands	4–8mm × 50–100 mm	28-30days	18-26days
Eisenia Andrei	25°C (0°C–35°C)	80%–85% (70%–90%)	Red	4–8mm × 50–100 mm	21–28 days	18-26 days

Eudrilus eugeniae was selected due to its suitable characteristics for vermicomposting in Ghana. It is a very common species in Ghana accessible along river banks, damp places and mostly in piled agricultural waste.

10Kg of worms were collected at a backyard plantain farm in Tarkwa and cultured for 48 days (as shown in F1g 1& Fig 2) and observed the following;

1. The culturing box was kept indoors to regulate the heat content as microbial and wormy activities emanate heat. Worms usually move out of culturing box when temperature rises beyond optimal.
2. Leaves of beans, dried cow dung, watermelon, avocado and shredded papers were given to them as feed.
3. The moisture content was kept at 78%-83% to provide the worms with enough water for metabolic process and hydrostatic movements.


Fig 1: Researcher collecting worms


Fig 2: Worms out of box due to heat.


Fig 3: Worms feeding

Site selection and biodiversity assessment

Experimental plot at the Beposo Quarry was selected at an elevation of 120m. The topsoil had been scrapped off thereby leaving the plot highly eroded with gullies and no flora colony (shown in Fig 4). Fauna that was located at the plot was omnivorous *Agama agama*. The bare surface of the plot made it effective for basking and breeding. Intensity of sun determines the sex of *Agama agama* eggs. Higher temperature will produce male and lower temperature will produce female (Waghmare, 2013). Plant growth promoter microbes were not present in the samples assessed.

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Fig 4: Nature of experimental plot before reclamation

The innovation and construction of vermicomposting beds (vermibeds)

The surface of the experimental plot of total dimension 10m×4m was ploughed. This provided loose materials to allow easy percolation of water. The experimental field was subdivided into two equal plots of dimensions 5m×4m (P1 and P2). P2 was the control experiment with laterite as growth medium while P1 was for amended laterite.

We innovatively constructed three rectangular beds of average dimension 2.30m×1m×1m directly on the P1 from nylon mesh, black polythene and bamboo. The mesh used was to ensure enough aeration and keep predators of *Eudrilus eugeniae* away. Black ventilated polythene was used to cover the beds to ensure total darkness in the bed. African Night Crawlers are nocturnal and keeping the beds dark was to ensure continuous feeding during the short period. Aeration, regular watering of substrate and shade provided kept the temperature of the bed optimum for vermicomposting. The general idea behind the in-situ beds was to induce natural conditions that stimulate vermicomposting.

Waste collection, education and field demonstration as part of community involvement in reclamation

Majority of the stakeholders of Beposo community are peasant farmers and belong to the lower income class. Stakeholders' involvement in land reclamation is one key element that QLA seeks to establish. Six stakeholders with experience in waste collection were selected from those who expressed employment concerns to collect and transport putrescible solid waste to the research site (shown in Fig 7). This was to give immediate economic value of the research to the stakeholders apart from the innumerable benefits the project promises. The characterisation of the wastes is represented in Fig 8.

Several stakeholders' consultations and educations were organised (Fig 5 and Fig 6). Most stakeholders expressed concerns about the high cost of NPK fertilizer on the market, making it unaffordable. Moving forward, a 13-member group headed was instituted to fully learn the vermicomposting processes. It was agreed that the group members would also share their findings to the rest of the stakeholders (shown in Fig 9). We adopted the ICRISAT-Project (Nagavallemma *et al,* 2006) modes of vermicompost application on farms during the practical demonstration. The education really made them appreciate the existence of the quarry in the community.

Majority of the political stakeholders such as Shama DCE, STMA Metro Coordinating Director, Shama Environmental Specialist, Shama City and Planning Officer and many more were educated about Quarry Life Award and its significance in biodiversity conservation.

We selected two of the most popular online media in Ghana, Modernghana.com (http://www.modernghana.com/news/552959/1/ghacem-qla-project-to-rescue-accra-from-seasonal-f.html) and Ghananewsreport.com (http://www.ghananewsreport.com/ghacem-qla-project-to-rescue-accra-from-seasonal-flood-menace/), to selflessly educate the masses about this unique and most promising project. This was done to directly create publicity for HeidelbergCement Group.

Fig 5: Pupil receiving award after QLA and biodiversity education.

Fig 6: Political stakeholder consultation.

Fig 7: Stakeholders engaged in waste collection.

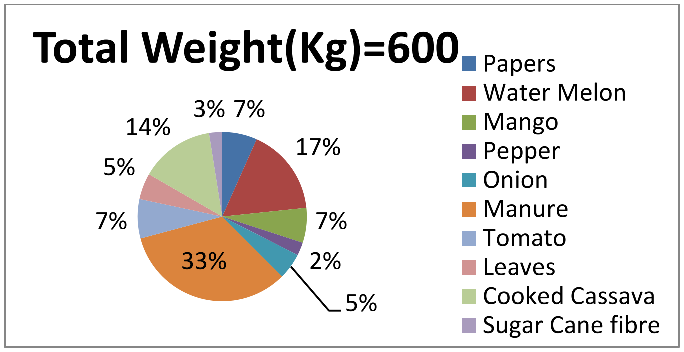

Fig 8: Characterisation of the putrescible wastes collected

Fig 9: 13-member group meeting

Pre-composting/Thermo-composting to promote fauna division of biodiversity

Thermo-composting comprises a short period of high temperature treatment followed by a period of lower temperature, facilitating mass reduction, waste stabilisation and pathogen reduction (Bajsa *et al*., 2003). Thermo-composting prior to vermicomposting was helpful in waste stabilisation, pH and moisture stabilisation as well as for mass reduction. Vermicomposting after thermo-composting was effective in inactivating the pathogens. Thermo-composting for 9 days followed by 2.5 months of vermicomposting produced pathogen safe compost. (Nair *et al*, 2005).

We pre-composted 300 kg of substrate in each of the three vermibeds for 16 days by covering the nylon with dark polythene. 30 cm gaps from the four edges of the beds were not covered with polythene. This was to stimulate aeration which played key roles in reducing odourisation and souring of substrate. Vermicomposting was done for 1.5 months. Most of the biodiversity were attracted to P1 during the Precomposting stage.

Vermicomposting

Vermicomposting involves the stabilization of organic solid waste through earthworm consumption which converts the material into worm castings. It is the result of the combined activity of microorganisms and earthworms (Domínguez, 2004). It is a mesophilic process, utilizing microorganisms and earthworms that are active at 10–32°C (not ambient temperature but temperature within the pile of moist organic material). The process is faster than composting; because the material passes through the earthworm gut, a significant, but not yet fully understood transformation takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and fortified with pest repellency attributes as well (Vermi Co, 2001).

Vermicomposting systems are influenced by the abiotic factors such as temperature, moisture and aeration (Domínguez, 2004). The moisture content of the substrate was kept at range of 78%-80% by watering the setup daily. Shade was provided for the setup to ensure optimal temperature for vermicomposting. Extreme temperatures, dry substrate, very acidic PH and anaerobic conditions usually lead to mortality of earthworms thereby stopping vermicomposting.

One thousand adult worms weigh approximately one kilogram. They can convert up to 5 kilograms of waste per day (Medany, 2011). 5kg of *Eudrilus eugeniae* were introduced to each vermicomposting bed after the pre-composting process and vermicomposting done for 44 days (as shown in Fig 3).

Assessment of the physicochemical properties of samples from P1 and P2 for land reclamation

Sample of the vermicompost and laterite were taken to KNUST Soil Research Laboratory and UMaT Geological Engineering Laboratory for the determination of the following: Nitrogen (N), Phosphorus (P), Potassium(K), Calcium (Ca), Magnesium (Mg) , Sulphur (S), organic matter content (OMC), pH and toxic elements such as Lead (Pb), Zinc (Zn), Copper (Cu), Cadmium (Cd), Arsenic (As), Nickel (Ni). Microbial organisms, Atterberg Limits and Bulk density of the samples were also determined.

Maize, cassava, tomatoes, beans, groundnut, palm tree, avocado and *Alchonea cordifolia* were selected for cultivation as suggested by the stakeholders. At P1 (amended laterite), the crops were cultivated very close together to stimulate tough competition for water, nutrients, air and sunlight. At P2 (laterite), the same crops were grown at intervals of 40cm to reduce competition for survival among selected flora. Growth rates and percentage survival of flora were determined after 30 days (shown in Fig 21).

Potentials of vermicompost, amended laterite and laterite in Greenhouse

Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, and flower and fruit crops. Benefits of compost application in agriculture mainly result from its content of organic matter, plant nutrients, promoting plant growth and inhibiting root pathogens/soil-borne plant diseases (Hoitink,1980; Alvarez et al., 1995; Perner et al.,2006). Vermicompost indicates that it increases macrospore space ranging from 50 to 500 μm, resulting in improved air-water relationship in the soil, which favourably affects plant growth (Marinari *et al.* 2000). Seeds of maize, beans, okra and tomato were nursed in 100% vermicompost, laterite and amended laterite (50% laterite+50%vermicompost) and their growth rates determined after 14 days (shown in Fig 14).

Fig 10: Greenhouse of laterite, amended laterite and vermicompost

RESULTS

Vermiculturing (Earthworm selection & multiplication)

Eudrilus eugeniae selected for vermiculturing and vermicomposting were prolific and efficient composters. Although, the time of the vermiculturing process was short, additional 5kg of worms were hatched when the right abiotic conditions were maintained for the worms. Vermiculture is a very essential step that should not be skipped when large numbers of worms are needed for large scale vermicomposting.

Innovation and construction of vermibeds

The maiden simple in-situ technology has been innovated for direct vermicomposting on highly degraded quarry waste. This is a simple soil conditioning technology that can be implemented directly on quarry laterite when the source of organic waste is relatively closer to the quarry site. The beds were cheap yet efficient way of directly vermicomposting on a degraded land.

Assessment of the physicochemical properties of laterite and amended laterite for land reclamation

Laboratory analysis of the amended laterite and laterite showed that all the physicochemical properties of the amended laterite conform to the FAO standards and could be used as a baseline for quarry site reclamation globally. With the exception of PH which was slightly acidic. The results displayed in Table 2.

Biodiversity

In the study, the biodiversity and growth rate of some selected native crops in the greenhouse in the three growth media has been represented in Fig 14. Crops in the vermicompost experienced the fastest growth rate followed by the amended laterite and laterite. Fig 23 and 24 show the nature of the experimental plots after five weeks of cultivating some native plants. The fauna part of biodiversity that had been attracted to the vermicompost plot within the short research period are shown in Fig 11-Fig 22.

Waste collection, education and field demonstration as part of community involvement in reclamation

Mass educative programmes organised for individuals and the major stakeholders yielded great result in promoting the HeidelbergCement Group QLA to Ghanaians. Stakeholders assessed the potentials of this innovative project in eliminating the current waste management problems and their associated cholera cases in Ghana (7000 cases from July to August in Accra alone) and also promises chains of employment. This contributed immensely to the tremendous increase of the project's Public Vote. At the end of community vermicomposting training, all the 13 members of the group could practically undergo the vermicomposting processes.

Fig 11-22: some of the biodiversity captured on the experimental plot


Fig 11: Termites


Fig 12: Cave cricket


Fig 13: Caterpillar

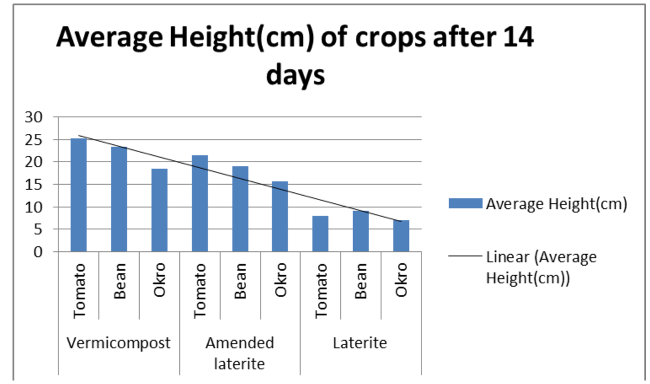

Fig 14: Growth rate of selected crops in greenhouse after 14 days.


Fig 15: Snail


Fig 16:Gecko


Fig 17: Grasshopper


Fig 18: *D. ventrimaculatus*


Fig 19: Spider


Fig 20: Butterfly

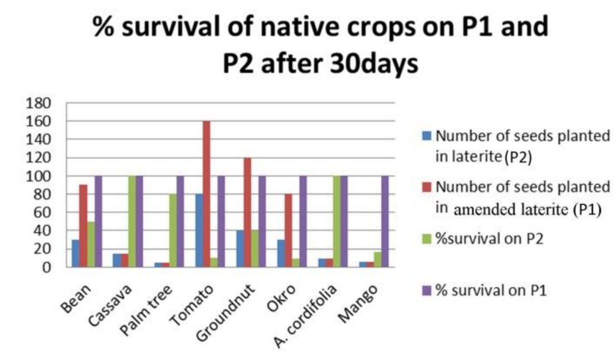

Fig 21: % survival of selected crops in the two growth media after 30 days.


Fig 22: Millipede


Fig 23: P2 after 30 days


Fig 24: P1 after 30 days

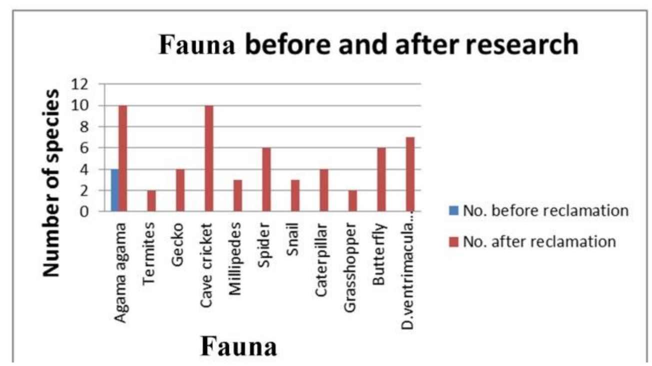

Fig 25: fauna recorded before and after research. Termite recorded two colonies.

DISCUSSIONS

Assessment of the physicochemical properties of laterite and amended laterite for land reclamation

The physicochemical parameters of amended laterite (P1) were within the FAO standards. There was a reduction in the original concentrations of cadmium and arsenic that were in the laterite from 0.900 (mg/Kg) and 1.67(mg/Kg) to 0.055(mg/Kg) and 0.072(mg/Kg) respectively after the in-situ vermicomposting on P1. The earthworms, the drivers of many processes in soil, apart from the known vermicomposting, are also found to enhance phytoextraction of metals from contaminated soils (Sinha, *et al,* 2010).

The presence of plant growth promoters like Azotobacter, Rhizosphere and cyanobacteria in the amended laterite was also a factor that resulted in the cumulative concentrations of N, P, and K. These flora growth promoters were not present in the laterite (P2). These microbial organisms contributed immensely to the percentage survival of crops on P1 plot. The concentrations of metal in the amended laterite were all within the permissible limits.

PH of the laterite was 5.7. The parent material of the soil is granite and this greatly factored in the acidic PH of the laterite. The amended laterite recorded a PH of 6.21 which is within the PH range 6.0-7.0 at which nutrients are readily available for plant use. The pore spaces of the laterite were 26% and that of the amended laterite was 49%. Vermicompost in its original state was discovered to have pore spaces of 68%. This affected the pore spaces of the amended laterite significantly.

The research has indicated that amending laterite with vermicompost yielded 100% survival of flora which is directly linked to fauna. On P1, crops were closely cultivated to ensure keen competition for water, air, sunlight and nutrients but the crops at P2 were well spaced to greatly reduce competition for water, air, sunlight and nutrients. But there was 100% and 20% survival of crops cultivated on P1 and P2 respectively. The crops on P1 were healthier than P2- P2 crops showed stunted growth due to lower concentrations of nutrients.
Organic Matter (OM) of laterite was 0.58% and the amended was 5.20%.

Potentials of vermicompost, amended laterite and laterite in Greenhouse

The results from the Greenhouse showed that vermicompost had the highest growth rate and the seedlings were healthiest. This was as a result of higher concentration of seeds protecting microbes. Earthworm castings increased plant (including root) growth stems diameters, and flower numbers (Hidalgo et al., 2006). Laterite with 50% vermicompost flourished with healthy stem and leaves after 14 days of assessment. 100% laterite did not promote seedlings growth as a growth medium in greenhouse. This was a result of nutrients and microbe deficiency. All growth media were given the same treatment during the study.
Vermicompost is the best growth medium to be used in commercial agroforestry greenhouse which can be implemented by WAQL and Yongwa Limestone Quarry during their post reclamation activities.

ADDED VALUE OF THE PROJECT TO BIODIVERSITY, THE SOCIETY AND THE COMPANY

Biodiversity

For the first time in Ghana, direct method of vermicomposting has been done to amend quarry waste into efficient growth medium to restore biodiversity. The amended laterite supported native plants that were planted as agreed between the stakeholders' and the researcher. Most large scale agroforestry plantations need greenhouse (nursery), vermicompost and amended laterite protected seeds from pest and promoted the seedlings growth. This feat has provided an organic baseline for protecting seeds and seedlings from pests and diseases.
At the end of the research, fauna alone increased by 1375% excluding microbial organisms in the amended laterite. Flora enhancement was ultimate as at the experimental site after the study (Fig 24).

Community

The project so far has been useful to the Atta-ne-Atta community. The stakeholders who are mostly peasant farmers were practically educated to prepare their own vermicompost for their farms. The ripple effects are:

1. The community people have been taught how to recycle organic waste in the community into "wealth" for socio-

economic transformation. This aims at ensuring cleanliness and eliminating diseases such as cholera and malaria that have recently been a menace in Ghana.

2. The community people would save money which they would have used in buying inorganic fertilizer to treat their farms. This is an economic-relief project to the community.
3. Vermicompost is not only an organic fertilizer but it is also a soil conditioner. It has high OM and promises to conserve their agricultural lands.
4. The project has created a strong interpersonal relationship between the community and the company. In case of any future implementation of the project at WAQL, the stakeholders can be contracted to undertake the reclamation activity. This has created employment opportunity for the stakeholders.

Company

The project is a baseline on how to cheaply change a mine waste (laterite) into a potential growth medium to restore biodiversity during reclamation. Yongwa Limestone Quarry and West Africa Quarries Limited, subsidiaries of GHACEM, currently lack topsoil and have to undertake topsoil amendments during reclamation. This project will release GHACEM from the challenges it was meant to face in future reclamation exercises at Yongwa and Beposo.

The future implementation of this project will release GHACEM from Environmental Protection Agency reclamation bonds since the nutritional content of the amended laterite conforms to the threshold of the FAO. Some metals concentrations can be reduced through phytoextraction by *E. eugeniae* when this study is replicated during reclamation.

The project has explored other biodiversity existing at WAQL site. These organisms can be added to the already existing biodiversity baseline and will help WAQL during its post reclamation activities.

GHACEM and WAQL have been greatly advertised to Ghanaians especially the students of the University of Mines and Technology, Tarkwa, who are a potential work force for the company. The educative programmes that were included in this project have provided the platform for some students, for the first time, to know great deal about HeidelbergCement Group. The research has brought the Company closer to majority of stakeholders.

GHACEM has also fulfilled its corporate social responsibility by sponsoring such a great project that has the potentials of saving Ghana from putrescible waste and its related environmental problems.

CONCLUSIONS: Statement on Chances of Success and Outlook on Future Implementation

In future reclamation activities, this project seeks to change quarry laterite which is mostly deficient in soil nutrients into suitable growth medium to restore biodiversity. Though, the objectives outlined for this research have been accomplished, but the following recommendations must be observed in the future implementation of the project.

This is a pilot project but on large scale implementation, vermicomposting must be done at lower elevation and the vermiculite transported to the reclamation plots if the reclamation site is hilly because the bulk density of the vermiculite (476Kg/m^3) is less than the organic waste (677Kg/m^3). Termites increase mortality of worms hence vermicompost system must be termite controlled.

Thorough assessment of physicochemical parameters of laterite must be done during the implementation of the project. This will give prior knowledge on the correct qualitative and quantitative application of the vermicompost.

There are a lot more to be done since this project can be implemented outside QLA. Commercial vermicomposting will not only change laterite into topsoil for restoring biodiversity, it will also be a boon for socio-environ-economic transformation of Ghana. It could create chains of companies; Waste Collection Company; Vermiculture Company; and Vermicomposting Company. With current unemployment and waste management problems in Ghana, replication of this project will be positive transformation in the socio-economic history of Ghana.

Other discovered fauna at the quarry site should be added to WAQL biodiversity baseline if they are not already captured. This is to prevent more organisms at the site from entering IUCN Red List as threatened after post reclamation activities. See also http://www.quarrylifeaward.com/project/use-vermicompost-organic-food-waste-potential-treat-topsoil-restoring-biodiversity-quarry for more information about the discovered biodiversity at the quarry site.

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