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Assessment of the Impact of Cow Dung on the Stability of Soils from two Erosion Prone Areas of Delta State.

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Abstract

This study was to determine the impact of cow dung on the stabilities of erosion prone soils from Agbor and Ukwu-nzu communities of Delta State. Soil Samples of depth ranging from 10-15cm were collected and analyzed for physicomechanical properties. Particle size distribution plastic and liquid limits, plasticity index and Califonia bearing Ratio using standard methods. Cow dung sample was also obtained and analyzed to ascertain their nutritional values and heavy metals content. The soil samples were then treated with cow dung at different rates of 10, 20, 30 and 40% after 3 and 6 months respectively for the same soil parameters as in the raw soil samples. Triplicate analysis was carried out for each parameter and mean values obtained showed soil %CBR for Agbor sample ranged from 6.5±0.2 to 8.7±0.1; optimum value of 8.7±0.1 was obtained with 40% mix at 6 months post-application. Plasticity Index for Agbor sample was between 12.3±0.2 and 22.6±0.3 with optimum value of 16.2±0.3 obtained at 3 months post application with only 10% mix. CBR for Ukwu-nzu sample ranged from 9.0±0.2 to 11.8 ±0.3; Plasticity Index ranged from 13.3±02 to 17.8±0.5. Optimum values for both %CBR and Plasicity Index were obtained at 3 months pot-application with 10% mix. Result obtained clearly demonstrated cow dung's ability to improve soil structure and by extension, the stability of erosion prone areas. For Agbor soil, optimal improvement was observed at 3 months post-application of 10% cow dung mixture while Ukwu-nzu sample achieved optimal stability with 20-30% cow dung mix at 6 months. Therefore, 10% and 20-30% cow dung mix at 3 and 6 months respectively are recommended for a remarkable improvement in soil structure and subsequent soil stability of Agbor and Ukwu-nzu areas of Delta State.

Keywords: Erosion prone soil, cow dung plasticity index califonia bearing ratio

Introduction: Soil is the thin layer of the earth's surface and is the source of food that sustains the growth of plants and animals (Balba, 1995). Soil consists of a mixture of minerals, organic matter, and water which are the most fundamental requirements for agriculture. Ajibulu, Adefemi, Asaolu and Oyakhilome (2013), opined that soil is the final product of the weathering action of physical, chemical and biological processes on rocks which largely produce clay minerals. The organic portion of soil is made up of decaying plant biomass (Manahan, 2011). Obolo et al, (2023) believes that decomposition of carbon generate microorganisms which makes microorganisms that can improve soil organic content. Inadequate land management has resulted in soil degradation in many agricultural areas around the world (Ihejirika, Onwudike,Nwaogu, Emereibeole, Ebe and Ejiogu, 2012). This has further resulted in deterioration of soil health in terms of both physical and chemical conditions (Han, Young, Jachorg, Bi and Byung, 2015).

The effects of soil stability and consequent erosion go beyond the loss of fertile land. The major consequences of soil deterioration is poor soil fertility, erosion and general soil destabilization and this has forced the land use stakeholders to consider ways of improving soil quality through soil stabilization. Adekanni et, al (2022) reported an interesting finding on soil impacted with organic and inorganic fertilizers; they noted that the soil on the organic manure plot had a better structure than that impacted with inorganic fertilizers. Follet et al, (1981) believes that organic materials from plant and animals, present in the soils are beneficial to soil and plants because of their nutritional content. They balance the soil ph, introduce macro and micro-elements into the soil, increase cation exchange capacity of the soil, protecting the soil from rapid degradations and toxicity while reducing water and wind erosion. Cow dung is the excreta of cows and a product of the undigested residue of food materials consumed by cows and excreted to the surface of the earth. According to, Kartikey, K.G.; Karmal, R.A.&, Deepansh, R. (2016), cow dung is made up of undigested plant material, water, micro-organisms and fibre. Recently, researchers discovered that adding cow dung to biomass derived from palm oil industries improves the physical and chemical properties of soil like pH, electrical conductivity and organic matter, as well as its nutritional composition (Vakili, Zwain, Rafatullah, Gholami, and Mohammadpour, 2015. according to Adekanni, et al, 2022, it is high in organic materials and rich in nutrients; they argued that organic soil amendments like cow dung have feasible effects on its physical properties. Many researchers have linked cow dung to improved soil physicomechanical properties and by extension, stabilities of the impacted soils. Phani, K.V,; Madhu, B.; Likhitha, C & Vashith, R, (2024) believe, 10-20% replacement of predominantly clayey soil sample with cow dung

significantly increases the stability of the soil, while Sharma, R. and Malik, M., opined that increased quantity of fibre (present in cow dung, sugar cane etc) replacement destabilizes the impacted soil sample. Njike, M., Walter O. and Timothy, N. (2015) conclude that the addition of cow dung to black cotton soil reduces the number of cracks and the amount shrinkage on blocks and also increases the strength of the blocks. Thus, cow dung is a cheap and economically viable and eco-friendly organic waste resource, which can be useful in the improvement of soil stabilities through the improvement of certain soil properties aMs which is easily available.

This study therefore seeks to use cow dung to improve certain soil physicomechanical properties and by extension, soil stability in the erosion prone areas of Ukwu-Nzu and Agbor communities of Delta State

Materials and Methods: Materials: Soil samples of study were collected from the erosion prone areas of Ukwu-Nzu and Agbor communities in Anioma area of Delta state, by grab sampling method and a soil depth ranging from 10 – 15cm using soil auger as specified in APHA, (2010). Cow dung was obtained from Oghara abattoir (close to Oghara market) and farms in Mosogar and carefully stored in 100kg capacity plastic drum with adjustable air-tight lids and labelled accordingly

Methods: Pre-treatment Analyses : Soil Samples were analyzed for physicomechanical properties: particle size determination using standard procedure described in ASTM D6913 (1999); atterberg's limits (plastic limit, liquid limit plasticity index) according to standard methods contained in ASTM- D4318 (2018) and california bearing ratio; as specified in ASTM- D1883 (2021). Cow dung was analysed for selected parameters like pH, organic matter, nutritional values like nitrogen, phosphorus, calcium, magnesium, sodium, potassium to determine their nutritional contents using standard methods as contained in APHA (2010).

Post-treatment Analyses: The raw soil samples were then treated with various percentages of the cow dung at the rates of 10%, 20%, 30%, and 40% and left to cure for over a period of 3-6 months. At 3 months maturation period, the sample mixtures were subjected to analyses based on same parameters used for the raw soil samples (physicomechanical parameters) and the results were tabulated. After 6 months maturation period, the same set of analyses were again effected on the sample mixtures and the results tabulated.

Results and Discussion: Conclusion: While none of the treatment variation of the cow dung for both soil samples achieved the standard (15%) for the %CBR of non-erodable and fine grain soil according to ASTM (2021), there was a significant increase in the CBR (6.5±0.2 – 8.7±0.1) for Agbor soil sample which had and an optimum value of 8.7±0.1 obtained with 40% cow dung mix at 6 months post-application. However, the next optimal %CBR value of 8.6±0.1 and 16.2±0.3 optimum value for PI were both obtained with 10% cow dung mix after 3months post – application, making 10% cow dung mix (with a utilization period of 3 months) the most suitable for Agbor soil sample. There was a less significant increase in the %CBR (10.0±0.5 – 11.8±0.3) for Ukwu-nzu soil sample which had and an optimum value of 11.8±0.3 obtained with 30% cow dung mix at 6 months post-application. The next optimal %CBR value of 11.1±0.3 and 16.4±0.5 optimum value for PI were both obtained with 20% cow dung mix after 6 months post – application, making 20% cow dung mix (with a utilization period of 6 months) the most suitable for Ukwu-nzu soil. Both communities share same geographical location but very different soil physicomechanical properties especially in relation to cow dung manure, and this resonates the dynamic nature of soil properties.

Recommendation: The application of cow-dung to Agbor soil with the aim to improve soil stability for planting and other applications should be at 3 months post-application period with 10% treatments while 20-30% cow dung mixture at 6 months post-application period, should be considered for Ukwu-nzu soil. Secondly, there should be more research work on the compatibility or not of these areas to other organic wastes using similar ratios for soil fertility assessment

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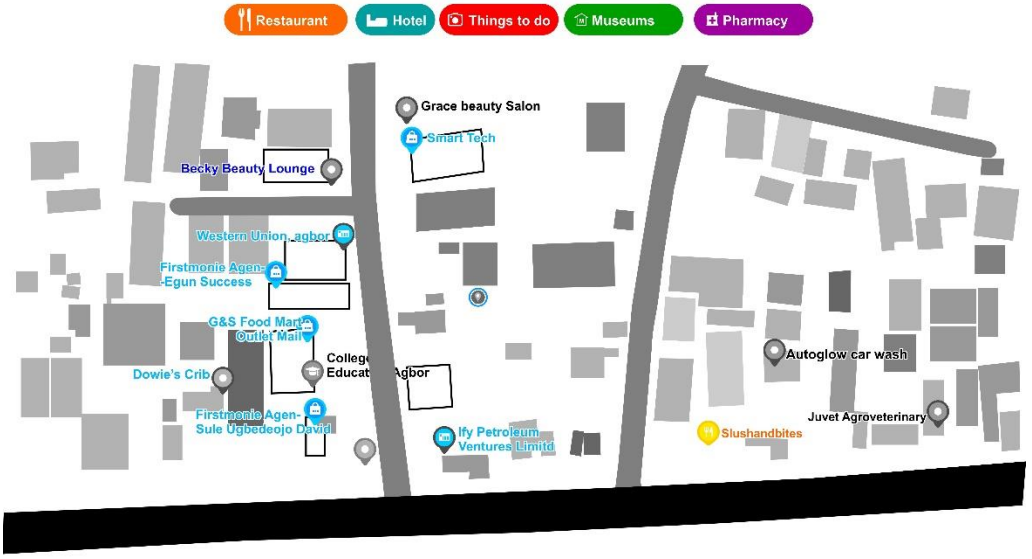

Figure 1. Description of site for Agbor Soil Sampling Old College Road, University of Aabor, Delta State

Figure 2. Description of Site for Ukwu-nzu Soil sampling (Ogbe-Utu Primary School Area) UKwu-nzu, Delta State

Results

Table 1: Physicochemical Properties of the Cow dung

PARAMETER	COW DUNG
pH	5.5±0.1
Fe (mg/kg)	190.2±00
Zn (mg/kg)	51.7±0.4
Mn (mg/kg)	8.7±00
Pb (mg/kg)	0.08±0.0
Cd (mg/kg)	0.14±0.0
%N	1.57±0.1
P(meq/100g)	42
Mg(meq/100g)	66.0±0.2
Ca(meq/100g)	0.57±0.4
K(meq/100g)	30.5±0.2
Na(meq/100g)	10.5±0

Table 2: Physicomechanical Properties of Untreated Soil Samples

SOIL PARAMETER	UKWU-NZU	AGBOR
%MC	21.5±0.4	19.5±0.5
Plasticity Index	18.3±0.1	12.3±0.2
Clay (%)	17.1±0.2	9.3±0.2
Slit (%)	25.4±0.5	22.5±0.2
Sand (%)	32.3**±0.2**	42.1±0.2
CBR %	11.3±0.3	6.5±0.2
Liquid Limit	42.4±0.3	41.0±0.2
Plastic Limit	24.1±0.2	28.7±0.3

Table 3: Physicomechanical Properties of Agbor Soil Sample treated with Cow Dung

DURATION		3 MONTHS				6 MONTHS			
SOIL PARAMETER	**CONTROL**	**10%**	**20%**	**30%**	**40%**	**10%**	**20%**	**30%**	**40%**
%MC	21.5.±0.4	20.5±0.2	21.5±0.1	22.6±0.2	23.9±0.1	20.4±0.2	19.4±0.1	20.6±0.4	19.8±0.2
Clay (%)	9.3±0.2	17.5±0.1	17.5±0.3	17.5±0.2	17.5±0.2	17.5±0.1	13.2±0.2	17.5±0.3	17.5±0.2
Silt (%)	22.1±0.2	16.5±0.2	16.3±0.1	16.1±0.2	16.2±0.3	16.2±0.3	16.4±0.1	16.2±0.2	16.2±0.3
Sand (%)	42.1±0.2	35.5±0.3	35.5±0.2	35.5±0.1	35.5±0.3	35.5±0.2	42.5±0.1	35.5±0.2	35.5±0.3
CBR %	6.5±0.2	8.6±0.1	8.4±0.3	8.5±0.1	8.6±0.3	8.5±0.2	8.5±0.3	8.5±0.5	8.7±0.1
Liquid Limit	41.0±0.2	40.3±0.2	38.9±0.1	42.2±0.3	42.3±0.2	38.2±0.3	42.1±0.1	46.2±0.2	47.0±0.2
Plastic Limit	28.7±0.3	26.0±0.3	25.6±0.2	26.1±0.1	24.0±0.1	24.5±0.3	24.4±0.2	23.8±0.3	24.4±0.1
Plasticity index	12.3±0.2	16.2±0.3	14.6±0.2	18.2±0.1	18.3±0.2	13.7±0.3	17.7±0.1	22.4±0.2	22.6±0.3

Table 4: Physicomechanical Properties of Ukwu-nzu Soil Sample treated with Cow Dung.

DURATION		**3 MONTHS**				**6 MONTHS**			
SOIL PARAMETERS	Control	10%	20%	30%	40%	10%	20%	30%	40%
%MC	21.1.±0.2	21.0±0.2	21.1±0.1	21.3±0.1	21.4±0.2	20.6±0.2	20.4±0.3	19.9±0.2	19.7±0.1
Clay (%)	14.7±0.1	15.7±0.4	15.7±0.5	15.6±0.5	15.4±0.3	15.7±0.2	16.3±0.1	16.5±0.5	16.7±0.4
Silt (%)	18.5±0.4	18.5±0.5	18.5±0.4	18.5±0.4	18.5±0.1	18.5±0.1	18.2±0.4	18.5±0.2	18.5±0.3
Sand (%)	37.3±0.4	37.8±0.3	37.0±0.1	37.1±0.3	37.8±0.2	37.4±0.2	37.3±0.4	37.3±0.5	37.5±0.4
CBR %	10.0±0.5	9.0±0.2	9.4±0.3	9.7±0.2	10.0±0.5	11.0±0.2	11.1±0.3	11.8±0.3	10.5±0.2
Liquid Limit	43.8±0.5	41.2±0.1	41.4±0.1	41.5±0.1	41.3±0.1	41.0±0.	41.3±0.2	42.3±0.2	40.3±0.1
Plastic Limit	26.0±0.5	23.2±0.4	24.1±0.3	24.2±0.2	24.0±0.2	24.0±0.3	24.1±0.3	26.0±0.1	25.0±0.1
Plasticity index	17.8±0.5	17.6±0.5	17.5±0.3	16.7±0.1	13.4±0.1	13.3±0.2	16.4±0.5	17.4±0.2	15.6±0.1

Figure 3: Physicomechanical Properties of Agbor Soil Sample treated with Cow Dung.

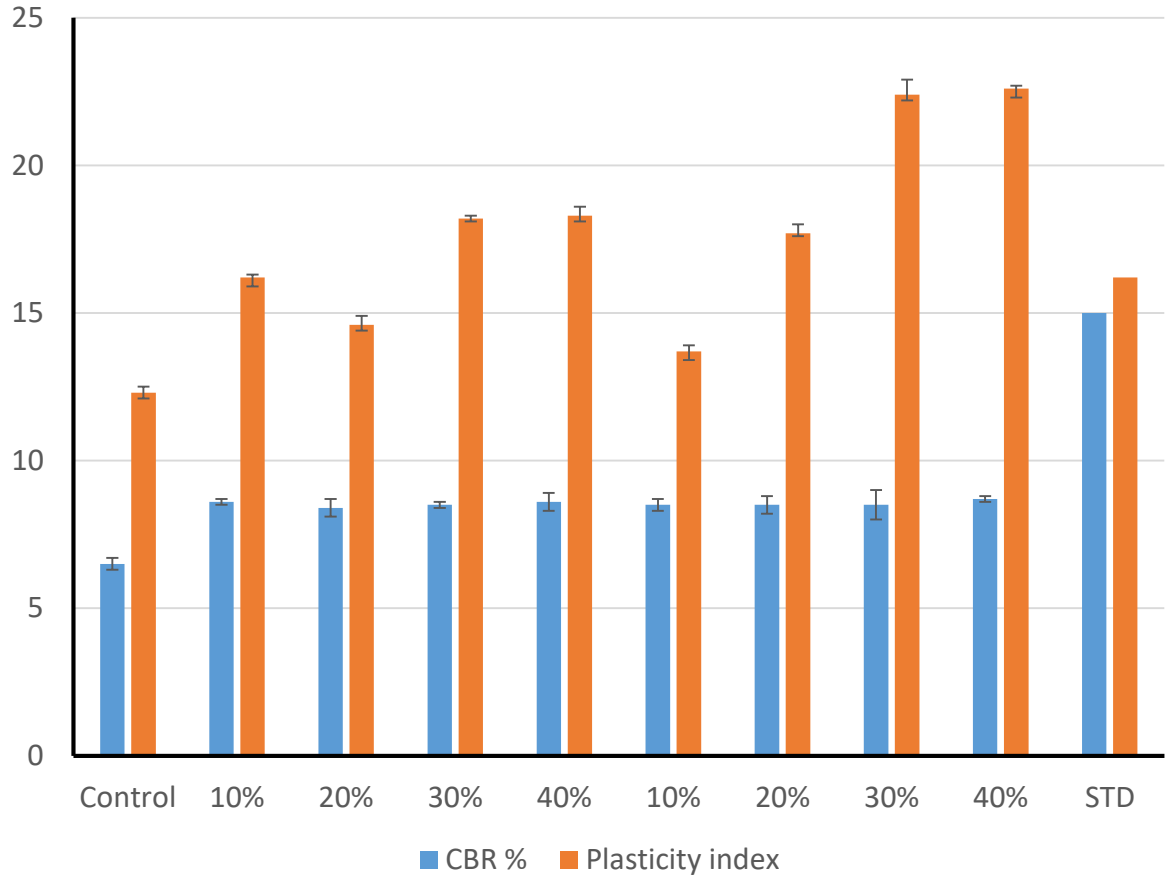

Figure 3 shows the result of the effect of cow dung on the key stability parameters under consideration: the %CBR and the Plasticity Index of the Agbor soil sample. The result revealed an increase in the %CBR of the soil sample from 5.5±0.2 to 8.7±0.1 and peaked at 8.7±0.1 with 40% of cow dung mixture.

For the Plasticity Index, the soil became more plastic as the plasticity index increased from 12.3±0.2 to a breaking point if 22.6±0.3 observed with 40% mixture after 6 months. The result however, revealed an optimum value of 16.2±0.3, obtained with 10% mixture after 3 months.

Figure 4: Physicomechanical Properties of Ukwu-nzu Soil Sample treated with Cow Dung.

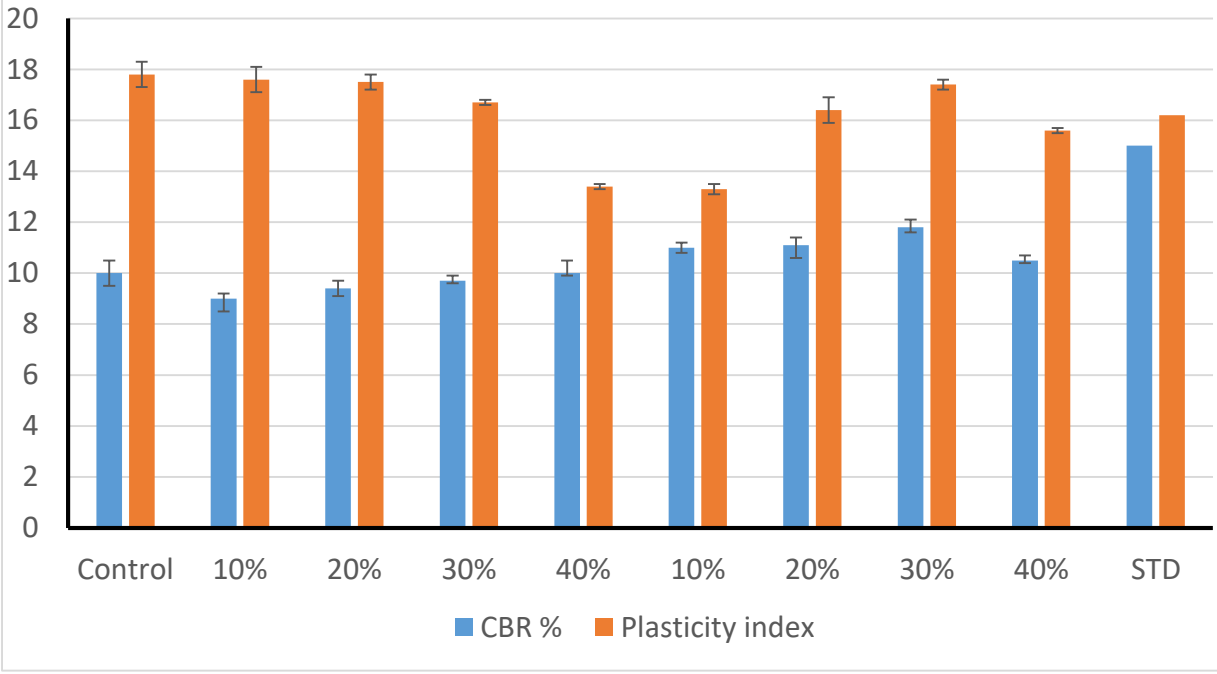

Figure 4 reveals the effect of cow dung on the Plasticity Index and %CBR of the Ukwu-nzu soil sample. The %CBR ranged between 9.0±0.2 and 11.8±0.3 with its peak at 11.8±0.3 obtained at 30% mixture with cow dung after 6 months post-application. The effect of the cow dung on the plasticity index of Ukwu-nzu soil sample showed that the soil Plasticity Index decreased from 17.8±0.5 to 13.3±0.2. The optimum value of 16.4±0.5 was obtained with 20% cow dung after 6months post-application. The impact of cow dung mixture on Ukwun-Nzu soil was best achieved with 20-30% cow dung mix obtained after 6 months post-application analysis.

References

Adekanni, J.S, Popools O.O. & Afolasin M.S. (2022). Short-term investigation to the effectiveness of Cow Dung powder on Lime Stabilized Tropical Soil in Road Construction. *Journal of Mechanical and Civil Engineering (Vol 9(2) pp 51-57.*

Ajibulu, K.E., Adefemi, O.S., Asaolu, S.S. and Oyakhilome, G.I. (2013). Determination of Heavy Metals in the Soil Samples of Selected Saw-mills in Ekiti State. *Journal of scientific Research and Reports* 2: 23-27.

American Society for Testing and materials, ASTM D1883 California Standard Test methods California Bearing Ratio. Retrieved from https://en.m.wikipedia,org/wiki/California_bearing_ratio.5/05/20

American Society for Testing and Materials, ASTM D4318 (2017). Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index. ASTM D4318-10. Retrieved from https://en.m.wikipedia,org/wiki/Atterberg_limits.15/04/2

American Society for Testing and Materials, ASTM D6913 (2017). Standard Test Methods for Particle Size Distribution (Gradation) of soil using Sieve Analysis. . Retrieved from https://en.m.wikipedia,org/wiki/California_bearing_ratio.5/05/24

APHA (2010). Standard Methods for the Examination of Water and Waste Water, 21st Ed. Washington,DC, New York: American Public Health Association.

Balba, A. M. (1995) Management of Problem Soils in Arid Ecosystems. CRC Press, Boca Raton, Florida. 250 pp.

Follet R.H, Murphy L.C. & Ghue R.C. (1981). Fertilizer and soil amendment Practice Hall Inc. USA.

Ho Han, Ji Young, N., Jachorg H., Kim, S.B. and Byung, B.P. (2015). The Effects of organic manure and chemical fertilizer on the growth and nutrient concentration of tomatoes in a nursery system. *Journal of Forest Science and Technology.*12:3-7.

Ihejirika, C.E., Onwudike, S.U., Nwaogu, L.A., Emereibeole, E.I., Ebe, T.E. and Ejiogu, C.C. (2012). Assessment of aquaculture sediment for agricultural fertilizer supplement and soil conditioner in Owerri

Urban, Nigeria. Journal of Research in Agriculture 1: 034-038

Kantiker, K.G, Kamal, R. A, & Decpanshu R. (2016) Current Status of Cow dung as a bioresource for sustainable development. *Bioresources and Bioprocesses.* 3:28

Manahan, S.E. (2011). Fundamentals of Environmental Chemistry, Third Edition. CRC Press

Njike, M., Walter O. and Timothy, N. (2015) Potential of Quary Dust and Cow Dung as Stabilizaers for Blank Cotton Soil Eco-blocks for Housing. *Civil ENgeneering Research.* VOl. 7(8). Pp117-124.

Obolo B., Ezeonyejiaku, C.D., Okeke, J.J., & Offorbuike, I.I. (2023). Cow dung, Vermicompositing: A Comparative Study on Physicochemistry and Biodegradability of *Eudrilus eugeniae and Lumbricus rubellus. J. Appl. Sci. Environ. Manage.* Vol. 27 (10) pp2195-2203.

Phani, Madhu, B, Maidhili, A, Likhitha, Ch,and Varshith (2024) Stabilazation of Clay soil using Cow dung. Journal of Emerging Technologies and Innovative Research (J.Vol 11 (4)

Sharma R. . & Malik M. (2002) Composting of a crop residue through treatment with microorganisms and subsequent vermicomposting. *Bioresour. Technol*, 85(2): 107-111.

Solange D., Nzeshala, S. E., Obalum, C. A., Igwe (2023). Some utilization options for cattle dung as soil amendment and their effect in coarse-texture Ultisols and maize growth. *International Journal of Recycling of Orhin Waste Agriculture*

Vakili, M; Zwain, HM; Rafatullah, M; Gholami, Z; Mohammadpour, R (2015). Potentiality of palm oil biomass with cow dung for compost production. *KSCE J. Civ. Eng.*, *19*, 1994-1999.