Aerobic Sponge Method Vermitechtonology for Macro-Level Conversion of Organic Garbage

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Abstract:
Earthworms in the second decade of 21st century are the most significant figure in the realm of biodegradation of agricultural wastes, agro-industrial wastes, urban organic garbage and sewage sludge. The degraded product as their excreta find resolvable route to sustainable agriculture, a most relevant solution for the developed-developing country like India to enhance sustainability of soil organic matter for balance of physical-chemical-biological properties. Earthworms virtually stand alone as a symbol of “clean technology” in the field of organic waste transformations and also stand alone as a symbol of “sustainable organic agriculture technology”. Although several protocols and techniques have been shown and implemented in India we still lack a suitable, modifiable and appropriate feasible technology for organic garbage into vermicompost at the levels of ward, community and corporate/municipality, which is the need of the hour. India being an agrarian country needs valuable, processed organic inputs to sustain its soils. Indian wet garbage accounting for average 60% of the country’s total organic garbage generated, must be considered as resourceful by-product for human endeavor, to make it a ready source for vermicomposting and finding a return route to productive soils. Business partnership considering organic garbage as “organic wealth”, for innovation and entrepreneurship, research, education and technology development, all within a framework of a partnership between city Corporations, private research and development units and Universities as sustainable workable models for all seasons need to be implemented in India, independent of Govt. agencies for fruitful ventures. Currently handling of garbage by the Corporations and Municipalities need a thorough brush-up which is operating on the grounds of political scenario rather than on the grounds of techno-commercial ventures. This paper calls for the attention of theoretical scientists to look for macro-level practicalities and also challenges its current, innovative Aerobic Sponge Method Vermitechtonology (ASMV), its implementations anywhere with authenticity in terms of feasibility and sustainability on the grounds of working modalities along with sustainable returns through “organic garbage filth to organic cabbage growth” motto.

Keywords: ASMV technology, Aerobic Sponge Bed, conventional vermitechnology, Eudrilus eugeniae, open land access, wet garbage.

1.0 Introduction:
Earthworms are greatly appreciated by White (1789) for their evolved system in soil burrowing and feeding activities. Later Savigny (1826) studied extensively on the diversity of earthworms. It was the great naturalist Darwin (1881) who laid the actual foundation on the research of earthworms and revealed these animals’ importance in the economy of nature. Voluminous work on earthworms has been carried out due to improved laboratory equipment and evolved techniques, followed by the side-by-side research being done under natural habitats i.e., under field conditions. The enormous quantities of available scientific data show the valuable facts and figures on various aspects. Degradation of organic wastes through earthworms to abate organic pollution (Abe et al., 1978; Balasubramanian and Bai, 1995; Barois et al., 1994; Butt, 1993; Elvira et al., 1996; Mato et al., 1994; Murugesan and Sukumaran, 1994; Loehr et al, 1984, 1992); potentials to convert organic wastes into resourceful vermicompost for sustainable agriculture (Bhadauria and Ramakrishnan, 1989; Cegarra et al., 1987; Edwards, 1983a; 1985; Ferriere, 1980; 1992; Flaig et al., 1977; Lofty, 1974; Mackay and Kladivko 1985; Bano and Kale, 1987; Manna et al, 1997; Mitchell, 1997; Rhee, 1963; Mba, 1989, 1996; Sunitha and Kale, 1995a; 1995b); presence /absence of earthworm activity in the soil to reveal the fertility/toxicity level to indicate soil health (Barley, 1959; Edwards and Bohlen, 1996; Ewer and
Hall, 1972); ability to store/destroy/transformation of toxic substances like pesticides and heavy metals in earthworms’ body physiology (Bouche, 1971; 1977; 1977b; 1982; Cuendet and Ducommun, 1990); earthworms association with microbial population to study on earthworm-microbial interactions (Allevi et al., 1987; Dash et al., 1979b); being soil dwellers and their ability to make complicated burrows, feeding activities with valuable excreta/casts to help to study the physico-chemical properties on soil (Bolton and Phillipson, 1976; Coleman and Sasson, 1978; Edwards et al., 1988).

Stabilizing and fermenting enormous bulk quantities of biodegradable organic anthropogenic wastes by the usual methods of composting is limited in performance and continual sustainability (Haimi and Huhta, 1987; Sharma, 1995; WASTE WISE, 1995; Steinford et al., 1996; Gandhi et al., 1997; Subier et al., 1998; Wawolumaya and Maclaren, 1998). Nature has created compost earthworms of selected species that has been successfully shown to work on biodegradability of plant and animal origin under laboratory conditions (Neuhauser et al., 1988; Edwards, 1988; Mba, 1989; Reinecke et al., 1992; Mato et al., 1994; Kale et al., 1994; Manna et al., 2003; Suthar and Singh, 2008) to guarantee to march towards zero pollution with the possibilities of bulk productions of stabilized vermicompost for arable lands (Sinha et al., 2008). Research and Development in the field of organic garbage, urban sewage sludge and an array of agro-industrial waste management has found so far very few species (among 3,000 species) of earthworms as waste converters/stabilizers/degraders. Some of the known species are Eudrilus eugeniae, Eisenia fetida, Eisenia andrie, Perionyx excavatus, Perionyx sansibaricus, Dendrobaena veneta, Lumbricus terrestris and Pheretima asiatica. (Lee, 1985; Edwards, 1996).

Given a thorough studies under lab to land implementations (micro-level to macro-level) conversion of organic garbage into conventional vermicomposting dwindle for reasons; namely, limited facilities, limited monetary benefits at the level of daily wages, interruptive unsustainable support from the Govt. agencies, the severity of limited practicality of theoretical vis-a-vis practical scientists at large for the fruitful utilization of organic garbage generated round the clock. The present research document and its sustainable indigenous technology for the bioremediation of organic garbage is the modified version of conventional vermitechnology as ASMV (Aerobic Sponge Method Vermitechonology). The subject of present study for wet garbage at macro-level is shown to be simpler adaptations using ASMV technology and is nuisance-free in terms of leachate, fly menace and odor - the most relevant problematic parameters in handling bulk quantities of organic garbage. For the efficient work of ASMV, one need to be dependant on dry LARM (leachate absorbing raw material) like cocopith (waste of coir industry)/bagasse (waste of sugar cane mills)/jute waste (from jute industry) for Southern parts of India, North-Western parts of India and Eastern parts of India respectively. The right kind and efficient earthworm candidate used for ASMV is Eudrilus eugeniae for its ability to feed and defecate in open access land under huge mass of aerobic partial decomposed organic garbage with dry LARM in standardized proportions by weight. Thus produced defecated vermicompost used for agricultural lands for all crops without chemicals or with 0.5% - 10% chemical fertilizers (Sunitha et al., 1997; Jadav et al., 1997; Karmegam et al., 1999).

2.0 Materials and Method:

Details of the laboratory research are not explicitly presented here. The indigenous Aerobic Sponge Method Vermitechonology (ASMV) development at macro-level field conditions is documented here. The studies done were strictly semi-scientific, under semi-natural conditions for an easy access of ASMV technology in all seasons of rainy, winter and summer under Indian circumstances for eco-conscious citizens, entrepreneurs, business persons and Govt. agencies. ASMV technology operated at two phases: In phase-I, segregation of recyclable/nonbiodegradable garbage from unsegregated garbage within the premises of the allotted site/ at the source was done and simultaneously loaded back for its suitable placement. The details of the Phase – I operation was irrelevant for the present research paper hence only Phase – II of organic garbage conversion into vermicompost with ASMV is explained here.

Phase-II, ASMV technology was implemented for the total conversion of organic garbage into vermicompost by employing the classical compost earthworm Eudrilus eugeniae. The ratio of dry LARM use was based on micro-level research and worked out to be 10: 2 (10 parts of organic garbage to 2parts of dry LARM) on weight basis. For 3 – model macro-level studies, 10 tons of wet garbage to 2 tons of dry
LARM was used as standardized measure for the present study. Based on the data an average of organic garbage generated at 3 – levels (Table: 1), Day-to-day collections of segregated wet garbage was dumped in a layer wise manner and ensured a bottom and surface layer with dry LARM sandwiched by the organic garbage. The ratio of organic garbage and dry LARM became a natural aerobic sponge bed that created aerobicity and arrested anaerobicity; leachate got bound to the dry LARM, fly menace got no record because anaerobicity and putrification was not in the picture thus fly menace was solved at one go. The average organic garbage procurable/day/month/annum, the used quantum of dry LARM, 20% reduction of the biosolid material on initial aerobic decomposition and further 40% reduction of biosolids after vermi-processes, the obtainable vermicompost in 3-level models and an outlay of the requirements for the entire work operation has been shown in detail in Table:1. The nutrient status of the vermicompost shown in Table: 2 was an indication of best organic nutriments for arable lands, vegetable crops and ornamental nurseries.

3.0 Results and Discussion:
Based on the research work and successful operation of organic garbage conversion in 2 model version of 4 – member family and 10 – member family using ASMV for micro-level studies (Sunitha, 2011a, 2011d), in the present study as an advancement of organic garbage conversion at the macro-level research for 3 –sets of models namely – decentralized unit (individual ward level) for an urban population of > 1Lakh, Centralized unit (zonal level) for a population of > 10Lakhs and Corporation unit (100 wards level) for a population of > 1Crove (Table : 1) had been worked out and shown the workability (Fig: 4, 5, 6, 7 and 10). The organic garbage with its 90% moisture during decomposition oozed out as leachate that always lead to putrification with anaerobic conditions and emancipation of obnoxious odor due to putrification to harbor nuisance - causing flies were trickyly overcame in the present study by implementing ASMV by use of dry LARM (Fig: 1) that acted as natural, eco-friendly, biodegradable, leachate absorbent and so-much-so-that the dry LARM with leachate became rich nutrient binder and enhanced faster aerobic degradation in the form of a self – made organic aerator sponge (Fig: 8 and 9). This technique had not been specified and modulated in the earlier works of Kale et al (1994), although shown the best utilization of ligno-cellulose material (Senapati, 1992) like cocpith and other farm wastes for biodegradation by the compost earthworms of *Eudrilus Eugeniae* and *Eisenia fetida*.

Biology of compost earthworms, vermicomposting and conventional vermitechnology has been worked out under laboratory conditions by several workers (Kaplan *et al*., 1980a; Graff, 1982; Hartenstein, 1983; Haimi and Huhta, 1987; Neuhauser, *et al*., 1988; Edwards, 1988; Edwards and Bater, 1992; Kale and Bano, 1984; Kale and Sunitha, 1993; Kale *et al*., 1994; Sunitha and Kale, 1995a and 1995b; Lotzof, 2000; Vermi Co, 2001; Sunitha, 2001; Patnaik and Reddy, 2009). Under laboratory conditions, the success of organic garbage degradation by earthworms has been 100%; however under field conditions the same has been known to workable to a limited extent and sustainability has been meager due to varied disturbances under Indian circumstances be it monetary limitations, mechanical limitations, labor – oriented uncertainties, inappropriate guidelines, crucial changes not made from lab to land implementations, political disturbances, non co-operation of citizens, technical problems of leachate, putrification, fly nuisance, improper aerobic degradation, anaerobicity situations during the compost earthworm activity which made the worms to surface out leading to preying, etc.

In the present paper, a different approach and methodology has been explained to show continual, successful macro level activities to convert organic garbage either under community based organizations/ward level/corporation level. This paper has been proven based on experiences in lines of technology transfer, working implementations and change of working modalities at varied aspects and overcame lacunae, problems faced at every level with rectifications of conventional vermicomposting of the organic garbage for the continual and successful operations on the grounds of sustainability to use ASMV throughout the year irrespective of seasonality and the end product of stabilized, granular vermicompost (Fig: 11) best suited for dry land crops, commercial crops and vegetable crops with the addition of 0.5% - 10% chemical fertilization (Tomar *et al*, 1998; Sukumaran, 2008; Suhane *et al*, 2008; Ansari and Abdhullah, 2008; Sunitha, 2011b, 2011c).
<table>
<thead>
<tr>
<th>Details</th>
<th>Decentralized unit at individual ward level (covering a population of &gt; 1 Lakh)</th>
<th>Centralized zonal level unit (covering 10 wards, a population of (&gt; 10 Lakhs)</th>
<th>Corporation level unit (covering 100 wards, a population of (&gt; 1 Crore)</th>
</tr>
</thead>
</table>
| Categories of wet garbage generators | 1. Retail fruit and vegetable markets  
2. Restaurants and hotels  
3. 25,000 urban houses  
4. Road-side vendors  
5. Road-side snack suppliers | 1. Retail fruit and vegetable markets  
2. Restaurants and hotels  
3. 2,50,000 urban houses  
4. Road-side vendors  
5. Road-side snack suppliers | 1. whole sale market yards of fruits and vegetables  
2. Retail fruit and vegetable markets  
3. 25,00,000 urban houses  
4. Road-side vendors  
5. Road-side snack suppliers |
| Type of wet garbage generation/day | decomposed fruits and vegetable wastes,  
Paper cartoon wastes,  
Filler wastes like hay, trash, Food waste,  
Urban household wet garbage, Cattle dung from semi-urban areas, Park and avenue tree waste | decomposed fruits and vegetable wastes,  
Paper cartoon wastes,  
Filler wastes like hay, trash, Food waste,  
Urban household wet garbage, Cattle dung from semi-urban areas, Park and avenue tree waste | decomposed fruits and vegetable wastes,  
Paper cartoon wastes,  
Filler wastes like hay, trash, Food waste,  
Urban household wet garbage, Cattle dung from semi-urban areas, Park and avenue tree waste |
| Average quantity of wet garbage generated per day per month per annum (in MT) | Per day: 30  
Per month: 900  
Per annum: 11,000 | Per day: 300  
Per month: 9,000  
Per annum: 1,10,000 | Per day: 3,000  
Per month: 90,000  
Per annum: 10,80,000 |
| Recommended location for implementation of ASMV technology | Open access land within 1Km radius | Open access land within 5Kms radius | Open access land 40Kms away |
| Required area of open access land | 2 acres | 10 acres | 150 acres |
| Requirement of permanent structures (with area in sq.ft.) at the site | Godown, (2,500) vermicompost yard,  
(10,000) Office, (1,000) Laboratory, (500)  
Parking area, (10,000) | Godown, (25,000) vermicompost yard, (1Lakh) Office, (1,000) Laboratory, (500)  
Parking area, (10,000) | Godown, (2.5Lakh) vermicompost yard,  
(10Lakh) Office, (1,000) Laboratory, (5000)  
Parking area, (10,000) |
| Requirement of permanent tank with zinc sheet roofing for AOSB | 30 structures  
Size : 30’X10’X2’ | 150 structures  
Size : 30’X10’X2’ | 1,500 structures  
Size : 30’X10’X2’ |
| Requirement of vehicles (in numbers) | Tippers (2)  
Luggage autos (5)  
Motor bikes (2) | Tippers (20)  
Luggage autos (50)  
Motor bikes (10) | Tippers (200)  
Luggage autos (500)  
Motor bikes (200) |
<p>| Requirement of machineries (in numbers) | Horizontal vibrating sieves (2) | Horizontal vibrating sieves (20) | Horizontal vibrating sieves (20) |
| Requirement of Electricity (in Kwatts) | 10/day | 50/day | 500/day |
| Requirement of water (in gallons) | 2,000/day | 20,000/day | 5 Lakh |
| Requirement of Technicians | 5 | 15 | 25 |</p>
<table>
<thead>
<tr>
<th>Requirement of skilled labors</th>
<th>Males: 10</th>
<th>Males: 100</th>
<th>Males: 1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement of unskilled labors</td>
<td>Females: 40</td>
<td>Females: 400</td>
<td>Females: 4,000</td>
</tr>
<tr>
<td>Outsourcing material in MT either Cocopith /bagasse/jute waste/milled agrowastes (ligno cellulose base) as dry LARM requirement in tons/day/month/annum</td>
<td>Per day: 6</td>
<td>Per day: 60</td>
<td>Per day: 600</td>
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<tr>
<td></td>
<td>Per month: 180</td>
<td>Per month: 1,800</td>
<td>Per month: 18,000</td>
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<td>Per annum: 2,200</td>
<td>Per annum: 22,000</td>
<td>Per annum: 2,16,000</td>
</tr>
<tr>
<td>Quantity of organic garbage with dry LARM prior to partial aerobic decomposition in MT</td>
<td>Per day: 36</td>
<td>Per day: 360</td>
<td>Per day: 3,600</td>
</tr>
<tr>
<td></td>
<td>Per month: 1,080</td>
<td>Per month: 10,800</td>
<td>Per month: 1,08,000</td>
</tr>
<tr>
<td></td>
<td>Per annum: 13,200</td>
<td>Per annum: 1,32,000</td>
<td>Per annum: 12,96,000</td>
</tr>
<tr>
<td>Quantity in MT on 20% Reduction of wet garbage + LARM after initial aerobic decomposition in 30 days</td>
<td>Per day: 28.8</td>
<td>Per day: 288</td>
<td>Per day: 2,880</td>
</tr>
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<td></td>
<td>Per month: 864</td>
<td>Per month: 8,640</td>
<td>Per month: 86,400</td>
</tr>
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<td></td>
<td>Per annum: 10,560</td>
<td>Per annum: 1,05,600</td>
<td>Per annum: 10,36,800</td>
</tr>
<tr>
<td>Quantity on 40% Reduction of wet garbage + LARM after vermicomposting in 60 days in MT</td>
<td>Per day: 17.28</td>
<td>Per day: 173</td>
<td>Per day: 1,728</td>
</tr>
<tr>
<td></td>
<td>Per month: 519</td>
<td>Per month: 5,184</td>
<td>Per month: 51,840</td>
</tr>
<tr>
<td></td>
<td>Per annum: 6,336</td>
<td>Per annum: 63,360</td>
<td>Per annum: 62,080</td>
</tr>
<tr>
<td>Obtainable quantity of vermicompost after sieving in MT</td>
<td>Per day:15.5</td>
<td>Per day:155.75</td>
<td>Per day: 1,572</td>
</tr>
<tr>
<td></td>
<td>Per month: 467</td>
<td>Per month: 4,665</td>
<td>Per month: 46,656</td>
</tr>
<tr>
<td></td>
<td>Per annum: 5,702</td>
<td>Per annum: 57,024</td>
<td>Per annum: 55,972</td>
</tr>
<tr>
<td>Assuming 100% sales through Govt. Subsidy (at the rate of Rs. 2,000/MT)</td>
<td>Rs. 31,100 = 00</td>
<td>Rs. 3,11,400 = 00</td>
<td>Rs. 31,44,960 = 00</td>
</tr>
<tr>
<td></td>
<td>Rs. 9,34,200 = 00</td>
<td>Rs. 93,31,200 = 00</td>
<td>Rs. 9,33,12,000 = 00</td>
</tr>
<tr>
<td></td>
<td>Rs. 1,14,04,800 = 00</td>
<td>Rs. 11,40,48,000 = 00</td>
<td>Rs. 111,97,44,000 = 00</td>
</tr>
</tbody>
</table>

Fig 1: Cocopith from coir industry, an abundancy in Southern India. Three decade ago, due to disposal problem was burnt to ashes; currently utilized for cocopeat processes and as decomposed filler material in the nurseries for the ornamentals.

Fig 2: Partial or aerobically degraded segregated organic garbage and cocopith in the ratio of 10:2 by weight. A material view prior to vermicomposting processes/during partial aerobic decomposition.
Fig 8: A proportionate addition of organic garbage with cocopith. Leachate absorption seen as wetness. Work under open access land, fly menace no entry. Purifications and anaerobicity were not a factor of existence. Aerobic decomposition hastened by overnight experienced by the fruity odor of the biosolids. The entire material of biosolids formed Aerobic Sponge bed. An easiest workable operation under Indian conditions. Is cost-effective, no need of aerators to create aerobic conditions. Anaerobicity gets arrested by overnight. The proportions of organic garbage and dry LARM create aerobic sponge thus the given for this indigenous technology - ASMV – Aerobic Sponge Method Vermitechnology.

Fig 3: Eudrilus eugeniae – a well known candidate for bioremediation in waste technology. Growth and reproduction was directly proportional to the ratio of nitrogenous based and lignocellulosic based wastes. From the commercialization point of faster degradation and enhanced reproductive potentialities this particular species is a competitor over other compost species.

Fig 9: A view of the Aerobic Sponge bed of the biosolids of organic garbage and dry LARM after partial aerobic degradation followed by the feeding and defecating activities of the compost earthworm Eudrilus eugeniae.

Fig 10: A view of vermicomposted product of biosolids of organic garbage and dry LARM, prior to the segregation of earthworms and sieving processes.

Fig 11: The final product vermicompost after sieving with 0.5mm mesh. Ready for use as organic nutrients.
Both the species of compost earthworms *Eudrilus eugeniae* and *Eisenia fetida* were the candidates suitable for organic garbage conversion into vermicompost under laboratory studies (Bano and Kale, 1988; Kale and Sunitha, 1993; Mitchell, 1997; Periasami and Vasuki, 2010; Sunitha, 2011a; Norbu, 2002). However under macro-level field conditions for the conversion of organic garbage into resourceful vermicompost through ASMV, in the present study *Eudrilus eugeniae* (**Fig : 3**) alone were preferred and recommended for faster handling, sorting, feeding and conversion efficiencies mainly due to open land access with Aerobic Sponge Bed (AOSB) size within the concrete tank of 5’ X 10’ X 3.5’ (**Fig: 4 and 5**) and another version of above land working module of 2 – layered Tarpaulin vermi bag with in-between mosquito net. The vermi bag of size 50’ X 10’ X 2.5’ that seemed to be well fitted for

**Fig. 4:** Segregated organic garbage at community level, a work implemented as a technology transfer project with Waste Wise Trust, under Urban Waste Expertise Program (UWEP) at Mahadevapura, Bangalore, India. The study carried out for segregated organic garbage of 0.5-1 ton per day basis using ASMV.

**Fig. 5:** A view of the segregated organic garbage prior to the coverage with quantified dry LARM

**Fig. 6:** Release of compost earthworm *Eudrilus eugeniae* to the 2-layered Tarpaulin vermi bag of dimension 50’ X 10’ X 2.5’, after the aerobic degradation of organic garbage with requisite quantity of dry LARM.

**Fig. 7:** A view of the vermibed enclosed by the bottom layer of Tarpaulin of 200G.S.M. and a middle layer of mosquito net during aerobic degradation as well as vermi processes.
this particular species with voracious feeding and conversion efficiencies, an indication of its tropical forest litter inhabitancy and its other dual purpose of holding capacity of 15 tons of organic garbage with 3 tons of dry LARM (10:2 proportion by weight) and zipping with mosquito net for immediate and proper aerobic microbial activity that readily arrested nuisance-causing fly entry and exudation of leachate. The material view shown in Fig: 2. A complete study of bioenergetics of Eudrilus eugeniae under laboratory conditions studied by Sunitha (2001) supported the better use of this species under three seasonality.

Table 2: shows nutrient status in vermicomposted wet garbage

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Values in %</th>
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<tbody>
<tr>
<td>01.</td>
<td>Total organic matter</td>
<td>31.0</td>
</tr>
<tr>
<td>02.</td>
<td>Total organic carbon</td>
<td>18.0</td>
</tr>
<tr>
<td>03.</td>
<td>Total nitrogen</td>
<td>1.78</td>
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<tr>
<td>04.</td>
<td>Total phosphorus</td>
<td>0.54</td>
</tr>
<tr>
<td>05.</td>
<td>Total potassium</td>
<td>0.60</td>
</tr>
<tr>
<td>06.</td>
<td>Total magnesium</td>
<td>2.35</td>
</tr>
<tr>
<td>07.</td>
<td>Total sulfur</td>
<td>0.65</td>
</tr>
<tr>
<td>08.</td>
<td>Total dissolved solids</td>
<td>0.90</td>
</tr>
<tr>
<td>09.</td>
<td>C:N ratio</td>
<td>15:1</td>
</tr>
<tr>
<td>10.</td>
<td>pH</td>
<td>7.30</td>
</tr>
<tr>
<td>11.</td>
<td>Moisture</td>
<td>40.0</td>
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HCl [0.1 N] soluble constituents:

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<tbody>
<tr>
<td>12.</td>
<td>Iron</td>
</tr>
<tr>
<td>13.</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>14.</td>
<td>Potassium</td>
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<tr>
<td>15.</td>
<td>Calcium</td>
</tr>
<tr>
<td>16.</td>
<td>Magnesium</td>
</tr>
<tr>
<td>17.</td>
<td>Sodium</td>
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</table>

Available nutrients:

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<tbody>
<tr>
<td>18.</td>
<td>Phosphorus</td>
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<tr>
<td>19.</td>
<td>Potassium</td>
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<tr>
<td>20.</td>
<td>Calcium</td>
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<tr>
<td>21.</td>
<td>Magnesium</td>
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<tr>
<td>22.</td>
<td>Sulfur</td>
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<td>23.</td>
<td>Sodium</td>
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</table>

ASMV developed for organic garbage for Indian subcontinent as an innovative, cost-effective, easiest method without fly nuisance, without leachate and without obnoxious odor was a challenging technology over other workers developed in the same lines of research be it, indoor, outdoor, laboratory, and/or pilot scale (Datar et al, 1997; Lotzof, 2000; Sinha et al, 2002; UNSW, ROU, 2002b; Georg, 2004; Visvanathan et al, 2005; Sinha et al, 2008; Sinha and Chanr, 2009; Pattnaik and Reddy, 2009; Sinha et al., 2002; 2009; 2010). The ASMV technology developed for open land access was named as Aerobic Sponge Method Vermitechnology (ASMV) for organic garbage with a modified version of conventional vermitechnology feasible to implement in all seasons of rainy, winter and summer under Indian circumstances. The 2-layered Tarpaulin vermibags were development especially meant for organic garbage; the bottom layer of Tarpaulin of 200G.S.M. was of high durability and had the capacity to withstand the wear and tear during hydraulic unloading by vehicles for day-day-day organic garbage. The middle layer of mosquito net covered over the organic garbage sandwiched with dry LARM created formation of aerobic sponge bed and enhanced aerobic degradation by overnight and arrested entry of flies and obnoxious odor. The top layer of Tarpaulin of 200G.S.M. was used before the onset of rains to protect entry of rain water (Fig: 6 and 7). To avoid earthworms becoming an easy prey for birds, cats, bandicoots and wild boars was overcome by the maintenance of cleanliness of the Phase I and Phase II operations of ASMV and also by ensuring everyday regular human activity which kept at bay the enemies of compost earthworms (Fig. 7).

4.0 Conclusion:

Although several protocols and techniques have been shown and implemented, India still lacks a sustainable, suitable, modifiable and appropriate feasible technology of organic garbage into vermicompost which is the need of the hour. India being an agrarian country needs valuable, processed organic inputs to sustain its soils; First World Countries’ technology part as energy production from organic garbage doesn’t required for an agrarian country like India. Even landfills and dump sites must be discouraged. Indian wet garbage accounting for average 60% of the total garbage generated from the urban areas must be considered as resourceful by-product for human endeavor to make it a ready source for vermicomposting using the indigenous ASMV technology to find a sustainable, return route to productive soils. Goldstein (2004) report an on-going project for its
master plan since 1970’s in handling recyclable garbage and organic garbage hand-in-hand through business partnership for innovation and entrepreneurship, research, education and technology development, all within a framework of a partnership between Burlington County and Rutgers University. Such models need to be implemented in India, independent of Govt. agencies for fruitful ventures. Currently handling of garbage by the Corporations and Municipalities need a thorough brush –up which is operating on the grounds of political scenario rather than from the techno-commercial point of view. This paper challenges and calls for the attention of theoretical scientists to look for macro-level practicalities and also authenticate the said ASMV technology for its implementations anywhere with 100% possibility for its feasibility and sustainability on the grounds of working modalities with sustainable returns. Through “organic garbage filth to organic cabbage growth” motto.

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