Asian Journal of Agriculture and Food Sciences (ISSN: 2321 – 1571)
Volume 03 – Issue 02, April 2015

Vermicomposting of School Wastes with *Eudrilus euginae:* Production and Economic Valuation

Jennifer D. Pano*, Jewish A. Merin

College of Teacher Education
Cebu Normal University
Osmeña Blvd., Cebu City
**Correspondng author's email: jenniferpano90 [AT] yahoo.com*

ABSTRACT---*In response to the call of environmental distress brought about by the indiscriminate throwing of garbage, schools may play a big role in reducing the disposal of these wastes. Left untreated or without intervention, schools are exposed to environmental and economic problems. As a practice, the school is waiting for the City garbage truck to dispose its wastes. In vermitechnology, 'wastes can be turned into gold'; reduce the accumulation of environmental and economic problems and the addition of wastes to the dumpsite.*

This study experimented on the possibility of using vermiculture in school waste management. The following findings were drawn after analyzing the data gathered: the earthworm, Eudrilus euginae had a good volume of waste reduction when given papers for decomposition; nevertheless, faster decomposition was recorded when the E. euginae were given food left-overs. There was a significant difference between the soil productions of E. euginae when given various food supplies. In the same vein, there is also a significant difference between the economic valuation of the vermisoil produced and the commercial vermisoil. Therefore, in having the vermitechnology, there will be economic gains, thus it can turn school garbage into 'gold'. In addition, vermicomposting will not show any negative tradeoff in the context of waste management rather making environmental, health and safety tradeoffs on the basis of cost-benefit analysis. Vermitechnology offers good potential to turn school wastes into a valuable soil amendment and a source of livelihood.

Keywords--- component: vermiculutre, bio-composting, solid waste management, eco-friendly, *Eudrilus euginae*

I. INTRODUCTION

The Philippines is inhabited by 92.33M populace (NSO, 2010). Along the surge of the population, the country is facing several problems particularly on environmental concerns. It is estimated that almost half of this population is in school and could therefore contribute wastes on a daily basis. Taking into account that there are 58,914 elementary and secondary schools (as of SY 2010-2011, DEPED) in the country thus schools can potentially contribute to a growing environmental distress. Optimistically, the school community may, at the same time, actively perform its communal role in solid waste management to minimize the environmental problem by applying vermitechnology.

There are several reasons why vermicomposting lends itself well in the classroom/school setting: first: it is a possible answer to reduce solid waste in the school and even of the community; second, the materials are readily available and is inexpensive; Finally, many researches can be conducted in two weeks or less using the worm set-up.

In vermicomposting, an earthworm - *Eudrilus euginae*, fragment the litters, perform the microbial activity in its gut and the debris mixture egested forms the soil plasma called vermicast (Shipitalo & Protz ,1989). In the study of Thomas (1999), earthworm cast leaves soil that is five to eleven times organically enriched as the materials they consume, thus may enhance germination and plant growth (Hidalgo,1999; Galli, 1992).

Considering that vermicomposting entails a low technology yet an eco-friendly means of waste management (Lazcano, 2010) in the same vein, it can be a better option for a livelihood source (Purkayastha, 2012). Thus it is the focus of this study to determine soil produced on a variety of substrate and to find out the economic valuation of vermisoil.

II. REVIEW OF RELATED LITERATURE

Republic Act No. 9003 (Ecological Solid Waste Management Act of 2000) Article 1 sec.1 states that the "*State should adopt a systematic, comprehensive and ecological solid waste management program which shall: Institutionalize public participation in the development and implementation of national and local integrated, comprehensive, and ecological waste management programs…"* . Taking this into consideration, school shall also make its move to "*incorporate ecological solid waste management in the school system at all levels"*, Generally, schools follow the segregation as stipulated in RA 9003, afterwards the trash is given to the local government units for disposal. There are few moves toward solid waste management on a school-based program (Ortega, 2010, etc.) Schools are not limited in choosing its waste management program, unfortunately there has been no record of a unified plan to eradicate school wastes. Thus vermicomposting is hereby suggested to schools as a viable alternative in the disposal of wastes.

III. RESEARCH METHODOLOGY

A. Research Design

This study made use of static group comparison experimental design. This qualitative research focused on three experimental groups wherein each set has the same intervention that is the introduction of *Eudrilus euginae* into the vermiset. Set A has the substrate and paper; Set B has the substrate and the food wastes and Set C has the substrate, paper and food wastes. Experimentation was done from July 2009 – September 2009.

B. Research Subject

Eudrilus euginae was obtained from the Department of Agriculture. These worms are commercially sold for P500 per kilo or P1 per piece and fast growing, reasonably prolific and would be ideal for protein production. They eat 75% of their weight daily. Fecundity of these worms is at 6.75 cocoons per week, which are hatched in only 12 days at 25^0C. Their sexual maturity is attained in 35 days and can gain weight at 280 mg per week (Dominguez, 2001). Each earthworm weighs about 0.5 to 0.6 g, eats waste equivalent to its body weight and produces cast equivalent to about 50% of the waste it consumes in a day Earthworms consume various organic wastes and reduce the volume by 40–60%. Each earthworm weighs about 0.5 to 0.6 g, eats waste equivalent to its body weight and produces cast equivalent to about 50% of the waste it consumes in a day. (Sarawat, 2004).

Organic wastes fed to the worms include the food leftovers from ILS Kiosks and the paper used during the 5S of the university.

C. Research Procedure

1. Vermibed preparation

Clean the fruit boxes (commercially sold) and cover the inside with the green screen wire mesh. Set it aside for the substrate transfer.

2. Substrate Preparation

(**Anaerobic Decomposition**)

Put together 4-6 sacks to serve as floor mat. Put the sawdust, rice hay, horse manure in a 1:1:1 ratio. Add in 3 kilos ipil-ipil leaves and 5 kilos sand to the former mixture. Mix thoroughly using a shovel. Put in the fruit boxes the mixed ingredients. Mix also the shredded paper on Set A, Dried food left over on Set B and the combination of paper and food left over on Set C. Cover and set aside for 18 days (Anaerobic decomposition) to allow decomposition and heat release, water as needed.

3. Actual Composting Preparation

(**Aerobic decomposition**)

After anerobic decomposition, introduce 100 pcs worms each on the three sets of bins. Always check for rats or other organism's that may destroy the set.

IV. DATA ANALYSIS AND INTERPRETATION

This study focused mainly on the treatment of papers and food leftovers of the school. The experiment started with the same and equal amount of substrate i.e. sawdust, horse manure, rice hay and ipil-ipil leaves 60 kilos each and 10 kilos for paper or food left over. The combination paper and food leftover had a 5:5 combination. Each set has three replicates, but the sum of the soil produced refers to the total of the replicates per set.

The table below revealed that *Eudrilus euginae* has some preference for food. In the process of vermicomposting in 60 days, Set B produced more soil compared to the rest of the sets with a total of 63 kilos, while the least production is on the Set A (pure paper) with only 42 kilos produce. The softness of the food leftover may be counted as to the speed of worm decomposition. The paper on the other hand has fiber which made it hard and less palatable for the E. *euginae*. Noteworthy to mention that the worms had completely decomposed food left overs than all its counterpart. There is a biochemical conversion of cellulosic and proteinaceuos materials from the wastes as translated in soil production.

Table 1: Soil Production using *Eudrilus euginae*

	School Wastes Input in kilograms (k)				Soil Produced / Output in kilograms (k)				% Volume of waste reduction
Layer	1	2	3	Sum	1	2	3	Sum	
Set A Substrate and Paper	60 + 10			70	10	15	17	42	60%
Set B Substrate and Food wastes	60 + 10			70	19.5	20	23.5	63	90%
Set C Substrate Paper and Food wastes	60 + 10			70	16.5	19	19.1	54.66	78% Ave 76%

Note: 100 *E. euginae* was introduced per vermiset

In the study of Nagavallema et.al. (2004), earthworms produces casts equivalent to about 50% of the wastes it consumes in a day and may reduce the volume of wastes into 40-60%. This study supports the same finding having a general average of 76% volume of waste reduced. Considering that the bulk of school wastes are paper and food leftovers, vermicomposting of paper in this study had a 60% volume reduction. This result could have a profound effect on the waste management of the school. All the more with the result of vermicomposting of food left over which had 90% waste volume reduced. Considering that all the wastes are biodegradable, thus the worms were able to convert the school wastes into fertile soil.

2. **Soil Production**

Data on the soil collection (Table 1) was statistically treated using the Kruskal-Wallis Test. Results showed that there is a significant difference between the soil production on the three sets having an F value = 0.039. Therefore vermicomposting of food left overs will produce more soil compared to that of composting with papers only. The foods fed to the worms are softer and has less fiber material than the blunt taste of paper which is also harder for them to eat. The presence of "food" gave rise to a rapid biochemical conversion of the cellulosic and proteinaceous materials from the food.

Table 2: Kruskal Wallis Test for Vermicomposting of various substrate

Set	N	Median	Ave Rank	Z
1	3	15	2.3	-2.07
2	3	20	8	2.32
3	3	19	4.7	-0.26
Overall	9		5	

H = 6.49 DF = 2 **F = 0.039**

3. Is there a significant difference between the economic valuation of the vermisoil and the commercial vermisoil?

Economic value expresses the degree to which a good or service satisfies individual preferences, using money matrix (Dziegielewska, 2009). Table 3 shows the economic gain of vermicomposting in terms of soil production and worm multiplication. According to Dominguez (2001), the fecundity mean of E. *euginae* is 6.75 cocoons per week and will be hatched in 12 days at 25^0 Celsius. In the same study, it was also pointed out that E. euginaes' sexual maturity is at 35 days. As per observation of the Department of Agriculture there are approximately 4 cocoons per adult worm produced in 45 days considering that daily temperature has an average of $28\text{-}30^0$C. The latter became the basis of computation in the succeeding table.

Table 3: Economic valuation of gains from vermicomposting

No. of Days	Soil Produced	Soil Valuation Amount	Worm Produced	Worm Valuation Amount	Total Gain*
45	63	630	100	100	730
90	135	1350	800	800	2150
135	405	4050	3200	3200	7250
180	585	5850	4100	4100	9950

Note: Worm production (approximately) = 1 adult worm to 4 baby worms in 45 days.
*Total Gain = Soil valuation amount + Worm valuation amount

Noteworthy in this study is the economic gain obtained from worms. Table 3 shows the reproduction of worms at an exponential rate i.e. 100, 800, 3200 and 4100 respectively. Actual count was not done by the researcher; rather the usual observation from the Department of Agriculutre (DA) was used as a basis for worm reproduction rate (four cocoons/worms per one adult worm).

The hypothetical gain from the vermicomposting is shown on table 3. The table revealed that **there is a positive correlation between the soil produced and the worm reproduction**. In a span of 45 days initial soil production has been more than doubled to 135 kilos. In the succeeding harvest soil production was six times the amount of the initial soil produced. The worms' exponential reproduction contributed much to the fast soil reproduction. Consequently the economic value of the worms could be P4100 without the exertion of hard labor and less the input on expensive materials. Thus, gain on soil and worms are evident on the continuous vermicomposting translated into economic gains. This experiment proves that vermicomposting can be another source of income-generating project.

The figure below shows the direct proportionality of soil and worm production during the first, second and third harvest.

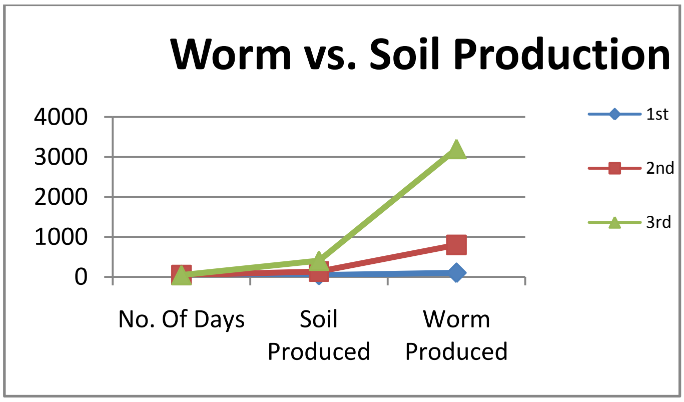

Figure 1: Graphical representation of soil vs. worm production

Further analysis of the economic value of vermicomposting is shown in the table below. Using cost benefit analysis, the researchers tried to include all the input and the output for this experiment. Results are as follows:

Table 4: **Cost Benefit Analysis**

1ST Harvest			
OPERATIONAL COST			
Construction Materials	P	200	
Vermicomposting Materials		P	270
Maintenance (per month)	P	300	
Total		P	770
BENEFIT			
Soil produced (kilo)			159.66
Economic Value (P10/kilo)	P	1,596.60	
Operational cost	P	770.00	
Initial Net Gain	P	926.60	
Economic Valuation of soil		P	4. 82

Construction materials were just purchased once thus the operational cost in Table 5 covers only the maintenance cost. Vermicomposting materials were solicited from the school community for free. Considering that the current market value of vermisoil is at P10 per kilo, while the vermiculture soil harvested will cost only P4.82 per kilo. The P5.18 difference is a significant amount to emphasize that vermicomposting will save a lot of money and at the same time will give economic gain. The table that follows show supplementary computation for the next three harvests. It should be noted here that harvest time is equivalent to 45 days each and every harvest requires the full harvest of the soil. It should also be considered that the current market value of soil is P10 per kilo.

Table 5: Cost Benefit Analysis for the 2nd to 4th Harvest

	2nd Harvest	3rd Harvest	4th Harvest
Soil Produced (in kilos)	135	405	585
Economic Value	P 1350	P 4050	P 5850
Operational Cost	P 300*	P 300*	P 300*
Net Gain	P 1150	P 3850	P 5850
Economic Valuation of Soil	P 2.22	P 0.74	P 0.51
Savings [1]	P 7.78	P 9.26	P9.49

Note: *Means maintenance cost only for gathering paper and food leftovers and watering

Economic Valuation = $\frac{\text{Operational cost}}{\text{Soil Produced}}$

[1]Savings = Current Market Value - Economic Valuation of Soil

The cost benefit analysis clearly shows the purchase of materials is justified by the profit from vermicomposting. Savings from the soil harvest are P7.78, P9.26 and P9.49 respectively. Buying commercial soil will entail more expenses, but will gain great savings if vermiculture is done. Thus, there is a significant difference between the economic value of the vermisoil and the commercial vermisoil.

V. CONCLUSION

The vermicomposting is a good technology for school waste management. In having the vermitechnology, there will be economic benefits gained, thus it can turn garbage into 'gold'. In addition, vermicomposting will not show any negative tradeoff in the context of waste management rather making environmental, health and safety tradeoffs on the basis of cost-benefit analysis. Therefore vermitechnology is a potential tool for an ecologically friendly and sustainable solid waste management program and viable source of livelihood for the community.

VI. ACKNOWLEDGMENT

It is a pleasure to thank those who made this research possible: Cebu Normal University for the financial support ; all the authors of the references used in this study; and all CTE students who helped in the gathering of materials. We are heartily thankful to our statistician, Dr. Zosima Pañares, who gave us the encouragement, guidance and support.

The authors wishes to express their love and gratitude to their beloved families; for their understanding & endless love, through the duration of the study.

Our warmest thanks to the Almighty God for He is the source of our strength and wisdom to do this research.

VII. REFERENCES

- Abbasi, P. A., Al-Dahmani, J., Sahin, F., Hoitink, H. A. J. and Miller, S. A. (2002). Effect of composts on disease severity and yield in organic and conventionally produced tomatoes. Ohio, USA.
- Bogdanov, Peter., (1996). Commercial Vermiculture. How to Build a Thriving Business in Redworms. Orlando, Florida, USA
- Bohlen, P.J. Edwards, C.A. (1995). Earthworm Effects on N Dynamics and Soil Respiration in Microcosms Receiving Organic and Inorganic Nutrients. Soil Biology & Biochemistry. USA.
- Chaoui, I.H., Zibilske, L.M., Ohno, S. (2003). Effect of earthworm casts and compost on microbial activity and plant nutrient uptake. Soil Biol. And Biochem., 35, 295-302.
- Chen, W., Hoitink, H. A. J., Madden, L. V. (1988). Microbial activity and biomass in container media for predicting suppressive to damping-off caused by Pythium ultimum. Phytopathology, 78, 1447-1450.
- Chung, Y.R., Hoitink, H.A.H., Lipps, P.E. (1988). Interactions between organic-matter decomposition level and soilborne disease severity. Agriculture, Ecosystems and Environment, 24, 183-193.
- Daniel, O. Anderson, J.M. (1992). Microbial Biomass and Activity in Contrasting Soil Materials after Passage Through the Gut of the Earthworm *Lumbricus Rubellus* Hoffmeister. Soil Biology & Biochemistry, 24 (5), 465-470.

- Dominguez, J. et al. "A Comparison of Vermicomposting and Composting"BioCycle (April 1997): 57-59.
- Eastman, B.R. (1999). Achieving Pathogen Stabilization Using Vermicomposting. Biocycle, Nov. 1999, 62-64.
- Edwards, C.A. (1995). Historical overview of Vermicomposting. Biocycle, 36 (6), 56-58.
- Edwards, C.A. and Bates, J.E. (1992). The use of earthworms in environmental management. Soil Biology and Biochemistry. 14 (12): 1683-1689.
- Fauziah S.H, and Agamuthu, P., (2009*) Sustainable Household Organic Waste Management via Vermicomposting.* Malaysian Journal of Science, 28 (2). pp. 135-142. ISSN 13943065
- Finola, M., Rodrigues, C. and Beoletto, V. 1995. Gastrointestinal bacaeriology of the earthworm Eisenia foetida grown in composted broiler litter. Rev. Argent Microbiol., 27, 210-213.
- Fragoso, C., Barois, I., Gonzales, C. Artega, C., Patron, J.C. (1993). Relationship between earthworms and soil organic matter levels in natural and managed ecosystems in the Mexican tropics. Proceedings of an international symposium on Soil Organic matter dynamics and the sustainability of tropical agriculture, Leuven, Belgium.
- Gaddie, Ronald Sr. and Douglas Donald. (1997). Earthworms for Ecology and Profit – Volume 1: Scientific Earthworm Farming. Bookworm Publishing Company., Ontario, Canada. ISBN: 0916302-01-6. Library of Congress Catalog Number 76-23923.
- Hidalgo, P. (1997). Study of auxins in earthworms and in media containing earthworms castings as related to plant growth of marigold (Tagetes erecta) (Eisenia fetida andrei). MS. Mississippi State University.
- Marinissen, J.C.Y. Dexter, A.R. (1990). Mechanisms of stabilization of earthworm casts and artificial casts. Biology & Fertility of Soils, 9 (2), 163-167.
- McInerney, M. & Bolger, T. (2000). Temperature, wetting cycles and soil texture effects on carbon and nitrogen dynamics in stabilized earthworm casts. Soil Biology & Biochemistry, 32, 335-349.
- Minnich, J. et al, "The Rodale Guide to Composting", (Emmaus, Pennsylvania:Rodale Press, 1979)
- Ndegwa, P.M., Thompson, S.A., Das, K.C., 1999. Effects of stocking density and feeding rate on vermicomposting of biosolids. Biores. Technol. 71 (1), 5-1.
- Ndegwa, P.M.; Thompson, S.A. 2000. Effects of C-to-N ratio on vermicomposting of biosolids. Bioresour-technol., 75 (1), 7-12.
- Orozco, F.H. Cegarra, J. Trujillo, L.M. Roig, A. (1996). Vermicomposting of coffee pulp using the earthworm Eisenia fetida: effects on C and N contents and the availability of nutrients. Biology & Fertility of Soils, 22 (1/2), 162-166.
- Parmelee, R.W. Crossley, D.A. Jr. (1988). Earthworm production and role in the nitrogen cycle of a no-tillage agroecosystem on the Georgia piedmont. Pedobiologia, 32 (5/6), 355-361.
- Rangel, A., Thomas, R. J., Jimenez, J.J., Decaens, T. (1999). Nitrogen dynamics associated with earthworm casts of Martiodrilus carimaguensis Jimenez and Moreno in a Colombian savanna Oxisol. Pedobiologia, 43 (6), 557-560.
- Ruz-Jerez, B.E. Ball, P.R. Tillman, R.W. (1992). Laboratory assessment of nutrient release from a pasture soil receiving grass or clover residues, in the presence or absence of Lumbricus rubellus or Eisenia fetida. Soil Biology & Biochemistry, 24 (12), 1529-1534.
- Saciragic, B., Dzelilovic, M. (1986). Effect of worm compost on soil fertility and yield of vegetable crops (cabbage leeks) and fodder sorghum. Agrohemija, 5-6, 343-351.
- Santamaria-Romero-S; Ferrera-Cerrato-R; Almaraz-Suarez-JJ; Galvis-Spinola-A; Barois-Boullard-I. 2001. Dynamics and relationships among microorganisms, C-organic and N-total during composting and vermicomposting. Agrociencia-Montecillo, 35 (4), 377-384.
- Scheu, S. (1993). Cellulose and lignin decomposition in soils from different ecosystems on limestone as affected by earthworm processing. Pedobiologia, 37, 167-177.
- Schrader, S., Zhang, H. (1994). Earthworm casting: stabilization or destabilization of soil structure. 5th international symposium on earthworm ecology held in Columbus, Ohio, USA, 5-9 July 1994.
- Seekins, Bill "Troubleshooting The Compost Pile" BioCycle (November 1999): 53.
- Shields, Earl. (1994-revised). Raising Earthworms For Profit. Published by Shields Publications, P.O. Box 669, Eagle River, WI 54521. ISBN: 0-914116-21-5. 128
- Shipitalo, M.J. & Protz, R. (1989). Chemistry and micromorphology of aggregation in earthworm casts. Geoderma, 45, 357-374.
- Shipitalo, M.J. (1987). Soil structure formation and stabilization by earthworms and tillage effects on soil porosity. PhD University of Guelph Canada.
- Stephens, P.M. & Davoren, C.W. (1997). Influence of the earthworms Aporrectodea trapezoides and A. Rosea on the disease severity of Rhizoctonia solani on subterreanean clover and ryegrass. Soil-biol-biochem, 29 (3/4), 511-516.
- Szczech, M. & Smolinska, U. 2001. Comparison of suppressive of vermicomposts produced from animal manures and sewage sludge against Phytophthora Breda de Haan var. nicotianae. Phytopath-Z, 149 (2), 77-82.

- Purkayazca , Rajanita (2012)., Forming Community Enterprises using Vermicomposting as a tool for Socio-Economic Betterment. Centre for Social Entrepreneurship, Binary University College, Malaysia
- Szczech, M., Rondomanski, W., Brzeski, M.W., Smolinska,-U., Kotowski, J. (1993). Suppressive effect of a commercial earthworm compost on some root infecting pathogens of cabbage and tomato. Biol-agric-hortic., 10 (1), 47-52.
- Tomati, U., Galli, E., Grappelli, A., Hard, J.S. (1994). Plant metabolism as influenced by earthworm casts. Mitteilungen aus dem Hamburgischen Zoologischen Museum and Institute, 89 (2), 179-185.
- Villar, M.C. Beloso, M.C. Acea, M.J. Cabaneiro, A. Gonzalez-Prieto, S.J. Carballas, M. Diaz-Ravina, M. Carballas, T. (1993). Physical and chemical characterization of four composted urban refuses. Bioresource Technology, 45 (2), 105-113.
- Vinceslas-Akpa, M. Loquet, M. (1997). Organic matter transformations in lignocellulosic waste products composted or vermicomposted (Eisenia fetida andrei): chemical analysis and 13C CPMAS NMR spectroscopy. Soil Biology & Biochemistry, 29 (3/4), 751-758.
- Zhang, H. Schrader, S. (1993). Earthworm effects on selected physical and chemical properties of soil aggregates. Biology & Fertility of Soils, 15 (3), 229-234.s