

DEVELOPMENT OF WINDROW COMPOST PILE MIXER

**MARIA SARAH DG. BULACLAC
REDEKAH RUTH U. CASTRO**

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ABSTRACT

BULACLAC, MARIA SARAH DG and CASTRO, REDEKAH RUTH U.,
Department of Agricultural and Biosystems Engineering, College of Engineering, Central
Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **July 2023,**
DEVELOPMENT OF WINDROW COMPOST PILE MIXER.

Adviser: JEFFREY A. LAVARIAS, Ph.D.

This study was carried out to design, fabricate and evaluate the testing performance of compost mixer in mixing the windrow compost pile. The specific goal of this study was to determine the appropriate mixing speed to facilitate its mixing performance and perform simple cost analysis on the machine.

The compost mixer was designed and drawn based on the physical characteristics of the windrow compost pile. The machine was fabricated based on design plans and specifications. The components of the compost mixer include engine, power transmission system, counterweight, frame, wheel, flywheel and mixing arm. The mixing arm was designed with steel shafting solid round bar covered by a flat steel bar with a length of 0.67m and an angle bar welded to the shaft (0.002m x 0.02m) by which its spacing varies from 5 inches and its clearance from the ground is 3 inches. These gaps were sized up based on the actual size of the windrow compost pile.

Three different mixing speeds of the mixing arm (150 rpm, 200 rpm, and 250 rpm) were evaluated. Nine (9) windrow compost pile with the dimensions of (L: 2.5 m x W: 0.70 m x H: 0.75 m) were used in the treatment at three (3) replications. Results showed that the appropriate mixing speed was at 250 rpm giving an actual mixing time of 1.85 minute, and

fuel consumption of 25 ml. Likewise, the distances of debris on both length and width are closely aligned and do not appear to have a noticeable impact.

The overall cost of the machine excluding the engine was Php21,174.50. The machine was calculated to operate with fixed annual cost of Php 23, 027.27/yr and a variable cost of Php 123.41/hr.

Keywords: compost; compost mixer; windrow compost pile

LITERATURE CITED

- Abdelmotaleb, I. A. 2007. Repair and Maintenance Cost Analysis of Tractors and Combines. Retrieved April 4, 2023, from [Iowastate.com.pdf](#)
- Agricultural Machinery and Testing Evaluation Center (AMTEC). 2002. AMTEC Specifications. Retrieved April 4, 2023, from [amtec.com.pdf](#)
- Baron, K. (2022, September 25). Tips on when to turn your compost pile. Retrieved March 24, 2023, from <https://www.happysprout.com/gardening/how-often-turn-compost/>
- Berry, J. (2020, January 27). Composting: Benefits, how-to, and more. Retrieved March 24, 2023, from <https://www.medicalnewstoday.com/articles/composting-benefits>
- Desta, K. G., & Ali, M. S. (2017, March 1). Compost turning: The key to quick composting. Retrieved March 24, 2023, from <https://extension.okstate.edu/fact-sheets/compost-turning-the-key-to-quick-composting.html>
- Function of Compost Windrow Turner in Compost Production (n.d.). *Richentek*. Retrieved April 1, 2023, from https://www.fertilizer-machine.net/solution_and_market/fertilizer-compost-windrow-turner.html
- Hu, S. (2020, July 20). Composting 101. Retrieved March 24, 2023, from <https://www.nrdc.org/stories/composting-101>
- Joshi, P., A. Malviya, and P. Soni. 2008. Manual Driven Platform Cleaner, and International Journal of Emerging Technology and Advanced Engineering (ISSN 2250- 2459, ISO 9001:2008 Certified Journal, Volume 3, Issue8). Retrieved April 4, 2023, from [www.ijetae.com.pdf](#).
- Lapuz, N. T. Design, Fabrication and Performance Evaluation of Grain Sweeper. 2008
- Philippine Agricultural Engineering Standard (PAES) 302 – Flat Belts & Pulleys. Retrieved April 4, 2023, from <https://law.resource.org/pub/ph/.pdf>
- Reducing the impact of wasted food by feeding the soil and composting. (2022, February 12). Retrieved March 24, 2023, from <https://www.epa.gov/sustainable-management-food/reducing-impact-wasted-food-feeding-soil-and-composting>
- Renae, K., M. Marti, and J. Schilling 2013. Resource for Implementing A Street Sweeping Best Practice, International Journal of Technical Sciences. Retrieved April 4, 2023, from [www.strteetsweepingmanual.com.pdf](#)

Schilling, J. G. 2005. Street Sweeping. State of the Practice. Prepared for Ramsey-Washington Metro Watershed District North St. Paul, Minnesota. Retrieved April 4, 2023, from <https://www.rwmwd.org.pdf>.

Schmitz, J. 2009. Machinery Cost. Harper publishing house. Retrieved April 4, 2023, from www.machinery.org.pdf.