DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF SMALL TRAILER FOR ROW CROPS APPLICATION

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An undergraduate Thesis Submitted to the Faculty of the Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines
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BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
(AB MACHINERY AND POWER ENGINEERING)

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ACCEPTANCE SHEET

This undergraduate thesis entitled **"DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF SMALL TRAILER FOR ROW CROPS APPLICATION"** prepared and submitted by **CHRISTIAN L. MARTIN, AND CEE-JAY ANGELO L. SANTIAGO** in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AB MACHINERY AND POWER ENGINEERING)**, is hereby accepted:

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BIOGRAPHICAL SKETCH

Christian L. Martin was born in Bitas, Cabanatuan City, Nueva Ecija, on February 13, 2002. He is the youngest of the three children of Mr. Cirilo P. Martin and Mrs. Gina L. Martin. He finished his primary education at General Ricarte Elementary School with an academic award. Then he took his secondary education at General Luna National High School for his junior high school with an award of honor and other recognition for being an active student at the school. Christian transferred to another school to pursue the academic strand he wanted: Science, Technology, Engineering, and Mathematics (STEM). He took his senior high school at PHINMA Araullo University, where he graduated with honors, therefore finishing his secondary education. As he moved to tertiary education, he then took the entrance exam at Central Luzon State University (CLSU) and at Nueva Ecija University of Science and Technology (NEUST). He passed the entrance exam at both universities, one with the BSABE program and the other with the BSEE program. He chose to take the Bachelor of Science in Agricultural and Biosystems Engineering program at Central Luzon State University because of the love and passion he has for the agricultural sector.

As he progressed in his college education, he took the major of AB Machinery and Power Engineering. Despite his busy college life, Christian values time spent with his loved ones and friends. He enjoys reading books, playing basketball, playing online games, and playing with his pet.

Cee-Jay Angelo L. Santiago was born in Brgy. Abar 1st, San Jose City, Nueva Ecija, on May 13, 2001. He is the only child of Mr. Celedonio P. Santiago and Mrs. Jesusa L. Santiago. He finished his primary education at Core Gateway College with an academic award. When he was in elementary school, he represented his school at the city meet that every year happened. He played basketball and volleyball back then. Then he also took his secondary education at Core Gateway College for his junior high school. Cee-Jay transferred to another school to pursue the academic strand he wanted: Science, Technology, Engineering, and Mathematics (STEM). He took his 11th grade at St. Joseph School of San Jose City, Nueva Ecija, and then finished his 12th at San Jose City National High School, where he graduated with honors. As he moved to tertiary education, he then took the entrance exam at Central Luzon State University (CLSU) and at the University of the Philippines (UP). He passed the entrance exam at CLSU with the BSABE program. He chose this program because when he was in grade ten, that's when he decided to take the course he is now taking because he saw that the government's support for farmers at that time was lacking. That's what impacted him greatly to pursue his bachelor's degree in Agricultural and Biosystems Engineering at Central Luzon State University.

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ABSTRACT

MARTIN, CHRISTIAN L. & SANTIAGO CEE-JAY ANGELO L., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Philippines, July 2024, **DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF SMALL TRAILER FOR ROW CROPS APPLICATION**

Adviser: MARLON T. DELOS SANTOS, M.Sc

This thesis aimed to design, fabricate, and perform a performance evaluation of a small trailer for row crop applications that is fit for small farms in the Philippines. Conventional methods of hauling used in the Philippines are inefficient, time-consuming, and physically demanding, leading to increased cost and labor requirements. A small trailer for row crops was designed to address these challenges. The small trailer for row crops was designed using 3D Sketchup and AutoCAD software, and it was fabricated locally. Its performance was evaluated in terms of theoretical machine field capacity, actual machine field capacity, machine field efficiency, and fuel consumption. Evaluation included functional testing, preliminary testing, and final testing of the machine. The machine traveled 20 meters for the testing, according to PAES 137:2004. "Agricultural Trailer: Methods of Testing" It is shown that the machine achieved its optimal theoretical field hauling performance at a speed of 1.80 km/h with a 200 kg load. In addition, it is also shown that the machine achieved its optimal actual machine hauling performance at a speed of 1.00 km/h with a 200 kg load. With a mean fuel consumption of 1.64 l/hr at high speed. This study successfully developed a functional small trailer for row crops. Further research can optimize the design of the machine for further adaptation by different vegetable farms.

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LITERATURE CITED

Brempong, M. B., & Addo-Danso, A. (2022). Improving Soil Fertility with Organic Fertilizers. In *IntechOpen eBooks*. https://doi.org/10.5772/intechopen.103944

Budynas, R., & Nisbett, K. (2010). *Shigley's Mechanical Engineering Design*. McGraw-Hill Science/Engineering/Math.

Cundiff, J. S., & Grisso, R. D. (2021). Load and unload technology to improve Round-Bale hauling efficiency. *AgriEngineering*, *3*(3), 584–604. https://doi.org/10.3390/agriengineering3030038

Dar, W. (2022). GUIDELINES ON THE SCALING UP THE USE OF MICROBIAL-BASED FERTILIZERS AS INTERVENTION TO REDUCE COST OF PRODUCTION IN RICE FARMING. Administrative order No.4. https://www.da.gov.ph/wp-content/uploads/2022/02/ao04_s2022.pdf

deliverfem. (2022). *Different Types of Fabrication*. Fem Ltd. https://www.femltd.com/2022/03/07/what-are-the-different-types-of-fabrication/

DEPARTMENT OF AGRICULTURE. (2017). *EGGPLANT PRODUCTION GUIDE*. https://cagayanvalley.da.gov.ph/wp-content/uploads/2018/02/Eggplant.pdf

Ebert, W. L. (2012, January 1). *5.20 - Metallic Waste Forms* (R. J. M. Konings, Ed.). ScienceDirect; Elsevier. https://www.sciencedirect.com/science/article/abs/pii/B9780080560335001099

Edwards, W. (2015). *Estimating Farm Machinery Costs | Ag Decision Maker*. Www.extension.iastate.edu. https://www.extension.iastate.edu/agdm/crops/html/a3-29.html#:~:text=Farm%20machinery%20costs%20can%20be

Engineering Product Design. (2023, February 4). *What are Mechanical Power Transmission and its elements?* https://engineeringproductdesign.com/knowledge-base/mechanical-power-transmission/#What_is_Mechanical_power_transmission

Estimating Farm Machinery Costs | Ag Decision Maker. (n.d.). https://www.extension.iastate.edu/agdm/crops/html/a3-29.html#:~:text=Farm%20machinery%20costs%20can%20be,the%20amount%20of%20machine%20use.

Farhat, H. (2021). *Operation, Maintenance, And Repair Of Land-Based Gas Turbines*. Elsevier. https://www.sciencedirect.com/topics/engineering/bending-tests

Home | official portal of the Department of Agriculture. (n.d.). https://www.da.gov.ph/wp-content/uploads/2022/03/mo28_s2022.pdf

Karimi, K. (2021). *SAFETY OF FARM VEHICLES ON DELAWARE'S PUBLIC ROADS*. Www.proquest.com; University of Delaware ProQuest Dissertations Publishing, https://www.proquest.com/openview/8463272bf351a02fcd700d79681fcd92/1?pq-origsite=gscholar&cbl=18750&diss=y

Key factors in vegetable production - Vegetable resources Vegetable resources. (n.d.). https://aggie-horticulture.tamu.edu/vegetable/guides/organic-vegetable-production-guide/key-factors-in-vegetable-production/#:~:text=Soil%20type%20and%20quality%20%E2%80%93&text=Optimum%20vegetable%20production%20is%20achieved,and%20can%20restrict%20root%20growth.

Khan, Y. (2019). *Torsion Testing - an overview | ScienceDirect Topics*. Sciencedirect.com. https://www.sciencedirect.com/topics/engineering/torsion-testing

Kumar, A. A., Tewari, V., & Nare, B. (2016). Embedded digital draft force and wheel slip indicator for tillage research. *Computers and Electronics in Agriculture*, *127*, 38–49. https://doi.org/10.1016/j.compag.2016.05.010

Libretexts. (2021). 11.2: Belt- and Gear-Driven Systems. *Engineering LibreTexts*. https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Mechanics_Map_(Moore_et_al.)/11%3A_Rigid_Body_Kinematics/11.2%3A_Belt-_and_Gear-Driven_Systems

Lozada, B. (2014, April 25). *Filipinos second-shortest in Southeast Asia | Global News*. INQUIRER.net. https://globalnation.inquirer.net/102688/filipinos-second-shortest-in-southeast-asia

Muda, M. K. H., & Mustapha, F. (2018). *Compression Testing - an overview | ScienceDirect Topics*. Www.sciencedirect.com. https://www.sciencedirect.com/topics/engineering/compression-testing

Nagar, H., Rajendra Machavaram, Paul, A., Soni, P., Vijay Mahore, Arjun Chouriya, & None Ambuj. (2023). *A Data-Driven Approach to Forecast Engine Torque of an Agricultural Tractor Across Varied Operational Range Using Machine Learning*. https://doi.org/10.1109/incoft60753.2023.10425702

Neil. (2021). Palay production costs top P47,000 per hectare in 2020. *BusinessWorld Online*. https://www.bworldonline.com/agribusiness/2021/11/01/407319/palay-production-costs-top-p47000-per-hectare-in-2020/#:~:text=THE%20average%20cost%20to%20produce,of%20P46%2C650%2Fha.

PHILIPPINE AGRICULTURAL ENGINEERING STANDARD. (n.d.). https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/124.pdf?fbclid=IwAR0P_lbNWbBVUx1c3J3yzsRfFmCHKoDvWDGLv0ZKw4tZ1JmFBGf_5xHJfzM

Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. Agricultural mechanization in the Philippines. (2009). *Agricultural Mechanization in the Philippines*.http://scinet.science.ph/union/Downloads/BS%20Agricultural%20Mechanization%20in%20the%20Philippines_beta_361500.pdf

Reyes, E. (2022). Would you pay to spray from the sky? *Philippine Rice Research Institute*. https://www.philrice.gov.ph/would-pay-spray-sky/#:~:text=Investing%20on%20a%20unit%20of,500%20rental%20fee%20per%20hectare.

Rudy. (2021). *PAGSASABOG NG PATABA SA saka ni Kabulol | BUHAY BUKID*. Www.youtube.com. https://youtu.be/oc6vL4Hwr2o?si=ldcqCSJf0D1N8Io5

Saba, N. (2019). *Tensile Testing - an overview | ScienceDirect Topics*. Sciencedirect.com. https://www.sciencedirect.com/topics/engineering/tensile-testing

Santiago, M. (2022). *Pagsasabog ko ng Pataba sa aking Bukid |Macario Santiago*. Www.youtube.com. https://youtu.be/aERWLW24i3A?si=y4Mih11skbXc4bWZ

Sild, S. (2022). Belt Drives & Types of Belts. *Fractory*. https://fractory.com/belt-drives/

Skoropad, M. (2023, August 24). What All-Terrain Tires Are Used for and How They Differ from Other Types. Tire Reviews, Buying Guide & Interesting Facts - Utires.com. https://www.utires.com/articles/what-all-terrain-tires-are-used-for-and-how-they-differ-from-other-tires/

Turan, M., & Yildirim, E. (2021). *https://www.intechopen.com/chapters/81931*. Www.intechopen.com. https://www.intechopen.com/chapters/81931

UN.ESCAP (2014). *2nd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific : enabling environment for custom hiring of agricultural machinery, 9-11 September 2014, Serpong, Indonesia*. Retrieved from: https://hdl.handle.net/20.500.12870/4574

Walking - Multidaywiki. (n.d.). https://multidays.com/multidaywiki/index.php?title=Walking

Water management - IRRI Rice Knowledge Bank. (n.d.). http://www.knowledgebank.irri.org/step-by-step-production/growth/water-management#:~:text=Keep%20the%20water%20level%20in,to%20the%20end%20of%20flowering.

Wang, H., Zheng, H. (2013). Model Testing, Machine Learning. In: Dubitzky, W., Wolkenhauer, O., Cho, KH., Yokota, H. (eds) Encyclopedia of Systems Biology. Springer, New York, NY. https://doi.org/10.1007/978-1-4419-9863-7_231

What's Mechanical Efficiency? (n.d.). Bayt.com. https://specialties.bayt.com/en/specialties/q/200165/what-s-mechanical-efficiency/#:~:text=The%20ideal%20transmission%20or%20mechanism,are%20eventually%20dissipated%20as%20h

Willems, R. C., Willems, T., Deen, N. G., & Somers, T. (2019). *A Comparison of Low-Load Efficiency Optimization on a Heavy-Duty Engine Operated With Gasoline-Diesel RCCI and CDC*. https://doi.org/10.1115/icef2019-7