DEVELOPMENT OF WATER ROLLER DRUM FOR FARM IRRIGATION

MARY ANTOINETTE S. BUNAO
PRINCESS C. MANANGUIT

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 Munoz, Nueva Ecija Philippines
in Partial Fulfillment of the Requirements
for the Degree of

BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
(AB Power and Machinery Engineering)

JULY 2024

ACCEPTANCE SHEET

This undergraduate thesis entitled **"DEVELOPMENT OF WATER ROLLER DRUM FOR FARM IRRIGATION"** prepared and submitted by **BUNAO, MARY ANTOINETTE S.** and **MANANGUIT, PRINCESS C.** 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:

NOVALYN G. DELOS SANTOS, M.Sc.
Member, Advisory Committee

06-14-24
Date Signed

HERALD KAM G. HERNANDO, M.Sc.
Member, Advisory Committee

6-19-24
Date Signed

MARLON T. DELOS SANTOS, M. Sc.
Chair, Advisory Committee

6-14-24
Date Signed

Accepted as partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AB MACHINERY AND POWER ENGINEERING):**

JOHN PAULO C. SACDALAN, Ph.D.
Head, Department of Agricultural and Biosystems Engineering

6-14-24
Date Signed

ROY SEARCA JOSE P. DELA CRUZ, Ph.D.
Dean, College of Engineering

6-14-24
Date Signed

BIOGRAPHICAL SKETCH

Mary Antoinette S. Bunao, was born on October 28, 2000 in San Jose City, Nueva Ecija, the 4th child of Mr. Antonio O. Bunao and Mrs. Pacita S. Bunao. She was raised in a simple life with her nine siblings by her parents who did everything to provide for their needs.

The author finished her elementary education at Dizol Elementary School in 2013 as the class salutatorian. From there, she continued and was able to graduate high school in San Jose City National High School at San Jose City, Nueva Ecija in 2019 with honors. She came from an economically challenged family where she was able to find and given the opportunity to study in college under the assistance of CHED-Tulong Dunong Program, and GAD-Financial Assistance Program for Students in her later years in college.

She entered college at Central Luzon State University in Science City of Muñoz, Nueva Ecija, where she took up a Bachelor of Science in Agricultural and Biosystems Engineering major in AB Machinery and Power Engineering. During her stay at the University, she was a resident of Ladies Dorm 3 from 2022-2024 and also became a student assistant at the dorm during her last semester of residency.

BIOGRAPHICAL SKETCH

Princess C. Mananguit is a 23-year-old student from Brgy. Sta. Catalina Matanda, San Ildefonso, Bulacan. She was born on the 29th of January, 2001, and is the youngest daughter of Mrs. Elena C. Mananguit and Mr. Joseph P. Mananguit.

She completed her elementary education at Sta. Catalina Matanda Elementary School in 2013. She continued her junior secondary education at Liceo De Buenavista in San Ildefonso, Bulacan, and received her diploma in 2017. She took the Science, Technology, Engineering, and Mathematics (STEM) strand at the same school for her senior secondary education, graduating with honors.

In 2019, she began taking her Bachelor's degree at Central Luzon State University (CLSU) with the course of Bachelor of Science in Agricultural and Biosystems Engineering.

ACKNOWLEDGEMENT

First and foremost, the authors would like to express their endless gratitude to Jesus Christ, our Lord and Saviour, for giving them enough wisdom, strength, and guidance to accomplish this thesis.

To their adviser, Engr. Marlon T. Delos Santos for sharing his knowledge, suggestions, and expertise upon making, improving, and finishing this study, as well as the reconsideration, revisions, and guidance he provided for the authors.

To Engr. Novalyn G. Delos Santos and Engr. Herald Kam G. Hernando being the advisory committee member, for also lending their knowledge and guidance, together with all the suggestions to improve this thesis. The authors appreciate your kindness and patience from the writing up to the fabrication of this machine.

To Mr. Renato Domingo, who worked on fabricating the water roller drum, the researchers would like to express their gratitude for accepting the task and investing time to bring it into reality.

To Dr. Marilou M. Sarong, the Director of Crops and Resources Research and Development Center (CRRDC), who without hesitation let the researchers conduct their thesis in their facility and assisted them from start to end at the CLSU CRRDC.

And finally, the authors wholeheartedly thank the people around them, especially their family and friends, who sincerely supported and comforted them while making this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABSTRACT

BUNAO, MARY ANTOINETTE S., and **MANANGUIT, PRINCESS C.** Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines. **JULY 2024.**
DEVELOPMENT OF WATER ROLLER DRUM FOR FARM IRRIGATION

Adviser: MARLON T. DELOS SANTOS, M.Sc.

The study developed a water roller drum for farm irrigation, aiming to improve efficiency for small-scale farmers. The prototype, tested against pail and dipper methods, showed lower discharge rate, higher field capacity, better ease of operation and faster operating speed.

The study found that despite a lower discharge rate of 394.79 liters per hour, the water roller drum had a higher field capacity of 0.0716 hectares per hour, faster operating speed of 88.68 minutes, and a lower operator pulse rate of 112.11 beats per minute, making it easier to operate. A survey with 30 respondents confirmed the marketability of the water roller drum, with a majority preferring it over traditional methods and willing to purchase within a specified price range. The estimated fabrication cost is Php 5,185.00, with labor cost being 40% of material cost. The machine has a break-even value of 2.54 ha/yr, earning profit when the area is at least 127 sqm and with two cropping seasons.

The study highlights the water roller drum's potential for improving irrigation efficiency, labor reduction, and crop productivity, with future improvements involving lighter materials, ergonomic features, and improved traction.

LITERATURE CITED

American Society of Mechanical Engineers. (2015) pp. V004T05A053—V004T05A053. *5 Uses For Steel Flat Bars*. (n.d.). Austen Knapman. https://www.austenknapman.co.uk/blog/uses-of-metal/5-uses-for-steel-flat-bars/

Administrator. (2021). Ergonomic Handle Design: An Introduction. *ergonomicsblog.uk*. https://ergonomicsblog.uk/ergonomic-handle-design/

American Frame. (2023, January 30). The advantages and limitations of metal and wood picture frames. *Picture Frame Blog*. https://www.americanframe.com/pictureframeblog/the-advantages-and-limitations-of-metal-and-wood-picture-frames

Ampalaya Production Guide. (2017). https://cagayanvalley.da.gov.ph/wp-content/uploads/2018/02/Ampalaya.pdf

Avient. (2021). Ergonomic Grip Design ConsiderationS. [Online] Available from https://www.avient.com/sites/default/files/2021-11/avient-design-ergonomic-design-guide.pdf

Belonio, A., [Alexis T. Belonio]. (2005).Agricultural Engineering Formula (Revised Edition

Blog-Manager. (2021, July 10). 5 Advantages Of Using Steel Frames. Astron Metal Works Corporation. https://astronmetal.com/blog/advantages-using-steel-frames/

CableOrganizer.com. (n.d.-c). *What makes a hand tool ergonomic?* https://www.cableorganizer.com/learning-center/articles/ergonomic-hand-tools.html

CCOHS. (2024). Hand Tool Ergonomics - Tool Design. https://www.ccohs.ca/oshanswers/ergonomics/handtools/tooldesign.html

Celac (2011). Proper crop spacing for higher crop yields. Word press.com /category/ farmer- to- farmer- advise. p. 3.

Eggplant Production Guide. (n.d.). https://ati.da.gov.ph/rtc10/sites/default/files/EGGPLANT%20PRODUCTION%20GUIDE.pdf

FAO (1997). Small-scale Irrigation for Arid Zones. Principles and Options. Rom: Food and Agriculture Organisation of the United Nations (FAO) URL [Accessed: 23.06.2011]

FAO. 2006. Food supply situation and crop prospects in sub-Saharan Africa.http://www.fao.org/DOCREP/004/W1144E/w1144e54.htm

Fujiie, M., Hayami, Y., & Kikuchic, M. (2005). *Agricultural economics* (Vol. 33). https://doi.org/10.1111/j.1574-0862.2005.00351.x

Geneva Solutions. https://genevasolutions.news/explorations/11-african-solutions- for-the-future-world/with-the-hippo-roller-a-revolution-in-fetching-water-rolls-on

G. Harih, B. Dolsak (2013, June 13). Tool-handle design based on a digital human hand model. Laboratory for Intelligent CAD Systems, Faculty of Mechanical Engineering, University of Maribor, Smetanova ulica 17, SI-2000 Maribor, Slovenia. https://doi.org/10.1016/j.ergon.2013.05.002

Grace, B. (2016, March 11). Loop transport system keeps water on a roll. Prospector Knowledge Center. https://www.ulprospector.com/knowledge/3980/pe-loop-transport-system-keeps-water-roll/

Hippo roller - simple ideas changing lives in the global water crisis. (n.d.). Hippo Roller. https://hipporoller.org/

Hippo Water Roller Project - Atlas of the Future. (2021, January 29). Atlas of the Future. https://atlasofthefuture.org/project/hippo-water-roller-project/

Hogberg, D., Backstrand, G., Lamkull, D., Hanson, L., Ortengren, R., 2008. Industrial customisation of digital human modelling tools. International Journal of Services Operations and Informatics 3, 53-70.

Lenzer, Anna. Fiji Water: Spin the Bottle. (2009). Retrieved March 24, 2012, from catchment, Limpopo Basin, Zimbabwe. Physics and Chemistry of the Earth 31: 885–892.

Luthe, T., Kägi, T. and Reger, J. Journal of Industrial Ecology 17, 605 (2013).

Ma, J. and Kremer,G. E. O. ASME 2015 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference

Malloy-Good, Sarah, et.al. Cost-Benefit Analysis of Improved Water and Sanitation for Women and Girls in Sub-Saharan Africa. (2008). Retrieved March 24, 2012, from Columbia University: http://mercurypoisoningproject.org/malawi/pdf/MALLOYGOODSMITH.apw.pdf

Mattson, C.A., Wood, A.E., and Renouard, J. ASME International Design Engineering Technical Conferences and Information in Engineering Conference (2016), 10.1115/DETC2016-60141.

McCabe, C. (2011, January). We'll take care of this like our life. Oxfam Exchange , pp. 8-11.

Meinzen-Dick, R. (1997). Journal of Economics, Management & Agricultural Development. *Irrigation and Drainage Systems*, *11*(2), 103–118. https://doi.org/10.1023/a:1005739528481

MotherJones: http://www.motherjones.com/politics/2009/09/fiji-spin-bottle?page=1

Moyo R, Love D, Mul M, Mupangwa W and Twomlow SJ. 2006. Impact and sustainability of low-head drip irrigation kits in the semi-arid Gwanda and Beitbridge Districts, Mzingwane

Nairobi, Kenya. ISBN 9966-896-77-5. 54 pp.

Playpumps Bringing Clean Water to Rural African Communities. (n.d.). Bestcasinosonline.co.ke. from http://www.playpumps.org

Power Steel Specialist Trading Corporation. (2021, August 3). *Steel Bars - Power Steel Specialist Trading Corporation*. https://www.powersteel.com.ph/steel-products/steel-bars/

Purkayastha D (2009) Trevor field and the playpumps of Africa. ICMR Center for Management Research Report 809-022-1, Hyderabad, India

Q Drum - Akvopedia. (2013). Akvopedia.org. https://akvopedia.org/wiki/Q_Drum

Qureshi, A. S., & Shoaib, I. (2016). Improving agricultural productivity by promoting low-cost irrigation technologies in Sub-Saharan Africa. Global Advanced Research Journal of Agricultural Science, 5(7), 283-292.

Reichel, R., Wu, N., & Clark, G. (Supervisor). (2011). Water Transport System for Rural Africa. Escholarship.mcgill.ca. From https://escholarship.mcgill.ca/concern/reports/tm70mv32b

Rockstrom J. 2007. Managing water in rainfed agriculture. Pages 322-323 in Comprehensive Assessment of water management in agriculture, Chapter 8.

Sabo, M.U., Wailare, M.A., Aliyu, M., Jari, S. And Shuaibu, Y.M. (2013). The effect of NPK fertilizer and spacing levels on growth and yield of Watermelon (Citrillus lanatus L). Scholarly J. Agric. Sci. 3(8) : 325- 330.

Sijali IV. 2001. Drip irrigation: Options for smallholder farmers in eastern and southern Africa.Regional Land Management Unit, RELMA/Sida, ICRAF building, Gigiri, P.O. Box 63403,

Solving the Global Water Crisis Moves Beyond the Technical Feasibility Stage. Trends Magazine 104 (2011): 19-24. Business Source Complete. Web. 5 Mar 2012.

Steel Drums - Best Containers. (n.d.). Bestcontainers.com. Retrieved April 25, 2024, from https://bestcontainers.com/product-category/drums/steel-drums/

Steenhuisen, B. Journal of Design Research 11, 301 (2013).

The World Bank, World Development Indicators 2016 (World Bank Publications, 2016).

United Nations. (2011). Climate change adaptation is mainly about water... Retrieved January 23, 2011 , from UN Water: http://www.vestergaardfrandsen.com/lifestraw/lifestraw

Upo Production Guide. (2017). https://cagayanvalley.da.gov.ph/wp-content/uploads/2018/02/Upo.pdf

Water Crisis - Learn About The Global Water Crisis | Water.org. (n.d.). Water.org. http://water.org/learnabout-the-water-crisis/facts/

Water For People | Ending the Global Water Crisis. (n.d.). Water for People. http://waterforpeople.org

Wikipedia contributors. (2023). High-density polyethylene. *Wikipedia*. https://en.wikipedia.org/wiki/High-density_polyethylene

Wikipedia contributors. (2023a). Hippo water roller. *Wikipedia*. https://en.wikipedia.org/wiki/Hippo_water_roller

Wikipedia contributors. (2023b). Hippo water roller. *Wikipedia*.