DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF UNSHELLED CASTOR BEAN (*Ricinus communis L.*) SORTER

ANA MAY P. DOCTOLERA

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, in Partial Fulfillment of the Requirements for the Degree of

BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
(Agricultural Machinery and Renewable Energy)

JUNE 2019

This undergraduate thesis entitled **"DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF UNSHELLED CASTOR BEAN (*Ricinus communis L.*) SORTER,"** prepared and submitted by **ANA MAY PALMA DOCTOLERA** in partial fulfilment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AGRICULTURAL MACHINERY AND RENEWABLE ENERGY)** is hereby accepted:

HELEN F. GAVINO, Ph.D.
Member, Advisory Committee

05/31/19
Date Signed

EMMANUEL V. SICAT, Ph.D.
Member, Advisory Committee

06/07/19
Date Signed

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

05/27/19
Date Signed

Accepted as partial fulfilment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AGRICULTURAL MACHINERY AND RENEWABLE ENERGY):**

MARVIN M. CINENSE, Ph.D.
Chairperson, Department of Agricultural and Biosystems Engineering

6/10/19
Date Signed

VICTORINO T. TAYLAN, Ph.D.
Dean, College of Engineering

6/11/19
Date Signed

BIOGRAPHICAL SKETCH

The author, Ana May P. Doctolera, was born on the 23rd of July 1998 in Llanera, Nueva Ecija, the only daughter of Mr. Crispin P. Doctolera Jr. and Mrs. Ana Marie P. Doctolera, by whom the latter died after she was born. She was raised in a simple life and a fearful child of God by her two grandmothers, Carmelita P. Doctolera and Anita G. Palma.

The author finished her elementary education at Mabini Elementary School in 2010 as the class valedictorian. From there, she continued and was able to graduate high school in San Ricardo National High School at San Ricardo, Talavera, Nueva Ecija in 2014 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 Department of Science and Technology – Science and Education Institute (DOST-SEI) Undergraduate Scholarship RA 7687 throughout her college years.

She entered college at Central Luzon State University in Science City of Muñoz, Nueva Ecija, where she took up Bachelor of Science in Agricultural and Biosystems Engineering major in Agricultural Machinery and Renewable Energy. During her stay in the University, she was a resident of Ladies Dorm 6 from 2014 to 2019 and also became a student assistant at the dorm during her last semester of residency; she was also a former secretary of Association of DOST Scholars in CLSU, school year 2016 to 2017; the former Editor-in-Chief of the official students publication of the College of Engineering, The Mechanics, during 1st semester 2018; and, also a youth leader under the Lakas-Angkan Ministry.

ACKNOWLEDGMENT

This study would not have been possible without the ideas, knowledge, support, and encouragement of the people who extended their helping hands towards the completion of this research work. Thus, the author wants to express her deepest gratitude to recognize the contribution and dedication of the following individuals:

To Engr. Marlon Delos Santos, her adviser, for his significant contribution in making this paper excellent, for his outstanding guidance, and also for making himself available despite his schedules. He truly deserves all credits.

To Dr. Emmanuel V. Sicat and Dr. Helen F. Gavino, members of the advisory committee, for their constructive criticism, suggestions, and encouragement during the course of this study.

To Engr. Marlon Galad, for the valuable assistance upon the design and during the fabrication of the machine.

To the AREC staffs and AgMech students for their support and for lending needed resources and labor for the improvement of the study.

To her classmates, who became her companions during the conduct and writing of her manuscript, Jannah, Aira, David, Mark Joseph, Cherrie, Hannah, Lenard, Klark,, Thea, Rhona, Monette and Roy for sharing stress-relieving moments after a long day at school. You guys are truly commendable.

To her friends, Diane, Dixie, Mjean, Novy, Jessa, Charie, Des, Jang and Joyjoy for the encouragement, support, motivation, and memories shared with the author.

To her dorm manager Nanay Linda, her cell leader Mommy Helen, to her cell group and follow ups, to her co-scholars and friends in the publication, for all the understanding and favors they have given to complete this study.

To her family, Lola Anita, Tatay, Tito Randy, Tita Cecil, Tita Ruby, Kuya Leivy, Kervin, Rojan, and to her siblings Criss and Crizcel, for the unconditional love and valuable time they have given to complete this study.

Above all, to Almighty God, Who gives exceedingly abundant with strength, time, right people, resources, knowledge, patience, and understanding by which all of the reasons how this study was ever possible from the very first idea unto the final output. Your grace is sufficient, Father.

To all of them, this piece of work is humbly dedicated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABSTRACT

DOCTOLERA, ANA MAY P., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **June 2019, DESIGN, FABRICATION, AND PERFORMANCE EVAUATION OF UNSHELLED CASTOR BEAN (*Ricinus communis L.*) SORTER.**

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

The study was carried out to design, fabricate, and evaluate the performance of unshelled Castor bean sorter in classifying Castor pods by size. The specific goal of this study was to determine the appropriate oscillation speed to facilitate its sorting performance and perform simple cost analysis on the device.

The unshelled Castor bean sorter was designed and drawn based on the physical characteristics of the Castor pods. The machine was fabricated based on design plans and specifications. The components of the sorter include the hopper, sorting unit, receiving funnel, oscillation assembly, power transmission system, and frame. The sorting unit was designed with slatted stainless steel (6.35 mm diameter, 40 cm long) by which the clearance varies from 15 mm, 20 mm, and 25 mm. These gaps were sized up based on the actual sizes of Castor pods. The diameter of Castor pods as testing samples were 16mm to 20 mm, 21 to 25 mm, and 26 mm and above – small, medium, and large.

Three different sorting speeds of the shafts (430 rpm, 358 rpm, and 307 rpm) were evaluated. Five (5) kilograms of mixed Castor pods were used in the treatment at three (3) replications. Results showed that the appropriate sorting speed was at 358 rpm giving a system efficiency of 73.49% in sorting, and throughput capacity of 400.53 kg/hr.

Likewise, the amount of damaged pods was only 1%, the lowest among the three treatments.

The overall cost of the device was Php19,338.20 with a break-even weight of 16,115.17 kg/yr of Castor pods at a custom rate of Php1.2/kg and a breakeven operational cost of Php8,379.87/yr. Equivalent annual fixed cost of the device was Php21, 310.70 and variable cost of Php71.84/hr.

LITERATURE CITED

Angeles, A.V. (1987). Agricultural Machinery Design: Generic Procedure in Machinery Design, AE 502 Resource Materials, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines.

Anjani, K. (2011). Castor genetic resources: A primary gene pool for exploitation. Industrial Crops and Products 35(1):1-14. Indian Council of Agricultural Research.

Armstrong, W. P., et al. (1999). The Castor Bean. Wayne's Word, An On-Line Textbook of Natural History. Last updated on June 20, 2018. http://azolla.fc.ul.pt/ aulas/documents/Ricinuscom.pdf

Blau, P. J. (1996). Fifty years of research on the wear of metals. Friction Science and Technology, Marcel Dekker, Inc. Tribology International Volume 30, Issue 5, May 1997, Pages 321-331.

Belonio, A. (2006). Agricultural Engineering Formula, Revised Edition. Department of Agricultural Engineering and Environmental Management, College of Agriculture. Central Philippines University, Iloilo City, Philippines. Pages 9-13.

Chase, G. G. (2001). Bulk Properties. Department of Chemical and Biomolecular Engineering. The University of Akron. https://www..ecgf.uakron.edu/cem/ fclty/chase/SolidsNotyes4%20%Bulk%20 Properties.pdf

Corpuz A. G., and J. S. Ilano. (2004). Design, Fabrication and Performance Evaluation of a Peanut Kernel Sorter. Undergraduate Thesis for Bachelor of Science in Agricultural Engineering. Central Luzon State University.

Costa C., F. Antonucci, F. Pallottino, and J. Aguzzi. (2011). Shape analysis of agricultural products: a review of recent research advances and potential application to computer vision. Food and Bioprocess Technology 4(5): 673–692

Cuaresma, F. D., and L. M. Cabanayan. (2012). Compiled Lecture in Engineering Economy. Department of Engineering Sciences, College of Engineering, CLSU. Volume I, Pp 7-9.

Dela Cruz, M. L. (2017). Modification, Fabrication, and Performance Evaluation of Onion (*Allium cepa L.*) Quick Sorter. Undergraduate Thesis for Bachelor of Science in Agricultural Engineering. Central Luzon State University, Nueva Ecija, Philippines.

De Lucia, M., and Assennato, D. (1994). Agricultural Engineering in Development: Post-harvest Operations and Management of Foodgrains. FAO Agricultural Services Bulletin No. 93. Rome: FAO.

Dhatt A. S., B. V. C. Mahajan. (2007). Horticulture Post Harvest Technology. Punjab Horticultural Postharvest Technology Centre. Punjab Agricultural University Campus, Ludhiana.

Fashina A. B., Salcha., and Akande F. B. (2015). Development and Evaluation of a Groundnut In-Shell Grader. Department of Agricultural Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Agricultural Sciences, 2015, 6, 217-223. Published Online February 2015 in SciRes.

Field, H. L., J. B. Solie. (2000). Equipment Efficiency and Capacity. Introduction to Agricultural Engineering Technology. Pp 118-128.

Fitzpatrick, W. P., and J. S. Weissman. (2013). Atomic Structure. PNAS published ahead of print March 19, 2013. Edited by Jonathan S. Weissman, University of California, San Francisco, CA. https://www.pnas.org/content/early/2013/03/18/1219476110

Food and Agriculture Organization. (2011). FAOSTAT. . Food and Agriculture Organization of the United Nations, Rome. https://www.google.com/search?q=Food+and+Agriculture+Organization.+(2011)

Food and Agriculture Organization. (2014). Grading and Classification of Green Coffee. Good Hygiene Practices along the coffee chain. Pp 1-5. http://www.coffeeresearch.org/coffee/ classification.htm

Gamea, G. R., M. A. Aboamera, and M. E. Ahmed. (2011). Design and Manufacturing of Prototype for Orange Grading Using Phototransistor. Department of Agricultural Engineering, Faculty of Agriculture, Minoufiya, Egypt. Australian Journal of Agricultural Engineering. http://www.sciencej.com/gamea_2_3_2011_74_81.pdf

Gatmen, N. C. (2015). Design, Fabrication, and Performance Evaluation of Shelling Machine for Castor Bean (*Ricinus communis L.*). Master's Thesis for Master of Science in Agricultural Engineering. Central Luzon State University, Nueva Ecija, Philippines.

Godofredo, S. U. Jr. (2018). Philippine Medicinal Plants. Castor Oil Plant (*Tangan-tangan*). StuartXchange. Last updated on August 2018. http://www.stuartxchange.com/ TanganTangan.html

Gunathilake, D. M., W. M. Wasala and K. B Palipane. (2015). Design, Development and Evaluation of a Size Grading Machine for Onion. International Conference of Sabaragamuwa University of Sri Lanka 2015.

Hancock, J. N., L. D. Swetnam, and F. J. Benson. (1991). Calculating Farm Machinery Field Capacities. Agricultural Engineering Extension Publications. 20. University of Kentucky, College of Agriculture Cooperative Extension Services. Volume V:1991, Pp 1-5. https://uknowledge.uky.edu/aen_reports/20

Hodges, R.J., J. C. Buzby, and B. Bennett. (2010). Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. First published online 19 November 2010. Journal of Agricultural Science (2011), 149, 37–45. Cambridge University Press 2010.

Jiaxiang, H. (2009). Material returnable castor-oil plant threshing cleaning and sorting machine. CN2015633977U, CN Grant. Google Patents.. https://patents.google.com/patent/CN201563397U/en?q=castor+bean&q=sorter&oq=castor+bean+sorter

Lai, O. M., C. P. Tan, and A. C. Casimir. (2005). Palm Oil: Production, Processing, Characterization, and Uses. A publication of AOCS Press. P.O. Box 17190. Urbana, USA. Pp 532-533. https://aocs.personifycloud.com/PersonifyEBusiness/Default.aspx?TabID=251&productId=365439

Lantin, R. M. (2016). Agricultural mechanization in the Philippines, Part I: Brief History. Article in Ama, Agricultural Mechanization in Asia, Africa & Latin America 47(2):80-86. https://www.researchgate.net/publication/305165185_ Agricultural_mechanization_in_the_Philippines_Part_I_Brief_history

Londhe, D., S. Nalawade, G. Pawar, V. Atkari. (2013). Grader: A Review of Different Methods of Grading of Fruits and Vegetables. Department of Farm Machinery and Power, Dr. A. S. College of Agricultural Engineering, MPKV, Rahuri, Maharashtra, India. https://www.researchgate.net/publication/287864312_Grader_A_review_of_different_methods_of_grading_for_fruits_and_vegetables

Kara M., B. Sayincia, E. Elkocab, İ. Öztürka, T. B. Özmenc. (2013). Seed Size and Shape Analysis of Registered Common Bean (*Phaseolus vulgaris L.*) Cultivars in Turkey Using Digital Photography. Journal of Agricultural Sciences.

Karthik, S. K. (2015). Development of On-Farm Onion Grader. Master's Thesis for Bachelor of Science in Agricultural Engineering. University of Agricultural Sciences, Bengaluru.

Khurmi, R.S. and J.K. Gupta. (2005). Machine Design (S.I. Units). EURASIA PUBLISHING HOUSE (PVT.) LTD. RAM NAGAR, NEW DELHI-110 055. Chap 4 Pg. 87-95 and Chap 14 Pg. 509.

McRae, D. C. (1985). A review of developments in potato handling and grading. Journal of Agricultural Engineering Research, 31:115-138. https://www.sciencedirect.com/science/article/abs/pii/0021863485900654

Morimoto T, Takeuchi T, Miyatah & Hashimoto Y. (2000). Pattern recognition of fruit shape based on the concept of chaos and neural networks. Computers and Electronics in Agriculture 26: 171-186

O'brien, M. (1968). Sorting, sizing and field filling of fruit and vegetables into bins. Journal Agricultural Engineering Research, 13(4):318-322. https://www.sciencedirect.com/science/article/abs/pii/002186346890142X

Official Gazette. Press release from the Department of Agriculture on May 21, 2013. PHL farm mechanization is 1.23 hp/ha. Official Gazette of the Philippines. https://www.officialgazette.gov.ph/2013/05/21/phl-farm-mechanization-is-1-23-hpha/

Pius, C. O., S. P. Obuka Nnaemeka1, O. Charles, N. Oriah Vincent, and A. Igwegbe Chinenye (2014). Design Enhancement Evaluation of a Castor Seed Shelling Machine. Journal of Scientific Research and Reports. Article no. JSRR.2014.004. https://www.sciencedomain.org

Philippine Agricultural Engineering Standard (PAES) 116:2001. Agricultural Machinery-Small Engine-Specifications.

Philippine Agricultural Engineering Standard (PAES) 221:204. Agricultural Machinery-Peanut Sheller-Methods of Test.

Philippine Agricultural Engineering Standard (PAES) 301:2001. Engineering Materials – V-belts and Pulleys for Agricultural Machines – Specifications and Applications

Razak T. R., M. B. Othman, M. N. Abu Bakar, K. A. Ahmad, and A. R. Mansor. (2012). Mango Grading by Using Fuzzy Image Analysis. International Conference on Agricultural, Environment and Biological Sciences, Phuket, Thailand. http://psrcentre.org/images/extraimages/5%20512525.pdf

Robin G. C., R. N. Smith and L. Simpson. (2017). Castor Growers Workshop. Jamaica Castor Industry Association. Castor bean production presented at The CARDI Experience on May 30, 2017. http://www.jamaicatradeandinvest.org/sites/default/files/CARDI%20Castor%20Bean%20Presentation%20Rohan%20Smith.pdf

Roque, A. (2012). Massive *'tangan-tangan'* Planting is On. CLSU Alumni Association, Inc., Nueva Ecija. Published on May 2, 2012. Central Luzon State University. http://clsualumni.org/?page=news&action=details&REFECODE=AM12050001

Ruiz, E. (2013). Castor Oil Plant Production. An article published by Pinoyentre last April 17, 2013. Pinoy Entrepreneur. http://www.pinoy-entrepreneur.com/2013/04/17/castor-oil-plant-production/

Navie, S., and S. Adkins. (2004). The Environmental Weeds of Australia, Centre for Biological Information Technology, University of Queensland. https://www.researchgate.net/publication/43521531_Environmental_weeds_of_Australia_electronic_resource

Neha Goyal, Pardha-Saradhi P, Sharma GP. (2014). Can adaptive modulation of traits to urban environments facilitate *Ricinus communis L.* invasiveness? Environmental Monitoring and Assessment, 186(11):7941-7948.

Scholz, V., and J. N. Da Silva. (2008). Prospects and risks of the use of castor oil as a fuel. Article in Biomass and Bioenergy 32(2):95-100 · February 2008. https://10.1016/j.biombioe.2007.08.004.

Shafiee S., J. Hashemi, and K. Kheiralipur. (2009). Moisture Dependent Physical Properties of Castor Bean Seeds. World Applied Sciences Journal 7 (10): 1216-1221.

Shahir, S. and V. Thirupathi. (2009). Performance Evaluation of a Divergent Roller Grader for Selected Vegetables. Department of Food and Agricultural Process Engineering, Tamil Nadu Agricultural University. https://www.academia.edu/3457548/Performance_Evaluation_of_a_Divergent_Roller_Grader_for_selected_vegetables

Shewfelt, R. S. and S. E. Prussia. (1993). Postharvest Handling a system approach (Language Material). San Diego: Academic Press, Inc. 189 p.

Tripathi, P. and Lawande, K. E. (2008). Kharif onion production Technology- Bulletin. National Research Center for Onion and Garlic Rajgurunagar, Pune, India. https://www.researchgate.net/publication/235680343

Truong, V., B. Bhandari. and S. Fukai. (2007). Investigation of rice kernel cracking and its control in the field and during post-harvest processes in the Mekong Delta of Vietnam. Project Progress Report, 026/VIE05. Australian Government, Ministry of Agriculture & Rural Development.

Williams, J. F., J. F. Thomson, and R. G. Mutters. (2002). Rice milling quality. University of California Rice Research. Quartly. Vol. 1 California. University of California. https://acta.mendelu.cz/media/pdf/actaun_2017065051469.pdf

Valentin, M. (2014). Design, Fabrication, and Performance Evaluation of Village-Type Potato Grader. Master's Thesis for Agricultural and Biosystems Engineering. Central Luzon State University, Nueva Ecija, Philippines.

Valenzuela, D. R. (1981). Design, construction and performance test of portable tomato sorter/grader. Unpublished undergraduate thesis. Central Luzon State University, Nueva Ecija, Philippines.

Zittel, D. R. (1992). Bean Grader. Lyco Manufacturing Inc. US5332103A, US Grant. Published last December 31, 1992. https://patents.google.com/patent/US5332103A/en