DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF ONION (*Allium cepa l.*) BULB DESCALER

ERNEST RODS L. LIBREA

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
(AB Machinery and Power Engineering)

FEBRUARY 2025

ACCEPTANCE SHEET

This undergraduate thesis entitled "**DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF ONION *(Allium cepa l.)* BULB DESCALER**" prepared and submitted by **ERNEST RODS L. LIBREA,** in partial fulfillment of the requirements for the degree **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AB MACHINERY AND POWER ENGINEERING),** is hereby accepted:

ELIZA E. CAMASO, M.Sc.
Member, Advisory Committee

08/28/2024
Date Signed

JONATHAN V. FABULA, Ph. D.
Member, Advisory Committee

09/09/2024
Date Signed

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

08/02/2024
Date Signed

Accepted as partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING:**

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

09/12/2024
Date Signed

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

09/12/2024
Date Signed

BIOGRAPHICAL SKETCH

Ernest Rods L. Librea, 22 years old, was born on December 03, 2001, in Heart of Jesus, San Jose City, Nueva Ecija. He is the eldest son of Ingrid L. Librea & Joseph F. Librea, that resides in Purok 3, Bakal II, Talavera, Nueva Ecija.

He completed his primary education at Bakal II Elementary School, also known now as Bakal II Integrated School, where he was awarded an honorable mention. Furthermore, he finished junior high school at Sto. Domingo National Trade School (SDNTS) and Technical Vocational Education (TVE) in Drafting Technology. In senior high school, he finished his studies in a Science, Technology, Engineering, and Mathematics (STEM) strand at the same school where he finished his junior high school program. He was a consistent honor student until he graduated high school.

He pursued his bachelor's degree at Central Luzon State University (CLSU) and is currently enrolled in the Bachelor of Science in Agricultural and Biosystems Engineering (BSABE) program with a major in AB Machinery and Power Engineering as a senior student.

Ernest, inspired by his supportive aunt, persevered through the Bachelor of Science in Agricultural and Biosystems Engineering (BSABE) program. During his studies, he gained valuable practical experience through an on-the-job training (OJT) at the Agricultural Machinery Testing and Evaluation Center (AMTEC). This immersive experience allowed Ernest to apply his classroom knowledge to real-world scenarios focused on agricultural machinery. The OJT not only broadened his understanding of machine testing but also enabled him to establish professional networks and develop in a

encouraging work setting. Now, as a senior student, Ernest is poised to obtain his first degree, a testament to his dedication and the support he received along the way.

Upon graduation, he aspires to pursue a career in ABE field, together to pass the board exam, where he can continue to grow and make meaningful contributions. His long-term goals including continuous gaining knowledge day-by-day, and he is excited to embark on this next chapter of his professional journey.

ACKNOWLEDGEMENT

The accomplishment of this paper represents the culmination of a challenging yet rewarding journey filled with growth, discovery, and invaluable learning experiences. Throughout this endeavor, Mr. Ernest Rods L. Librea received guidance, support, and encouragement from various individuals and institutions, without whom this achievement would not have been possible.

Mr. Librea takes this section to express his heartfelt gratitude to the following people who have contributed to this thesis:

To Engr. Novalyn G. Delos Santos, for her invaluable guidance, continuous support, and patience throughout the research and writing process. Her expertise, constructive feedback, and encouragement have been instrumental in shaping this thesis and helping Mr. Librea grow as a researcher.

To his advisory committee member, Dr. Jonathan V. Fabula, for dedicating time and effort to review the paper and offer valuable feedback that significantly improved the quality of the research. Mr. Librea also extends his appreciation to Engr. Eliza E. Camaso, for her patience, encouragement, knowledge sharing, and valuable suggestions and comments during the development of this research.

Mr. Librea extends his heartfelt appreciation to his family for their unwavering support, understanding, and encouragement throughout his academic journey. Their love and belief in him have been a constant source of motivation and strength that fuels him to continue. Especially to his Mama Ingrid, Mommy Tess and Lola Nanay, who mentally, emotionally, and financially supported him in whatever it took from them just to let him finish his studies; their sacrifices and efforts were not in vain.

To his father, who is already in the hands of God, Mr. Librea is almost at the finish line of this phase. He knows this was his father's dream for their family. His father must be proud in heaven. Mr. Librea dedicates this achievement to him. He thanks his father for having them and expresses his love.

To those professional people who extends their knowledge to the author to help thrive this journey at more ease, particularly to Engr. Deo – Jay Manglal-Lan, and Engr. Christopher Japones of UPLB – AMTEC, for their invaluable feedback to the development of this thesis.

To his friends, Mr. Christian Martin, Mr. Gabriel Tibayan, Mr. Jr Bagaporo, Mr. Ron Jay De Vera & Mr. Eduardo Tan, Mr. John Pierre Nuncio, Ms. June Angela Florence Agaton, Mr. Sem Caputol, Mr. Renzon Tadeo, And Mr. Xyrus John Sanchez, for their help throughout this journey. For all the laughs and cheers, their physical, intellectual, and emotional support means a lot during the rough times.

Mr. Librea's loving girlfriend, Ms. Juliene Dc. Pagaduan, has been his constant source of inspiration, encouragement, and support throughout this academic journey. He thanks her for being his partner in every sense of the word. This achievement would not have been possible without her love, care, and understanding.

TABLE OF CONTENTS

	PAGE
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF APPENDICES	xii
INTRODUCTION	
Background of the Study	1
Statement of the Problem	3
Objectives of the Study	5
Significance of the Study	5
Scope and Limitation of the Study	6
Time and Place of the Study	6
REVIEW OF RELATED LITERATURE	
Onion Production in the Philippines	7
Onion Variety in the Philippines	8
Descaling Practices	8
Mechanized Descaling	8
Manual Descaling	8
Curing of Onion	8
Onion Size(s) Classification	9
Onion Physical Properties and Mechanical Properties	10
Design & Performance of Available Descaler	11
Testing and Evaluation of Onion Descaler	14
Brush Roller Selection	15
METHODOLOGY	
Conceptualization of the Study	16
Design Consideration	18
Design Criteria	19

Principle of Operation 20

Design of Components 21

Feed hopper 21

Feed hopper volume 22

Brush Roller 22
Bulb Discharge Chute 24
Peel Collection Chute 24
Prime Mover 25
Main Frame 26
Transmission Assembly 27
Wheels 28

Fabrication of the Machine 30

Fabrication 30

Performance Evaluation 31

Preliminary Testing 31
Modifications 32
Final Testing 33

Data Gathering 34

Input Capacity 34
Descaling Efficiency 34
Descaling Loss 35
Electricity Cost 36

Experimental Design 36

Cost Operation of the Machine 37

Annual Cost 37
Fixed Cost 38
Variable Cost 38

Depreciation 39
Interest on Investment 39
Repair and Maintenance 40
Labor Cost 40
Total Cost 41
Payback Period 41

RESULTS AND DISCUSSIONS

Onion Bulb Descaler 42
Performance Evaluation 43

Input Capacity 43
Descaling Efficiency 44
Descaling Loss 46
Electricity Consumption 47

Cost Analysis 48

SUMMARY, CONCLUSION, AND RECOMMENDATION

Summary 51
Conclusion 52
Recommendation 53

LITERATURE CITED 55

APPENDICES 58

LIST OF TABLES

TABLE		PAGE
1	Size Classification of Common Onion	9
2	Determination of Physical Properties	10
3	Experimental Layout of the Study	37
4	Specifications Onion Bulb Descaler	43
5	Input Capacity	43
6	Descaling Efficiency	44
7	Descaling Loss	46
8	Electricity Consumption	47
9	Cost Analysis	49

LIST OF FIGURES

FIGURE		PAGE
1	Dimension of Existing Onion Bulb Descaler	13
2	Design of Existing Onion Bulb Descaler	13
3	Conceptual Framework of the Study	17
4	Feed Hopper	22
5	Brush Roller	23
6	Bulb Collection Chute	24
7	Peel Collection Chute	25
8	Prime Mover	26
9	Main Frame	27
10	Wheels	28
11	Design of Onion Bulb Descaler	29
12	Onion Bulb Descaler	42

LIST OF APPENDICES

APPENDIX		PAGE
I	Appendix tables	59
II	Appendix figures	65
III	Raw data and computations	85

LIST OF APPENDIX TABLES

APPENDIX		PAGE
1	Detailed Specification of Onion Bulb Descaler	59
2	Specification of Onion Bulb Descaler	61
3	Computed Input Capacity	61
4	Computed Descaling Efficiency	61
5	Computed Descaling Loss	62
6	Computed Electricity Consumption	62
7	ANOVA Table for Input Capacity	62
8	ANOVA Table for Descaling Efficiency	62
9	ANOVA Table for Descaling Loss	62
10	ANOVA Table for Electric Consumption	63
11	Bill Of Materials	63
12	Cost Analysis of Onion Bulb Descaler	64

LIST OF APPENDIX FIGURE

APPENDIX		PAGE
1	Machine Design	65
2	Fabrication of Main Frame	66
3	Assembling of Brushes	67
4	Installing of Stainless-Steel Rod	68
5	Machine Shop of Sprockets	69
6	Assembly of Transmission	70
7	Size Determination of Medium	71
8	Preparation of Medium	72
9	Preliminary Testing Output	73
10	Gathering different RPM Using Tachometer	74
11	During the Machine Testing	75
12	Treatment 1 – Replicate 1 (T1R1)	76
13	Treatment 1 – Replicate 2 (T1R2)	77
14	Treatment 1 – Replicate 3 (T1R3)	78
15	Treatment 2 – Replicate 1 (T2R1)	79
16	Treatment 2 – Replicate 2 (T2R2)	80
17	Treatment 2 – Replicate 3 (T2R3)	81
18	Treatment 3 – Replicate 1 (T3R1)	82
19	Treatment 3 – Replicate 2 (T3R2)	83
20	Treatment 3 – Replicate3 (T3R3)	

ABSTRACT

LIBREA, ERNEST RODS L., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Philippines, **February 2025, DESIGN, FABRICATION, AND PERFORMANCE EVALUATION OF ONION *(Allium cepa l.)* BULB DESCALER**

Adviser: NOVALYN G. DELOS SANTOS, M.Sc.

This study focused on addressing the challenges faced by onion farmers in post-harvest operations, particularly in the effective removal of excess peel and dirt from onion bulbs. The primary objectives included designing, fabricating, and evaluating the performance of an onion bulb descaler machine, using locally sourced materials.

The results indicated that the machine achieved a peak descaling efficiency of 90.43% at 500 rpm, with minimal damage to the bulbs and a descaling loss of 9.63%. A cost analysis revealed an initial investment of PHP 45,016.20, a total annual cost of PHP 19,735.00, and a breakeven point of 7,853.85 kilograms per year, leading to a payback period of approximately 3.07 years.

Overall, the study successfully designed and fabricated an onion bulb descaler that effectively reduced post-harvest losses and labor costs for small-scale farmers, enhancing the efficiency of onion handling and improving the economic viability of onion farming in the country. To enhance the machine's effectiveness, it is recommended to further optimize its design parameters, conduct additional testing on other vegetable such as garlic, and, operate the brush rollers at a speed of 500 rpm. By implementing these recommendations, the onion bulb descaler can significantly improve post-harvest efficiency, reduce losses,

and increase profitability for onion farmers, ultimately contributing to the economic viability of onion farming in the Philippines.

Keywords: Onion Bulb Descaler, Descaler, Descaling Efficiency, Onion

LITERATURE CITED

Ambrose, D. C. P. (2020). Engineering properties of peeled and unpeeled multiplier onion. *Current Agriculture Research Journal*, *8*(3), 232–238. doi:10.12944/carj.8.3.09

Arcalas, J. Y. (2023). "cut onion harvest losses to boost local supply": Jasper Y. Arcalas. Retrieved from https://businessmirror.com.ph/2023/02/02/cut-onion-harvest-losses-to-boost-local-supply/

Asian Journal of postharvest and mechanization - philmech. (2020). Retrieved from https://www.philmech.gov.ph/assets/publication/Journal/AJPM%20Vol.%203%20No.2%202020.pdf

Domingo, A. (2023). The plight of the onion industry in the onion capital of the Philippines: Basis for intervention strategies. Asian Journal of Agriculture and Rural Development, 13(1), 66–74. doi:10.55493/5005.v13i1.4766

FALOLA, A., MUKAİLA, R., UDDIN II, R. O., AJEWOLE, C. O., & GBADEBO, W. (2023). Postharvest losses in onion: Causes and determinants. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, *26*(2), 346–354. doi:10.18016/ksutarimdoga.vi.1091225

Higuchi, Shiyunichirou., Katayose, Kazunobu. (1977). Variable capacity type torque converter.

Jauron, R., & Wallace, G. (2017). Retrieved from https://www.extension.iastate.edu/news/yard-and-garden-harvesting-drying-and-storing-onions#:~:text=After%20harvesting%2C%20dry%20or%20cure,bulb%20scales%20begin%20to%20rustle.

Kate, Adinath & Chakraborty, Subir & Pawar, Dilip & Gorrepati, Kalyani. (2019). Airflow resistance and pressure drop behavior in different conditions of bulk-stored onion and its dynamic modeling. Journal of Food Process Engineering. 42. 10.1111/jfpe.13141.

Kate, A. E., Pawar, D. A., Chakraborty, S. K., & Gorepatti, K. (2021). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9114231/?fbclid=IwAR1T0SgwYTU4fGjSYJYv6puDzjVDv-rSMwTx_snb9ntepVT7aGcpOuthgS8

Kara Lynch, M. S. U. E. (2023). Retrieved from https://www.canr.msu.edu/news/simple_steps_to_harvesting_and_preserving_onions

Loo, W. Volume of a Trapezoidal Prism Calculator. Available at: https://www.omnicalculator.com/math/trapezoidal-prism-volume. Accessed: May 22, 2024.

Opara, L. U. (2003). Onions: Post-Harvest Operation. Retrieved from https://www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harvest_Compendium_-_Onion.pdf

PAES-129-2019 Retrieved from https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/129.pdf

PAES-301-2000 Retrieved from https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2020/06/PNS-PAES-301-2000-Engineering-Materials-V-belts-and-Pulleys-Specifications-and-Applications.pdf

PAES-303-2000 Retrieved from https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2020/06/PNS-PAES-303-2000-Engineering-Materials-Roller-Chain-and-Sprochets-Specifications-and-Appli.pdf

Pascual, M. P., Lorenzo, G. A., & Gabriel, A. G. (2018). Vertical farming using hydroponic system: Toward a sustainable onion production in Nueva Ecija, Philippines. *Open Journal of Ecology*, *08*(01), 25–41. doi:10.4236/oje.2018.81003

PSA. (2022). Retrieved from https://rsso03.psa.gov.ph/article/central-luzon%E2%80%99s-other-crops-value-and-volume-production-2021

PNS/BAFS. (2022). Retrieved from https://bafs.da.gov.ph/bafs_admin/admin_page/pns_file/PNS.BAFS%2014.2022_Onion%20-%20Product%20Standard%20-%20Grading.pdf

Suo, Wei., Jin, Lei., Zhang, Shiyan., Mou, Jinyong., Yuan, Xiaolei., Chen, Jun. (2013). Variable frequency motor drive circuit test method.

Toledano, I. (2023). Retrieved from https://www.wattco.com/2023/05/speed-control-ac-motors/#:~:text=AC%20Motor%20Speed%20Controller,generated%20by%20the%20AC%20Controller.

Department of Energy, U. S. (1997). Determining Electric Motor Load and efficiency. Retrieved from https://www.energy.gov/eere/amo/articles/determining-electric-motor-load-and-efficiency

YANG, H., WANG, B., GU, F., WU, F., ZHANG, Y., & HU, Z. (2022). Determination of some physical and mechanical properties of Onion. Retrieved from https://inmateh.eu/volumes/volume-68--no-3--2022/determination-of-some-physical-and-mechanical-properties-of-onion/