

**COMPREHENSIVE SEMESTRAL REPORT AT CENTRAL LUZON STATE
UNIVERSITY - CENTER FOR RENEWABLE ENERGY
AND TECHNOLOGY (CLSU-CREaTe)**

EDUARD C. CRUZ

An Undergraduate Comprehensive Semestral Report 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 in Partial Fulfillment of
the Requirements for the Degree of

**BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS
ENGINEERING
(AGRICULTURAL POWER, MACHINERY, AND RENEWABLE ENERGY)**

MAY 2024

ACCEPTANCE SHEET

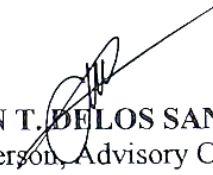
This undergraduate field practice manuscript entitled, “**COMPREHENSIVE SEMESTRAL REPORT AT CENTRAL LUZON STATE UNIVERSITY-CENTER FOR RENEWABLE ENERGY AND TECHNOLOGY (CLSU-CREaTe)**,” prepared and submitted by **EDUARD C. CRUZ** as partial fulfillment of the requirements for the degree **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AGRICULTURAL POWER, MACHINERY, AND RENEWABLE ENERGY)**, is hereby accepted:


JAYSON S. GELACIO, M.Sc.
Member, Advisory Committee

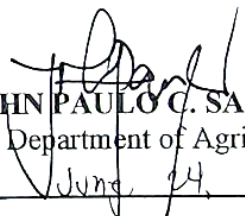
June 19, 2024
Date Signed

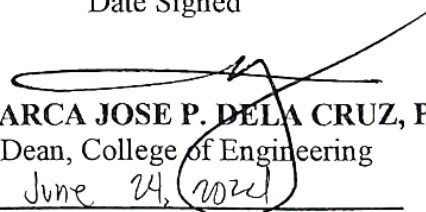

ROLDAN T. QUITOS, M.Sc.
Member, Advisory Committee

June 20, 2024
Date Signed


MARLON T. DELOS SANTOS, M.Sc.
Chairperson, Advisory Committee
JUNE 19, 2024
Date Signed

Accepted in partial fulfillment of the requirements for the degree **BACHELOR OF SCIENCE IN AGRICULTURAL ENGINEERING (Agricultural Power, Machinery, and Renewable Energy)**:


JOHN PAULO C. SACDALAN, Ph.D.
Head, Department of Agricultural Engineering
June 24, 2024
Date Signed


ROY SEARCA JOSE P. DELA CRUZ, Ph.D.
Dean, College of Engineering
June 24, 2024
Date Signed

BIOGRAPHICAL SKETCH

Eduard Cortez Cruz was born on April 10, 1998 in Science City of Muñoz, Nueva Ecija. He is the Eldest Son of Mr. Eduardo Ayuste Cruz and Mrs. Delia Cortez Cruz. His sibling is Diane Cortez Cruz. He started his elementary education in June 2004 at Palusapis Elementary School, Palusapis Science City of Muñoz, Nueva Ecija, and graduated in April 2010. He continued his secondary education at CLSU-University Laboratory High School Palusapis, Muñoz, Nueva Ecija where he attained his high school diploma in March 2014. He entered College at Central Luzon State University in June 2014 as the only College Admission Test that he passed and took a Bachelor of Science in Agricultural and Biosystems Engineering major in Agricultural Mechanization and Renewable Energy.

ACKNOWLEDGEMENT

The author would like to express his wholehearted appreciation and gratitude to the people who contributes and help him during the Field Practice Program.

Above all else, The Almighty God for His guidance to fulfill my duty as a student, wisdom, strength, and His blessings.

To Engr. Marlon T. Delos Santos, author's adviser for giving the opportunity to conduct Field Practice to the student, who gave his full attention in supervising the student to his full extent. Allowing the student to sharpen their skills and make exceptional values.

To Engr. Roldan T. Quito and Engr. Jayson S. Gelacio, author's advisory committee, for their expertise, feedback, and encouragement that have been crucial to the completion of this study. The author thank them for their time, support, and invaluable insight.

To Engr. May Cabral, Field Practice coordinator of Central Luzon State University who facilitate and gave this opportunity to the students.

To CLSU-CREaTe for accepting him as a trainee and for welcoming wholeheartedly. To Engr. Wendy C. Mateo, CREaTe director, Ma'am Joana Padua, and Kuya Nato for sharing their knowledge and experiences, for guiding the trainees in doing their task, and for their kind consideration. Truly, the lessons he learned and inspiration messages he heard from them for a short time will last a life time.

To his co-trainees, Jeramie, Kimberly, and Anjohn who stayed with him and helped with all they can do. The author's on the job training is even more precious to him

knowing that he has a good company who were continuously help him accomplish tasks and to become a better person.

To his father, mother, and sister, Eduardo A. Cruz, Delia C. Cruz, and Diane C. Cruz, respectively, for serving as the pillar of his strength, for providing an unending support and going all the trouble to help him financially and sacrificing better choices in exchange of his upbringing.

To his girlfriend, Kristine B. Ruiz, for always believing in him, cheering him on, being always there during the challenging times, and for ever supporting prayers. The author was deeply grateful for her constant presence and understanding

This hardship and enjoyable experience are dedicated to you.

TABLE OF CONTENTS

	PAGE
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF APPENDIX TABLES	xii
LIST OF APPENDIX FIGURES	xiii
INTRODUCTION	1
Background of the Field Practice	1
Objectives of the Field Practice	2
Activity 1. Performance Evaluation of 250L Semi-automated Bioreactor Using AC and Solar Powered Source	3
Activity 2. Design of 800L Tank Capacity of Bioethanol Distiller	3
Activity 3. Perform Other Activities	4
Significance of the Field Practice	5
Scope and Limitation of the Field Practice	5
Location and Duration of the Field Practice	6
REVIEW OF RELATED LITERATURE	7
Bioreactor	7
Electric Motor	9
Gearbox	10
Renewable Energy	11
Biomass	12
Biofuels	13
Bioethanol	15
Distillation	16
METHODOLOGY	17
Conceptualization of the Field Practice	17
Activity 1. Performance Evaluation of 250L Semi-automated Bioreactor using AC and Solar Powered Source	19
Key features and components typically found in a Bioreactor	19
Preparation for Instruments and Materials	20

Working Principle	21
Preparation of the Inoculants	22
Yeast Activation Process	23
Fermentation Process	24
Data Gathering	24
Distillation Process	25
Determination of Alcohol Content	26
Determination of Fermentation Efficiency	27
Power Consumption	27
Cost of power Consumed	28
Activity 2. Design of 800L Capacity Bioethanol Distiller	28
Design and Computation of Components of Distiller	29
Reflux Column Design	32
Condenser Design	33
Furnace Assembly Design	33
Frame	33
Design Consideration and Requirements	34
Engineering CAD Software	34
Bill of Materials	35
Activity 3. Other Activities	35
RESULTS AND DISCUSSION	36
Activity 1. Performance Evaluation of 250L Semi-automated Bioreactor using AC and Solar Powered Source	36
Sugar Reduction as Affected by the Changes in Temperature during Fermentation	38
Theoretical Ethanol Content	41
Actual Ethanol Content	42
Fermentation Efficiency	42
Power Consumption	43
Other Observations	43
Activity 2. Design of 800L Capacity Bioethanol Distiller	44
Reflux Column	45
Primary Condenser and Secondary Condenser	46
Frame	47
Bill of Materials	47
Activity 3. Other Activities	48
Activity 3.1. Research Innovation and Development Festival 2023 (Ride Fest 2023)	48
Activity 3.2. Assisting Visitors from NIA-Gapan	49

Activity 3.3. Field Test for the Mobile Solar Pump Irrigation System (SPIS)	50
Activity 3.4. Sitting Water Pump Around CLSU	52
Activity 3.5 Performance Evaluation of Biomass Shredder	52
Activity 3.6. Basic Welding Troubleshooting, and Maintenance of Different Machinery and Equipment	53
SUMMARY, CONCLUSION AND RECOMMENDATION	56
Summary	56
Conclusion	58
Recommendation	59
LITERATURE CITED	61
APPENDICES	63
Appendix Tables	64
Appendix Figures	66

LIST OF TABLES

TABLE		PAGE
1	Conceptual framework of the Field Practice	11
2	Instruments and equipment that will be used for evaluation	20
3	Specification of semi-automated bioreactor	37
4	Two independent sample t-test for pH using AC and Solar power in fermentation process of semi-automated bioreactor	39
5	Two independent sample t-test for temperature using AC and Solar power in fermentation process of semi-automated bioreactor	41
6	Theoretical Ethanol Content for AC and Solar	41
7	Actual Ethanol Content	42
8	Computed fermentation efficiency	42
9	Power Consumption of Semi-Automated Bioreactor for AC source	43

LIST OF FIGURES

FIGURE		PAGE
1	Flow Chart	21
2	Bottom and top surface area of Bioethanol distiller tank	30
3	Frustum of a cone	31
4	Pythagorean Theorem	32
5	Actual picture of semi-automated bioreactor	36
6	Sugar reduction as affected by the change in pH of the hydrolysates for the whole duration of yeast fermentation of sugarcane molasses for AC	38
7	Sugar reduction as affected by the change in pH of the hydrolysates for the whole duration of yeast fermentation of sugarcane molasses for solar powered source	39
8	Sugar reduction as affected by the change in temperature of the hydrolysates for the duration of fermentation of sugarcane molasses for AC	40
9	ugar reduction as affected by the change in temperature of the hydrolysates for the duration of fermentation of sugarcane molasses for sola	40
10	800L tank capacity bioethanol distiller	45
11	Reflux column	46
12	Assisting a visitor	49
13	Demonstrating the solar powered biomass chopper	50
14	Mobile Solar Pump Irrigation System	51
15	Grinding the edges of Biomass Shredder	53
16	Constructed the sawing equipment frame	54
17	Assisting for building the structure of the costume	54
18	Constructing the sawing equipment frame	57

LIST OF APPENDIX TABLES

TABLE		PAGE
1	Bill of materials	64
2	Data collected on evaluation of Solar Power Irrigation System	65

LIST OF APPENDIX FIGURES

FIGURE		PAGE
1	Isometric view of bioethanol distiller	66
2	Bioethanol distiller with dimension	67
3	Different perspective of bioethanol distiller	67
4	Front view of tank	68
5	Isometric view of tank	68
6	Top view of tank	68
7	Primary condenser	69
8	Secondary condenser	69
9	Frame	70
10	Right side view of the frame with dimension	71
11	Top view of frame with dimension	71
12	Front view of frame with dimension	72
13	Yeast activation and weighing of additives	73
14	Pouring and diluting of molasses with additives including transferring of broth into the bioreactor	73
15	Data gathering	74
16	Fermentation of broth using AC and solar powered source	74
17	Hardware in San Jose, Nueva Ecija as well as canvassing of materials	75
18	CLSU Ride Fest 2023	75
19	Constructing the frame of sawing equipment	76
20	Measuring the area of farm and data gathering of mobile solar powered irrigation system (SPIS)	76
21	Disassembling the walking type two-wheel hand tractor	77
22	Evaluation of biomass shredder	77
23	Constructing the structure of pageant costume	78

ABSTRACT

CRUZ, EDUARD C., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, May 2024, **COMPREHENSIVE SEMESTRAL REPORT ON FIELD PRACTICE AT CENTRAL LUZON STATE UNIVERSITY - CENTER FOR RENEWABLE ENERGY AND TECHNOLOGY (CLSU-CREaTe)**

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

The field practice took place at the Central Luzon State University - Center for Renewable Energy and Technology (CLSU-CREaTe), Science City of Muñoz, Nueva Ecija. It occurred from October to December 2023 and from March to May 2023.

The objective of Field Practice Activity 1 was to evaluate the operation of a 250L semi-automated bioreactor utilizing both AC and solar power. The main goals of this activity were to: 1) evaluate a semi-automated bioreactor using both AC and solar power sources; 2) determine the fermentation efficiency of the semi-automated bioreactor using both AC and solar power sources; and 3) compare the power consumption between the AC and solar power sources.

The objective of field practice activity 2 was to design a bioethanol distiller with a tank capacity of 800 liters. The main goals of this activity were to: 1) ascertain the most favorable dimensions (area and height) for an 800L tank capacity bioethanol distiller; 2) identify the additional components required for the bioethanol distiller; 3) create a design layout for the bioethanol distiller; and 4) compile a bill of materials for the bioethanol distiller.

The objective of field practice activity 3 was to carry out more tasks. The primary aims of this activity were to: 1) carry out additional tasks as directed by the center

director, student-trainee supervisor, or any CLSU-CREaTe staff; and, 2) enhance the students' preparedness and adaptability in their chosen fields of expertise.

An evaluation was conducted on the fermentation efficiency of the 250L semi-automated bioreactor, utilizing both AC and solar power sources. The results demonstrated a fermentation efficiency of 81.7% and 83.5%, correspondingly. The AC supply consumed 6.25 pesos, while solar power saved more but was more expensive in terms of initial cost. Solar power delivers economic savings in the long run and environmental benefits, making it an attractive alternative for numerous applications.

The bioethanol distiller's design, which holds a capacity of 800L, has been adjusted to a bigger size. The design contains a tank, reflux column, primary condenser, slanted secondary condenser, vertical secondary condenser, and frame. The final dimensions were computed to assure the machine's efficiency and durability.

Moreover, the student-trainee acquired knowledge with numerous areas of renewable energy, including participation in events, executing machine evaluation tests, and partaking in equipment installation during field practice time frame.

LITERATURE CITED

- Abenes, F. B. and Agrupis, S. (2013). Personal Communications on Protocols of Sugarcane Molasses Fermentation for Bio-ethanol Production.
- Agrupis, S.C., Mateo, N., Madigal, J., Birganas, M., Lucas, M., and Abenes, F. (2014). "MMSU Hydrous Bioethanol: Properties and Performance of the Different MMSU95hBE Blends with Commercial Gasoline." Mariano Marcos State University.
- Awogbemi, O., & Von Kallon, D. (2022). Valorization of agricultural wastes for biofuel applications. *Heliyon*, 8.
- Bello, S. R., (2006). Guide to Agricultural Machinery Maintenance, and Operation. ResearchGate; Fasmen Communications, Okigwe Nigeria. Retrieved September 2023 from: https://www.researchgate.net/publication/275642288_Guide_to_Agricultural_Machinery_Maintenance_and_Operation Bioprocess Engineering. (n.d.). Retrieved September 2023 from: https://www.mlsu.ac.in/econtents/1808_Bioprocessengg.pdf
- Bioenergy: Renewable, Sustainable, Attainable. (2016). Energy.gov. Retrieved September 2023 from: <https://www.energy.gov/eere/articles/bioenergy-renewablesustainableattainable#:~:text=Bioenergy%20is%20renewable%20energy%20produced,conversion%20process%20at%20a%20biorefinery>
- Broda M., Yelle DJ., & Serwańska K. (2022). Bioethanol Production from Lignocellulosic Biomass - Challenges and Solutions. *Molecules*; 27(24):8717. <https://doi.org/10.3390/molecules27248717>
- Busic, A., Mardetko, N., Kundas, S., Morzak, G., Belskaya, H., Ivancic Santek, M., Komes, D., Novak, S., Santek, B. (2018). Bioethanol Production from Renewable Raw Materials and its Separation and Purification: A Review. *Food Technol. Bioethanol*. 56 (3), 289-311.
- Central Luzon State University. (2014). Retrieved September 2023 from: Placeandsee.com. <https://placeandsee.com/wiki/central-luzon-state-university>
- Choy, Y. (n.d.). Volume of Frustum. Retrieved September 22, 2023, from https://qcweb.qc.edu.hk/math/Teaching_Learning/Frustum.pdf
- Damian, G. B. (2011). Design, fabrication, and evaluation of anaerobic bioreactor for biomass hydrolysis.

- Distillation Purification of Liquid Organic Compounds. (n.d.). retrieved September 2023 from: https://acikders.ankara.edu.tr/pluginfile.php/75185/mod_resource/content/0/Distillation.pdf
- Karthick, C., Nanthagopal, K., (2021). A Comprehensive review on Ecological Approaches of Waste to Wealth Strategies for Production of Sustainable Biobutanol and its Suitability in Automotive Applications. *Energy Convers. OR Manag.*. 239 (114219).
- Lazatin, H. (2022). Everything You Need to Know Before Applying to Central Luzon State University. Retrieved September 2023 from: [Candymag.com. https://www.candymag.com/lifestyle/central-luzon-state-university-a1753-20220429-lfm](https://www.candymag.com/lifestyle/central-luzon-state-university-a1753-20220429-lfm)
- Magar, S. T. (2023, May 7). Bioreactor- Definition, Design, Principle, Parts, Types, Applications, Limitations. *Microbe Notes*. September 2023 from: <https://microbenotes.com/bioreactor>
- M. Balat, Havva Balat, & O. Cahide. (2008). Progress in bioethanol processing. Retrieved September 2023 from: [ResearchGate; Elsevier BV. https://www.researchgate.net/publication/281041405_Progress_in_bioethanol_processing](https://www.researchgate.net/publication/281041405_Progress_in_bioethanol_processing)
- Mulvaney, Dustin. (2018). *Renewable Energy*. 10.1093/OBO/9780199874002-0138 Shinnosuke Onuki, Jacek A. Koziel, J.(Hans) van Leeuwen, William S. Jenks, David Grewell, Lingshuang Cai. (2008). *Ethanol Production, Purification, and Analysis Techniques: A Review*.
- Sustainable Energy Science and Engineering Center. (n.d.). Retrieved September 2023 from: <https://esc.fsu.edu/documents/lectures/ECSI/Bioenergy.pdf>