

## TABLE OF CONTENTS

<b>COVER .....</b>	<b>i</b>
<b>ANTI-PLAGIARISM STATEMENT .....</b>	<b>ii</b>
<b>APPROVAL FORM .....</b>	<b>iii</b>
<b>PROJECT FORM.....</b>	<b>iv</b>
<b>DEDICATION AND QUOTE.....</b>	<b>v</b>
<b>ACKNOWLEDGEMENT.....</b>	<b>vii</b>
<b>TABLE OF CONTENTS.....</b>	<b>ix</b>
<b>LIST OF FIGURES .....</b>	<b>xiii</b>
<b>LIST OF TABLES .....</b>	<b>xv</b>
<b>NOMENCLATURE.....</b>	<b>xvii</b>
<b>ABSTRACT .....</b>	<b>xx</b>
<b>INTISARI .....</b>	<b>xxi</b>
<b>CHAPTER I INTRODUCTION.....</b>	<b>1</b>
I.1. Background .....	1
I.2. Problem Statement .....	4
I.3. Objectives.....	5
I.4. Benefits .....	6
<b>CHAPTER II LITERATURE REVIEW .....</b>	<b>7</b>
II.1. Life Cycle Assessment.....	7
II.2. Remote Sensing and GIS for Plantation Management .....	10
II.3. Palm Oil-derived Biodiesel and Its Performance .....	14

<b>CHAPTER III THEORETICAL BACKGROUND .....</b>	<b>16</b>
III.1. The Palm Tree .....	16
III.1.1. Classification of Palm Tree .....	16
III.1.2. Palm Fruit and Fresh Fruit Bunch (FFB).....	17
III.1.3. Palm Productivity with Respect to Land Suitability Class (LSC).....	19
III.1.4. Relationship between CPA and Age .....	21
III.1.5. Relationship between Palm's Age and FFB Yield .....	22
III.2. Palm Oil Mill (POM).....	23
III.2.1. From FFB to CPO.....	23
III.2.2. From CPO to Refined Palm Oil.....	26
III.3. Composition of Palm Oil.....	26
III.4. Palm Biodiesel.....	27
III.4.1. Biodiesel .....	27
III.4.2. Palm Biodiesel Production Process .....	28
III.5. Co-products from Palm Oil Mill .....	31
III.5.1. Empty Fruit Bunch (EFB) .....	31
III.5.2. Fiber and Shell.....	33
III.5.3. Palm Oil Mill Effluent (POME) .....	34
III.6. Water Consumption in Life Cycle of Palm Oil-based Biodiesel .....	35
III.7. Airborne LiDAR Vegetation Mapping.....	36
III.8. Geographic Information System (GIS) .....	39
III.9. Policy on Biodiesel Blending Mandate in Indonesia .....	39
III.10. Palm Production in Indonesia.....	40
<b>CHAPTER IV RESEARCH METHODOLOGY .....</b>	<b>43</b>
IV.1. Tools and Materials .....	43

IV.2. Research Methods .....	43
IV.2.1. Data Collection .....	43
IV.2.2. Scenarios and Assumptions .....	44
<b>CHAPTER V RESULT AND DISCUSSION .....</b>	<b>51</b>
V.1. Digital Imagery of The Plantation .....	51
V.1.1. Orthophoto .....	51
V.1.2. Orthophoto with Stand-per-hectare Data Layer .....	53
V.1.3. Orthophoto with Land Use/Land Cover .....	54
V.2. Study Area .....	54
V.3. Age Distribution of Palm Trees .....	59
V.4. Forecast of Production Yields .....	68
V.4.1. FFB Yield .....	68
V.4.2. Co-products of Palm Oil Mill .....	71
V.4.3. CPO Yield .....	72
V.4.4. Biodiesel Yield .....	73
V.5. Water Consumption in Biodiesel Production .....	76
V.6. Summary of Forecasted Production and Water Consumption .....	77
V.7. Fulfillment Ratio and Palm Plantation Area Required .....	77
V.7.1. Fulfillment Ratio .....	77
V.7.2. Palm Plantation Area Required to Fulfill Biodiesel Demand .....	81
<b>CHAPTER VI CONCLUSION AND RECOMMENDATION .....</b>	<b>83</b>
VI.1. Conclusion .....	83
VI.1. Recommendation .....	84
<b>REFERENCES .....</b>	<b>85</b>
<b>APPENDICES .....</b>	<b>93</b>

APPENDIX A: Palm Productivity Standard Based on Land Suitability Classes	
.....	94
APPENDIX B: Raw Attribute Table As Stored in GIS, with CPA and Age, Tree	
No. 1–100 .....	95
APPENDIX C: FFB Yield Forecast 2013–2030 (Tons/Year), Tree No. 1265242	
- 1265334.....	99