

Table of Contents

DEDICATION.....	II
TABLE OF CONTENTS.....	III
LIST OF TABLES	V
LIST OF FIGURES	VII
ABBREVIATIONS	VIII
ABSTRACT	1
1 INTRODUCTION	2
2 METHODOLOGY	3
2.1 RESEARCH QUESTIONS	3
2.2 OBJECTIVES	3
2.3 LAND AVAILABILITY FOR BIOFUEL PRODUCTION	4
2.3.1 <i>Geographic potential</i>	6
2.3.2 <i>Technical potential: Conversion routes</i>	7
2.3.3 <i>Available land for energy crops</i>	11
2.4 THE PARTIAL EQUILIBRIUM MODEL.....	13
2.4.1 <i>Market equilibrium models</i>	13
2.4.2 <i>Partial models</i>	14
2.4.3 <i>Modeling international trade</i>	17
2.4.4 <i>The functional form</i>	17
2.4.5 <i>The elasticities</i>	18
2.4.6 <i>The mathematical form of the model</i>	19
3 AGRICULTURAL POTENTIAL	20
3.1 ENERGY CROPS: CHARACTERISTICS AND YIELDS.....	20
3.2 NET EXPORTS, A FIRST APPROACH.....	24
3.2.1 <i>Biodiesel</i>	24
3.2.2 <i>Bioethanol</i>	24
4 LAND REQUIREMENTS: YIELDS AND POTENTIAL CHANGES IN AGRICULTURE	
LAND USE.....	26
4.1 CURRENT YIELDS	26
4.2 POTENTIAL YIELD CHANGES AND ITS EFFECT IN BIOFUEL PRODUCTION	29
4.3 POTENTIAL CHANGES IN AGRICULTURAL LAND USE.....	29
4.3.1 <i>Present land needs for 5% blends</i>	30
4.3.2 <i>Agricultural frontier</i>	35

5	ESTIMATED PRODUCTIVE POTENTIAL OF BIOFUELS IN LACC FOR THE YEAR	
2025	42
5.1	PROJECTED LAND AVAILABILITY	42
5.2	GEOGRAPHIC POTENTIAL	43
5.3	TECHNICAL POTENTIAL.....	46
5.3.1	<i>Technical potential from woody biomass</i>	49
6	POTENTIAL OF RESIDUES	50
6.1	BIOMASS FROM AGRICULTURAL FIELD RESIDUES.....	51
6.2	BIOMASS FROM WASTE CROPS	53
7	RELATIONSHIP BETWEEN BIOFUELS, OIL AND FOOD. HOW DO PROCESSORS	
	DECIDE BETWEEN ENERGY AND FOOD?	55
8	INDUCED PRICE EFFECTS OF A BIOFUEL DEMAND INCREASE	56
8.1	SOME ESTIMATES	57
9	MARKET EFFECTS OF A BIOFUEL DEMAND INCREASE IN LACC	59
9.1	CROP MARKETS FOR BIODIESEL.....	60
9.1.1	<i>Cottonseed</i>	60
9.1.2	<i>Rapeseed</i>	61
9.1.3	<i>Soybean</i>	61
9.1.4	<i>Sunflower</i>	62
9.2	CROP MARKETS FOR BIOETHANOL	63
9.2.1	<i>Cassava</i>	63
9.2.2	<i>Maize</i>	64
9.2.3	<i>Sorghum</i>	65
9.2.4	<i>Wheat</i>	66
9.2.5	<i>Sugar beet</i>	67
9.2.6	<i>Sugarcane</i>	67
9.3	OTHER IMPORTANT CEREAL MARKETS	68
9.3.1	<i>Barley and rice</i>	68
9.4	WELFARE CHANGE.....	71
10	CONCLUSIONS	73
	BIBLIOGRAPHY	76
	WEBSITES	79
	APPENDIX	80

List of Tables

<i>Table 1: Latin American and Caribbean countries included in the study.....</i>	5
<i>Table 2: Transformation efficiencies for FT diesel and bioethanol from lignocellulosic biomass.</i>	9
<i>Table 3: Oil content and densities from different oil crops.....</i>	9
<i>Table 4: Transformation efficiencies for biodiesel from oil crops.....</i>	10
<i>Table 5: Transformation efficiencies for bioethanol from sugar/starch crops.....</i>	10
<i>Table 6: Cultivated energy crops in Latin American and Caribbean countries.</i>	20
<i>Table 7: General characteristics of energy crops for biodiesel production.....</i>	22
<i>Table 8: General characteristics of energy crops for bioethanol production.....</i>	23
<i>Table 9: Biodiesel productive potential using oil crops net exports from Latin American and Caribbean countries. Average 2000-2003 in (M Lt).....</i>	24
<i>Table 10: Bioethanol productive potential using sugar/starch crops net exports from Latin American and Caribbean countries. Average 2000-2003 in (M Lt).....</i>	25
<i>Table 11: Oil crop yields from Latin America and Caribbean countries. Average 2000-2003 in (Mt / Ha).....</i>	27
<i>Table 12: Sugar/starch crop yields from Latin America and Caribbean countries. Average 2000-2003 in (Mt / Ha).....</i>	28
<i>Table 13: New area required in (K Ha) for a biodiesel 5% blend and necessary expansion of current areas, average 2000 – 2003.....</i>	32
<i>Table 14: New area required in (K Ha) for a bioethanol 5% blend and necessary expansion of current areas, average 2000 – 2003.....</i>	34
<i>Table 15: Available area in Latin America and Caribbean for energy crops in (K Ha).....</i>	37
<i>Table 16: New vs. available land for a biodiesel 5% blend, in (K Ha).....</i>	39
<i>Table 17: New vs. available land for a bioethanol 5% blend, in (K Ha).....</i>	41
<i>Table 18: Projected land availability for energy crops in Latin America and Caribbean for the year 2025, in (K Ha).....</i>	42
<i>Table 19: Geographic potential for biodiesel production in Latin America and Caribbean in (M Mt): Scenario 3.....</i>	44
<i>Table 20: Geographic potential for bioethanol production in Latin America and Caribbean in (M Mt): Scenario 3.....</i>	46
<i>Table 21: Technical potential for biodiesel production in Latin America and Caribbean in (G Lt): Scenario 3.....</i>	47
<i>Table 22: Technical potential for bioethanol production in Latin America and Caribbean in (G Lt): Scenario 3.....</i>	48
<i>Table 23: Technical potential for FT diesel and bioethanol from woody biomass in (G Lt).....</i>	49
<i>Table 24: Characteristics of crop residues and bioethanol yields.....</i>	51
<i>Table 25: Theoretical bioethanol yields from crop residues.....</i>	51
<i>Table 26: FT diesel and bioethanol productive potential from agricultural field residues for the year</i>	

<i>2025 in (M Lt)</i>	52
<i>Table 27: Biodiesel and bioethanol productive potentials from waste crops for the year 2025 in (M Lt)</i>	53
<i>Table 28: Effects of a biodiesel demand increase in terms of price and production as (%)</i>	57
<i>Table 29: Price increase of non-energy crops due to a demand increase of energy crops as (%)</i>	58
<i>Table 30: Effects on the cottonseed market</i>	60
<i>Table 31: Effects on the rapeseed market</i>	61
<i>Table 32: Effects on the soybean market</i>	62
<i>Table 33: Effects on the sunflower market</i>	63
<i>Table 34: Effects on the cassava market</i>	64
<i>Table 35: Effects on the maize market</i>	65
<i>Table 36: Effects on the sorghum market</i>	65
<i>Table 37: Effects on the wheat market</i>	66
<i>Table 38: Effects on the sugar beet market</i>	67
<i>Table 39: Effects on the sugarcane market</i>	68
<i>Table 40: Effects on the barley and rice markets</i>	70
<i>Table 41: Welfare changes in Latin American and Caribbean countries</i>	72
<i>Table 42: Price effects of a demand shift; producer subsidy and price support on domestic and world markets for the analyzed energy crops</i>	75
<i>Table 43: Technical potential for biodiesel production in Latin America and Caribbean in (G Lt): Scenarios 1 and 2</i>	80
<i>Table 44: Technical potential for bioethanol production in Latin America and Caribbean in (G Lt): Scenarios 1 and 2</i>	80
<i>Table 45: World biodiesel and ethanol production by country, 2005</i>	81
<i>Table 46: Comparison between expected production of biofuels and consumption of fossil fuels in (G Lt)</i>	83

List of Figures

<i>Figure 1: Biomass conversion routes</i>	8
<i>Figure 2: Producer subsidy for a small importing country</i>	15
<i>Figure 3: Price support for a large exporting country</i>	16
<i>Figure 4: Relative importance of biodiesel geographic potential by sub-region and by energy crop in (%) : Scenario3</i>	44
<i>Figure 5: Relative importance of bioethanol geographic potential by sub-region and by energy crop in (%) : Scenario3</i>	45
<i>Figure 6: How do processors decide between biodiesel and food?</i>	56
<i>Figure 7: Biodiesel and bioethanol production per hectare considering average yields of Latin American countries (2000-2003), in (Lt/Ha)</i>	73
<i>Figure 8: Development of world ethanol and biodiesel production 1975-2005</i>	81
<i>Figure 9: World biodiesel production by country, 2005</i>	82
<i>Figure 10: World ethanol production by country, 2005</i>	82

Abbreviations

AEZ	Agro-ecological zone
B5	5% blend of biodiesel in diesel
E5	5% blend of bioethanol in gasoline
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization of the United Nation statistical data base
FT Diesel	Diesel obtained by Fischer-Tropsch process
g	Gram
G	Giga = 10^9
GAMS	General Algebraic Modeling System
Ha	Hectare = 10.000 m^2
HYV	High yielding varieties
K	Kilo = 10^3
Kg	Kilogram
LACC	Latin America and Caribbean countries
Lt	Liter
m³	Cubic meter
M	Mega = 10^6
Max.	Maximal
mm	1 millimeter of rainfall = $1 \text{ Lt} / \text{m}^2$
Mt	Metric ton = 1.000 kg
N	North latitude
ROW	Rest of the World
S	South latitude
US\$.	United States Dollars
WTO	World Trade Organization