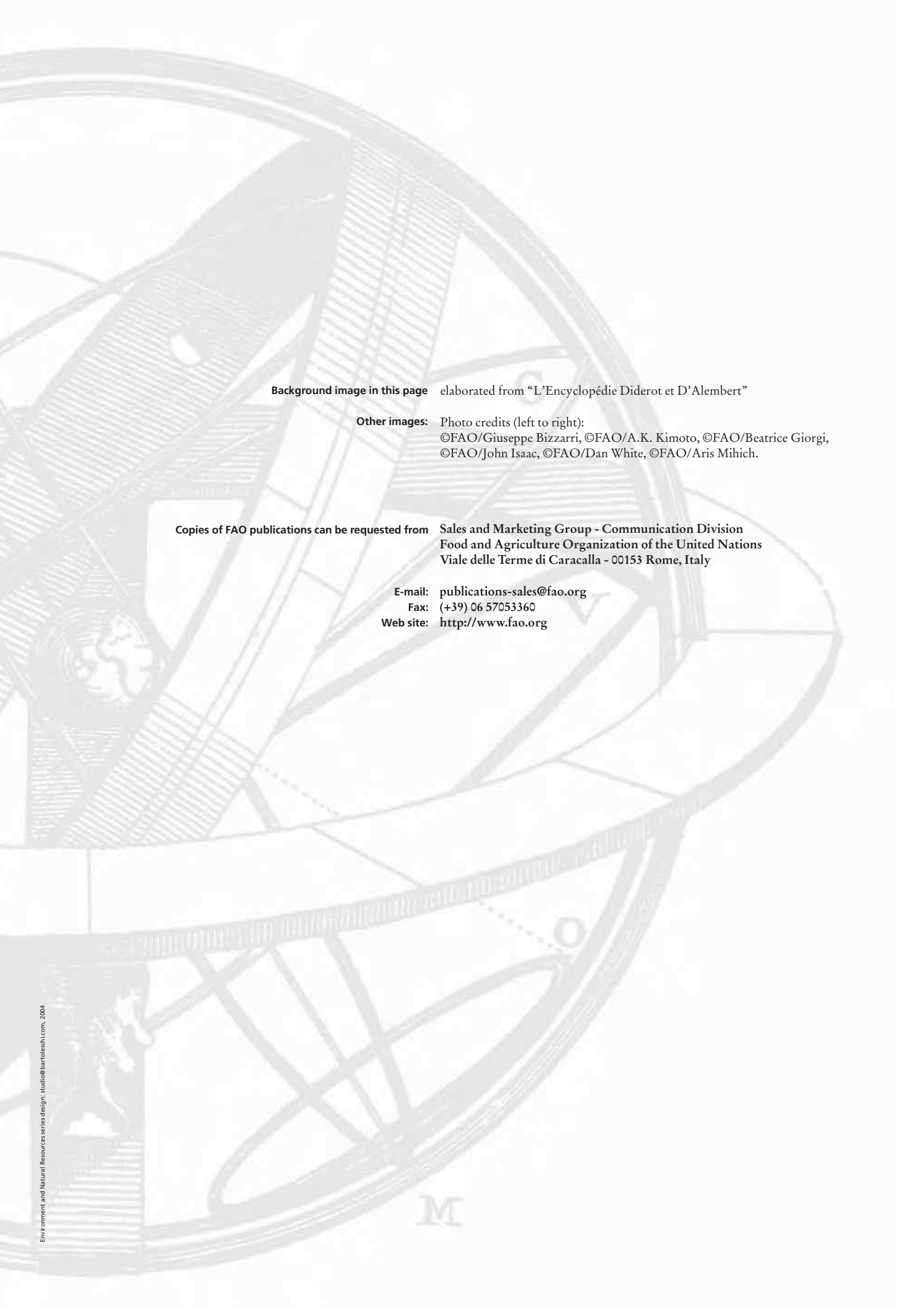


Bioenergy and Food Security

The BEFS analysis for Thailand

ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER
ENVIRONMENT CLIMATE CHANGE [BIOENERGY] MONITORING AND ASSESSMENT





Background image in this page elaborated from “L’Encyclopédie Diderot et D’Alembert”

Other images: Photo credits (left to right):
©FAO/Giuseppe Bizzarri, ©FAO/A.K. Kimoto, ©FAO/Beatrice Giorgi,
©FAO/John Isaac, ©FAO/Dan White, ©FAO/Aris Mihich.

Copies of FAO publications can be requested from Sales and Marketing Group - Communication Division
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla - 00153 Rome, Italy

E-mail: publications-sales@fao.org
Fax: (+39) 06 57053360
Web site: <http://www.fao.org>



Bioenergy and Food Security

The BEFS analysis for Thailand

Mirella Salvatore
Beau Damen



The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of FAO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

ISBN 978-92-5-106644-7

FAO declines all responsibility for errors or deficiencies in the database or software or in the documentation accompanying it, for program maintenance and upgrading as well as for any damage that may arise from them. FAO also declines any responsibility for updating the data and assumes no responsibility for errors and omissions in the data provided. Users are, however, kindly asked to report any errors or deficiencies in this product to FAO.

All rights reserved. FAO encourages the reproduction and dissemination of material in this information product. Non-commercial uses will be authorized free of charge, upon request. Reproduction for resale or other commercial purposes, including educational purposes, may incur fees. Applications for permission to reproduce or disseminate FAO copyright materials, and all queries concerning rights and licences, should be addressed by e-mail to:

copyright@fao.org

or to the

Chief
Publishing Policy and Support Branch
Office of Knowledge Exchange
Research and Extension
FAO
Viale delle Terme di Caracalla, 00153 Rome, Italy

© FAO 2010

FOREWORD


In an effort to improve energy access, energy security and to lower global green house gas emissions, many countries have placed bioenergy developments high on their agenda. Over time, however, serious concerns about the effect of bioenergy on food security, its social feasibility and level of sustainability have arisen, especially with first generation bioenergy. In this context FAO, with generous funding from the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), set up the Bioenergy and Food Security (BEFS) project to assess how bioenergy developments could be implemented without hindering food security.

During its term, the BEFS project has supported Peru, Tanzania and Thailand in assessing the feasibility of the bioenergy sector, potential impacts on food security, growth and poverty. In this effort, BEFS has constructed an analytical framework that can assist countries with the development of bioenergy policy and/or clarification of the potential impacts of bioenergy developments.

The analysis presented in this document describes the implementation of the BEFS Analytical Framework in Thailand. The results of the analysis formed the basis for the policy discussion with the Thai Government during the *BEFS Thailand Policy Consultation* in June 2010.

The main findings and recommendations for policy-makers how to achieve the envisaged biofuel targets in a sustainable way without impacting food security are being published in a separate volume entitled "*BEFS Thailand – Key results and policy recommendations for future bioenergy development*".

As part of its activities, BEFS has also run training programmes in the participating countries to ensure full ownership, replicability and potential extensions to the analysis presented.



Heiner Thofern
Senior Natural Resources Management Officer
BEFS Project Coordinator

ABSTRACT

The Government of Thailand, through its Alternative Energy Development Plan, has set a target of increasing its biofuels production to five billion litres by 2022. The Thai Government sees this expansion as a way to strengthen the country's energy security, foster rural development and reduce greenhouse gas emissions.

In recent years, due to a broad global interest in bioenergy development, FAO set up the Bioenergy and Food Security (BEFS) project to support countries to make informed decisions in order to limit the risks of hindering food security, and at the same time to increase their opportunity to improve the lot of the most vulnerable and underprivileged part of the society.

The analysis presented in this document is the result of the implementation of the BEFS Analytical Framework in Thailand. The framework envisages analyzing the effects of the bioenergy sector on the agricultural market and the use of natural resources, it evaluates the economic competitiveness and the effects on greenhouse gas emissions, and finally, it highlights the socio-economic aspects of bioenergy development at the macro and micro level.

The main findings and recommendations for policy-makers for the development of the biofuel sector without impacting food security are being published in “*BEFS Thailand – Key results and policy recommendations for future bioenergy development*”.

Bioenergy and Food Security: the BEFS analysis for Thailand

by Mirella Salvatore and Beau Damen

107 pages, 40 figures and 45 tables.

Environment and Natural Resources Working Paper No. 42 - FAO, Rome, 2010.

Keywords:

Bioenergy, food security, rural development, Thailand, BEFS.

This series replaces the following:

Environment and Energy Series

Remote Sensing Centre Series

Agrometeorology Working Paper

A list of documents published in the above series and other information can be found at the Web site:

www.fao.org/climatechange/49363@138259/en/

ACKNOWLEDGEMENTS

A very large number of experts have assisted in the work reported in this publication. First of all we would like to thank the BEFS Thailand Technical Partners for their technical contribution in specific chapters of this document:

- Chapter 3: Dr Jirapa Inthisang, Ms Tapee Vatcharangkool and Ms Orapim Sundaraketu, Office of Agricultural Economics (OAE), Ministry of Agriculture and Cooperatives, with the technical training, support and supervision of Holger Matthey, Trade and Markets Division of FAO;
- Chapter 4: Mr Yuttachai Anuluxtipun, Land Development Department (LDD), Ministry of Agriculture and Cooperatives;
- Chapter 5: Mr Upali Amarasinghe, International Water Management Institute (IWMI);
- Chapter 6 and 7: Mr Werner Siemers, Dr Boonrod Sujjakulnukij and Mr Nattapong Chayawatto, Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi;
- Chapter 8: Dr Somchai Jitsuchon, Thailand Development Research Institute (TDRI); Dr Apichai Puntasen, Rural and Social Management Institute (RASMI); Mr Thanapon Sreshtaputra, ChangeFusion Institute; and Prof Sombat Chinawong, Krabi Campus Establishment Project, Kasetsart University.

Within to all the BEFS Thailand Policy Counterpart, we would like to thank the following for useful insights and comments in the preparation of this document:

- Mr Montree Boonpanit and Dr Suppatra Cherdchuchai, National Economic and Social Development Board (NESDB);
- Dr Twarath Sutabutr, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy;
- Dr Shabbir Gheewala, JGSSE.

The BEFS Thailand project benefited from the overall support of Mr Hiroyuki Konuma and from collaboration with experts of the Regional Office for Asia and Pacific. A special thank to Mr Sverre Tvinnereim, Ms Suntaree Rangkusone, Ms Delgermaa Chuluunbaatar, Mr Ruben van der Laan, Mr Patrick Durst, Mr Simmathiri Appanah, Mr Sumiter Brocha, Mr Thierry Facon and Mr Yuji Niino.

In FAO Headquarters we would like to thank Heiner Thofern and Andreas von Brandt, for their managerial support.

Claudia Tonini provided valuable assistance with graphic design and formatting and Jeannie Marshall with editing.

This study was undertaken in the framework of the Bioenergy and Food Security project (GCP/INT/020/GER) with funding from the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV).

CONTENTS

iii	Foreword
v	Abstract
vi	Acknowledgements
xi	Acronyms
1	1. INTRODUCTION
3	2. THAILAND CONTEXT
4	2.1 The energy sector
7	2.1.1 The Alternative Energy Development Plan
9	2.1.2 Ethanol sector
10	2.1.3 Biodiesel sector
11	2.2 The agriculture sector
12	2.2.1 Agricultural policy
12	2.3 Social and environmental issues
12	2.3.1 Poverty and smallholder farmers
14	2.3.2 Soil degradation, deforestation and water management
15	2.4 References
17	3. AGRICULTURE MARKET PROJECTIONS
17	3.1 COSIMO methodology
18	3.1.1 Macro-economic assumptions
18	3.1.2 Biofuel assumptions
19	3.2 Thai agricultural market projections
19	3.2.1 Thailand baseline
23	3.2.2 Low GDP growth rate scenario
23	3.3 Conclusions
24	3.4 References
25	3.5 Appendix
27	4. NATURAL RESOURCE ANALYSIS: LAND
27	4.1 The methodology of land assessment
28	4.1.1 Land Suitability Assessment
29	4.1.2 Availability of suitable land
30	4.1.3 A tool to support farmers
31	4.2 Results
31	4.2.1 Sugar cane
33	4.2.2 Cassava
35	4.2.3 Oil palm
37	4.3 Conclusions
38	4.4 References
39	4.5 Appendix
43	5. NATURAL RESOURCE ANALYSIS: WATER
43	5.1 The methodology of water footprints
44	5.1.1 Water footprints of ethanol production
46	5.2 Water footprints of ethanol production in Thailand

46	5.2.1 Data and assumptions
46	5.2.2 Water footprint of sugar-based ethanol
47	5.2.3 Water footprints of cassava-based ethanol
48	5.2.4 Future trends of biofuel water footprint
51	5.3 Water quality impacts on local water systems
53	5.4 Conclusions
53	5.5 References
55	5.6 Appendix
57	6. ECONOMIC COMPETITIVENESS
57	6.1 The methodology
58	6.2 Results
58	6.2.1 Competitiveness of cassava-based ethanol
62	6.2.2 Competitiveness of sugar-based ethanol
65	6.2.3 Competitiveness of biodiesel
67	6.3 Conclusions
68	6.4 References
69	6.5 Appendix
71	7. CLIMATE CHANGE MITIGATION
71	7.1 The methodology
73	7.2 Results
73	7.2.1 GHG emissions of cassava-based ethanol
73	7.2.1.1 GHG emissions in the agricultural production of cassava
74	7.2.1.2 GHG emissions with land use and crop change in cassava production
76	7.2.1.3 GHG emissions in cassava dried-chip production
77	7.2.1.4 GHG emissions in cassava-based ethanol processing
80	7.2.2 GHG emissions of sugar-based ethanol
82	7.2.3 GHG emissions of biodiesel
85	7.3 Conclusions
86	7.4 References
87	7.5 Appendix
89	8. SOCIO-ECONOMIC ASPECTS
89	8.1 The methodology
90	8.1.1 Microeconomic analysis
90	8.1.2 Macroeconomic analysis
92	8.1.3 A survey analysis of small-scale bioenergy practices
93	8.2 Results
93	8.2.1 Impact of biofuels on households
97	8.2.2 Impact of biofuels on Thai economy
99	8.2.3 Limitations of the micro and macro analysis
99	8.2.4 Small-scale bioenergy and rural development
101	8.2.4.1 Best practice case - Don Phing Dad
101	8.2.4.2 Best practice case - Lao Khwan
102	8.2.4.3 Best practice case - Ta-Ong
102	8.2.4.4 Financial analysis of zero-waste bioenergy projects
103	8.3 Conclusions
104	8.4 References

LIST OF FIGURES AND TABLES

FIGURES

- 2 Figure 1.1 BEFS Analytical Framework in Thailand
- 4 Figure 2.1 Final energy consumption by economic sector in 2009
- 5 Figure 2.2 Final energy consumption by type in 2009
- 6 Figure 2.3 Alternative and renewable energy mix
- 8 Figure 2.4 Alternative Energy Development Plan
- 8 Figure 2.5 Actual and planned biofuel production under AEDP
- 9 Figure 2.6 AEDP roadmap for ethanol
- 10 Figure 2.7 AEDP roadmap for biodiesel
- 13 Figure 2.8 Poverty incidence in 2004
- 20 Figure 3.1 Thai projections for production and consumption profile
- 29 Figure 4.1 Sampling points for sugar cane, cassava and oil palm
- 30 Figure 4.2 Forests and natural disaster area
- 32 Figure 4.3 Actual versus potential area under sugar cane by suitability class
- 34 Figure 4.4 Actual versus potential area under cassava by suitability class
- 36 Figure 4.5 Actual versus potential area under oil palm by suitability class
- 44 Figure 5.1 Schematic of water uses in the biofuel life cycle
- 45 Figure 5.2 Process of sugar-based ethanol production
- 47 Figure 5.3 Sugar-based ethanol WF by districts
- 48 Figure 5.4 Cassava-based ethanol WF by districts
- 50 Figure 5.5 Total WF of sugar and cassava-based ethanol
- 59 Figure 6.1 Average cost structure of cassava plantation
- 60 Figure 6.2 Comparison of cassava ethanol production costs
- 61 Figure 6.3 Cost and benefit summary for each cassava ethanol scenario
- 63 Figure 6.4 Comparison of sugar ethanol production costs
- 64 Figure 6.5 Cost and benefit summary for each sugar ethanol scenario
- 65 Figure 6.6 Comparison of biodiesel production costs
- 66 Figure 6.7 Cost and benefit summary for large scale biodiesel production
- 67 Figure 6.8 Cost and benefit summary for small-scale biodiesel production
- 78 Figure 7.1 GHG emissions of different cassava-based ethanol configurations
- 79 Figure 7.2 Influence of LUC and CC on the medium efficiency fossil scenario
- 79 Figure 7.3 Influence of LUC and CC on the renewable energy scenario
- 81 Figure 7.4 GHG emissions of different sugar-based ethanol configurations
- 82 Figure 7.5 Breakdown of GHG emissions by step for sugar-based ethanol scenarios
- 84 Figure 7.6 GHG emissions of different biodiesel configurations
- 84 Figure 7.7 Renewable energy potential of medium sized CPO mill
- 90 Figure 8.1 Impact of price variation of biofuel crops on Thai households
- 91 Figure 8.2 Impact of price variation of biofuel crops on Thai economy
- 94 Figure 8.3 Poverty incidence by area, 1986-2009
- 95 Figure 8.4 Food price and farm income 1990-2008
- 100 Figure 8.5 Location of small-scale bioenergy projects

TABLES

- 19 Table 3.1 Ethanol targets
- 19 Table 3.2 Share of ethanol targets by feedstock
- 19 Table 3.3 Biodiesel targets
- 22 Table 3.4 Main commodity highlights

28	Table 4.1 Attainable yield by suitability class for the key biofuel crops
31	Table 4.2 Area under sugar cane cultivation by suitability class
33	Table 4.3 Actual use of available suitable land for sugar cane
33	Table 4.4 Area under cassava cultivation by suitability class
35	Table 4.5 Actual use of available suitable land for cassava
35	Table 4.6 Current area under oil palm cultivation by suitability class
37	Table 4.7 Actual use of available suitable land for oil palm
49	Table 5.1 Sugar cane WF under scenarios of irrigated area and yield growth
51	Table 5.2 Chemical fertilizer and other inputs for sugar cane and cassava
51	Table 5.3 Characteristics of spent wash from sugar and cassava-based ethanol
58	Table 6.1 Reference retail prices for transport fuels in September 2009
58	Table 6.2 Development of cost structure for cassava from 1997 to 2008
60	Table 6.3 Characteristics of cassava-based ethanol configurations
60	Table 6.4 Production cost and IRR for cassava ethanol scenarios
62	Table 6.5 Results of sensitivity analysis
63	Table 6.6 Characteristics of sugar-based ethanol configurations
63	Table 6.7 Production cost and IRR for sugar ethanol scenarios
65	Table 6.8 Characteristics of biodiesel configurations
66	Table 6.9 Production cost and IRR for biodiesel scenarios
72	Table 7.1 Measures of GHG emissions and energy requirements
72	Table 7.2 EU requirements for sustainable biofuels
73	Table 7.3 Average figures for cassava production
74	Table 7.4 Emissions and energy demand for cassava production
75	Table 7.5 GHG emissions for LUC and CC into cassava production
76	Table 7.6 Comparison of GHG emissions for agricultural production scenarios of cassava
76	Table 7.7 Emissions and energy demand for cassava production and chipping process
77	Table 7.8 Emissions and energy demand for cassava-based ethanol processing
80	Table 7.9 Additional sugar-based ethanol processing scenarios
80	Table 7.10 Emissions and energy demand for sugar-based ethanol
82	Table 7.11 Additional biodiesel processing scenarios
83	Table 7.12 Emissions and energy demand for biodiesel
85	Table 7.13 Comparison of GHG emissions for CPO large scale configurations
94	Table 8.1 Per capita income and expenditure, poverty line and incidence by region in 2009
95	Table 8.2 Number of households by poverty status and economic sectors in 2009
96	Table 8.3 Scenario assumptions
96	Table 8.4 Changes in poverty incidence by region
97	Table 8.5 Changes in poverty incidence by household type
97	Table 8.6 Impact of one percent increase in import food price on economic growth and price levels
98	Table 8.7 Impact of one percent increase in import food price on change in foreign trade
98	Table 8.8 Impact of one percent increase in import food price on change in real final demand
98	Table 8.9 Impact of one percent increase in import food price on change in real household income

ACRONYMS

ADB	Asian Development Bank
AEDP	Alternative Energy Development Plan
AFTA	ASEAN Free Trade Area
ASEAN	Association of South-East Asian Nations
B2	Biodiesel blending target at 2 percent
B5	Biodiesel blending target at 5 percent
BAAC	Bank of Agriculture and Agricultural Cooperatives
BEFS	Bioenergy and Food Security
BHD	Bio-hydrogenated diesel
CDM	Clean Development Mechanism
CGE	Computable General Equilibrium
COSIMO	Commodity Simulation Model
CPI	Consumer producer price
CPO	Crude palm oil
DEDE	Department of Alternative Energy Development and Efficiency
EIA	Energy Information Administration
ENCON	Energy Conservation Promotion
EPPO	Energy Policy and Planning Office
EU	European Union
FAO	Food and Agriculture Organization
FFB	Fresh fruit bunch
FTA	Free Trade Area
GDP	Gross Domestic Product
GEMIS	Global Emission Model for Integrated Systems
GEF	Global Environment Facility
GHG	Green House Gas
HDI	Human Development Index
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
JGSEE	Joint Graduate School of Energy and Environment
LCA	Life Cycle Analysis
LDD	Land Development Department
LEF	Low efficiency fossil
LPG	Liquefied petroleum gas
LRA	Logistic Regression Analysis
LSA	Land Suitability Assessment
LUC	Land use change
LUT	Land utilization type
MDG	Millennium Development Goal
MEF	Medium efficiency fossil
MOAC	Ministry of Agriculture and Cooperatives
MoE	Ministry of Energy
NAEO	National Alternative Energy Office

NESDB	National Economic and Social Development Board
NET	North Eastern Thailand Development Foundation
NPV	Net present value
NSO	National Statistical Office
OAE	Office of Agricultural Economics
OECD	Organization of Economic Cooperation and Development
OCSB	Office of the Cane and Sugar Board
RASMI	Rural and Social Management Institute
RE	Renewable energy
R&D	Research and Development
SES	Socio-Economic Survey
TDRI	Thailand Development Research Institute
TRWR	Total renewable water resource
TSM_SIMFARM	Thai Soil Management Simulation Farming
UN	United Nations
UNDP	United Nation Development Programme
WF	Water footprint
WTO	World Trade Organization

UNIT OF MEASURES

\$	United States dollar
g	Gram
ha	Hectare
kg	Kilogram
ktoe	Kilotonne of oil equivalent
L	Litre
m ³	Meter cubic
mg	Milligram
MJ	megajoule
MLPD	Million litre per day
MLPY	Million litre per year
mm	Millimetre
MW	Megawatt
THB	Thailand bath (local currency unit)
ton	Tonne