

Roland A. Jansen

 WILEY-VCH

Second Generation Biofuels and Biomass

Essential Guide for Investors,
Scientists and Decision Makers



Second Generation Biofuels and Biomass

Essential Guide for Investors, Scientists
and Decision Makers



WILEY-VCH Verlag GmbH & Co. KGaA

The Author

Roland A. Jansen
Mother Earth Investments AG
Zürcherstrasse 37
8852 Altendorf
Switzerland

■ All books published by **Wiley-VCH** are carefully produced. Nevertheless, authors, editors, and publisher do not warrant the information contained in these books, including this book, to be free of errors. Readers are advised to keep in mind that statements, data, illustrations, procedural details or other items may inadvertently be inaccurate. The views of the author are his own and do not represent those of Wiley-VCH.

Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <<http://dnb.d-nb.de>>.

© 2013 Wiley-VCH Verlag & Co. KGaA,
Boschstr. 12, 69469 Weinheim, Germany

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form – by photoprinting, microfilm, or any other means – nor transmitted or translated into a machine language without written permission from the publishers.

Registered names, trademarks, etc. used in this book, even when not specifically marked as such, are not to be considered unprotected by law.

Composition MPS Limited, Chennai

Printing and Binding Markono Print Media
Pte Ltd, Singapore

Cover Design Formgeber, Eppelheim

Print ISBN: 978-3-527-33290-8

ePDF ISBN: 978-3-527-65300-3

ePub ISBN: 978-3-527-65299-0

mobi ISBN: 978-3-527-65298-3

oBook ISBN: 978-3-527-65297-6

Printed in Singapore

Printed on acid-free paper

Second Generation Biofuels and Biomass

Roland A. Jansen

Related Titles

Ulber, R., Sell, D., Hirth, T. (eds.)

Renewable Raw Materials New Feedstocks for the Chemical Industry

2011

ISBN: 978-3-527-32548-1

Deublein, D., Steinhauser, A.

Biogas from Waste and Renewable Resources An Introduction

2011

ISBN: 978-3-527-32798-0

Soetaert, W., Vandamme, E. J. (eds.)

Industrial Biotechnology Sustainable Growth and Economic Success

2010

ISBN: 978-3-527-31442-3

Vertes, A., Qureshi, N., Yukawa, H.,
Blaschek, H. (eds.)

Biomass to Biofuels Strategies for Global Industries

2010

ISBN: 978-0-470-51312-5

Olah, G. A., Goeppert, A., Prakash, G. K. S.

Beyond Oil and Gas: The Methanol Economy

2010

ISBN: 978-3-527-32422-4

Soetaert, W., Vandamme, E. (eds.)

Biofuels

2011

ISBN: 978-0-470-02674-8

Siegel, J., Nelder, C.

Investing in Renewable Energy Making Money on Green Chip Stocks

2008

ISBN: 978-0-470-15268-3

Acknowledgments

I want to thank the following people, who inspired me and have been instrumental to put me on the biofuel and biomass road, which enabled me to write this book:

Ben Sze from Hong Kong. In 2007, I was invited for an interview on the Asian channel of Bloomberg Television in Singapore to talk about renewable energies. I talked about this exotic plant called "*Jatropha*" and 5 minutes after the interview my BlackBerry rang. A voice said: "Hi, my name is Ben Sze. We have *Jatropha* plantations in China and I would like to meet you"! A little while afterwards we met in Hong Kong and we flew to Hainan, the beautiful island south of China where his company CPE Ltd. cultivates over 100 hectares of *Jatropha* nurseries in collaboration with the China–UN Development Program Green Poverty Alleviation Collaboration Project. This was a new world for me and from that moment on I was inspired and convinced that this plant could deliver not only energy, but also organic fertilizers on a giant scale. Ben Sze is extremely knowledgeable about *Jatropha* and has insight information how the government in Beijing plans its clean energy future. Ben moves very easily between Western and Chinese cultures, and is a great interpreter. He has been a partner and a loyal friend ever since.

Professor Feng Shang, PhD in Life Sciences at the University of Sichuan in Chengdu. His research team is developing a medicine, made out of *Jatropha*, against lung cancer. He is probably the best *Jatropha* scientist in China and a real authority. He closely linked to the renewable energy policy of the Beijing government. He inspired me very much.

Hans van den Berg is a private equity specialist in Zurich who has always helped me throughout the years.

Peter Poort, a grain specialist from Glencore Grain in Rotterdam, has always inspired me with "the big picture" and always given me his view from one of the big grain traders in the world.

Bloomberg TV has always given me room to communicate my commodity views live on the air in their programs worldwide. I have been interviewed in their studios in New York, London, Zurich, Singapore, Hong Kong, and Tokyo. Bloomberg always treated me extremely well.

Vital Kharoshi is one of the *Jatropha* pioneers in Ethiopia. With very modest means he develops *Jatropha* plantations where he gives employment to the poorest of the poor. He practices "intercropping", and the farmers grow sorghum,

tomatoes, coffee, and sesame between the *Jatropha*, and improve the quality of their lives. He inspired me about what you can achieve with simple means.

Frank ter Voorde is a very experienced palm oil trader and always has time to discuss the latest developments. I learned a lot from him about how the physical markets function.

Dr. Walter Ammann from Davos, Switzerland, Chairman of the Global Risk Forum. (www.grforum.org). Dr. Ammann organizes a large biennial conference on global risks, and he gave me a platform to speak about desertification, marginal land, erosion, its consequences, and planting *Jatropha*.

Lucas Bruggeman, an expert on derivative products in Zurich and one of the best marketers in Switzerland, always stimulated me in my development into renewable energies and introduced me to several decision makers in his network.

Stephan and Christiane Oberacher, my German partners with whom I learned the ins and outs of biomass, calorific values, and gigajoules.

Peter Berger, a well known journalist on financial matters, who brought me in contact with Wiley-VCH Verlag in Germany.

Dominique Menoud from Switzerland and living most of the time in Romania, who lives and dreams megawatts and kilowatts. She is a great connoisseur of the power industry and the best planner of renewable energy power plants I have ever met.

Dr. Julia Stuthe from Wiley-VCH Verlag in Germany, who guided me from the manuscript presentation to the publication of this book.

John Teo from Kuala Lumpur, who introduced me to important biofuel and biomass players in Malaysia.

Peter Möckli, CEO Sharewood Switzerland AG, an expert in wood and teak plantations in Brazil, who has always inspired me with new ideas.

Dr. Hong Yan, Chief Scientific Officer of JOil, the premier research company in *Jatropha* plant biotechnology in Singapore for the production of elite lines, development of tissue culture facilities, and nurseries. Dr. Hong Yan taught me a lot about the future of *Jatropha* as a source for clean energy.

Chris Niemandt, biofuel farmer in South Africa, who has always informed me from his tractor about the latest developments in the energy plantations.

The Bionas Management team from Kuala Lumpur: Mohd Safi'e M. Jaffri (Chairman), Zurina Amnan (CEO), and Khairil Anuar Bin Zainuddin (General Operations Manager). Bionas is probably one of the very few profitable companies in *Jatropha* worldwide and they showed me how it is done with contract farming in 13 countries.

My wife Anna, who always stimulated me into realizing this project. She always gives me new ideas, inspires me, is always realistic, critical, loyal, and a big support in life.

I dedicate this book to my children Laura and Vincent. As a singer, Laura Jansen is becoming a real star and she has a global audience today. She works very hard in composing beautiful music, she performs on stage in the United States, Europe,

and China, and never gives up her goals. You can follow her on Facebook. Vincent saves lives as a helicopter pilot in the US Coast Guard in Alaska. In November 2011, he starred in a documentary on the Weather Channel about the Coast Guard heroes, doing their work under extreme circumstances. The film is comparable to *Top Gun* with Tom Cruise. Only *Top Gun* is fiction and the Coast Guard documentary is for real!

Abbreviations

AAU	Assigned Amount Unit
ABPPM	Associação Brasileira de Produtores de Pinhão Manso
AIREG	Aviation Initiative for Renewable Energy in Germany
ARA	Amsterdam, Rotterdam, and Antwerp
ASA	Asian
ASTM	American Society for Testing and Materials
ASTM	American Society for Testing and Materials
ASTM	American Society for Testing and Materials
ASTM	American Society for Testing and Materials
ASTM	American Society for Testing and Materials
BCAP	Biomass Crop Assistance Program
BEES	Bio-Energy Emission Solution
BTL	biomass-to-liquid
BTL	biomass-to-liquid
BTL	biomass-to-liquids
CAAC	Civil Aviation Administration of China
CDM	Clean Development Mechanism
CDM	Clean Development Mechanism
CEPI	Confederation of European Paper Industries
CERs	Certified Emission Reductions
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
COFCO	China National Cereals, Oils and Foodstuffs Corporation
CPI	Consumer Price Index
DESC	Defense Energy Support Center
EIA	Energy Information Administration
EIA	Energy Information Administration
EIA	Environmental Impact Assessment
EITI	Extractive Industry Transparency Initiative
EPA	Environmental Protection Agency
EPFL	Ecole Polytechnique Fédérale de Lausanne
ETF	exchange-traded fund
ETS	Emission Trading Scheme

ETS	emissions trading scheme
ETS	Emissions Trading Scheme
ETS	Emissions Trading Scheme
EUAs	European Emission Allowances
FAA	Federal Aviation Administration
FAO	Food and Agricultural Organization
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FCCC	Framework Convention on Climate Change
GIPC	Ghana Investment Promotion Council
GRC	Genetic Resource Center
GTL	gas-to-liquid
IATA	International Air Transport Association
IATA	International Air Transport Association
IATA	International Air Transport Association
IATA	International Air Transport Association
IEA	International Energy Agency
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IPO	initial public offering
IPPC	International Plant Protection Convention
IUCN	International Union for Conservation of Nature
MGO	marine gas oil
NGO	non-governmental organization
NGO	non-governmental organization
NGO	non-governmental organization
NGO	non-governmental organization
NGO	non-governmental organization
NGO	non-governmental organization
NREL	National Renewable Energy Laboratory
OPEC	Organization of the Petroleum Exporting Countries
PET	polyethylene terephthalate
QABP	Qatar Advanced Biofuel Platform
RLS	Reliance Life Sciences
RSB	Roundtable on Sustainable Biofuels
RSB	Roundtable on Sustainable Biofuels
RSB	Roundtable on Sustainable Biofuels
RSPO	Roundtable on Sustainable Palm Oil
SAFUG	Sustainable Aviation Fuel Users Group
SAFUG	Sustainable Aviation Fuel Users Group

SORESIN	SOcially RESponsible INvesting
SPK	synthetic paraffinic kerosene
UNDP	UN Development Programme
UNEP	United Nations Environment Programme
USDA	US Department of Agriculture
WMO	World Meteorological Organization
WWF	World Wide Fund for Nature
WWF	World Wide Fund for Nature

Contents

Acknowledgments *xv*

Abbreviations *xix*

1	The Commodity Case – Introduction	1
1.1	Commodity Cycles – Past and Present	1
1.2	The Most Precious Commodity: Energy	3
1.3	Cheap and Expensive	5
1.4	Federal Reserve	7
1.5	Transformation to a Low-Carbon Society	8
1.6	Commodity Costs	9
1.7	The “ <i>Per Capita</i> ” Factor	10
1.8	Demographics: India and China	12
1.9	Oil, and First- and Second-Generation Biofuels	13
1.10	Nuclear Energy	14
1.11	Eleven Megaforces	15
1.12	Resource Wars	17
1.13	Geopolitical Shift in Oil Production	18
1.14	Oil Companies, Production, and Transportation	18
2	First- and Second-Generation Biofuels	21
2.1	Second-Generation Requirements	21
2.2	Applications	22
2.3	First-Generation Feedstock: What Speaks against Biofuels of the First Generation?	22
2.4	Second-Generation Feedstock	24
2.5	Biomass	24
2.6	Bioethanol and Biodiesel Production	26
2.7	Biodiesel Refining	26
2.8	Benefits of Biodiesel	27

2.9	The Big Biofuel Inventors	28
2.9.1	Rudolf Diesel	28
2.9.2	Henry Ford	29
3	Biofuels Feedstock: <i>Jatropha curcas</i>	31
3.1	Characteristics	31
3.1.1	Plants in Marginal Growing Conditions	31
3.1.2	Nature Around the Equator	32
3.1.3	Plant Description	33
3.1.4	Where Does <i>Jatropha</i> Originate?	34
3.1.5	Properties	34
3.1.6	Toxicology	34
3.1.7	Whole Plant and Food/Fodder	35
3.1.8	Light in the Dark	35
3.1.9	Medicine	36
3.1.10	Pressing the Oil	36
3.1.11	Biokerosene	37
3.1.12	Breeding Objectives	37
3.1.13	Survival in Harsh Conditions	38
3.1.14	Breeding Method	38
3.1.15	Ecological Aspects	39
3.1.16	Agronomy	39
3.1.17	Harvesting and Man-Hours	40
3.1.18	Mechanical Harvesting	40
3.1.19	Managed and Contract Farming	40
3.1.20	Storage	41
3.1.21	Yield Comparisons and Research	41
3.1.22	Propagation Methods	42
3.1.23	Pricing	43
3.1.24	<i>Jatropha</i> Facts Related to Biodiesel	43
3.1.25	Pests and Diseases	44
3.1.26	Limitations of the Crop	44
3.1.27	Prospects	45
3.1.28	Research Needs	45
3.1.29	Cracking the Nut	45
3.2	<i>Jatropha</i> Products	46
3.2.1	Main Products	46
3.2.1.1	Glycerin	46
3.2.1.2	Medical Applications	46
3.2.1.3	Organic Fertilizer and Animal Feed	47
3.2.1.4	Insecticides and Pesticides	47
3.2.2	Byproducts	48
3.2.2.1	Active Carbon	48
3.2.2.2	Biochar	49

3.2.2.3	Woodpellets	49
3.2.2.4	Polyol	49
3.2.2.5	Paint	49
3.2.2.6	Electricity	49
3.2.2.7	Carbon Dioxide Collection	50
3.2.2.8	Smog Reduction in Chimneys	50
3.3	Advantages and Risks of <i>Jatropha</i>	51
3.3.1	Overview	51
3.3.2	Domestication	51
3.3.3	Potential Negative Effects	52
3.3.4	Variable Yields	53
3.3.5	Diesel Demand, Diesel Cars, and Demography	53
3.3.6	<i>Jatropha</i> Jet Fuel Demand	55
3.3.7	Significant Events	56
3.3.8	Yield Comparisons	56
3.3.9	Global <i>Jatropha</i> Demand	56
3.3.10	How Large is the Biokerosene Market?	57
3.3.11	Energy Security, US Military, and Fuel Costs	58
3.4	Negative Aspects and Risks	58
3.4.1	<i>Jatropha</i> in Ghana	58
3.4.2	Africa's "Land Grab"	59
3.4.3	More Examples of Land Grab Attempts [2]	60
3.5	Water Use	62
3.6	Invasiveness	63
3.7	Opinion of the UN FAO	64
3.8	Opinion of the World Bank	64
3.9	Code of Conduct	65
3.10	Summary of <i>Jatropha</i>	66
3.11	Where Does <i>Jatropha</i> Grow?	67
3.12	Genetic Improvement of <i>J. curcas</i>	68
	References	69

4	Other Biofuel Feedstocks	71
4.1	<i>Pongamia pinatta</i>	71
4.2	Algae	72
4.2.1	Introduction	72
4.2.2	Yield	75
4.2.3	Benefits of Algae	76
4.2.4	Navy Orders	76
4.3	Palm Oil	77
4.3.1	Roundtable on Sustainable Palm Oil	77
4.3.2	Controversy	77
4.3.3	The Other Oil Spill	78
4.3.4	Clean Start	79

4.3.5	Threat from Facebook	81
4.3.6	Rainforests and Palm Oil	81
4.3.7	Sustainable Palm Oil [12]	83
4.4	<i>Camelina</i>	83
4.4.1	The Basics	83
4.4.2	Rotation with Wheat	84
4.4.3	<i>Camelina</i> as a Biofuel	84
4.4.4	<i>Camelina</i> Agronomy	85
4.4.5	Crop Potential	86
4.4.6	Shock Wave!	87
4.5	<i>Crambe</i>	88
4.5.1	Basics	88
4.5.2	EMPRAPA	89
4.6	Cheers!	90
4.7	Pennycress	90
4.8	<i>Moringa</i>	91
4.8.1	Planting: Seeds and Cuttings	92
4.8.2	Medicinal Applications	92
4.8.3	Biogas	93
4.9	Castor	93
4.10	Halophytes	93
4.11	Sugarcane	94
4.12	<i>Miscanthus</i>	94
4.13	Grass to Ethanol: Napier Grass	94
5	Cropping Methods	97
5.1	Intercropping and Double Cropping	97
5.2	Reliance Life Sciences	99
5.3	Nestlé	99
6	Socially Responsible Investing	101
6.1	Principles	101
6.2	Practice: <i>Jatropha curcas</i>	101
6.3	Breaking the Cycle of Poverty	102
6.4	Food First	103
6.5	A Wider Context	104
6.6	Guatemala	104
6.7	Corporate Governance	105
6.7.1	Business	105
6.7.2	Bee Hives/Honey Harvesting	106
6.7.3	Company–Community Committees	106
6.7.4	Education	106
6.7.5	Employment Opportunities	107

- 6.7.6 Farmland Preservation 107
- 6.7.7 Fire Control and Prevention 107
- 6.7.8 Healthcare 108
- 6.7.9 Hiring Women 108
- 6.7.10 Outgrower Program 108
- 6.7.11 Safe Drinking Water and Sanitation 109
- 6.7.12 Soil Fertility 109

7 Sustainability 111

8 Biomass 113

- 8.1 What Is Biomass? 113
- 8.2 Five Basic Categories 114
- 8.3 Benefits of Biomass 114
- 8.4 Feedstock of Biomass 115
 - 8.4.1 Trees and Woodpellets 115
 - 8.4.2 Woodchips 115
 - 8.4.3 Palm Kernel Shells 116
 - 8.4.4 *Miscanthus* Pellets 116
 - 8.4.5 Agripellets 117
- 8.5 Biomass Potential in Brazil 118
- 8.6 Sustainability of Agripellets 119
- 8.7 Agripellets versus Coal and Lignite 120
- 8.8 Energy Density: Gigajoules per Tonne 120
- 8.9 Why Is Biomass in High Demand? 121
- 8.10 EU Environmental Regulations: Poland 124
- 8.11 The Challenges 125

9 Carbon Credits 127

- 9.1 Carbon is the Enemy 127
- 9.2 Jatropha Kerosene: A Monster Market Emerges 128
- 9.3 Carbon Reductions 130
- 9.4 Global Warming Around Us 130
- 9.5 Extreme Weather Patterns 131

10 Biofuels in Europe – EU Policies 133

- 10.1 EU Policy in 2008 133
- 10.2 Heated Debates 133
- 10.3 National Policies 134
- 10.4 EU Rift in Biofuel Policy 135
- 10.5 Indirect Land-Use Change 136
- 10.6 Where Do We Stand Now? 136

11	Biofuels in the United States	137
11.1	Biomass Demand in the United States	137
11.2	Second-Generation Biofuels for the United States	138
11.3	A Growing Shortage of Domestic Oil Production	139
11.4	Fuel Use at the USDA	140
11.5	Partnership with the FAA	140
12	Biofuels in China	141
12.1	Clean Energy? Go to China	141
12.2	China is Going Green	142
12.3	China's 12th 5-Year Plan	143
12.4	Inclusive Growth	143
12.5	The Beneficiaries	144
12.6	China's Energy Consumption	145
12.7	Staggering Car Sales Numbers	146
12.8	China's Diesel Pricing Mechanism	149
12.9	China–United States Biofuel Pact	150
12.10	China's Biofuels Expansion	151
12.10.1	2007	151
12.10.2	2010	151
12.10.3	An Area of 13 Million Hectares	152
12.10.4	Barren Lands in Southwest China	154
12.10.5	Hainan	154
12.10.6	Biodiesel Refineries	155
12.10.7	Poverty and <i>Jatropha</i>	156
12.10.8	Subsidies	157
12.10.9	Tax Exemptions for Biodiesel	158
13	Biofuels in Brazil	159
13.1	Introduction: Biofuel Industry Leader	159
13.2	Comparison with the United States	160
13.3	What is Driving the Urgency in Renewable Jet Fuel?	160
13.4	Biofuels from Sugarcane	160
13.5	Sugar Production	161
13.6	Ethanol Production and Flex-Fuel Cars	162
13.7	Bagasse, Bioelectricity, and Biofuels	162
13.8	Flex-Fuel = Biofuel	163
13.9	Fuel Consumption	163
13.10	Greenhouse Gas Reductions	164
13.11	Energy Balance	165
13.12	Sugarcane for Biofuels	165
13.13	Sugarcane Straw: A Growth Opportunity	166
13.14	Bioplastics	166