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66 Plant Biotechnology for Sustainable Production of Energy and Co-products

Peter N. Mascia, Jürgen Scheffran and
Jack M. Widholm *Editors*

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Plant Biotechnology for Sustainable Production of Energy and Co-products

 Springer

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This volume is dedicated to the late Peter Mascia, who had the foresight to see the future value of plant biomass and who was intimately involved in plant biotechnology and the commercial development of biomass crops. He is an editor of this volume since he helped plan a large part of it, but was unable to complete the work due to his untimely death on 6 May 2009.

Preface

This book is a collection of chapters concerning the use of biomass for the sustainable production of energy and chemicals—an important goal that will help decrease the production of greenhouse gases to help mitigate global warming, provide energy security in the face of dwindling petroleum reserves, improve balance of payment problems and spur local economic development.

Clearly there are ways to save energy that need to be encouraged more. These include more use of energy sources such as, among others, manure in anaerobic digesters, waste wood in forests as fuel or feedstock for cellulosic ethanol, and conservation reserve program (CRP) land crops that are presently unused in the US. The use of biofuels is not new; Rudolf Diesel used peanut oil as fuel in the first engines he developed (Chap. 8), and ethanol was used in the early 1900s in the US as automobile fuel [Songstad et al. (2009) Historical perspective of biofuels: learning from the past to rediscover the future. *In Vitro Cell Dev Biol Plant* 45:189–192]. Brazil now produces enough sugar cane ethanol to make up about 50% of its transportation fuel needs (Chap. 4).

The next big thing will be cellulosic ethanol. At present, there is also the use of *Miscanthus x giganteous* as fuel for power plants in the UK (Chap. 2), bagasse (sugar cane waste) to power sugar cane mills (Chap. 4), and waste wood and sawdust to power sawmills (Chap. 7).

We have attempted to put together a distinguished group of authors to write chapters discussing many topics including the need for energy and the present problem of global warming that might be mitigated by using biomass instead of fossil fuels (Chap. 1). While ethanol is the most familiar fuel produced from biomass there are many other energy producing possibilities (Chap. 2). Of course, biomass can also be burned directly, and when mixed with coal helps decrease emissions of SO₂, NO_x, and non-renewable CO₂.

The overall general principals, possibilities and methods for designing plants for use as biomass feedstock are discussed in Chap. 3. Specific discussion of crops that produce sugar, starch or oil and trees and grasses can be found in Chaps. 4, 5, 6, 7 and 8. The general problems of invasiveness and gene dispersal and how to mitigate these problems are covered in Chaps. 9, 10 and 11. Chapter 12 describes models for

integrated biorefineries that can produce many different products including industrial chemicals, and Chapter 13 describes models for the use of maize stover to supply heat and power for ethanol plants.

Other topics covered include new agricultural systems for biomass production for biofuels (Chap. 14), the life cycle analysis of biofuels (Chap. 15) and overall discussions of the many uses of biomass and possible cautions and criteria for standards for biomass sustainability and certification (Chap. 16).

Clearly, much development is still needed to fulfill the dream of the widespread use of biomass for energy and co-products. One of the biggest key questions is when will the production of cellulosic ethanol or other fuels become economically competitive with other liquid fuels. The infrastructure is in place to utilize ethanol if costs become competitive. We feel confident that progress will be made in cellulosic processing and fermentation due to the large amount of current interest and research and development funding so that this goal should be realized. Clearly, in the end, economics will decide the winners among the many crops and processes. The next decade should be exciting to see the winners and losers in the race to produce biomass for energy and co-products and to see how effective this is for the good of the world.

We have attempted to clarify the units used in the actual chapters, but the following list may be useful for comparative purposes.

Energy value of ethanol = 67% that of gasoline

1 kilogram (kg) = 2.205 pounds

1 metric ton = 1,000 kg = 1 mega gram (Mg) = 1 million g = 2,205 pounds

1 giga ton (Gt) = 1 billion metric tons

1 short ton = 2,000 pounds = 0.907 metric ton

1 hectare (ha) = 2.47 acres

1 liter (l) = 0.265 gallons

1 barrel (bbl) = 42 gallons = 158.8 l

1 meter (m) = 1.094 yard = 3.28 ft

MJ (megajoule) = million joules

BTU (British thermal unit) = 1,054.5 joules or 252 calories

KW (kilowatt) = 1,000 joules

KWH (kilowatt hour) = 3.6 MJ

TW (terawatt) = 1 million MW (megawatts)

MW (megawatt) = 1 million watts

June 2010

Jack M. Widholm

Contents

Part A Introduction to Biofuels

1 Introduction Overview: World Energy Resources and the Need for Biomass for Energy and Lower Fossil Carbon Dioxide Emissions	3
Charles E. Wyman	
1.1 Introduction	3
1.2 World Dependence on Petroleum	4
1.3 Oil and Global Climate Change	7
1.4 What are our Options to Reduce Petroleum Use?	7
1.5 Why Biomass for Transportation?	8
1.6 Overview of Conversion Approaches	10
1.6.1 Biomass Composition	10
1.6.2 Higher Temperature Processes	11
1.6.3 Lower Temperature Processes	13
1.6.4 Comparison of Conversion Options	15
1.7 What is the Goal and How Much Biomass will be Needed?	16
1.8 Challenges to Commercial Applications	18
1.9 Closing Thoughts	19
References	21
2 Designing Biomass Crops with Improved Calorific Content and Attributes for Burning: a UK Perspective	25
Gordon G. Allison, Mark P. Robbins, José Carli, John C. Clifton-Brown, and Iain S. Donnison	
2.1 The Need for Non-Food Energy Crops	25
2.2 Biomass Combustion Technologies	26
2.2.1 The Combustion Process	26
2.2.2 Biomass as a Feedstock for Combustion	27

2.3	Lignocellulose	28
2.3.1	Structure and Composition of the Plant Cell Wall	28
2.3.2	Plant Cell Wall Architecture	29
2.4	The Effect of Chemical Composition on Feedstock Properties	30
2.5	Energy Crops for Combustion Processes in the European Union ...	31
2.5.1	Miscanthus Species	33
2.5.2	Switchgrass	35
2.5.3	Willow and Poplar	36
2.5.4	Reed Canary Grass	38
2.6	Technologies for Crop Design	38
2.6.1	Modification of Hemicellulose and Cellulose	38
2.6.2	Modification of Lignin	39
2.6.3	Breeding Strategies	42
2.6.4	Chemical Phenotyping and High-Throughput Screening	42
2.6.5	Case Study: Variation in Cell Wall Composition Between 249 <i>Miscanthus</i> Genotypes	44
2.7	Conclusions and Future Perspectives	46
	References	47
3	Designing Plants To Meet Feedstock Needs	57
	Peter N. Mascia, Michael Portereiko, Mark Sorrells, and Richard B. Flavell	
3.1	Introduction	57
3.2	Feedstock Crops	58
3.3	Trait Improvement	61
3.4	Molecular Markers for Breeding and Genetic Mapping	64
3.5	Comparative Genomics	66
3.6	Heterosis	67
3.7	Improving Traits by Molecular Plant Breeding	68
3.8	Transgenic Traits	72
3.8.1	First Generation Transgenic Traits	72
3.8.2	Transgenic Output Traits	73
3.8.3	Co-products	76
3.8.4	Genetic Confinement and Prevention of Seed Formation	77
3.9	Concluding Remarks	79
	References	80
 Part B Specific Biofuel Feedstocks		
4	Engineering Advantages, Challenges and Status of Sugarcane and other Sugar-Based Biomass Resources	87
	Ricardo A. Dante, Plinio T. Cristofolletti, and Isabel R. Gerhardt	
4.1	Introduction	87
4.1.1	Sugar-Based Industry and Ethanol Uses	87
4.1.2	Sugarcane Production System	90

4.2	Biotechnology and Breeding Strategies for Increasing Sugarcane Sucrose Yields	91
4.2.1	Photosynthetic Capacity of Sugarcane and the Sink–Source Relationship: What Determines Sucrose Accumulation?	91
4.2.2	Sugarcane Biotechnology	94
4.2.3	Molecular Markers in Sugarcane Breeding	98
4.3	Other Sugar Crops Suitable for Ethanol Production	99
4.4	Perspectives	101
	References	102
5	High Fermentable Corn Hybrids for the Dry-Grind Corn Ethanol Industry	111
	Joel E. Ream, Ping Feng, Inigo Ibarra, Susan A. MacIsaac, Beena A. Neelam, and Erik D. Sall	
5.1	Introduction	111
5.2	Value of High Fermentable Corn Hybrids	112
5.3	Factors Influencing the Fermentability of Corn Grain	114
5.4	Measuring Corn Grain Fermentability	116
5.4.1	NIT Calibration	116
5.4.2	Reference Chemistry	117
5.4.3	NIT Calibration	118
5.4.4	Commercial Validation of NIT Calibration	119
5.5	Designation of High Fermentable Corn Hybrids	121
5.6	Opportunities to Increase Corn Grain Fermentability	122
5.7	Summary	123
	References	123
6	Engineering Advantages, Challenges and Status of Grass Energy Crops	125
	David I. Bransby, Damian J. Allen, Neal Gutterson, Gregory Ikonen, Edward Richard Jr, William Rooney, and Edzard van Santen	
6.1	Introduction	125
6.2	Miscanthus	126
6.2.1	<i>Miscanthus</i> Phylogeny and Growth	127
6.2.2	Genetic Improvement of <i>Miscanthus</i>	127
6.2.3	Conventional Breeding Challenges	128
6.3	Switchgrass	131
6.3.1	Switchgrass Phylogeny and Growth	132
6.3.2	Genetic Improvement of Switchgrass	133
6.3.3	Conventional Breeding Challenges	134
6.4	Sugarcane	136
6.4.1	Sugarcane Phylogeny and Growth	136
6.4.2	Genetic Improvement Needs	139
6.4.3	Genetic Improvement Strategies	141

- 6.5 Sorghum 142
 - 6.5.1 Sorghum Phylogeny and Growth 142
 - 6.5.2 Genetic Improvement 144
- 6.6 Integration of Grasses into Cellulosic Biomass Supply Systems .. 146
- 6.7 Conclusions 147
- References 147

- 7 Woody Biomass and Purpose-Grown Trees as Feedstocks for Renewable Energy 155**
 - Maud A.W. Hinchee, Lauren N. Mullinax, and William H. Rottmann
 - 7.1 The Forest Industry and Renewable Energy 155
 - 7.2 Biopower 158
 - 7.2.1 Processes for Energy Production from Woody Biomass 159
 - 7.2.2 Characteristics of Wood Feedstock that Impact Bioenergy Production 164
 - 7.2.3 Tree Species for Biopower 167
 - 7.2.4 Softwood Species for Bioenergy 172
 - 7.3 Liquid Biofuels 173
 - 7.3.1 Cellulosic Ethanol 173
 - 7.3.2 Conversion Processes 175
 - 7.3.3 Other Cellulosic Liquid Fuels 179
 - 7.3.4 Feedstock Characteristics Affecting Biofuel Production 180
 - 7.4 Purpose-Grown Trees for Renewable Energy 181
 - 7.4.1 Genetic Improvement for Productivity 184
 - 7.4.2 Genetic Improvement for Wood Properties 191
 - 7.5 Sustainable Production of Purpose-Grown Trees 193
 - 7.6 Conclusion 197
 - References 198

- 8 Engineering Status, Challenges and Advantages of Oil Crops 209**
 - Richard F. Wilson and David F. Hildebrand
 - 8.1 Global Trends in Supply and Demand for Edible Oils 209
 - 8.1.1 Constraints on the Use of Edible Crop Products for Biofuel 209
 - 8.1.2 Availability and Cost of Biodiesel Feedstocks 212
 - 8.1.3 Sustainability 216
 - 8.2 Technology Trends to Further Enhance the Sustainability of Edible Oils for Biofuel 218
 - 8.2.1 Physical Properties of Edible Oils 218
 - 8.2.2 Genetic Modification of the Physical Properties of Edible Oils 221
 - 8.2.3 Development of Markets for Edible Oils with Modified Traits 222

8.3 Advances in Genetically Modified Oil Trait Technology in Major Oilseed Crops	223
8.3.1 Biological Basis for Trait Modified Oils	223
8.3.2 Modified Oil Traits in the Commercial Pipeline	226
8.4 Advances in Genetically Modified Oil Trait Technology in New or Underdeveloped Oilseed Crops	229
8.4.1 New Crop Oils for Industrial Chemicals	229
8.4.2 Biological Basis for Industrial Oil Traits	241
8.5 Conclusions	247
References	248

Part C Mitigating Invasiveness

9 Invasive Species Biology, Ecology, Management and Risk Assessment: Evaluating and Mitigating the Invasion Risk of Biofuel Crops	263
Jacob N. Barney, Joseph M. DiTomaso	
9.1 Biofuel Crops and Invasive Species	263
9.2 Invasive Species Biology and Ecology	265
9.3 Assessing the Invasive Risk of Biofuel Crops	267
9.3.1 Risk Assessment	268
9.3.2 Species biology	269
9.3.3 Niche Modeling	271
9.3.4 Propagule Biology	272
9.3.5 Habitat Susceptibility	273
9.3.6 Hybridization Potential	274
9.3.7 Competitive Interactions	274
9.4 Mitigating the Invasion Risk Along the Biofuel Chain	275
9.4.1 Crop Development	276
9.4.2 Crop Importation and Dissemination	277
9.4.3 Crop Production	277
9.4.4 Feedstock Harvesting, Processing, Transport, and Storage ..	278
9.4.5 Feedstock Conversion	279
9.5 Response to Biofuel Crop Escapes	279
9.5.1 Eradication Techniques	279
9.6 Conclusions	280
References	281
10 Gene Flow in Genetically Engineered Perennial Grasses: Lessons for Modification of Dedicated Bioenergy Crops	285
Albert P. Kausch, Joel Hague, Melvin Oliver, Lidia S. Watrud, Carol Mallory-Smith, Virgil Meier, and C. Neal Stewart	
10.1 Introduction	285
10.2 Gene Flow in Glufosinate-Resistant Grasses	287

10.3 Gene Flow in Glyphosate-Resistant Creeping Bentgrass 289
 10.3.1 Gene Flow via Pollen in Glyphosate-Resistant
 Bentgrass 290
 10.4 Gene Flow via Seed Scatter 292
 10.4.1 Gene Flow via Seed Escape in Glyphosate-Resistant
 Bentgrass 293
 10.5 Future Impacts of Gene Flow from Glyphosate-Resistant
 Creeping Bentgrass 294
 10.6 Conclusions 294
 References 296

11 Genetic Modification in Dedicated Bioenergy Crops and Strategies for Gene Confinement 299

Albert P. Kausch, Joel Hague, Melvin Oliver, Yi Li, Henry Daniell,
 Peter Mascia, and C. Neal Stewart Jr
 11.1 Introduction 299
 11.2 Methods for Gene Confinement in Genetically Engineered Plants . 300
 11.2.1 Physical, Spatial, Mechanical and Temporal Control 300
 11.2.2 Pollen Sterility 301
 11.2.3 Cytoplasmic Male Sterility, Chloroplast Transformation
 and Maternal Inheritance 302
 11.2.4 Seed-Based Gene Confinement 304
 11.2.5 Perceived Risks Associated with GURT's 304
 11.2.6 Gene Deletor System 309
 11.2.7 Total Sterility 309
 11.2.8 Total Sterility and Confinement Expression Systems 310
 11.3 Regulatory Issues for Perennial Bioenergy-Dedicated Crops 311
 11.4 Conclusions 311
 References 313

Part D Models for Uses of Biomass Feedstocks

12 Integrated Biorefineries—A Bottom-Up Approach to Biomass Fractionation 319

Birgit Kamm
 12.1 Introduction 319
 12.2 Biorefinery Technologies and Biorefinery Systems 321
 12.2.1 Background 321
 12.2.2 Lignocellulosic Feedstock Biorefinery 322
 12.2.3 Whole Crop Biorefinery 324
 12.2.4 Green Biorefinery 327
 12.2.5 The Two Platforms Biorefinery Concept 329
 12.3 Platform Chemicals 330
 12.3.1 Background 330