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Edited by Jack M. Widholm and Toshiyuki Nagata

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

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

Springer

Biotechnology in Agriculture and Forestry

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Plant Biotechnology for Sustainable Production of Energy and Co-products

Springer

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ISSN 0934-943X
ISBN 978-3-642-13439-5 e-ISBN 978-3-642-13440-1
DOI 10.1007/978-3-642-13440-1
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2010935443

Cover design: WMXDesign GmbH, Heidelberg, Germany

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

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 SO_2, NO_x, and non-renewable CO_2.

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

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