Perennial Biomass Crops for a Resource-Constrained World

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Editors

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Preface

This book is a product of a conference held at the University of Hohenheim in September 2015, which brought together five European Framework Programme 7 research consortia to report the results of their work over the previous 5 years. The research was initiated in recognition of Europe's need for sustainably produced biomass to support European strategic objectives for the bioeconomy.

The conference title was 'Perennial Biomass Crops for a Resource-Constrained World' and we have retained this for the title of this book. The book contains 24 chapters which are largely the written accounts of presentations made in Hohenheim. The chapters were solicited by the editors and have been peer reviewed and placed under five broad topic areas relating to the use of perennial biomass crops in Europe. These are 'Bioenergy Resources from Perennial Crops in Europe', 'European Regional Examples for the Use of Perennial Crops for Bioenergy', 'Genotypic Selection of Perennial Biomass Crops for Crop Improvement', 'Ecophysiology of Perennial Biomass Crops' and 'Examples of End Use of Perennial Biomass Crops'.

We focus on two major issues relating to the future use of biomass energy: the identification of the most suitable second generation biomass crops, and the need to utilise land not used for intensive agricultural production (broadly referred to as 'marginal' land) so that we avoid the potential conflict between food and fuel production. Perennial biomass crops (PBCs) are crops that are established only once in a plantation's lifetime which can be harvested regularly over a lifespan of at least 20–30 years. The two main categories of plants that fit this description are perennial rhizomatous grasses and trees that can be coppiced, although there are others, such a fibre nettle (*Urtica dioica*).

In Part I: 'Bioenergy Resources from Perennial Crops in Europe', the overarching questions are related to the suitability of perennial crops for feedstocks for a European bioeconomy and in particular the need to exploit environments for biomass crops which do not compete with food crops. Bioenergy is the subject of a wide range of national and European policy measures, and the development of public policy based on an examination of bioenergy policy in Germany, the UK and Ireland is examined. New developments in the use of perennial grasses to produce protein for animal feed, the potential for long-term yields and soil carbon

sequestration from the PBC, *Miscanthus* are presented. It is also shown that *Miscanthus* can complement grassland as a bioenergy source on marginal land in Europe.

In Part II: 'European Regional Examples for the Use of Perennial Crops for Bioenergy', the chapters review the use and development of PCBs across Europe. A range of PBCs has been shown to suit the different climatic and soil conditions of Europe, particularly on marginal land. *Miscanthus* has been shown to out-yield other PBCs in trials in central Europe and the Far East. Other PBCs are also shown to have high potential including *Arundo donax* in Italy, fibre nettle (*Urtica dioica*) in Lithuania and perennial grasses in maritime climates such as Ireland.

In Part III: 'Genotypic Selection of Perennial Biomass Crops for Crop Improvement', the chapters highlight how breeding work on PBCs is in its infancy compared to annual food crops and progress is slower than for annual crops because of the long selection cycles. Breeding still often starts with germplasm collection from places where these species grow wild and progresses through the screening of germplasm and the making of novel crosses and evaluation. However there is also the development of novel variation by polyploidization and mutagenesis to enlarge variation in the gene pools. Important breeding objectives for the perennial rhizomatous grass, *Miscanthus*, are frost and chilling stress where significant progress has yet to be achieved. Significant breeding efforts are also directed towards coppiced trees and giant reed for traits like heavy metal uptake. For traditional C_3 grass species improved drying rates harvested for biomass are of prime interest.

In Part IV: 'Ecophysiology of Perennial Biomass Crops', the chapters illustrate how an understanding of the ecophysiology of different PBC species and genotypes is essential to draw conclusions and forecasts on the adaptation to, as well as survival and growth on, marginal land. Marginal land by definition severely limits the productivity of crops because of a range of abiotic stresses, including shortage/excess of soil water, low nutrient availability, salinity and high and low temperatures, and it is shown that the use of mycorrhiza-based biofertilizer to provide nutrients for the growth of *Arundo donax*, tall fescue and reed canary grass on nutrient-depleted soils improves adaptation. The selection of suitable species for particularly challenging situations is of utmost importance to ensure adaption and the best biomass production potential on marginal land sites, but a systems approach can be used to guide future PBC development on marginal land.

Finally in Part V: 'Examples of End Use of Perennial Biomass Crops', the chapters illustrate how end uses of biomass can be novel and lead to new applications and products like using specific plant fragments for biorefining, as well as using *Miscanthus* as the aggregate base in concrete masonry blocks and even as horse bedding.

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