



Biomass production for sustainable aviation fuels: A regional case study in Queensland



Helen T. Murphy^{a,*}, Deborah A. O'Connell^b, R. John Raison^b, Andrew C. Warden^b, Trevor H. Booth^b, Alexander Herr^b, Andrew L. Braid^c, Debbie F. Crawford^b, Jennifer A. Hayward^d, Tom Jovanovic^b, John G. McIvor^e, Michael H. O'Connor^f, Michael L. Poole^g, Di Prestwidge^h, Nat Raisbeck-Brown^f, Lucas Ryeⁱ

^a CSIRO Land & Water Flagship, PO Box 780, Atherton, QLD 4883, Australia

^b CSIRO Land & Water Flagship, GPO Box 1700, Canberra, ACT 2601, Australia

^c RileM P/L, PO Box 6190, O'Connor, Canberra, ACT 2602, Australia

^d CSIRO Energy Flagship, PO Box 330, Newcastle, NSW 2300, Australia

^e CSIRO Agriculture Flagship, GPO Box 2583, Brisbane, QLD 4001, Australia

^f CSIRO Land & Water Flagship, Private Bag 5, Wembley, WA 6913, Australia

^g CSIRO Agriculture Flagship, Private Bag 5, Wembley, WA 6913, Australia

^h CSIRO Land & Water Flagship, GPO Box 2583, Brisbane, QLD 4001, Australia

ⁱ CSIRO Marine and Atmospheric Research, 107 - 121 Station Street, Aspendale, VIC 3195, Australia

ARTICLE INFO

Article history:

Received 27 June 2013

Received in revised form

19 August 2014

Accepted 4 January 2015

Available online 24 January 2015

Keywords:

Aviation biofuels

Regrowth

Short rotation trees

Grass

Economics

Lignocellulose

ABSTRACT

The aviation industry in Australia has aspirations to supply 5% of its domestic fuel use from biomass by 2020. The majority of available sources of biomass in Australia are lignocellulosic, and novel production systems that integrate existing land uses with energy production systems could have many benefits to growers and regions through enterprise diversification. This study assessed the operational and economic factors associated with lignocellulosic biomass supply for production of sustainable aviation fuel in a case study region in central Queensland, Australia. We examined the potential for biomass supply from native grasses, naturally regenerating woody vegetation (regrowth), and newly established plantings of short rotation trees (SRT) from the Fitzroy Catchment (14.2 million hectares). We outline a hypothetical industry scale-up strategy that achieves a production target of 470 ML of aviation fuel within a 25 year timeframe. We assess the amount of biomass required to support the scale-up strategy and the associated costs of supply to meet production targets during the scale-up.

Approximately 5 million tonnes of biomass per year are required to support full production capacity after 25 years; 1.1 millions of land is required to be managed to supply this quantum of biomass. A preliminary assessment of the cost of supply for each feedstock indicates that grasses are most expensive at ~\$142 t⁻¹ due to relatively low biomass potentially available for harvest per hectare, and relatively high costs of harvesting and transporting compared with woody biomass. Regrowth is the least expensive at ~\$56 t⁻¹ due to low establishment and maintenance costs.

We conclude that the case study region has the potential to produce sufficient biomass to support the hypothetical industry scale-up and that a mixed feedstock base maximises the sustainability of biomass supply. We discuss a range of sustainability issues associated with biomass production.

© 2015 Elsevier Ltd. All rights reserved.

Contents

1. Introduction.....	739
1.1. Case study area in Queensland.....	739
2. Industry development.....	740
2.1. Conversion technology.....	741
2.2. Production scale-up strategy.....	741

* Corresponding author. Tel.: +61 7 4091 8828; fax: +61 7 4091 8888.

E-mail address: Helen.Murphy@csiro.au (H.T. Murphy).

3.	Lignocellulosic biomass production in the Fitzroy catchment.....	742
3.1.	Grasses.....	742
3.2.	Short rotation trees (SRTs).....	744
3.3.	Regrowth.....	744
4.	Strategy for biomass supply.....	744
5.	Biomass supply costs and assumptions.....	746
6.	Discussion.....	746
6.1.	Mixed biomass types for use as biofuel feedstock.....	747
6.2.	Securing biomass supply—Future supply chain arrangements.....	747
6.3.	Sustainability.....	747
6.3.1.	Food security.....	748
6.3.2.	Maintaining soil fertility to sustain rates of biomass production.....	748
6.3.3.	Biodiversity.....	748
7.	Conclusions.....	749
	Acknowledgements.....	749
	References.....	749

1. Introduction

Interest in using biomass for liquid fuels, electricity and other products is increasing in Australia due to volatile and increasing oil prices, the pressing need to reduce greenhouse gas emissions, and the recent introduction of a tax on carbon emissions. Current production of biofuel in Australia makes only a very small contribution to fuel demand [1,2]. Aviation fuel accounts for 13% of total liquid fuel demand in Australia. However, over the next two decades, global aviation is expected to grow at between 3 and 5% per annum [3–5]. In Australia and New Zealand regional growth is expected to be 4 to 5% per annum reflecting strong growth in trade and personal travel [4–7].

While the aviation sector contributed only 2% to total global greenhouse gas emissions in 2005, it has been strongly focussed on reducing emissions and limiting its exposure to carbon price liability by improving fuel economy. Bio-derived jet fuels are another essential part of the industry's greenhouse gas reduction strategy [8]. There is an opportunity for novel biomass production systems to be developed in Australia to meet the aspirations of the aviation industry to supply 5% of domestic aviation fuel from biomass by 2020 and thus reduce greenhouse gas emissions [7,8].

The scope for potential production of advanced biofuels from lignocellulosic biomass in Australia was demonstrated by Farine et al. [9]. Lignocellulose can be converted to bio-derived fuels via several processes [10] and most of these processes can produce both road and jet fuels. Currently, while there is promising research on the distribution and production potential of individual lignocellulosic feedstocks in Australia (e.g. grasses [11,12] and cereal stubble [13]), there has been little assessment of the potential for integrating energy production systems with existing production systems such as grazing and cropping. New biomass production systems could have many benefits at the 'grower' part of the value chain including enterprise diversification, reduction of risk, and reduction of GHG emissions. They could also benefit regional development, diversify employment and provide new manufacturing opportunities. In addition, Hayward et al. [14] have shown that the cost of biomass-based jet fuels may be competitive with conventional fuel within the timeframe of the case study outlined here.

In this paper we consider the economic, operational and sustainability factors associated with lignocellulosic biomass supply in a novel production system arrangement where biomass is regionally distributed and integrated with existing agricultural production systems. We demonstrate a framework for assessing the complex logistics of biomass scale-up and supply to meet industry demands in order to provide investor confidence in the feasibility of a biofuel industry in a new region. A case study

region, the Fitzroy Catchment of central Queensland (Fig. 1), was chosen to demonstrate the framework. The paper draws on information from studies of potential biomass production in the Fitzroy Catchment for grasses [11] and woody biomass [15]. We evaluate these potential biomass resources and demonstrate a scale-up strategy for production of 470 ML of aviation fuel over a 25 year timeframe. A separate paper [14] examines the economics of producing jet fuel based on this industry scale-up strategy in the case study region.

1.1. Case study area in Queensland

The Fitzroy Catchment covers an area of 142,665 square kilometres (14.3 million hectares) and is the largest river catchment flowing to the east coast of Australia. It adjoins the Burdekin catchment to the north and the Burnett River to the south. The Fitzroy catchment has a total resident population of nearly 70,000. Emerald is the largest town in the catchment (~13,500 residents), followed by Moranbah to the north (~8500) and Biloela to the south (~5800) [16]. The dominant land-use is grazing of natural vegetation, accounting for nearly 90% of the catchment area; the conservation estate accounts for approximately 10% of the catchment (Fig. 1). Agricultural industries, particularly grazing and dry land grain cropping, have traditionally underpinned the economy of the area but mining is now the largest employer, followed by agriculture, together representing nearly 40% of the workforce. Unemployment in the region is significantly lower (2.3%) than the Queensland average (5.5%) [16]. The total value of agricultural production in the region in 2005–2006 was \$949.4 million, 10.9% of the total value of agricultural production in Queensland [16].

The dominant native plant communities are woodlands of highly water stress tolerant brigalow (*Acacia harpophylla*). Much of the Brigalow Belt bioregion has been cleared for agriculture, and 16 regional ecosystems within the Brigalow Belt are listed as threatened (endangered) ecological communities under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) [17].

Previous work has shown that a range of lignocellulosic feedstocks are potentially available in the region in sufficient quantity to sustain a biofuel production industry [12,13]. Most of the catchment area lies within the 600–900 mm yr⁻¹ rainfall zone (Fig. 1) and the mean annual temperature range is 19–22 °C, providing suitable conditions for maintaining reasonable levels of biomass production. The case study area mostly excludes the high rainfall (> 800 mm) coastal zone where competition for land with food production is highest, and where land prices are also

Download English Version:

<https://daneshyari.com/en/article/8117447>

Download Persian Version:

<https://daneshyari.com/article/8117447>

[Daneshyari.com](https://daneshyari.com)