Mapping potential biofuel crops in the agricultural landscape of Victoria, Australia

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Abstract

Biofuels and bioenergy production are considered attractive alternative agricultural industries for the future of Victoria. Thirty three potential biofuel crops (including oil crops, cereal crops, starch crops and solid biofuel crops) were identified and their potential distributions across Victoria were mapped for the current environment (2007) and for the future (2050) - based on climate predictions. In general, those crops that offer the most potential as a source of biofuel in Victoria are those that: do not compete with food production, are biomass derived, high yielding, pose no weed risk and are adapted to a broad region across Victoria both in the current environment and in the future. In addition, those potential biofuel crops that can be grown on land that has low agricultural productivity – a class of land that may increase throughout Victoria in the future – also show potential. Further research, involving detailed agronomic and economic studies regarding the cost of processing biofuels from these crops, as well as weed risk assessments on specific crops, is necessary before full recommendations can be made. In addition, a number of existing market barriers need to be overcome before a biofuel industry becomes viable in Victoria.

Key Words

bioenergy, biomass, crop agronomy

Introduction

Bioenergy represents around 10 per cent of the world's primary energy consumption, however in Australia, biofuels have been less widely adopted with bioenergy accounting for only 4 per cent of Australia's primary energy consumption in 2007-2008. In Victoria, Australia, the biofuel industry is small, but interest is growing and the number of established plants (ranging from the farm scale to large industrial scale) is increasing. The availability of reliable, consistent and sustainable biomass supply is critical for the development and expansion of the bioenergy sector.

The purpose of this study was to identify a range of bioenergy crops and to determine their potential adaptation across Victoria under current climatic conditions (2007) and under future climate predictions (2050). The focus of the study was solely on the potential of the crop to be grown in the Victorian climate and the crops were grouped into broad agronomic categories (e.g. cereal crops, oil crops, solid biofuel crops and starch crops). The study did not take into account the potential yield of the species under the different environments, the weed potential, nor the economics (such as the cost of production and processing) of growing these crops. In addition, the study examined each crop as a primary energy source and did not take into account any potential bioenergy value that may be derived from waste or by-products, nor any costs or benefits to the ecosystem (such as improved biodiversity, water quality or carbon sequestration) that may incur when bioenergy crops are grown across Victorian environments.

Methods

Bioenergy or biofuel crops are annual or perennial species that have been specifically cultivated to produce solid, liquid or gaseous forms of energy. A list of 33 potential biofuel crops and their climatic growth requirements were identified following an extensive search of published literature (e.g. Lewandowski et al 2003, Tuck et al 2006), available databases and through discussions with researchers.

Climate maps were drawn for (i) 2007 - using climate data from 1998-2007, and (ii) 2050 - using the future climate scenarios from the OZClim software. The data were recorded in 5 km grids. All public land was excluded from the mapping area. A limiting factor in mapping the biofuel crops to regions throughout Victoria was the availability of detailed soil information. The potential distribution of the selected biofuel crops was then mapped throughout Victoria for 2007 and 2050 using the specific climatic growth requirement information for each species. These maps were then verified by local agronomic experts.

Results

A series of approximately 70 maps were developed that outlined, in the broad scale, the potential distribution across Victoria for each of the selected bioenergy crops for 2007 and for 2050 (e.g. mustard, Figure 1). The predictions of higher temperatures and lower rainfall by 2050 generally led to a reduction in the area suitable for most of the selected biofuel crop species by 2050 – although there was some variation between crops.

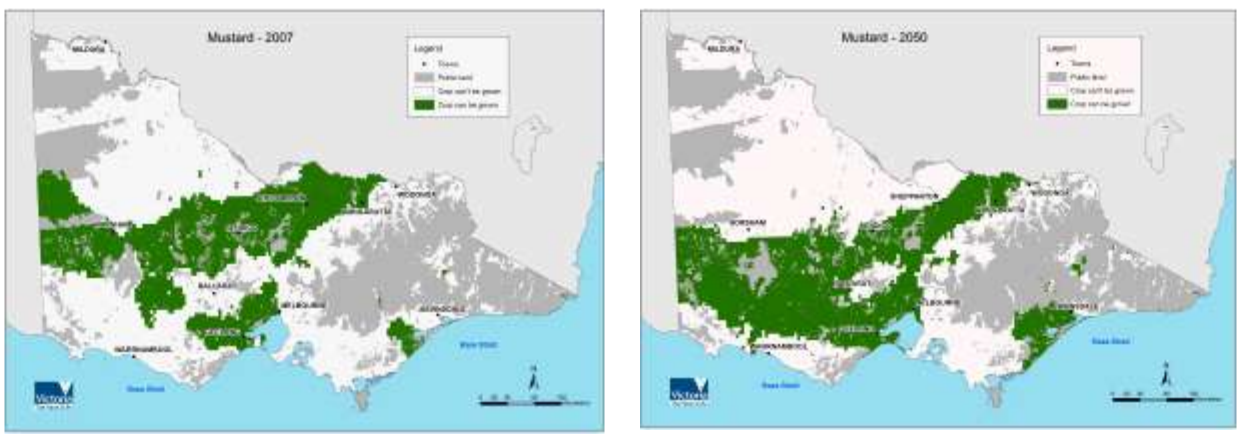

Figure 1. The potential distribution of mustard (*Brassica juncea*) across Victoria in 2007 and in 2050 based on future climate predictions

Discussion

An ideal biofuel crop is one that is biomass derived, perennial, high yielding, and does not directly compete with food production. This ideal crop preferably has low input (water, fertilizer and cultivation) requirement and is adapted to a wide region across Victoria. Biofuel crops that can act as break crops and fit into existing farm systems allowing the farmer to double crop with food crops have an advantage for Victoria – although suitable areas in this class may be confined to irrigation or high rainfall areas. Equally, bioenergy crops that can be grown on degraded or poorly resourced land not suitable for food production (and therefore not at the expense of food production) also show potential.

In general terms, leading bioenergy candidate crops for Victoria include:

- the native species – oil mallee and salt bush- that are adapted to marginal land, low rainfall and can be grown in a wide area across Victoria now and in the future;
- perennial, high yielding grasses (however several of the ones included in this study e.g. switch grass, *Miscanthus* are a potential weed risk);
- mustard (juncea) which is suited to low rainfall areas and has multiple uses;
- canola, where future predictions suggest that it could be grown across Gippsland by 2050;
- jerusalem artichoke and safflower which are salt tolerant and therefore could be grown on marginal land

- sorghum which has a lower rainfall requirement than other summer crops and is a multi-purpose crop;
- camelina which can be grown in degraded areas around but may pose a weed risk; and
- summer crops which can be double cropped with winter crops such as soybean and safflower.

A major concern with future bioenergy crops is their potential weed risk, and it is important that the economic, environmental and social values of any potential biofuel crop be fully assessed before its introduction and promotion. Several of the crops that have been mapped are multi-purpose crops that produce a range of end products such as fibre, fine timber, edible seeds or pharmaceutical products.

Conclusion

The potential distributions of the bioenergy crops presented in this paper are entirely based on climatic conditions. Further research, involving detailed agronomic (e.g. soil requirements) and economic studies regarding the cost of processing biofuels from these crops, is necessary before full recommendations can be made. The next stage of this study may involve identifying key target areas (such as specific climatic areas in Victoria, or particular land classes) where these crops can be grown. A particular focus would be identifying the production potential of specific biofuel crops on degraded or marginal land.

Further research is also required to develop integrated farming systems and cropping techniques that allow the efficient production of both food and fuel crops, as well as practices that allow the waste from these crops to be used as a source of biofuel (but not at the expense of soil health). The potential of specific biofuel crops would be enhanced if high value co-products such as pharmaceuticals and industrial chemicals can be identified - especially if these products require less processing than those sourced from fossil chemicals.

References

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