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TECHNICAL BRIEF

Biofuels

Water use of biofuel crops

A scoping study sponsored by the WRC investigated the water use of crops used for biofuels.

Worldwide move towards biofuel production

Worldwide, the demand for energy has grown rapidly in the recent past. Utilising the potential that exists for producing fuels from alternative sources has become a priority for many countries. The production of ethanol and diesel (i.e. biofuels) from vegetable biomass and oils has been promoted as an environment-friendly alternative to conventional oil-based fuels. However, many have warned against the rush to plant large areas of cropland for biofuel production citing, *inter alia*, possible consequences such as the loss of food production potential and the unanswered questions regarding water use for both feedstock growth and the final synthesis of liquid fuel.

South Africa, in line with many countries across the world, has developed its own biofuels strategy. However, the *Biofuels Industrial Strategy of South Africa* is generally considered to be conservative by comparison with the international drive towards large-scale biofuel production. The South African strategy has adopted the relatively pragmatic approach of aiming for 2% biofuel penetration within five years. In particular, sugarbeet and sugarcane have been highlighted as potential bioethanol feedstocks, and canola, sunflower and soya bean as potential biodiesel feedstocks.

Investigating impacts on water use

Impacts on water resources are a major concern in the production of biofuels. Several international studies have highlighted the fact that water used during the feedstock production phase is the biggest unknown factor when quantifying the total water requirement for biofuel production. This uncertainty is exacerbated when dryland crops are used as feedstock, since water use in dryland crop production is particularly difficult to measure or estimate.

In South Africa, the potential impacts of land use and land use changes on the hydrological cycle and on water resources have been extensively investigated. As a result, useful tools and valuable databases concerning water-use estimation have been built up over many years. This prior knowledge has been put to good use in a recent scoping study undertaken to assess the water use of crops that show promise as potential biofuel feedstocks in South Africa.

The approach followed in the scoping study was to first identify all field and tree crops grown in South Africa that are or can be grown in South Africa as a biofuel feedstock, both for bio-ethanol and for biodiesel production. By reviewing national and international literature, the available knowledge on water use of these crops and trees was assessed.

Where explicit information on water use was lacking, data suitable for the derivation of relevant crop parameters was gathered to enable appropriate models to be used in estimating the water requirements of selected crops and trees. The existence of gaps in knowledge relating to both water use and crop parameters provided a clear indication of future research priorities.

Biofuel crop production potential: consolidating current knowledge

The comprehensive analysis of available literature revealed 20 crops with the potential to be used for biofuel production in South Africa. Information regarding their growth requirements and potential water use, including information that could be used to derive model parameters, was collected and tabulated. Based on discussions with key stakeholders and guided by the South African National Biofuels Industrial Strategy, a subset (canola, cassava, *Jatropha*, sweet sorghum, soya bean, sugarbeet and sunflower) of these 20 crops was selected and investigated in greater detail.

Sugarcane was omitted from the subset because of having previously been studied in much greater detail than was required in the current scoping study. Climatic thresholds for the production of the selected crops were then derived from the available literature and tabulated for further use.

The information obtained from the various sources was initially used to map potential growing areas of the crops in question with the help of a commercial GIS package. This exercise showed that, based on climatological drivers only, canola, sugarbeet, *Jatropha* and possibly sweet sorghum, have the potential for their production areas to be expanded.

Biofuel crops: water use estimation

The *ACRU* agrohydrological modelling system was thereafter used to estimate the water use of these crops. Water use was assessed relative to that of natural vegetation as defined by the widely-used Acocks Veld Types. This is consistent with the established approach for the quantification of Stream Flow Reduction Activities according to Section 36 of South Africa's National Water Act. Output from this analysis has been presented in a series of maps which show that under dryland conditions, only sweet sorghum and sugarcane may have the potential to use substantially more water than that of the natural vegetation.

Knowledge gaps indicative of future research needs

Finally, an analysis of the areas of uncertainty relating to the above-mentioned assessments revealed key research needs regarding the water use of biofuel feedstock crops in South Africa.

The most significant of these needs are for:

- Better knowledge of optimal growing conditions and water use for each crop.
- More certainty about which crops are optimal for biofuel production in South Africa (given the current large uncertainties around sweet sorghum, sugarbeet and other emerging crops).
- More detailed mapping or specification of biophysical conditions (soil characteristics, finer spatial and temporal scale climatic data) needed for adequate local-scale assessment of benefits and impacts of specific biofuel crops.
- Accurate estimates of potential growing areas of these potential biofuel crops based on the more detailed biophysical information, especially information pertaining to soil characteristics.
- Detailed assessments of water-use efficiencies.
- Better understanding of the potential for climate change to result in shifting cropping patterns, regions and water use.
- Understanding of the potential impacts of second generation biofuel production systems, in which all crop cellulosic material as well as woody vegetation would qualify for use as biofuel feedstock. An implication is that perennial crops and natural vegetation could then become sources of cellulose for biofuel production. Should these sources include deep-rooted, evergreen crops which are able to transpire throughout the year, impacts on catchment water yields similar to those of commercial forests could be anticipated.

Further reading:
To obtain the report, *Scoping Study on Water Use of Crops/Trees for Biofuels in South Africa* (**Report No: 1772/1/09**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za to download a free copy.