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Is government's biofuel strategy waterproof? WRC study investigates

While the use of biofuels have been put forward as a viable alternative to the world's dependence on conventional oil, concerns over the impact of these fuel alternatives on South Africa's scarce water resources have prompted the Water Research Commission (WRC) to launch a series of investigations in this regard. Article by Petro Kotzé.

Globally, as the demand for energy is growing, so is the support for renewable energy and cleaner energy sources. As a result, the production of fuels from alternative sources has been a priority for many countries, particularly in Europe and America. The production of ethanol and diesel from vegetable biomass and oil (i.e. biofuels) has been promoted as one of the environmentally friendly alternatives to oil-based fuels.

South Africa is also making strides into this sector, and our fledgling biofuels industry has recently made the news again after the Department of Energy published the long-awaited draft position paper on the pricing regulations and rules for administering biofuel prices for comment. This is the final step in the process of getting the potentially R15 billion-a-year South African biofuels industry off the ground. It follows a pragmatic approach towards a goal of 2% biofuel penetration within five years, and the deadline for comment was set for 10 February.

Locally, our biofuels strategy, the National Biofuels Industrial Strategy, is driven predominantly by the need to address issues of poverty and economic development. The focus of the strategy is the promotion of farming in areas previously neglected by the apartheid system and areas that did not have market access for their produce.

Yet, there are a number of concerns regarding the development of our biofuels industry. One is the impact of biofuels production

on water resources, particularly since much of the country is water stressed, and there are already severe limitations on the availability of additional water for allocation to new uses. Irrigated agriculture already uses about 60% of the available surface water and groundwater resource, and irrigated cropping for biofuels will have to find its water from existing allocations, or compete for scarce new water sources.

The Department of Water Affairs (DWA) has noted that impacts on water quality (erosion and siltation, and fertiliser and pesticide run-off) are as important a concern as impacts on available volumes available to other users and the reserve, and that best practice management for both land and water will have to be applied to all biofuels cropping, both irrigated and dryland.

Consequently, the WRC launched a scoping study on the water use of crops and trees for biofuel production, which provided initial results on the water use and growing conditions of some biofuel crops. It also highlighted key gaps in available knowledge applicable to South Africa. After its completion, a follow-up study was launched to investigate the water use and optimal growing conditions for a comprehensive range of potential crops, particularly those that was identified as in need of further research in the scoping study. This project also involves detailed mapping of suitable production areas and the projected impact of biofuel production on water resources and food supply.

The six-year project, titled 'Water use of cropping systems adopted to bio-climatic regions in South Africa and suitable for biofuel production' (**WRC project no. K5/1874**), initiated and funded by the WRC, will be completed in 2015. The project is led by the Centre of Water Resources Research at the University of KwaZulu-Natal (UKZN) with the CSIR and the University of Pretoria. While it has already yielded useful results, much of which will be used as reference by the DWA, it has needed to adapt to the changing regulatory environment in which it is taking place.

THE SOUTH AFRICAN BIOFUELS INDUSTRY

On 7 December 2005, Cabinet approved the development of an industrial strategy targeted at creating jobs in the energy crops with the biofuels value chain.

Biofuels supply requires low-cost, high-yield and surplus agricultural production, generally not destined for food consumption, as well as government support, particularly when crude oil prices are low. South Africa has limited arable land, only 15% of the total land available and about 10% of this land is irrigated.

However, according to the National Biofuels Industrial Strategy, in most years South Africa has surplus crop production, which could generate sufficient ethanol to meet 5% of national petrol demand. In addition, there are 3 million ha of under-utilised, high potential land, mainly in the former homelands. Utilising 1 million ha of such land could produce biofuels representing about 5% of national diesel usage.

In South Africa, the main motivation for the development of the biofuels industry is the upliftment of the agricultural sector through utilisation of this underutilised agricultural land to produce products in excess food needs, and to promote sustainable development.

Because of this, the development of the industry based on imported feedstock has not been supported, and will only be considered in times of adverse agricultural production and when local producers cannot meet the investors demand.

An initial target of 4.5% penetration level of biofuels was proposed in the draft strategy document, later revised to adopt a short-term focus (5-year pilot) to achieve a 2% penetration level of biofuels in the national liquid fuel supply, or 400

Courtesy UKZN

Grain sorghum with bagged grain heads to prevent yield loss due to feeding birds.

Courtesy UKZN

Transplanting of sugarbeet seedlings in to the trial site at Ukulinga research farm.

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million litres pa, from 2008 to 2013.

For bioethanol, sugar cane and sugar beet was recommended while sunflower, canola and soya beans were proposed for the production of biodiesel. The exclusion of other crops and plants such as maize was based on food security concerns, as it was deemed that further research was needed to test the usability of these in the country. Questions marks were raised around the use of Jathropa, again, due to concerns around the potential for invasion.

Regardless of the approval of the strategy, no single, large scale biofuels industry player has emerged, attributed to the fact that biofuel projects on their own is not financially attractive at the prevailing feedstock and crude oil / liquid fuels process. The DoE then started focusing on the refinement of the Biofuels Industrial Strategy.

The most recently published draft position paper on the pricing regulations and rules for administering biofuel prices for comment stipulates that all oil refineries will be required to blend 2% of locally produced bioethanol into their petrol from October 2015. The choice of crops has also changed slightly to sorghum and soybeans as the bio-ethanol and biodiesel feedstock respectively. These choices have in part been motivated by the hope that it will revive the flagging sorghum farming industry, which has collapsed following the decline in popularity of sorghum beer.

A CLOSER LOOK AT THE SUGGESTED FEEDSTOCK'S WATER USE

The approach followed in the mentioned scoping study was to first identify all field and tree crops grown in South Africa as potential biofuel feedstock, both for bio-ethanol and biodiesel production, and then assessing their water use through literature review.

Twenty crops with the potential to be used for biofuel production in South Africa were identified, guided by the South African Biofuels Industrial Strategy. Canola, cassava, Jatropha, sweet sorghum, soya bean, sugar beet and sunflower were investigated in greater detail. Sugarcane was omitted from the subset because of having previously been studied in much greater detail.

Further investigation into the potential growing areas of the crops in question revealed that, based on climatological drivers only, canola, sugerbeet, Jathropa and possibly sweet sorghum, have the potential for their production areas to be expanded. The study further showed that, under dryland conditions, only sweet sorghum and sugarcane may have the potential to use substantially more water than that of the natural vegetation, and this have the potential to be defined as Streamflow Reduction Activities (according to the National Water Act). As such, it would need a water use license to be cultivated and would put these crops in the same category as commercial forestry.

Uncertainty also remained around certain emerging crops (like sweet sorghum and sugarbeet) as potential biofuel production.

The main aim of the current study is to estimate the water use and fuel yield of selected biofuel feedstock in regions suitable for feedstock cultivation. This will allow the project team to rate the feedstock in terms of water efficiency. "Our initial focus was led by the Biofuels Industrial strategy," says principal investigator Richard Kunz.

He explains that they looked at potential and unknown feedstock such as sugarbeet after indications were that it could be grown in fairly large scale. Sweet sorghum, that showed huge potential was also investigated, he says. Currently in its fifth year, field trials have now been conducted on emerging crops such as sugarbeet, sweet sorghum, grain sorghum, Jatropha and Moringa.

Their experience has taught them that, in general, there are a lot of the problems with these so-called wonder crops like sweet sorghum and sugarbeet, notes Kunz. Sugarbeet is a particularly difficult crop to grow in South Africa and getting it to the state where it is ready for production requires some effort. Kunz says he would think that it was lifted off the list of feedstock for bioethanol in the draft position paper for economic reasons. Similarly, grain sorghum cannot be advised to emerging or inexperienced farmers because there are other problems such as massive bird damage.

Courtesy UKZN

Sweet sorghum growing in an irrigated plot at the Hatfield research farm.

Regarding the choice of sorghum and soybeans for the bio-ethanol and biodiesel feedstock respectively, it seems to be a good choice. However, the final say on this from the project team's side will have to wait until the project has been completed.

"We're still looking at the numbers but according to preliminary results grain sorghum appears to be some of the more water sufficient option. It's also the one feedstock that can be grown in rural areas," reports Kunz.

While grain sorghum was not originally included in the choices of feedstock under investigation by this project, they have had to adapt to new information and legislations as they went along, adds project leader, Prof Graham Jewitt (Umgeni Water Chair of Water Resources Management). They are harvesting their first crop soon, and results will be included in the final report.

The project is also collaborating with another WRC-funded research project, titled 'Validation of the forcing variables (evaporation and soil moisture in hydrometeorological models)' (**WRC project no. K5/2066**). This project has provided water use and yield information for soybean and maize.

IS THERE LIGHT AT THE END OF THE BIODIESEL TUNNEL?

"The industry is very complex," says Kunz. "Grain sorghum looks to be the correct way forward for ethanol production, but you can't exclude sugarcane. At the moment it looks like the proposed two plants that are in the pipeline will produce enough to provide the legal blending rate. But, if you aim higher you would need to get the sugarcane industry involved. Plus, the deadline is short, and by 2015 we might only be in a better place to provide sugar based ethanol rather than sorghum, he says. At the moment we do not have the efficiency to grow all of this. Otherwise, we might have to import feedstock."

Courtesy UKZN

Two mesh bags used to protect each sorghum grain head at Ukulinga. Unprotected heads were completed stripped of seed by feeding birds.

Even though the project results will not be ready in time for the deadline for public comment on the draft position paper, when the biofuels industry does lift off, the results from this study will be very valuable in the long-term, says Prof Jewitt. The water use results will be beneficial to the DWA, as well as the water use efficiency results as this covers the aspect of "beneficial use" in the National Water Act, says Jewitt. In general, the water use efficiency results will be useful to all potential growers.

Yet, even if the biofuels industry never gets off the ground, the research results will still not be wasted because it can be used in the food production industries or by farmers, notes Prof Jewitt. "It has been a six-year project and that has given us time to establish decent field trials and continue with them, which is invaluable."

Research topics on biofuels are evolving constantly and in future, Prof Jewitt says that topics will move towards the understanding of second generation feedstock. This involves understanding the potential impacts of second generation biofuel production systems, in which all crop cellulose material as well as woody vegetation would qualify for use as biofuel feedstock. An example includes using eucalyptus trees.

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 this of commercial forests could be anticipated. ❑

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Courtesy UKZN

In-field weighing of heads, stems and leaves of sweet sorghum plants.