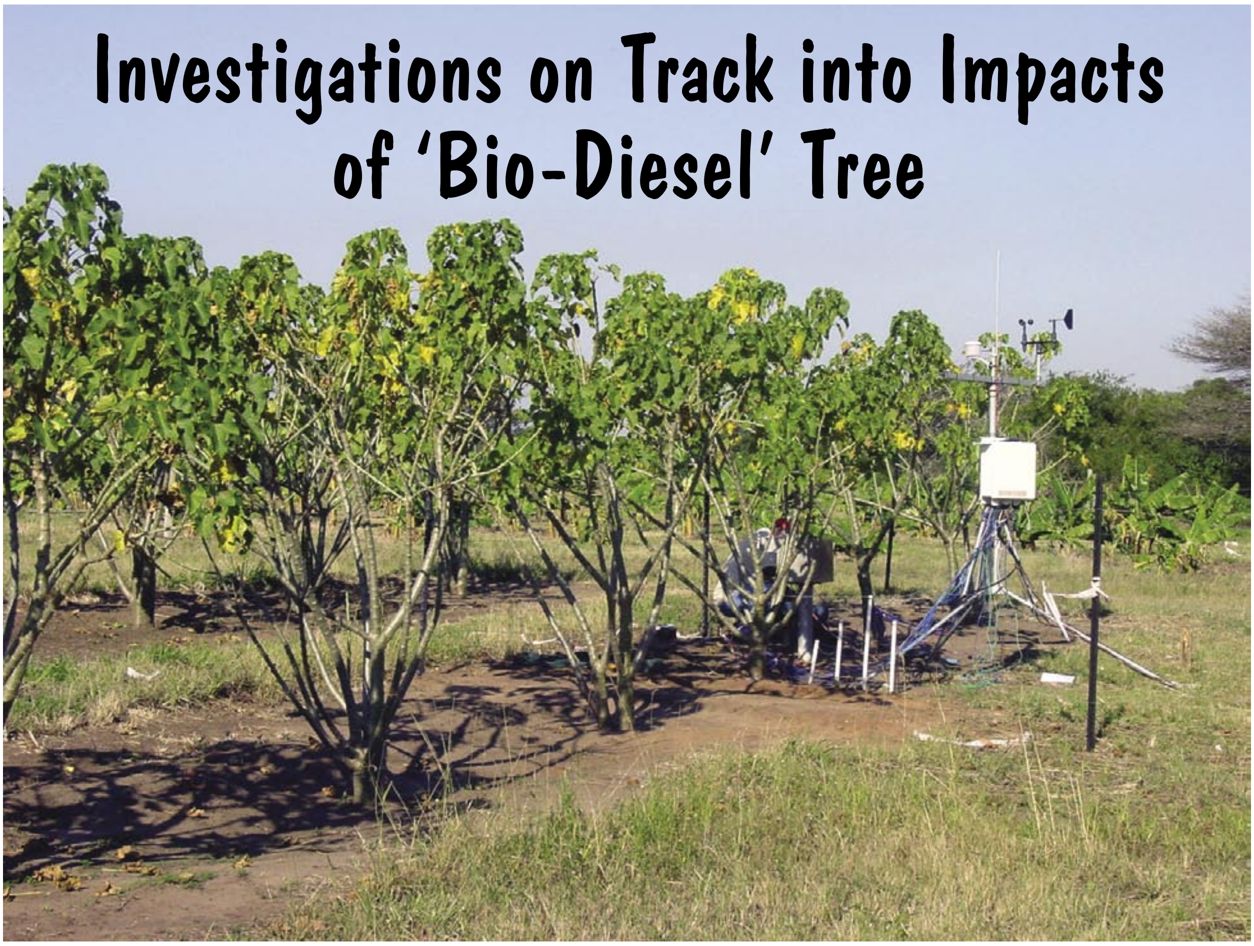
Investigations on Track into Impacts of 'Bio-Diesel' Tree



A three-year hydrological investigation is currently underway to determine the potential impact of the bio-diesel producing Jatropha curcas *tree on local water resources.*

Introducing an alien species into the environment, even if it could potentially contribute to rural employment and poverty alleviation and an alternative source of bio-fuel, is not an easy consideration. The social, economic and environmental implications need to be well understood. Investigations are currently underway to determine the potential for South Africa to 'grow' its own energy in the form of a bio-diesel producing tree.
Lani Holtzhausen reports.

The *Jatropha curcas* tree, which originates from Mexico, has long since been cited as a way for South Africa to increase its use of renewable energy sources. The prime ingredient in the manufacture of bio-diesel is vegetable oil (e.g. sunflower oil, soya or peanut oil); however, these oils are edible and generally fetch high prices, which preclude them from being used in bio-diesel production.

Research indicated that *Jatropha curcas,* whose oil-producing seeds are inedible (toxic) to humans, and most animals and birds, merited serious consideration as a viable alternative. Now initiatives have been proposed to introduce this exotic species for large-scale planting and bio-diesel production in the country.

GROWING BIO-DIESEL

A small tree or shrub with a maximum height of 5 m, *Jatropha curcas* reportedly grows readily in areas of low rainfall (from 250 mm a year) and in poor soils, however, yield is strongly affected by growing conditions. The trees are easy to establish (from seeds or cuttings), grow relatively quickly (producing seed after their second year) and are hardy to drought, although they are relatively sensitive to frost.

The seeds of the Jatropha contain high percentages (30%-35%) of oil, which can be extracted easily for further processing (trans-esterification) and refinement. This processed oil can then be used in diesel engines after minor modifications. To avoid engine modifications the bio-diesel can also be blended with conventional diesel. On average, each mature tree produces about four kilograms of seed per year.

The byproducts of the bio-diesel processing plant are nitrogen-rich press cake and glycerol, which are said to have good commercial value as fertiliser and as a base for soap and cosmetics respectively. The leaves, root and bark could also have potential for numerous other industrial and pharmaceutical uses.

ASSESSING THE POTENTIAL IMPACT

However, while this could provide welcome income to rural communities the potential impact of the crop on the country's environment has to be considered. There are several concerns around the affect of such a species on the country's already scarce water resources as well as the possible invasive nature of the plant.

The Water Research Commission (WRC) has launched a three-year research study into the water resource-related impacts of large-scale planting of *Jatropha curcas.* Two sites have been identified in KwaZulu-Natal where the water use patterns of existing Jatropha trees are currently being studied, namely at the Owen Sithole College of Agriculture near Empangeni, and on the Makhatini Flats between Jozini and the Makhatini Research Station.

Mark Gush of the CSIR Land Use Hydrology Group in Pietermaritzburg, who is leading the technical research team, explains that transpiration (sap-flow), climate and site water balance measurements are being conducted at each site. This includes soil moisture measurements beneath the selected trees in comparison with the soil moisture of unplanted grassland sites nearby.

Mature Jatropha *trees at Owen Sithole College of Agriculture near Empangeni. The trees effectively 'shut down' during dry periods and winter when they lose their leaves.*

Mark Gush of the CSIR Land Use Hydrology Group in Pietermaritzburg shows off the logging system at the Owen Sithole site. All data from the hourly measurements are fed into this logging system. Data is then downloaded remotely to the CSIR Pietermaritzburg office via cell phone link.

An automatic weather station has been set up at each site for climatic measurements. These include rainfall, wind direction/speed, solar radiation, and temperature and humidity measurements.

The heat pulse velocity (HPV) technique is being applied to determine the water use of the trees. This is done by measuring the sap-flow (transpiration) through the trees. A short pulse of heat is injected by means of a probe into the sap-conducting wood (xylem) of the tree. As the pulse of heat is carried up the tree by the sap, temperature-sensitive thermocouples detect the sap-flow velocity from the rate of ascent of this pulse in the stem. Sap-flow velocity by the cross-sectional conducting wood area gives the volume flow of water per unit time.

In addition, soil moisture and soil water potential sensors have been imbedded in the soil at the two sites. The project will look at hydrological impacts of *Jatropha curcas* by means of detailed plant water use, soil moisture, and site water balance measurements.

Once this project has been completed the relevant national government departments are expected to undertake specific environmental impact assessments to determine whether this wonder species is destined to be introduced on a wide scale in South Africa.

The data should reveal whether there is movement of water down through the soil into the groundwater table (i.e. excess water) or whether there is a net loss of water from the groundwater system. The team will also be able to determine where the tree is getting its water from i.e. near the surface or from deep underground sources.

REMOTE DATA COLLECTION

Measurements are taken hourly and all of the data are fed into a logging system. Data are downloaded remotely to the CSIR Pietermaritzburg office via cell phone link. While saving time and transport costs it also allows for rapid analysis of potential problems.

WRC Research Manager Renias Dube tells *the Water Wheel* that measurements will be taken for the next year to determine the *Jatropha*'s water requirements throughout the seasons. Hereafter a modelling exercise will be undertaken wherein site-specific simulations of water use will be verified against the measured data and extrapolated to a larger scale.

While it is still early in the project, the research has already yielded some interesting results. For example, early indications are that the trees at the Owen Sithole site are using more water than the nearby grassland.

There are clear diurnal patterns to the sap-flow with no transpiration occurring at night. The trees, which are deciduous, also seem to effectively 'shut down' during dry periods and in winter when they lose their leaves. Peak transpiration rates occur during the warm, wet summer months.

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BIO-DIESEL AT A GLANCE

In the wake of rising oil prices, bio-diesel has been identified as a way for the world to meet its increasing energy needs. Bio-diesel has similar physical and chemical properties to petroleum diesel with reference to the operation of a diesel motor. Also its physical and chemical properties as it relates to operation of diesel engines are similar to petroleum-based diesel fuels.

However, since it is produced from natural source, it produces 80% less carbon dioxide, 100% less sulphur dioxide and up to 75% less exhaust smoke emissions. In addition, it is reported to degrade about four times faster after spillage and provide significant lubricity improvement over petroleum diesel fuel.

It can be produced from edible oil sources, such as sunflower, soya or peanut oil, or non-edible oil sources, such as from Jatropha curcas.

Source: www.biodieselsa.co.za

Once this project has been completed the relevant national government departments are expected to undertake specific environmental impact assessments to determine whether this wonder species is destined to be introduced on a wide scale in South Africa. The verdict is likely to weigh up the negatives such as potential for invasiveness, likely hydrological impacts, and the feasibility of using alternative seed-oil producing species, against the potential benefits to local communities and the national economy, of this species.