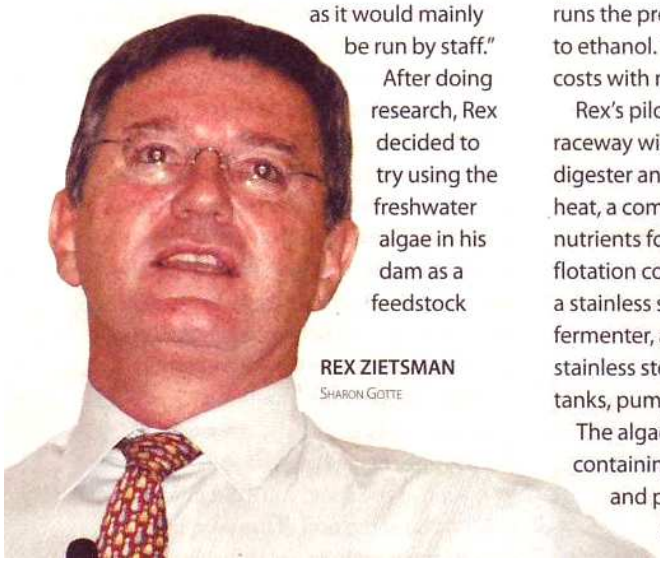
ABOVE, LEFT TO RIGHT:
Views of the pilot plant's 20m² raceways, where algae is farmed. The algae is initially sourced from the farm's dam. They then anaerobically digest stillage containing residual cellulose, starch and proteins. The solar panels are used to power the system. The end product is a bucket of green algae, harvested for conversion into bioethanol.
PHOTOS: REX ZIETSMAN

A farmer's experiment: ALGAE TO ETHANOL

KZN farmer and businessperson **Rex Zietsman** has successfully established a pilot production plant turning algae into ethanol. He reported on his success story at the recent Africa Biofuels conference and told **Sharon Götte** about his plans to establish a commercial plant.

"I BOUGHT A SMALL FARM IN KZN in 2007 and needed to find a way to make it pay for itself," says businessperson and part-time farmer Rex Zietsman.

"I was interested in producing biofuel, but the enterprise had to be simple, as I was only on the farm on weekends. The process itself had to be foolproof and able to withstand mistakes and continue without oversight, as it would mainly be run by staff."



REX ZIETSMAN
SHARON GOTTE

After doing research, Rex decided to try using the freshwater algae in his dam as a feedstock for bioethanol. As a feedstock, algae's major advantage is that it can double its weight every 24 hours under optimal conditions. As it was to be grown in open raceways, capital costs would be relatively low, even though the cost of converting algae to ethanol is relatively high.

When growing wild algae, an unskilled labourer can look after the general production, while a semi-skilled labourer runs the process of converting the algae to ethanol. This process has low operating costs with minimal nutrient and energy cost.

Rex's pilot plant consists of a 20m² raceway with 0,55kW paddle drive, a digester and solar panels to supply it with heat, a compost-tea maker to produce nutrients for the algae, a dissolved air flotation container to make "white water", a stainless steel pressure cooker, a plastic fermenter, an electrically operated stainless steel batch still and various tanks, pumps, drums and buckets.

The algae anaerobically digest stillage containing residual cellulose, starch and proteins. The liquid digestate, containing all the nutrient minerals released from the digested solids, is fed back into the ponds.

"The results so far have exceeded all the predictions in the literature," says Rex.

'An unskilled labourer looks after general production. A semi-skilled one runs the conversion process.'

"Algae density was maintained at 4g/ℓ from about October to February. Algae growth was 140g/day/m² of raceway surface area and ethanol production was in the range of 50ℓ/m²/day to 70mℓ/m²/day."

Suitable for small-scale farmers

Rex believes ethanol production from wild algae could be rolled out to small-scale farmers. Production is economically viable and doesn't require a lot of attention, and ponds can be established cheaply at R75/m².

"In rural areas, solar power can be an option for providing power to paddles. Theft and vandalism of cables, tanks and pumps should also be considered,"

Biofuel production from algae: the economics

Item	Units	500 ℓ/day	5 000 ℓ/day
Pond area	ha	1,0	10
Installed power	kW	30	150
Capital cost	US$	600 000	2,75m
Variable cost	US$/ℓ	0,05	0,1
Fixed costs	US$/year	17 500	35 000
Selling price	US$/ℓ	0,50	0,50
Sales	US$	85 000	850 000
Gross profit	US$	59 000	645 000

TOUGH AS NAILS

"Believe it or not, this algae is tough," says Rex. "It has lived through snow, lack of nutrients, too much sun, probably too many nutrients at times, and erratic harvesting as the operator works weekdays only. Yet, it seems to plug away despite what we do to it. This is one of its most attractive attributes.

he admits. For small-scale farming with algae, he suggests using a centralised conversion plant, which would allow better process and inventory control. A large plant also has a better economy of scale.

A tanker could transport nutrients to the production ponds, which would be scattered over a large area, and carry harvested algae to the digester at the central processing plant.

Next: a commercial plant

Given the excellent results from the pilot plant, Rex is planning to invest in a commercial one. He has all the necessary physical resources such as a level site, water supply and power supply. But there will be challenges, including the stability of the crude oil price, which needs to remain above US$40 a barrel, high capital investment (R6 million for the first hectare), a limited market for the small volume of product and protecting the plant from theft. Despite this, Rex believes using algae to produce bioethanol is the way to go.

"Algae has several benefits over maize in fuel production," he says. "It can be grown in a closed system almost anywhere, including deserts or even rooftops, and there's no competition for food or fertile soil. Algae is also easier to harvest because it has no roots or fruit and grows dispersed in water."

He hopes the commercial plant will be up and running in the near future. |fw

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Schematic representation of the algae-to-biofuel process