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Sugar rush

Foreign investment into biofuels has boosted Ghana's sugarcane industry. Will this potentially lucrative crop make life sweeter for the country's poor - or will its environmental impact leave them with a nasty aftertaste?

For almost forty years, Brazil has been a leader in bio-ethanol production. It is now second only to the US in output; producing around a quarter of the world's ethanol fuel. With rising global energy prices, some have hailed Brazil's successful biofuel experience as the answer to many a developing country prayer.

In 2010 Brazil invested $300m in exporting its sugar-cane cultivation and refinement technology to Ghana. The cultivation of sugarcane for fuel is a lucrative activity, and has the potential to attract this kind of major investment into poor regions right across Africa.
But there are potential drawbacks. Sugarcane is renowned as a thirsty crop. Not only might that impact its own success, but in a relatively dry climate like Ghana's, diverting water away from other uses might damage local livelihoods more than it improves them.

Plans to grow sugarcane in the country's Volta River region will without doubt require additional irrigation – but just how much additional water will it need? Will newly built dams be wise investments or a further drain on scant resources? And in a country that already receives less than a metre of rainfall a year, what impact will growing sugarcane have as the climate changes over coming decades?

To answer these questions, this ESPA project took a modelling approach; running complex simulations that encompassed land, water, climate, and economics. It then combined all of these to create sophisticated predictions as to the sustainability – and profitability – of this new industry.

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About this project

Name
Integrated Carbon, Water and Land Management for Poverty Alleviation.

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Time frame
October 2010 – March 2013.

Objective
This project produced the first evidence of how sugarcane cultivation in West Africa will impact on local ecosystems and wellbeing. This work has provided the biofuel industry, as well as other development projects, with robust economic and environmental information.

Summary
Sugarcane grown for biofuels has proved very lucrative for Brazil, but will its prospective cultivation in Ghana's dry climate be equally successful? This project produced the world's first study of the impact of climate change on biofuels. Its combined modelling approach shows that, provided sufficient irrigation water is available, sugarcane cultivation in the Volta River region is sustainable at around three quarters of benchmark yields from Brazil – even if CO_2 concentrations are doubled and temperatures rise by 4°C. It also shows that two proposed dams in the area would provide sufficient water for optimal irrigation in most, but not all, years. Damming the river would also benefit local communities by providing perennial water supply and reducing the risk of flash floods. Wealth distribution models are currently investigating whether the profits from sugarcane production can alleviate poverty, while remaining sustainable. This project has provided a case study for how poor communities can exploit their ecosystem services to attract major industrial investment.

On a high

Sugar producer Northern Sugar Resources provided extensive information to the project team on local climate, agronomical management practices and yield in Ghana. The results of this modelling will over the next few years help Northern Sugar Resources to plan their irrigation and manage the dam more effectively.

The models were built up in layers to produce a picture of the pluses and minuses of sugarcane production. On the one hand, they found that yields would only ever reach three quarters of those in Brazil due to the higher temperatures and more variable rainfall in Ghana.

However, the model also suggests that a warmer future under climate change wouldn't necessarily increase the crop's water requirements as, like all plants, sugarcane loses less water from its leaves when atmospheric CO_2 is high.

Sweetening the deal

Currently, sugarcane in Ghana needs 3-4mm of water a day. The impact of such irrigation on local water resources was further assessed in the context of two newly proposed dams that are intended to supply irrigation water from the Daka, a tributary of the Volta.

Scenarios involving the dams showed that in most years under the current climate, it would be possible to provide optimal irrigation for sugarcane cultivation. However, there will be some years when not enough water will be available. The number of such failures will depend on the size of the dams and the way they are operated.

The crop and hydrological modelling are now being drawn together into an economic framework which offsets the size of the dam – and its cost – against the cost of reduced yield due to irrigation failures. The economics modelling also incorporates a prices model that accounts for changes in global carbon, food and energy markets.

In the final phase of the project, a series of wealth distribution scenarios will be used to explore the balance between profits of the biofuel company and direct financial benefit to the local population – through factors such as taxation, land rent and employment.

Next steps

The overarching aim of this work was to develop a modelling framework capable of investigating the environmental and economic impacts of land management initiatives.

In the long term, the modelling framework will be applied widely to different crops within Africa, in order to provide other development projects with the most robust economic and environmental information possible.

A follow on project has already been funded under the UPGro programme. This will test the impact of changes in groundwater levels on poverty in Ghana.

Two other follow on projects (both funded by NERC) will also use the modelling framework as a test-bed for the design of weather-based index insurance contracts.

Successful index insurance products can lift millions of people out of poverty – and robust environmental/economic information is key to this success.

This work is being carried out in partnership with International Poverty Action in Ghana; in Ethiopia with the World Food Programme and International Research Institute for Climate and Society; and in Zambia, Rwanda, Tanzania and Uganda with the commercial organisation, MicroEnsure.

New knowledge

- This is the first modelling study of the impact of climate change on bio-fuel production. It shows that, provided sufficient irrigation water is available, sugarcane cultivation in the Volta River region of Ghana is sustainable at around 75% of Brazilian yields, even if CO_2 concentrations are doubled and temperatures rise by 4°C.
- Hydrological modelling has demonstrated that two dams on the River Daka would provide sufficient water for optimal irrigation in most years, but that there will be some years when irrigation rates fall below the optimal level. Damming the river would benefit local communities by providing perennial water supply and reducing the risk of flash floods.
- The climate and hydrological modelling are currently being combined within an economics modelling framework, which will offset the cost of production against the achievable income from sugarcane production. Wealth distribution models are investigating whether the profits from sugarcane production can alleviate poverty, while remaining sustainable.

Creating impact

- This project has provided a case study for how poor communities can exploit their ecosystem services to attract major industrial investment. Partnerships with industry, NGOs and government agencies in Ethiopia, Ghana and Sudan are already underway through several new projects and programmes.
- This new generalised crop/hydrological/economics modelling framework is being taken forward in several African projects. For example, the framework is informing the development of index insurance products by identifying weather indices that encapsulate environmental and economic vulnerabilities.

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