LEADING EDGE

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How to create a five-star energy rated farm

By Gary Alcorn

A new energy audit software tool developed initially to identify cotton growers' energy input cost could be applied across all agricultural enterprises. The dream of a farm energy star rating system similar to refrigerators and air-conditioners is almost reality.

Developed by NCEA researchers Dr Guangnan Chen and Craig Baillie and funded by the Cotton Research and Development Corporation, EnergyCalc will enable producers to monitor and optimise all crop-associated energy consumption.

"Every operation from fallow tillage or spraying right through to planting, irrigation and harvesting has been modelled based on real farm experience.

"Co-operators in several regions have given us access to very detailed operational cost histories and these have been built into algorithms which will enable any grower to test practical 'what if' scenarios on the in-office computer," Guangnan said.

With agriculture expected to play a major role in reducing global greenhouse gas emissions, EnergyCalc will help growers identify and fine-tune every production combination to minimise energy consumption on-farm.

"The Australian cotton growing industry is highly mechanised and heavily reliant on fossil fuels (coal-fired electricity and diesel). On-farm energy use is becoming increasingly important with rising energy costs and concern for greenhouse gas emissions," says Craig

"Within highly mechanised farming systems such as those used within the cotton industry, energy inputs represent a major cost to the grower. Overall, it has been estimated that machinery may contribute 40–50 per cent of cotton farm input costs."

EnergyCalc divides energy usage in cotton production into six broadly distinct processes:

- Fallow;
- Planting;
- In-crop;
- Irrigation;
- Harvesting; and,
- Post harvest.

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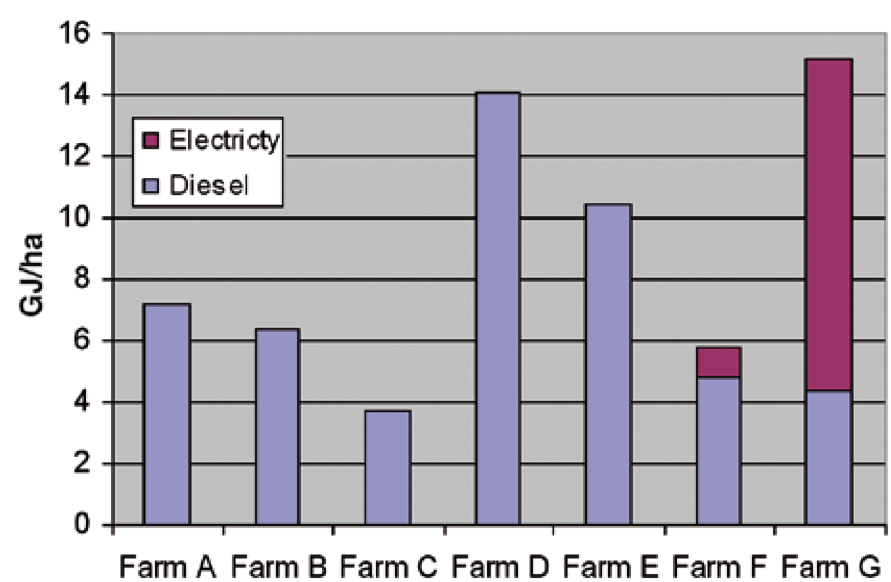
Guangnan Chen.

FIGURE 1: EnergyCalc flow chart

Calculator Inputs
↓
Production Processes/Stages (eg, fallow)
↓
Farming Operations (eg, tillage)
↓
Farming Practices/Methods (eg, subsoiling)
↓
Equations
↓
Model Outputs

FIGURE 2: Primary energy inputs of case study farms (cotton production only)



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This enables both the total energy inputs and the energy usage of each production processes to be assessed.

As well, this software also enables users to enter their own site-specific data so they can benchmark their performance with peer farmers and best practices to identify opportunities for reduced energy costs.

In their report seven case studies are presented. It has been found that total energy inputs for these farms were significantly influenced by the management and operation methods adopted, and ranged from 3.7–15.2 GJ per hectare of primary energy, at a cost of $80–310 per hectare and 275–1404 kg CO_2 equivalent per hectare greenhouse gas emissions.

Among all the farming practices, irrigation water energy use is found to be the highest and is typically 40–60 per cent of total energy costs (wherever water is pumped). Energy use in the harvesting operation was also significant, accounting for 20 per cent of overall direct energy use.

CASE STUDY A
(FURROW IRRIGATED FARMING SYSTEM)

Case Study A is a 450 hectare irrigated property growing cotton. It typically irrigates 400 hectares of cotton per annum. Cotton production is based on furrow irrigated Bollgard II with 5 per cent of the area allocated to a refuge area for insect control.

The basic input data for this farm are:

Crop type: cotton.
Area for cotton farm: 400 hectares.
Cost of fuel (diesel): $0.85 per litre.
Cost electricity: $0.10 per kWh.
Tractor size: 200 kW.
Irrigation method: furrow irrigation.
Pump motor type: diesel motor.
Number of subsoiling operation: 1.
Number of fertilising operation: 3.
Number of (boom) spraying operation: 1.
Number of inter-row cultivation operation: 3.
Number of (conventional drilling) planting operation: 1.
Number of (cotton picker) harvesting operation: 1.
Number of 'others' operation (heavy load): 1.
Number of 'others' operation (medium load): 1.
Number of 'others' operation (light load): 1.
Water Used: 9 ML per hectare.
Irrigated area: 400 hectares.
Head pressure: 8 metres.

"If a farmer moves from conventional tillage to minimum tillage, there is a potential saving of around 10 per cent of the fuel used on the farm. Compared with cotton, energy used in the production of other irrigated crops on these farms was generally half that of cotton.

"This is due to less intensive management required for these crops, leading to the lower number of farming operations (passes) carried out (generally about 10, in comparison with 17–18 for cotton) and reduced irrigation requirements," Guangnan said.

How does EnergyCalc work as an on-farm energy use calculator?

A significant aim of this project was to develop a practical framework and a software tool to assess on-farm operational energy uses. This calculation was based on the energy use by units of activities. So the software has a hierarchal structure as shown in Figure 1, which assumes that the farming activities are arranged in the order of six farming processes of fallow, planting, in-crop, irrigation, harvesting and post harvest. Each of these processes are then further divided into a number of farming practices such as tillage, harrowing, spraying, fertilising, and irrigation etc.

To enter data into the software, the user will need to select the appropriate farming and sub-farming actions and then enter the specific number of operations (passes) performed. The calculator will then automatically convert these input data into estimated energy use based on the default benchmarking energy use data built into the software.

If a specific action is not listed in the table, the user can enter data in the special cell provided. The fuel use for these operations can be either entered directly by the farmer or estimated based on tractor size and also tractor work rate. This will then be further adjusted by the loading conditions such as heavy, medium or light. A separate 'tractor calculator' is available to assist this calculation.

For most of these input data, default values are supplied, but the user is given the option to override these values using site-specific data.

EnergyCalc is accessed online by user name and password. All data is confidential and various inputs will be used by the authors to "grow" the database.

RESULTS

Based on the calculated results for each case study summarised in Figure 2, the total energy inputs ranged from 3.7–15.2 GJ per hectare of primary energy, corresponding to 275–1404 kg CO_2 equivalent per hectare greenhouse gas emissions. Diesel energy inputs ranged from 95 to 365 litres per hectare, with most farms using 120 to 180 litres per hectare. This is broadly consistent with that reported in the literature.

The results also show that values for energy inputs vary widely (300 per cent). Farm C uses the smallest amount of diesel energy (95 litres per hectare, or 3.7 GJ per hectare) due to gravity fed surface irrigation and minimum tillage. Farm D uses the largest amount of diesel energy (365 litres per hectare) due to irrigation water which is double pumped.

Compared with cotton, it has been found that the total energy use by other crops is generally much lower (wheat $42–130 per hectare, sorghum $60–130 per hectare, chickpeas $50–130 per hectare). The higher energy use by cotton harvesters (45 litres per hectare) may be one of the factors (compared with other types of crop harvesters using 10–20 litres per hectare of diesel). As a result, Craig said that obtaining accurate measurements for harvesting energy use and other machinery for Australia is more important in the context of the cotton production system.

"This research is limited to on-farm energy use, excluding ginning, drying and other off-farm activities. In a future version of this software, EnergyCalc could have the capacity to extract data from existing electronic farm records.

"We believe this concept is potentially applicable to other Australian agricultural industries so that in the future this tool should be modified and extended to other agricultural sectors and other energy end uses. This is particularly important if the Australian Government wishes to achieve the overall target of emissions cuts of 25 to 40 per cent by 2020.

"It would also be useful if this tool is further developed and integrated into an overall suite of environmental assessment tools or star-rating tools for the agriculture sector, to promote awareness, and practical and cultural changes," Craig said.

**For further information, contact Dr Guangnan Chen or Craig Baillie at the National Centre for Engineering in Agriculture (NCEA), University of Southern Queensland (USQ).
Email: chengn@usq.edu.au or bailliec@usq.edu.au. Telephone (07) 4631 2518 or 4631 2071.**