

Sugar research for a profitable industry

CSIRO Plant Industry



Sugarcane is grown primarily in concentrated areas from far north Queensland to northern NSW and is a major export crop for Australia. By developing new sugarcane varieties with higher yields CSIRO Plant Industry hopes to improve the efficiency of the sugar industry, so it can compete more effectively in the global market. It also aims to develop alternative products to open up new markets.

Working closely with BSES Limited, in a formal Joint Venture for Sugarcane Improvement, and through the Cooperative Research Centre for Sugar Industry Innovation through Biotechnology (CRC SIIB), CSIRO Plant Industry is well placed to deliver on these aims.

Harnessing the genetic diversity in mild sugarcanes

Modern commercial sugarcane varieties are mostly derived from two species. One, the 'original sugarcane' (*Saccharum officinarum*), has brought the genes for high sugar content. The other, a wild relative of sugarcane (*Saccharum spontaneum*), provides hardiness to harsh environments and the ability to ratoon or produce additional profitable crops from re-growth after harvest.



Australia is a major exporter of raw sugar. CSIRO Plant Industry research aims to improve sugarcane yields.

Sugar research highlights

- With CSR Ltd and BSES bred and commercially released KQ228 - a high yielding smut resistant sugarcane variety
- With BSES improved the efficiency of how new sugarcane varieties are selected
- Developed the most comprehensive map of the sugarcane genome to identify useful genes
- Identified DNA markers for smut resistance, now under evaluation for use in the breeding program to help speed up the delivery of resistant varieties
- Developed new ways to identify genes that are active in high sucrose genotypes
- With CRC SIIB, discovered a new way of storing products in sugarcane
- Providing information about the reproductive biology of sugarcane in the field, to aid decision making by the Office of the Gene Technology Regulator

There are however many varieties of these two species, and other related species that may be crossed with sugarcane, that have not yet been used in sugarcane breeding programs. These species are expected to provide a rich source of untapped genes for sugarcane breeding programs and may provide beneficial traits to cultivated sugarcane. These have not been used much in commercial sugarcane varieties as it is very difficult to incorporate only their favourable traits because negative traits are always incorporated in the first instance, too.

CSIRO Plant Industry is now evaluating material produced in collaboration with BSES and research institutes in China. The aim is to identify their favourable characteristics and genes. More importantly we need to find out how these can be incorporated into commercial sugarcane varieties whilst excluding the unfavourable ones.

One way this is being done is by developing DNA markers that flag the presence and location of useful and detrimental genes. This will also help sugarcane breeders isolate favourable genes from unfavourable ones.

Scientists have identified a number of DNA markers for smut resistance and high sugar content and are now testing their reliability.

Increasing sugar accumulation in sugarcane

Sucrose, or sugar, is produced from carbon dioxide and sunlight by sugarcane leaves and transported to the storage tissue in the stem. Sugar is ultimately extracted from this stem storage tissue at the sugar mill.

There are a number of steps that the plant goes through to transport sucrose to the storage tissue. CSIRO Plant Industry, within CRC SIIB, is investigating these steps by altering the rate of transport and studying the unique features of the storage tissue that allows very high concentrations of sucrose to be stored. We have, for example, discovered new ways of sending proteins to the storage tissue by identifying signals within the protein sequence. By understanding the steps of this process CSIRO Plant Industry aims to increase the amount of sucrose the plant can transport and store.

Aside from sucrose production, sugarcane also has the potential to produce a range of other compounds that can be used for food or industrial applications. A greater understanding of the transport and storage process for sucrose will also underpin the ability to enhance the production of these compounds that have a greater value than sucrose.

Genetically modified sugarcane

CSIRO Plant Industry with BSES and CRC SIIB is making experimental genetically modified (GM) sugarcane plants to test the effects of altering genes that regulate how sucrose is transported and stored in sugarcane. The results may highlight what can be done to increase sucrose content.

Currently there is no GM sugarcane commercially available in Australia but this research could lead to potential GM varieties. If GM sugarcane is considered as a commercial option, varieties will be developed in close consultation with the industry, in consideration of consumers and with the approval of the Office of the Gene Technology Regulator, which ensures GM plants are safe for humans and the environment.

CSIRO Plant Industry is conducting research to ensure that GM sugarcane would be released without any detrimental environmental effects.

Sugarcane for energy production

In the future, the fibre in sugarcane may be increasingly used for renewable energy production. This would be achieved by burning the fibre to generate electricity, or by converting it to ethanol, though fermentation.

CSIRO Plant Industry is currently considering options for developing varieties that produce high biomass levels with high yields of both sucrose and fibre to meet these emerging opportunities. Some hybrid varieties derived from crossing sugarcane with wild relatives could be particularly suitable for these production systems.

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