Suitable Biomass for a **Sustainable Sugarcane** Industry

UPDATE 1: Project overview

Background

Two of the main issues facing the Far Northern Milling company are inadequate feedstock supply and poor extraction of the full potential value in the feedstock. Any successful business model for a biomass dependent industry must be based on a 'zero wastage' policy and extraction of maximum economic value from the biomass.

The three major impediments for realising this objective at Mossman Australia are firstly the inadequate information on best varieties for tropical conditions. At best the current variety profile for Mossman reflects optimisation of feedstock for sucrose only production. Secondly, a total lack of information regarding the biomass composition, other than sucrose and fibre. Thirdly, the lack of diversification and adding value to bagasse and molasses he three major impediments for realising this objective at Mossman Australia are firstly the inadequate information on best varieties for tropical conditions. At best the current variety profile for Mossman reflects optimisation of feedstock for sucrose only production. Secondly, a total lack of information regarding the biomass composition, other than sucrose and fibre. Thirdly, the lack of diversification and adding value to bagasse and molasses.

Sugarcane is a significant component of the economy of tropical and subtropical Australia. The continuous pressure of low international market prices for sucrose necessitates a dedicated effort to find alternative and additional revenue streams from the sugarcane biomass.

This objectives of the project are to identify genotypes that could contribute to increased total biomass production per unit land area. Preference will be given to high biomass genotypes that could retain as close as possible the current sucrose production but increase the total bagasse and molasses. Do a comprehensive chemical analysis to identify potential ways to add value to the fibre, molasses and tops.

During the project we will evaluate biomass production from a range of commercial and near commercial varieties, and energy canes. These trials covered the Mossman and Tableland production conditions. A few sweet Sorghum genotypes will also

In this update

"The lack of knowledge and diversification options are major constraints for a prosperous and sustainable future"

"We need to break the traditional mould to select varieties for only sucrose production from the sugarcane stem. Achieving biomass yield gains and high sucrose content in sugarcane are opposing objectives"

"Any business model without adequate information about the quantity and quality of the feedstock is bound to fail"

be evaluated for their potential to ensure year-long feedstock supply to the Mossman mill.

Biomass opportunities

With mounting pressure to move away from fossil fuels to reduce global warming and environmental pollution new opportunities are being created to develop a sustainable biomass-based economy. A biomass based economy has a huge potential to generate jobs . However, to unlock these opportunities we will require entrepreneurship and innovation. The opportunities are linked to full utilisation of hemicellulose and lignin, sugar conversion to different high-value products, improved low cost biomass pretreatment technologies, more efficient fermentation technologies and a better understanding of crop chemical composition.

The Mossman Mill will remain highly dependent on sugarcane production. However, the current sugarcane production systems only deliver biomass to the processing facilities for approximately 6 months in the year. It would not be possible to create a sustainable biomass industry in such an environment of feedstock supply. The solution probably is in either modification to the length of the growing season of sugarcane or supplementation of the sugarcane supply with another non-sugarcane source that expresses the same high-value product.

Sugarcane

Sugar accumulation and growth

Sugarcane is renowned for its high biomass yield. This extraordinary high yield and well-established farming and processing technologies make sugarcane a leading candidate for bioenergy production and suitable feedstock for bio-refineries. The crop age and development stage of the crop are key drivers of profitable sugarcane production. Sucrose accumulation in sugarcane only occurs after a period of growth and expansion.

It should be evident from diagram (Fig. 1) that the faster the growth, and/or the higher the maintenance respiration component the less sucrose will be accumulated. In addition, because growth and maintenance respiration require sucrose to be broken down to glucose and fructose, the purity of the juice will be poor.

"A truly sustainable Mossman mill will be dependent on adequate feedstock supply and most likely will require supplementary plant material to ensure optimal infrastructure utilisation".

"As Energycanes will always have a higher and longer growth period it follows that it will have lower sucrose levels and poor juice purity than conventional sugarcane varieties"

Figure 1: *Sucrose is the lonk between photosynthesis , growth and cellular maintenance*

Germplasm

Fifteen sugarcane genotypes obtained from Sugar Research Australia (Table 1) are included in the trials at Mossman and Atherton Tablelands in Northern Queensland. These included 6 current commercial varieties and 9 non-commercial genotypes. At the Tablelands site SRA26 is included in the genotype mix. SRA 26 which was released to the industry in 2019 forms part of the trials. The trials were planted in a completely randomised design including three replicate plots per treatment. Each replicate consists of 4 x 10 meters of cane. Billets obtained from disease-free stalks, were used as planting material.

TABLE 1: *Sugarcane genotypes included in the field trials in Mossman and Tablelands*

Genotype	TYPE[1]	Parents		TCH[2]	Location	
		Female	Male	%	Mossman	Tablelands
WSRA24	Comm	QN80-3425	BN61-1123	30.864	Yes	Yes
QN13-609	Exp	Q256	SRA14	29.848	Yes	Yes
QS09-8404	Exp	QN80-3425	QN86-2168	16	Yes	Yes
QS10-7123	Exp	Q170	Q232	13.487288	Yes	Yes
QS10-8770	Exp	QN95-288	QN89-109	13.06465	Yes	Yes
QS07-9185	Exp	QN96-1017	QC83-627	9.50945	Yes	Yes
QN12-512	Exp	QN84-2969	QC90-353	8.741375	Yes	Yes
SRA26	Exp	QN97-2122	Q146	8.4033	No	Yes
QS09-8348	Exp	QN80-3425	Q170	7.1	Yes	Yes
QN13-173	Exp	Q183	Q232	6.738	Yes	Yes
QS08-8662	Exp	QC90-289	Q205	6	Yes	Yes
QN12-520	Exp	QC83-625	CP88-1540	5.957175	Yes	No
QS08-7370	Exp	QC84-620	QN91-3322	5.652275	Yes	Yes
KQ228	Comm	QN80-3425	CP74-2005	*	No	Yes
Q200	Comm	QN63-1700	QN66-2008	*	Yes	No
Q208	Comm	Q135	QN61-1232	*	Yes	Yes
Q240	Comm	QN81-289	SP78-3137	*	Yes	Yes

[1] Comm= commercial variety, Exp = non-commercial clones from SRA

[2] Difference in tonne cane ha^{-1} (TCH) versus commercial standards

The Mossman trial was established at the Mango Park Cane Farm Company, Farm number: 5185 (16°28'38.16"S 145°20'59.16"E). The clones were planted on 2 September 2020. The Tablelands trial was established at the Salvetti Farming Company, Farm number: 6207 (17°6’8”S 145°20’28”E). The clones were planted on 28 August 2020. The project will evaluate these genotypes over a plant and two ratoon crops.

‘Some of the experimental clones in these trials hold much promise to significantly increase the total biomass delivery in the FNM production area”

“Unfortunately, due to late project approval, the trials were planted late in the season. “

Sorghum

Sorghum is potentially a crop that can be used to supplement the biomass supply to the Mossman mill. Sorghum is an adaptable and multi-purpose crop from Africa with numerous applications to use the grains as food, leaves for feed, bagasse for fibre, and sugary juice for fuel. It is cultivated all over the world in tropical, semi-tropical, and semiarid tropical regions.

Its high rate of photosynthesis, resistance to water and nutrients deficiencies makes it an attractive biomass crop.

Sweet sorghum, like sugarcane, produces a high sugar concentration in the culm/stalk. The juice contains a mixture of sugars, namely, sucrose, glucose, and fructose. The sugar juice is well suited for direct fermentation to first-generation biofuel. The bagasse

"Sorghum (Sorghum bicolor L. Moench) has gained interest as a dedicated bioenergy crop due to its ability to accumulate large amounts of aboveground biomass even in sub-optimal conditions"

can be used as fodder or heat generation by burning or raw material for the production of second-generation biofuels after pretreatment.

The sorghum trials will primarily be conducted at Arriga on Singh Farming Pty Ltd ATF Singh Farming Business enterprise Trust, Farm 6208 (17°2'20"S 145°20'59.16"E). These trials will include five sorghum genotypes (Dynasweet, Megasweet, SE19, SE45 and SK106).

Anticipated project outputs

Because of the diverse range of germplasm, this project will establish to what extent the current biomass shortfall can be corrected with germplasm available in Australia. The analyses will deliver a comprehensive inventory of the properties of each genotype. This will indicate which varieties are best suited to produce sucrose or any of the chemicals present in the germplasm. In addition, the inclusion of some sorghum trials will provide and inventory of the biomass potential and chemical composition of the material.

The database that will result from this project will provide information about:

- Total biomass potential
- Total sucrose and fibre content
- Fermentation potential (expressed as litres ethanol) from both the water solubles and the lignocellulosic fractions. These numbers will consider five different fermentation/conversion technologies
- The biomethane potential (BMP) which will include data on total solids and volatile solids and biogas composition.
- A catalogue of all the biochemicals present in levels higher than 0.5% of total biomass.

All this information will used to at the highest level assign an economic value to each of the biomass components. Currently we assign an economic value to sugarcane purely based on its sucrose load and some penalties for high fibre and non-sucrose. It would be an interesting starting point to assign an economic value to each genotype based on total biomass and biomass composition. For the solubles purely a total $ value per ton of biomass. For the insolubles (bagasse) a value will be based on electricity generation, ethanol fermentation or simply anaerobic digestion. For the genotypes at the extreme ends of the spectrum we will look at their potential under different production combinations.

- Just sucrose and molasses
- Sucrose, molasses and electricity
- Sucrose, molasses and anaerobic digestion of surplus bagasse

Figure 2: *Sorghum (variety Megasweet) 70 days after planting*

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