Sugar Beet in South Eastern Australia

A high level economic and environmental feasibility study exploring the potential for a greenfield process sugar beet industry

A report for

By Robert Arvier

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Executive Summary

This report explores the economic and environmental feasibility of the potential re-establishment of a southern sugar industry in Tasmania and/or Victoria, Australia.

Sugar in Australia is currently 100% derived from the sugarcane plant (Saccharum officinarum) and has been this way for the last 70 years. Prior to this there was also a sizeable sugar beet (Beta vulgaris subsp. vulgaris convar. vulgaris var. altissima) industry located in eastern Gippsland, Victoria, which produced sugar for local manufacturing for some 54 years (McCole et. al., 1985).

Australia as a nation has a long and proud history of manufacturing high-quality sugar dating back to 1862 (ASHC, 2018). In this time, many innovative technologies developed here have gone on to become best practice and adopted globally such as mechanised sugarcane harvester design (NewsMail, 2013). This appetite for continuous improvement and research and development led to Australia becoming the most efficient producer of sucrose from a land use perspective for many years. Additionally, the yield improvements gave Australia a competitive advantage on the global market with an offering of high-quality and high volumes of raw sugar all while maintaining enviable cost of production figures.

More recently Chile has overtaken Australia as the most efficient producer of sugar. However, production efficiency and financial economics are not the only motivations for this investigation. During this research, the author also found that there are potential lower investment options to be considered in the short to medium term such as seed and fodder production. A key finding of this industry report is that a staged approach to industry development and investment will be key to success.

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Foreword

The concept for the topic of sugar beet and industry revitalisation came about through discussions with industry advisor Anthony Kennedy in the Victorian Department of Economic Development, when discussing the environmental challenges of industrial sugar production. This led to the initial investigation into the previous industry in Maffra, Gippsland (Victoria) which has been dormant for some 70 years.

Since then, the concept has changed substantially to focus on the production efficiency and sustainability more holistically to fit with community and producer expectations moving into the future. One of the key influences for this is Agricultural Economist Catherine Kling, at Iowa State University who's research is centred around determining the full cost of the agricultural supply chain and providing consumer transparency. *'Increasingly, government officials and economists are trying to put a number on ecological production cost. What is the price of soil in the Everglades? Or river water in Colorado. That price, if we could agree on it, might help all of us decide which food comes at a cost that we're not willing to pay*.' (Kling, 2016) '*In an ideal world, we would include the cost into a decision of where to produce, and how much to produce*,' she says.

The conversation in many regions globally is already more advanced that simply measuring Carbon dioxide (CO2) equivalent in emissions. Unfortunately, in Australia we have a lot of catching up to do for a variety of reasons. Kling (2016) admits that this is not easy. It forces economists to be inventive. They have studied how much further people are willing to drive to visit a pristine ecosystem versus a polluted one, for instance. That is a measure of how much they value it.

As such, the intended target audience of this report is quite diverse:

- Primary producers.
- Industry groups.
- Industrial sugar consumers.
- Local sugar processors (Cane refining and milling).
- European processors (Beet refining).
- Local, state and federal policymakers.
- Conservationists.

The entire premise of this report is based on 'lowest community cost' of production; that is taking into consideration all aspects of the value chain whether they be economic or environmental indicators and tangible or intangible. The conversation is not about sugarcane versus sugar beet versus corn versus wheat starch, but rather sustainable production and appropriate land, energy and water resource usage.

Figure 1: The Author, South-Eastern Australia 2017

Acknowledgments

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Abbreviations

ANZ	Australia and New Zealand
APAC	Asia Pacific Region
BoM	Bureau of Meteorology
CAPEX	Capital Expenditure
CO2	Carbon Dioxide
COP	Cost of Production
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSR	Colonial Sugar Refineries
CSR	Corporate Social Responsibility
DPIWE	Tasmanian Department of Primary Industries, Water and Environment
EU	European Union
FNQ	Far North Queensland
FOREX	Foreign Exchange Rate
GBR	Great Barrier Reef
ICE	Intercontinental Exchange
LGC	Large Scale Generation Certificates
NSW:	New South Wales
NUE	Nitrogen Use Efficiency
NYSE	New York Stock Exchange
OPEX	Operational Expenditure
SE	South East
Tas	Tasmania
Vic	Victoria
UNFAO	Food and Agricultural Organisation of the United Nations
UNGA	United Nations General Assembly
WBS	Work breakdown structure

Objectives

Localised objectives

A strong focus on a regional strategic plan will be required for a project of this magnitude to be successful. It is likely that a collaborative investment and operation model would be the preferred method not only between stakeholders but also state governments – this is due to sheer scale of such an industry. These objectives are essential for a sugar beet operation to justify its position in the market due to the relative scale of existing production when compared with close neighbouring markets of FNQ, Pacific Islands, SE Asia and even Brazil. All objectives must align with the overall vision of improving the sustainability of the supply chain from seed to consumption. It is not about replacing or competing on raw commodity price as this strategy is unlikely to be successful. Objectives listed are specific to a SE Australian production site and are ranked in order of significance in the overall strategic plan. This report will focus on the first four objectives due to the broad scope of a full agribusiness plan for SE Australia, however it is important to understand the wider requirements in this process.

Primary

- Compare the key sugar beet growing regions globally with Australian examples.
- Investigate the impact of sugar production on the landscape and industry best practice.
- Define the current status of global marketplace relative to sugar.
- Develop an indicative work breakdown structure for a sugar beet production facility in SE Australia.

Secondary

1. Investigate 100% reuse of sugar beet co-products into saleable fertiliser, stock feed or bio-energy (gas + CoGen) by investing alongside any primary processing facility.

Completion of this objective is essential in meeting any new Corporate Social Responsibility (CSR) goals of zero net effect on natural ecosystems, municipal wastewater treatment, landfill and community expectation.

2. Develop new and diverse markets for products manufactured from co-products to ensure continual demand regardless of season. This will include looking to opportunities outside the agricultural space.

Conversion of co-products will achieve the primary goal of waste elimination. However, it will be essential to secure markets for the products manufactured by any new treatment facility. This objective could take more than five years to implement.

3. Investigate the potential for co-location with other complimentary processing facilities.

On the supply side, co-location with a large confectionary business would further reduce costs for both parties. On the other hand. co-location on a large commercial dairy could provide a ready market for beet pulp.

4. Position SE Australia as an accessible base for variety research related activities in the Asia Pacific Region (APAC) region by encouraging collaboration with key genetics and crop protection companies through resource sharing.

Currently there is no regional base for activities in the APAC for beet research despite previous efforts and commercial willingness. This is due in part to geographical isolation from the European Union (EU) where the most relevant industry leaders are located. SE Australia is well placed to develop this position as result of national agricultural development in recent times, concentration of research institutions and market potential.

Chapter 1: Current Domestic Industry Status and CSR Impact

The Circular Agri-Economy

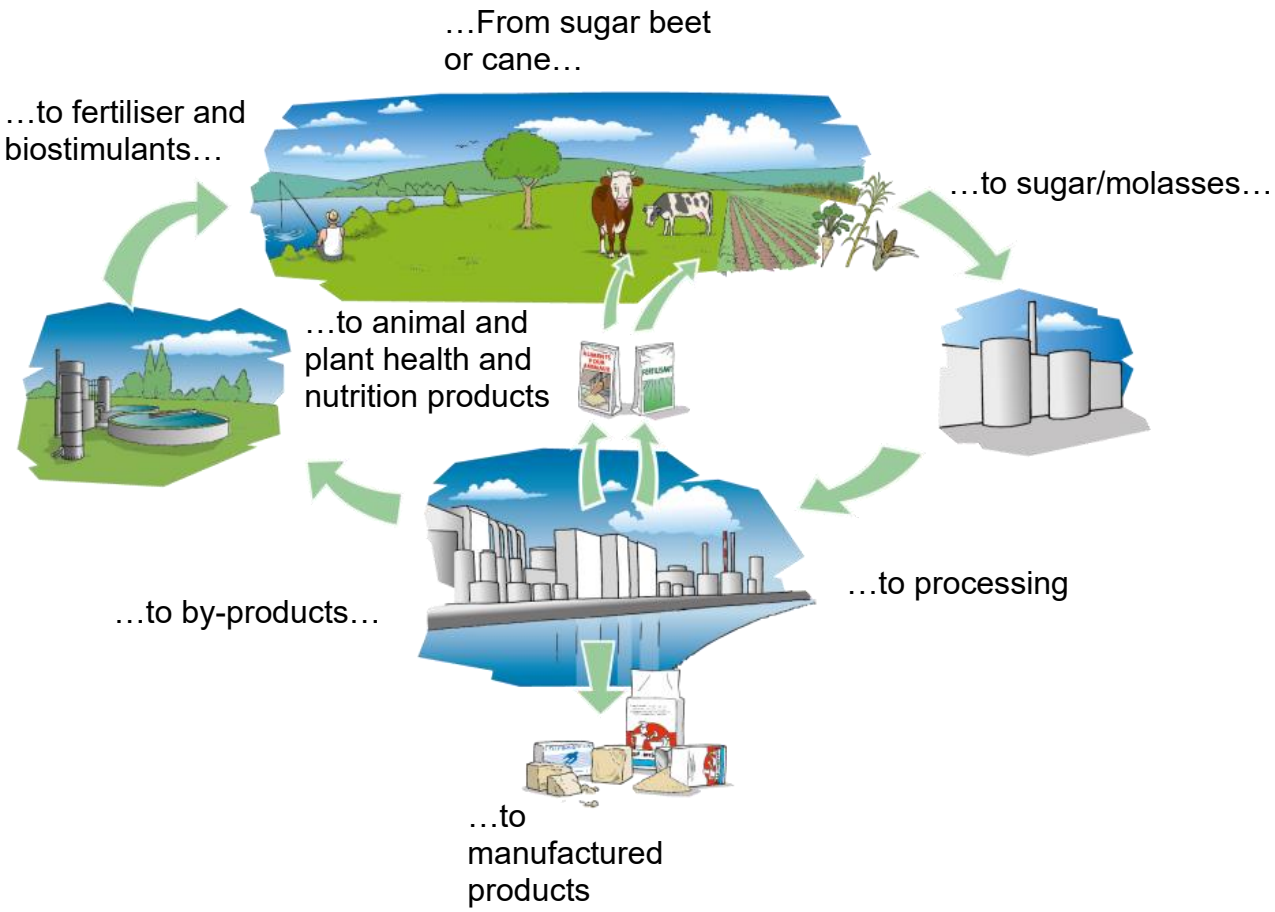


Figure 2: Product cycle explained - A visual representation example of a circular economy goal of Agri-commodities, not limited to only sugar (Source: Author)

Australian Sugar Production

Sugar production in Australia is now almost exclusively sourced from the sugarcane plant although there is some production of maltose and glucose sugars from wheat starch in northern New South Wales (NSW). Sugar is an important source of bio energy both in the human diet, manufacturing/process and as an alternative to hydrocarbon or dispatch-able fuels (Sugar Australia, 2016).

Historically cane sugar has been the staple for sugar substrate production in Australia due to the favourable climate of the tropical mid north coast of NSW to FNQ, however until the mid to late 1930's there was a well-established sugar beet industry in Eastern Victoria (Dobson, 1935).

Figure 3: Current sugarcane industry assets and geographical spread, the only missing asset is the Chelsea refinery in Auckland, owned and operated by Wilmar Australia (ASMC, 2017 & QSL, 2017)

The Australian sugar industry is primarily located in FNQ between Mossman and Mackay and is widely considered to be one of the most productive and efficient sugar growing regions globally. This is due to the favourable climate and soils types found in the region which are ideal for the commercial cultivation of the C4 (grass) plant; sugarcane (Saccharum officinarum). It is also an economically significant commodity in Australia as a vertically integrated industry and net exporter of finished and raw product (Sugar Australia, 2016). In 2011, Australian sugar exports exceeded $2 billion in industry value (ASMC, 2015) with the majority value captured by downstream processing and refining. Australian sugar is seen as a high-quality product with a very transparent production process comparative to other producers in the APAC region and beyond. This coupled with high yield efficiencies make Australian cane sugar very competitive on the world markets often fetching a premium on top of the ICE#11 futures market pricing (Queensland Sugar Limited, 2015).

Sugarcane and the environment

Climate change and associated variation in traditional weather patterns will have an increasing relevance to the Australian sugar industry, and FNQ in particular. This is not a new or unexpected projection given that there are very few places globally that are not facing changes to their agricultural production methods due to climate variability. The focus on this region is intentional as FNQ currently produces a majority of Australia's sugar (~90%) is produced in this region and the latitude of the region is such that many of the projected changes will be more pronounced here. Additionally, the effects of climate change are felt in a number of areas with proximity to the Great Barrier Reef (GBR) being of relevance to the majority of the general FNQ population.

Greenhouse gas (GHG) emissions during sugarcane production can be between 1,824 and 2,231 kg CO2eq. Ha (Acreche & Valeiro, 2013) where no mitigation practices are in place. This is considered to be a reasonably emission intensive industry when compared to other sucrose producing crops which is why adaptation alone is simply not enough for this industry.

Projected impacts

The sugarcane industry is mainly located on coastal floodplains (Stokes and Howden, 2010), the combination of sea level rise with increased storm and cyclone intensity will significantly increase the likelihood of inundation, damage to industry infrastructure, and soil erosion and nutrient loss from cane paddocks (Park et. Al., 2008). This impact along has the potential to be devastating for production in FNQ as there is little production in the Atherton Tablelands by comparison. Increasing flood events and potential sea level rise will prove especially detrimental for ongoing soil health and nutrition. Aside from flooding inundation which is quite a unique risk to this industry in the FNQ region there are also the common factors expected along the Eastern Seaboard that are outlined below. Increasing temperatures themselves will not be of a concern in the short to medium term as this species being a C4 plant (grass family) is extremely resilient to climate variability compared to other cropping options in the region provided irrigation water availability is maintained.

Since 2007 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BoM) climate models suggest that the future climate of Eastern Australia, including FNQ will include:

- Lower average rainfall;
- Increasing concentration of atmospheric carbon dioxide;

- Increasing frequency and periods of drought;
- More intense extreme rainfall events;
- Higher sea-level and storm surge events;
- Higher average temperatures;
- More frequent occurrence of extreme temperatures, and
- More frequent extreme fire danger days

Additionally, El Niño events are predicted to becoming drier and La Niña events becoming wetter (CSIRO and BoM, 2007) which will further exacerbate the conditions outlined above.

Indirect and social considerations include:

- GBR and tourism
- Monoculture and soil health
- Traditional farming culture of FNQ
- Foreign ownership

Indirect threats/challenges include:

- Competition with the coal industry for rail capacity
- Irrigation water storage alternatives and ground water

Adaptation to likely impacts

Flooding of river plains and sea level rise are projected to be the most detrimental aspects of climate impact on the sugar industry of FNQ. Unfortunately, on a local level there is not a lot that can be practically achieved to adapt as the crop is already grown on raised beds to aid free drainage around the root system. Physical barriers can be considered where pragmatic to do so along rivers that have low peaks but widespread flood waters however benefit/cost must be considered with such a macro effect like frequent flooding. When this is coupled with the prospect of temperature increases there is a strong argument for the partial relocation of the industry to more suitable land in the medium to long term even if this is simply to mitigate seasonal risk with increased variability. Somewhat ironically Park et al. 2007 identifies that another key adaptation required is the management of 'scarce' water resources.

The industry has traditionally been one of a monoculture due to the relatively effective pest and disease control in grass species such as cane which is further compounded by limited compatible rotation crops in the region. In contrast to the 'southern' cane growing regions between Bundaberg and Northern NSW where there are more suitable rotation crops.

However there has been promising work completed by the Bureau of Sugar Experimental Stations and QLD DPI on the economic and environmental benefits of legume-based rotations and controlled traffic. This work is directly in response to direct action on climate variability and indirectly in response to community expectation on nitrogen leaching and its effect on the GBR.

The degree of climate change impact on sugarcane is associated with geographic location and adaptive capacity (Zhao & Yang-Rui, 2015) which are two very key aspects to consider when evaluating the sugar industry in Australia and in particular the region of FNQ. The majority of production in this region is in low lying river valleys and flats which are usually not considerably higher than sea level. With sea levels expected to rise by 18 to 59 cm by the end of this century due solely to the thermal expansion of the world's oceans (Park et. Al., 2008) this is especially topical. From an adaptation standpoint the Australian industry is well resourced to investigate and react to increased climatic variability as there is an abundance of support systems in place comparatively to other nations facing the same threats to their business model from climate change.

Sea level rise is still a contentious issue and the estimates suggested by Park et. Al 2008 do not include additional rises resulting from the rapid disintegration of polar ice sheets. This is due to a lack of consensus among the IPCC on the likely scale and timing of ice melt (Park et. Al., 2008) which remains unresolved in 2016. The sugar industry remains reserved in their position on sea level rise opting for the lower estimations in extension communications which is disappointing given this is the most detrimental of the potential impacts facing the industry. It must be noted that the traditional position adopted by the sugar industry is not unique in an agricultural sense with the climate message being echoed by many other agronomic commodities and even state-wide advocacy groups. This has led to interest from non-government organisations (NGO's) like the World Wildlife Fund and 'Bonsucro' taking an altruistic view and private companies such as Coca Cola Amatil wanting to do similar or boost their CSR profile. These three entities have assumed a role in the education of farmers and mills along the value chain to drive change in the industry. This has been positive regardless of the motivations as Bonsucro in particular is issuing accreditation that is now internationally recognised for sustainability in the production systems of sugarcane farming.

The sugar industry must not only look at altering the current model of production to suit climate variability but consider ways in which to future proof the industry as a whole and not

just focus on specific regions. For example, looking to alternative crops capable of sugar synthesis that satisfy market demand and ever relevant social expectations. Examples include:

- Sugar beet (sucrose)
- Corn (fructose)
- Starches (maltose, glucose and dextrose)

By looking to diversify into alternative crops and regions the cane industry can not only emulate what is already being investigated in the wine grape industry but take it one step further as simple sugars are not synthesised by one plant species. The Manildra Group in NSW is already operating a starch plant in conjunction with part ownership of the Harwood Sugar Mill in Northern Rivers as part of their diversification policy.

Furthermore, there are exciting advancements in breeding in traditional cultivars of plants like sugar beet. Sugar beet is of particular interest as an alternative as it uses 50% less water than sugarcane from sowing to harvest to produce the same volume of sugar (Klenk et. Al. 2012), this factor alone justifies investigation as a possible diversification strategy in a southern climate. Additionally, the land usage requirement is lower with beet using 50% of the arable land required to produce the equivalent volume of sugar with the same (Klenk et. Al. 2012).

Aside from beets there are breeding advancements in emerging plant varieties such as sweet sorghum which will potentially outperform all existing sources of plant produced sucrose.

Mitigation strategies

Historically mitigation in the sugar industry of FNQ has been incremental by necessity rather than design. The environmental advances that have eventuated in the commercial cultivation of cane sugar ever since the inception of mechanised harvesting of 'green' cane. Prior to this it was standard practice to burn sugarcane pre harvest in FNQ, but incomplete burns were common, due to the lush condition of the crop and the occurrence of weeds (Arvier, 1965). This would lead to much heavier emissions than otherwise necessary. Early advances included the used of desiccant herbicides around the perimeter of the field to ensure that cleaner burn could be achieved although this focus was primarily to avoid yield penalties at the mill from foreign plant material (Arvier, 1970) it still achieved environmental outcomes. Once mechanised harvesting became the norm it was not long before machinery manufacturers released machines capable of harvesting green cane with the same efficiency as burnt or desiccated cane.

Unfortunately burning of cane fields is still practiced in some of the southern growing districts (Stokes & Howden, 2010) to improve harvesting efficiencies due to aging machinery and lack of investment in updating equipment to industry best practice. There needs to be an investigation into the root causes to ensure there is not market failure occurring which prevents farmers from having the funds available to invest in industry best practice. If it is simple cultural or traditional methods, then the state government must reassess the effectiveness of its local extension program. The southern regions are not only geographically isolated from FNQ but isolated in a market sense as the majority of mills (and refineries) are owned by Wilmar International. Majority foreign investment of the sugar commodity in Australia is somewhat concerning when considering adaptation and mitigation strategies to transition the history as often these groups have the ability to source product from a global pool. This is already demonstrated in the raw sugar imports to the Yarraville refinery in Melbourne where 70-150kT of sugar is imported from Brazil and Mexico (Sugar Australia, 2016). On one hand foreign interest often brings a welcome capital injection which can allow investment into new adaptation technologies but on the other can bring different views and values in the approach to climate variation. However, Australia as nation firmly remains a laggard of the OECD nations ranked the highest globally for emissions per capita (OECD, 2008).

More recently there are many opportunities that are currently being explored by the industry in general with some examples specific to FNQ. These include:

Bagasse burning

This is the practice of burning the waste organic matter at high temperatures to fire steam boilers that generate both steam and electricity over the crushing period. Bagasse is produced when the cane stalks are crushed by rollers to obtain the sugar 'juice'. This mills with Bagasse fired boilers can provide all the required steam and electricity needs for the season and are net exporters of power (ASMC, 2016). It is estimated that the industry returned 500 MwH to the grid in 2014 offsetting 1.5 million tonnes (AMSC, 2016) in carbon emissions by forgoing coal generated electricity.

Ethanol production

Whilst not a new or particularly innovative method to use waste sugar or plant based complex sugars the production of ethanol from molasses by-products reduces the costly transport and marketing associated with this stream. The end product is utilised in the production of 'green' fuel and pharmaceutical grade alcohol.

Vinasse/BioDunder

Linked to the bioethanol plant Vinasse is produced as a by-product of fermentation of molasses in the bioethanol process; essentially less viscous and de-sugarised molasses. Historically this was discharged into the ocean via municipal wastewater treatment plants which was costly and wasteful. CSR ethanol at the time identified the value of this by-product as an agronomic input high in organic nitrogen and potassium and developed a holding facility close to the ethanol distillery. This holding facility is now capable of blending other nutrients to supplement the Vinasse to suit the needs of local cane farmers (Wilmar, 2015) and is essentially cycling nutrients back to the fields they were originally harvested from.

'Sugarcane production relies on the application of large amounts of nitrogen (N) fertiliser. However, application of N in excess of crop needs can lead to loss of N to the environment which can negatively impact ecosystems. This is of particular concern in Australia sugarcane is grown within catchments that drain directly into the World Heritage listed Great Barrier Reef Marine Park.' (Thornburn et. al., 2017)

Carbon dioxide recovery

Also linked to bioethanol there is a currently a project proposal under way to capture waste carbon dioxide from the fermentation process of bioethanol and compress it for use as a refrigerant. Whilst dependant on a market this is an extremely innovative project that will further reduce the impact the sugar industry is having on net emissions in FNQ. The combination of these 'clean energy' processes lessen the overall impact of the cane industry considerably.

Where to next and will beet be accepted?

In summary, the sugar industry of FNQ is not exempt from the projected climate variability that is expected over the next 50 years. This is despite the very favourable growing conditions exhibited by this region currently with a summer dominant rainfall and robust varieties of sugarcane. As discussed C4 plants are especially resilient to climate change and can expect a slight increase in production over the next 30 years as carbon dioxide concentrations increase along with temperature. However as with projected climatic variation along most of the eastern seaboard there will be an increase in the frequency of severe weather events that will impact the commercial production of sugar from cane plants. These include but are not limited to; storm damage, heat stress and flooding of production areas on river plains (Park et. Al. 2008). The sugar industry is already committing resources to adapt to a changing and more variable climate in the future on several levels with a focus on social impacts such

nitrification of the GBR and efficient fertiliser usage. From here the industry needs to quickly transition on a number of fronts to educate growers of the likely impacts on their businesses and how to best manage this. From a bigger picture perspective there should be consideration into future growing districts and even alternative plants such as sugar beet. This is not dissimilar to the trend being displayed in the wine industry currently with producers securing southern land in cooler climates to ensure continued supply of the varieties less tolerant to temperature variability.

Sugar in general does not have an ideal track record historically in terms of impact and sustainability however this is due only in part to traditional crop management practices. It must be understood that pricing volatility and extreme weather events especially in recent years has led to an increase in activities to cut costs such as burning cane prior to harvest to increase yields and reduce machinery costs. It should also be said that beet is certainly not a 'low impact' crop and the conversation should focus on regional suitability.

Sugar and health

Whilst beyond the scope of this report the impact of sugar on human health is an active debate and one that is often raised in the context of industry development. The conversation surrounding sugar consumption is gaining traction globally and for good reason with strong linkage to a variety of chronic health conditions associated with poor diet choices. A common misconception of research relating to sugar is that the end game is for market growth and development of volumes. This is a misconception that the industry must take ownership of as many of the media releases link directly to the impact reduced demand or consumption have on farm gate prices. In contrast the focus of reports such as this are to improve the way in which the sector produces and delivers against a pre-existing demand. As companies and peak industry bodies begin to take a greater interest in social licence there will be a shift corporate image. All the same it is little comfort to producers who may be living on the threshold due to pricing volatility which makes it very difficult to focus on anything other than farm gate price.

Chapter 2: Sugar Beet: Observations from a Global Industry

Observations

- Yields of sugar beet in Chile exceeded expectations and documented results published by UNFAO.
- High-scale and quality of sugarcane production in Brazil.
- Opportunities exist for Australia to import sugar and molasses with insulation from the Wilmar controlled markets of Asia with a high level of quality.
- Dat-Agro expanding rapidly in the sugar and agritech space.
- Strong trade willingness toward Australia from EU-28 and Latin American nations.
- Businesses producing their own energy and gas to ensure certainty in production costs in both cane and beet.
- IANSA Sugar Chile acquired by ED&F Man.

The market

The sugar market is one of the most regulated and volatile ag commodities globally which has a substantial impact on producers and processors in Australia due to the export focussed nature of the sector. This is atypical of sugar alone. There have been similarities with the milk price crash and the opposite in natural gas exports and cereals. Ironically, only one year ago the sugar price was so high domestic users were having difficulty sourcing various sugar-based products and syrups due to opportunistic export markets.

Locally the industry struggles with marketing arrangements and industry ownership especially with the rapid rise of Wilmar Singapore. It is a confusing story but growers in Queensland believed that Queensland Sugar Limited should retain the sole responsibility for marketing their sugar 'post processing'. This was all despite the fact the industry had no marketing regulation at the time, in response the Queensland State Government introduced legislation that gave choice to growers in who marketed their sugar – the only options were QSL and Wilmar.

The issue with this approach is that it sets a dangerous precedent for foreign companies investing hundreds of millions worth of capital in domestic industries it also attracted the attention of the Productivity Commission.

‘The Queensland Productivity Commission and the federal Productivity Commission have said the legislation to let sugarcane growers direct how millers market internationally is likely to restrict competition and deter new spending on mills or more innovative marketing and should be repealed’.

These factors do not support the argument against structural changes in the industry or decentralisation of production that would occur under a sugar beet model as the focus is not the export market. Whilst any volume (no matter how small) will displace current supplied volume in some respects the intention would be to long distance imports where possible as these represent the highest potential gains from a carbon accounting perspective. However, some of the younger cane industries in Mexico and Brazil are producing high quality low colour sugar due to recent substantial investment in manufacturing.

At the time of writing, global sugar prices are at an all-time low due to many factors and this is impacting the traditional grower and miller base which are currently receiving less that the cost of production for their end product.

- Government held stocks in India and China
- Subsidies that place a floor in the market price
- De-regulation of the EU-28 sugar market
- Seasonality in overseas markets
- Increases in productivity year on year
- Uncertainty around health and associated taxation

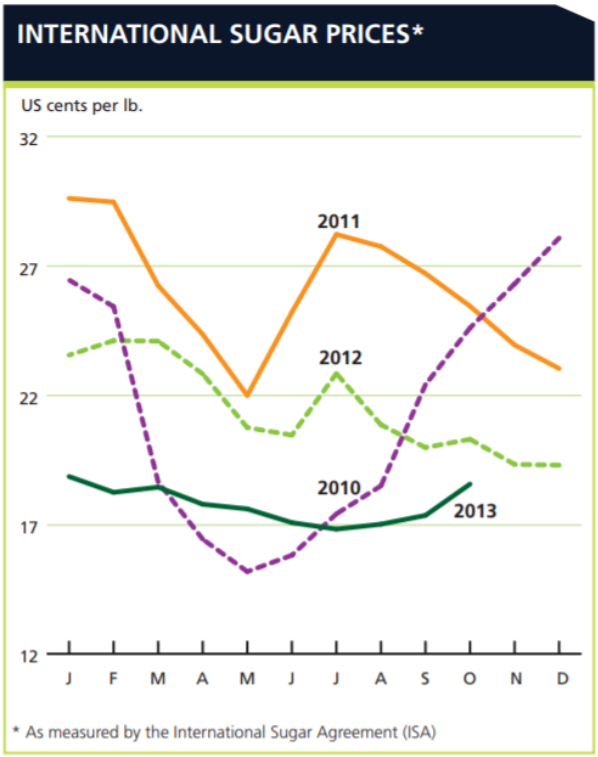


Figure 4: A volatile period in the global sugar market gives support to the removal of subsidies, allowing some nations to 'loss-lead' in the market (Source: International Sugar Agreement)

WORLD SUGAR MARKET AT A GLANCE

	2011/12	2012/13 *estim.*	2013/14 *f'cast*	Change: 2013/14 over 2012/13
		million tonnes		%
WORLD BALANCE				
Production	**175.2**	**179.6**	**180.2**	**0.29**
Trade	**52.5**	**50.4**	**56.7**	**12.49**
Total utilization	**169.8**	**172.1**	**175.4**	**1.93**
Ending stocks	**66.1**	**72.0**	**74.59**	**3.53**
SUPPLY AND DEMAND INDICATORS				
Per caput food consumption:				
World (kg/yr)	24.20	24.35	24.55	0.81
LIFDC (kg/yr)	16.46	16.45	16.76	1.87
World stock-to-use ratio (%)	*38.92*	*41.86*	*42.51*	

ISA DAILY PRICE AVERAGE (US cents/lb)	**2011**	**2012**	**2013** *Jan-Oct*	**Change: Jan-Oct 2013 over Jan-Oct 2012 %**
	26.0	21.5	17.80	-19.03

Figure 5: World sugar market. Most notably is the gap between global sugar consumption per. Capita and that of the low income deficit countries of more than eight kilograms (Source: FAO)

ICE11 – Raw Cane Sugar Futures (USc/lb):

Figure 6: The ICE11 futures market

The ICE11 futures market is the single most important indicator of market health in the global sugar marketplace despite it being only representative of sugarcane derived product. It is the most mobile of the two and that production volumes far exceed that of the other complex carbohydrates (Beet/Corn/Wheat Starch). Somewhat ironically this market is hosted on the New York Stock Exchange in a nation that subsidises it's industry to the tune of $2-4bn USD.

ICE16 – Imported Cane Sugar (USc/lb):

Figure 7: The ICE16 price.

The ICE16 price is important as it is the delivered price for raw sugar and is more reflective of the 'actual' pricing due to the simple fact it has often originated from a less subsidised market.

White Sugar Futures (USD/T):

Figure 8: The White Sugar Futures

The white sugar futures is the combination of all types of crystalline sugar and is where beet meets cane (post refining). Until this point comparison is tricky due to the fact that beet sugar does not require a refining stage in the process. Figure 8 depicts a worrying global downward trend in price over a 24-month period which points at substantial changes in supplied volumes to market and increased domestic supplies in some key export markets.

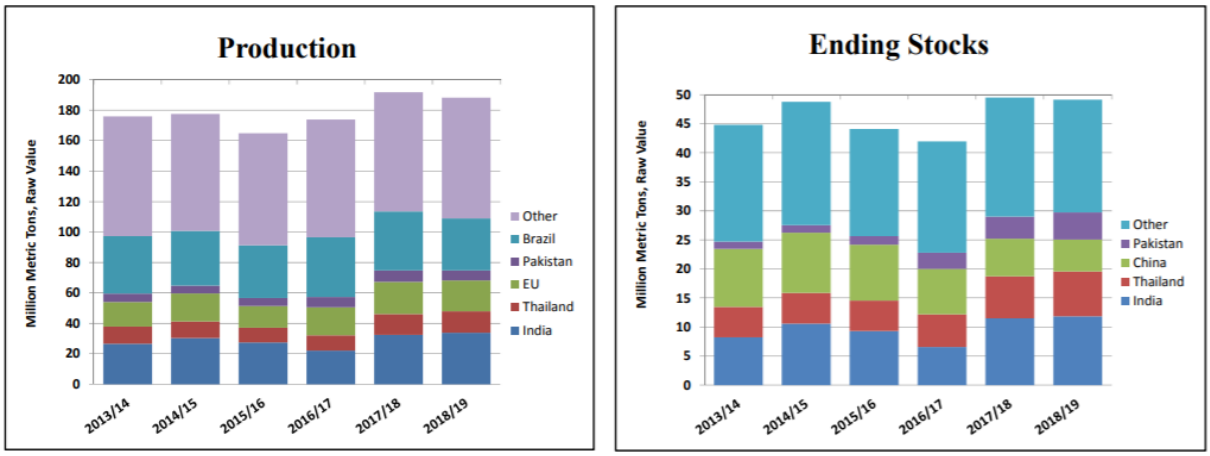


Figure 9: Total global production

Source: http://usda.mannlib.cornell.edu/usda/current/sugar/sugar-05-24-2018.pdf

Total global production is approaching 200 million tonnes and clear increases overall production in India, Thailand, Pakistan and EU-28. An immediate volume correction is projected for 2018/19 however this may not be enough to cover the ramp up we have seen in 2015. Volumes and prices can be very distorted by nations like China who can take swift decisions to purchase state funded 'safety stocks.

Below is an exert from the USDA farm bill guidelines from 2014 when the current subsidies were introduced. An extremely complicated system whereby subsidies are delivered via processors. As an indication the above subsidised price is more than 8c/lb (USD) or above market price which is funded directly by US taxpayers.

> *"The 2014 Farm Bill provides for USDA to make loans available to processors of domestically grown sugarcane and to domestic processors of sugar beets at set loan-rate levels for fiscal years (FY) 2014-18. Loans are taken for a maximum term of 9 months and must be liquidated along with interest charges by the end of the fiscal year in which the loan was made. Unlike most other commodity programs, the sugar program makes loans to processors and not directly to producers. The reason is that sugarcane and sugar beets, being bulky and very perishable, must be processed into sugar before they can be traded and stored. To qualify for loans, processors must agree to provide payments to producers that are proportional to the value of the loan received by the processor for sugar beets and sugarcane delivered by producers. USDA has the authority to establish minimum producer payment amounts.*
>
> *The loans are nonrecourse. When a loan matures, USDA must accept sugar pledged as collateral as payment in full, in lieu of cash repayment of the loan, at the discretion of the processor. "In-process" sugar and syrups must be converted into raw cane or refined beet sugar at no cost to the CCC before being eligible for forfeiture. The processor is not required to notify USDA of the intention to forfeit the sugar under loan. The loan rates for raw cane and beet sugar are set in the 2014 Farm Bill:"*

- The loan rates for FY 2011-18 are 18.75 cents per pound for raw sugar, and
- 24.09 cents per pound for refined beet sugar.

Chile

Perhaps the most interesting and relevant sugar beet industries globally to this report is located in Southern Chile due to:

- One of the newest industries globally relative to the more established industries in Europe and North America.
- Similar growing conditions to SE Australia (Soil type, climate and latitude).
- Non-GMO genetics.

- Highest industry average in yield performance of all forms of sugar production (Sucrose T/Ha).

Sugar beet farms and processors in Chile were the most interesting professionally and from the perspective of SE Australia. The close-knit nature of stakeholders in their supply chain which led to easy access to processing facilities (IANSA) and their most efficient producers. The ability and efficiencies in their industry are in another league to the Australian cane sugar industry and presumably IANSA would have the ability to invest and replicate their model in Australia with little difficulty. One of the more interesting pieces of information gained in Chile is that IANSA was acquired by ED & F Man which is one of the largest sugar traders in the world. It is a UK owned company that is well known in Australia. Language barrier will certainly be a challenge for future visits if wanting to spend time on some of the more traditional farms however this is less relevant as any potential Australian production would need to replicate the scale of the large Chilean producers.

EU-28

This report was quite timely with the EU sugar quotas expiring in October 2017 when the author was in Europe. Whilst not every member state that grows sugar beet is included in the scope of this report a representative cross-section was captured. Ireland gave a 'full circle' view of the positives and pitfalls of the sugar beet industry due to the current status of being a non-producing member state. This situation was created in 2006 when the EU began consolidating production to ensure sustainable unit pricing and smoothing of year-on-year pricing volatility.

United States (US)

The US as it is not only a regulated and subsidised commodity it also utilises Genetically Modified seed in 95% of its commercial production (KWS-SAAT, 2016). Interestingly this does not make the US the most productive sugar producing region due to the climate conditions and shorter seasons they must manage.

General learnings

Aside from the focus on global sugar production and the applicability of sugar beet to SE Australian agri-landscapes a significant proportion of the study period was general in nature. These additional experiences provide depth of understanding of market interaction and global trade. Furthermore, there are often many synergies between management styles and techniques between industries that are completely different.

Brazil

The 2017 Nuffield Contemporary Scholars Conference was held in Brasilia, Brazil, which was interesting from a cultural perspective before investigating rural policy and scale. Brasilia is about the same size as Melbourne and is a lakeside city built specifically as the capital of Brazil. Each continent and every industry had some level of exposure at the conference with many unrelated agri-commodities defining business linkages in places you would not expect.

Leaders in the South American sugar industry such as Gui Nastari from Dat Agro and Paulo Rigolin from Alltech were keynote speakers. He gave a through presentation on the strategic goals and vision of the company which is on track to have $5.6bn USD turnover by mid next year. Their growth has been rapid for a company that only began in 1980. It will be very interesting to see how competitors are planning on addressing some of challenges posed by these very agile businesses.

Farm tours

This took southern cropping regions where sugar is the primary crop and manufacturing industry revolves around refining/milling. This trip ran south from Brasilia to Santos on the coast. These visits incorporated many cropping enterprises that included: sugar, potatoes, carrots, sunflower forestry, corn, coffee, beef, dairy, pork, soya beans and palm oil. Whilst the focus was on businesses that are leading their field there was an impressive integration that most of them exhibited in both directions in the supply chain. For example, one producer faced with exceptionally high heating and energy costs has installed their own carbon neutral biomass boiler which has delivered certainty to this utility cost for the next 20 years with the added benefit of being carbon neutral.

Visits in Uruguay

La Invernada is one of the oldest and largest farms in Uruguay dating back to the family of the first president of Uruguay. Originally over 90,000 Ha the farm is now 16,000 Ha and grows rice, soya beans, pasture, beef, lamb and horses. It has over 12,000 ML of water available each year, mind blowing when compared to Australian examples. The most interesting thing about the family that owns this farm is their linkage to government and influence they have had on developing the region economically given that it is in a very remote location.

Uruguay appears to be a much more stable country than Brazil from an investment perspective with many more ‘western’ operations setting up businesses there. This has been further boosted by the instability of Argentina’s government over the last few years. There is

some talk about Uruguay looking at producing domestic sugar from beet similar to Chile based on the successes they are seeing over the border however it is conceptual at this stage. A revisit to this country would be required if work began in the trial cropping or processing.

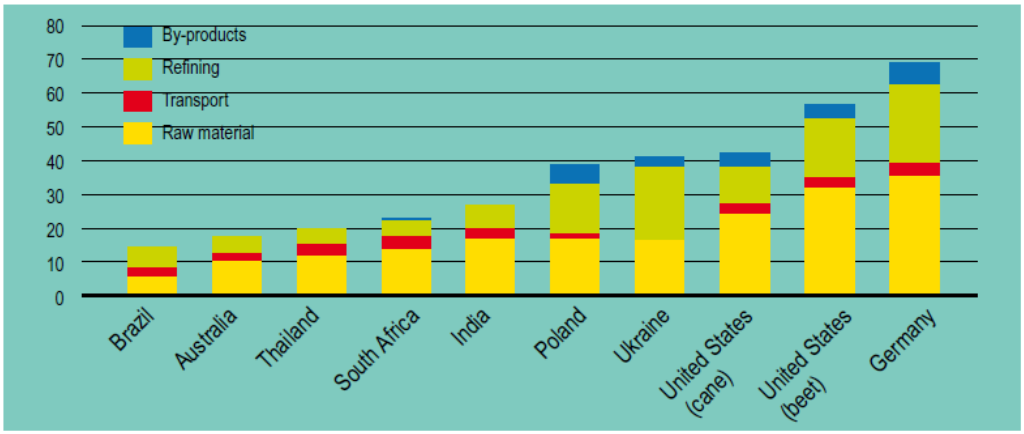
Global Focus Program

The Nuffield 'Global Focus Program' involves travelling in a small group on a structured trip. This trip visited Singapore, Indonesia, Japan, Israel, UK and the US. The focus is global food production and policy with no specific emphasis on sugar production. However, sugar was prevalent in Japan, UK, US and Israel components of the trip.

Chapter 3: Developing a Project for Industry Revitalisation

Processing cost of production

The key contrast between the production of sugar from beet and cane is the 'refining' step. Sugar crystals derived from sugarcane retain colour from the initial processing step whereas in beet they do not. Unfortunately, from an economic and environmental cost perspective it is not this simple – otherwise Australia would already be growing beet. One of the biggest advantages of cane is the use of bagasse as a 'clean energy' fuel discussed earlier in this report. This offsets much of the energy required for processing.



Source: USDA, own data, 1999

Figure 10: Cost of producing sugar across the key production countries, EUR/100kg (Source USDA)

External factors analysis

A SE sugar industry would be in the unique position of developing products that are currently unavailable and out of reach to competitors (EU and South America) due to the high cost of logistics to Australia. However, this sector is not immune from competition as Australian consumers remain fixated on price over impact regardless of the supply chain visibility and relative wealth. This may change with government policy if exportation of environmental impact is taken into consideration or on a local scale limitations of cane production in key Reef Catchment zones. Where businesses find themselves facing higher disposal costs and social responsibility issues in their respective communities the result will quite often be investigations into innovative alternatives. These alternatives must be monitored along with conventional production that are marketed in the same space as underlying fundamental (environmental) value commonly lies with process and story. There is every possibility that

there will be a paradigm shift in the sugarcane industry or another new metabolisation medium (plant based or otherwise) sometime in the future.

Process differential

Figure 11: Sugarcane from crop to finished goods. Sugar Association (2018)

Note in Figure 11 the additional steps of transport to a refinery and the refining process itself. This is key in understanding the 'carbon cycle' of each method of sugar production.

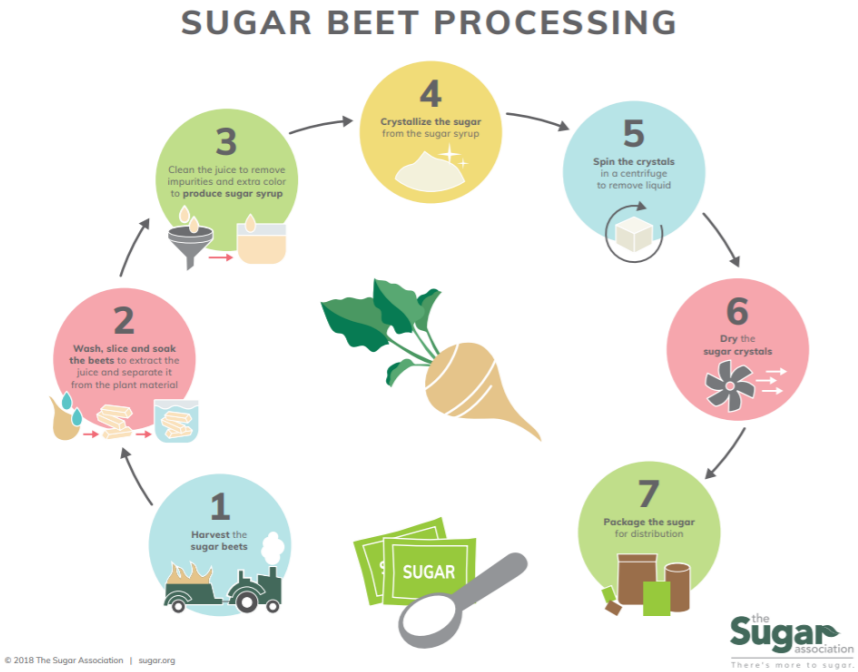


Figure 12: Sugar Beet from crop to finished goods. All processing can take place in one factory rather than two. Sugar Association (2018)

Threat of substitute products

There are already a very well-established sugar and molasses commodity markets in SE Australia with a wide range of products from numerous importers and manufacturers. Given this situation this is a factor that will remain an ongoing threat in a sense that it that is unlikely to disappear in the foreseeable future. However, the proposal is not become a majority player in the existing market but to provide a more sustainable alternative from a resource usage and carbon abatement perspective.

The most manageable aspect of this threat is the price fluctuations that occur due to international market forces in mining, oil and currency. Localised economies can capitalise on this aspect by providing a product that is stable in supply volume and price. There is also the possibility of very low sales prices to match significant global price drops as seen in the sugar market in recent years. It certainty holds substantial value in the markets of today where there are 200% price increases in essential services like energy, due to the product pricing being derived from a globally traded future market on the New York Stock Exchange. Existing substitutes include:

- Domestic cane sugar (Wilmar, MSL, MSF, Sunshine Sugar and Bundaberg Sugar)
- International cane sugar (Brazil, Mexico, Guatemala, Pacific Islands and Thailand)
- Domestic beet sugar (none yet)
- International beet sugar (ED & F Mann or potentially New Zealand)

Supplier bargaining power

This is the strongest and perhaps more unique aspect of the external forces as it is not strictly external being that the starting substrate is supplied by the business itself and is merely transferred to another business unit (from farming to process). Bargaining may become an issue if commodity prices for alternative cropping options increased dramatically due to a spike in demand which would increase residual land prices. The risk of this occurring is quite low due to the levels of waste produced by alternative commodities currently but must be monitored.

One aspect that cannot be ignored under this topic is the current cane producers themselves in Queensland and NSW who currently supply 100% of the national demand and Australian export market. Any partnership that involves a current cane business would put existing

relationships at odds which can be very detrimental in the small world of Australian agribusiness.

By refining the molasses by-product and marketing to large feedlots and feed blending companies, a beet company would ultimately end up competing in the same space as the most substantial suppliers currently. It is essential that this is done in a way that is sympathetic to the activities of existing producers and a partnership is often the most effective way to achieve this.

Client bargaining power

Currently the bargaining power of clients is considerably high. This is due to the large scale of the global market. Additionally, the number of alternative products as mentioned is not insignificant. However historically where this type of strategy has been implemented (in developed nations) the number of alternative markets available in other sectors outside of agriculture gives good sales diversity. This is coupled with the opportunity cost of using 'higher impact' product rather than accounting for impact and emissions. Ultimately if the benefits outweigh costs economically and environmentally this will be considered, and should the project be found to have social/environmental costs higher than the net benefit then production would cease under strict company CSR guidelines on the basis of community cost.

Threat of new entrants

The threat of new entrants is extremely remote as there are only five significant sugar production businesses in Australia; one of which controls the majority of the market in a pseudo monopoly. The more likely scenario is that a new entrant with higher potential energy carbohydrates will emerge suitable for food industries. However, there are barriers to entry in manufacturing product that is in a usable form for existing food-tech infrastructure and sugar beet has the comparative advantage of proven technology and marketing in this area in many regions globally.

Internal factors analysis

This current value chain is a long and complex pathway beginning with sugarcane production in FNQ and ending in confectionary/industrial process products with fertiliser and stockfeed taken out along the way (from co-products). A way to identify resources and capabilities that have the potential for creating competitive advantage for a firm is to engage in value-chain analysis (Barney, 2002) which is true in the current market with cane which will also apply to beet.

Any potential beet industry (food or fodder) will need to extend its current value chain in such a way that it can forward integrate into a variety of new markets in the agricultural space. This will be achieved by identifying local and international strengths and shortcomings. Porter (1985) first described the value chain by describing the pathway by which a product is developed and taken to market is a measure of a firms' available resources.

Fortunately, the existing value chain in comparative markets is one that can be modified due to the nature of the resulting products (sugar/syrup/molasses/pulp). Much of the on-farm infrastructure and transport is pre-existing to support other 'root crops' which will mean there is little reliance on specialised equipment investment outside of the new plant itself. However, there are many areas in need of improvement outlined in the SWOC analysis below.

SWOC analysis

Strengths

- → Strong push from industry and government for sustainable diversification of the sector.
- → >60 years of experience in similar projects.
- → Generational shift in farm ownership.
- → International product support.
- → Relative market isolation when considering supply chain expenditure (especially Tasmania).
- → Increasing resilience in rural communities by creating rotational options.

Weaknesses

- → Cultural challenges and traditional nature of Australian primary producers.
- → Regulatory relationships and new product registrations.
- → Australian research history is limited.
- → Marketing.
- → Reliance on contractors.

Opportunities

- → Focus on sustainable industries.
- → Unique product.
- → Diversified market options.
- → High product demand.
- → Retail possibilities through existing frameworks.

Challenges

- → Seasonal markets.
- → Crop storage.
- → Government compliance and recycled water targets.
- → Transportation.
- → Volatile international sugar market.
- → New Zealand as potential (experienced) market entrant.

Fortunately for any prospective industry player, many points outlined above are shared with direct competitors and potential future competitors as the plan is reliant on specific technology and marketing strategies that are not easily replicated. This presents quite a hurdle to new entrants.

Key strategic issues

- Significant cultural contrast between the current Australian sugar industry and the proposed business model are likely to be the most challenging issues. There are fundamental differences in management styles between the two and alignment will be critical. If the two sectors are not seen as 'complimentary' internally and externally it will be difficult to succeed.
- Competition in government funding pools for innovation grants.
- Instability of global sugar markets with typical pricing swings of 20% which can have very detrimental impacts on new entrants if not managed or hedged correctly.
- Volatile feed molasses and organic fertiliser pricing in the conventional products, these will need to be monitored closely to maintain the position of processing by-products. These will be key to the success of any sugar beet project regardless of whether the focus is crystalline sugar, industrial syrup or stock feed.

Work breakdown structure (WBS)

The first steps in the WBS within the project development is to address key stakeholder responsibilities in conjunction with the proposed project timeline. In this case the timeline is proposed to be dictated by government policy and funding release dates which can be delayed, however alignment with statutory bodies is often quite pragmatic in projects of scale.

Resource requirements

The five types of resources that must be considered in the sugar beet WBS:

1. People (appointment of project manager and project team).

2. Contractors (external labour and knowledge required).
3. Facilities.
4. Materials.
5. Capital plant and equipment.

Generally, these should be addressed in this order and can be revisited as necessary.

Quality management

Project quality assurance parameters on a compliance issue such as this are very structured with regular reporting requirements to external bodies such as government which assists in overall management. However, this does not protect against project failure and there are many variables that can be influenced by the project manager, team and even the board where appropriate. These include choice of contractors, quality of installed equipment, future proofing against policy regulation changes in the agricultural, supply chain, climate/energy efficiency space and alteration of strategic direction on affected areas of the business.

Business case

The business case is primarily centred on the opportunity cost of investing in this project over other adjacent space options however this project also has the additional complications of social, environmental and statutory compliance. Activities in this space are affected by the CSR policies of the wider stakeholder group which protect against standard rules on return on capital/investment.

Stakeholder consultation

Stakeholder consultation and project communication are projected to be the most time-consuming components of the project beside the physical construction phase. There are two key reasons for this; the range of stakeholders involved and the nature of the project conception from legislative changes in energy regulations. These mean that clear communication channels need to be maintained from initiation to completion to ensure that expectations are met. The list of identified stakeholders is as follows:

- Project manager.
- Project team members.
- Victorian Government (DEDJTR).
- Tasmanian Government (Department of State Growth).
- Federal Government.
- Energy providers (Reduced purchasing).

- Local community (impacted by business decisions).
- Environment.
- Human Resourcing.
- Accounting.
- Parallel responsibilities of the Enviro. BU and managerial oversight capacity.
- Manufacturers of processing and 'in-field' equipment technology.
- Direct competitor strategy on the same topics.

This is also an area to reflect on the relationship and reporting guidelines between the two major roles in this phase: the project sponsor and project manager (Frigenti & Cominos, 2002). In this instance there are multiple potential sponsors being the private investors, government regulated rebate programs and the company itself, so this is a critical consideration to manage right from the start.

Risk management and assessments

This is an area of historic weakness in the business as many of the project management group do not have formal risk assessment training so it must be addressed with caution. As Globerson & Zwikael (2002) discuss this is a critical component of the WBS and has a great bearing on outcomes and quality when managed poorly.

Localised strategic objectives (5-10 years)

A strong focus on a regional strategic plan will be required for a project of this magnitude to be successful. It is likely that a collaborative investment and operation model would be the preferred method not only between stakeholders but also state governments due to sheer scale of such an industry. These objectives are essential for a sugar beet operation to justify its position in the market due to the relative scale of existing production when compared with close neighbouring markets of FNQ, Pacific Islands, SE Asia and even Brazil. Again, it is important to remember that all objectives must align with the overall vision of improving the sustainability of the supply chain from seed to consumption. It is not about replacing or competing on raw commodity price as this strategy is unlikely to be successful. Objectives listed are specific to a SE Australian production site (Tas/Vic) and are ranked in order of significance in the overall strategic plan. This strategic plan will focus on the first two objectives due to the broad nature of the full agribusiness plan for Victoria.

Conclusion

This report has explored the economic and environmental feasibility of the potential re-establishment of a southern sugar industry in Tasmania and/or Victoria, Australia.

Sugar is a commodity that is increasing in demand from various markets in energy, industry and food production due to its calorific potential and taste. It is one that has a significant impact on agricultural landscapes and resources which gives reason for precise management techniques.

Action plan

A sugar beet strategic plan is required and reliant on the commissioning of a new factory of substantial scale with a build period of 24-28 months giving an adequate marketing lead time while allowing sufficient time in the planning phase to determine the required internal assistance and external stakeholder engagement required.

Funding

There are three key sources of funding applicable for the successful implementation of the strategic plan:

- Cost savings from supply chain consolidation (taxation concessions).
- Direct private capital allocation by way of equity leverage.
- Capital assistance grants from state and federal governments.

Moreover, much of the strategic plan will be reliant on the marketability of the final product to justify the expense of capital works.

Securing government funding to develop pilot scale processing examples and field demonstrations will build confidence in any new industry for farmers and processors alike.

Whilst the action plan period will be mostly spent in planning and negotiation, there are significant marketing challenges that will need attention early. This need can initially be met by the introduction of key stakeholders to the industry in the EU and Chile. Additionally, the importation of beet syrup and crystalline sugar will assist in building confidence of the substrate as a complimentary option to cane derivatives. By having access to this product, it allows a lot of background trial work and regulatory work to be initiated.

The recommendations section highlighted the due diligence points that must be actions that compliment the main objective of this report.

Recommendations

A strong focus on a regional strategic plan will be required for a project of this magnitude to be successful and the overall vision must be to improve the sustainability of the supply chain, from seed to consumption.

Action points

- Continue field trials of sugar beet locally.
- Expand variety trials to five cultivars across Tasmania and Victoria.
- Variable rate application, vegetation indexation.
- Initiate planning and engineering required for the processing of sugar beet for livestock consumption (washing and chopping).
- Begin investigations into external funding opportunities beyond current opportunities (not necessarily in agriculture).
- Develop stock feed business unit to a commercial level to support large scale variety trials.
- Outsource agronomy to KWS Germany (seed and genetics company).

These action points will require regular collaboration with potential funding partners and allocation of tasks to external providers (contractors/agronomists). The engineering/planning stage of any capital works is possibly the most time and labour intensive with very specific skill set requirements.

The most critical component of the plan will be the ability of project managers and stakeholders to secure funding assistance from private sources and potentially by way of innovation grants from the government.

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Plain English Compendium Summary

Project Title:	Sugar Beet in South Eastern Australia. A high level economic and environmental feasibility study exploring the potential for a greenfield process sugar beet industry
Nuffield Australia Project No.:	1722
Recipient:	Robert Arvier
Organisation:	Botanic Solutions Group 831 Pine Road Penguin, 7316 Tasmania
Phone:	+614 28 385 895
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Objectives	Primary Objectives • Compare and contrast the key sugar beet growing regions globally with Australian examples. • Investigate the impact of sugar production on the landscape and industry best practice. • Define current status of global marketplace relative to sugar. • Develop an indicative work breakdown structure for a sugar beet production facility in SE Australia.
Background	The concept for the topic of sugar beet and industry revitalisation came about through discussions with industry advisor Anthony Kennedy in the Victorian Department of Economic Development, when discussing the environmental challenges of industrial sugar production. This led to the initial investigation into the previous industry in Maffra, Gippsland which has been dormant for some 70 years. Since then, the concept has changed substantially to focus on the production efficiency and sustainability more holistically to fit with community and producer expectations moving into the future.
Research	The entire premise of this report is based on 'lowest community cost' of production; that is taking into consideration all aspects of the value chain whether they be economic or environmental indicators and tangible or intangible. The conversation is not about sugarcane versus sugar beet versus corn versus wheat starch, but rather sustainable production and appropriate land, energy and water resource usage.
Outcomes	Chile has overtaken Australia as the most efficient producer of sugar. However, production efficiency and financial economics are not the only motivations for this investigation. During this research, the author also found that there are potential lower investment options to be considered in the short to medium term such as seed and fodder production. A staged approach to industry development and investment will be key to success.
Implications	A sugar beet strategic plan is required and reliant on the commissioning of a new factory of substantial scale with a build period of 24-28 months giving an adequate marketing lead time while allowing sufficient time in the planning phase to determine the required internal assistance and external stakeholder engagement required.
Publications	Nuffield Annual Conference 2018. Melbourne, Victoria.