FARM DAMS - ARE THEY AN OPTION FOR THE QUEENSLAND SUGAR INDUSTRY

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Abstract

Sugar cane farms are the single biggest user of irrigation water in Queensland. Recent drought and unreliable rainfall patterns in areas traditionally reliant on rainfall for crop production has resulted in increasing interest in, and adoption of supplementary irrigation to help underpin production. As a result, demand for irrigation water now exceeds supply from surface and underground sources and growers who are not able to access irrigation schemes are considering other water supply alternatives. A simple spreadsheet model has been developed to accept simulated crop yield and irrigation application data from APSIM (Agricultural Production Systems Simulation Model) and evaluate investment options in on-farm water storage and reticulation. The analysis indicates that growers should consider the construction of on-farm water storages as a viable source of irrigation water.

Introduction

Queensland farmers' terms of trade have been trending downwards over the last two decades (refer Figure 1). Costs have increased on average, much more quickly than commodity prices (refer Figure 2). Queensland cane growers have survived to date by adopting improved farm management practices and technology that has reduced costs, increased productivity or improved the reliability of production.

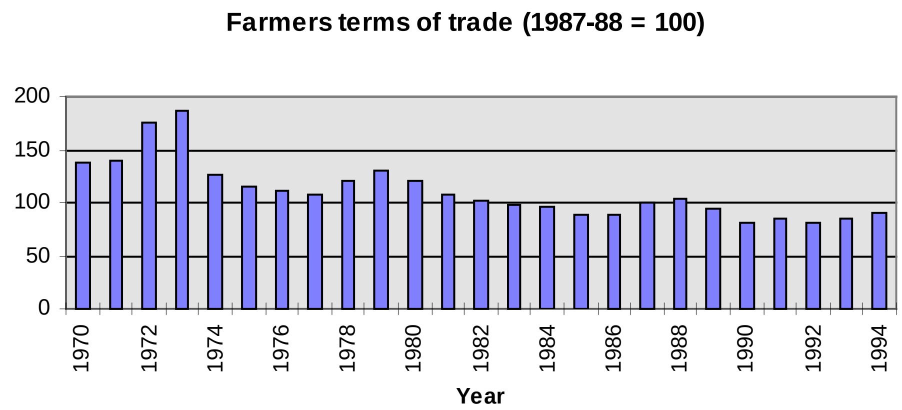

Figure 1 - Queensland farmers' terms of trade 1970 to 1994.

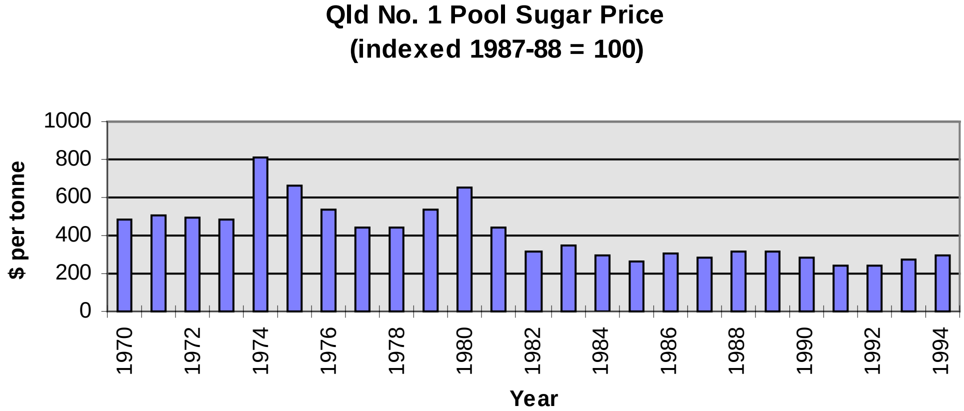

Figure 2 - Queensland No. 1 Pool Sugar Price 1970 to 1994.

Over the years growers have explored a number of avenues in order to remain viable including increased scale, reduced input farming, percentage of fallow, crop diversification (particularly through the fallow window), value adding (garden mulch from Rocky Point in South East Queensland), green cane trash blanketing, irrigation and associated technologies, and precision agriculture. While some of these examples have been widely adopted by the industry, others have not.

Recent drought and unreliable rainfall in many cane growing areas traditionally reliant on rainfall for crop production, has resulted in increasing interest in, and adoption of, supplementary irrigation to help underpin production. Three areas where this is particularly evident are the Herbert, Mackay and Bundaberg regions.

While some growers in these areas have increased their area under dryland production, many growers have recognised the more substantial benefits that are afforded through irrigation. Some direct advantages of expansion through irrigation include:

- reduced production risk
- increased margins per hectare
- less income lag than horizontal expansion
- ability to borrow and service debt is improved by the removal of some production uncertainty
- land has an improved ability to maintain value when other factors such as sugar price or drought may significantly reduce the value of low producing non-irrigated farms
- investment in production increasing irrigation often provides a far better return on additional capital than an equivalent investment in additional cane land, part of which is attributable to the considerable tax benefits associated with input costs that can be grouped under sections 75B, 75D and 51(1) of the Income Tax Assessment Act
- increased flexibility of farming activities.

Other more global reasons for the promotion of more intensive farming practices include a reduction in the area of good quality agricultural land (particularly as a result of urban encroachment in the cane industry), increasing community resistance to tree clearing, and the identified need to maintain reasonable areas of natural habitat and biodiversity.

As groundwater and regulated scheme water supplies have become fully committed, and unregulated streams have proven to be unreliable, many growers have questioned the viability of on-farm storages to provide some or additional water for irrigation. This paper reports on preliminary analysis conducted in the Mackay region.

Methodology

While economic analysis of irrigation has been conducted by the sugar industry, none of the work previously undertaken has considered irrigation investment in the context of a business subject to income tax, and eligible to claim deductions for certain irrigation expenditure. A spreadsheet model has been developed incorporating the capital and operating costs associated with six irrigation systems, expenditure on an on-farm storage, the ability to accept simulated crop yield data and water use associated with particular soil types and irrigation strategies, and conduct discounted cash flow (DCF) analyses on after tax income (Appendix 1). The DCFs are conducted over a twenty year timeframe to reflect what is considered to be a reasonable investment horizon for a grower, and to coincide with the expected life of much of the irrigation equipment.

The Australian Income Tax Assessment Act contains certain provisions to encourage the development of water resources and investment in irrigation infrastructure. The government provides these provisions to help stabilise income from primary production, facilitate self reliance and hence reduce the need and cost of government support during drought. Aspects of the act incorporated in this model include marginal income tax rates, income splitting, five year averaging, Section 51(1) provisions which allow primary producers to write-off irrigation investigation and planning costs and all irrigation operating costs in the year of expenditure, Section 75D provisions which allow primary producers to depreciate the full cost of soil conservation works in the year of expenditure, Section 75B provisions which allow growers to depreciate the capital costs associated with irrigation storage and reticulation works over three years, and Drought Investment Allowance which allows primary producers to claim an additional deduction of 10% of the capital costs (up to a maximum deduction of $5,000) associated with irrigation reticulation (excludes storages for irrigation) in the year of expenditure.

The capital costs for the irrigation systems were derived for farm sizes from 50 to 250 hectares. The costs associated with each system on an 80 hectare farm are shown in Table 1. Factors that will influence the selection of a particular system include soil type, the availability and cost of water and labour, water quality, slope, farm layout and equipment cost.

Component	Winch	Furrow	Pivot	Trickle
Pump	10000	5600	10000	10000
Suction	1000	1000	3000	2000
Discharge	4000	2500	5000	2000
Installation	4000	4000	6000	4000
Mainline	44800	38400	25200	44800
Submains	0	0	0	84000
Trickle tube	0	0	0	120000
Tailwater return earthwks	0	0	0	0
Tailwater return pump	0	0	0	0
Levelling	0	48000	0	0
Irrigator & hose	68000	0	0	0
Boom	0	0	0	0
Fluming	0	800	0	0
Centre pivot	0	0	140000	0
Capital Cost ($)	131,800	100,300	189,200	266,800
Capital Cost ($/ha)	1,648	1,254	2,365	3,335

Table 1 - Capital costs associated with each irrigation system.

The operating costs and application efficiencies associated with each system on an 80 hectare farm are shown in Table 2. The application efficiency figures adopted here are thought to be readily achievable where irrigation application (and system) is matched to soil type and topography. Water losses are attributed to evaporation, runoff and deep drainage.

Cost ($/Ml)	Winch	Furrow	Pivot	Trickle
R&M	8.50	2.00	2.00	8.50
Labour	69.00	31.00	9.00	9.00
Pumping	23.47	10.32	19.26	11.28
Application efficiency	75%	60%	85%	90%

Table 2 - Operating costs and application efficiencies associated with each irrigation system

In this analysis APSIM-Sugarcane was configured to simulate continuous cropping of Q124 where the crop was harvested green (greater than 90% of the Mackay cane crop is harvested green) on the 1 July each year, 250 kg nitrogen was applied to each crop at a depth of 100mm (BSES recommended rate is 180 kg/ha), and irrigations were applied when the fraction of available soil water fell to 50%. Climate and rainfall data for the period 1974 to 1993 was used for the simulations.

In the Mackay district, on-farm irrigation storages vary in size from tailwater pits of under one megalitre (Ml), to a 5200 Ml ringtank west of Mackay at Nebo. According to the the Department of Natural Resources (DNR), who are involved with many of the storages at the design or licencing stage, average cost of construction has been between $450 and $500 per Ml of storage.

A number of technical factors impact on the economics of on-farm storages, and DNR is able to provide landholders with indicative information on possible storage sites, storage volume, catchment size, estimated runoff, expected evaporation and seepage, yield, area of inundation when full, wall height, bywash dimensions, and construction cost based on required earthworks.

The basic steps in planning a farm water storage include:

- select the best site based on your water requirements, topography, catchment yield, soil types, location, area, and construction cost - it is worth taking advantage of the DNR Water Advisory Service to assist here
- assess the impact on farm layout - DNR can also assist with farm layout planning, Bureau of Sugar Experiment Stations, irrigation suppliers
- assess the licensing requirements for the works
- material investigation of the site
- survey and design
- application for necessary licences.

Results and Discussion

An example of the physical and financial information that is required by the model is shown in Table 3. Some of these numbers (available water, water applied, cane price) are calculated based on inputs such as the irrigation method selected, sugar price and CCS.

Table 4 mimics output information provided by the model. The model also calculates the breakeven value of a number of key input variables, while keeping all other variables constant.

Simulated yields for the period 1974 to 1993 have been captured in Table 5 for three irrigation systems on three different soil types. These results demonstrate the variability in the NPV and breakeven dam cost depending soil type, irrigation system (and strategy) and storage capacity/yield. Model runs have highlighted the need to refine the model so that it can be used as a decision support tool for growers/advisers evaluating specific irrigation development proposals.

Physical Inputs	
Cultivated area (ha)	80
Area of cane land lost to storage (ha)	0
Irrigated area (ha)	80
Storage capacity (Ml)	240
Storage cost estimate ($/Ml)	450

Yield (% of volume)	100
Available water (Ml)	225
Irrigation method (w=winch;f=furrow;p=pivot;t=trickle)	W
Water applied (Ml/ha)	2.25
Financial Inputs	
Ten year bond rate	5.3%
Inflation rate	0.5%
Discount rate adopted	4.8%
Sugar price ($/t)	320
CCS	13.5
Cane price ($/t)	27.97
Harvesting & levies ($/t)	7.49
Nett cane income ($/t)	20.47
Taxation	
Number of tax payers	2
Tax rate adopted (m=marginal;c=company)	M

Table 3 - Sample input variables

Variable	
Irrigation system	Winch
Capital cost ($)	239,800
Operating cost ($/Ml)	101
Water cost ($/Ml)	0
NPV (20 years) ($)	42,011
Internal Rate of Return	7%
Breakeven analysis (NPV=0)	
Storage cost ($/Ml)	679
Sugar price ($/t)	281
Reticulation capital cost ($/ha)	2,336
Total operating cost (including water) ($/Ml)	122

Table 4 - Sample output data using the input data in Table 3 on a sand soil with a plant available water content of 63mm to a depth of 1500mm.

Soil type	Sand - plant available water content of 63mm						
Irrigation system	Rainfed	Winch		Pivot		Trickle	
Available water (Ml/ha)	-	1	3	1	3	1	3
Effective irrigation (Ml/ha)	-	0.75	2.25	0.85	2.55	0.9	2.7
Average yield (t/ha)	82	93	112	94	116	94	119
Maximum yield (t/ha)	127	133	140	134	141	134	142
Minimum yield (t/ha)	31	59	85	61	85	62	91
NPV ($)	-	-36,585	42,011	-12,548	228,944	-125,656	154,367
Breakeven dam cost ($/Ml)	-	-	679	227	1,627	-	1,229
Soil type	Loam - plant available water content of 114mm						
Irrigation system	Rainfed	Winch		Pivot		Trickle	
Available water (Ml/ha)	-	1	3	1	3	1	3
Effective irrigation (Ml/ha)	-	0.75	2.25	0.85	2.55	0.9	2.7
Average yield (t/ha)	105	115	133	117	136	117	140
Maximum yield (t/ha)	142	148	155	149	156	149	160
Minimum yield (t/ha)	58	75	100	78	109	78	112
NPV ($)	-	-60,579	49,336	-14,360	170,538	-131,016	119,778
Breakeven dam cost ($/Ml)	-	-	711	161	1,435	-	1,117
Soil type	Clay - plant available water content of 162mm						
Irrigation system	Rainfed	Winch		Pivot		Trickle	
Available water (Ml/ha)	-	1	3	1	3	1	3
Effective irrigation (Ml/ha)	-	0.75	2.25	0.85	2.55	0.9	2.7
Average yield (t/ha)	119	128	144	129	150	130	148
Maximum yield (t/ha)	155	155	161	155	161	155	161
Minimum yield (t/ha)	74	88	114	89	120	90	123
NPV ($)	-	-26,657	-271	-16,132	98,045	-143,778	-93,907
Breakeven dam cost ($/Ml)	-	-	448	91	970	-	-

Table 5 - Comparison of results using yields generated by APSIM-Sugarcane for the period 1974 to 1993. The simulated yields were discounted by 10% to account for losses associated with pests, diseases, and mechanical harvesting, and a maximum yield cap set at 161 t/ha (70% of the maximum simulated yield under full irrigation).

At lower water application rates (Ml/ha) the capital costs associated with reticulation tend to outweigh the benefits, particularly when installing a trickle system. Slightly improved yields due to better application efficiency, and lower operating costs, resulted in higher NPV and breakeven dam cost figures to give the pivot system an edge on winching

The model has also been used to compare discounted cashflows generated from additional purchased unirrigated cane land (purchased at market value) with irrigation development on an existing farm. These analyses highlighted the need for growers to look to maximise their production from their existing area (possibly through the development of irrigation) before investing in additional dryland cane area. This is despite the fact that the NPV does not take into account the increased value of land resulting from investment in irrigation.

Conclusions

This framework has made it possible to evaluate various on-farm storage and irrigation investment scenarios depending on irrigation system to be adopted, dam size, dam yield, and construction cost. However, the analyses to date have assumed a static annual storage yield, which does not reflect actual variability in runoff from season to season.

The CRC for Sustainable Sugar Production is currently developing a farm water simulation model that uses APSIM, RUSTIC (Runoff, Storage & Irrigation Calculator), and MEDLI to simulate daily streamflow, runoff and storage yield figures, water use figures (where the grower may have access to water from an on-farm storage and a regulated/unregulated stream), and crop yield. Output from this model will then be fed into the economic analysis to help assess the feasability, implications and optimum design of on-farm storages within sugarcane production systems.

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Appendix 1 - Model calculation sheet using input data from Table 3.

On-farm catchment storage

				Qty	Rate	Cost ($)	Life (years)
Earthworks @	$	450	/Ml of yield	240	450	108000	N/A
Pumps, irrigator, pivot						87000	20
Mains & fittings						44800	30
Trickle tube						0	10
Earthworks						0	30
TOTAL CAPITAL COST						239800	

Operating Costs		No	Rate	$/Ml
R&M	$/Ml - servicing, repairs			8.50
Labour	$/Ml - moving, checking, repairing			68.75
Water	Scheme dependent	0	0	0
Pumping	$/Ml - electricity			23.47
TOTAL OPERATING COST				100.72

Dryland farming costs	$/ha
Variable costs excluding harvesting & levies	721.35

Normal fixed costs (on an average farm size c		60	hectares)
	Insurance		3100
	Registrations/licences		1400
	Fuel - 10000km		1000
	Rates		3200
	Electricity		300
	Wages		1250
	Administration		3500
	Other expenses		1000
			14750
	Fixed costs/ha		245.83

Discounted cash flow analysis - including reticulation works

Discount rate 4.8%

Year	Income		Less Additional Expenses			Dam cost	Capital costs (S 75B)	Soil conservation (S 75D)	Taxable Nett Income	Taxable income 5-year averaging	Tax payable	Net cash flow after tax	Dryland income after tax	Change after tax
	Without a	With b	Operating c	Water d	DIA/75B deductions e			f	g=b-(c+d+e+f)					
0	-	-	-	-	-	108000	131800	0	-	-	-	-	-	-239800
1	119502	142343	24173	0	84933	0	0	0	33237	51917	10395	107775	91012	16763
2	88962	124978	24173	0	79933	0	0	0	20872	44774	7845	92960	64176	28785
3	115646	137098	24173	0	79933	0	0	0	32992	40055	6348	106577	89034	17543
4	80916	106397	24173	0	0	0	0	0	82224	45182	7990	74234	59726	14507
5	24370	87632	24173	0	0	0	0	0	63459	46557	8481	54978	21425	33552
6	116698	138362	24173	0	0	0	0	0	114188	62747	14261	99927	89574	10353
7	46225	106776	24173	0	0	0	0	0	82603	75093	18669	63934	37862	26072
8	89137	120283	24173	0	0	0	0	0	96110	87717	24230	71880	64273	7608
9	32332	87818	24173	0	0	0	0	0	63645	84001	22569	41076	27659	13417
10	7229	99774	24173	0	0	0	0	0	75601	86429	23654	51947	7229	44717
11	13168	110624	24173	0	0	0	0	0	86450	80882	21175	65276	12655	52621
12	38365	89815	24173	0	0	0	0	0	65642	77490	19658	45984	32384	13600
13	96443	123936	24173	0	0	0	0	0	99763	78220	19985	79778	68313	11466
14	1906	68124	24173	0	0	0	0	0	43951	74281	18379	25572	1906	23665
15	68926	121295	24173	0	0	0	0	0	97121	78585	20148	76973	52459	24514
16	130803	152304	24173	0	0	0	0	0	128130	86921	23874	104256	96809	7447
17	18537	61147	24173	0	0	0	0	0	36974	81188	21311	15663	16858	-1196
18	25067	87951	24173	0	0	0	0	0	63777	73991	18275	45502	21971	23531
19	43818	89546	24173	0	0	0	0	0	65372	78275	20009	45363	36314	9049
20	-26319	90327	24173	0	0	0	0	0	66154	72081	17593	48560	-26319	74880
NPV	(a project is generally accepted if NPV>0)													$42,011
IRR	(a project is generally accepted if the IRR>discount rate)													7%