ECONOMIES OF SCALE IN CONTRACT HARVESTING OF SUGARCANE

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Abstract

With increasing international competition it is imperative that the South African sugar industry improves cane yields and quality, and curtails production costs. It is thus likely that increasing domestic labour costs will result in the long-run substitution of capital for labour (i.e. increased mechanisation). Given the high cost and indivisible (or lumpy) nature of mechanical inputs, it is important that machinery used in the production of sugarcane is efficiently utilised. This creates the opportunity for efficient contractors to exploit economies of scale in cane harvesting, loading and transport by spreading fixed capital and management costs over a large tonnage. This paper investigates the economic optimum size contracting unit using information from the North Coast region, and extends this analysis to investigate the cash flow implications of different levels of capital leverage (debt financing) on contractor viability.

Introduction

Given the high cost and indivisible (or lumpy) nature of mechanical inputs, it is important that machinery for the production of sugarcane be utilised efficiently. This creates the opportunity for syndication to exploit economies of scale in cane harvesting, loading and transport by spreading fixed capital and management costs over a large tonnage. It also creates the opportunity for efficient contractors to benefit from significant economies of scale.

The contracting system analysed in this paper is typical of contracting businesses currently in operation on the North Coast. The analysis is limited to cane which is mechanically loaded infield. The entire harvesting process, from cutting the cane to loading it into the heavy transport vehicle at the loading zone, is described briefly below. Specific equipment used in the analysis will be detailed later in the paper.

- Cane is cut and windrowed manually.
- It is then loaded infield by a grab loader into a box trailer, which is used to haul the cane to the loading zone.
- The cane is then loaded directly into a heavy road transport vehicle using a cane transloading crane.

Costing procedures

Machinery costs

The costs of owning and operating machinery can be divided into two categories – fixed costs and variable costs. Fixed costs are related to the ownership of the machinery and are incurred regardless of the extent of the use, and vary inversely proportional to the annual use of the equipment. These costs include depreciation, the value of foregone interest earnings, licences and insurance.

Variable costs are directly related to the degree of utilisation of the machine, and include factors such as repairs and maintenance costs, fuel and lubrication.

Fixed costs

a) Depreciation

For the purpose of this analysis, depreciation is regarded as a fixed cost as its inclusion captures the cost of obsolescence as the machine's value reduces with the passage of time. The cost is based on straight-line depreciation over the anticipated life of the machine.

b) Interest (opportunity cost)

The opportunity cost of investing in machinery is the value of the highest foregone alternative investment. For this analysis, the highest foregone alternative is estimated to be the interest that could have been earned on a medium term (5-year) fixed deposit.

c) Licences and insurance.

Variable costs

Costs associated with repairs and maintenance, and fuels and lubricants, vary greatly depending on operating conditions, management and maintenance programs (Anon, 1997b). Furthermore, repair costs per hour usually increase with age, but at a decreasing rate (i.e. repair costs tend to level off as the machine gets older) (Kepner *et al.*, 1978, cited by Anon, 1997b).

For the purpose of this analysis, repairs and maintenance costs are calculated as a percentage of the machine's purchase price. This procedure yields an average cost for repairs and maintenance over the useful life of the machine. The fuel and lubricant cost estimates of Anon (1997b) are utilised.

Labour costs

Due to the confidential nature of labour cost data, actual regional averages for labour costs are not included in the analysis. Hypothetical labour costs are thus substituted for regional averages.

Management costs

Since the cost of management is subjective and is difficult to define, the estimated opportunity cost of managing the contracting operation is substituted for the cost of management. This represents the foregone income from an alternative source of employment. For the sake of this analysis, the gross income foregone is assumed to be R170 000 per annum, which represents foregone remuneration, inclusive of typical employment benefits (medical aid, pension, car allowance).

Overhead costs

Associated with the running of the contractor business are a number of office and administrative costs which are included in the analysis.

Analysis

Machinery utilisation

To determine the economically optimum size (tonnage) contracting unit, it is necessary to ensure that all equipment is utilised efficiently. Furthermore, since box trailers are loaded mechanically, utilisation of both the mechanical loader and the box trailers/tractor are interdependent. For this reason, loading and haulage capacity must be compatible to ensure maximum utilisation of all system components. To determine the annual capacity for the infield haulage operation it is necessary to determine how may round trips the tractor/trailer rig is capable of making in a day. The estimated cycle times per trip is illustrated in Table 1. The capacity (tons/annum) of all mechanical system components is illustrated in Table 2.

Table 1. Haulage cycle: shuttle operation.

Operation	Distance standard (one way)	Operation time (minutes)
Payload	8 tons	
Loading (field)	30 tons/h	16
Hitching	15 km/h	5
Travel infield	2 km	16
Zone (crane)	5 min/bundle	10
Downtime	10%	4,7
Total	Bell operating time	16
	Tractor travel time	34,1

Table 2. Assumed equipment capacity at full utilisation.

Equipment			Tons
Bell	30 tons/h	1 000 h	30 000
Infield haul (actual)	34 min travel time/trip	1 600 h	22 522
Crane	10 min/5 ton	2 000 h	60 000

Benefits from economies of scale are achieved when fixed costs associated with the most costly capital input are spread over the maximum output (tonnage). The most costly mechanical input is the grab loader, which for the sake of this analysis is assumed to be fully utilised loading 30 000 tons cane per annum (see Table 2). This figure can vary depending on cane yields and infield conditions. Two 8 ton box trailers will be required for each Bell loader, neither of which will be fully utilised.

Contract costing

The proceeding analysis estimates the optimum size contracting unit based on machinery performance standards used by the South African Sugar Association Experiment Station (Anon, 1997a). Since it is assumed that efficient mechanical utilisation is achieved at approximately 30 000 tons for a Bell loader, three alternative size contract harvesting units are analysed (30 000 tons, 60 000 tons and 90 000 tons).

The analysis in Table 3 includes the cost of labour, overheads and management. An acceptable return on management is assumed to be 15% of costs incurred. This relates to the opportunity cost of investing time and money in the contracting business, as opposed to alternative employment. The opportunity cost of alternative employment has already been estimated at R170 000 per annum, which represents the most costly 'lumpy' input in the contracting operation. To achieve overall economies of scale in the contracting business, management must thus be fully utilised.

Table 3. Costing for different tonnage contracting units.

Unit size	30 000	60 000	90 000
Harvest	R7,01	R6,99	R6,98
Loading (field – Bell)	R2,63	R2,87	R3,23
Haulage (infield + load)	R5,54	R5,36	R5,20
Zone (crane)	R1,81	R1,69	R1,65
Management	R5,67	R2,83	R3,78
Overheads	R1,81	R1,15	R0,94
Total	R24,47	R20,89	R21,78

A 60 000 ton contracting unit generates a 15,6% return on management. This tonnage is thus regarded as the economically optimal size unit as it ensures that both management and equipment are optimally utilised. The addition of a further 30 000 tons to the contracting business, required to justify the addition of the next most costly input (Bell loader) would result in management being a constraint, as one manager cannot efficiently manage a unit of this size.

Cash flow implications

Financial leverage is defined as the ratio of borrowed capital to own capital used in the financing of capital items (i.e. medium to long term financing). Alternatively it can be defined as the ratio of debt to equity. Provided the return from the asset is greater than the return interest rate, increasing financial leverage increases the rate of growth of the contracting business. However, as leverage increases, financial risk increases and the potential for the loss of equity capital (own capital as opposed to borrowed capital) increases. Furthermore, as asset values decline (i.e. as the equipment gets older), leverage ratios automatically increase (Barry *et al.*, 1979). In South Africa, high real rates of interest and declining real asset values limit the potential for growth from leverage. Leverage ratios in excess of 0,5 are considered

risky. A leverage ratio of 0,5 indicates that for every R1,00 of own capital employed, R0,5 borrowed capital is utilised.

Apart from increasing the potential for losses of equity capital, high leverage also reduces the liquidity of a business. The financing structure of contracting operations is thus of great importance given the high capital requirements of a business.

Fixed costs (depreciation and interest) included in the machinery costings are determined over the anticipated life of the equipment, and do not necessarily relate to the cost of financing the equipment over the short to medium term. Excessive reliance on borrowed finance in the purchase of equipment can place severe cash flow stress on the contracting business in the short term.

Table 4 illustrates the cash flow cost of financing new equipment required to harvest and haul 60 000 tons of cane per season, at different leverage ratios, ignoring potential tax implications. This cost is compared with fixed cost recovered in the contracting rate (i.e. depreciation plus interest). From Table 4 it is evident that a leverage ratio of greater than 0,5 will result in short term cash flow stress as repayment commitments exceed the provision for fixed costs in the rate.

Table 4. Cash flow cost at alternative leverage ratios.

Number of units		Equipment value	Fixed costs in rate	Financing costs at different leverage ratios				
				0	0,25	0,5	0,75	1,0
Tractors	2	370 000	88 586	–	–35 225	–70 450	–105 675	–140 900
Trailers	4	288 000	51 715	–	–27 418	–54 837	–82 255	–109 674
Bell	2	478 000	87 195	–	–45 507	–91 014	–136 521	–182 028
Crane	1	119 900	30 087	–	–11 415	–22 830	–34 244	–45 659
		R1 255 900	R257 584	R0	–R119 565	–R239 130	–R358 696	–R478 261

Discussion and conclusion

The analysis illustrates that significant economies of scale can be achieved in contract harvesting and infield haulage, given the lumpy nature of equipment required. Based on the assumptions made in the analysis, the efficient utilisation of management is achieved with a contracting unit at approximately 60 000 tons. Since this is the most costly input, this represents the economic optimum size contracting unit. The analysis further highlights the short term cash flow constraint experienced with high levels of financial leverage. The financing cost of acquiring equipment required to run a 60 000 ton contracting unit with more that 50% borrowed capital (i.e. a 0,5 leverage ratio) jeopardises short term cash flow as actual costs exceed fixed costs recovered in the contracting rate, determined over the lifespan of the equipment.

Thus, while significant savings can be realised by taking advantage of economies of scale, by syndicating cutting, infield loading and haulage and transhipment operations to achieve optimally sized contracting operations, excessive reliance on borrowed capital can jeopardise short term cash flow and the long term viability of the business.

REFERENCES

Anon (1997a). Costing machinery systems. In: Mechanisation Report 97/1, published by the South African Sugar Association Experiment Station, Mount Edgecombe, South Africa.

Anon (1997b). *Guide to Machinery Costs*. Published by the KwaZulu-Natal Department of Agriculture, South Africa.

Barry, PJ, Hopkin, JA and Baker, CB (1979). *Financial Management in Agriculture*. (Second Edition). Interstate Printers and Publishers Inc. 191 pp.

Kepner, RA, Baines, R and Barger, EL (1978). *Principals of Farm Machinery Management*. (Third Edition). AVI, Connecticut.