EVALUATION OF TWO POSSIBLE HAULAGE ROUTES FOR THE TRANSPORT OF SUGARCANE

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Abstract

A typical problem faced by sugarcane transport operators is whether a short route, over a low quality or steep road, should be selected in preference to a longer route with a better quality road surface or lower gradients. The selection from the two options is not a problem if the short route is a high quality road with no expensive tolls or safety issues. In such a case, a subjective judgement should not be used, and preferably a thorough costing of the two routes should be performed to ensure that the lower cost route is used. Sugarcane growers in the Mid Illovo area have two possible routes to use when transporting their cane to the Eston Mill. The one is the tar road from Mid Illovo to the Mill via the Umbumbulu (R78) road and the other is the direct route, which is shorter, has a rougher road surface and has sections which are untarred. Both routes are used by hauliers and growers and each have their own reason for doing so. Thus the problem to be addressed is to decide on the preferable route, which should be the least cost option in the long term.

This problem was investigated and two methods were used to quantify the difference in cost between the two options. Firstly, performance tests were carried out on both routes using a conventional haulage vehicle, and standard costing methods were applied. Secondly, a vehicle performance and costing simulation package was used to achieve the same aim. The performance of the vehicle, costs and recommendations are made to show the factors that should be taken into consideration when making such a choice. The results showed that the shorter route was the more economical.

Keywords: sugarcane transport, vehicle performance, vehicle costs, road surface, road gradients, vehicle performance simulation

Introduction

Sugarcane growers in the Mid Illovo area have two possible routes to use when transporting their sugarcane to the Eston mill. The first route, which is tarred over the entire length, is from Illovo to the mill via the Umbumbulu road (R78), and the second, shorter and more direct route to the Eston mill is only partly tarred. At present both routes are used by hauliers and growers, and it is necessary to determine the best route in terms of fuel efficiency, repairs and maintenance, as well as safety. As the study indicates that the shorter, more direct route is more economical to use, an issue that needs to be addressed is whether there is justification for the growers to lodge a request with the road authority for the shorter route to be upgraded.

In an effort to quantify any differences between the two routes, the Illovo/Eston Mill Group Board's Transport Task Team approached the Agricultural Engineering Department at the South African Sugarcane Research Institute (SASRI) to undertake tests to evaluate both routes using a typical sugarcane haulage vehicle.

The University of KwaZulu-Natal's School of Bioresources Engineering and Environmental Hydrology (BEEH) supplied both the hardware and software used during the haulage tests, and several staff members assisted in installing the monitoring equipment and in the collection of vehicle performance data. In addition, this opportunity was used to gather vehicle performance data for the development of the computerised vehicle performance simulation software 'Simtrans' (Lyne *et al*, 1996; Lyne *et al*, 1998; Cole *et al*, 1999).

Method

Haulage routes

Prior to conducting the road haulage tests, the two route profiles were surveyed by Green Belt Mapping using a Trimble Pro XRS, which is a mapping-grade GPS with horizontal accuracy to within 1 m. The route profiles were then extracted from the logged data and transferred to a Microsoft Excel spreadsheet.

The road from Mid Illovo to Eston leaves the village and approximately 2.5 km further on a loading zone (Zone 3) is located, as shown in Figure 1. The tests were carried out in both directions between Zone 3 and the weighbridge at the Eston Mill. Just after Zone 3, the shorter route to the mill (Route 2) branches off to the left, and the longer route (Route 1) carries on to the R78, where it turns left to Eston, as shown in Figure 1.

Route 1 is 4.7 km longer than Route 2, and from Zone 3 to the mill this represents a 39% longer route. The difference in altitude between Zone 3 and the mill is only 30 m. Route 1 has more undulations than Route 2, which results in a total accumulated climb of 317 m compared with 282 m for the shorter route. The road profiles for Route 1 and Route 2 are shown in Figures 2 and 3 respectively.

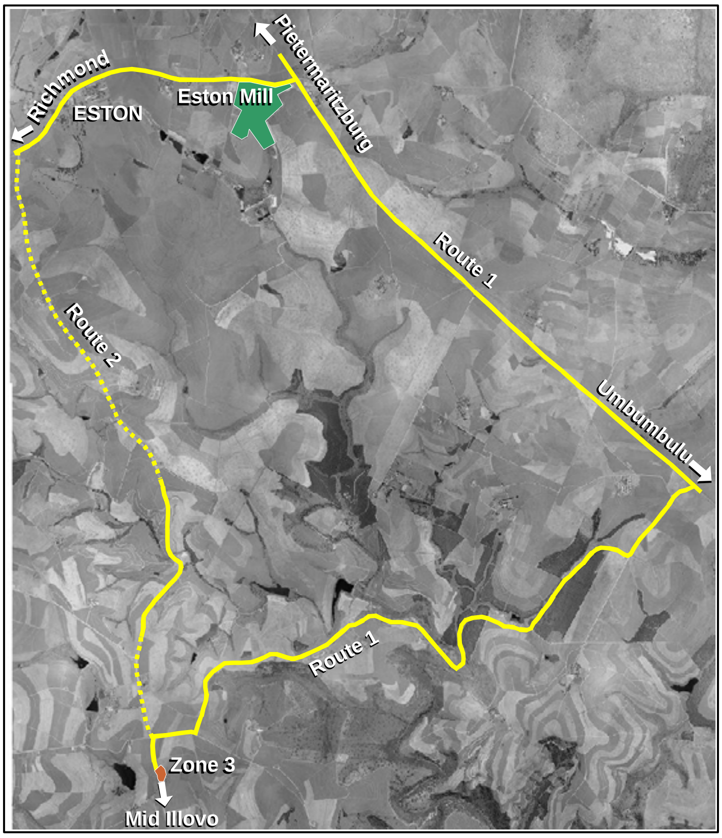

Figure 1. Aerial view of the two haulage routes.
(Dotted lines indicate sections of untarred road surfaces.)

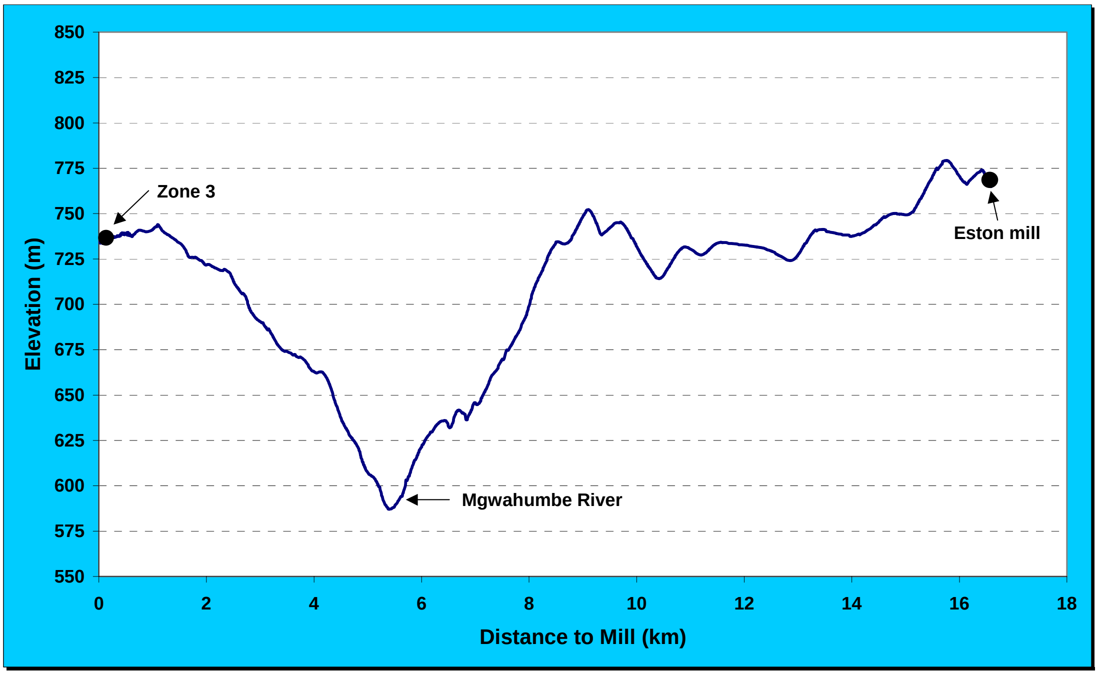

Figure 2. Profile of Route 1 – tarred road from Zone 3 to the Eston mill.

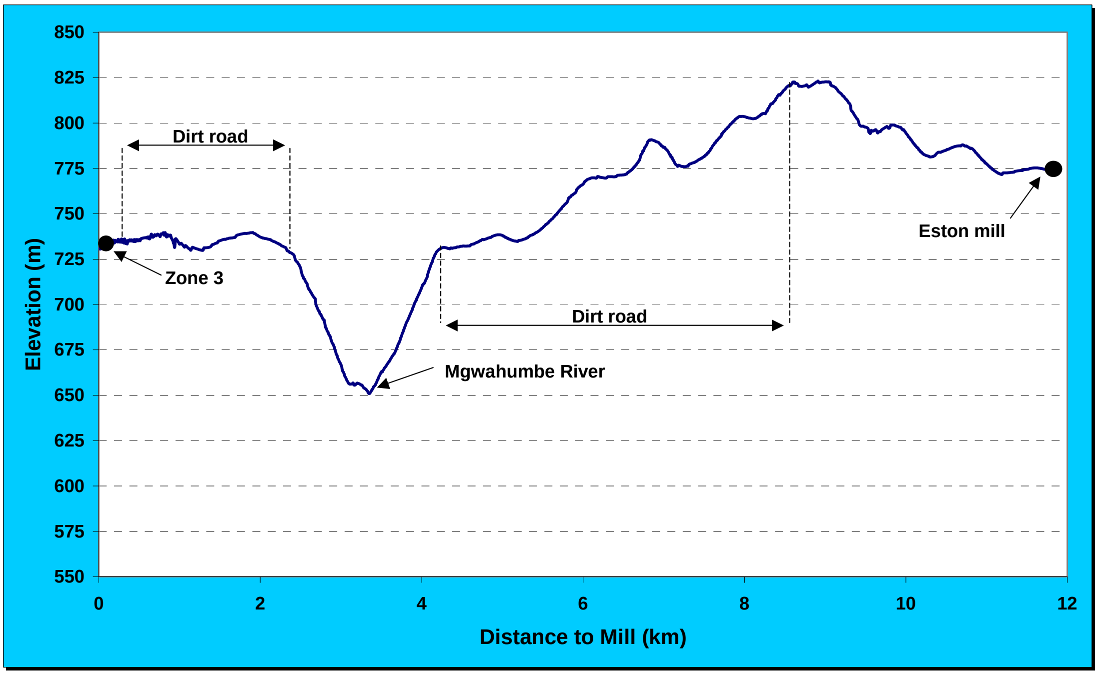

Figure 3. Profile of Route 2 – partly tarred road from Zone 3 to the Eston mill.

Haulage vehicle used for the tests

As shown in Figure 4, the haulage vehicle used was a Mercedes Benz 2637 truck-tractor fitted with a V10 naturally aspirated 260 kW engine. The truck-tractor was coupled to a conventional set of timber interlink trailers. The vehicle was driven by an experienced driver who operated the engine revolutions strictly within the 'Greenband' range.

Figure 4. The road haulage vehicle used in the tests.

The vehicle was instrumented to measure and record the following data:

- Ground speed: measured by Trimble SV8 GPS (accuracy: <0.1%).
- Geographic position: measured by Trimble SV8 GPS (accuracy: x,y <0.5 m, z <3 m).
- Elapsed time: measured by Campbell Scientific CR10X data logger (accuracy: 0.1%).
- Throttle position: linear potentiometer.
- Engine speed: obtained via alternator tachograph signal (accuracy: <1%).
- Fuel consumption: measured by two Micro Oval II meters (supply and return lines).

The University of KwaZulu-Natal's School of Bioresources Engineering and Environmental Hydrology (BEEH) supplied both the hard and software used during the haulage tests and several staff members from BEEH assisted in installing the monitoring equipment and the collection of the vehicle performance data. The hardware and software used during the haulage tests was fitted and evaluated on a LDV prior to conducting the haulage tests. In addition, this opportunity was used to gather vehicle performance information to evaluate computerised vehicle performance simulation software ('Simtrans'), developed by Lyne *et al.* (1996), Lyne *et al.* (1998) and Cole *et al*. (1999).

All the vehicle performance data was stored on a Campbell Scientific CR10X data logger located in the cab of the vehicle, as shown in Figure 5. The data logger was also fitted with a cell phone modem, which was used to download the data to a computer. It was also possible to update the software on the data logger using this facility. With the above hardware and software it was possible to identify the gear and engine revolutions at any given time along the route.

Haulage tests

The haulage tests were carried out during January 2004. Initially the vehicle was driven unladen in both directions over both routes. As the tests were carried out during the sugar cane off-crop period, the vehicle was loaded with timber and again driven in both directions over both routes. The payload of the vehicle during the loaded tests was 31.45 tons. As a result of the logistics of moving the vehicle around, an extra trip was made fully laden from Mid Illovo to Eston mill on the short route.

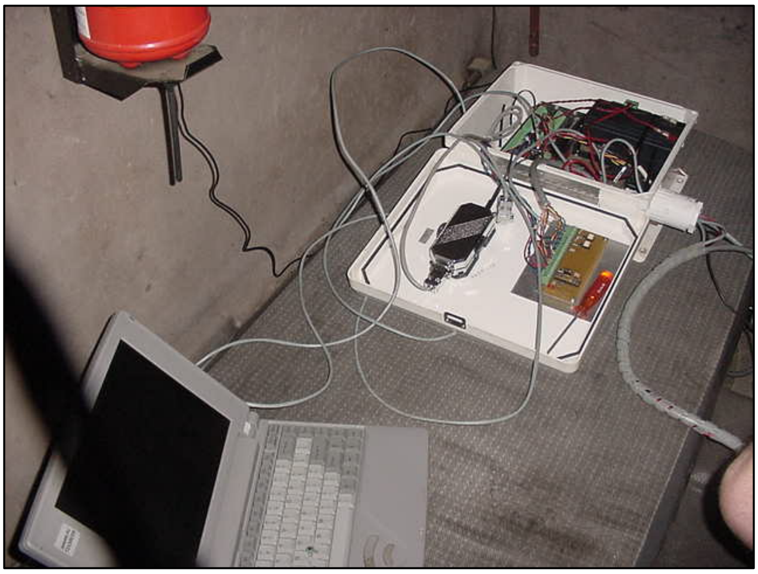

Figure 5. Electronic case containing some of the measuring devices used during the tests.

In addition to the physical evaluation using an existing haulage vehicle, a commercial consulting company, Hellberg Transport Management cc, was approached to conduct a simulation using a commercially available vehicle simulation tool on the two routes to obtain an independent assessment (personal communication[1]). Although the software was able to use the same vehicle configuration as that used in the tests, the engine was a later, more powerful model. The benefit of this was that results were obtained for two different engines.

Results and discussion

On completing the road haulage test runs the data was downloaded from the Campbell Scientific CR10X data logger and analysed. The measured results of vehicle performance are shown in Table 1.

Table 1. Results obtained from the test runs of the loaded and unloaded trips between Mid Illovo and the Eston Mill.

Direction of trip	Load	Trip number	Start time	Trip dist (km)	Avg speed (km/h)	Max speed (km/h)	End time	Trip time (min)
Short Distance Route 2								
To Mid Illovo	Empty	1	08h28	11.9	36.3	66.3	08h47	19.7
To Eston	Empty	4	09h48	11.9	35.5	74.1	10h09	20.1
To Mid Illovo	Full	6	14h28	11.9	25.0	59.2	14h57	28.6
To Eston	Full	5	13h45	11.9	19.9	75.2	14h21	35.9
To Eston	Full	9	16h20	11.9	21.2	73.8	16h54	33.7
Long Distance Route 1								
To Mid Illovo	Empty	3	09h25	16.6	45.8	78.9	09h46	21.7
To Eston	Empty	2	08h53	16.6	42.4	72.4	09h17	23.5
To Mid Illovo	Full	8	15h44	16.6	30.2	80.7	16h17	33.0
To Eston	Full	7	15h02	16.6	26.8	70.8	15h40	37.2

[1] Dammann M (2004). Hellberg Transport Management cc, Westville, Etekwini, South Africa.

From Table 1 it can be seen that, although the average speed of the vehicle was consistently higher on the longer route (Route 1), the travelling time was longer compared with the shorter route (Route2). On both routes the vehicle travelled at a higher average speed from Eston to Mid Illovo due to the slight drop in altitude. A summary of the differences between the two haulage routes are presented in Table 2.

Table 2. Results of the loaded trip to the mill and the empty return trip.

Difference between routes with the shorter route as the standard						
Direction of trip	**Load**	**Trip dist difference (km)**	**Avg speed difference (km/h)**	**Avg speed difference (%)**	**Trip time difference (min)**	**Avg time difference (%)**
To Mid Illovo	Empty	4.7	9.5	26	-2.1	-10.6
To Eston	Full	4.7	6.3	30	-2.4	-6.9

The vehicle on the empty trip to Mid Illovo, using the longer route, was able to travel at a higher average speed, 9.5 km/h or 26% faster than on the short route, but, because of the longer distance, it took two minutes or 11% longer to travel this route.

The vehicle on the loaded trip from Mid Illovo, using the longer route, was also able to travel at a higher average speed, 6.3 km/h or 30%, but again because of the extra distance it took two minutes or 7% longer to complete the trip.

The fuel consumption from both the measured results and the simulation were computed for an empty trip from Eston to Mid Illovo and a loaded return trip. The short route proved to be the most fuel efficient, and the fuel savings were 23.5 and 36% for the measured and simulated results respectively.

The independent evaluation of the two routes generally confirmed the trends of above results. The time taken on both routes was the same, but the fuel consumption for the longer route was more by 22% and 28% for the loaded and unloaded trips respectively.

Tyres

Operators would have to take care with their tyre selection when moving from an entirely tar road to a tar and dirt road. Incorrect selection could lead to severe tyre damage. Tyre costs are expected to be greater when using the shorter route because of the steeper gradients and sections of untarred road surface.

Vehicle operating costs

Cost data from the Road Freight Association ‘Vehicle Cost Schedule’(Edition 28, September 2003) was used to obtain an estimate of the cost differences between using the two alternative haulage routes. The various assumptions made to obtain realistic vehicle operating costs are listed below:

- six trips are completed each day
- the milling season is 38 weeks long and operates six days per week
- the vehicle chosen for the costing excerise was a seven axle interlink dropside
- the variable costs are given in Table 3. Repair and maintenance (R&M) costs and tyre costs were inflated by 20% when the vehicle was travelling on the short route. Research has shown that R&M and tyre costs will increase when vehicles are operated on gravel or rough road surfaces (Lyne *et al*, 1996).

Table 3. Vehicle operating costs used in the cost comparisons.

Variable vehicle costs	Variable costs (c/km)	
	Route 1	Route 2
Fuel	188	188
Lubricants	5	5
Repair and maintenance	81	97
Tyres	52	62
Total	**324**	**351**

The final result of this investigation, using the information given above, and including the extra R&M and tyre costs, indicated an annual saving of R33 106 per vehicle by using the shorter route.

Safety

This is a difficult judgement to make as both routes have sections with steep slopes and sharp corners, and each fleet owner or vehicle operator should base their decision on the experience and skill of their drivers.

Conclusions

In terms of travelling time there is very little to choose between the two routes, with the vehicle speed being slightly faster in both directions on the shorter route. The longer route does, however, mean an increase of 39% (9.4 km on each round trip) in distance and resulted in increased time and cost. It is therefore reasonable to assume that significant savings would result by using the shorter route, even though higher repair and maintenance costs and tyre costs would be incurred. The fuel consumption results also indicate that the vehicle uses significantly less fuel on the shorter route. The consultant's simulation programme confirmed the trends in terms of cycle times and fuel consumption.

From the above, the shorter route is recommended. Any upgrading of the road would lead to further benefits for users of this road. It is therefore recommended that efforts be made to engage the authorities to upgrade the road on the shorter route as this would lead to increased economic benefits to the area as a whole.

In addition to the above conclusion, BEEH obtained useful vehicle performance data which should prove valuable in refining a vehicle performance prediction simulation programme currently under development.

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