MAURITIUS RESEARCH COUNCIL
INNOVATION FOR TECHNOLOGY

DESIGN AND MANUFACTURE OF A COST EFFECTIVE TRAILER FOR CANE HAULAGE FROM FIELDS WITH HUMID SOIL CONDITIONS ONTO ASPHALT ROADS TO THE MILL

Final Report

MAURITIUS RESEARCH COUNCIL

Address:

Level 6, Ebène Heights,
34, Cybercity,
Ebène 72201,
Mauritius.

Telephone: (230) 465 1235
Fax: (230) 465 1239
Email: mrc@intnet.mu
Website: www.mrc.org.mu

This report is based on work supported by the Mauritius Research Council under award number MRC/RUN-0019. Any opinions, findings, recommendations and conclusions expressed herein are the author's and do not necessarily reflect those of the Council.

TECHNICAL ACHIEVEMENT REPORT

Design and manufacture of a cost-effective trailer for cane haulage from fields with humid soil conditions onto asphalt roads to the mill

AWARD NO. MRC/RUN-0019

Principal Investigator - Errol Jacquin

Mauritius Sugar Industry Research Institute

SUMMARY

A sugar cane trailer was designed to transport 15 tonnes payload without overfilling, from fields with humid soil conditions, straight to Mon Desert Alma factory. It was a longer trailer than the standard ones operating on the estate and was built with the objective of increasing carrying capacity. The maximum height and width are however determined by the National Transport Authority. A lighter material was used to avoid increase in weight of the trailer. Hitched to a 100 HP tractor, the trailer operated on an industrial scale during the 2001 and 2002 crop seasons. In spite of its lower weight, it transported on average two tonnes cane more per trip than standard trailers. Its light weight and large tyres inflated at very low pressure allowed the trailer to operate alongside a chopper harvester on tracks, in extremely humid field conditions without any deleterious effect on the soil and the sugar cane plants. The combination of light weight and tyres also resulted in better fuel use efficiency and reduced shocks in the tractor cabin during haulage. As the harvester operator is able to see through expanded metal sidewalls, better filling of the trailer bin can be achieved.

ACKNOWLEDGEMENTS

This project was carried out under partial funding by the Mauritius Research Council (MRC) and Mon Desert Alma Sugar Estate. The assistance of Mrs. P.V. Ramjeeawon (MRC) and Mr. Jean Claude Hoareau, OBE (General Manager, MDA) is gratefully acknowledged.

I would like to express my sincere appreciation and thanks to the following :

Messrs Georges Rouillard, Stellio Prefurno, Jimmy Anthony, as well as the workshop and weighbridge staff of MDA.

My colleagues Dharam Gunness, Vivian Riviere and Berty Bonne for their precious help

-Professor Marie France Destain from the Faculte des Sciences Agronomiques of Gembloux, Belgium and Mr. Jocelyn Deville, former Deputy Director, MSIRI for having acted as referees to the project

Mr. Roland Pirot from CIRAD for his guidance on the utilization of the data logging system

I am also grateful to the local agents of ALLIANCE and MICHELIN tyres for providing technical information.

Finally, my special thanks go to the tractor driver Coomar for his careful driving and valuable feedback.

Table of contents

List of figures

List of tables

List of Appendices

I - Technical features of Light Weight Trailer

Introduction

Until 2001, the side walls of tipper trailers used for the transport of chopped cane at Mon Desert Alma Sugar Estate were made of thick (4.5 mm) iron sheeting. At the initiation of the project, three trailers were modified by the estate with the objective of reducing tare weight as proposed in the project, but a different material was utilized. The performance of the Light Weight trailer, built under the aegis of a project partially funded by the Mauritius Research Council, was compared to that of two other trailer types operating at MDA. Low pressure tyres, essential for the humid conditions of the estate, were also evaluated.

Volume, payload and tare weight

In Mauritius, most trailers used for the transport of sugar cane are characterized by a high dead (tare) weight with respect to the weight of cane transported (Pyneeandee, 1995). According to Poole (1989), the dead weight should be reduced to a minimum since half of the life of a transport unit is spent in trips without payload back to the fields. The ratio of payload to total vehicle tare should be 2:1. He reported that for every unit of fuel consumed, one third is for carrying metal and two thirds for payload. De Beer (1991) proposed a ratio of 1.5:1.

Figure 1 : Standard trailers for whole-stalk and chopped cane

a - basket b - bin

However, the above ratios apply to trailers transporting whole cane in baskets with openwork side walls (Fig. 1-a). The same ratio is not applicable chopped cane bins (Fig. 1-b), where the full side walls are heavier, as shown in table 1.

Table 1 : Some payload : tare weight ratios for chopped cane transport units

Estate (year)	Payload (t)	Tare (t)	Ratio
Beau Champ(2001)			
Lorry & fixed trailer	26	19	1.37
Tractor & parked bin trailer	21	15	1.40
Belle Vue Mauricio (2002)			
Lorry & moving bed trailer	20	18	1.11
Tractor & tiooer trailer	15	15	1.00
FUEL (lorry & parked bin trailer)	24	25	0.96
Medine (2001)			
Tractor & parked bin trailer	21	19	1.11
MDA (1999)	13	12	1.08
Tractor & tiooer bin			

The main concern up to now is the robustness of trailers. Those to be hitched to lorries or agricultural tractors should be able to carry maximum permissible payloads without breaking down during operation. Big iron bars or sections, most often too big with respect to the payload, were used as a precautionary measure. The same reasoning applied when bins for chopped cane transport were manufactured.

Table 2 : Technical parameters of operation for 3 trailers at MDA

	TRAILER TYPES (2001)		
	Light-weight (LW)	Iron sheeting (IS)	Galvanized sheetino (GS)
Bin volume (m^3)	38	25	34
Tractor (73 kW) and trailer tare weight (t)	10.550	12 450	11.850
Maximum payload : tare weioht ratio	1.99 : 1	1.41 : 1	1.51 : 1
Mean oavload (t)	15.55	13.33	14.17
Mean oavload : tare weioht ratio	1.47 : 1	1.07 : 1	1.20 : 1
Mode (t)	15.800	12.470	13.530

A significant weight reduction as compared to the Iron Sheeting trailer as well as an increase in volume were obtained. However, when compared to the trailers modified by MDA (Galvanized Sheeting), the weight reduction may appear negligible, but the volume of the Light Weight trailer is still greater by 4 m^3.

Figure 2 Three trailer types operating at MDA (20()1)

A-Iron Sheeting (IS)

B -Light-Weight (LW)

C-Galvanized Sheeting(GS)

As shown in **table 2,** the LW trailer has the lowest tare weight. Although it has the highest useful volume, it is lighter than the IS trailer by nearly two tonnes and than the GS trailer by 750 kg. This was made possible with the use of lighter material for the construction of the trailer.

Structures - chassis et Side supports

The main chassis of the LW trailer was made with the same I girders of slightly smaller dimension as IS trailers. It was not possible to use smaller sections as the trailer would be longer and transporting higher payloads. However, the tipping chassis was made of lighter material (half the thickness of the section used for the IS trailer **– Table 3, item No 2)**

Table 3 : Material used for manufacturing two trailer types

No	Item	Iron Sheeting (IS)	Light-Weight (LW)
1	Main chassis	Mild steel I channel 254 x 152 mm	I girders 254 x 127 mm
2	Tipping Chassis	Box sections 204 x 150 mm	U channels 204 x 75 mm
3	Side and floor supports	U channel 102 x 51	U Channel 75 x 37.5 mm
4	Floor	Steel sheet 2.8 mm thick	steel sheet 3 mm thick
5	Side walls	Expanded metal 'Flatex'	steel sheet 4.5 mm thick

Side walls material

One of the main components contributing to the weight of standard trailers in Mauritius is thick side wall material. In South Africa, wire netting, a very light material, is currently used. Since this type of product was not available locally, expanded metal was used instead.

Table 4 : Comparison of side wall material for two trailer types

Material	Weight of unit area (ko m^{-2})	Total weight (ko)
4.5 mm Iron Sheeting	22.45	1007
Expanded Metal	6.11	274

Apart from being lighter, expanded metal allows to see through, and thus allows the chopper harvester operator to have a better outlook on where the cane billets are falling. This is conducive to a better filling of bins by ensuring a uniform height to avoid cane falling during transport **(Fig. 3).**

Figure 3 : Filling of Light-Weight bin by chopper harvester

This principle has been adopted by FUEL for its parked bins system receiving chopped cane from infield tippers **(Fig. 4).** One unit modified in 2002 operated satisfactorily during the crop. Several other bins have been modified for the 2003 crop. Otherwise, labour has to be used to level cane in the bin **(Fig. 5)** after filling by infield tippers.

Figure 4 : Parked bin of FUEL with expanded metal side wall

Figure 5 : Levelling of chopped cane in parked bins at Savannah

Tipping device

No problems were encountered with the tractor after two years operation of the trailer tipping device by the tractor's hydraulic system. Previously a PTO driven pump and an oil tank had to be mounted on the trailer. This feature has led to a 200 kg weight reduction. It has also allowed to avoid the use of a PTO shaft which can become a serious safety hazard if necessary precautions are not taken. Moreover, the driver task is simplified as he does not have to engage the PTO shaft to initiate lifting of the basket for tipping.

II - Cane transported and fuel consumption

Following problems encountered with the cane grab during mechanical loading of manually harvested cane at the start of the 2001 crop (Progress Report 2002), the Light-Weight trailer was utilized solely for the transport of chopped cane. Moreover, with the reduction of labour force after application of the Voluntary Retirement Scheme (VRS) by MDA, chopper harvesting is programmed to gradually replace manual harvest. Hitched to a 73 kW agricultural four wheel drive tractor, the LW trailer was assigned together with two other transport units (GS and IS trailers) of MDA to a chopper harvester on tracks operating under humid conditions in a radius of 5 – 8 km from the mill.

Table 5 : Comparison of weight transported by 3 trailer types

	August - October2001			2002 crop*	
	IS	LW	GS	LW	GS
Total cane transported (t)	6304	5724	5738	11949	11 256
Number of trips	474	368	405	863	884
Mean payload (t)	13.30	15.55	14.17	13.85	13.00
Mode (t)	12.47	15.80	13.53	14.39	10.95
Density of payload (t m^{-3})	0.532	0.409	0.416	0.365	0.369

*In 2002, IS trailers were no longer assigned to chopped cane transport

As shown in table 2, the Light-Weight trailer with 4 m^3 space more than the GS, has transported on average one tonne cane more per trip. However, considering the density, the GS trailer seemed to benefit from a better filling. In fact, the figures show instead that a higher payload can be transported without overfilling the LW trailer. The layer of cane over the rim shown in figure 3 shows the opposite of the research objective which was to transport about 15 tonnes cane without the risk of dropping cane on roads. The photo was made during a test to measure the maximum capacity of the trailer which was found to be 20 tonnes. The mode values show clearly the superiority of the LW trailer.

It is not always possible for trailers to transport cane to their maximum capacity. Figure 6 shows the frequency distribution of payloads for the three trailer types in operation in 2001.

Two factors are responsible for payloads lower than 12 tonnes. For the first three months of the crop season (June to August), the payload was voluntarily limited to 10-12 tonnes on rainy days to avoid deep ruts (Fig. 9) and reduce damage to cane plants. The mean payload values for the whole crop as compared to those of the drier period only (Table 6) show the effect of this strategic decision. For the remaining of the crop season, when harvest of a block is completed, the unit must transport the cane left to the mill, even if its trailer is not completely filled.

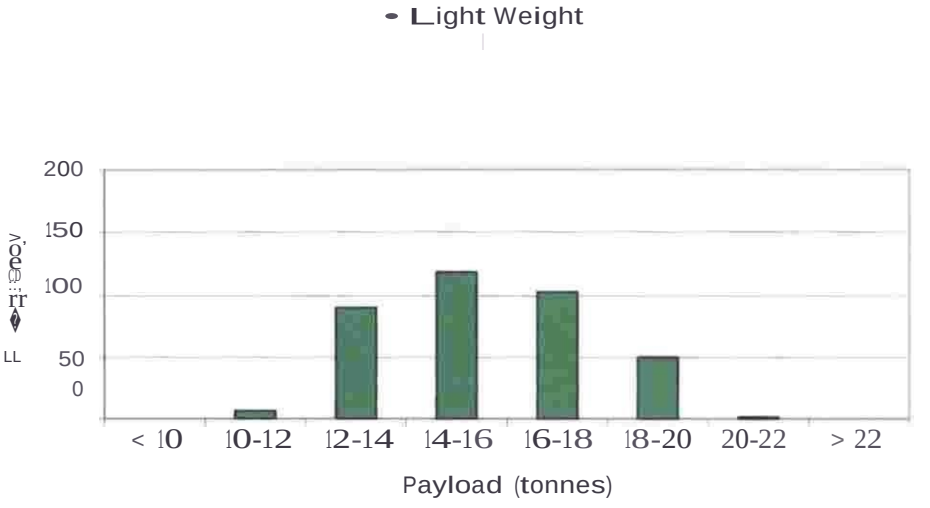
Table 6 : Effect of rainy weather on payloads

	LW		GS	
	Whole crop	As from September	Whole crop	As from September
Number of trips	863		884	
Total weight transported (t)	11948		11493	
Mean payload (t) (as from September)	13.85	14.07	13.00	13.82
Mode (t)	14.390		10.950	

Payloads higher than 12 t represent the normal conditions of operation. Both the LW and GS trailers performed the majority of their trips in the 14 – 16 t payload range as compared to 12 – 14 t for the LW trailer (Fig. 6). This trailer has however more trips in the high payload (>16t) range than the GS trailer. It is also the only of the three to have transported payloads higher than 18 t.

The GS and LW trailers have a superior carrying capacity than the IS. Consequently, after 2001 crop, MDA decided to convert all its IS trailers operating with the chopper harvester with the view of reducing tare weight. Unfortunately, as it was not yet possible to assess the lifetime of expanded metal, the material chosen to replace the thick IS was GS, which although being a light material, does not, like expanded metal, allow to see through.

Figure 6 -a Comparative frequency distribution of payloads (t) for 3 trailer types 2001 crop



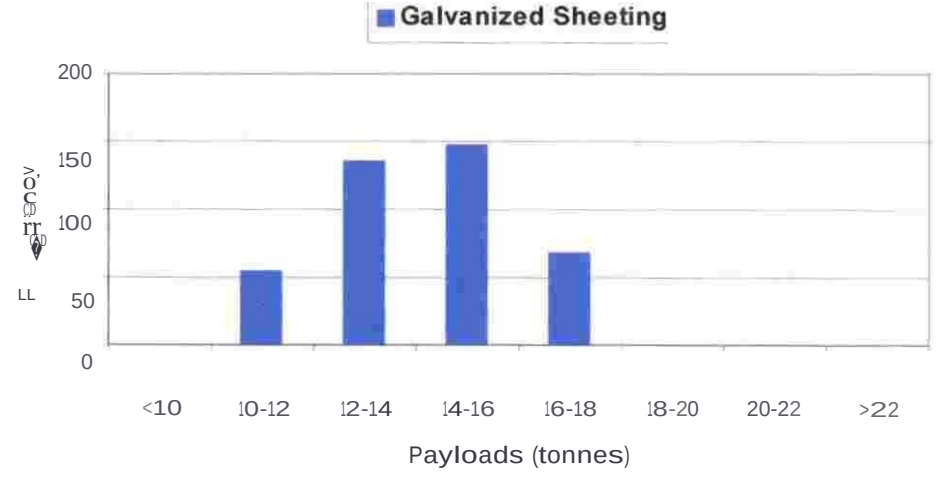
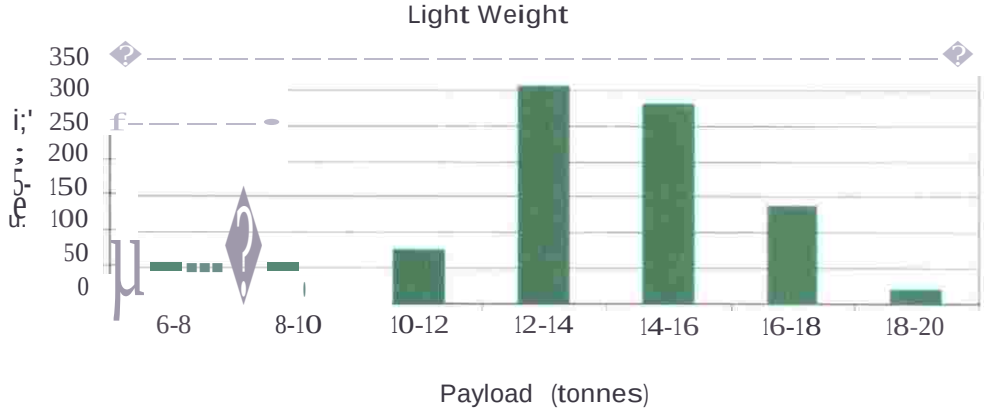
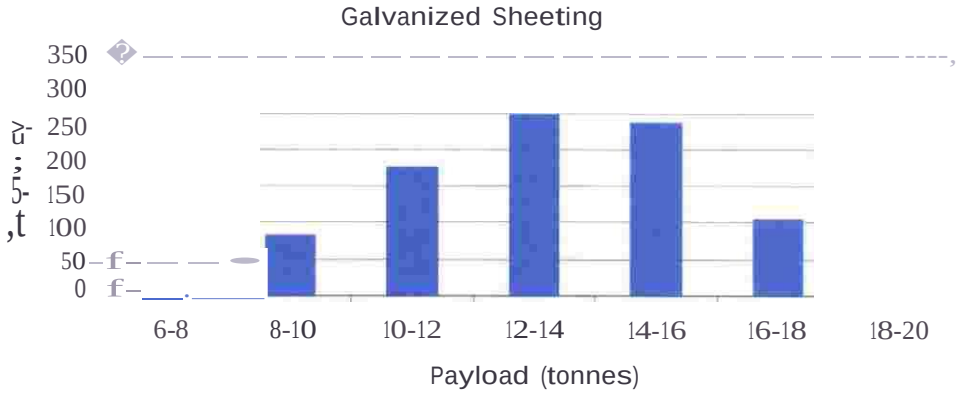


Figure 6-a : Comparative frequency distribution of payloads (t) for 2 trailer types 2002 crop





Fuel consumption

The fuel consumption was measured in L h^{-1} for the LW and a lS trailers drawn by the same 73 kW tractor equipped with the electronic data acquisition system (Progress Report, 2002). The comparisons in table 7 and figure 7, based on measurements recorded by the electronic system show clearly a higher fuel use efficiency of the LW trailer, which is attributed to :

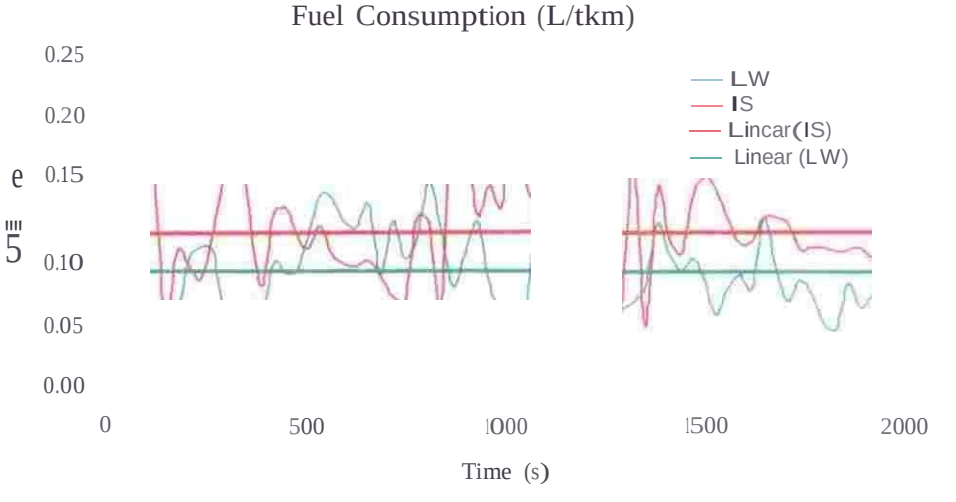
a lower empty (tare) weight
a higher payload transported and
low pressure tyres

Table 7 : Comparative fuel consumption during cane transport (2001)

Light-weight trailer			Iron Sheeting trailer		
Payload (t)	Speed (km h')	Fuel (l h^{-1} t^{-1})	Payload (t)	Speed (km h^{-1})	Fuel (l h' t')
16.71	17	1.43	12.74	18	1.58
12.96	17	1.58	12.13	20	1.67
11.52	15	1.57	11.94	17	1.70
15.37	15	1.44	-	-	-

Low pressure tyres, being wider and of larger diameter than standard ones ensure a better grip, resulting in superior traction and reduced rolling resistance. These factors contribute to lower fuel consumption by the prime mover pulling the trailer equipped with such tyres.

Figure 7 : Comparative fuel consumption during road haulage phase



Considering payload and fuel consumption, the LW trailer is the most cost-effective, followed by the GS trailer. The IS trailer is too heavy with respect to its payload. The superiority of the LW trailer over the GS is due to an extra capacity of 4 m^3 and the material of the side walls which allow to see through, ensuring a better filling.

III -Low pressure tyres

In Mauritius, tyres fitted to tandem axle trailers are inflated to 600 -800 kPa. During in-field operation in extremely humid conditions (up to 70% soil moisture), wheel slippage occurs frequently, resulting in :

damage to soil structure
trailer sliding and wheels damaging cane stubbles
transport unit being immobilzed in the field

Transport units, with low pressure tyres and other adapted accessories, operate in similar conditions during sugar beet harvest and for log haulage from forests. The use of low pressure tyres for field to mill cane haulage on an industrial scale in extremely humid conditions can be considered to be a major breakthrough. Mauritius is one of the few, if not the only sugar cane producing country to have initiated research in this field.

The first set of tyres tested in 1999, prior to project initiation, were 550/60 R 22.5, 12 ply tyres. The trailer fitted with these tyres transported about 20 000 tonnes cane during the 1999 and 2000 crop seasons. As compared to standard tyres (Table 8), low pressure tyres are wider, ensuring less ground pressure but better adherence. The combined effects of lower inflation pressure and bigger diameter are a reduced rut formation and sinkage in soft and humid ground. This explains the ability of transport units equipped with such tyres to operate without damaging the field and without being stuck.

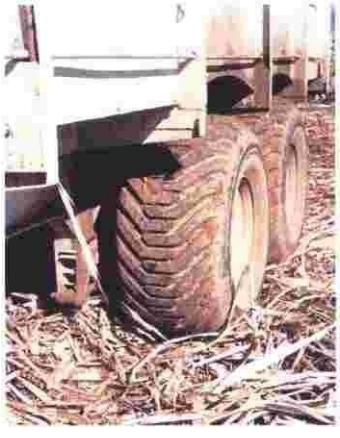


Figure 8 :
The Low pressure Alliance
550/60 - 22.5 12 PR tyre

Table 8 : Characteristics of low pressure and standard tyres utilized at MDA

Dimension	Standard tyre 425/65R22.5	Low pressure tyres 550/60 - 22.5
Width (mm)	408	550
Sectional height (mm)		330
Rim diameter(mm)	570	570
Total height (m)	1.092	1.230
Rolling circumference (mm)	3406	3440
Tyre construction	Radial	Cross Ply
Ply rating	-	12
Maximum load (kg)	8630	3600
Recom. Pres. (k Pa)**	700	* 210
(maximum speed)	(110 km h^{-1})	(60 km h^{-1})

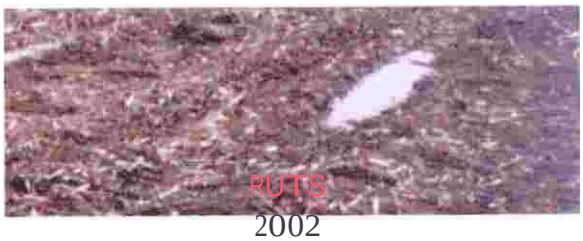
**Source: Alliance brochure (Appendix 1)

* As the operating speed both on road and in the field is much lower than 60 km h', the low pressure tyres were inflated at 150 k Pa under the suppliers instructions (Appendix 2). With the trailer operating with such tyres, transloading on field edge was avoided, thus reducing transport costs (3 small in-field tipper units redundant). The LW trailer was fitted with this tyre type.

With the excessive amount of rainfall in early 2002 as compared to 2001 (Appendix 3) the ground was so humid at the start of the crop season that rut formation was again observed (Fig. 9). Observations of the transport units in operation revealed that it was the tractors' wheels and not those of trailers that were responsible for rut formation. Consequently, for the first three months of the crop, payloads had to be reduced to decrease weight transferred to the tractor's rear axle and minimize damage to the field and crop. The effect of this decision on payloads is shown in table 6 and figure s-b.

Figure 9: Ruts formed in 2002

1999 - 2001
Neat footprint



2002

Lifetime of low pressure tyres

The inflation pressure of low pressure tyres is a compromise between field and road conditions. On soft ground (low speed and payload), a lower pressure is adequate while on the road with full payload, higher pressures are recommended (Table 9) Similar information on Alliance 550/60 – 22.5 tyre are in Appendix 1.

Table 9 : Influence of load (kg) on tyre inflation pressure and speed

CARGOXBIB 560/60 R 22.5 tyre	Pressure (kPa)			
	150	200	260	320
30 km h-1	3980	4910	5910	6370
65 km h-1	2670	3270	3920	4220

Tyre dimensions (mm)

Width	*Sectional height*	Total height	Rolling circumference
570 mm	336	1251	3678

Source : Michelin brochure (Appendix 4)

At MDA, priority was given to field conditions rather than payload. Transport units with tyres inflated at a very low pressure nevertheless transported about 20 000 tonnes cane over two crop seasons. Low pressure tyres for tractors are also available. Ideally the same tyres should be used at low pressure in the fields and inflated to a higher pressure when the unit has to travel on asphalt to the mill. A device allowing pressure variation is available on the market (**Appendix 5).** This device could allow tyre use in their optimal conditions and significantly increase lifetime.

Low pressure tyres with radial ply

After the 2001 crop, standard trailer tyres were no longer required by MDA. To avoid losing this market (> 24 tyres every 2 years), the supplier of these tyres who did not have low pressure ones in its range decided to manufacture them as from 2002. The innovation was that his low pressure tyres were with radial ply as compared to cross ply for previous ones. In 2003 most tyre manufactures decided to follow this trend. The advantages of radial construction over cross ply no longer need proof :

- better traction and less slip, as the tyre rolls like a track
- better distribution of pressure on the ground, the contact patch giving lower compaction
- reduced fuel consumption
- longer tread life
- comfort and flexibility

A set of radial low pressure tyres was fitted to the LW trailer at the end of September 2002. As humid conditions no longer prevailed at that period, the efficacy of the radial construction could not be assessed.

IV - Tractor Driver's point of view

If technical characteristics give a precise evaluation of an equipment's performance, the best judge remains the utilizer. The LW trailer, with respect to its length, increased capacity and low pressure tyres, being completely different from other transport equipment, acceptance by the tractor driver is also an important criterion of evaluation.

The first driver to work on the tractor pulling the LW trailer did not find any difficulty to drive the trailer in the usual field conditions and topography of the estate. However, on side slopes, he considered his tractor-trailer assembly less stable than conventional transport. Particular attention should be given when operating in such condition. Another driver working with the trailer in 2002 was of the same opinion.

Both drivers were fully aware of the benefits of low pressure tyres. They experienced less shocks during braking and when travelling over pot holes.

As regards solidity of the trailer, according to the drivers, it has not spent more time at repairs in spite of the lighter framework sections and filling to full capacity (**Fig. 3).** This was confirmed by the total number of trips and weight transported in 2001 and 2002 (**Table 5)** with a higher average payload than the other trailers built with stronger material.

V - Self opening back door

Normally lorry helpers of transport units open the back door of trailers for cane unloading by tipping. With the application of the Voluntary Retirement Scheme (VRS), less and less labour is available on sugar estates. MDA decided in 2001 to allocate one helper to each transport unit. Three GS trailers were thus fitted with self opening doors. The design was adapted from side opening/unloading trailers operating in south Africa.

As no problems were encountered with the new doors, it was decided in 2002 to fit one to the LW trailer.

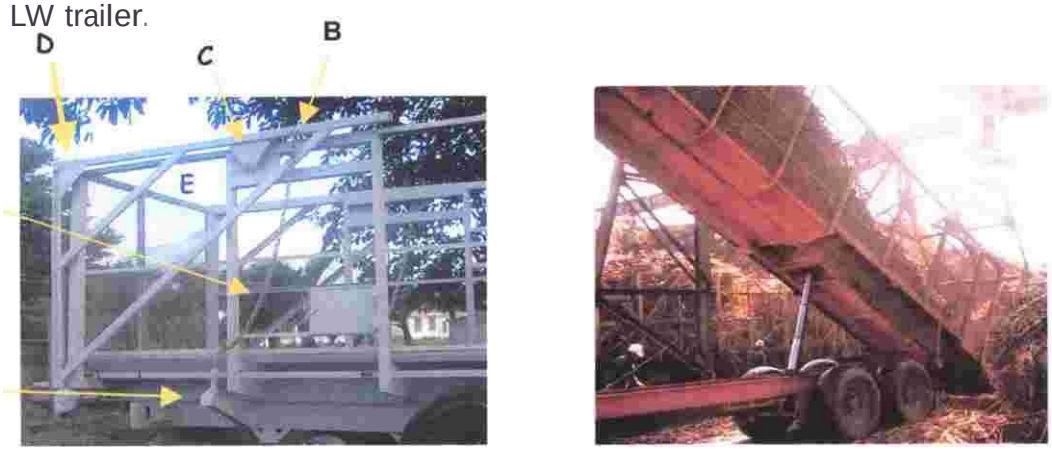


Figure 10 : Principle of operation of self opening door

The principle of operation of the door is very simple. When the trailer basket is lifted for tipping cane, the chain which is fixed to the chassis at point **A** pulls on the top of the door at point **B** making it pivot around point **C.** As tipping proceeds, edge **D** of the door is lifted, allowing cane to slide down the rear end of the basket. The upper frame of the door acts as a support to the basket side walls, preventing them to be pushed apart by the cane load.

No problems were encountered with the new door.

VI - Cost of Light Weight trailer

The technical characteristics of the LW trailer having been assessed, the economic aspect was then looked into. The trailer was manufactured by GEROLAIN Mechanical Services, a well known manufacturer of transport equipment for the sugar industry.

Table 10 shows the actual costs of the LW and the IS trailers. The quotations are in appendix 6 . As there are no significant differences in labour required, the cost of manufacture (labour and material) is more or less the same. The smaller sections (Table 3) used in the framing of the LW trailer should have reduced the cost, but more material have been used, the trailer being longer (Progress Report 1) than the Iron Sheeting one.

Table 10 : Comparative costs (MUR - *VAT* excluded) of trailers

		Light Weight	Iron Sheeting
1	Manufacture of trailer (GEROLAIN)	335 500	332 850
2	Tandem axles	90 300	90 300
3	Underslung suspension	64 600	64 600
4	Hydraulic brake and one hand brake lever	15 500	15 500
5	One tipping ram assembly of 25 tonnes capacity	39900	39 900
6	One hydraulic kit (pump, PTO shaft, oil tank	0	30 500
7	One tow bar with spring	42 000	42 000
	Total	587800	615650

With respect to accessories (items 2 – 6), both trailers use the same type and capacity. However, as no hydraulic kit was used for tipping of the LW trailer (Progress Report 1), cost of accessories was reduced by MUR 30 500, bringing the total cost to MUR 587 000. The cost of the trailer is thus MUR 32 027 (including VAT) lower than the IS trailer which has a lesser carrying capacity.

Table 11 : Comparative costs (MUR, excluding *VAT)* of low pressure and standard tyres from same manufacturer

	Low Pressure 560/60 R 22.5	Standarad 425/65R22.5
Unit	25 590	17152
Set of Four	102 360	68 608
Difference (incl. VAT)	38 815	-

The project has highlighted the advantages of low pressure tyres in extremely humid conditions. Their use should prove to be cost-effective even under other climatic conditions. As mechanized harvest extends, it is expected that producers equip more and more of their transport units with such tyres. Moreover, if their use can reduce fuel consumption as claimed by manufacturers (Appendices 2 & 4), a further benefit would be environment conservation.

Cost can however be deterrent. Tyre prices comprise an import duty of 30%. Duty removal on tyres for agricultural use should be considered by relevant authorities so as to make them more accessible to producers.

VII - Conclusions and Recommendations

1. This project has shown that the use of light material for the manufacture of sugar cane trailers is feasible. Operation of the tipping device by the tractor hydraulic system was also successful.

2. Better filling with cane is possible with the use of expanded metal side walls.

These features contribute to more efficient cane transport and reduced costs. In addition, expanded metal for side walls of parked bins should improve filling efficiency.

3. The above findings should not be limited to cane haulage in the superhumid zone.

4. Mauritius is among the first few countries to have successfully tested low pressure tyres in extremely humid field conditions and on roads. Consequently, their use in industrial conditions has contributed to the reduction of chopped cane transport cost at Mon Desert Alma.

5. Low pressure tyres could also prove to be cost-effective in dry field conditions and long distance road haulage

6. One of the project outcomes has been the importation of several makes of low pressure tyres. Competition should contribute to price reduction. Furthermore, reduction of duty would render these tyres more accessible to producers.

7. The use of a high volume trailer does not refrain tractor drivers from over filling their trailers. Therefore, drivers should be made aware of the technical and legal implications of over loading trailer and tractor axles.

8. It has been shown that hydraulic PTO driven pump and oil tank on trailers are no longer needed. This should result in reduced trailer purchase and operation costs as well as safer use.

9. In spite of increased volume, manufacturing costs of the Light Weight trailer are not higher than that of standard ones.

10. The Light Weight trailer is a cost effective transport equipment which, as a result of the project, can be recommended for direct field-mill delivery of chopped cane in Mauritius.

References

De Beer, G., Hudson, J.C., Meyer, E. and Torres, J. (1995). Cost effective mechanization. *Proc. int.* Soc. Sug. *Cane Technol.* 21 (2): 228-239

Jacquin, E. (2001). Design and manufacture of a cost-effective trailer for cane haulage from fields with humid soil conditions onto asphalt roads to the mill. Progress Report No. 1, - AWARD NO MRC/RUN-0019 (Unpublished report)

Jacquin, E. (2002). Design and manufacture of a cost-effective trailer for cane haulage from fields with humid soil conditions onto asphalt roads to the mill. Progress Report No. 2 -AWARD NO MRC/RUN-0019. (Unpublished report)

Poole, H. (1989). Cost effective sugar cane transport. Sug. *Cane* (1): 4-6

Pyneeandee, D. (1995). Cost effective transport systems in a modernized cane sugar industry. Project, B. Tech (Hons) in Sugar Engineering, University of Mauritius.

Appendix 1

Technical information on ALUANCE 550/60 - 22.5 tyres

Flotation High Speed

(low section) 1–3 tubeless

Tubeless flotation high speed tire wrth se◊-<:leanng design. High load capacity at low inflation pressures prevent damage to fields and crops. Suitable for on and off-the-road agricultural service on traiers and implements. Strong nylon construction and compounds ensure long IWe at high speed application

Speed 70 km/h (45 mph) for 22.5" rim

60 km/h (35 mph) for 26.5" rim

Size	P.R	Rim	M3ldmum load		Inflation		Unloaded inflation dimensions				Loaded static radius		Rolling circumference	
					psi	bar	Section width		Overall diameter					
			lbs	kg			inches	mm	inches	mm	inches	mm	inches	mm
	8		5700	2585	23	1.6								
500/60-22.5	12	16.00 DC	7205	3275	35	2.4	19.89	500	46.06	1170	19.69	500	135.43	3440
	16		8540	3875	46	3.2								
	8		6395	2900	20	1.4								
550/60-22.5	12	16.00 DC	8025	3600	30	2.1	21.65	550	48.74	1238	20.75	522	143.31	3640
	16		9495	4310	40	2.8								
	8		5920	2685	19	1.3								
600/50-22.5	12	20.00DC	6930	3150	29	2.0	23.62	600	46.06	1170	19.69	500	135.43	3440
	16		9090	4120	38	2.6								
	8		6950	3155	19	1.3								
600/55-22.5	12	20.00DC 19.00 DC	8730	3970	29	2.0	23.62	600	49.80	1265	20.94	532	146.46	3720
	16		10175	4625	38	2.6								
	8		6205	2815	16	1.1								
700/40-22.5	12	24.00 DC	8010	3640	25	1.7	27.56	700	46.06	1170	19.69	500	135.43	3440
	16		9305	4230	32	2.2								
	8		7790	3535	18	1.2								
700/50-22.5	12	24.00 DC	9980	4535	26	1.8	26.35	700	50.00	1270	21.02	534	147.00	3734
	16		11815	5370	35	2.4								
	8		7390	3360	19	1.3								
600/55-26.5	12		9230	4195	29	2.0	23.27	600	52.48	1333	22.09	561	154.30	3919
			11010	5005										
	8		8145	3700	18	1.2								
700/50-26.5	12	24.00 DC	10330	4695	26	1.8	27.36	700	46.06	1333	22.09	561	154.30	3919
	16		12530	5695	35	2.4								

Size	PR L1	Unloaded dimension Width mm	Diam mm	Loaded Static Radius mm	Rolling Circumf mm	Speed km/h 0	20	40	50	60	70	tion Pressure bar
550/45-22.5 1600 D.C 18.00 D.C Regular duty I-328	8 137A8	550	1070	485	3230	4130	3500	2500	2270	2130	2000	1 1
						4340	3680	2630	2390	2240	2100	1.2
						4540	3850	2750	2500	2340	2200	1.3
						5360	4550	3250	2950	2770	2300	1 4
						6430	5460	3900	3540	3320	2760	1.9
	12 145A8	550	1070	485	3230	5360	4550	3250	2950	2770	2600	1.5
						5580	4730	3380	3070	2880	2700	1 6
						5780	4900	3500	3180	2980	2800	1.7
						6810	5780	4125	3750	3510	2900	1.8
						8170	6940	4950	4500	4210	3480	2.5
						6670	5660	4040	3670	3440	3230	2.5
	16	550	1070	485	3230	6830	5800	4140	3760	3520	3310	26
						6980	5920	4230	3850	3600	3380	27
500/60-22.5 1600 D.C Regular duty I-328	8 141E	500	1170	510	3440	9650	8200	5850	5320	4980	4140	3.8
						4500	3820	2730	2480	2320	2180	1 2
						4700	3990	2850	2590	2430	2280	1 3
						5120	4340	3100	2820	264	2480	1 5
						5360	4550	3250	2950	2770	2575	1.6
						6430	5460	3900	3540	3320	3090	22
	12 149E	500	1170	510	3440	5680	4820	3440	3130	2930	2750	1 8
						6020	5110	3650	3320	3110	2920	2.0
						6370	54	3860	3510	3290	3090	2.2
						6810	5780	4125	3750	3510	3250	24
						8170	6940	4950	4500	4210	3900	33
	155E	500	1170	510	3440	7080	6010	4290	3900	3650	3430	2.6
						7390	6270	4480	4070	3810	3580	2.8
						7690	6520	4660	4240	3970	3730	30
						8040	6830	4875	4430	4150	3875	3.2
						9650	8200	5850	5320	4980	4650	4.4
550/60-22.5 1600 D.C Regular duty I-328	8 145E	550	1238	540	3640	5200	4410	3150	2860	2680	2520	1.1
						5460	4630	3310	3010	2820	2650	1.2
						5740	4870	3480	3160	2960	2780	1 3
						6020	5110	3650	3320	3110	2900	1.4
						7220	6130	4380	3980	3730	3480	1.9
	12 153E	550	1238	540	3640	6170	5240	3740	3400	3180	2990	1.5
						6650	5640	4030	3660	3430	3220	1.7
						7100	6020	4300	3910	3660	3440	1 9
						7430	6300	4500	4090	3830	3650	2.1
						8920	7560	5400	4910	4600	4380	29
						7840	6650	4750	4320	4040	3800	2.2
	16 159E	550	1238	540	3640	8250	7000	5000	4550	4260	4000	2.4
						8650	7340	5240	4760	4460	4190	2.6
						8990	7630	5450	4950	4640	4375	2.8
						10790	9160	6540	5940	5570	5250	3.8

High load variation (HLV)
When fitted on tractor steering wheels load capacities are 80% of free rolling and inflation pressure 20% higher.
For 10 km/h and stationary use inflation pressure raised 20°/0 and 25% respectively.

Appendix 2

Instructions on conditions of use of 'ALUANCE'low pressure tyres by supplier (Undergear)

UNDERGE'AR
EQUIPMENT(RBP) LTD

UNDERGEAR EQUIPMENT (RBP) LTD
BLACK LAKE WORKS. WEST BROMWICH
WEST MIDLANDS 870 OPD. ENGLAND
TELEPHONE: 0121-553-1606

FAX No 0121-553-1301

FROM: DEREK G. CARPENTER
DATE 2nd January 1997

PAGES 1/2

To : MAURITIUS SUGAR INDUSTRY RESEARCH
ATTN: E. JACQUIN
FAX No. 0230 4541971

FAX

A VERY HAPPY NEW YEAR!

RE : TYRES/WHEELS FOR SUGAR CANE TRAILERS

Thank you for your fax of 23.12.96.

On your trailers you currently have 22.5 wheels and I assume they are fitted with truck tyres running at high inflation pressures e.g. 7 or 8 bar (90 PSI) or more.

With tandem axles and a load requirement of 15 tonnes I suggest you fit:-

TYRE SIZE 550/60-22.5 12 PR 328/404 PATTERN fitted to wheels 16-22.5"

TYRE DIMENSIONS ARE:-Width 550mm (21.65") Diameter 1238mm (48.74")
Static Loaded Radius 522mm *(20.55')*

The use of this tyre would raise your axle height (and deck loading height) by about 40mm. But you could operate these tyres at an inflation pressure below 2.1 Bar (30 PSI)
The actual maximum load of each tyre is 4550 kgs at 2.1 Bar giving a total capacity over 4 tyres (2 axles) of 18200 kgs.

You state 15000 Kgs total load and if we assume 20% on the drawbar this gives 12000 Kgs on the axles or 3000 kgs per tyre. On these figures you could operate at 1.5 Bar (22 PSI) a dramatic reduction compared with the existing fitment.
The question is whether you can accomodate the 550rnm width *of* each tyre. We could produce the wheels with an offset if necessary, to keep the tyres inside the trailer body. The wheels can be made to match your existing hubs (10 stud?)

To sum up you would have tyres wit11 a very flat profile, 550mm wide running at considerably reduced inflation pressures. The result will be considerably reduced soil damage and the trailer will be much easier to pull, with consequent fuel savings. These tyres do have a 45Kph maximum speed rating!

Now to the bad news. The cost of each tyre and wheel, fitted ,ready to bolt on to your trailer is £535 ex works. I will be happy to quote CIF Mauritius for a specific quantity.

Best Regards

, tread pattern is enclosed.

viii need to get some hub details from you in order to produce the wheels to the correct specification. I any quenes.

DEREK G CARPENTER
fANAGTNG DIRECTOR

Appendix 3

Rainfall data (mm/week) for January to August 2001 & 2002

Rainfall in the Centre (mm)

Month	Period	2001	2002
January	1–5	25.1	131.1
	6-10	9.1	67.9
	11–15	96.3	29.7
	16-20	88.1	22.7
	21–25	38.0	518.8
	26-31	26.7	58.7
		283.3	**828.9**
February	1–5	16.7	32.4
	6-10	31.6	4.9
	11–15	31.9	24.0
	16-20	42.5	77.3
	21–25	17.6	0.5
	26-28	22.8	2.8
		163.1	**141.9**
March	1–5	17.1	60.5
	6-10	16.4	43.8
	11–15	20.2	82.0
	16-20	5.7	6.0
	21–25	60.3	19.1
	26-31	7.7	11.4
		127.4	**222.8**
April	1–5	47.3	30.4
	6-10	47.8	32.8
	11–15	144.0	1.2
	16-20	5.1	5.4
	21–25	41.6	17.4
	26-30	2.3	5.6
		288.1	**92.8**
May	1–5	2.1	41.1
	6-10	3.3	13.5
	11–15	8.9	2.3
	16-20	20.7	26.1
	21–25	11.5	9.7
	26-31	22.8	45.6
		69.3	**138.3**
June	1–5	1.2	31.2
	6-10	10.9	10.9
	11–15	8.1	23.0
	16-20	16.2	10.0
	21–25	17.4	26.5
	26-30	31.9	10.8
		85.7	**112.4**
July	1–5	28.2	17.7
	6-10	5.5	18.2
	11–15	8.5	7.4
	16-20	6.3	10.8
	21–25	5.8	28.6
	26-31	36.9	15.8
		91.2	**98.5**
August	1–5	61.5	15.0
	6-10	10.3	29.9
	11–15	1.1	17.9
	16-20	8.2	4.6
	21–25	4.5	13.2
	26-31	16.6	36.5
		102.2	**117.1**

Source: Mauritius Meteorological Services

Appendix 4

Technical information on MICHELIN CARGOXBIB 315/60 R 22.5 tyres

CARACTÉRISTIQUES TECHNIQUES

Ø	DIMENSIONS	Indice de charge / Code vitesse										
	CARGOXBIB	D = 65 km/h						CHARGE PAR PNEU EN kg				
22.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30 km/h 65 km/h	[illegible]	[illegible]	[illegible]	[illegible]
	560/60 R 22.5	161 D TL	570	1251	536	3678	16,00 x 22.5	30 km/h 65 km/h	3980 2670	4910 3270	5910 3920	6370 4220
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20.00 x 22.5	30 km/h 65 km/h	[illegible]	[illegible]	[illegible]	[illegible]
26.5	600/55 R 26.5	165 D TL	626	1348	587	3976	20.00 x 26.5	30 km/h 65 km/h	4450 2970	5470 3640	6590 4380	7100 4700

Le CARGOXBIB salué par la presse européenne professionnelle

« Le CARGOXBIB : il surprend par la basse pression qu'il requiert, malgré les charges importantes qu'il supporte. » *L'Argus du machinisme agricole*

« Michelin CARGOXBIB : Priorité au respect du sol. » *La France Agricole*

« CARGOXBIB = énorme écart [...] On n'en croit pas ses yeux, car le look du CARGOXBIB n'a rien de révolutionnaire. Avec ses nombreux pavés en forme de flèche, façon pneu génie civil, on ne lui donne aucune chance face aux profils signés par la concurrence.
Les apparences sont trompeuses, car avec la carcasse radiale et les faibles pressions de gonflage, c'est ce profil qui donne (de loin) les meilleurs résultats. » *Le Pneumatique*

« La pole position pour Michelin, également dans le domaine agricole »
Bayerisches Landwirtschaftliches Wochenblatt

« Puissant en traction, tout en préservant le sol. » *Eilbote*

« De bonnes caractéristiques de flotation permettent non seulement d'augmenter le rendement et l'efficacité des récoltes, mais aussi de protéger les sols du compactage issu d'autres utilisations des remorques. » *Crops*

« Le CARGOXBIB est conçu pour donner sa meilleure performance plus bas dans l'échelle des pressions. »
Irish Farmers Journal

« Sa structure radiale, son grand volume et son ellipse au sol importante offrent un maximum de flotation et réduisent le tassement des sols. » *Arable Farming*

« C'est sa performance dans le champ qui le distingue. » *Profi*

MICHELIN

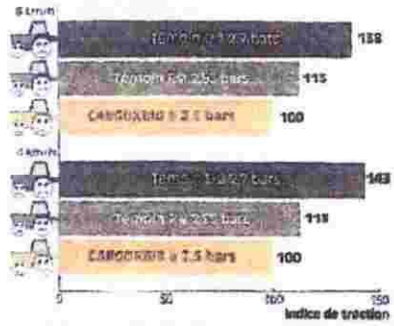
GAIN DE TEMPS ET DE CARBURANT

- Des tests réalisés en présence de la presse européenne ont mis en évidence une productivité du travail nettement améliorée : un **gain de temps de 14 %** et une **économie de carburant de 12 %**. Cette productivité supplémentaire, le **CARGOXBIB** la doit notamment à :
  - sa faible résistance à l'avancement ;
  - sa capacité de charge élevée, même à très basse pression ;
  - son sommet plat, qui favorise des pressions de contact homogènes et un glissement réduit, comparé à un pneu au profil plus arrondi.

SÉCURITÉ RENFORCÉE

- La stabilité "benne haute" du **CARGOXBIB**, sa tenue au décoincement et son maintien sur terrains en dévers s'expliquent par :
  - ses pains sortants arrondis et ses pains rentrants droits, qui assurent une meilleure tenue sur terrains en dévers (important lors de chantiers où plusieurs engins évoluent côte à côte : ensilage, etc.) ;
  - la rigidité de ses flancs, renforcée par l'épaisseur de gomme ;
  - l'architecture de ses flancs (pointe de talon allongée, tringle de forte section), qui offre une meilleure tenue sur jante à basse pression.

FACILITÉ DE TRACTION : GAIN DE TEMPS ET DE CARBURANT

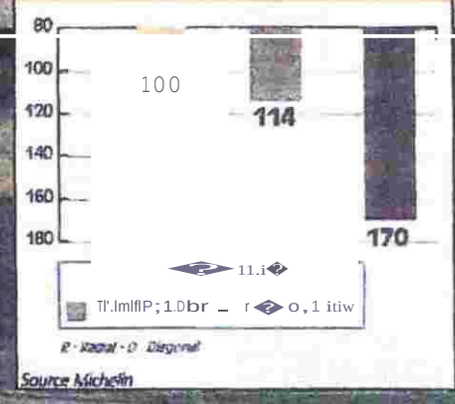


Source Michelin

POTENTIEL AGRONOMIQUE PRÉSERVÉ

- Une portance au sol exceptionnelle qui se traduit par des ornières moins profondes **(15 % d'enfoncement en moins)** et qui s'explique par :
  - sa capacité de charge élevée, même à très basse pression ;
  - son sommet plat, qui favorise des pressions de contact homogènes et un glissement réduit par rapport à un pneu au profil plus arrondi.

INDICE DES VALEURS D'ORNIÉRAGE



Source Michelin

Appendix 5

Technical information on TELEFLOW automatic pressure adjustment device

Téléflow

DISPOSITIFS EMBAROUES POUR CONTROLE ET REGLAGE DE LA PRESSION DES PNEUS

MAITRISEZ LA PRESSION DE VOS PNEUS EN ROULANT

Specialises depuis 10 ans dans la fabrication de dispositifs pour ameliorer la mobilite nous avons equipe pres d'un millier de vetucules tout terrain: attelages agricoles mais aussi vehlcules pour les rallyes raids, EDF-GDF, les Pompiers, la Defense, ou d'autres engins speciaux ...

Aucun risque de degonflage accidentel !
Adaptable sur la plupart des engins aqricoles y compris les attelages
Le *TELEGONFLAGE* contere de precieux avantages

- Plus de securite et de contort en roulant toujours bien gonfle (sur la route et aux champs)
- Respect des sols fragiles (evite l'ornieraqe, le compactage)
- Gains de temps importants pour mesurer / degonfler / regonfler
- Possibilite de compenser les crevaisons (pour finir un travail...)
- Moindre usure des pneus et consommation de carburant en conditions de transport
- Meilleure mobilite (allongement possible des calendriers de travail sur certaines parcelles)

Tous nos produits sont garantis 2 ans, conr;us et tabrques
sous Assurance Qua lite ISO 9001,
leur fiabilite a encore ete confinnee sur le PARIS-DAKAR 2003 (vu a la TV)!

Le *Telegonflage* : la bonne pression à tout moment!

TELEFLOW 4, impasse Champromis 42300 Roanne - France
@ : contact:@teleflow.net

Tel :+33 (0) 4.77.70.71.73 Fax:+33 (0) 4.77.70.71.74

Teleflow

PRÉSENTATION GENERALE DU SYSTEME TELEFLOW

OBJECTIFS

Adapter la press.c.• nes pneus d'un tracteur a son chargerrert a sa vuesse :ilnsl :L:; a 1<lr...,r .es ·rp::ir.s ·oute +iermn ...':!''i- r.oneux terrain hurruce -narecage ere 1 oartir du posts '1e :Jllotag. n rou!ant

AVANTAGES

- meHoratIon ce nc ··tctte en terrain difficile (limitation du paunage. at du comcactaqe
- Possibdite de ccr ens er des crevaisons, pour terminer un travail en-cours
- Economies de 'Jr .s ct je carburant (pressions adaptees a la charge t J. 'a itessej
- t..met,oration de " ..£.o ·rte et du confort
- Diminution des ..'S1,t...ef de destruction des pneus par sous-gonflage l..;ontroles l1ses ..t trecucnts.

COMPOSITIO!'J DU SYSTEME

_e dispcsmf crrno t: --;n· orend

- ...n oucitre -t= ·omrnar.ce a placer vers le coste de pilotage rposs.orhte de nte-jrer su taoresu ::e .rcrc:
- Jr ooitier 3·c ....,·:r cue a placer proche :lL uupttre Ce commence :cur version ;1..;:cr.-iauque
- Jn olcc de 1l. T.b:i:1On 1ul assure a reparuticn de l'arr et le ouctace des ,a.i,es ie cues Jar ·er....ectatre
- J\.n crr-t :cL. ·an- ...onovoie
- 'Jes valves v c:a,es brevetees a raison c' .me oar roue en jereral Ces a.l·,·s scec.aies aer ; e·:en1 B
- 3ontlage -:-;;er iage et le contr6le de a oression oar .me urucue vote ::e raison
- Des .uvauter .s ce raccordements pneumatiques.
-)es cacles .:; a:ns etectnct.es

/AL'/E ET 1OINT TOU''.iAi''T '1.SSOCIES (SOLUTION RETROFIT)

-;, elte 1 ast Jds ::r......... rgl1le 'a mrse en place Cu ;O!n1 .corr-ant a nter.et.r c ...cveu :t.e -s: :cerai:cri

corno.exe et couteus ; ..i eafiser

De ce i.J1, '':CLS prccc scrs ;;llrrenter les rcues 'par "sxteneur" dans ,1 nesure : .lr ecer ceccrce.rer-t :Heral 'le rr-3sar ti!! pas J' rec· '?i··nt raieur Jn ensemble 'valve soec:ale et cm: tourr-art =sccc.es ' sst a.crs ;-xe ;1... ·=nir6 d a ·(r'.

_J al:jc:· ::e a ,a! scf- ::ale avec e oneu se 'art oar a ,alve ;tan0ard acres ::r!21enerr :e ci.s ':L. :ar ..r irfice .. morerr-en-a- "_r,"":rage sur a ante sl en cesire .me /uess s .e jegorr' ,e :;?s "ievee ·r s :e .as l .:t ·eces:. Jt'e ; tr= "te "r -- .oeless

_ =nsen ole (dl',e · cir. ·x..rnent" 9St raccorce au oicc 1e nstnbunon car .m tuyau .cuc.e e ::rict r-,e--.err :es ,lues Aut etr= :)f.J'"" = c–r .ne 'i.vaurer-e nglaeJ

·cur :;, .en.cuies .lC 01..:ue. or asservua .m 1ouveau crcc ce :li:-tr:c .ncn ai, :.r:c :t: xs.r-c ···c :.r:r::,:al :OL." oermettre c!'hmen: · €:-, rl'es du 1ent:cule princrpal et relles CL rr1a13rrel eriiCr":ue (les 3sslel:x :e a "mcrot..e pouvant etre les se r- ...rs. ss pour e oassage de '3!r'

::.- reqlt:: 1811 ;r.1le 1 cc.c,,l· s; allmente oar a gener3uor 01 =i.rat:aLc ehicule. s er est pas dote : r:glr.r :au, ..:r

1eleflow

fELEGONFLAGE A COMMANDE TEMPORISEE

Ce dispositif permet un ajustement de ess.cn ces cr ei.s :r -:::l.:larL l'operation pouvant tr:: ffectuee sur une au ptusieurs roues simuttanement.

- t-ONCTION MESL:,E

  ":alectionner ,ı rcuc 3,;r aaL,-1 1.J rr.esure den '?tr-? erfecn.ee cascurerr-eot Je 'nter..ic1r:1_(-,c .11 ::)rrscondant ,;cs1tion I

  Appuyer sur le pousso IE SURE' rec 3

  - :..ttcrr la s::1!;1lrsar-r,r & al<;ul1le ::u +ar-cmetre,

  re 3 oress: :r

  Relâcher le bouton poussoir

- FONCTION DEGOflt-1.AGc

  :: - .:ctlonr t:r ,i c1 --- rues st.r esque.les e degonflage den etre erfectue

  -r-cuyer et el3crle ;; rc- ssou Jegonflage rep 5) 'a fcncnon est ernoonsee

  eglag•: Ce ::. .cree . :rr-r 1.-a.t.cr' est reause en -uelier en 'oncnon :u •ıpe Ct: ne:,l, at.cue e! ..:es seuils :e pression spécifiés.

- •CNCT1ON GONFLIGE

  .;...l-ctlcnner a rou. cu 1:!s .n.es si.r escueiles e gonrlage con etre erfectue

  ccuyer -:t '9li:lce,. e rcusscrr Gonflage rec -) 'a 'oncnon est temponsee

  - "=glage je a furee ce:'emnonaaucn est reanse er atelier en rcncnon du rvpe ce pnet.:ric:tlcu.e et ces seurls :e Jr:;sslon 1cec:fies

Remorcue

_es CE:r-:1crs ,e cegnntlage ..., le Gon-laqe en cours oeuvent etre stoppees a out mom er• "?r cc...vent 3Lr e cci.sscrr Vlesu r ct-))

- TEMO!NS DE FONCTIONS cc 5 =t .O\

:es Jvanls erts ;; llt..me:nt cnac...,: fok: 11 me fonction Gonf!age ou Degonflage sr 2n ccurc :::.:s ovants es:ent 3!L.r.es pendant toute la durée de temporisation

, fEMOIN 0 LARMC -p ,

Un voyant rouge s'allume

;1 : oressicr "it:L<ee st r-ter.eur> au seurl 111n1rr.a1 orereqte

det:-:t1c;1 ar rr anc-ccr-tact s.tue sLr e crcc cneurnanqt,e ce crsmounor-,

pr ess.cn J' , e-u.mcr- ':.: ;lr.,: .:St rreneure au 3eu11 rT11n1ma1 :-rer'=gle

Remarque :

L'allumage du Témoin d'alarme entraine

- L'arrêt des fonctions sélectionnées

  ":1111ctlur; -l,s e,11O1 de -oncuons

1eleflow

TELEGONFLAGE A COMMANDE AUTOMATIQUE

t nscosmf ;er met ur 1;1.sc:2merc 3ui:cr12t:c;,L..2 -;,! a cress.en ::e er=eroore des pneus seicn ces ::leurs prese.ectrocnees. i iveaux Ce ressrons r ccss.ties vec Jirerenc:aticr rl / AR l. 3L.vant l'unhsancr UL: ,ehlcu!e r aarar-etrera pa,.. -:x-:mole jes ;rss;ons -C:,l Route, rJut terrain Sable et Urgence

DEMARRAGE

.; a mse en rcute 0 mveau te cressicn anterteurernent selectionne est active et un contr6le ::e a cress.on Je .nacuo roue ! mmeciaterner- ecttie

.in1:: vrverilar c-: r;r; la »ress.cn je cnaque cue est e-isune 'arte cer.odrquerneru avec ooss.cuite ...e -:0151r .me .er ::.1r:1te Nor-rta+a JL Rapide

:3ur,r l ": e rcrrrav -;s!a£ "e Tilr J t..S1P.1.:r:: LeLres
:3u111 1Uc..r1..e aGit.:e Eglage 1e J seconces J .! rnn J.5 sec.

Un 1recuori e a r::sricn ::::t :3lte ;h2u2! tors ::;ue 3 lalur rnesuree lors Je a surveetance sort:e ... c1.2r,r 0

orev.« .our e tv.:au sel.cnonr.e

- "1OO1F!Ct ..ON DES IVE,>.cJX JE PRESSIONS

_'n 1ppL.1 bref sur n ccuton de rlvenu jjfferent je celul en cours lance une operaticn de gcnftage cu ce Jf" gur J& :ot..r 1lte1ndre ld !"1..uve!l pressron ie1rl:le

::et:e aeration s .nsctue sum, tanerr=r-t sur l'ensemole des cues en contr6le 'cce par cue ctarn cr3l!CL.C .ou:

"aiusrernsnt fina:

- LARME Ci<EVAISCN

Sl la cress.en mesuree est tres nteneu.e -tu -uveau selectionne e voyant d'Alarme crevaison est actrve :!lgnotarit Jans lr 'er err.os i avertit utilisateu lue a press.on mesuree est comprise entre 3O et 60 ,. .ie oress.c-:

'Cn1lr ,l=: l 3'alltJrrt. =r :or:url, 31 a or=:sron devient roo basse pression infeneur0 a 60 :,..)

'aleurs cocvem Flcro mooitiees)

: Z ... c en cL!c: i un cneu = t .cc.s 1CiiTje de facon manueste e systerne le slgnale par e ,oyarl c lk:r:""

-r-,ctscr. et enjac-s in egc.-ilaoe .» .ovant s eteir-t ces que d oression normale est retabue

- ALARME SdRVITESS":

ne vur' ultanr-e re a ,it.:ssi.: es: tf(;:L i::: :! cnacue seconce

31[1]:: lt-::c.Se aeoa::i:,.._ 'a ,leLr L1-1:see ccur lP l'lr,e:iL. :e oression =etecuonr-e voyar-t c'atarrr-e :crr=su,1,,.r-

5 alh...roe l setemr ;,,5 ci,e la 1ltesse ?Si =cescenoce en dessous ie ::3 urnue autcnsee

- AUTRES ALARMES

;ar .cr orr-a.sc r s :n ;ligr8telr,;, ts es G:a-:s o'alar+es crevascr t survltessc: 'Jeuvent 1£r'l'3ler au1re:::

e,.ts ie fer, ..rcr..,::w,ert !:.i ;L

Tid'1Ct.e :!e .ciessior j'a!l,.,,enraticn
oroulf=cn? i. ,ao!L!r

liaison electrique coupee, etc.

- COMMUT" EUR 'JIDE :HARGE

_'action ;:..r r'. .,,talt:.; --r difie a valeur de la pression requiee pour le niveau selectionn :e .1 :er h.:!

j'obtenir des pressions adaptees a deux etats de charge (vehicule a vide, ou vehicule charge)

Appendix 6

Quotations for the manufacture of Light Weight and Iron Sheeting trailers

Ga:◆OLAUN MIECHANICAB.. SIERVICf.◆ & CO. t.ro.
PAIIIfA ROADOUATRE-BORNESMAURITIUS Mechanic Contractor
TEL 425 0095
FAX: (230) 4241718
emaV geroWr@intnef.mu

05 July 2002
HD/RD/I 11 b/O2
Mr. **Errol** Jacquin
M.S.R.I
REDUIT

Dear Sir

Further to your request, we are pleased to quote there under our best price for the fabrication and supply of one (18) eighteen tons tipping trailer to be used to transport chopped canes.

Dimension of the trailer: Length: 9 605 mm
Width: 2 500 mm
Height: 3350 mm from ground level,

The trailer will be fitted with:

- High flotation low pressure tyres 550/60 x 22.5.
- Tandem under slung suspensions and two axles 11,670 kgs capacity.
- Hydraulic brakes and one hand brake lever.
- One tipping ram assembly of 25 Tons capacity
- The doors to open by the sides
- One hydraulic kit (pump, PTO shaft,oif tank)
- One tow bar with spring

The trailer will be made with:

- Metal steel sheets of 2.8 *mlm* thick on floor
- The main_chassis will be made of I girders 254 *m!m* x 127*ml–*. The tipping chassis will be made of U channels 204 *mlm* x 75 *mlm*.
- The sides and the floor supports will be made of U channels 75 *mlm* x 37.5 *mlm*.
- The trailer will be painted with two coats of metal primer paint and two coats of gloss finish paint to the colour of your choice.

Please note that we **will** supply all the steel sections and all the metal sheet for the construction of the trailer and will be supplied to us: hydraulic kit, oil tank pump, the tow bar, spring and U bolts, two axles, tandem suspension, under slung and spring and four tyres and wheels 550/60 x 22.5.

Price: Rs. 305,000.00 + 15% VAT | **Add 10 % to obtain actual cost**
Engineer permit: Rs. 2,300 – VAT included
Payment: 45 % on confirmation of order
Balance:
Delivery: ths from date of order

Assuring you of ou,_ , times and iemain at your disposal for any further information

Yours faithfully,

HANS DAVIDSEN

HANS DAVIDSEN Manager

GEROLAIN MECHANICAL SERVICES & CO. LTD.

PALMA ROAD QUATRE-BORNE SAUHmUS
TEL. 415000
FAX: (210)42411\8
email: gerolain@intllet.mu

Mechanic Contractor

30 April 2003

HD/RD/085/03

Mr. Errol Jacquin
M.S.R.I
REDUIT

Dear Sir,

We are pleased to quote there under our best price for the manufacture of one Hydraulic Tipping Trailer 15/18 Tons for Sugar canes.

The body will have a length of 20'
The width of the body will be 8'
The height of sides of the body 91"

- The trailer chassis will be made from 10" x 6" standard mild steel I channel.
- The tipping chassis will be made of box sections 8" x 6" from 8" x 3" standard mild steel U channel.
- The framing will be made of 4" x 2" U channel covered with 4.5 m/m steel sheets and the sides and rear gate will be lined with 3 m/m mild steel sheets.
- One hydraulic ram assembly with 4 stages extension with a lifting capacity of 20 / 25 tons together with oil tank complete with pump and hydraulic control also one universal joints and shaft.
- The trailer will be equipped with hydraulic brakes. The tow bar will be of the spring suspended type.
- The trailer will be painted with two coats of metal primer and two coats of gloss finish paint.
- The trailer will be equipped with tandem 10 leaves of 16 m/m thick springs suspension and dual axles and wheels 4255/95 R. 22. 5

Price:	Rs.686,000.- + 15 % VAT
Delivery:	Four months from date of order.
Payment:	45 % on confinnation of order.
Balance:	Cash on delivery.

Assuring you of our best attention at all times and remain at your disposal for any further information.

Yours faithfully,

JS DAVIDSEN Manager