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PRODUCTION TRIALS WITH A WIDE TYRED SKIDDER

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ABSTRACT

The productivity of a 75 kW skidder was tested on both wide (109 cm) and standard tyres. The trials were carried out over a ten month period in eight different forests as part of a comprehensive study of wide tyres which also looked at soil impact, machine stability, fuel consumption and other operating characteristics.

Overall the wide tyres were at least as productive as the standard size, with higher unloaded travel speeds, particularly on steeper slopes. This was a result of the improved machine stability. However these advantages were offset by reduced manoeuverability and increased bladework.

The wide tyred skidder was not suitable for steep terrain thinning operations. The climbing ability in reverse was not as good as expected and the machine was difficult to control on top of heavy slash or logs.

Average fuel consumption per m³ was 10% less with the wide tyres fitted. The study results however showed that the reduced fuel consumption did not compensate for the extra cost of the wide tyres.

Figure 1 : The John Deere Skidder fitted with 109 cm wide tyres

Unseasonally dry weather conditions minimised the effect that low ground pressure tyres may have offered in soft or unstable soil conditions.

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INTRODUCTION

Research in Canada (Mellgren and Heidersdorf, 1984) had recorded productivity gains of up to 61% and fuel savings of 41% with wide tyred skidders on Muskeg swamps. A 16% increase in travel speed with an associated 18% reduction in fuel usage was also recorded on slopes up to 13° on wet clay loam soils. Sauder (1985), measured production of wide tyred skidders over a range of sites on Vancouver Island and noted distinct sideslope and climbing ability advantages on slopes up to 19°. Stumps and wet debris on steeper slopes however, hampered machine performance. Similar problems had been encountered in later FERIC studies (Heidersdorf and Ryans, 1986) where slopes in excess of 20° had been harvested with a skidder on wide tyres.

A 75 kW John Deere skidder equipped with standard 59 cm wide tyres and a set of 109cm wide F23 Firestone tyres was imported for New Zealand trials in 1985. The F23 tyres have a 23° lug angle and an aggressive tread which was considered important for the range of conditions that the machine was to operate in. The skidder had heavy-duty axles fitted to enable wide tyres to be used. These axles were 30 cm wider than the standard axles for that machine.

The machine was operated in a range of soil types and terrain conditions throughout North Island forests over a ten month period. One operator was employed to drive the machine for the duration of the project.

Five companies contributed funds to the New Zealand project and three of these companies provided the crews and the forests to operate in. This Report summarises the results from the production trials that were run.

OBJECTIVE

The objective of these studies was to compare machine productivity on both wide tyres and standard tyres in a range of logging conditions.

STUDY METHOD

In each forest the skidder replaced the regular extraction machine used by the crew. No attempts were made to alter the logging system although the method of extraction was sometimes adjusted to suit the wide tyres. Both wide and standard tyres were evaluated at each site. Two methods of data collection were used :

1. **Time Studies**

   Element times and log volumes were collected for each cycle. Travel speeds recorded over various slope categories were used to derive travel empty and travel loaded times for a standard 150 m haul path.

2. **Daily Records**

   Machine activities were recorded by tachograph and on-site conditions obtained from a portable weather station. A piece count was kept of logs pulled per cycle and the consumable supplies measured at the end of each shift.

Eight clearfell and two thinning operations were studied. Three of the clearfell sites were on sandy clay loam soils, four were on pumice ash soils and one was on sand.

RESULTS

A detailed account of the trial results in each forest is summarised in a Project Report (Prebble, et al 1989). In this Report the clearfell and thinning operations will be considered individually.

Clearfelling Trials

Production Studies

Table 1 shows the production per productive machine hour (PMH) from the studies for the eight clearfell trials.

TABLE 1 : SUMMARY OF PRODUCTION STUDY RESULTS FOR CLEARFELL TRIALS

Forest	WIDE TYRES Av. Cycle Time, mins	Av. Drag Volume, m^3	Production Per PMH, m^3	STANDARD TYRES Av. Cycle Time, mins	Av. Drag Volume, m^3	Production Per PMH, m^3
Kinleith	*10.41*	*4.46*	*25.7*	*10.51*	*5.43*	*31.8*
Ngaumu	*8.65*	*5.66*	*39.3*	*8.80*	*5.59*	*38.1*
Kaingaroa	*10.61*	*6.06*	*34.3*	*8.63*	*8.03*	*55.8*
Matahina	*8.76*	*4.75*	*32.5*	*9.86*	*5.21*	*31.7*
Woodhill	*8.24*	*3.67*	*26.7*	*7.72*	*3.49*	*27.1*
Tarawera	*9.27*	*3.88*	*25.1*	*10.90*	*4.51*	*24.8*
*Mangatu**	*7.01*	*4.78*	*36.3*	-	-	-
Maramarua	*7.92*	*5.57*	*42.2*	*8.10*	*5.08*	*37.6*

** No production studies were done on the standard tyres at Mangatu*

Paired comparisons of wide tyres versus standard tyres is not possible because of variations in piece size and number of pieces hooked on. Travel times have been standardised to a 150m average haul distance.

Figures 2 and 3 illustrate productivity versus piece size and drag volume.

Figure 2 suggests that, for a given tree size, productivity on wide tyres was higher than on standard tyres but when this is related to average drag size (see Figure 3) the difference is not significant.

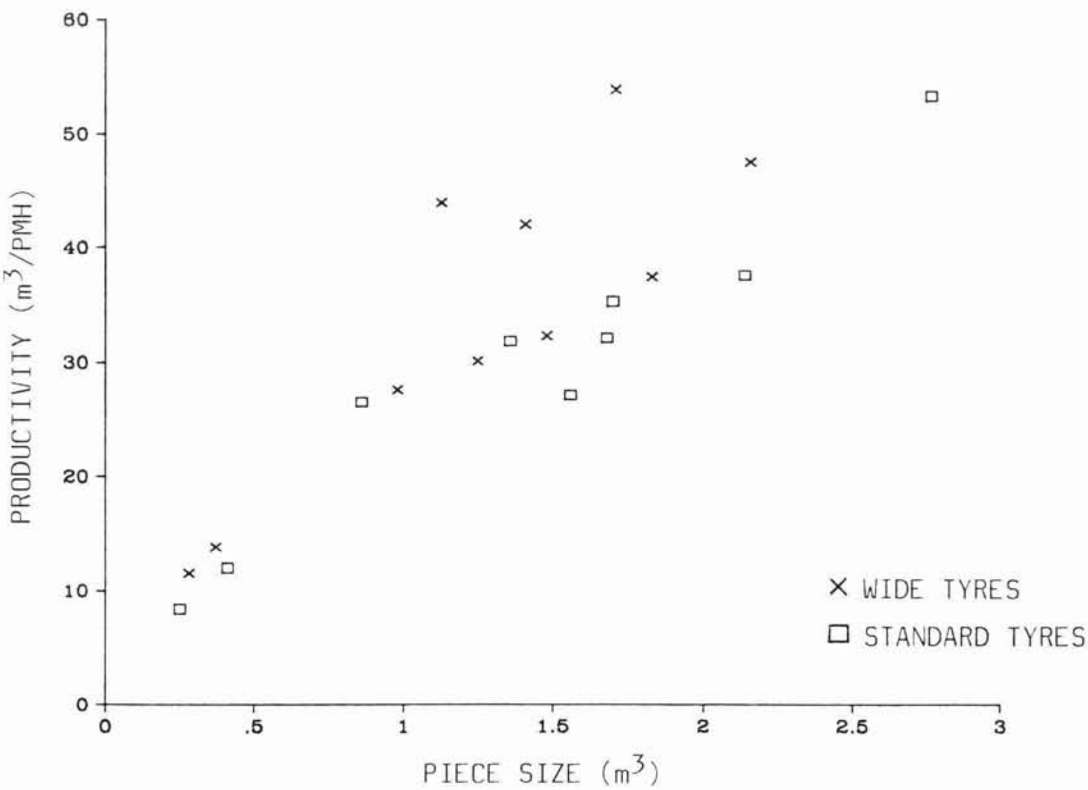

Figure 2 : Productivity versus Piece Size

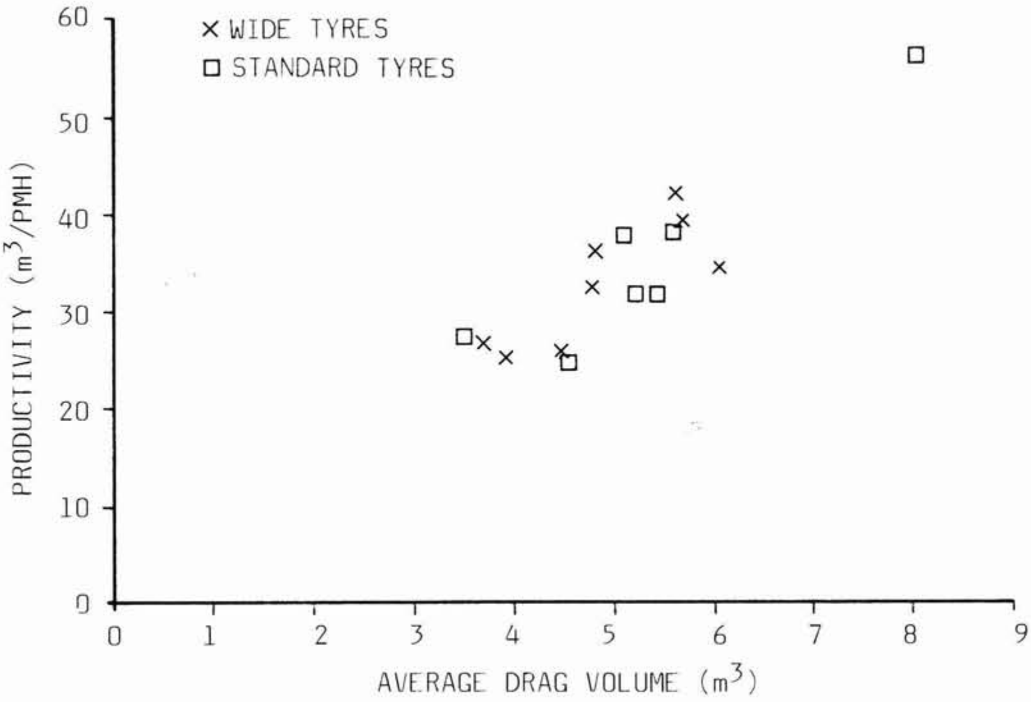

Figure 3 : Productivity versus drag volume

The following are conclusions drawn from comparing the different element times between the trials.

(i) **Manoeuvrability on the landing:** The wide tyres were generally slower to manoeuvre, loaded or unloaded, on the landings. Congestion was an influencing factor - especially on smaller narrow landings. In some cases the skidder on wide tyres had to do a 3-point turn to manoeuvre off the landing after unhooking.

(ii) **Travel speeds:** In all but two forests (Ngaumu and Woodhill) the travel loaded speeds were up to 8% higher with the wide tyres. In Ngaumu forest the wide tyres were 15% slower with a similar drag size. Travel loaded was also slower in Woodhill (by 13%) although drag sizes were larger. In all forests the wide tyres were faster unloaded than the narrow tyres. Differences ranged from 5% quicker in Maramarua to 46% quicker in Ngaumu.

Figures 4 and 5 illustrate travel speeds, loaded and unloaded, versus slope. Travel speeds were affected by the increases in slope, both favourable and adverse. The generally higher unloaded speeds on wide tyres reflect their relative stability on steeper slopes and improved traction.

(iii) **Blading logs:** Blading logs in preparation for break-out is common practise in New Zealand skidder operations. Apart from two forests, Kaingaroa and Tarawera, the wide tyred skidder spent less time blading logs prior to breakout. The main reason was that precise blade control was more difficult on the wide tyres because:

- their larger diameter reduced effective blade travel
- their extra width extended beyond the outside edge of the blade

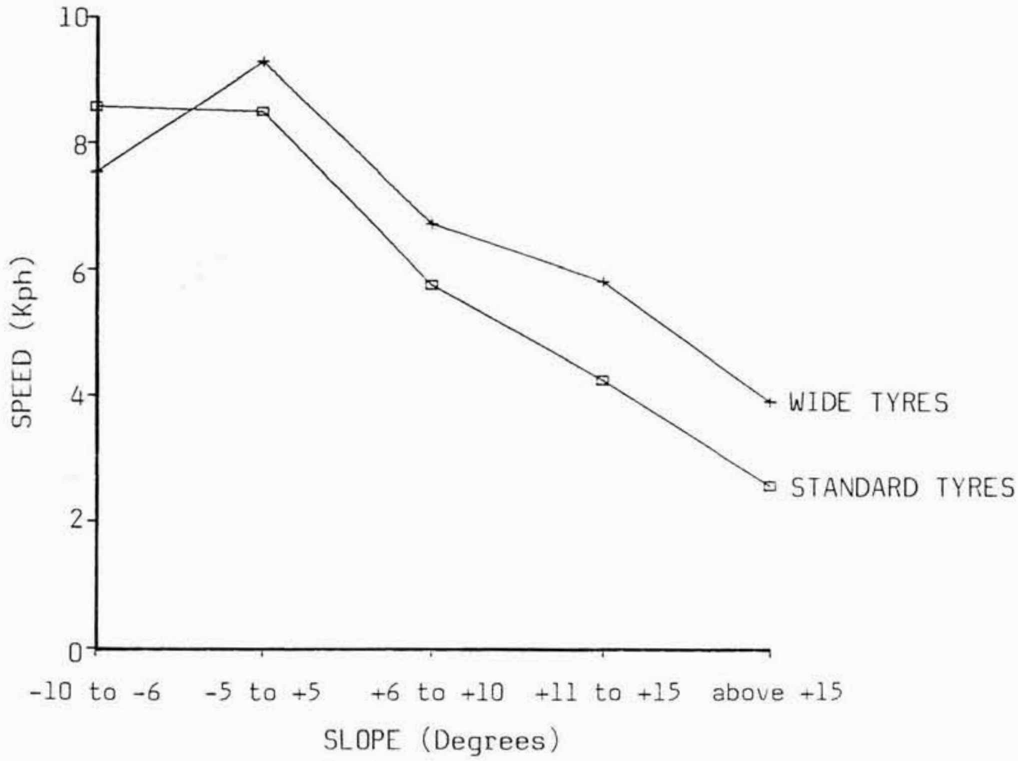

Figure 4 : Travel Empty Speeds versus Slope

- their flotation effect made it hard to get the machine level.

When using wide tyres the operator was consistently doing more blade work either on the skids or along the haul path to remove obstacles.

Daily Records

Information from the daily records are summarised in Table 2. Production per PMH is calculated by taking the weighted average of piece size recorded in the production studies, multiplying it

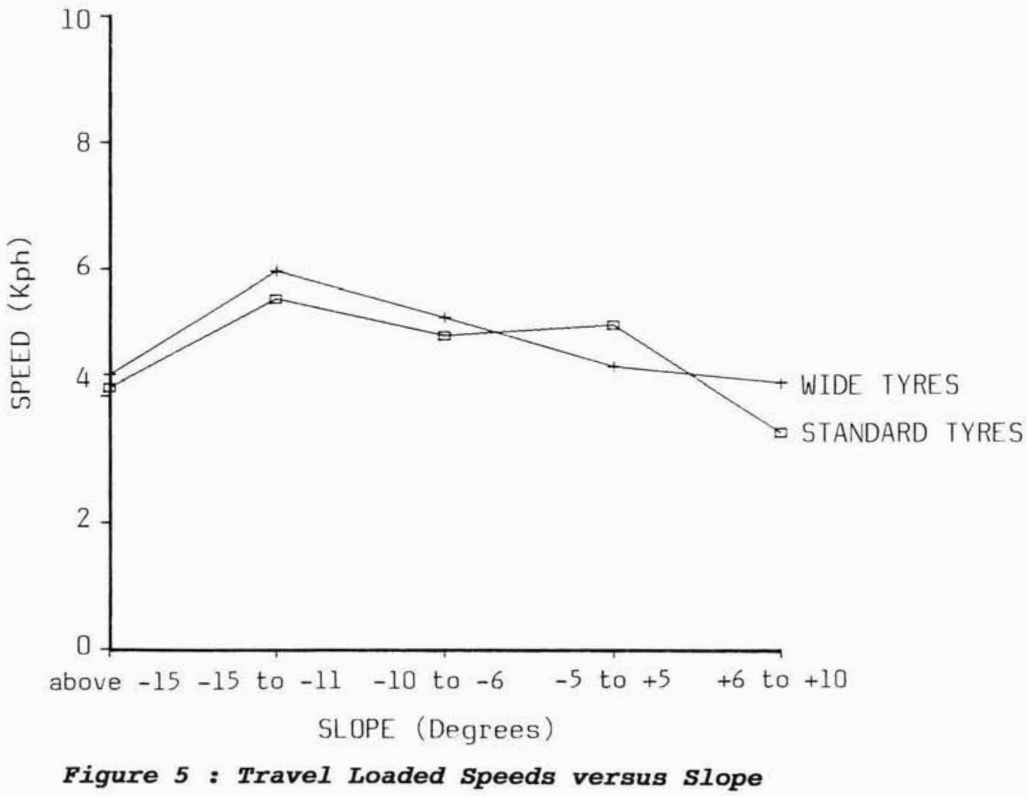

Figure 5 : Travel Loaded Speeds versus Slope

TABLE 2 : FUEL CONSUMPTION AND PRODUCTION LEVELS RECORDED FROM DAILY RECORDS

	WIDE TYRES			STANDARD TYRES		
Forest	*Fuel Used per PMH*	*Litres per m^3*	*Production per PMH, m^3*	*Fuel Used per PMH*	*Litres per m^3*	*Production per PMH, m^3*
Kinleith	*11.4*	*0.46*	*32.1*	*11.2*	*0.45*	*31.3*
Ngaumu	*12.2*	*0.38*	*31.9*	*13.6*	*0.37*	*36.5*
Kaingaroa	*10.9*	*0.27*	*39.7*	*11.7*	*0.23*	*50.5**
Matahina	*10.1*	*0.37*	*27.6*	*11.0*	*0.37*	*29.6*
Woodhill	*12.4*	*0.46*	*26.8*	*14.9*	*0.60*	*24.8*
Tarawera	*9.1*	*0.34*	*26.7*	*11.3*	*0.45*	*24.9*
Mangatu	*11.4*	*0.42*	*27.4*	*12.5*	*0.54*	*23.0*
Maramarua	*10.9*	*0.29*	*37.1*	*10.5*	*0.28*	*37.6*

* *There was such a large difference in piece size between the two areas logged in Kaingaroa that a weighted average per piece could not be used.*

by the number of pieces pulled and dividing by PMH. Fuel usage is calculated by dividing fuel used by PMH and by cubic metres produced.

The skidder on wide tyres used an average of 8% less fuel per PMH and 10% less fuel per m^3 produced.

Total hours worked and mechanical availability are summarised in Table 3.

Note that the lower availability of the machine on wide tyres was not due to the tyres.

Using the LIRA Costing Format (Wells, 1981) the cost of owning and operating the two different tyre configurations can be compared. These costs are based on 1986 machine, tyre and fuel costs and use actual fuel and oil consumption figures, a predicted tyre life of 4000 hours and 50% of depreciation for repairs and maintenance. Table 4 shows the cost per hour and relates it to the production figures from the daily records (excluding Kaingaroa).

The skidder on wide tyres cost $6.32 per hour more than it did on standard tyres. Data from the production studies and performance monitoring indicated that this additional cost is not offset by the reduced fuel consumption in these studies.

TABLE 3 : HOURS WORKED AND MECHANICAL AVAILABILITY

	Wide Tyres	*Standard Tyres*
Hours worked	*565.9*	*201.5*
Mechanical availability	*89.1%*	*93.4%*

TABLE 4 : COST COMPARISON OF WIDE TYRES VS STANDARD TYRES

	Wide Tyres $	*Standard Tyres $*
Owning costs/hr	*23.92*	*22.54*
Operating costs/hr	*29.05*	*24.11*
Total cost/hr	*52.97*	*46.65*
Cost/m^3 (based on 30 m^3/hr)	*1.78*	*1.56*

Production Increase required for break even *3.6 m^3/hr (+13%)*

Thinning Trials

The objective of trialling the wide tyred skidder in thinnings was to utilise the machine's superior climbing ability to access logs on steeper slopes. It was envisaged that a skidder reversing up the slopes would be more cost competitive than small hauler or tractor thinning operations. The machine was tested in both hauler and tractor logging areas where slopes of up to 33° were negotiated.

The wide tyred skidder was unable to reverse up the slopes as far as expected and as a consequence it had to climb up the ridges and come down over the top of the logs. When travelling over logs and slash on steep slopes the machine was virtually uncontrollable causing severe crop damage by spinning out and on one occasion endangering the operator by rolling over.

When on standard tyres the skidder penetrated through the slash and logs laying in the outrow which resulted in better traction and stability.

In the hauler thinning area, all travel speeds (both unloaded and loaded) were slower with the wide tyres on and while the detailed study showed the machine to be more productive (due to piece size differences) the daily records indicated performance was 16% lower.

Travel loaded times in the tractor thinning area were quicker with the wide tyres but all other travel times were slower. Both production studies and daily records showed lower productivity with the wide tyres. A second roll over incident (with standard tyres fitted) occurred in the tractor thinning area.

It was concluded that the wide tyres were not suited to thinning operations and that slopes above 31° were too steep for safe skidder operation.

GENERAL OBSERVATIONS

* The 75 kW skidder was considered too light for new crop clearfelling operations. Comparisons with a 90 kW Cat 518 skidder on two of the forests showed that the larger machine could travel loaded faster (by 4 - 19%). Control tests (Prebble, et al 1989) indicated that fuel consumption per m³ was also lower with the 90 kW skidder.

* The wider heavy duty axles made John Deere skidder more stable than other skidders of similar capacity and side slopes of up to 23° could be negotiated with relative ease.

* The wide tyres made the skidder even more stable and side slopes of up to 31° could be traversed but this is not recommended.

* Crushed undergrowth and logging slash on slopes were a hindrance to the performance of the wide tyres. The standard tyres could penetrate through the slash and gain better traction but the operator received a rougher ride and climbing ability was affected more by gradient.

* Tree roots or buried debris also restricted the climbing ability of the wide tyres.

* The width of the haul path had an influence on travel speeds with the wide tyres. Where obstacles such as high stumps or rejected logs were present the operator was forced to slow down to negotiate around or over them to reduce the risk of tyre damage and improve the comfort of the ride. The standard tyres could often fit between the stumps without slowing down.

* A range of tyre pressures from a high of 172 kpa (25 psi) at the start of the Kinleith trial to a low of 55 kpa (8 psi) in Maramarua were tried in the wide tyres. The optimum pressure for most conditions appeared to be 83 kpa (12 psi). Below this the tyres tended to deform when

under load and the build up of debris between the tyre and the rim increased.

* After 590 hours of use, the wide tyres were 10% worn which would be considered normal wear for standard tyres. Tyre damage (such as rips and stick penetration) did not appear to deteriorate beyond the original injury.

* In the Kinleith trial the landings were situated on a dried up water course and when operated on in the rain they cut up badly. On wide tyres, the skidder caused considerably less disturbance than when on standard tyres.

* Weather conditions were exceptionally dry throughout the whole project with only 224 mm falling over a 10 month period. The dry ground conditions meant that the real advantages of the wide tyres on soft, wet ground could not be fully exploited in these trials.

CONCLUSIONS

While machine related elements in the cycles were quicker overall with the wide tyres there were no significant advantages in machine productivity. Fuel consumption of the skidder on wide tyres was 8% lower per PMH and 10% per m^3 produced. Travel speeds both unloaded and loaded were generally faster but production would have to be 13% higher for the wide tyres to compete on a cost basis with standard tyres.

Wider than normal axles on the skidder made it more stable on standard tyres than other machines of similar capacity.

The wide tyred skidder was not considered suitable for thinning operations.

Some of the advantages in operating characteristics were apparent with the wide tyres e.g. improved side slope stability and reduced landing deterioration but these were offset by less effective blade operation and manoeuvrability problems on small or congested landings.

Ground disturbance on landings and haul paths was lower with the wide tyres. Exceptionally dry weather conditions however, did not allow the full benefits of reduced ground disturbance with wide tyres to be established.

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The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook for Logging Contractors. They are only an estimate and do not necessarily represent the actual costs for this operation.

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