



Terrain vs. roadside chipping in Mediterranean pine salvage cuts



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Large demand for chips

Delivered price of chips from 30 to > 60 €/gt

Intense effort to expand the resource base

Type	n	MW	t/year
DHP	131	370	280,000
CHP	26	286	3,010,000



Chipping in Italy: small scale



Chipping in Italy: industrial



Heavy chippers



Tuscany: pine thin & salvage



1460 Hp Monster chipper



Comparison test



Differences



Costing elements

Operation	Terrain Chipping		Roadside chipping			Loading	
	n	€ SMH ⁻¹	n	€ SMH ⁻¹	n	€ SMH ⁻¹	
Terrain chipper	1	121.1	0	0.0	0	0.0	
Chip shuttle	2	59.8	1	29.9	0	0.0	
Forwarder	0	0.0	3	211.2	0	0.0	
Roadside chipper	0	0.0	1	301.6	0	0.0	
26-t loader	0	0.0	1	41.6	0	0.0	
20-t loader	0	0.0	0	0.0	1	43.3	
Crew	2	40.0	4	80.0	1	20.0	
Total		220.9		664.3		63.3	

Operation		Terrain chipping	Roadside chipping
Loading net productivity	gt PMH ⁻¹	59.2	59.2
Loading gross productivity	gt SMH ⁻¹	43.0	43.0
Delay Factor for loading	%	37.7	37.7
Loading cost	€gt ⁻¹	1.5	1.5
% mass loaded	%	100	10
Cost of loading	€gt ⁻¹	1.5	0.1
Cost of felling	€gt ⁻¹	2.2	2.2

Productivity and cost

Operation		Terrain chipping	Roadside chipping	p
Observations	N	57	51	
Load size	gt	7.8	25.1	< 0.0001
Moisture content	%	49.3	48.8	0.6831
Chipper productivity	gt chip only hour ⁻¹	23.3	111.1	< 0.0001
Net operation productivity	gt PMH ⁻¹	16.7	90.9	< 0.0001
Gross operation productivity	gt SMH ⁻¹	15.2	66.7	< 0.0001
Delay factor for chipping	%	10.7	32.4	0.5333
Unit production cost	€ gt ⁻¹	18.3	12.3	< 0.0001
Felling cost	% of total cost	12.0	17.8	
Chipping & Extraction cost	% of total cost	79.9	81.0	
Loading cost	% of total cost	8.1	1.2	



Surge bin

Surge bin

		Yes	No
Extraction & chipping rate	€ SMH ⁻¹	664	634
Extraction & chipping productivity	gt SMH ⁻¹	66.7	60.8
Extraction & chipping cost	€ gt ⁻¹	9.96	10.43
Loading cost	€ gt ⁻¹	0.15	0
Total cost	€ gt ⁻¹	10.11	10.43
Cost increment	€ gt ⁻¹	-	0.33
Cost increment	%	-	+ 3.2

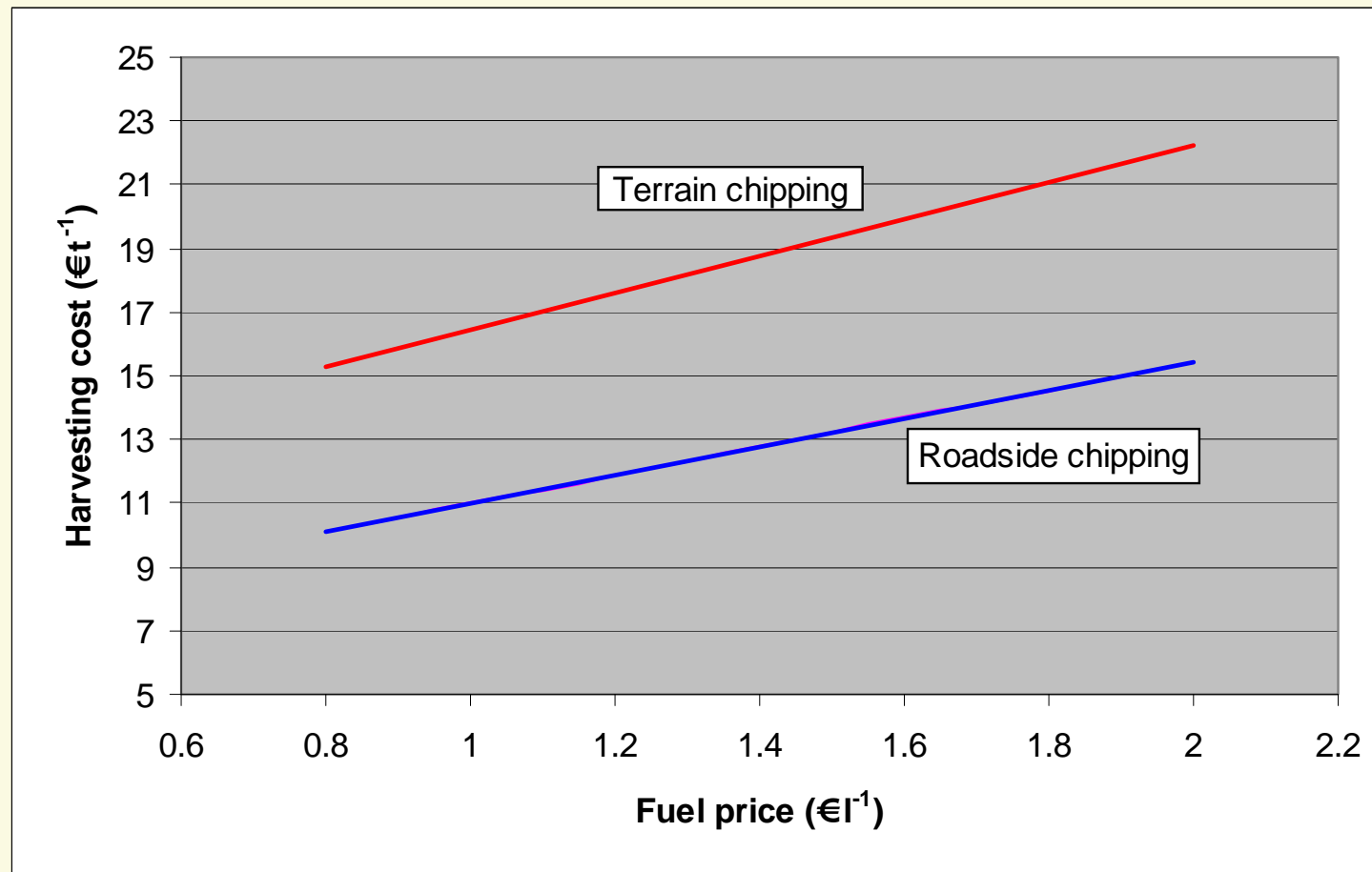


Energy budget

	Terrain chipping		Roadside chipping	
	MJ h ⁻¹	MJ odt ⁻¹	MJ h ⁻¹	MJ odt ⁻¹
Inputs				
Felling	959	54	959	54
Chipping & extraction	3516	456	12468	365
Loading	959	44	959	4
Total		554		423
Total output		20000		20000
Output/Input		36.1		47.3
Input/Output %		2.8		2.1



Sensitivity to diesel cost



Conclusions

- Original technology mix
- Terrain and silviculture
- Bigger is better (efficiency, truck waiting)
- Cheap shuttles (container dilemma)
- Enlarged space forwarders

