FORMEC

Use of synthetic rope in the extraction of stems and whole-tree in a radiata pine thinning on steep terrain in the North of Spain

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- Forest biomass has a great potential to achieve the main goals of European energy strategies.
- In the case of silvicultural treatments, biomass utilization has opened a new funding possibility for these treatments.
- However, it is necessary to get over the present barriers (high costs, lack of integration of timber and biomass supply, seasonal production, etc) to take advantage of this opportunity.
- Especially in difficult conditions as is the case in Northern Spain (steep terrain, small harvesting areas and deficient forest road networks) with low profit margins.
- To increase productivities and improve the conditions of workers, it is necessary to look for new alternatives.
- In this study, two harvesting systems to obtain biomass in pine thinnings, using a synthetic rope were analysed.

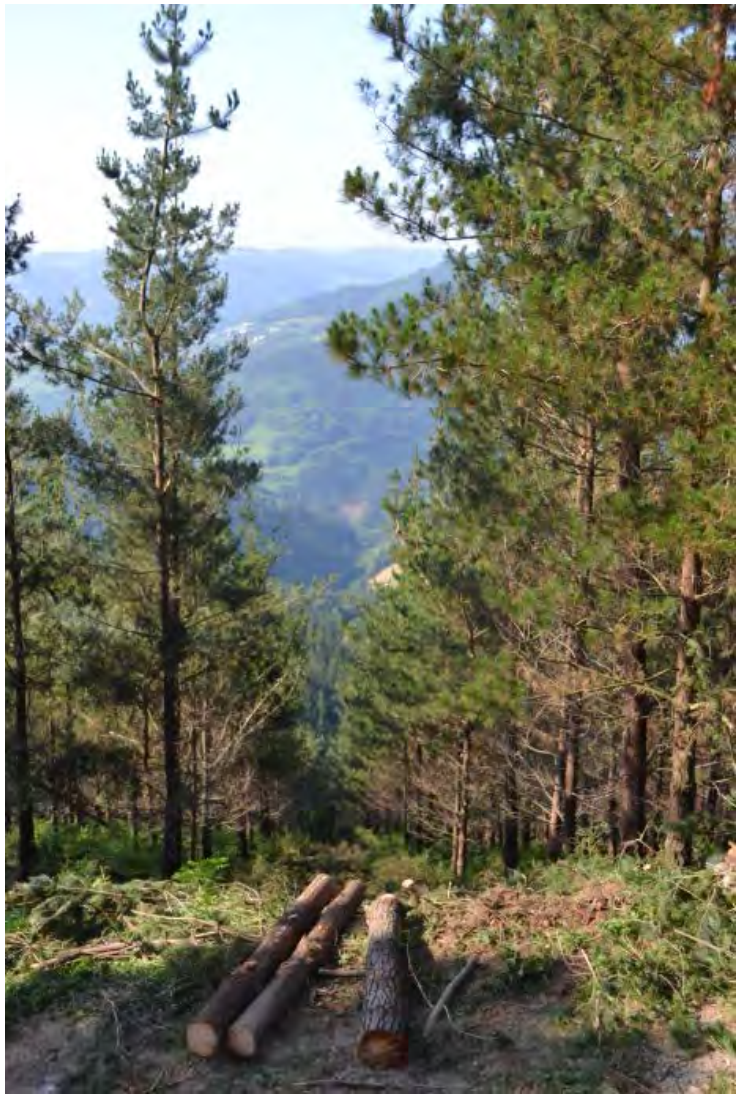
A thinning of a radiata pine stand:

- 30.53 ha
- Slope 50%
- 233.96 m^3/ha
- 1,591 trees/ha.

A first semi-systematic thinning (26,6% of stocking was removed)

	Avg.	Min.	Max.
d (cm)	17.40	8.05	25.25
h (m)	13.88	10.90	18.40
v (m^3)	0.1598	0.0507	0.3152

Note: d, diameter at breast height in cm; h, total height in m; v, volume of individual trees in cubic meters.



A synthetic rope was used in the skidding of both stems and whole tree. In order to improve the productivity and reduce the workload of operators, several chockers and sliders were atacched to the main line.

- The two systems evaluated were:

System 1. Stems/ Chipping at plant
Manual felling (Stihl 362 chainsaw)
Skidding stems to roadside (Same Explorer 66 kW tractor)
Wood preparation (Doosan Solar 40 kW mini excavator + chainsaw)
Forwarding logs Valtra 8400 tractor (110 kW) with Guerra RTH-8000 tráiler
Transport logs (truck Man 19-362, 24 tonnes)
Chipping at plant (Pezzolato PTH 900/660)

System 2. Whole tree - Chipping at roadside
Manual felling (Stihl 362 chainsaw)
Skidding whole tree to roadside (Same Explorer 66 kW tractor)
Chipping whole-tree at roadside (Pezzolato PTH 900/660)
Forwarding chips Same Laser 150 tractor (110 kW) with 25 m^3 tráiler
Transport chips (Volvo 480 truck with walking floor trailer 90 m^3)

- Two plots (0.8 ha) with similar characteristics.
  - A band painted on each tree → diameter class
  - Inventory: dbh and a sample of heights

Detailed time study
Manual felling
Skidding
Forwarding
Transport

Work sampling
Wood preparation
Chipping

- A total of 112 hours and 9 minutes were recorded during the time study.
- Productivities and costs were calculated.

MATERIAL AND METHODS
Wood Fuel quality

- Several samples in different pile positions

UNE- EN ISO Standars:

- Moisture content
- Particle size classification
- Bulk density
- Ash content
- Calorific value

BIOFUELS LABORATORY

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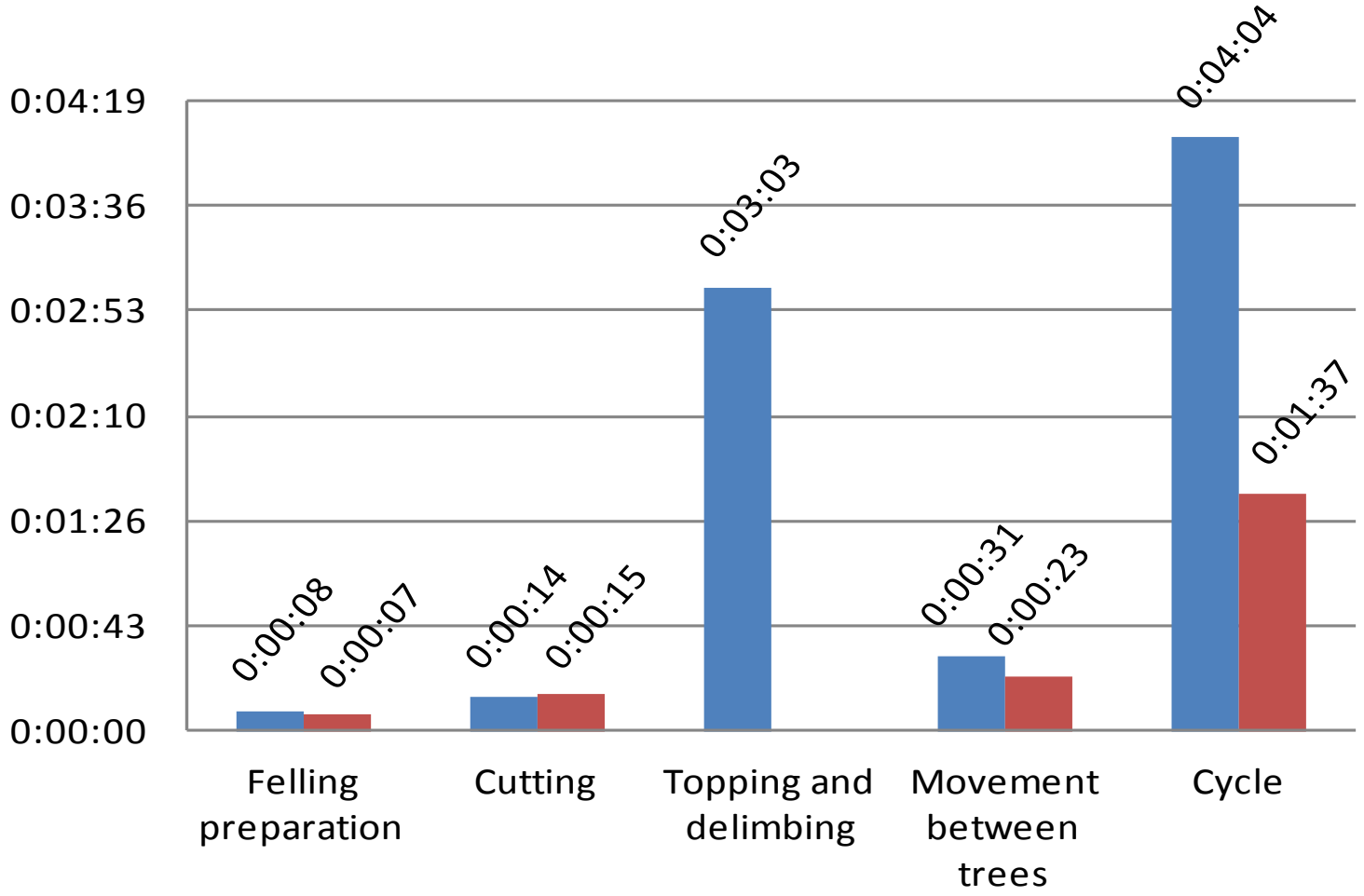
Oven

Sieves

Ashing furnace

Calorimeter

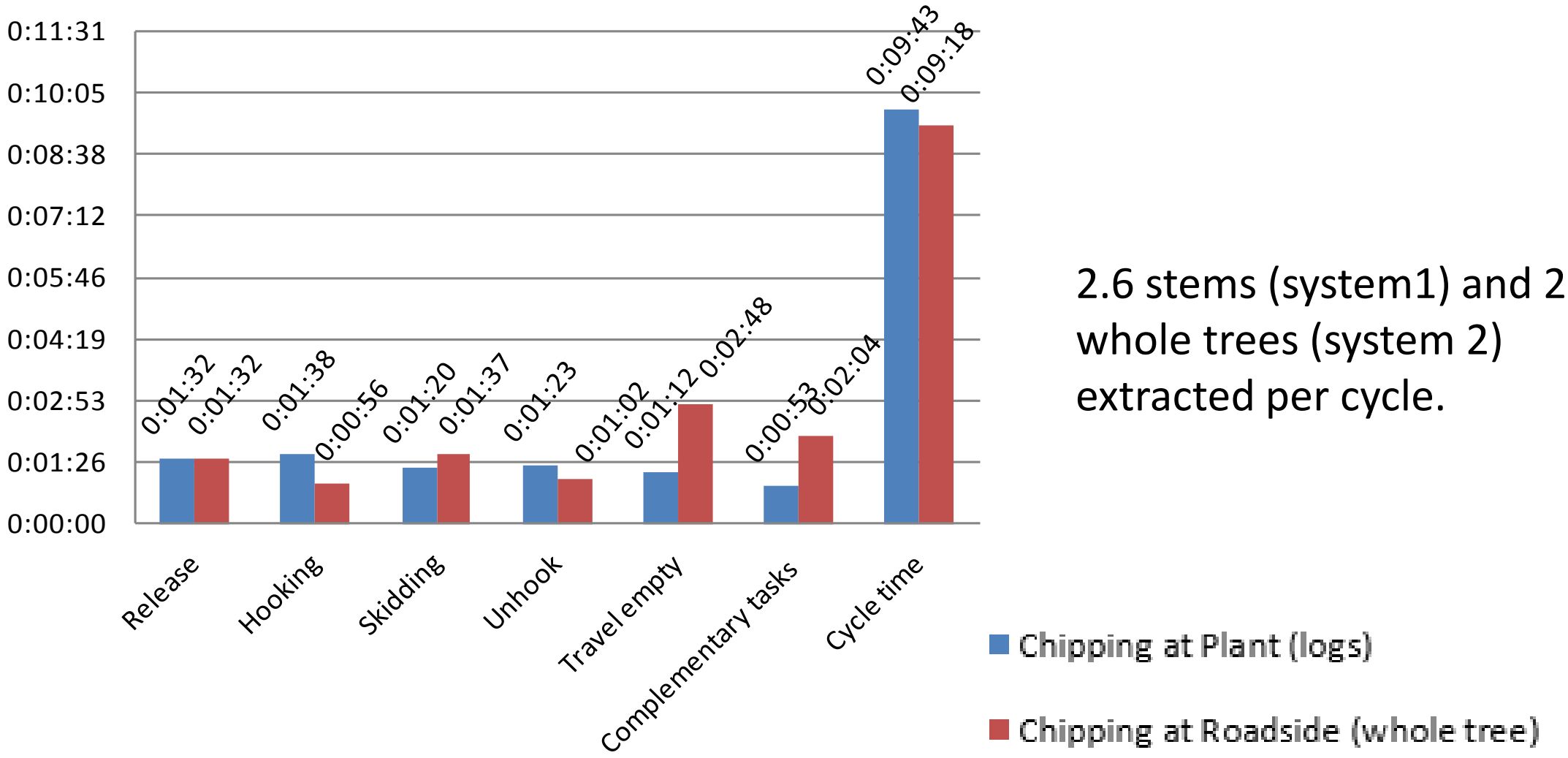
- Manual felling



Utilization rate 60-68%

Average time consumption (hh:mm:ss) in main work elements of manual felling.

- Skidding



2.6 stems (system1) and 2.3 whole trees (system 2) extracted per cycle.

Average time consumption (hh:mm:ss) in main work elements of skidding.

Wood preparation. System 1

- A mini-excavator and a chainsawer worked simultaneusly → Interferences were high.

• Chipping at roadside. System 2

- Pezzolato PTH 900/660 chipper.
- The utilization rate was low (61.26%) due to interferences with the hauling tractor

Forwarding logs or whole tree (system 1 or 2)

Forwarding distance: 1,200 – 1,700 m
Cycle time: 1:16 (system 1, logs) , 1:55 (system 2, whole tree).
In system 2, chips were unloaded directly on ground

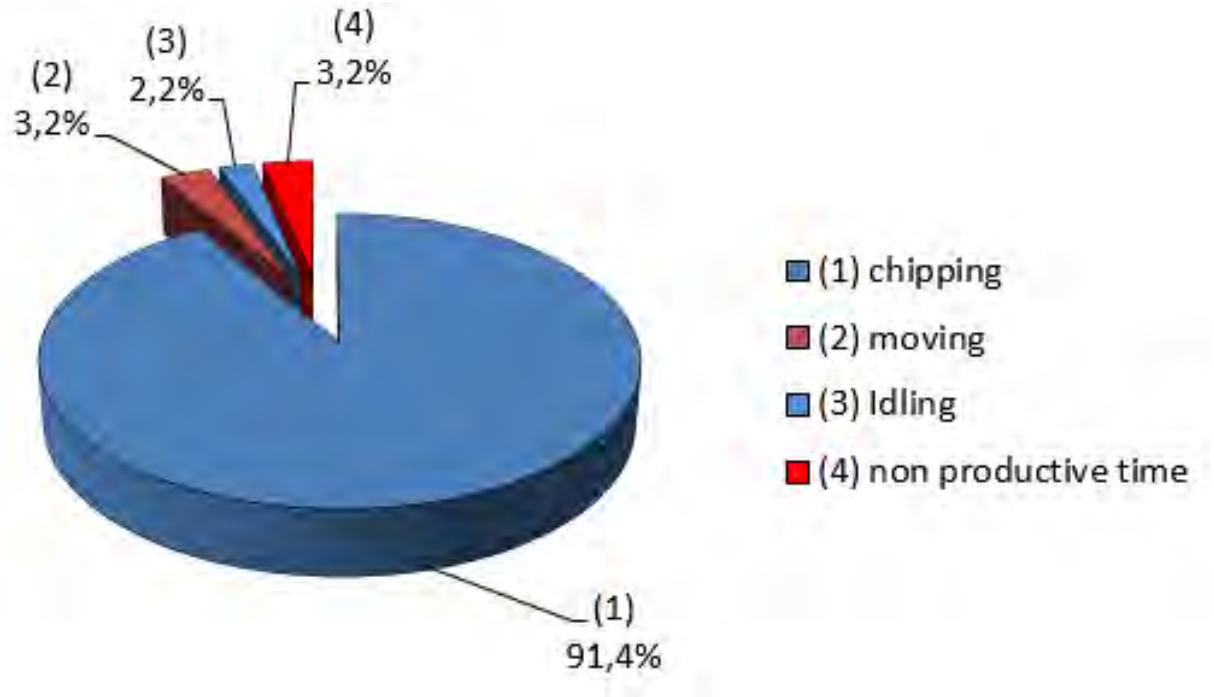
Transport logs (system 1) or chips (system 2)

Man 19-362 truck. 24 tonnes
Cycle time 3 hours and 46 minutes

Volvo 480 truck with walking floor trailer of 90 m^3
cycle time of 3 hours and 20 minutes

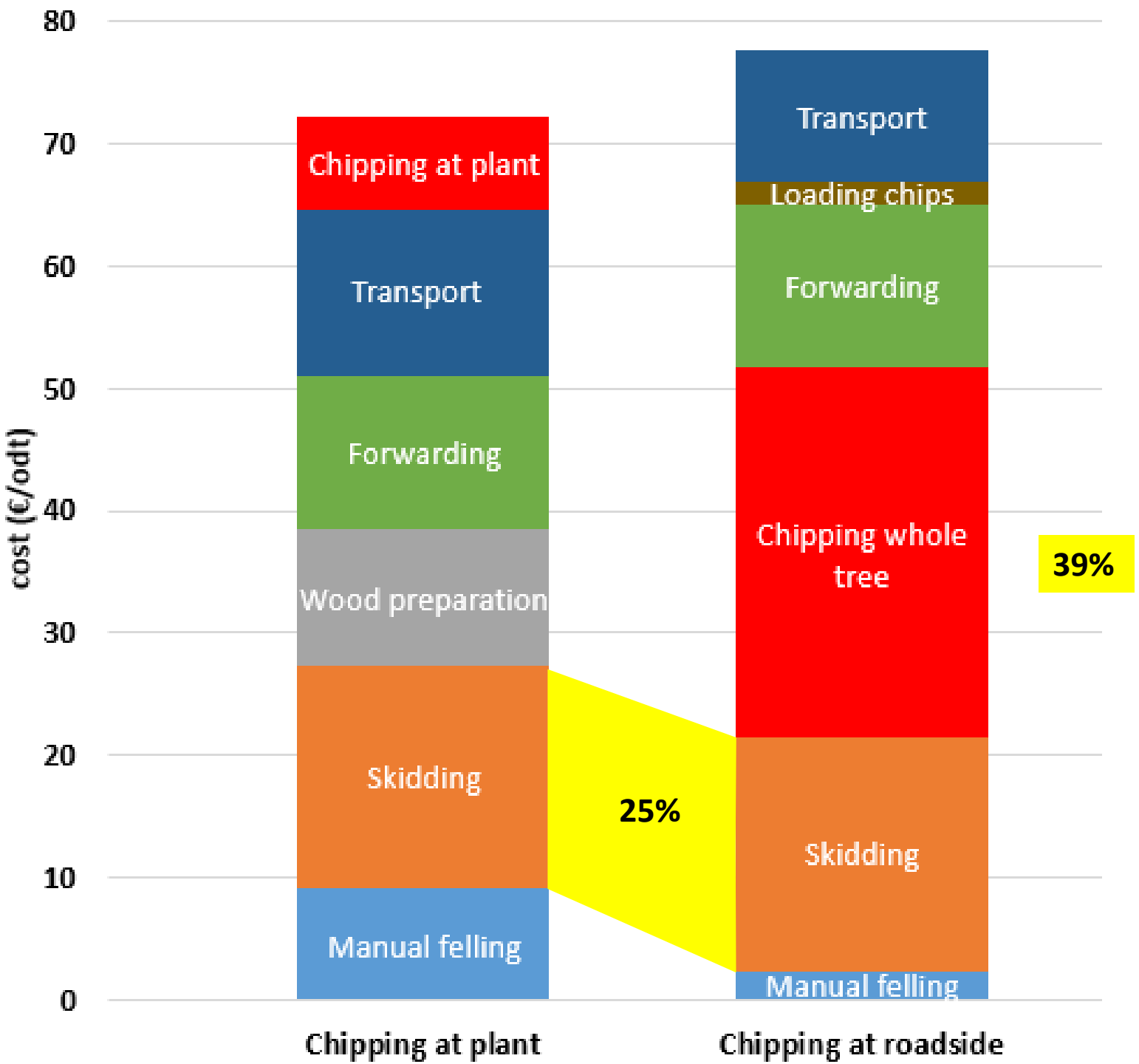
Chipping at plant

- Pezzolato PTH 900/660 chipper
- The utilization rate was very high (96.8%)



Productivities and costs of system 1 (Chipping at plant) and 2 (Chipping at roadside).

	Chipping at plant			Chipping at roadside	
Stage	odt/h	€/odt	**Stage**	odt/h	€/odt
Manual felling	1.17	9.18	**Manual felling**	4.31	2.49
Skidding	1.4	18.11	**Skidding**	1.79	19.04
Wood preparation	2.01	11.26	**Chipping whole tree**	2.53	30.11
Forwarding logs	2.52	12.42	**Forwarding whole trees**	2.35	13.40
Transport to plant	2.55	13.64	**Loading chips**		1.81
Chipping at plant	10.11	7.53	**Transport to plant**	4.33	10.85
		72.15			**77.71**


80
70
60
50
40
30
20
10
0
cost (€/odt)
Chipping at plant
Transport
Forwarding
Wood preparation
Skidding
Manual felling
Transport
Loading chips
Forwarding
Chipping whole tree
Skidding
Manual felling
25%
39%
Chipping at plant
Chipping at roadside

Wood fuel quality parameters evaluated in the study.

	Chips from whole-trees		Chips from stems	
	Results	Classification ISO 17225-1	Results	Classification ISO 17225-1
Moisture content (%)	46.70	M50	48.59	M50
Bulk density	304.85	BD300	327.77	BD300
Dimensions	P31S	P31S	P31S	P31S
Fines	F10	F10	F10	F10
Ash (%)	0.8	A1.0	0.4	A0.5
Gross Calorific Value (MJ/kg)	20.54		20.06	
Classification (ISO 17225-4)	B1		B1	

1. The productivities of manual felling and skidding were influenced by climatic conditions and the dense understory, so total harvesting cost will decrease in usual conditions.
2. In cases where it is feasible, one alternative to improve felling is increasing mechanization by using a harvester or a feller-buncher.
3. Chipping at plant was more productive than chipping at roadside, due specifically to the interferences between the chipper and the hauling tractor in the latter.
4. System 1 (chipping logs at plant) was a low profit margin.
5. System 2 (chipping whole trees at roadside) was not cost effective → improve logistics.
5. Both types of chips were classified as B1 (part 4, UNE-EN ISO 17225). They cannot be classified with the higher quality due to their moisture content.

Thank you!

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