Appendix 1

Supplementary material define the total hourly cost, the hourly productivity and CO_2 emissions per forest process.

Tab. S1 - Definition of total hourly cost per forest process. **(***): cost of 3rd level worker: 10.00 €/h; (**): cost of 5th level worker: 13.90 €/h.

Process	**N° workers (3rd level)***	**N° workers (5th level)****	**Hourly machine cost (€/h)**	**Total hourly cost (€/h)**
Felling and/or felling-processing cost with chainsaw	1	0	3.17	13.17
Processing cost with processor	0	1	73.52	87.42
Felling and processing cost with harvester	0	1	82.43	96.33
Extraction cost with high power cable crane	2	1	77.54	111.44
Extraction cost with medium power cable crane	2	1	70.41	104.31
Extraction cost with forwarder	1	1	46.80	70.70
Extraction cost with skidder	1	1	30.46	64.36
Chipping	0	1	136.97	150.87
Transport with truck	0	1	51.00	64.90

Tab. S2 - Definition of hourly productivity per forest process.

Process	Productivity (Pr) equation	U.M	References
Final felling with chainsaw in high forest	$\Pr = \frac{42 - 2.6d}{-20} \cdot 1.65 \cdot \left(1 - \frac{s\%}{100}\right)$	m^3/h	Hippoliti & Piegai 2000, modified
Thinning with chainsaw in high forest	$\Pr = \frac{42 - 2.6d}{-20} \cdot 1.65 \cdot \left(1 - \frac{1000 - 90 \cdot s\%}{-8000}\right)$	m^3/h	Hippoliti & Piegai 2000, modified
Felling and processing with chainsaw in coppice	$\Pr = \frac{0.3 - 1.1f}{-4}$	m^3/h	Hippoliti & Piegai 2000, modified
Processing with processor	$\Pr = 0.363 \cdot d^{1.116}$	m^3/h	Nakagawa et al. 2010
Felling and processing with harvester (final felling)	$\Pr = \frac{60}{K \cdot e^{0.1480 - 0.3894ST + 0.0002s\%^2 - 0.2674Sb} + 1.0667 + 0.3094 \cdot t^{-1} - 0.1846}$	m^3/h	Stampfer & Steinmüller 2001, modified
Felling and processing with harvester (thinning)	$\Pr = \frac{60}{K \cdot e^{0.1480 - 0.3894ST + 0.0002s\%^2 - 0.2674Sb} + 1.0667 + 0.3094 \cdot t^{-1} - 0.1846 \cdot 0.8}$	m^3/h	Stampfer & Steinmüller 2001, modified
Extraction with high power cable crane	$\Pr = 56 \cdot ext^{-1.1685} \cdot ext / dwh \cdot r_{cc}$	m^3/h	Lubello 2008, modified
Extraction with medium power cable crane	$\Pr = 149.33 \cdot ext^{-1.3438} \cdot ext / dwh \cdot r_{cc}$	m^3/h	Lubello 2008, modified
Extraction with forwarder	$\Pr = 16.14 \cdot ext^{-0.8126} \cdot ext / dwh \cdot r_f$	m^3/h	Lubello 2008, modified
Extraction with skidder	$\Pr = 36.293 \cdot ext^{-1.1791} \cdot ext / dwh \cdot r_s$	m^3/h	Lubello 2008, modified
Chipping (high forest material)	$\Pr = \frac{V_{res}}{34}$	h	Spinelli et al. 2007, Spinelli & Magagnotti 2010
Chipping (coppice material)	$\Pr = \frac{V_{res}}{45.9}$	h	Spinelli et al. 2007, Spinelli & Magagnotti 2010
Transport with truck	$\Pr = transp \cdot V_{ch} \cdot 56 \cdot 10^{-6}$	h	Bernetti & Romano 2007

where
d: mean tree diameter (cm);
s%: slope (%);
f: fertility degree;
K: conversion factor for delay times computation (preliminary setting: 1.5);

ST: number of tree felled per stop;
Sb: soil bearing capacity (preliminary setting: 2.5 %CBR);
t: mean tree cormometric volume (m^3);
ext: extraction distance (m);
dwh: daily working hours (h);
r_{cc}: reduction factor to consider Full Tree System extraction with cable crane (preliminary setting: 0.75);
r_f: reduction factor to consider Full Tree System extraction with forwarder (preliminary setting: 0.6);
r_s: reduction factor to consider Full Tree System extraction with skidder (preliminary setting: 0.6);
V_{res}: volume of residues in *i-th* pixel (bulk m^3);
trans: transport distance (m);
V_{ch}: volume of equivalent woodchip in *i-th* pixel (bulk m^3).

Tab. S3 - Definition of CO_2 emissions per forest process.

Process	Fuel consumption (l fuel/operating h)	Conversion factor (g CO_2/kg fuel)	Fuel density (kg/l)	CO_2 emissions (g CO_2/h)	References
Final felling and thinning with chainsaw in high forest	2	3150	0.75	4725	Karjalainen et al. 2001
Felling and processing with chainsaw in coppice	1	3150	0.75	2363	Piegai 2000, Karjalainen et al. 2001
Processing with processor	13	3455	0.84	37729	Moscatelli et al. 2007, Valente et al. 2011, Karjalainen et al. 2001
Felling and processing with harvester (final felling and thinning)	12	3455	0.89	36899	Kilpelainen et al. 2011, Karjalainen et al. 2001
Extraction with high power cable crane	8	3455	0.75	20730	Piegai 2000, Karjalainen et al. 2001
Extraction with medium power cable crane	5	3455	0.75	12956	Piegai 2000, Karjalainen et al. 2001
Extraction with forwarder	9,8	3455	0.75	25394	Karjalainen et al. 2001
Extraction with skidder	6	3455	0.75	15548	Karjalainen et al. 2001
Chipping	45	3455	0.84	130599	Piegai 2000, Valente et al. 2011, Karjalainen et al. 2001
Transport with truck	9	3180	0.84	24041	Valente et al. 2011, Karjalainen et al. 2001