

Table 1. Description of processes carried out in a representative industrial pine wood stand in Brazil

Subsystem	Operation	Year	Machinery	Weight (kg) & Power (kW)	Implement	Weight (kg)	Operating rate (h·ha <sup>-1</sup> )	Diesel consumption (L·ha <sup>-1</sup> )
Soil preparation	Subsoiling	0	Tractor	8,568 kg 107.7 kW	Plower	2,000	1.8	9
	Pest control <sup>a</sup>	0	Tractor	8,568 kg 107.7 kW	Sprayer	230	2.3	4
	Chemical weeding <sup>b</sup>	0	Tractor	8,568 kg 107.7 kW	Sprayer	230	2.3	3.6
	Lowering stumps	0	Tractor	8,568 kg 107.7 kW	Milling	-	0.2	0.9
	Waste scattering	0	Tractor	8,568 kg 107.7 kW	Roller	4,700	3.2	11
	Mineral fertilization <sup>c</sup>	0	Tractor	8,568 kg 107.7 kW	Sprayer	230	2.0	3.5
Seedlings plantation	Planting <sup>d</sup>	0	Truck	8,030 kg 191.2 kW	-	-	3.3	3.2
		0	Tractor	8,568 kg 107.7 kW	Furrower	190	0.5	2.5
	Irrigation	0	Tractor	8,568 kg 107.7 kW	Tanker truck	640	1.2	5.7
	Re-plantation <sup>e</sup>	0	Tractor	8,568 kg 107.7 kW	Furrower	190	0.3	1.3
Forest management	Chemical weeding <sup>f</sup>	0-12	Truck	8,030 kg 191.2 kW	Tanker truck	-	17	34
	Pest control <sup>g</sup>	0-11	Tractor	8,568 kg 107.7 kW	-	-	12	25
	Mineral fertilization <sup>h</sup>	0-11	Tractor	8,568 kg 107.7 kW	Sprayer	230	13	24
Forest harvesting	Harvesting	11	Harvester	28,725 kg 219 kW	Tracer	1400	24	585
	Extraction	11	Forwarder	19,500 kg 160 kW	-	-	16	340
	Loading onto trucks	11	Bulldozer	23,530 kg 110.0 kW	-	-	6	115
Infrastructure establishment	Roads building and maintenance	0	Crawler Tractor	7,795 kg 55.2 kW	Blade	-	0.53	0.3
		0	Motor grader	13,032 kg 93 kW	-	-	0.5	1.8
		0	Backhoe	10,200 kg 58 kW	-	-	0.9	3.5

<sup>a</sup>5 kg·ha<sup>-1</sup> of Sulfloramid based ant bait; <sup>b</sup> 2 kg·ha<sup>-1</sup> of glyphosate; <sup>c</sup> 672g·ha<sup>-1</sup> of urea, 1.5 kg·ha<sup>-1</sup> of ammonium sulfate, 36 kg·ha<sup>-1</sup> of superphosphate and 12.5 kg·ha<sup>-1</sup> of potassium chloride; <sup>d</sup> Planting of 1,750 seedlings per ha; <sup>e</sup> Re-planting of 200 seedlings per ha; <sup>f</sup>11 kg·ha<sup>-1</sup> of glyphosate; <sup>g</sup>26.6 kg·ha<sup>-1</sup> Sulfloramid-ant bait; <sup>h</sup> 9.48 kg·ha<sup>-1</sup> of urea, 3.2 kg·ha<sup>-1</sup> of ammonium sulfate, 74.9 kg·ha<sup>-1</sup> of superphosphate and 24.5 kg·ha<sup>-1</sup> of potassium chloride

Table 2. Average transport distances corresponding to the inputs' delivery up to the forest site

<b>Inputs</b>	<b>Distance (km)</b>
Urea	2117
Ammonium sulfate	2389
Superphosphate	2173
Potassium chloride	2634
Glyphosate	2403
Sulfluramide-ant bait	566

Table 3. Summarized inventory data corresponding to 1 m<sup>3</sup> under bark (ub) of pine roundwood production at forest stand

	Quantity	Unit
<b>INPUTS FROM TECHNOSPHERE</b>		
<i>Materials</i>		
Seedlings	15	units of plants
<i>Herbicide</i>		
Glyphosate	26	g
<i>Insecticide</i>		
Sulfluramide-ant bait	82	g
<i>Fertilizers</i>		
Urea	21	g
Ammonium sulfate	10	g
Superphosphate	225	g
Potassium chloride	76	g
<i>Fossil fuel</i>		
Diesel	234	g
<i>Transport</i>		
Truck	280	t-km
<b>OUTPUTS TO TECHNOSPHERE</b>		
<i>Product</i>		
Pine logs	1	m <sup>3</sup> ub
<b>OUTPUTS TO ENVIRONMENT</b>		
<i>Emissions into air</i>		
<i>from diesel combustion</i>		
NMVOC	10	g
NO <sub>x</sub>	83	g
CO	25	g
CO <sub>2</sub>	5	kg
SO <sub>2</sub>	4	g
CH <sub>4</sub>	3	g
Benzene	4	g
Particles	13	g
Cadmium	10	g
Chromium	10	g
Copper	10	g
Dinitrogenmonoxide	3	g
Nickel	10	g
Zinc	10	g
Benzo(a) pyrene	4	g
PAH <sup>a</sup>	6	g
Heat	70	kg
Ammonia	3	g
Selenium	10	g
<i>from fertilizers application</i>		
Urea	67	g
<i>from herbicide application</i>		
Glyphosate	14	g
<i>Emissions into soil</i>		
<i>from herbicide application</i>		
Glyphosate	119	g
<i>Emissions into water</i>		
<i>from herbicide application</i>		
Glyphosate	14	g
<i>from fertilizers application</i>		
Sulfate leaching	27	g
Phosphate	0.73	g

<sup>a</sup>polycyclic aromatic hydrocarbons

Table 4: Potential environmental profile per 1 m<sup>3</sup> ub of pine roundwood production in Brazil. Acronyms: SS1: Soil preparation; SS2- Seedlings plantation; SS3- Forest management; SS4- Forest harvesting; SS5- Infrastructure establishment; CC- Climate Change; OD –Ozone Depletion, TA- Terrestrial Acidification, FE- Freshwater Eutrophication, ME- Marine Eutrophication, HT- Human Toxicity, POF- Photochemical Oxidants Formation, TET- Terrestrial Ecotoxicity, FET- Freshwater Ecotoxicity, MET- Marine Ecotoxicity; WD- Water Depletion; FD- Fossil Depletion.

<b>Impact category</b>	<b>Unit</b>	<b>SS1</b>	<b>SS2</b>	<b>SS3</b>	<b>SS4</b>	<b>SS5</b>	<b>Total</b>
CC	kg CO <sub>2</sub> eq	1.17	3.43·10 <sup>-1</sup>	1.53	5.28	2.14·10 <sup>-1</sup>	8.54
OD	kg CFC-11eq	1.67·10 <sup>-7</sup>	4.56·10 <sup>-8</sup>	2.32·10 <sup>-7</sup>	8.2·10 <sup>-7</sup>	2.94·10 <sup>-8</sup>	1.30·10 <sup>-6</sup>
TA	kg SO <sub>2</sub> eq	9.15·10 <sup>-3</sup>	2.18·10 <sup>-3</sup>	8.50·10 <sup>-3</sup>	4.46·10 <sup>-2</sup>	1.13·10 <sup>-3</sup>	6.55·10 <sup>-2</sup>
FE	kg P eq	7.75·10 <sup>-4</sup>	7.53·10 <sup>-5</sup>	7.30·10 <sup>-4</sup>	4.40·10 <sup>-4</sup>	6.92·10 <sup>-5</sup>	2.09·10 <sup>-3</sup>
ME	kg N eq	3.54·10 <sup>-4</sup>	1.26·10 <sup>-4</sup>	4.83·10 <sup>-4</sup>	2.71·10 <sup>-3</sup>	6.31·10 <sup>-5</sup>	3.73·10 <sup>-3</sup>
HT	kg 1,4-DB eq	7.22·10 <sup>-1</sup>	1.14·10 <sup>-1</sup>	7.18·10 <sup>-1</sup>	7.97·10 <sup>-1</sup>	9.27·10 <sup>-2</sup>	2.44
POF	kg NMVOC	7.76·10 <sup>-3</sup>	3.67·10 <sup>-3</sup>	1.10·10 <sup>-2</sup>	7.70·10 <sup>-2</sup>	1.70·10 <sup>-3</sup>	1.01·10 <sup>-1</sup>
TET	kg 1,4-DB eq	2.29·10 <sup>-4</sup>	4.95·10 <sup>-5</sup>	2.97·10 <sup>-4</sup>	5.10·10 <sup>-4</sup>	1.29·10 <sup>-5</sup>	1.10·10 <sup>-3</sup>
FET	kg 1,4-DB eq	2.25·10 <sup>-2</sup>	2.51·10 <sup>-3</sup>	1.87·10 <sup>-2</sup>	1.56·10 <sup>-2</sup>	2.34·10 <sup>-3</sup>	6.16·10 <sup>-2</sup>
MET	kg 1,4-DB eq	2.16·10 <sup>-2</sup>	2.62·10 <sup>-3</sup>	1.88·10 <sup>-2</sup>	1.64·10 <sup>-2</sup>	2.40·10 <sup>-3</sup>	6.18·10 <sup>-2</sup>
WD	dm <sup>3</sup>	10.2	1.47	8.25	12.2	1.16	33.3
FD	kg oil eq	4.30·10 <sup>-1</sup>	1.15·10 <sup>-1</sup>	5.32·10 <sup>-1</sup>	1.74	7.55·10 <sup>-2</sup>	2.89