Pure Energy Ratio of logging residue processing

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Idea

How to define (assess) which of the technologies used for logging residues processing is the most suitable with regards to environment.

Is the use of logging residues effective, can we earn more than we invested with respect to renewable and fossile energy?

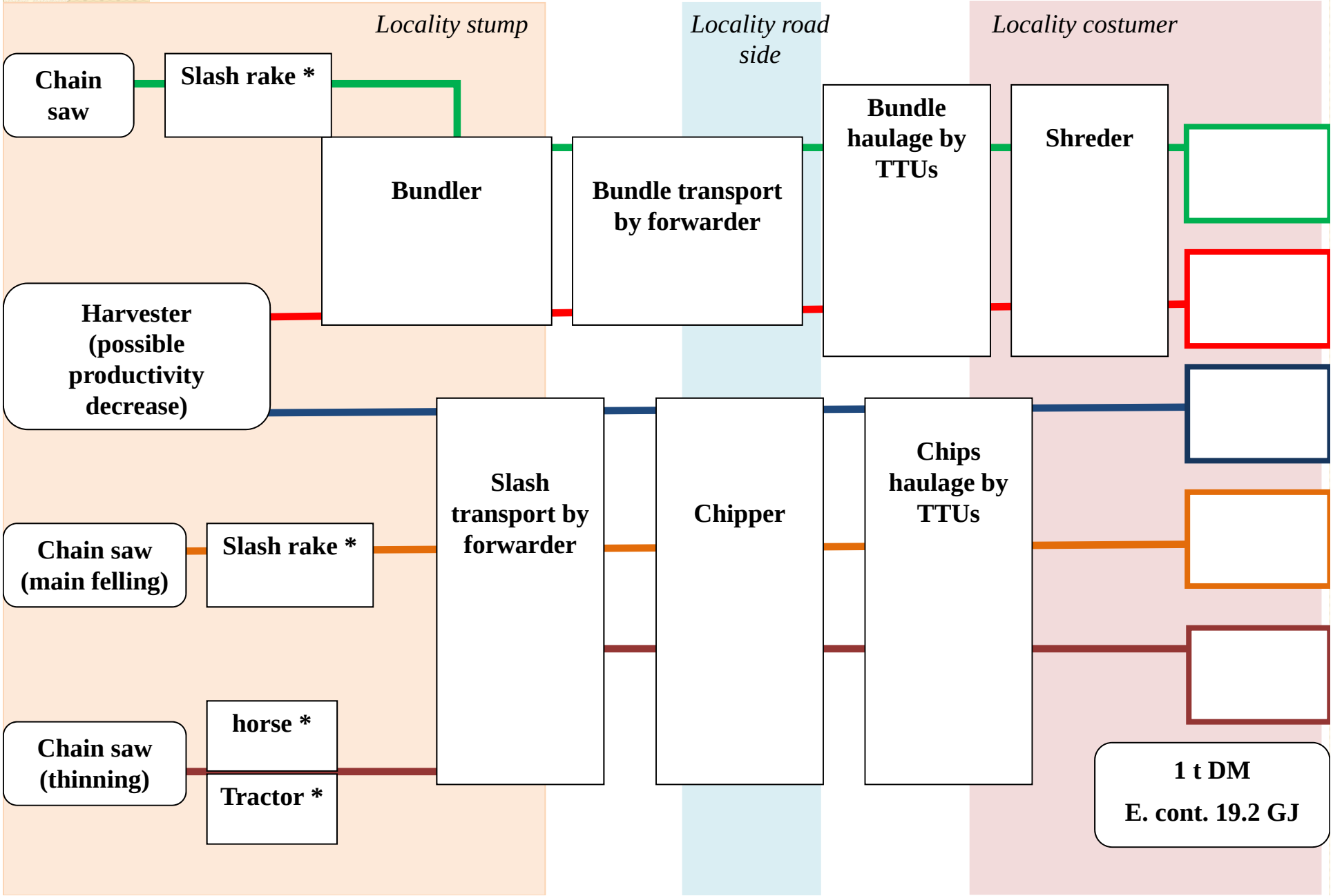
Terms "energy balance" or "energy ratio" are used to characterize relations between the energy input and output.

Energy balance is a difference between the energy output and input.

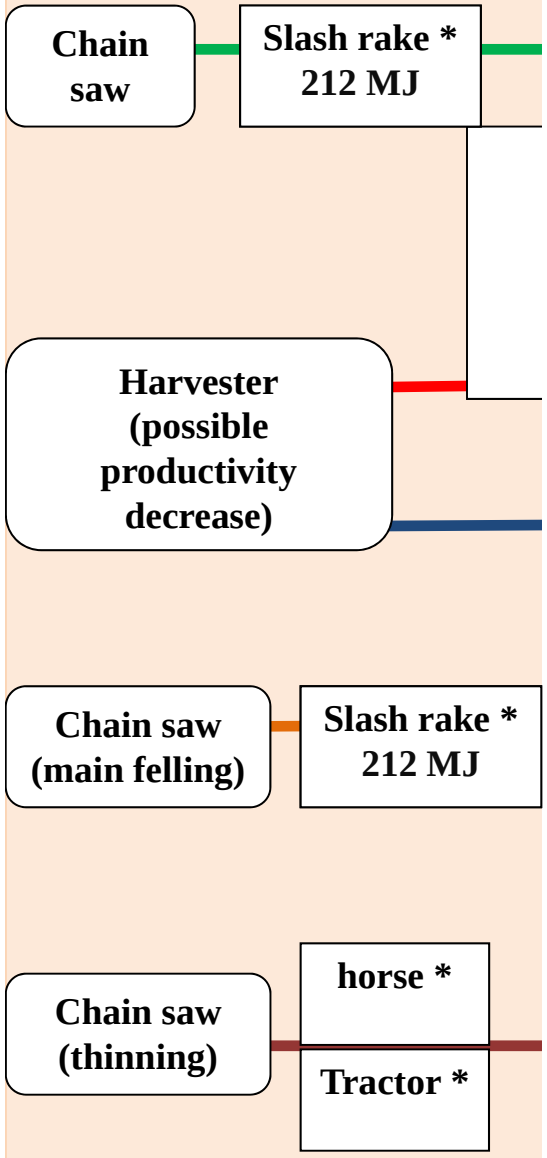
Energy ratio is a ratio between the energy output and energy input

Pure = renewable

Processing chains identification



Processing chains



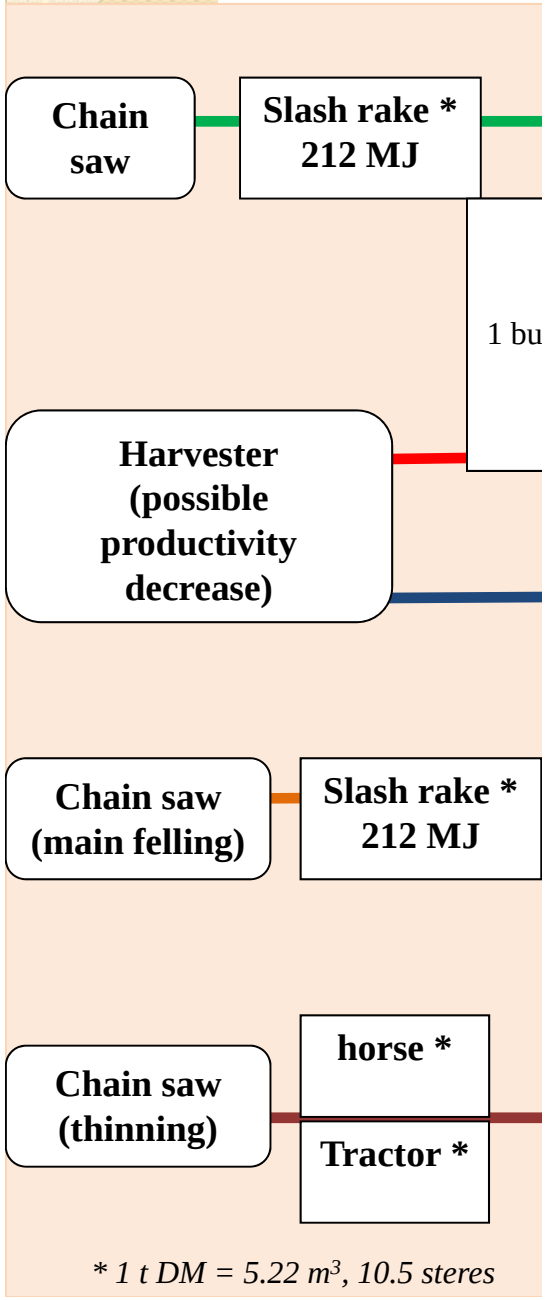
Slah rakes

Productivity 65/8 steres per shift/hour

Fuel consumption: 3,9 *l*.h^{-1} ; 0,5 *l*.stere^{-1}

** 1 t DM = 5.22 m^3, 10.5 steres*

Processing chains



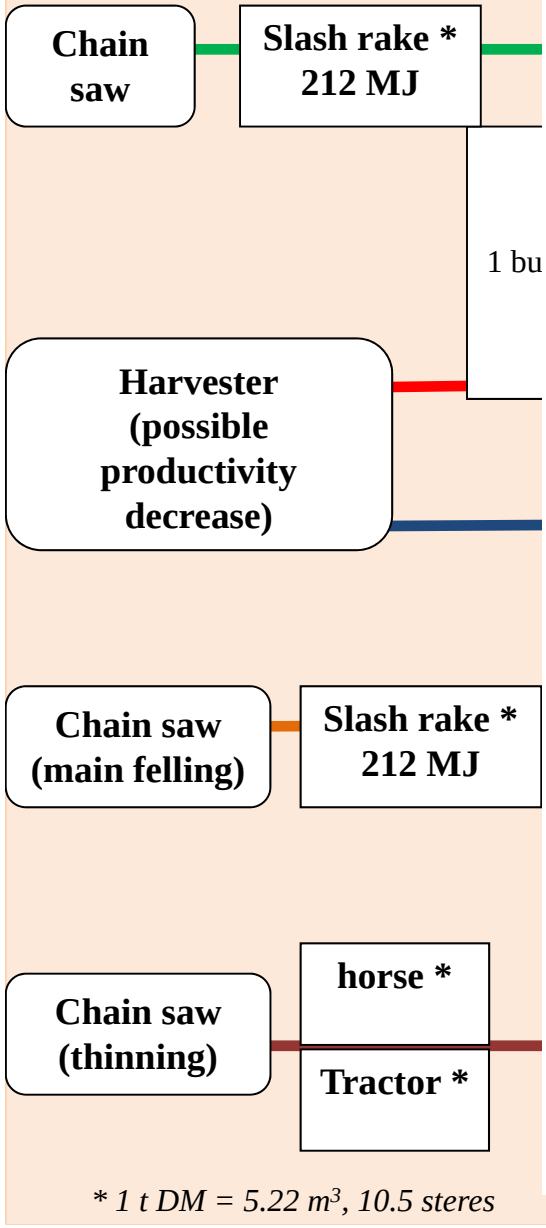
Bundler

Average production rate: 13844 bundles (FU) per year
Number of working hours: 3474 hours per year
Fuel consumption: 7.3 *l*.h^{-1}; 1.83 *l*.FU^{-1}
Consumption of oils: 0.62 *l*.h^{-1}; 0.16 *l*.FU^{-1}

period	2007	2008
SMH	3389	3558
bundles (pcs)	10041	17647
Tons (1bundle = 340.85 kg)	3360.6	6015
Utilization	79.6 %	83.6 %
Productivity pcs.SMH^{-1}	3	5

GJ

Processing chains



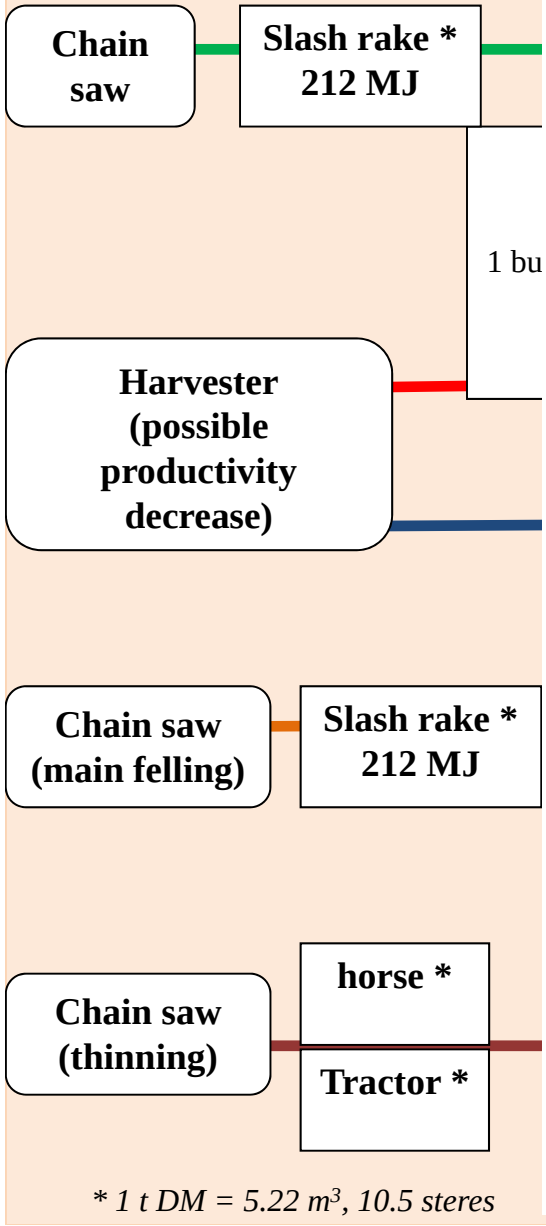
** 1 t DM = 5.22 m^3, 10.5 steres*

Frowarder after bundling

capacity of forwarders ranges between 10 – 20 bundles (FU)
1 bundle = 179 kg DM

Fuel consumption: 13.72 $l.h^{-1}$; 1.25 $l.FU^{-1}$
Consumption of oils: 0.64 $l.h^{-1}$; 0.06 $l.FU^{-1}$

Processing chains



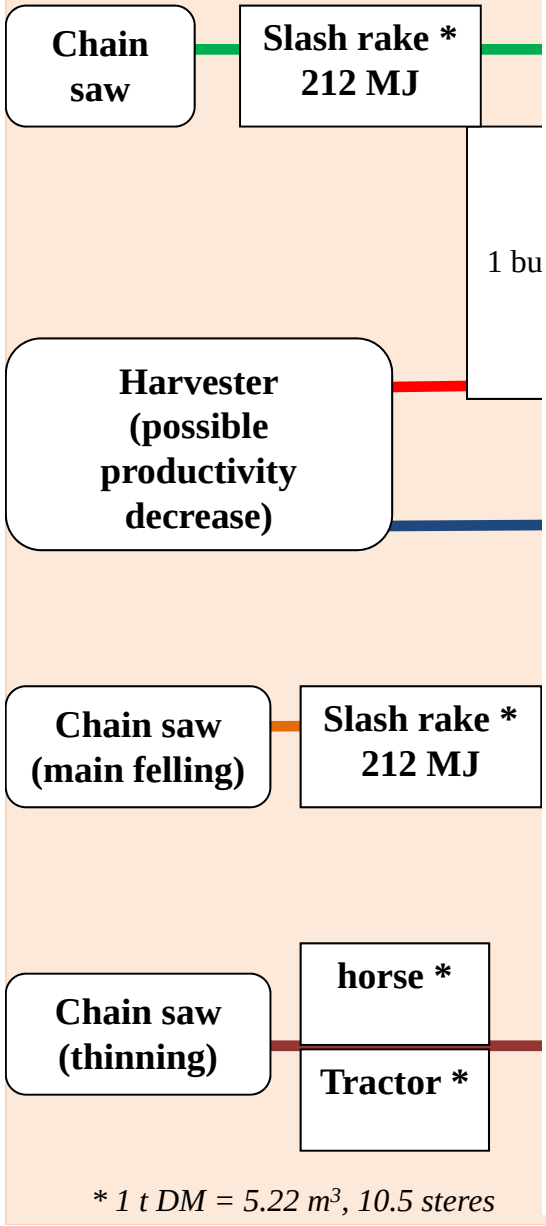
Hauling of bundles

distances were 206 and 114 km and this is why we considered mean hauling distances for the transportation of bundles to be 75 and 150 km

Average productivity:	53 bundles (FU) per haulage
Fuel consumption:	50 *l*.100 km^{-1}; 1.42 and 2.83 *l*.FU^{-1}
Consumption of oils:	0.45 *l*.100 km^{-1}; 0.013 *l*.FU^{-1}

GJ

Processing chains



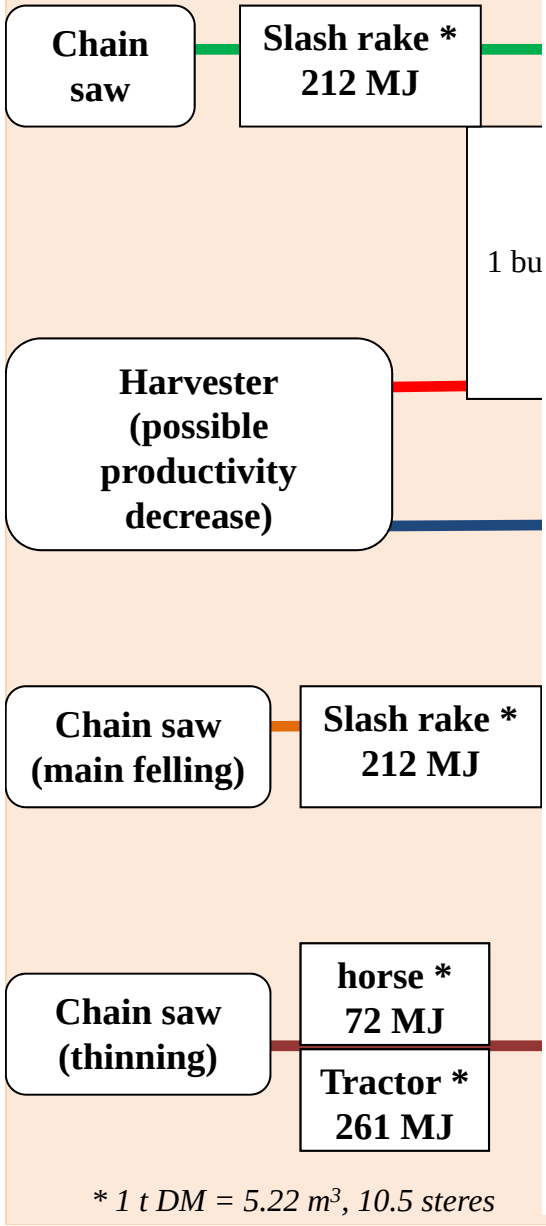
Shredding

Average consumption of diesel oil per hour was 23.5 litres
The productivity of the crusher may reach up to 22 tons per hour actual production rate ranged about 15 tons per hour.

Fuel consumption: 1.6 litres per ton

GJ

Processing chains



Horse and/or Tractor

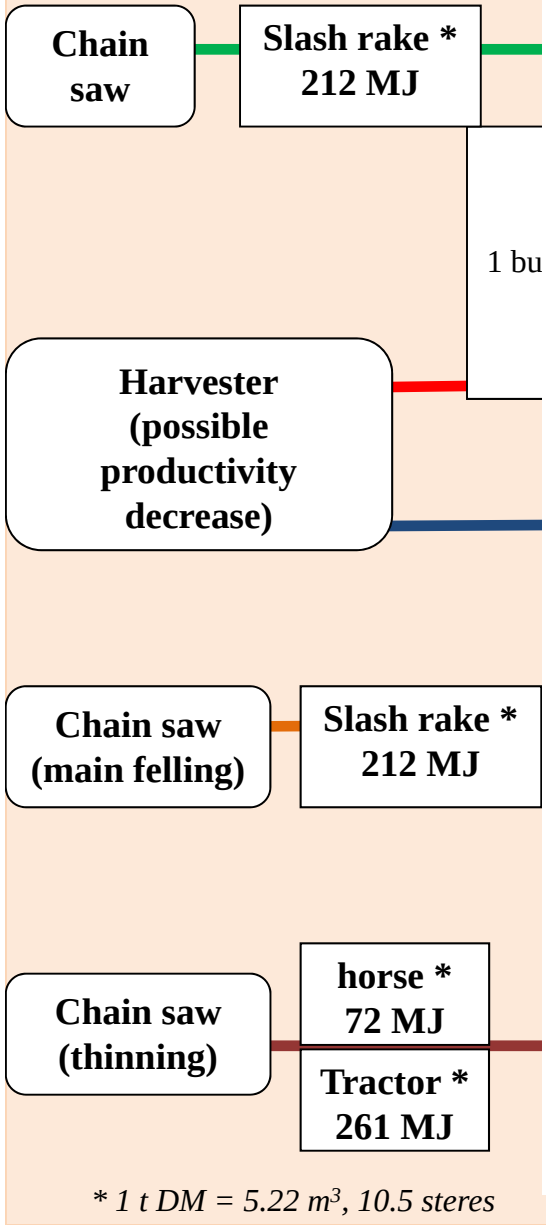
energy consumption of horses amounts to 13.7 MJ.hour^{-1} (Magagnotti and Spinelli, 2011)

Farm tractor

Fuel consumption:	1 – 1.2 *l*.m^{-3}
Transmission oil consumption:	6.7 *l*.1000 m^{-3}
Motor oil consumption:	6.7 *l*.1000 m^{-3}
Consumption of lubricants:	1.7 kg.1000 m^{-3}
Lubrication spray:	1 *l*.1000 m^{-3}

GJ

Processing chains



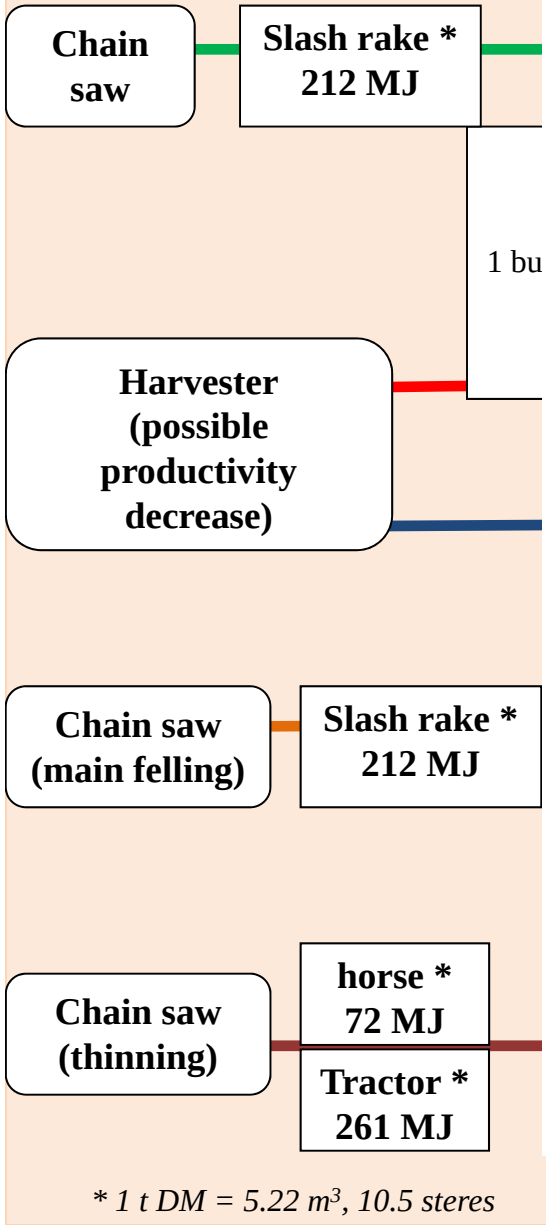
Logging residue forwarding

According to the loading area size, the capacity of forwarders ranges from 4 – 7 stacked cubic metres (steres) of logging residues (FU). Output per hour fluctuates in dependence on the logging system (preparedness of the site) and average skidding distance.

Fuel consumption:	13.72 *l*.h^{-1}; 2.29 *l*.FU^{-1}
Consumption of oils:	0.64 *l*.h^{-1}; 0.11 *l*.FU^{-1}

GJ

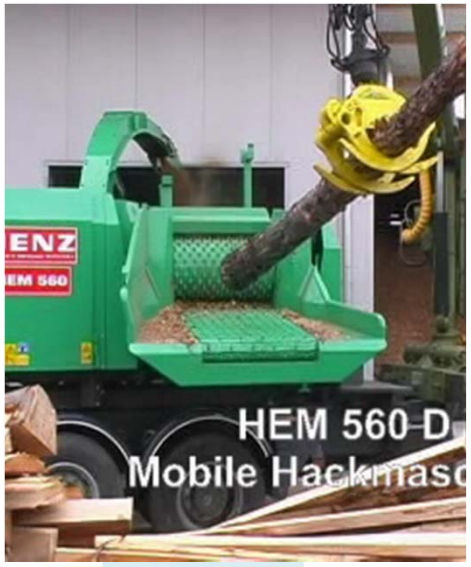
Processing chains



Cipping

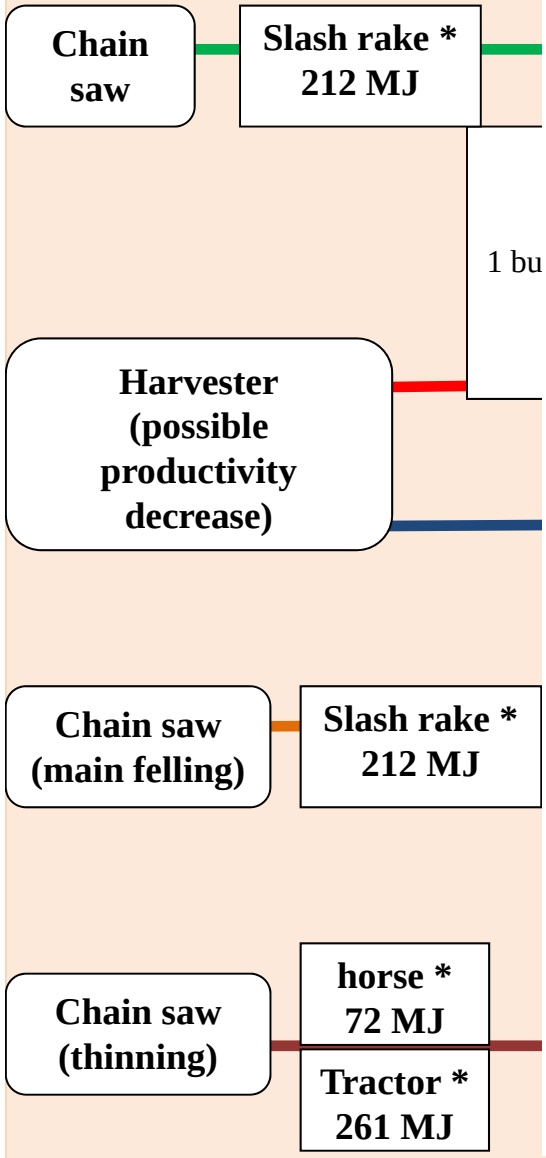
The calculation was made for a machine assembly containing the chipper JENZ HEM 420 Z (JH 420 Z) and the tractor FENDT 716 VARIO.

Average production rate:	6608 tons (FU) per year
Number of working hours:	2702 PMH per year
Fuel consumption:	7.18 $l.h^{-1}$; 2.96 $l.FU^{-1}$
Consumption of oils:	0.06 $l.h^{-1}$; 0.026 $l.FU^{-1}$



GJ

Processing chains



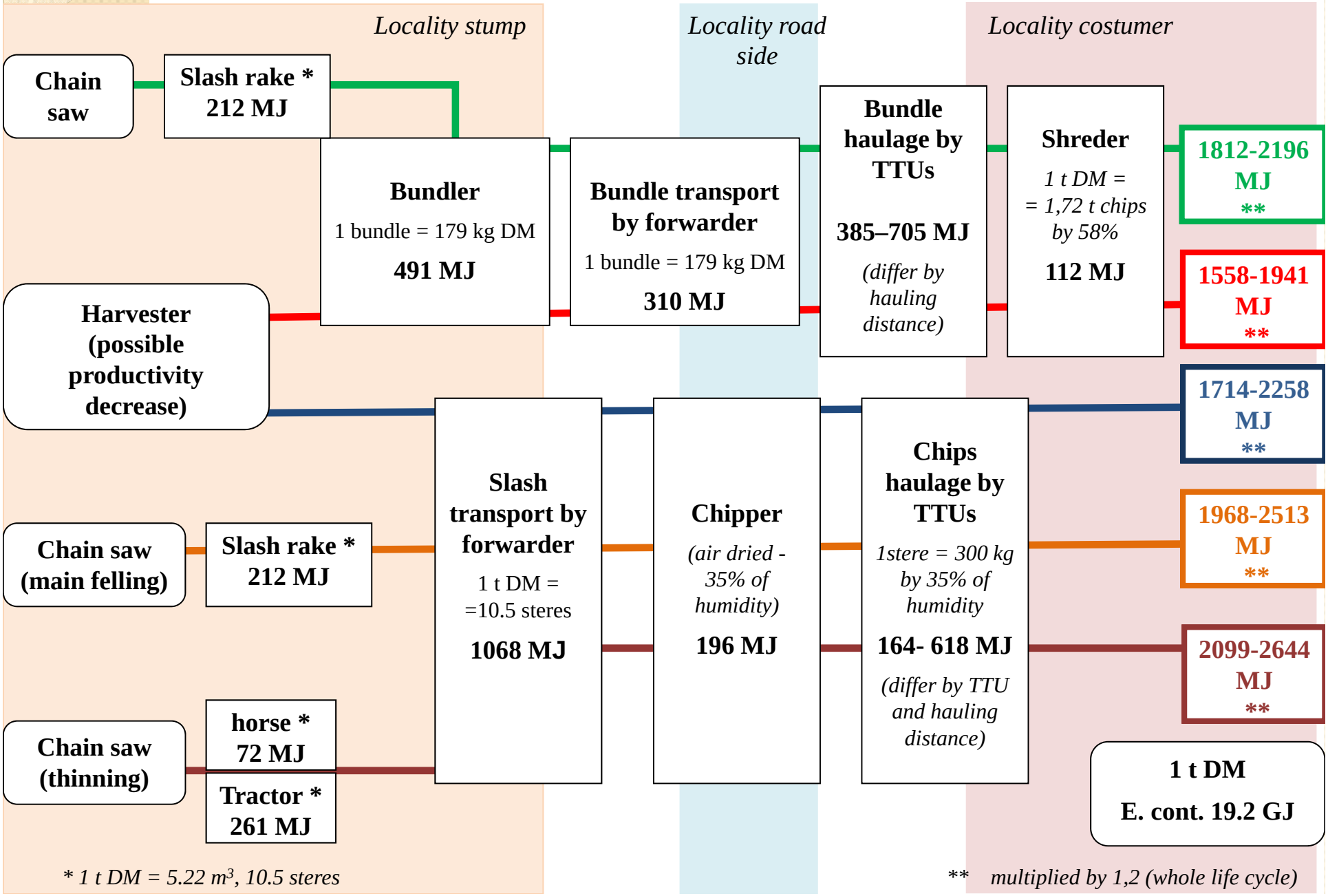
** 1 t DM = 5.22 m^3, 10.5 steres*

Haulage of chipps

Average productivity:	35 and 70 steres per journey
Fuel consumption:	60 *l*.100 km^{-1} and 65 *l*.100 km^{-1}
Fuel consumption:	1.71 *l*.FU^{-1} and 0.93 *l*.FU^{-1}
Consumption of oils:	0.45 *l*.100 km^{-1}; 0.013 *l*.FU^{-1}

Average hauling distance	TTU type*	Energy balance (MJ. $stere^{-1}$) from the operational phase	Energy balance (MJ.t^{-1} DM) from the operational phase
50	small	80.9	270
	large	49.2	164
100	small	133	443
	large	72.8	243
150	small	185.3	618
	large	98.4	328

Processing chains



PER for logging residue processing

Depending on the chosen technological chain, the pure energy ratio ranged from 8 – 12. With this multiple gain of energy, the used method of manufacturing and processing raw material for fuel (chips) can be considered highly effective and contributing to sustainable management.

PER after burning – Effect?

Technology	En. content 1 t DM	En. use of processing*	En. balance supplied to costumer**	Boiler efficiency	En. balance 1t DM	**pure energy ratio**
	[GJ]	[GJ]	[GJ]	[%]	[GJ]	
	Col. 1	Col. 2	Col. 3=1-2	Col. 4	Col. 5	Col. 6=1:(1-5)
(Local) district heat	19.2	1.8	17.4	85-93	14.79 - 16.2	**4.35 - 6.4**
Combined production (electricity and heat)	19.2	2.1	17.1	60-70	10.26 - 11.97	**2.14 - 2.66**
Large power plant (co-firing with coal)	19.2	2.5	16.7	23-27	3.84 – 4.5	**1.25 – 1.31**

Col. = Column

* Hauling distances are considerably shorter in district heat plants and energy use for haulage is therefore markedly lower . Large power plants require the collection of sources from longer distances and energy intensiveness ranges at the upper limit

** The longer the storage time, the greater the material degradation is (ca. 5% per month). This is why a higher degradation risk exists in large power plants due to the necessary advance storage of supplies.

Thank you for your attention