

Productivity of stump extraction with experimental prototype head MCR-500

Andis Lazdiņš¹, Agris Zimelis¹, Igors Gusarevs²

¹ LVMI Silava, ² Orvi SIA

Contact: andis.lazdins@silava.lv

The first published studies on stump extraction for bioenergy in Latvia are dated with second half of 19th century. In the 3rd decade of the 20th century stump extraction was identified as one of the most prospective and challenging tasks of forest sector to secure sustainable deliveries of solid biofuel. In that time stump extraction using explosives was considered to be a conventional forestry technology.

Now we are returning to the same challenges; however, mechanical power is used instead of explosives to pull and to crash stumps.

MCR-500 is the first prototype of combined stump extraction and mounding head for caterpillar excavator produced in Latvia by joining forces of the LSFRI Silava and engineering company Orvi SIA. The device is supposed to be used for extraction of stumps with diameter up to 50 cm in coniferous and deciduous tree stands. Additional benefit of the device is ability to prepare soil by making mounds for the following forest regeneration.

The article summarizes results of productivity trials of stump extraction and preparation of soil using the MCR-500 head. In total 3,5 ha were extracted during the studies. Harvested amount of stumps was estimated using biomass equations; therefore, might be corrected in further forwarding and comminution studies, when actual amount of biomass will be estimated. Average stock of extractable biomass (stumps and coarse roots) in the experimental sites was 28 tons ha⁻¹. Productivity of stump extraction was 2.4...3.4 tons per efficient hour (2.5 tons in case of optimal rate of scarification of soil).

Consumption of efficient time for scarification of soil is 3.4...4.3 hours per ha. Figures of productivity of stump extraction are comparable with the ones obtained with similar stump extraction heads.

Scarification of soil with stump lifting head consumes twice more time than conventional trenching; however in wet sites productivity figures become closer making excavator competitive.



Target of the study:

- Estimation of characteristics of the extracted stands including parameters of stumps, extracted and total biomass.
- Estimation of productivity of stump extraction using the MCR-500 stump extraction head prototype.

Stand characteristics:

Object	Area, ha	Extracted stumps	Share of extracted stumps	Average diameter of extracted stumps, cm	Biomass of extracted stumps, kg	Extractable biomass	Biomass of average stumps, kg	Prepared mounds
104-9	0,7	269	63%	32	17479	53%	65	1047
176-18	1,1	415	90%	30	25197	72%	61	346
98-4	1,7	550	71%	30	54108	66%	98	604
All	3,5	1235	74%	33	96784	64%	78	1997

Productivity in hourly expression:

Productivity per efficient hour	Extractable biomass - total time	Extractable biomass - time except soil treatment	Number of mounds per hour	Prepared soil, ha per hour	Prepared soil (if 2200 mounds ha ⁻¹)
104-9	2,5	3,8	346	0,23	0,16
176-18	2,4	2,7	106	0,34	0,05
98-4	3,1	3,7	104	0,29	0,05
All	2,9	3,7	167	0,29	0,08



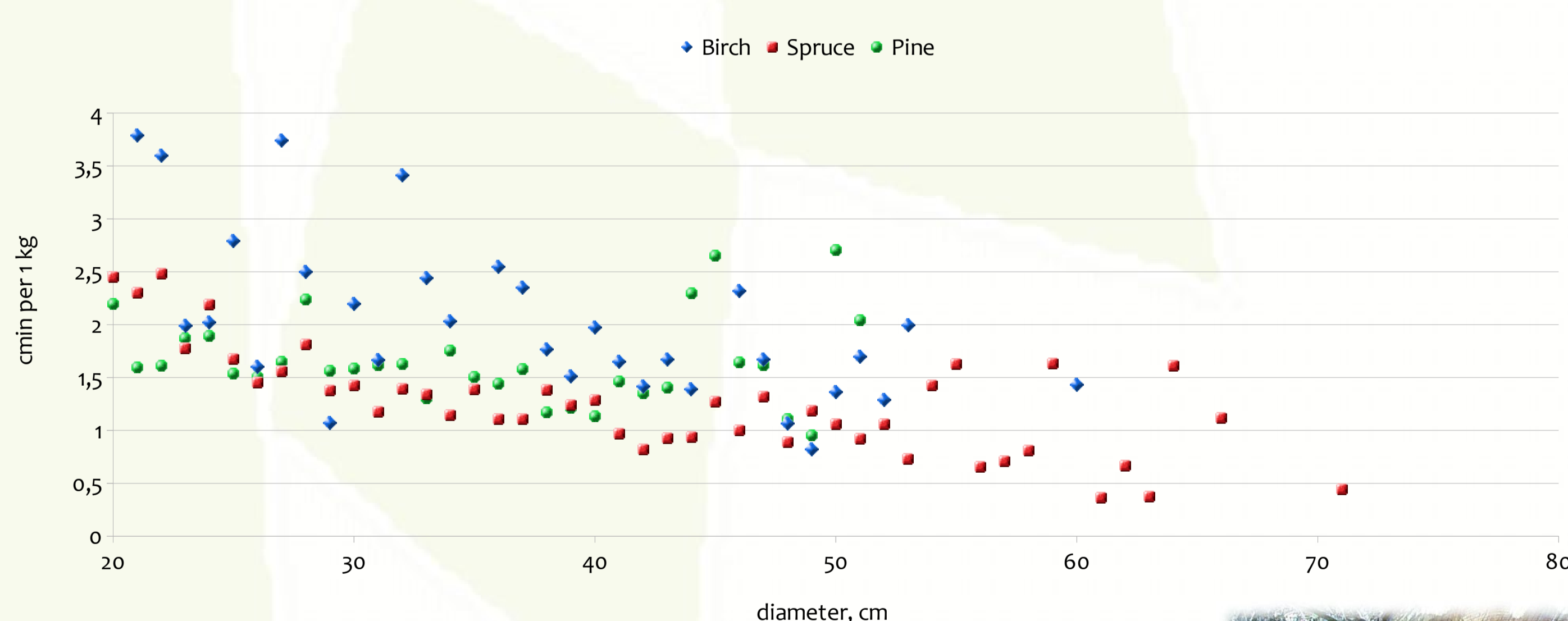
Productivity of stump extraction:

Object	Number of extracted stumps, per ha	Total number of stumps per ha	Extractable biomass of extracted stumps, kg ha ⁻¹	Extractable biomass of all stumps, kg ha ⁻¹	Prepared mounds, gab. ha ⁻¹	Total efficient time, min. ha ⁻¹	Efficient time for stump processing min. ha ⁻¹	Efficient time of mounding, min. ha ⁻¹	Efficient time of soil preparation, min. ha ⁻¹
104-9	384	607	24970	47242	1496	591	394	197	259
176-18	377	419	22907	31774	315	563	500	63	177
98-4	324	455	31828	48511	355	624	511	113	206
All	353	476	27653	43145	571	568	454	114	205

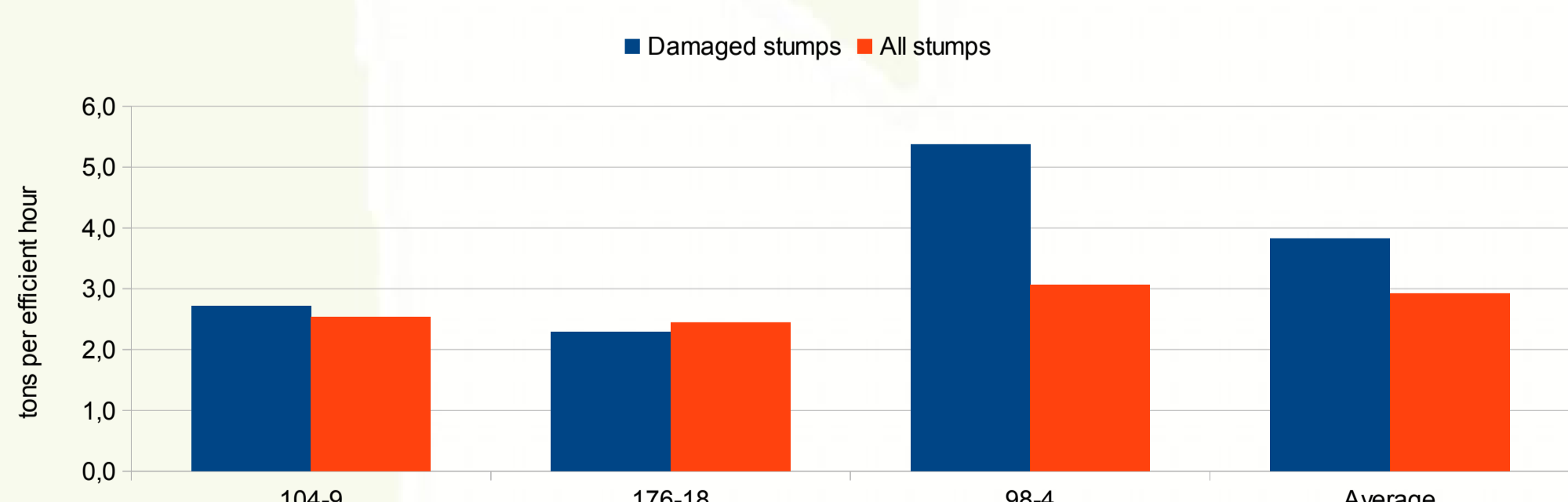
In hours:

104-9	9,8	6,6	3,3	4,3
176-18	9,4	8,3	1,0	3,0
98-4	10,4	8,5	1,9	3,4
All	9,47	7,6	1,9	3,4

Productivity of extraction of stumps of different tree species



Comparison of productivity of extraction of healthy and rotten stumps

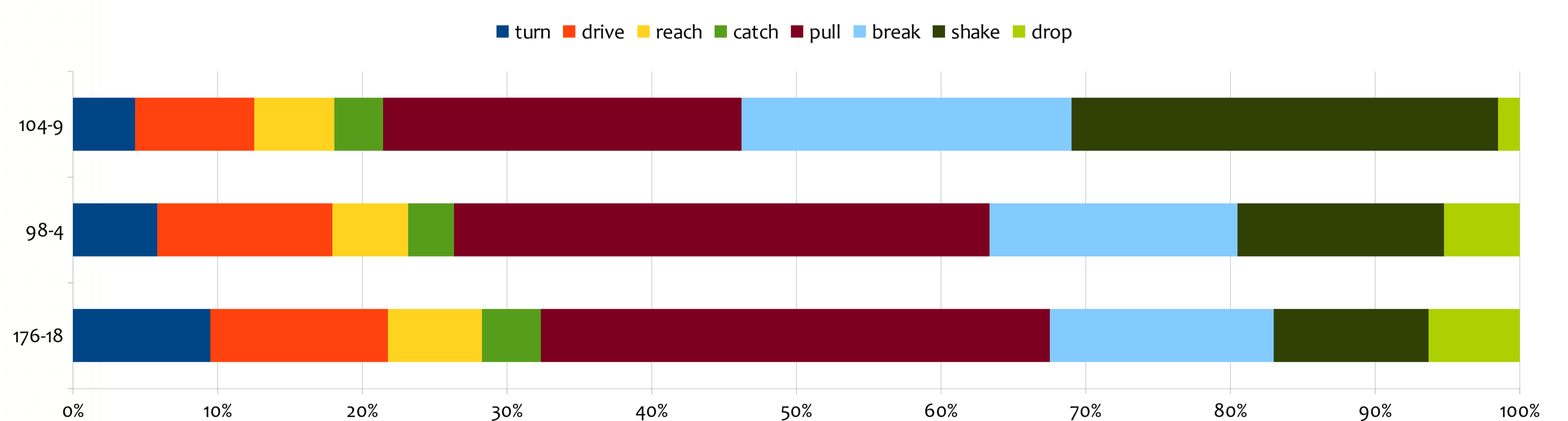


Productivity of trenching (alternative technology)

ID	Block	Compartment	Stand type	Area, ha	Sample plot	Time consumption min.	Time consumption min. per 1 ha	Number of manoeuvres per 1 ha
1	176	9	Dms	0,4	2	29,0	80,6	61
2	176	9	Dms	0,6	4	44,5	70,6	73
3	104	1	As	0,8	1	79,6	106,1	60
4	98	4	Dm	0,2	1,1	34,0	170,0	75
5	98	4	Dm	0,9	1	49,0	54,5	27
6	98	4	Dm	1,0	3	52,1	52,1	65
Total				3,84	-	288,15	89	60
						Fuel consumption	18	L ha ⁻¹
						Service price	12	L h ⁻¹
							110	LVL ha ⁻¹
							74	LVL h ⁻¹



Share of different operations



Conclusions:

- Share of extracted stumps in average is 74 %, share of extracted biomass - 64 %, average weight of extractable biomass of stump (stump and large roots) in trials is 78 kg.
- Total efficient time for stump extraction is 9,5 hours ha⁻¹, including 10...31 % of the efficient time for mounding. If calculating to mounding only (without stump extraction relevant operations), 1 ha requires 4 hours of efficient working time.
- The most time consuming operations are pulling and breaking, which is closely related to technical faults of the base machine (insufficient hydraulic pressure).
- Extraction of multiple stumps per operation increases productivity and should be recommended for operators.
- Productivity of extraction of spruce stumps constantly grows with increase of size of stump, productivity of extraction of birch and pine decreases if stumps are larger than 50 cm in diameter.
- Extraction of damaged (rotten) stumps is faster than extraction of healthy stumps due to smaller time consumption for pulling.