

Smallwood International Conference:
The pathway for efficient utilization of small diameter wood

Empirical findings on the sustainability analysis of Small diameter stands harvesting in Finland, Slovenia, Spain, and Sweden

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Project SMALLWOOD is supported under the umbrella of ERA-NET Cofund ForestValue by Formas, Swedish Energy Agency, Vinnova, Academy of Finland, Ministry of Agriculture and Forestry of Finland, Ministry of Education, Science and Sport (MIZS), Ministry of Economy, Industry and Competitiveness (MINECO). ForestValue has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773324.



UNITE
FOREST-HUMAN-MACHINE INTERPLAY

Outline

Objectives & What was assessed

Sustainability and value creation analysis – preliminary results

- Sweden
- Finland
- Slovenia
- Spain

Conclusions & What next



Photograph: Teppo Hujala

Objective and steps taken



- To determine and compare the overall sustainability impacts and value-creation effects of the studied harvesting and extracting innovations
 - Constructing an analytical multi-criteria framework
 - Collecting relevant results from the project's traditional economic system analysis, socio-economic analyses and environmental analyses
 - Eliciting ratings and weightings from invited experts and stakeholders
 - Calculating and illustrating the overall sustainability and value creation results
 - (Discussing the results with stakeholders in national workshops – not reported here)



Photograph:
Brackeforest.com



Intertwined targets of assessment



Service/business model

- Improved profitability for contractors
- Value proposition for forest owners

Working methods

- Boom-corridor thinning
- Combined felling and chipping; biomass baling

Harvesting technology

- Felling head
- Wood extraction system



Here the assessment was connected to the national context and relational to current prevailing practise!

Photograph: Teppo Hujala



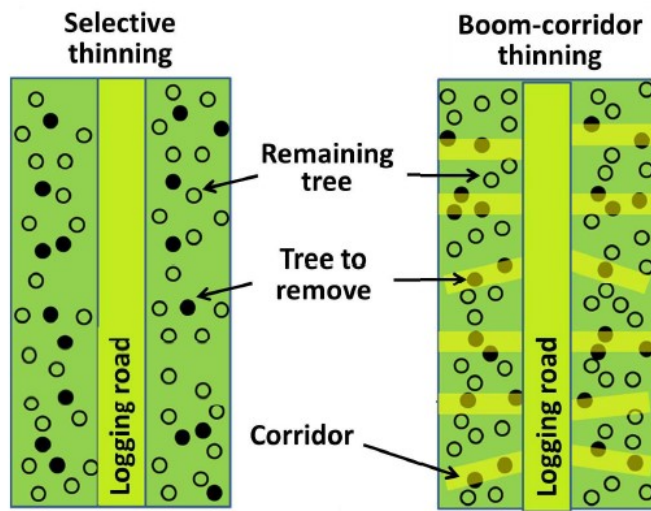
Assessed innovation candidates



- Bracke C16.c felling head with an additional horn-shaped support
- Boom-corridor thinning working method
- Mechanized small-diameter wood harvesting in general
- In Spain: i) BioBaler; ii) Retrabilio



Photograph: Raul
Fernandez Lacruz



Photograph:
grpanderson.com



Photograph: Eduardo
Tolosana



Background information for the rating exercise – Finnish example



Bracke C16.c



Bracke C16.c

Keräävä Metsänhoito- ja bioenergiakoura

Bracke C16.c on keräävä bioenergiakoura metsänhoito- ja energiapuun korjaukseen. Kourassa on asennettu kattausjärjestelmä ja suuri keräyskapasiteetti. Bracke C16.c hyödyntää patentoitua keräysjärjestelmää, joka takaa suuren keräyskapasiteetin. Bracke C16.c peruskone- vaihtoehdot ovat harvesteri, kuormaajaksi, kiviurakoita tai muu nosturiin varustettu peruskone.

C16.c rakenne

Kattausjärjestelmä koostuu kettulevystä, johon on asennettu "iv" keräysruu. Kettulevyn pintoa voidaan muotoilla ansoista teräksellä peyry automaattisesti kinnä. Kettulevyn pyörittäjä hydraulinen moottori, joka parantaa työn tehokkuutta ja vähentää polttoaineen kuluja. C16.c mallin verrattuna.

Monipuolista ja tehokasta metsänhoitoa

Bracke C16.c:n tehokkaan kattausjärjestelmän ansiosta koura soveltuu kaikenlaisiin metsätyöskentelyihin, kuten bioenergian korjaukseen, taimien hoitoon, pellonruo- nojen, tienvarien- ja vesikoiden raivaamiseen joihin.



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INFOSHEET

Environmental assessment of thinning with Bracke C16c

This study assessed the damages to remaining trees in Swedish, Finnish and Slovenian forest stands thinned with Bracke C16c Smallwood version following two different working methods: boom corridor (BC) and selective (S) thinning. In addition, stump heights, soil damages and harvesting emissions were analyzed.

AIM OF THE STUDY

The aim of this study was to assess soil and tree damages in the remaining stands, and harvesting emissions from a life cycle perspective.

MATERIALS AND METHODS

The experimental design consisted in repeated study units of 50 m x 20 m (Figure 1) in the three countries. Trees with dbh > 7 cm were sampled throughout the strip roads after thinning and throughout 40 transects in Sweden, 24 transects in Finland, and 56 transects in Slovenia after forwarding.

Soil damages (cutting > 10 cm depth) along the strip roads and stump height of all the stumps with diameter > 1 cm within the transects were recorded.

Harvester fuel consumption was estimated by the engine management computer. Data was taken for each study unit. A life cycle perspective was used to calculate the environmental impacts of the harvesting process.



Figure 1: Study unit

RESULTS

The number of damaged trees / 100 m strip road after thinning and before forwarding was lower in boom corridor thinning than in selective thinning (Table 1). This difference between working methods was statistically significant. The analysis of damaged trees after forwarding did not show a significant difference. However, the average number of damaged trees was lower in boom corridor than in selective thinning in Finland and Slovenia, and similar for both working methods in Sweden (Table 2).

Table 1. Number of damaged trees / 100 m strip road after thinning. Values are average per study unit and working method with minimum and maximum values in brackets.

Working method	Sweden	Finland	Slovenia
Boom C	18 (0.0-12.0)	12 (0.0-4.0)	8 (0.0-16.0)
Selective	21 (2.0-6.0)	12 (0.0-14.0)	16 (6.0-20.0)

Table 2. Number of damaged trees / ha after forwarding. Values are average per study unit and working method with minimum and maximum values in brackets.

Working method	Sweden	Finland	Slovenia
Boom C	125.0 (30.0-190.0)	12 (30.0-200.0)	16 (0.0-350.0)
Selective	125.0 (30.0-250.0)	12 (30.0-300.0)	20 (0.0-400.0)

Final remarks

And what about the modification in the head (the "horn-shaped" support)? According to the machine operator we had in all countries (which worked with the standard C16 for several years), the handling of the stems was notably improved. Additional technical tests to assess the "horns" are yet to be done.



Small diameter wood utilization with innovative stand management for multifunctional forests and a growing sustainable bio-economy

Smallwood WP3 Finnish forest owner's questionnaire and Forestry contractors interviews preliminary results

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ForestValue

Expert rating, Sweden (+ Stakeholder rating for comparison)



Bracke C16.c N=4+7

							Stakeholder rating: Difference to current best practice, %	
Dimension	Criterion	Average Weight	Average Rating	Difference to current best practice, %		Weighted average		
Econ	Operational efficiency	38 %	122,50	22,5		9,4		13,6
	Investment payoff	32 %	102,50	2,5				0,7
	Harvesting damages	30 %	100,00	0,0				5,0
Ecol	Fire risk	26 %	101,25	1,3		1,0		2,9
	Climate benefits	29 %	102,50	2,5				10,7
	Biodiversity	25 %	100,00	0,0				-5,7
	Ground water	21 %	100,00	0,0				0,0
Soc-cult	Attractive to forest owners	29 %	108,75	8,8		5,6		0,0
	Attractive to contractors	27 %	111,25	11,3				12,1
	Recreational benefits	22 %	93,75	-6,3				-7,9
	Rural jobs	22 %	106,25	6,3				10,7
Value creation	Business model renewal	32 %	102,50	2,5		4,6		11,4
	National upscaling	36 %	103,75	3,8				10,0
	European upscaling	33 %	107,50	7,5				15,7

Expert rating, Finland (+ Stakeholder rating for comparison)



Bracke C16.c N=2+5

Dimension	Criterion	Average Weight	Average Rating	Difference to current best practice, %	Weighted average	Stakeholder rating: Difference to current best practice, %
Econ	Operational efficiency	38 %	85,00	-15,0	-16,6	3,0
	Investment payoff	33 %	80,00	-20,0		-1,0
	Harvesting damages	30 %	85,00	-15,0		5,0
Ecol	Fire risk	18 %	90,00	-10,0	-7,2	6,0
	Climate benefits	34 %	90,00	-10,0		8,2
	Biodiversity	35 %	100,00	0,0		3,8
	Ground water	14 %	85,00	-15,0		2,0
Soc-cult	Attractive to forest owners	31 %	85,00	-15,0	-16,80	11,0
	Attractive to contractors	24 %	75,00	-25,0		3,4
	Recreational benefits	19 %	95,00	-5,0		3,0
	Rural jobs	26 %	80,00	-20,0		11,0
Value creation	Business model renewal	24 %	65,00	-35,0	-23,25	4,4
	National upscaling	34 %	75,00	-25,0		10,0
	European upscaling	42 %	85,00	-15,0		13,0

Expert rating, Slovenia

Bracke C16.c N=8



Dimension	Criterion	Average Weight	Average Rating	Difference to current best practice, %	Weighted average
Econ	Operational efficiency	34 %	208,13	108,1	52,7
	Investment payoff	34 %	137,19	37,2	
	Harvesting damages	32 %	109,38	9,4	
Ecol	Fire risk	23 %	108,91	8,9	1,7
	Climate benefits	26 %	102,03	2,0	
	Biodiversity	22 %	93,75	-6,3	
	Ground water	28 %	101,88	1,9	
Soc-cult	Attractive to forest owners	26 %	104,69	4,7	19,31
	Attractive to contractors	34 %	158,59	58,6	
	Recreational benefits	14 %	101,88	1,9	
	Rural jobs	26 %	92,50	-7,5	
Value creation	Business model renewal	38 %	141,88	41,9	60,28
	National upscaling	29 %	174,97	75,0	
	European upscaling	34 %	168,41	68,4	

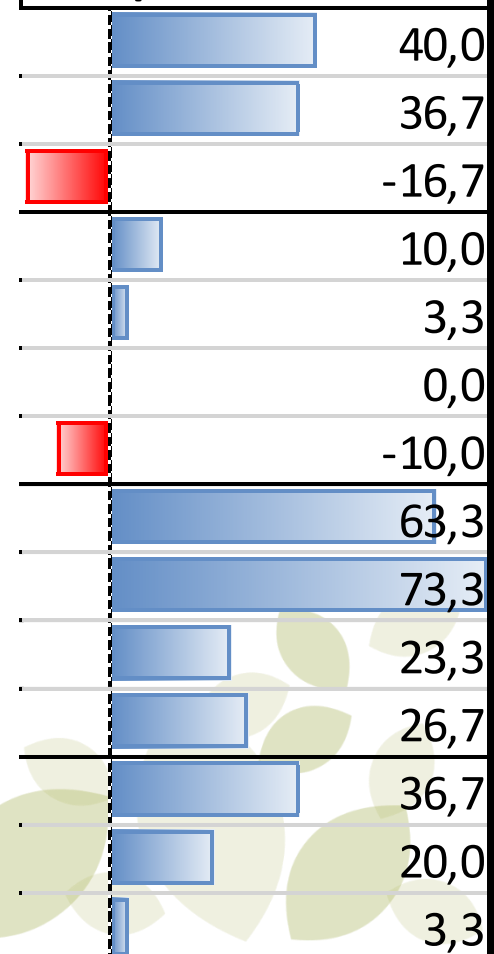
Expert rating, Spain (+ Stakeholder rating for comparison)

Bracke C16.c N=3+3



Dimension	Criterion	Average Weight	Average Rating	Difference to current best practice, %	Weighted average
Econ	Operational efficiency	37 %	216,67	116,7	68,5
	Investment payoff	33 %	146,67	46,7	
	Harvesting damages	30 %	133,33	33,3	
Ecol	Fire risk	67 %	103,33	3,3	-11,2
	Climate benefits	1 %	33,33	-66,7	
	Biodiversity	1 %	66,67	-33,3	
	Ground water	33 %	56,67	-43,3	
Soc-cult	Attractive to forest owners	10 %	53,33	-46,7	21,44
	Attractive to contractors	53 %	150,00	50,0	
	Recreational benefits	1 %	66,67	-33,3	
	Rural jobs	35 %	100,00	0,0	
Value creation	Business model renewal	75 %	150,00	50,0	33,23
	National upscaling	13 %	83,33	-16,7	
	European upscaling	13 %	83,33	-16,7	

Stakeholder rating:
Difference to current best practice, %



Expert rating, Spain (+ Stakeholder rating for comparison)

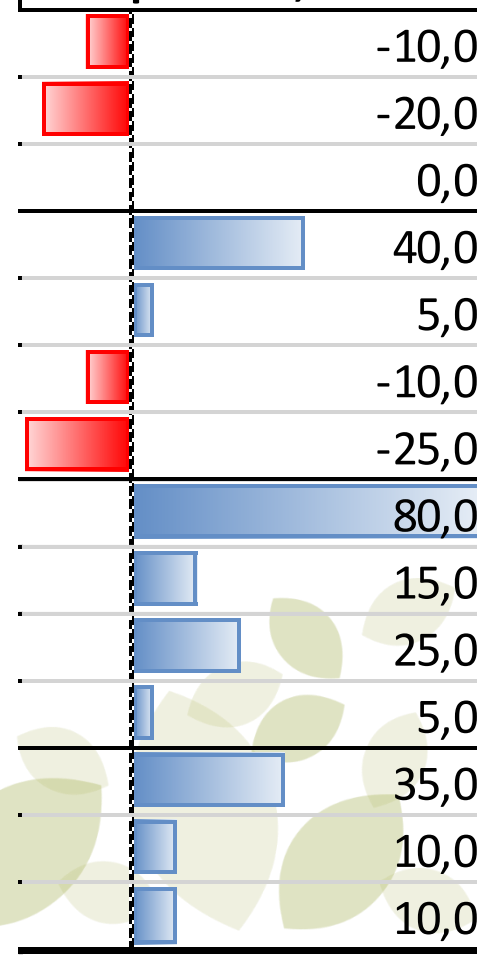
BIOBALER

N=2+2



Dimension	Criterion	Average Weight	Average Rating	Difference to current best practice, %	Weighted average
Econ	Operational efficiency	43 %	95	-5,0	-13,7
	Investment payoff	39 %	70	-30,0	
	Harvesting damages	19 %	100	0,0	
Ecol	Fire risk	38 %	105	5,0	11,0
	Climate benefits	36 %	125	25,0	
	Biodiversity	15 %	100	0,0	
	Ground water	10 %	100	0,0	
Soc-cult	Attractive to forest owners	34 %	88	-12,5	-0,86
	Attractive to contractors	22 %	80	-20,0	
	Recreational benefits	18 %	100	0,0	
	Rural jobs	26 %	130	30,0	
Value creation	Business model renewal	31 %	130	30,0	21,66
	National upscaling	39 %	120	20,0	
	European upscaling	30 %	115	15,0	

Stakeholder rating:
Difference to current best practice, %



Expert rating, Spain (+ Stakeholder rating for comparison)

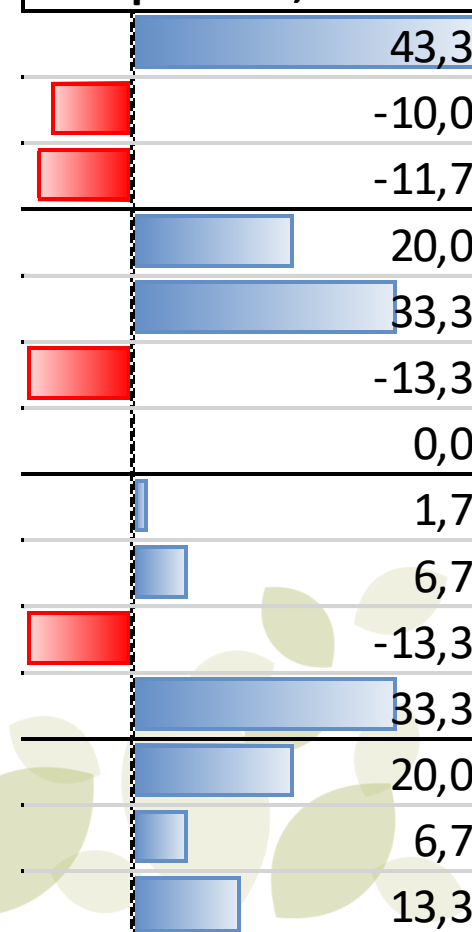
RETRABIO

N=2+3



Dimension	Criterion	Average Weight	Average Rating	Difference to current best practice, %	Weighted average
Econ	Operational efficiency	38 %	110	10,0	0,0
	Investment payoff	38 %	90	-10,0	
	Harvesting damages	25 %	100	0,0	
Ecol	Fire risk	30 %	120	20,0	19,8
	Climate benefits	34 %	140	40,0	
	Biodiversity	26 %	100	0,0	
	Ground water	9 %	100	0,0	
Soc-cult	Attractive to forest owners	27 %	110	10,0	9,49
	Attractive to contractors	26 %	105	5,0	
	Recreational benefits	20 %	100	0,0	
	Rural jobs	27 %	120	20,0	
Value creation	Business model renewal	37 %	120	20,0	10,56
	National upscaling	33 %	105	5,0	
	European upscaling	30 %	105	5,0	

**Stakeholder rating:
Difference to current
best practice, %**



Conclusions



The intertwined target of assessment and experts'/stakeholders' varying perspectives can be seen in the results (especially in Finland)

The numbers represent innovation candidates' relative up-/downgrading in percentages compared to current prevailing practice

- The numbers may only be viewed as indicative
- ...to point to relative strengths/weaknesses and aspects to praise and issues to tackle

Overall, the highest contribution of Bracke C16.c was in economic sustainability with high contextual variation in socio-cultural sustainability (note: trade-offs were not studied here)

Slovenia exhibited high interest in mechanized smallwood harvesting

Swedish evaluators trusted a lot in the upscaling potential, reasons for that?

Both BioBaler and Retrabilio had upscaling potential in Spain and beyond, despite some notable negative sustainability impacts

What next? Some suggestions



More **evidence** for assessing the **environmental** sustainability of smallwood harvesting, both on forest stands and in forest use

- Preferably **absolute**, not relational sustainability impacts

Continuing studies to address the aspects that received **high negative sustainability impacts**: what is wrong with those innovation candidates and what could be done?

More focus on **business model renewal** and **success factors for upscaling**

Using **digital twins of forests** to do harvesting tests with **spatially realistic** virtual forests, simulators, and a higher number of test persons (students and entrepreneurs)



Photograph: Satu Helenius



Thank you!

