

## Sustainability and value-creation impacts of harvesting and extraction innovations - participatory multi-criteria analysis

*This report presents the results of the multi-criteria analysis, which sought to determine and compare the overall sustainability impacts and value-creation effects of the studied harvesting and extracting innovations*

### Methodology

The participatory analysis begun with constructing an analytical multi-criteria framework, which comprises economic, socio-cultural, and ecological dimensions and 3-4 criteria under each (Table 1). For indicators of the criteria, direct results from SMALLWOOD harvesting productivity and environmental assessment analyses, forest owner survey, and contractor interviews were used (Figure 1). While no direct correspondence between criteria and indicators exist, the evaluators' holistic interpretations were pivotal to generate the ratings.

*Table 1. Dimensions and criteria of the multi-criteria assessment.*

Dimensions	Criteria
Economic	Operational efficiency
	Investment payoff
	Harvesting damages
Ecological	Fire risk
	Climate benefits
	Biodiversity
	Ground water
Socio-cultural	Attractive to forest owners
	Attractive to contractors
	Recreational benefits
	Rural jobs
Value creation	Business model renewal
	National upscaling
	European upscaling



*Figure 1. Multiple sources for research and technical evidence for the holistic rating exercise.*

The second step was eliciting weightings and ratings from invited experts and stakeholders in each partner country. In the assessment, experts represented scientific-technical proficiency of small-wood harvesting and its impacts, while stakeholders represented various roles and organisations within the forestry value network, including public, private, and civic sectors.

Organisation of the rating exercise varied between countries, ranging from filling Excel sheets sent by email to filling the form during an online discussion and to filling the forms during a facilitated workshop. Rating participants varied, being 34 in Slovenia, 14 in Spain, 11 in Sweden, and 7 in Finland (altogether 66). The rating question was: »Assess the innovation, according to your holistic assessment, in comparison to current best available practise in your country (reference value 100), according to each criterion, e.g. 110 means that the innovation is 10% better and 90 means it is 10% worse than the best available practise, etc.«

## Results

Expert ratings concerning the Bracke C16.c harvesting head and boom-corridor thinning (Figure 2) reveal a critical view in the Finnish context and a positive view in Slovenia, Spain, and Sweden. Operational efficiency is considered the strongest feature, and most problems are interpreted in the ecological dimension and recreational benefits.

Dimension	Criterion	Finland (n=2)		Slovenia (n=8)		Spain (n=3)		Sweden (n=4)	
		Difference to current best practice, %	Weighted average	Difference to current best practice, %	Weighted average	Difference to current best practice, %	Weighted average	Difference to current best practice, %	Weighted average
Econ	Operational efficiency	-15.0		90.0		116.7		22.5	
	Investment payoff	-20.0	-16.6	-7.1	26.3	46.7	68.5	2.5	9.4
	Harvesting damages	-15.0		-14.3		33.3		0.0	
Ecol	Fire risk	-10.0		11.4		3.3		1.3	
	Climate benefits	-10.0		-6.4	-0.6	-66.7	-11.2	2.5	1.0
	Biodiversity	0.0		-2.9		-33.3		0.0	
	Ground water	-15.0		-4.3		-43.3		0.0	
Soc-cult	Attractive to forest owners	-15.0		-2.9		-46.7		8.8	
	Attractive to contractors	-25.0	-16.80	33.6	9.06	50.0	21.44	11.3	5.6
	Recreational benefits	-5.0		-2.9		-33.3		-6.3	
	Rural jobs	-20.0		-4.3		0.0		6.3	
Value creation	Business model renewal	-35.0		32.9		50.0		2.5	
	National upscaling	-25.0	-23.25	15.7	22.87	-16.7	33.23	3.8	4.6
	European upscaling	-15.0		17.1		-16.7		7.5	

Figure 2. Expert ratings on Bracke C16.c harvesting head coupled with boom-corridor thinning.

Stakeholder ratings concerning the Bracke C16.c harvesting head and boom-corridor thinning (Figure 3) show that the perception of the sustainability and value creation potential was overall highly positive, also in Finland where the expert presented doubts. The Slovenian context stands out as the greatest positive sustainability improvements compared to current practice. In Finland and in Sweden the evaluations are more modest than in Spain and Slovenia.

Dimension	Criterion	Finland (n=5)		Slovenia (n=26)		Spain (n=3)		Sweden (n=7)	
		Difference to current best practice, %	(Non-weighted) average	Difference to current best practice, %	Weighted average	Difference to current best practice, %	(Non-weighted) average	Difference to current best practice, %	(Non-weighted) average
Econ	Operational efficiency	3.0		100.7		40.0		13.6	
	Investment payoff	-1.0	2.3	47.3	57.4	36.7	20.0	0.7	6.4
	Harvesting damages	5.0		15.4		-16.7		5.0	
Ecol	Fire risk	6.0		8.3		10.0		2.9	
	Climate benefits	8.2	5.0	4.2	2.6	3.3	0.8	10.7	2.0
	Biodiversity	3.8		-6.2		0.0		-5.7	
	Ground water	2.0		2.7		-10.0		0.0	
Soc-cult	Attractive to forest owners	11.0		6.2		63.3		0.0	
	Attractive to contractors	3.4	7.1	62.9	21.68	73.3	46.7	12.1	3.8
	Recreational benefits	3.0		3.5		23.3		-7.9	
	Rural jobs	11.0		-6.9		26.7		10.7	
Value creation	Business model renewal	4.4		43.1		36.7		11.4	
	National upscaling	10.0	9.1	88.4	67.99	20.0	20.0	10.0	12.4
	European upscaling	13.0		80.0		3.3		15.7	

Figure 3. Stakeholder ratings on Bracke C16.c harvesting head coupled with boom-corridor thinning. Note: other countries gathered no weightings, but the Slovenian rating exercise was done jointly by experts and stakeholders, which yielded weighted averages for each dimension for Slovenian stakeholders.

From the ratings overview for Biobaler and Retrablo (Figure 4), only done in Spain, a clearly positive view on the value creation and upscaling potential is seen for both technologies and by both evaluator groups. The economic dimension and the attractiveness for main market players are however rated negatively for Biobaler. Retrablo, in turn, received overall more positive ratings, although some negative impacts on individual criteria, such as biodiversity and recreational benefits, may be seen.

Dimension	Criterion	Biobaler: experts (n=2); stakeholders (n=2)			Retrabio: experts (n=2); stakeholders (n=3)				
		Difference to current best practice, %	Weighted average	(Non-weighted) average	Difference to current best practice, %	Weighted average	(Non-weighted) average		
Econ	Operational efficiency	-5.0	-13.7	-10.0	-10.0	10.0	0.0	43.3	7.2
	Investment payoff	-30.0		-20.0		-10.0			
	Harvesting damages	0.0		0.0		-11.7			
Ecol	Fire risk	5.0	11.0	40.0	2.5	20.0	19.8	20.0	10.0
	Climate benefits	25.0		5.0		40.0		33.3	
	Biodiversity	0.0		-10.0		0.0		-13.3	
	Ground water	0.0		-25.0		0.0		0.0	
Soc-cult	Attractive to forest owners	-12.5	-0.86	80.0	31.3	10.0	9.49	1.7	7.1
	Attractive to contractors	-20.0		15.0		5.0		6.7	
	Recreational benefits	0.0		25.0		0.0		-13.3	
	Rural jobs	30.0		5.0		20.0		33.3	
Value creation	Business model renewal	30.0	21.66	35.0	18.3	20.0	10.56	20.0	13.3
	National upscaling	20.0		10.0		5.0		6.7	
	European upscaling	15.0		10.0		5.0		13.3	

Figure 4. Expert and stakeholder ratings for Biobaler and Retrabio in Spain.

### Conclusions

When interpreting the results and in particular the observable differences in ratings, it must be acknowledged that the target of evaluation was intertwined, comprising the harvesting technology in the core, the work techniques, a potentially improved business model, and in general more active and more innovative mechanised smallwood harvesting. Therefore, while paying a varying attention to these aspects of the assessed system, the experts and stakeholders may have gone through different reasoning in their evaluation. This is not obscure or wrong but an inherent feature of a holistic assessment, which contains a subjective element although aimed at a systematic, carefully conducted rating.

Overall, the rating results provide evidence of a notable upscaling potential of the assessed harvesting and extraction systems. At the same time, the results pinpoint some critical criteria that worsen the sustainability impacts – those are suggested to take into account when continuing the innovation work. Furthermore, the results offer framing for a wider societal discussion on what kind of impacts are desirable and acceptable from small-diameter wood management. Synergy and trade-off analyses were not done here, but these results offer some hints towards the kinds of compromises that innovative forest management may need to make in sustainability impacts.

### AUTHOR/S

**Teppo Hujala**  
University of Eastern Finland  
teppo.hujala@uef.fi

### DATA CONTRIBUTORS

**Teresa de la Fuente**  
Universidad Politécnica de Madrid  
maria\_teresa\_fuente@yahoo.com

**Thomas Kronholm**  
Swedish University of Agricultural Sciences  
thomas.kronholm@slu.se

**Matevž Triplat**  
Slovenian Forestry Institute  
matevz.triplat@gozdis.si



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