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TECH4EFFECT

KNOWLEDGE AND TECHNOLOGIES FOR EFFECTIVE WOOD PROCUREMENT

Luke LUONNONVARAKESKUS

Manipulating work setting to reduce fuel consumption in CTL timber harvesting machines

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TECH4EFFECT

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Bio-based Industries Consortium

BIO-BASED INDUSTRIES Public-Private Partnership

Source

Robert Prinz, Raffaele Spinelli, Natascia Magagnotti, Johanna Routa, Antti Asikainen (2018):

Modifying the settings of CTL timber harvesting machines to reduce fuel consumption and CO_2 emissions.

Journal of Cleaner Production 197 (2018): 208-217.

Outline

- Background
- Material and methods
- Results
- Discussion & Conclusions
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- Acknowledgements

Background

Towards a more effective wood procurement – TECH4EFFECT field trials

- Felling and processing alone require over 1.1 l diesel per m3 of roundwood (Athanassiadis, 2000).
- This amount multiplied for the volume harvested in industrialized countries, consumption soars to over 1 billion litres of diesel per year.
- In the short run, large-scale changes to existing machinery can only occur through the adaptation of the existing fleet through retrofitting or suitable adjustments.
- The novelty of this work is in exploring the fuel saving potential of simple adjustments of machine settings in cut-to-length harvesting machines.

Background

- **Towards a more effective wood procurement – TECH4EFFECT field trials**
- Field tests were conducted by the project partners Luke, CNR-IVALSA and Ponsse in cooperation with a contractor and their operators
- The study focussed on the determination of the effects of selected setting treatments in single-grip harvesters on the diesel fuel consumption per unit product, as well as on relative productivity.
- Field trials in thinning operation near Jyväskylä, Finland
- Tests during August 2017

Material and methods

- Ponsse CTL harvesters
  - Beaver
  - ScorpionKing
  - Ergo

Material and methods

General characteristics of the harvesters:

Harvester	Beaver	Scorpion	Ergo
Make and model	Ponsse Beaver	Ponsse ScorpionKing	Ponsse Ergo
Wheels	6	8	6
Power [kW]	150	210	210
Engine model	Mercedes-Benz /MTU OM 934 LA EU Stage IV	Mercedes-Benz OM936 EU Stage IV	Mercedes-Benz OM936LA EU Stage IV
Harvester head model	H5	H6	H7
Crane type	C44+	C50	C5
Typical weight [kg]	17 500	22 500	20 000
Engine's maximum torque [Nm]	800	1 150	1 150
Tractive force [kN]	130	180	160
Fuel tank volume [l]	300	320	380

Material and methods

- Three main settings:
  - BAU (business-as-usual)
  - ECO (fuel saving mode)
  - POWER (high production mode)

- Each setting was based on a mix of specific parameter changes, e.g.
  - Engine (RPM)
  - Harvester head pump pressure
  - Engine control

Material and methods

- Stand characteristics measured:
  - Sample plots
  - DBH measured
  - Heights measured

- Machine data collection:
  - Fuel consumption
  - Production figures

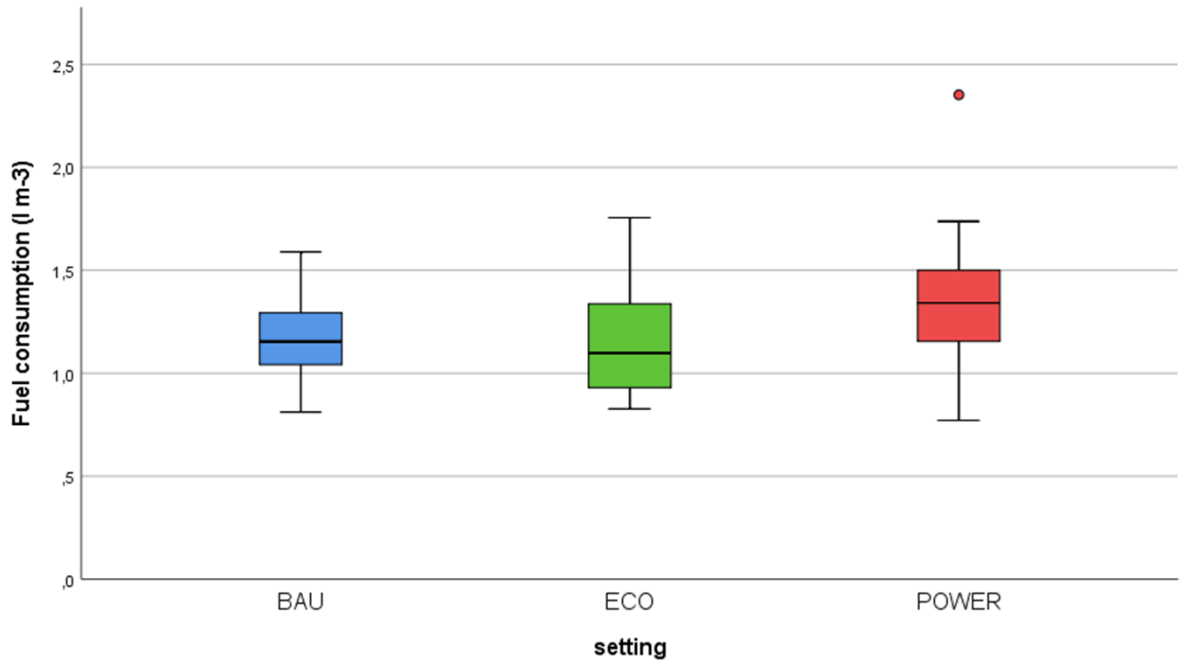
- Fuel consumption measurements

Material and methods

- Data analysis
  - Stand characteristics
  - General operational parameters
  - Statistical analyses

- Results of:
  - Fuel consumption (l m^{-3})
  - Relative production figures (%)
  - CO2 emissions (kg m^{-3})

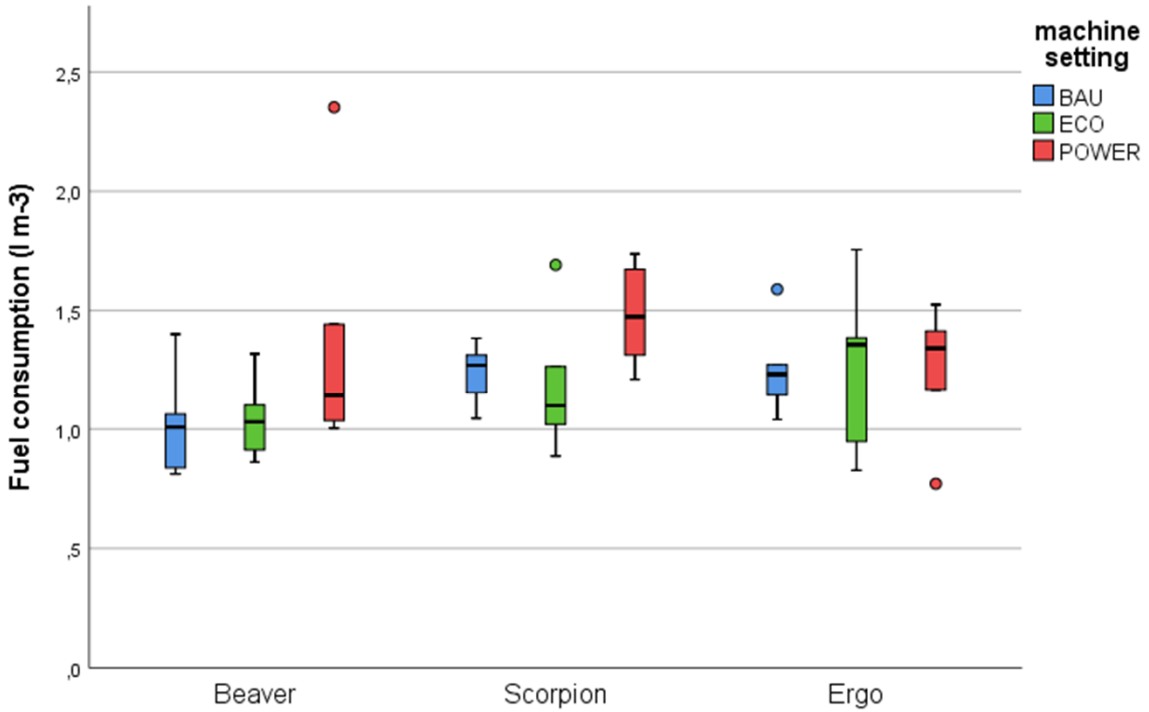
Results



Box plot graph of fuel consumption (l m^{-3}) for the three studied machine setting treatments.

Source: Prinz et al. 2018

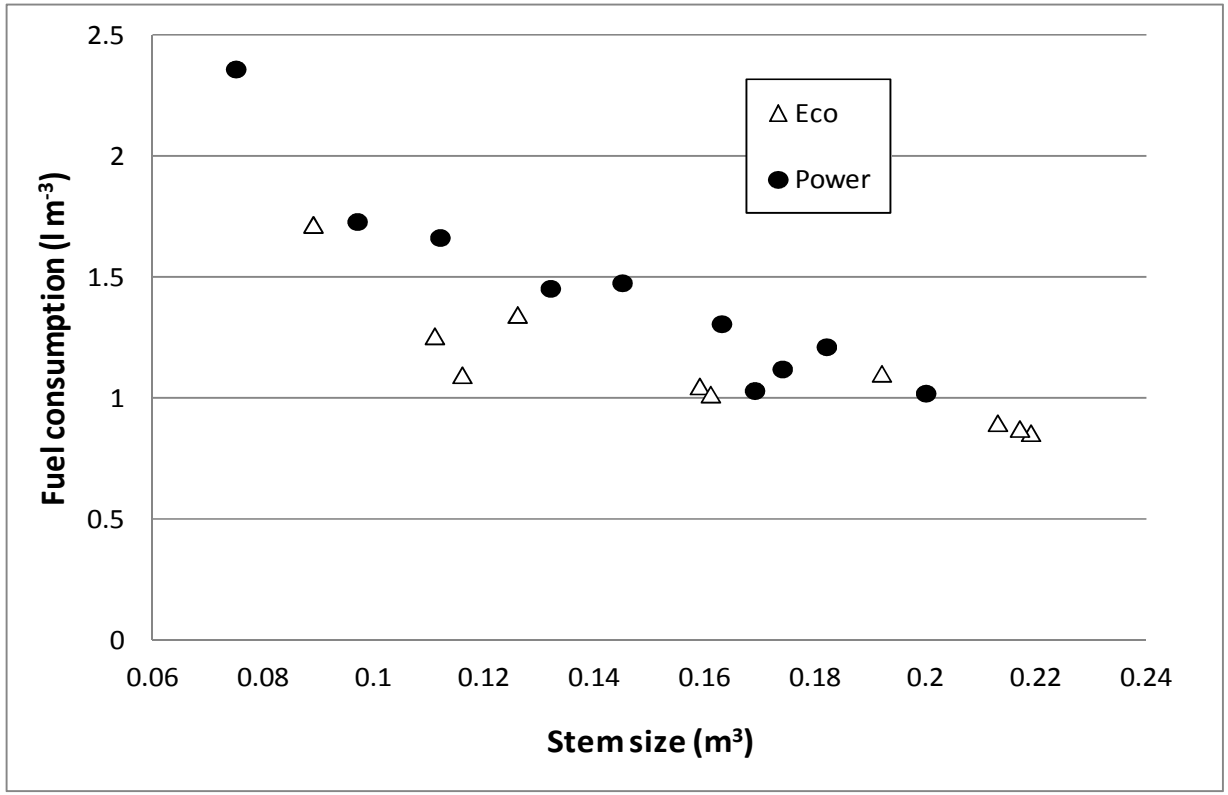
Results



Box plot graph of fuel consumption (l m^{-3}) for the three studied machines under the three machine setting treatments.

Source: Prinz et al. 2018

Results



Scattergram of the fuel consumption (l m^{-3}) data as a function of stem size, for the two setting treatments. The analysis excludes the Ergo machine and BAU setting input data.

Source: Prinz et al. 2018

Results

- Significant difference between settings on the fuel consumption per unit product (l m^{-3}).
- Main factor significantly affecting both fuel consumption and productivity was stem size.
- The difference in fuel consumption per unit product is apparent between the setting treatment POWER and the other settings.

Source: Prinz et al. 2018

Discussion

- POWER setting is designed for maximum performance, but achieves its goal at the cost of increased fuel consumption and should be switched on only when full power is actually needed.
- The differences between BAU and ECO are less obvious.
- This may indicate that the currently used BAU setting already integrates aspects of the ECO setting regarding fuel economy concerns within the regular entrepreneurial harvesting operations.
- Operators agreed that under the conditions of the study the ECO setting enabled them to proceed without any major changes of their operating technique and behaviour.
- One operator stated that the POWER setting was very aggressive and may have an effect on the ergonomics and productivity in the long run.

Source: Prinz et al. 2018

Conclusions

- Adjustment of machine settings can reduce the fuel consumption and CO_2 emissions in CTL harvesting operations.
- A quick estimate of the wood harvested mechanically in the Nordic and Baltic countries indicates a total of about 160 million m3 per year.
- Multiplying that amount by an average saving of 0.3 l m^{-3} will return a total of 47 million litres of diesel.

Source: Prinz et al. 2018

Conclusions

- The possible use of various pre-defined settings could provide new opportunities for operators and entrepreneurs when adjusting machine performance for instance to stand characteristics or operational targets.

- Successfully tested for CTL harvesters, similar measures could be now considered for other machine types, such as forwarders.

Source: Prinz et al. 2018

Source

- **Open access publication:**

Robert Prinz, Raffaele Spinelli, Natascia Magagnotti, Johanna Routa, Antti Asikainen (2018). **Modifying the settings of CTL timber harvesting machines to reduce fuel consumption and CO_2 emissions.** Journal of Cleaner Production 197 (2018): 208-217.
https://doi.org/10.1016/j.jclepro.2018.06.210

- A video about the trials can be found on the TECH4EFFECT webpage:
https://youtu.be/zOQoAgg1Mro?list=LL7nSYBLnOJAWSuSb4bTHSiw

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Consortium

Research institutes and universities

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BOKU University of Natural Resources and Life Sciences, Vienna

CNR-IVALSA TREES AND TIMBER INSTITUTE

UNIVERSITY OF COPENHAGEN

EFI

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Luke NATURAL RESOURCES INSTITUTE FINLAND

WARSAW UNIVERSITY OF LIFE SCIENCES SGGW

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Owner associations and forest contractors

BOSCHIVE IMPRESE CoNaIBo COORDINAMENTO NAZIONALE

Kuratorium für Waldarbeit und Forsttechnik GmbH

NORSKOG

SKOVDYRKERNE

Machine manufacturers and SMEs

IB

KONRAD

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PONSSE

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State forests

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Statskog

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Thank you for your attention…

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