



The Profitability of Biomass Harvesting in Spruce Stands when Considering Nutrient Cycling

50th International Symposium on Forestry Mechanization

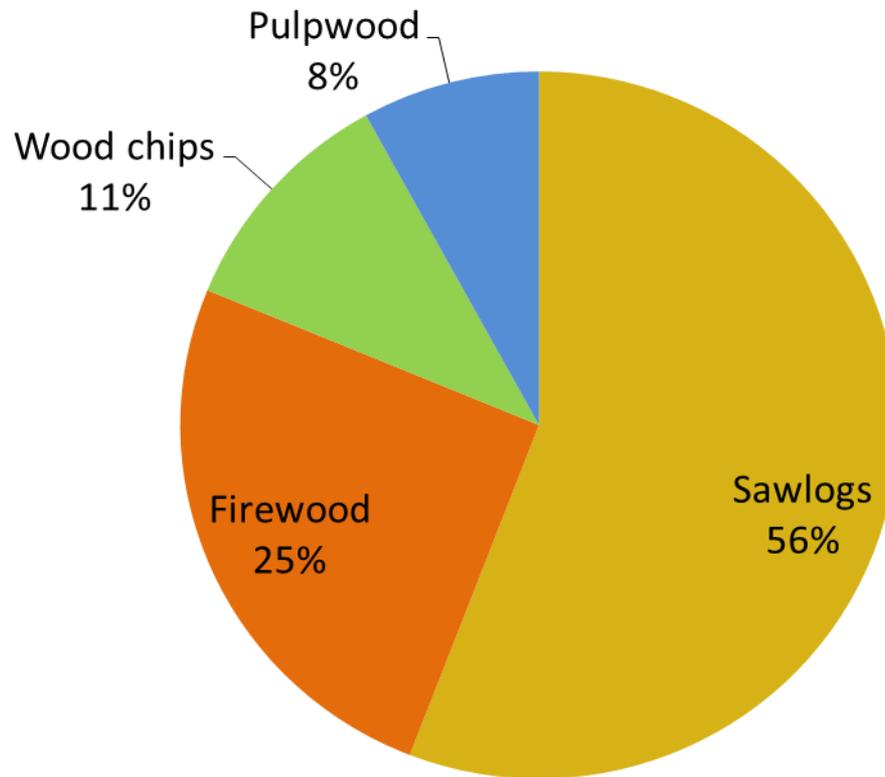
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September 27th, 2017

Structure

1. Introduction
2. Data basis
3. Results
4. Conclusions

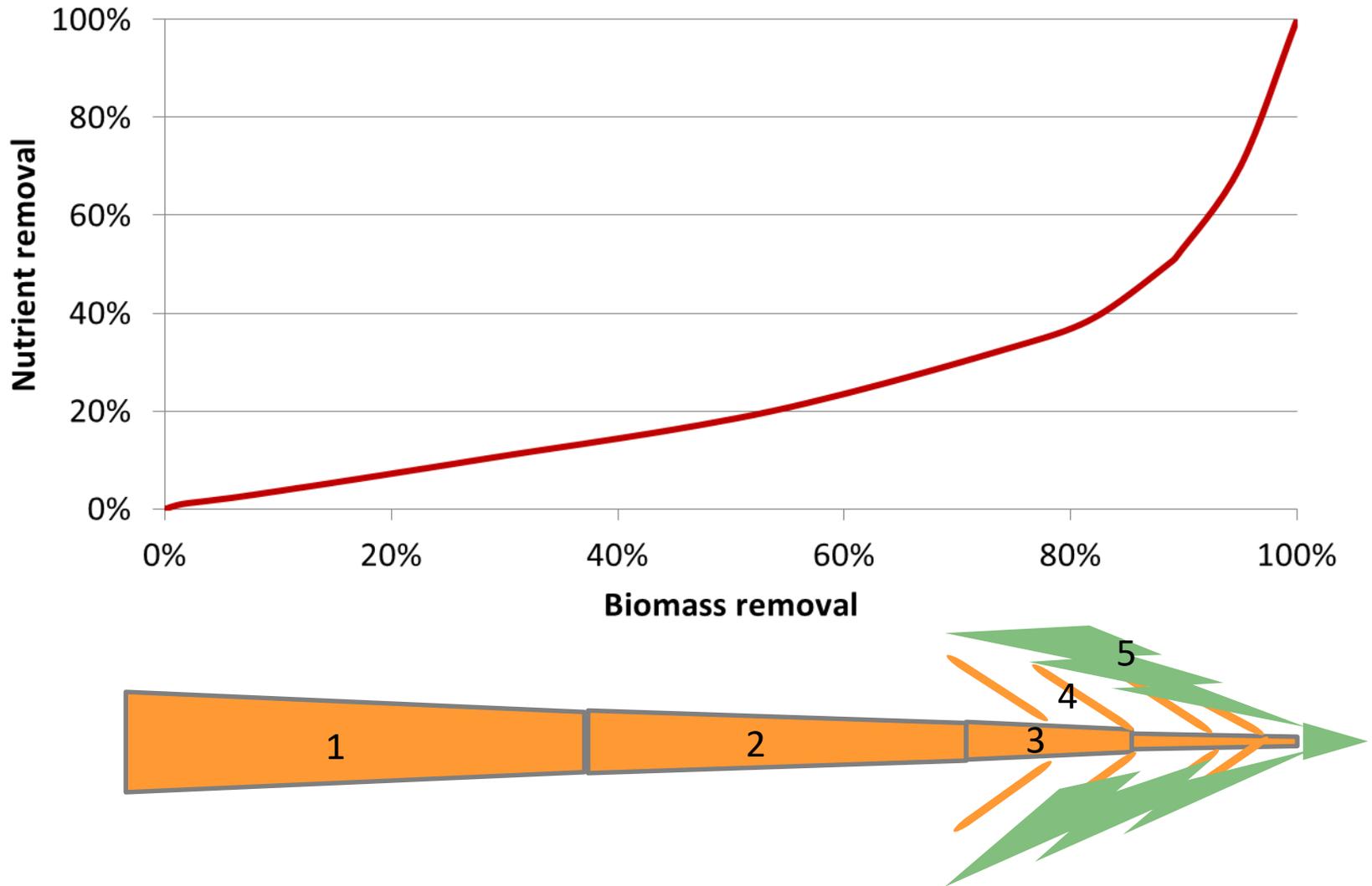
Introduction

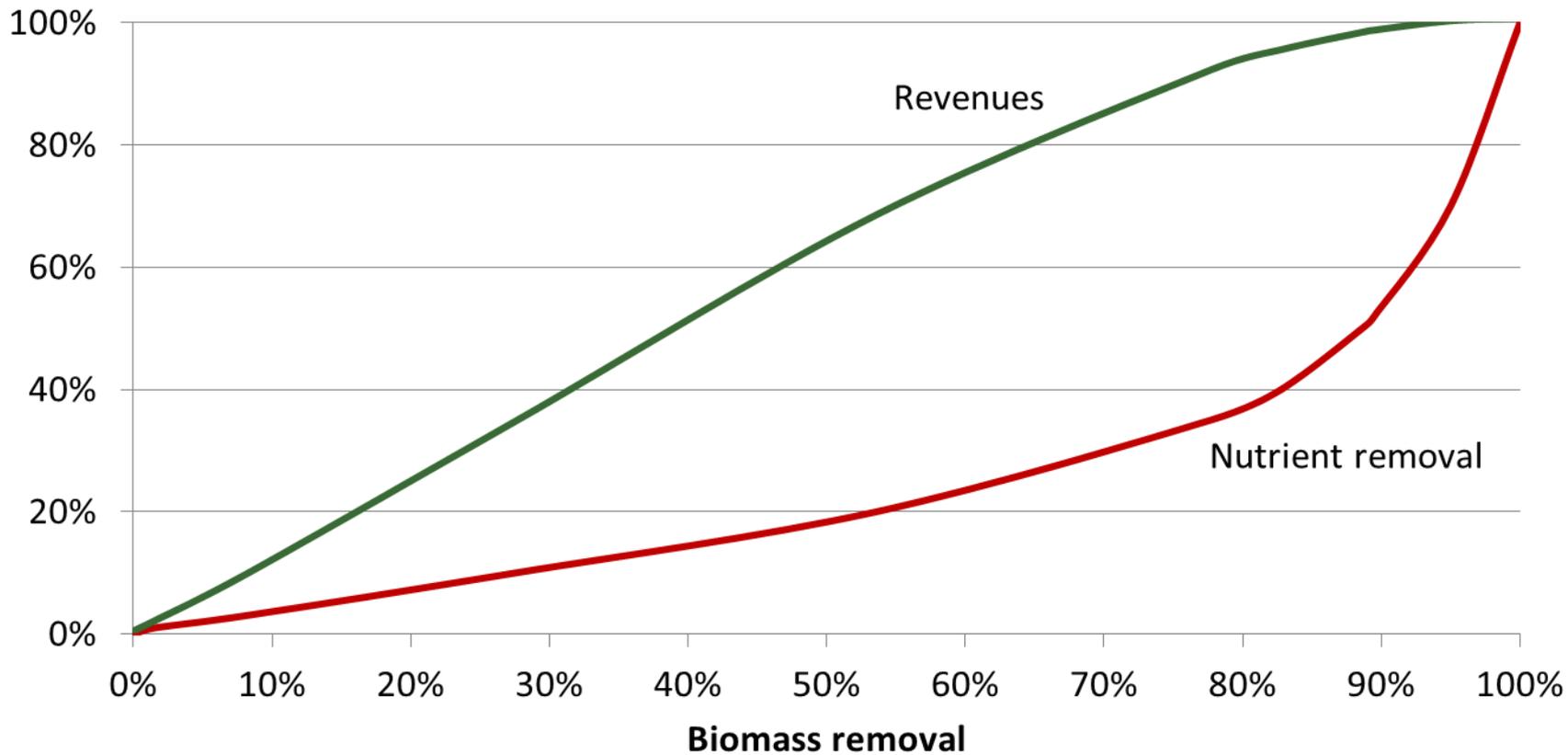


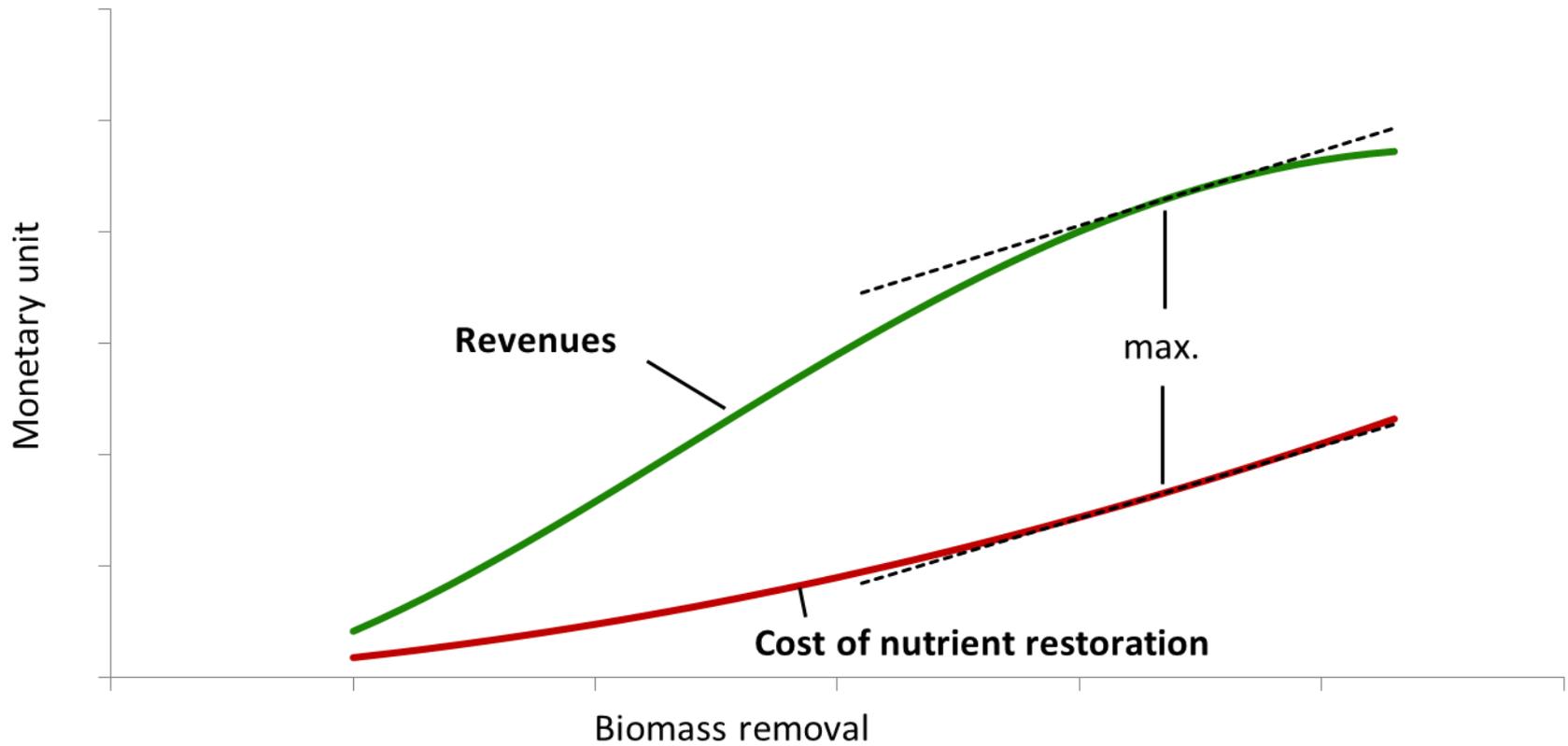
Assortments 2014 in Bavaria (total 18 m m³)



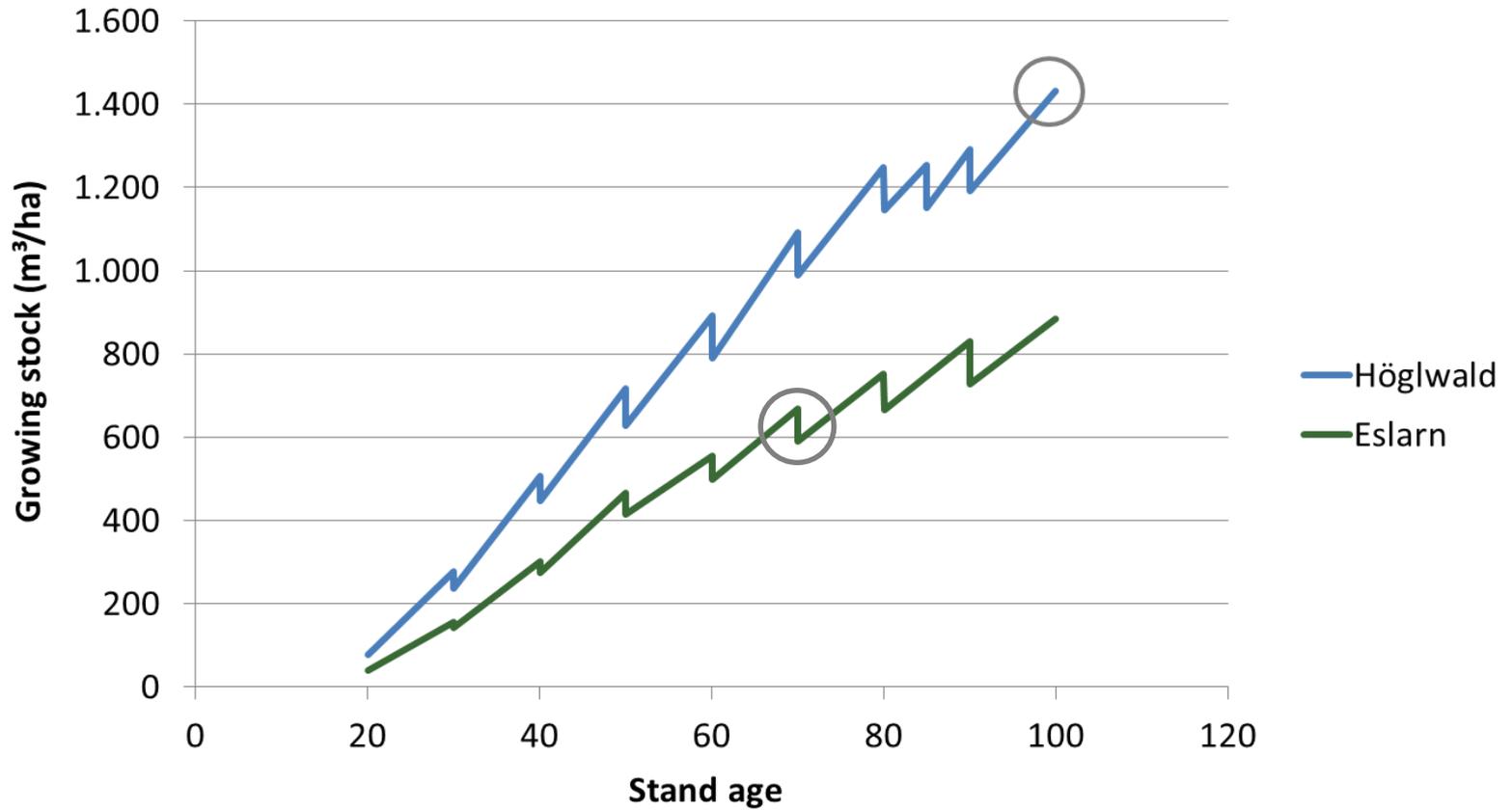
Lorenz curve of nutrient removal







- One spruce stand on a poor site, one on a rich site; measuring yield data
- Modelling the stand development with program SILVA



- One spruce stand on a poor site, one on a rich site; measuring yield data
- Modelling the stand development with program SILVA
- Calculating the amount of biomass of the different parts of the trees using biomass functions of Pretzsch et al. 2014

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- Modelling the stand development with program SILVA
- Calculating the amount of biomass of the different parts of the trees
- Measuring nutrient concentration of the different parts of 7 trees at each stand
- Measuring the biomass lost between skid trails during harvesting





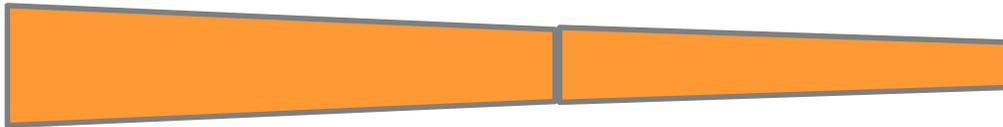




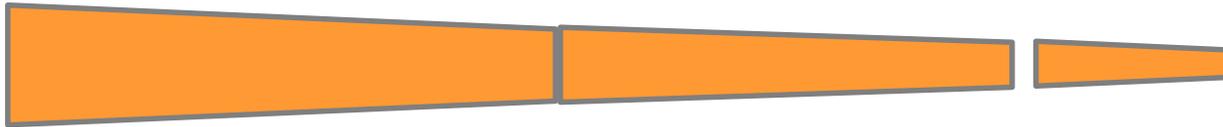
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- Four harvesting options

Harvesting options

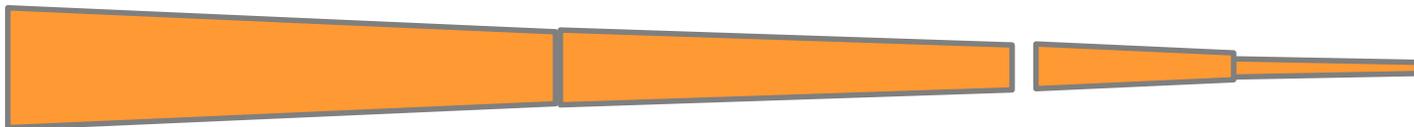
1. Remove only sawlogs



2. Remove sawlogs and pulpwood

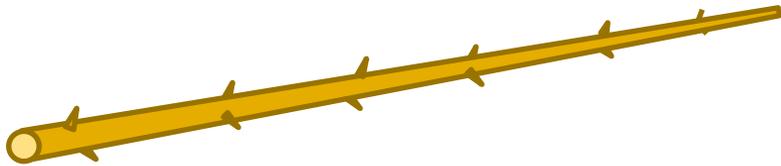


3. Remove sawlogs and energy roundwood (ERC)



Energy roundwood

Roughly delimbed spindles

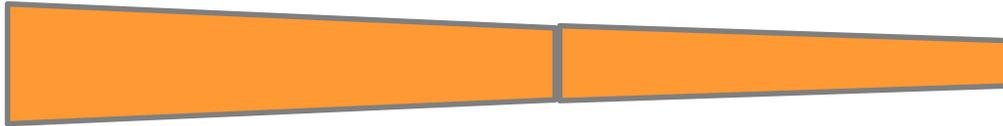


Chips from energy roundwood (ERC)

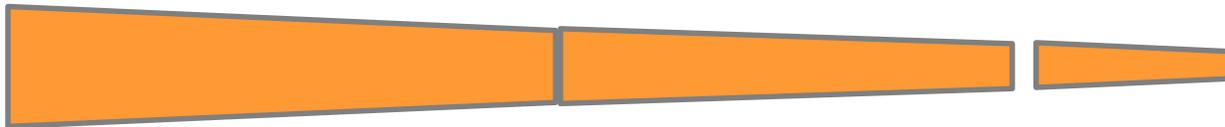


Harvesting options

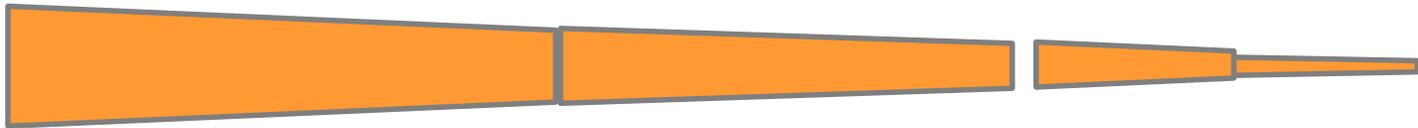
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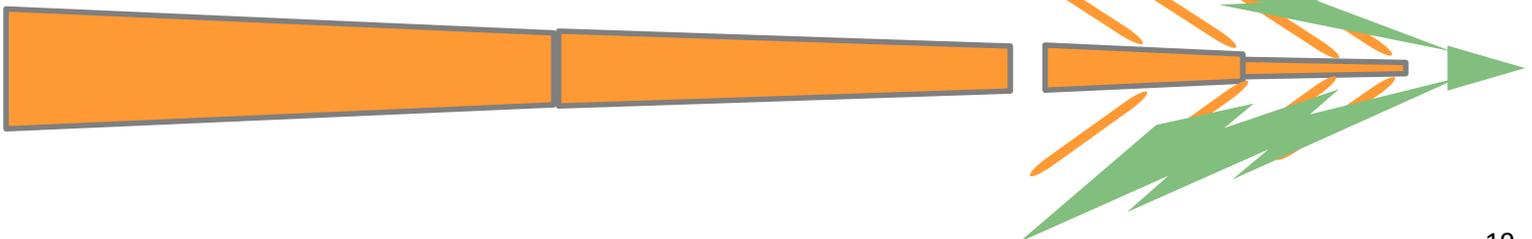
2. Remove sawlogs and pulpwood (≥ 7 cm u.b.)



3. Remove sawlogs and energy roundwood (ERC)

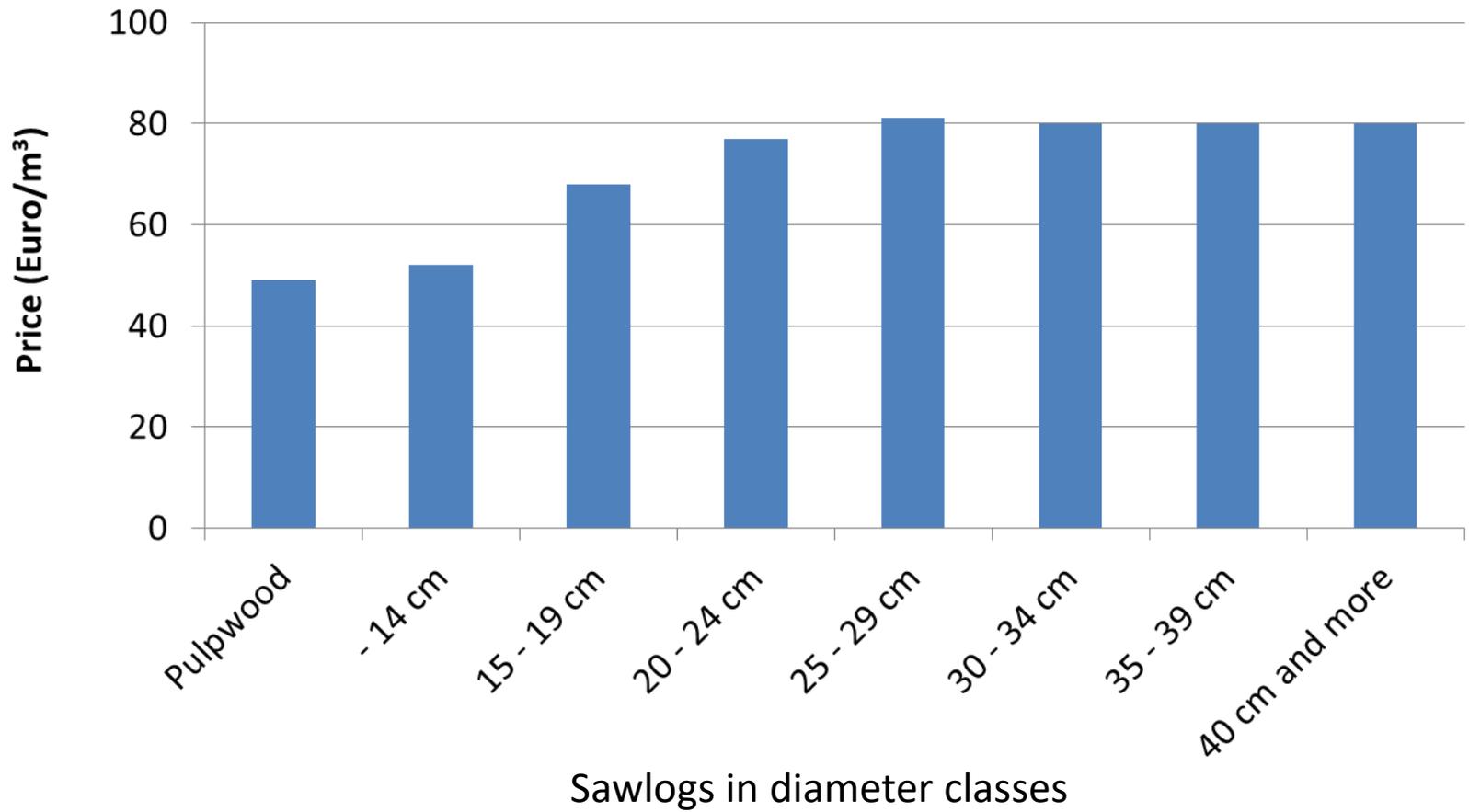


4. Remove sawlogs and whole crown (forest residues FRC)



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- Four harvesting options
- Calculating the revenues from timber sales

Timber prices



Wood chip prices

Current prices

Energy roundwood (spindles) 90 Euro/ ODT

Whole crowns 70 Euro/ODT

(oral information by M. Pflügler, manager of a biomass combustion plant Sept. 2017)

Prices declined since 2014 by 16 %

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- Calculating logging costs

Logging costs

- Harvester – productivity model HeProMo (Lemm et al. 2014)
130 Euro/PMH machine 33,40 Euro/WPSH salary
- Forwarder – productivity model based on time study
90 Euro/PMH machine
- Felling and forwarding of spindles and crowns, chipping and transport
according to Schulmeyer et al. 2016

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- Calculating logging costs
- Calculating costs of fertilization

Costs of fertilization

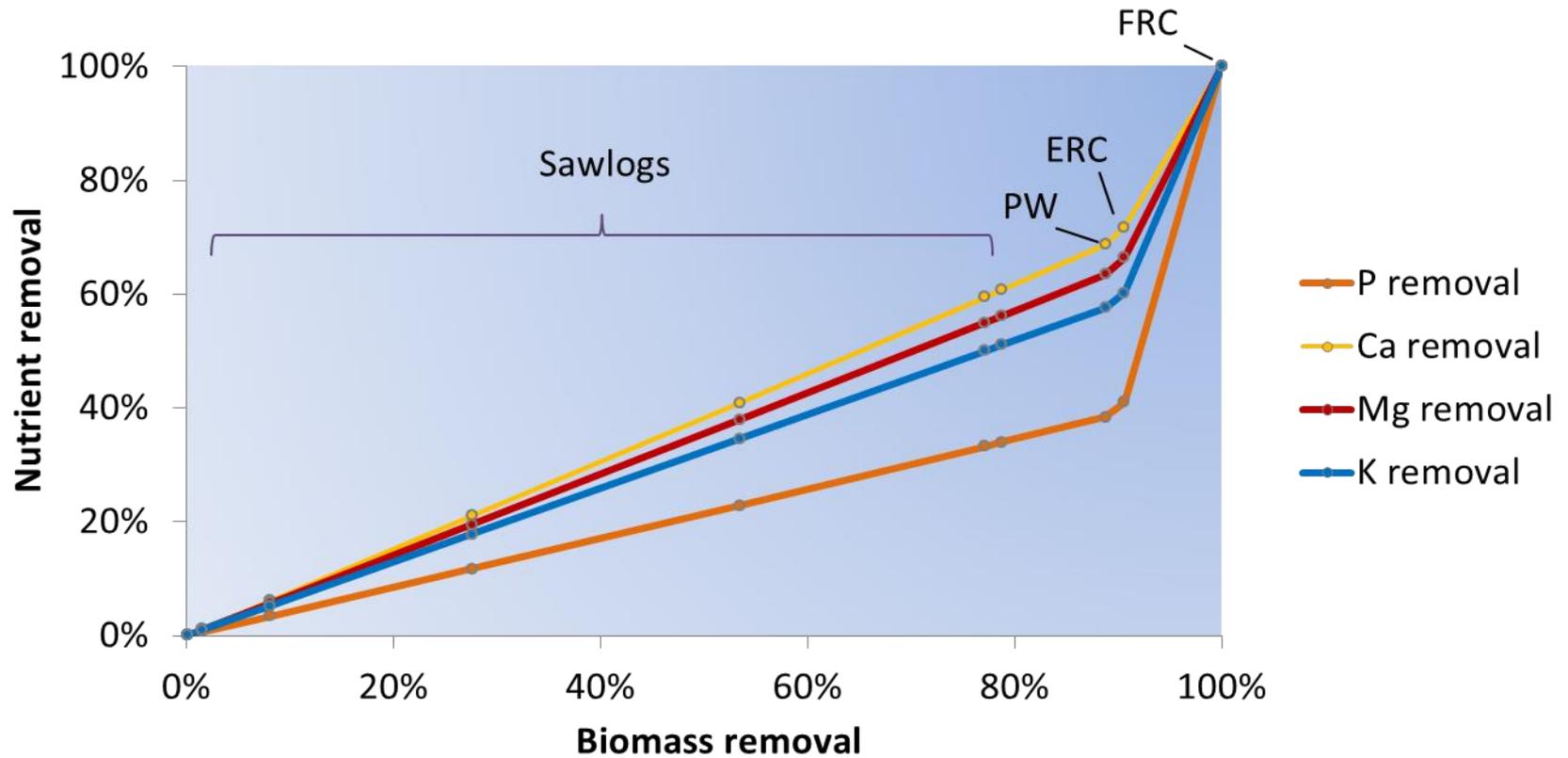
P	2,47€/kg
Ca	0,18€/kg
Mg	1,38€/kg
K	1,10€/kg

Distribution by helicopter 130 Euro/ha

20 % of fertilizer - 30 years before
20 % of fertilizer - 10 years before
60 % of fertilizer - 10 years after } final cut

Costs discounted or prolonged to the age of final cut (100 years) with an interest rate of 2 %

Nutrient removal

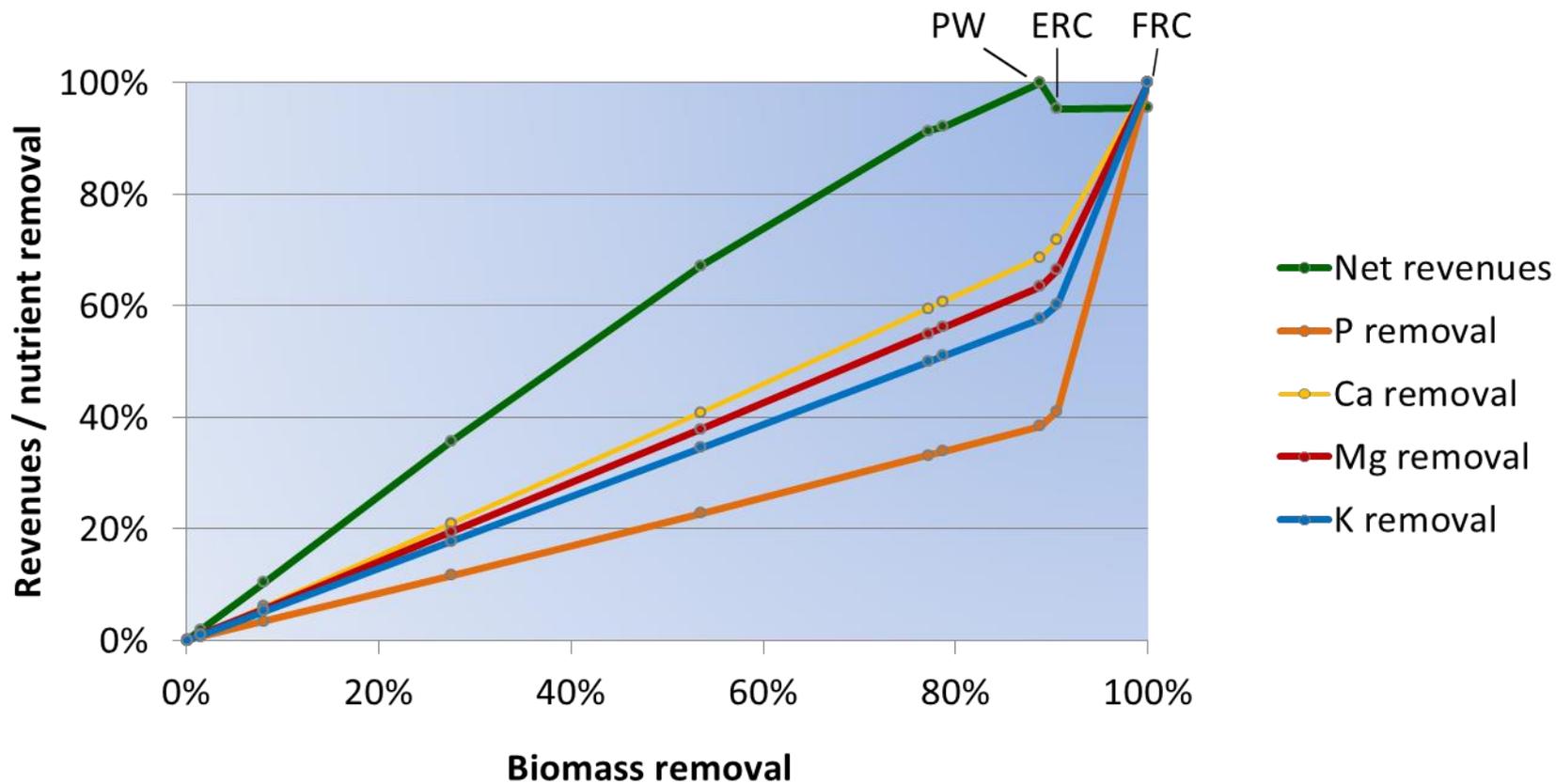


PW = Pulpwood

ERC = Energy roundwood

FRC = Forest residues

Revenues and nutrient removal

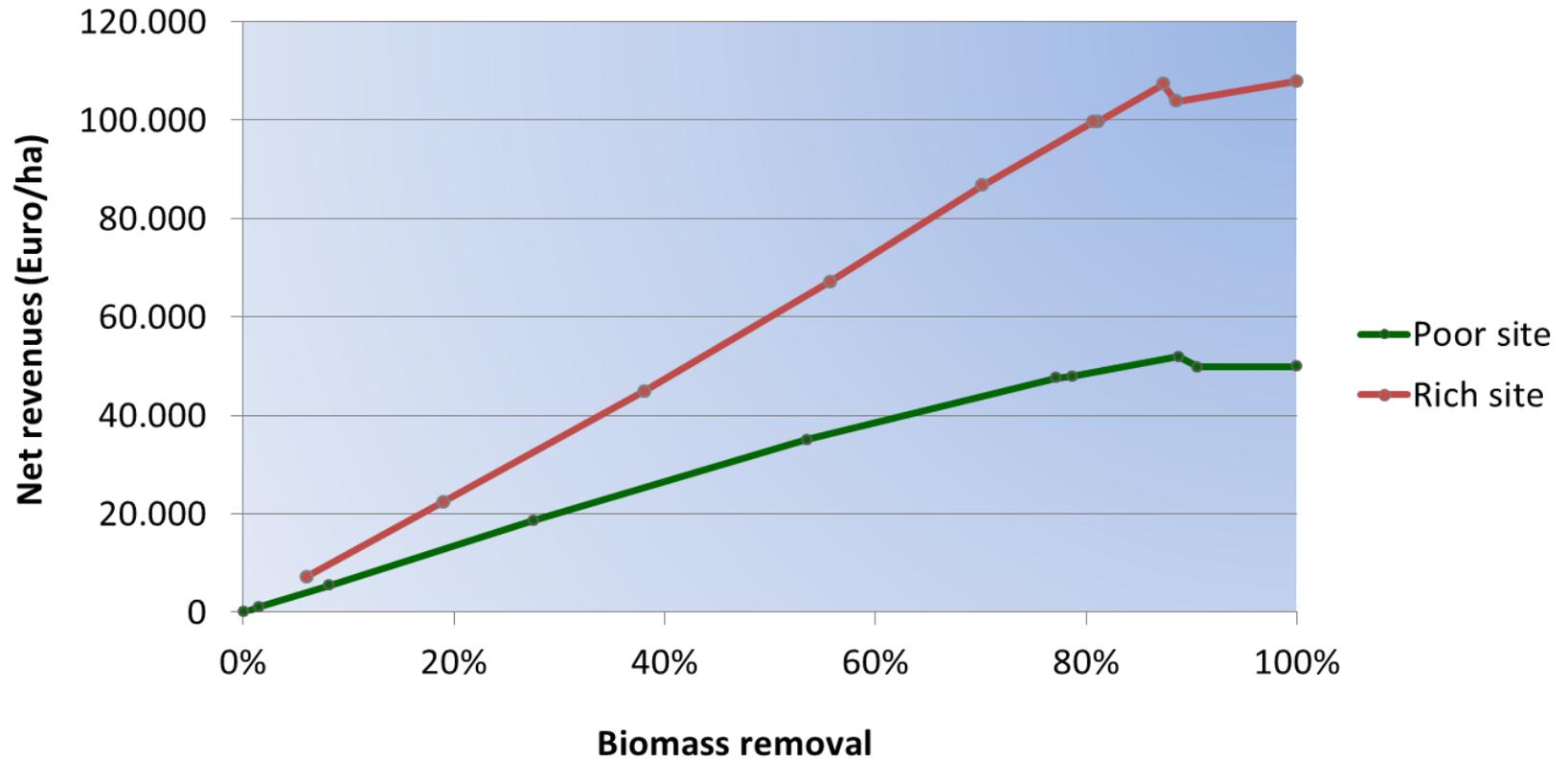


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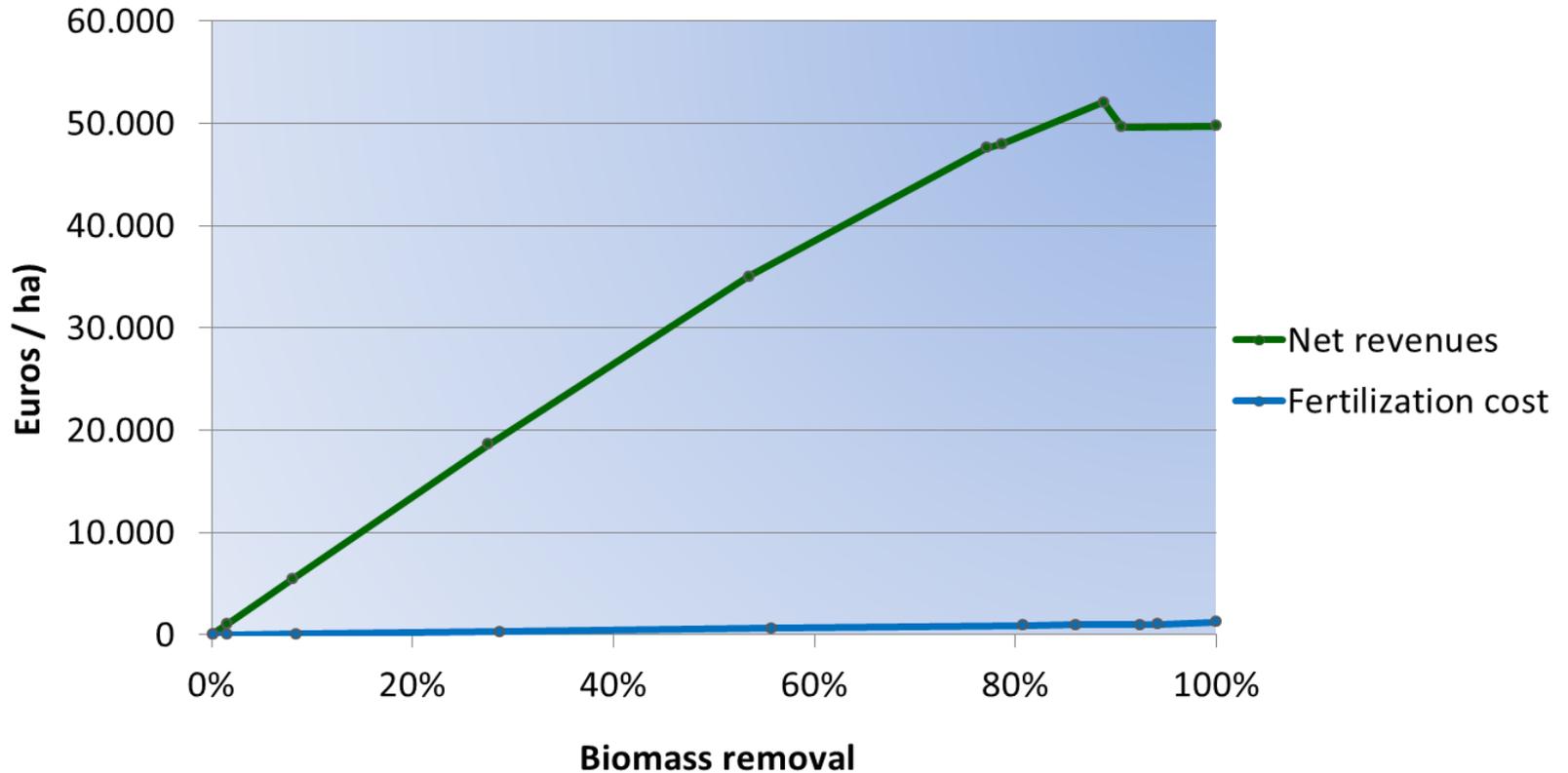
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Revenues on different sites

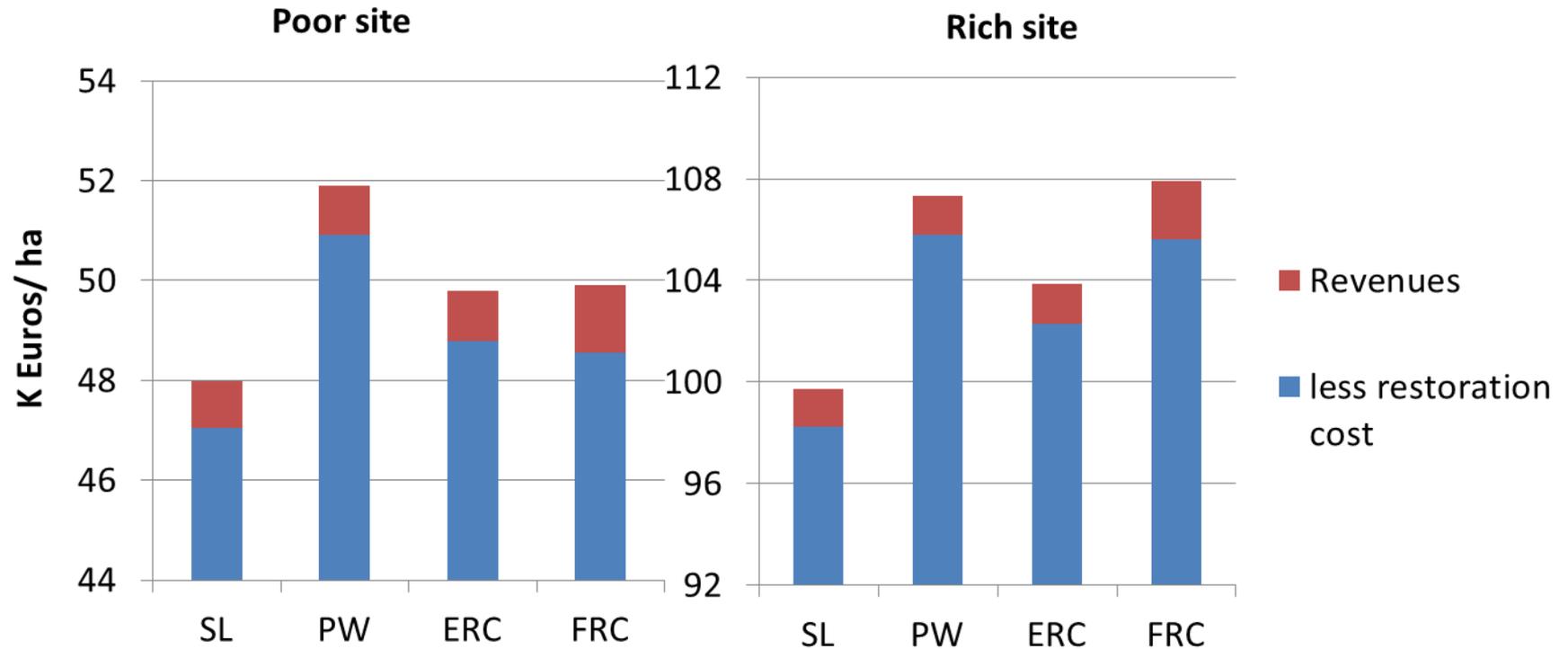


Revenues and cost of nutrient restoration



Profitability

2017



SL = Sawlogs

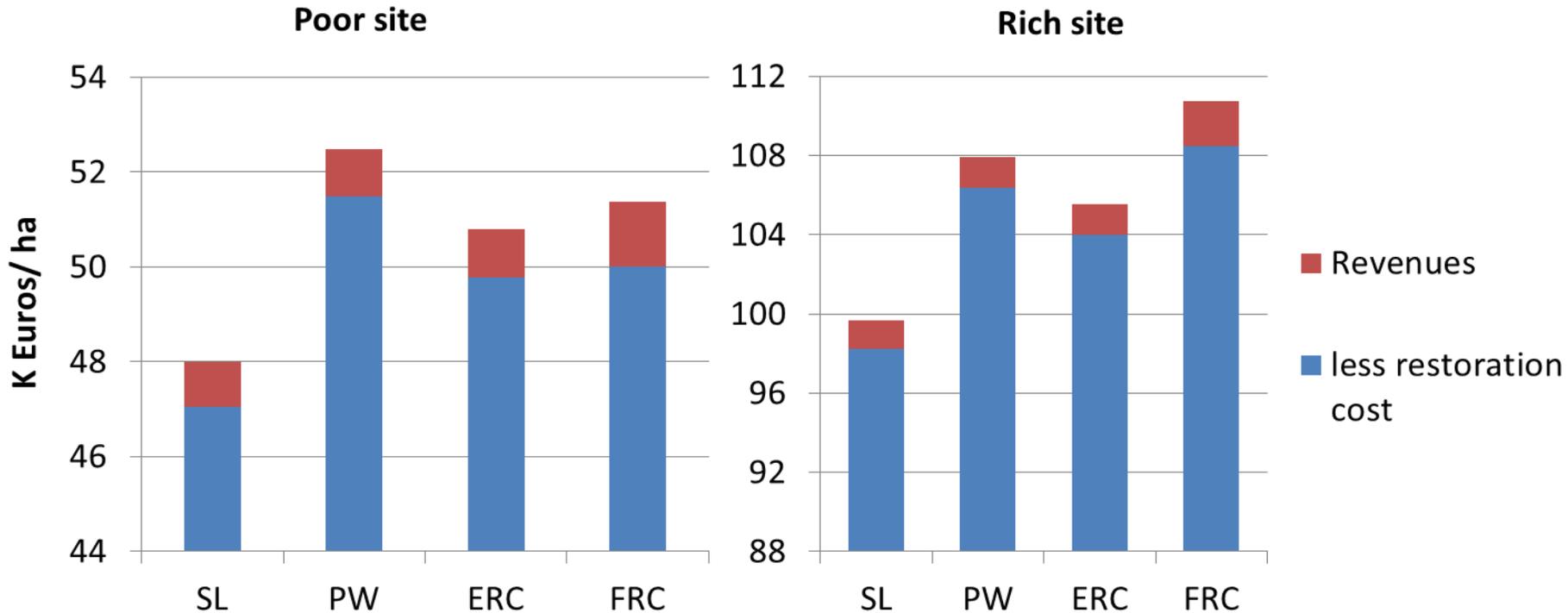
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Profitability

2014



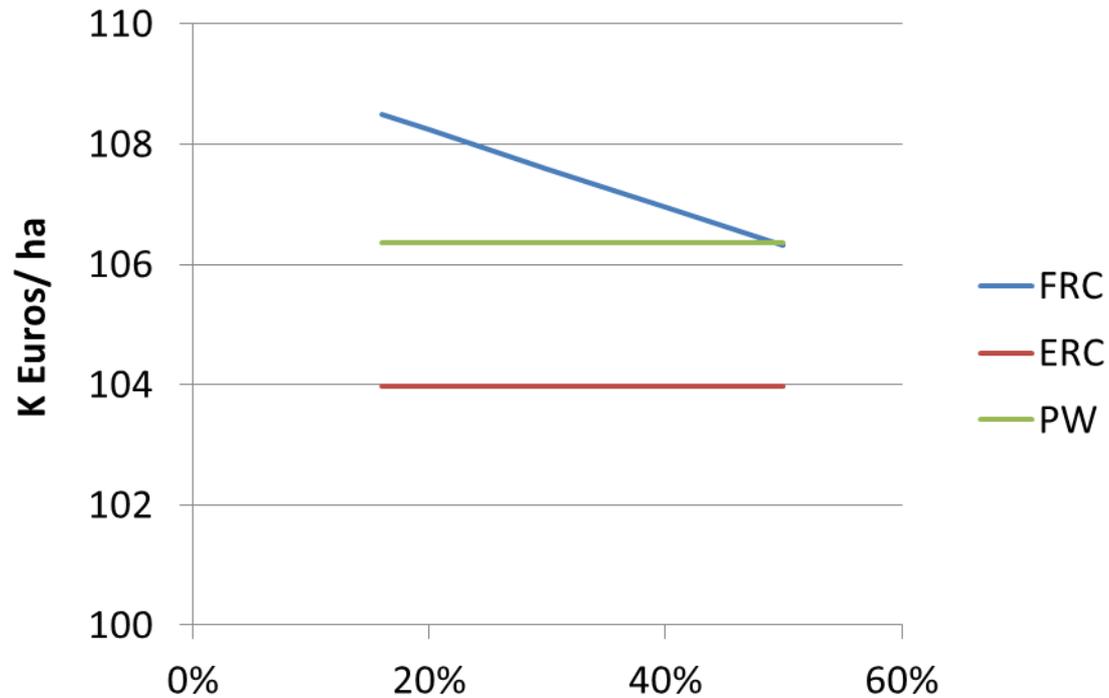
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Profitability



Proportion of forest residues left in the stand

Conclusions

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Conclusions

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2. Loss of soil fertility can reduce the yield considerably
3. If nutrient restoration cost are considered whole-tree harvesting might not be the most profitable option
4. Nutrient mass-balances are necessary for determining critical nutrients
5. Energy roundwood production can be an option to prevent bark beetle infestation