A step towards optimal wood supply chain: A case study on optimal tree bucking in Central Finland

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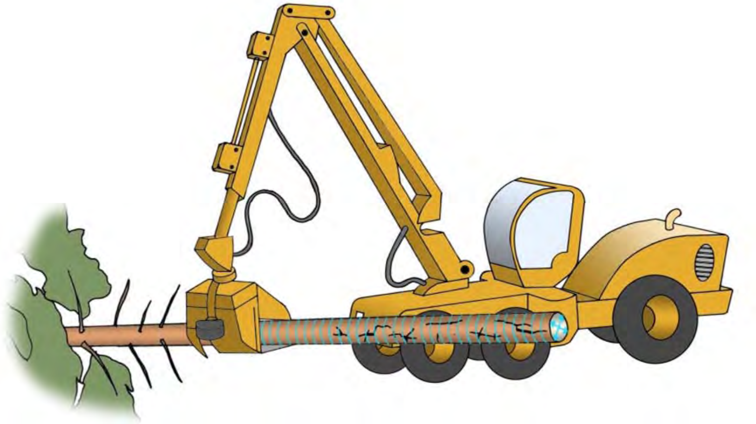
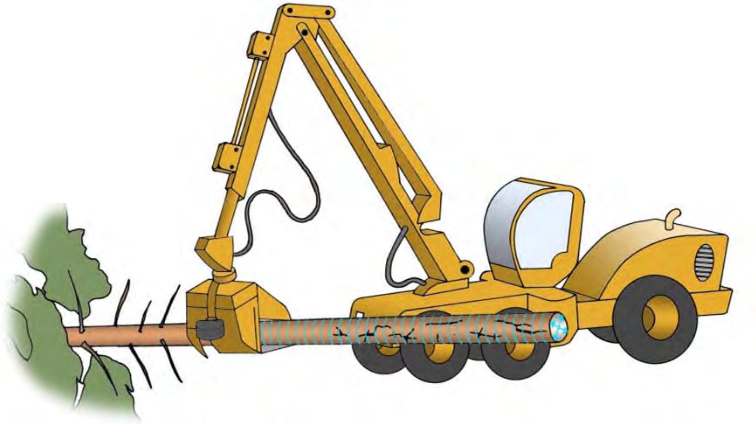
Tree bucking control



Two main questions to be solved:

- What kind of wood assortments (products) from which stand
- What kind of log (length, diameter, quality) within each wood assortment

Tree bucking control



Three main levels:

- Stem level - optimize cutting of one stem
- Stand level – optimize cutting of all stems in a stand
- **Forest level – optimize bucking of all trees of several stands**

Aim of the study

- **How large net profit can be achieved provided that a forest-level tree bucking can be achieved?**
  - A Case study: search for the maximum net profit and minimum net profit (assuming all restrictions are fulfilled)
  - Potential gain: (Maximum – Minimum)/2

Case study: Mills/assortments

Own Mills
Delivery mills

SAWMILL2

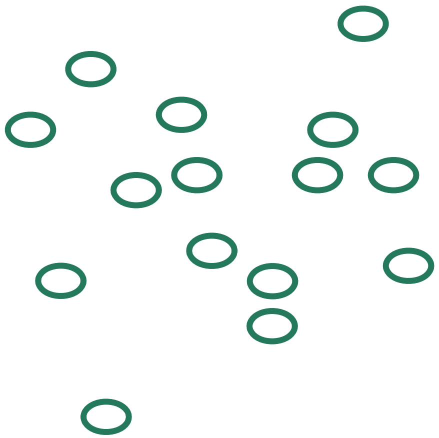
Sawlogs 450 m3
Small sawlogs 150m3

LOGGING FACTORY

Special dimensions
Sawlogs170m3

SAWMILL1

Sawlogs
3420 m3



PULPMILL

Pulpwood
470m3

Supply
15 study stands >=5080m3
Demand
All mills = 4830m3

JOINERY FACTORY

Qood quality
Butt logs 170m3

Calculation of costs and revenues

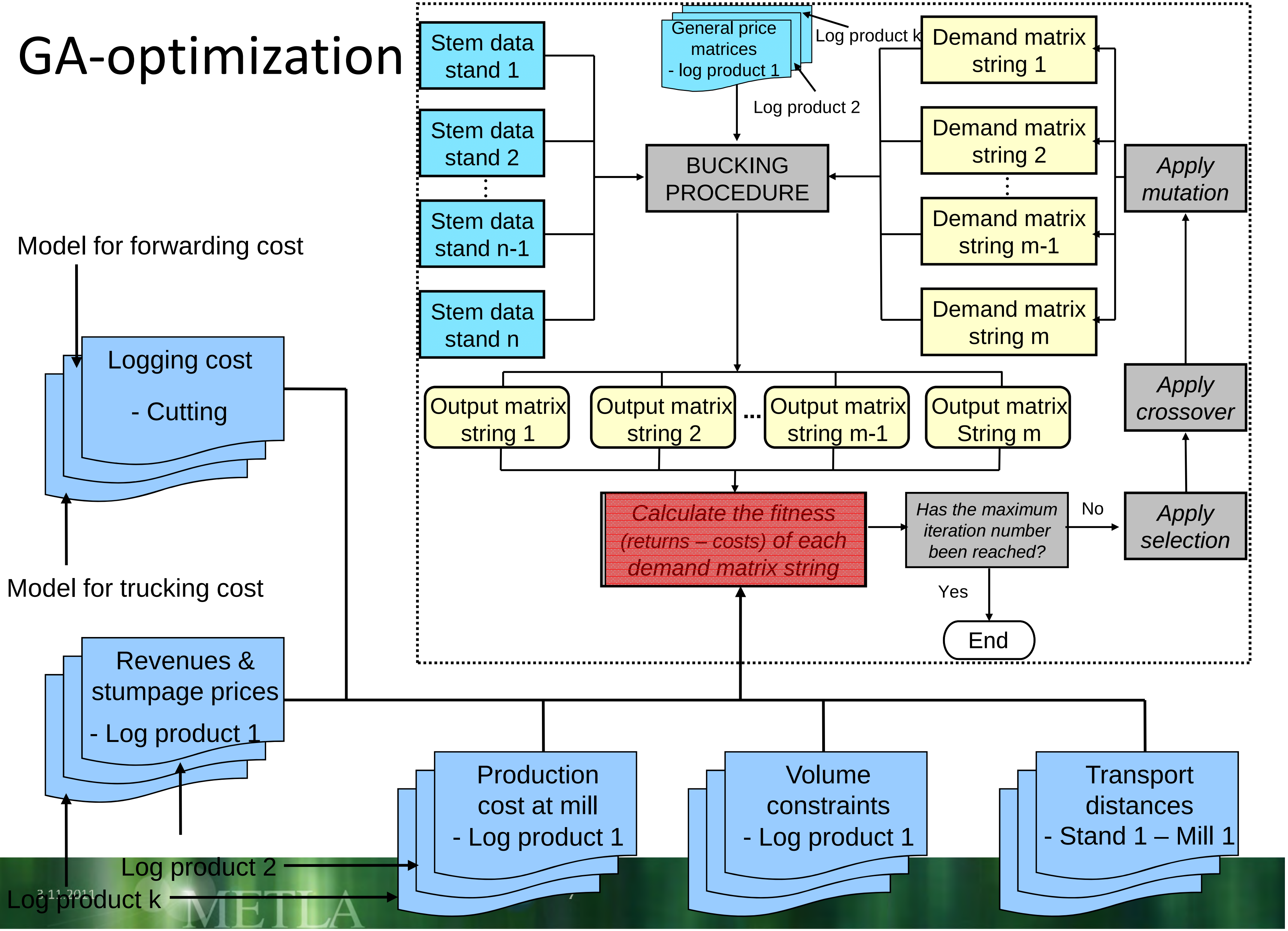
Own mills

- **Costs**
  - Stumpage price
  - Cutting costs
  - Forwarding costs
  - Timber trucking costs
  - Capital costs of wood
  - Wood supply chain management cost
  - Processing costs
- **Revenues**
  - final products (lumber, pulp, etc)

Delivery mills

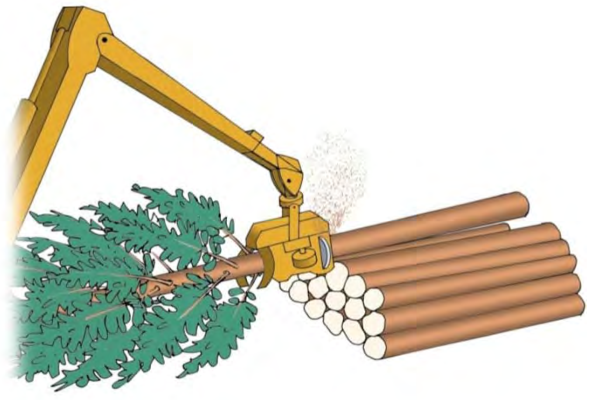
- Costs
  - Stumpage price
  - Cutting costs
  - Forwarding costs
  - Timber trucking costs
  - Capital costs of wood
  - Wood supply chain management cost
- **Revenues**
  - log products (sawlogs, pulpwood, etc)

GA-optimization



Activity based costing

- A cost management system developed for harvesting and timber trucking
  - The more time certain product requires resources the more cost must be allocated to it



Nurminen, T., Korpunen, H. & Uusitalo, J. 2009. Applying the activity-based costing (ABC) to cut-to-length (CTL) timber harvesting and trucking. *Silva Fennica* **43**(5), 847-870

Time consumption analysis of the mechanized CTL harvesting system

- Time study carried out in the Middle-Finland in 2004
- 9 final cutting stands, 5 thinning stands
- 8 harvesters, 10 operators
- 8 forwarders, 9 drivers

Nurminen, T., Korpunen, H. & Uusitalo, J. 2006. Time consumption analysis of the cut-to-length harvesting system. *Silva Fennica* **40**(2), 335-363.

Productivity of long-distance wood transportation

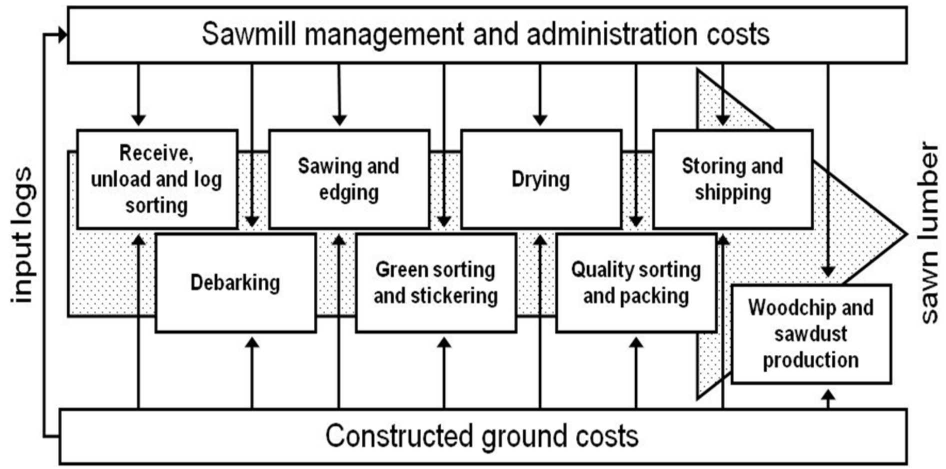
Time study carried out in the Middle-Finland in August 2005

- 368 loads, 17 900 m^3, 9 mills
- 62% from one storage, 38% collecting from several (2 – 8 storages)
- 13 drivers, 8 vehicles

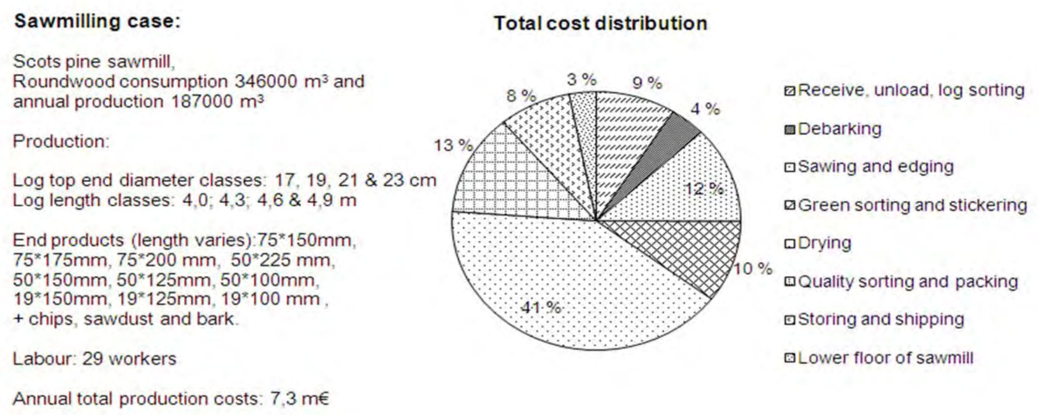
Nurminen, T. & Heinonen, J. 2007. Characteristics and time consumption of timber trucking in Finland. *Silva Fennica* **41**(3), 471-487.

Costing Method for sawmilling

A virtual "greenfield" sawmill



The model calculates the realistic cost for each log size



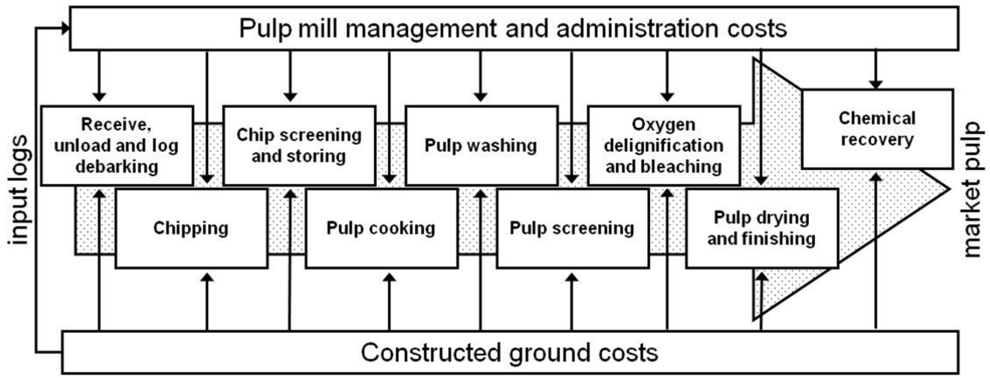
Outputs:

•A model running on excel –sheet

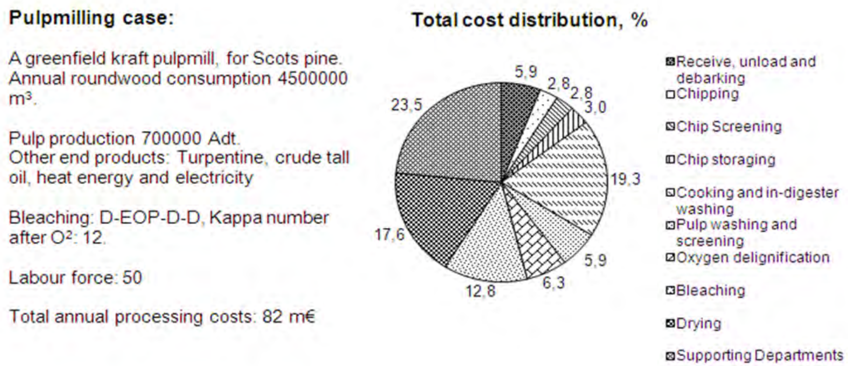
•Korpunen, H, Mochan, S. & Uusitalo, J. An Activity-Based Costing Method for sawmilling. Forest Products Journal 60(5):420-431.

Costing Method for kraft pulp mill

A virtual "greenfield" pulp mill



The model calculates the realistic cost for each log size



Outputs:

•A model running on excel –sheet

•Heikki Korpunen, Pekka Virtanen, Olli Dahl, Paula Jylhä and Jori Uusitalo: An activity-based cost calculation for kraft pulp mill. Manuscript 16 p.

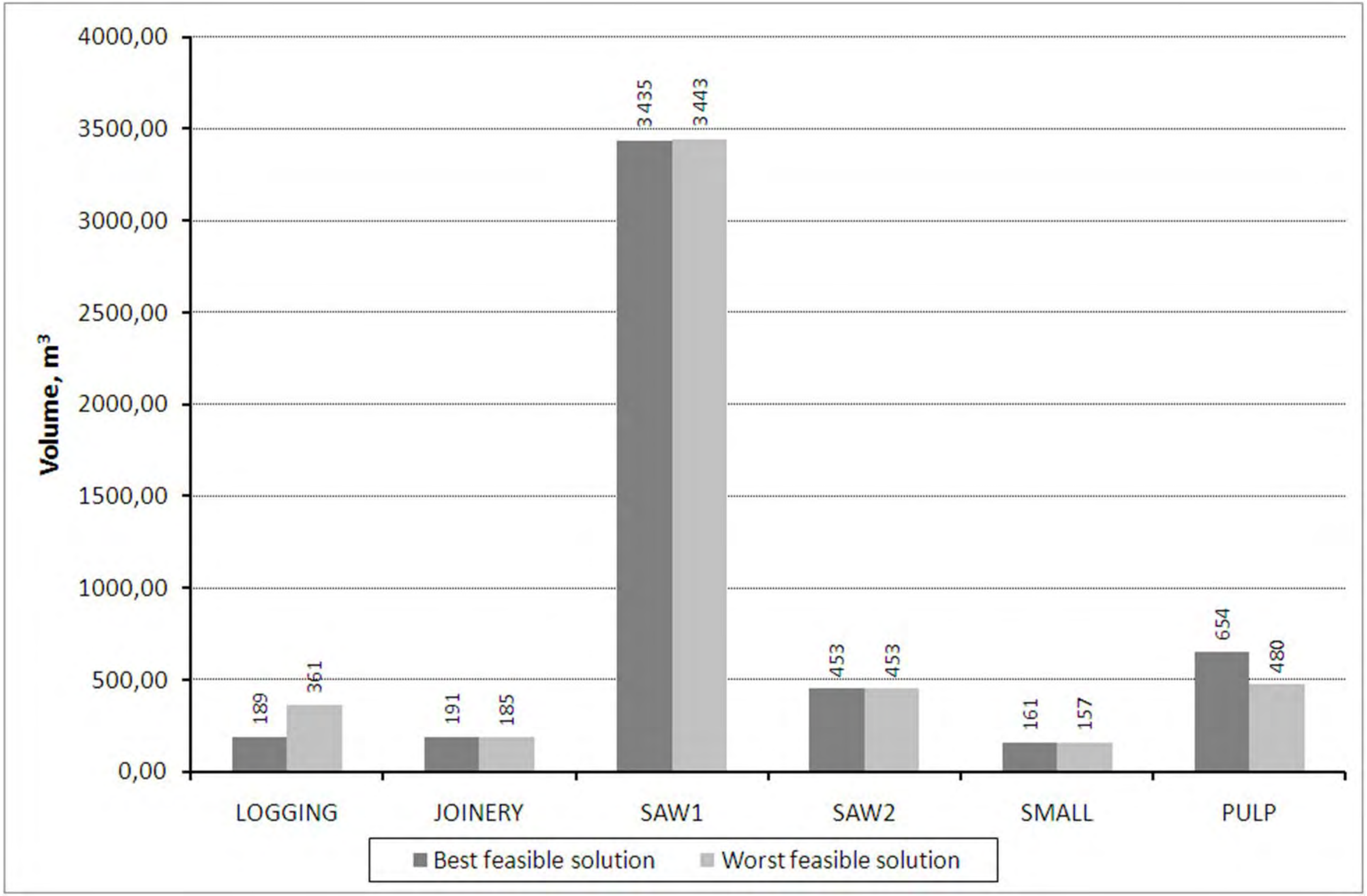
Revenues of sawmilling

– Revenues for each log
  – Quality differences between stands
    • Pre-harvest measurement (Uusitalo 1997)
  – Yields and proportions of quality grades by diameter and log type
  – Amount of by-products (chips, bark, sawdust)
  – Price level 2010

Revenues of pulp milling

- Revenues for each log
  - Amount of bark
  - Pulp yield
    - pulp yield increases with increasing basic density
  - Yield and markets prices of by-products (Bark, Oil, Turpentine, Black liquor)

Results



4000,00
3500,00
3000,00
2500,00
2000,00
1500,00
1000,00
500,00
0,00
Volume, m3
189
361
191
185
3 435
3 443
453
453
161
157
654
480
LOGGING
JOINERY
SAW1
SAW2
SMALL
PULP
Best feasible solution
Worst feasible solution

Results: Allocation of wood assortments

Log products	Stand														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LOGGING				A	B			A	B			B	AB	AB	
JOINERY	B		AB	AB	B		AB	A		AB		A	B	AB	
SAW1	AB	AB	A	B	AB	B	AB	AB	AB	B	B	A	A	B	AB
SAW2	A	A	B	A	A	A		A		AB		AB	AB	A	
SMALL	AB	B	AB	B	B	AB	AB	AB	B		A	AB	A	B	AB
PULP	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB

A = Best feasible solution B = Worst feasible solution

Results: Net profit

Allocation	Net Profit €	Allocated volume m3
A (best feasible solution)	24181	5083
B (worst feasible solution)	8380	5081
Difference	15801	-

- Increase of net profit by 50-100%
- In our Case study area (demand of pine 300 000m3) €500.000 - €1.000.000 annually

Conclusions

- It is theoretically possible to compare the profitability of various logistic chains (value chains) and search for (close) optimal solutions
- It can be only strategic or tactic tool – no operative
- Competition on energy resources and desire to develop new processes (bio-refinery) calls for tools that can compare production chains


Forest
METLA
KNOWLEDGE
Know-how
Well-being
Thank you