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Harvest of logging residues in the Netherlands

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Wood for thought

- In the last decade demand for Wood is growing steadily as new economies grow and new players occurred on the wood market.
- Wood for energy production is competing with other industries like panel and pulp processors.
- Dutch government policy on energy production is aiming at 20% sustainable energy in 2020. Biomass will take approximately a 30% share of the total.
- But where does it come from when demand is growing and wood production capacity is limited and even decreasing?

Answer

Alternative and unused sources!

Logging residues from regular managed forests

- 1. Goal
- 2. Harvesting logging residues international
- 3. Quick scan of the Dutch situation
- 4. Physical and chemical properties and logging residues
- 5. Moist and heat value
- 6. Costs
- 7. Forest ecosystem and harvest of logging residues
- 8. Nutrient balance
- 9. Regeneration
- 10. Harvest of logging residues in the Netherlands when, were and how much

1. Goal

- Main goal of this study is to collect information from various research programmes on the harvest of logging residues and related issues in order to provide decision makers insight in the various aspects of harvesting logging residues in the Netherlands.

2. Logging residues as additional source of woody biomass

- In Europe, the harvest of logging residues is already common practise in the classic timber producing countries like Sweden and Finland (Germany).
- In the Netherlands, local traders, clients, contractors and forest managers are interested in the concept but a lot of questions are still unanswered.

3. Quick scan of the Dutch situation 1

Important aspects:

- Harvest and processing of logging residues on site is only possible in large scale projects

- Processing and storage for drying on site is not favourable due to local forestry practice, regulations and legislation.

3. Quick scan of the Dutch situation 2

- Harvesting and processing elsewhere is technically feasible.
- Forest managers are interested in the concept as it can be used in specific situations like transformation of forest types, etc.
- Developments on the market are positive.

3. Harvesting of logging residues

From Dutch perspective, the most promising future scenario in the Netherlands is:

1. Felling,
2. Bundling,
3. Forwarding to forest road,
4. Transport with regular log truck,
5. Drying of the bundles,
6. Processing and screening with industrial stationary equipment,
7. Transport to the clients or storage prior to transition into energy on site.

Bundle machine

Bundles from pre-commercial thinning

Transport with log trucks

Processing with a mobile shredder

Bundle production rates

Location of the field test	Machine	Production (Bundles/h)	Bundle length (m)
Austria	Truck mounted bundler Timber jack 1490D	9,1-12,6	3
France	Forwarder mounted Timber jack FB370	11-24	3
Germany	Truck mounted bundler Timber jack 1490D	22	3
Finland	Forwarder mounted Timber jack FB370	24,5	3
Italy	Truck mounted bundler Timber jack 1490D	13	4
US	Forwarder mounted Timber jack 1490D	10-30	3

Processing

Location	Equipment	Bundles specs.	Production
Austria	Shredder Jenz, loaded with a four wheeled front loader	Coniferous	52-59 bundles/h.
Austria	Shredder TIMenvipro, loaded with a four wheeled front loader	Coniferous	64-75 bundles/h
US	Shredder loaded with a grapple loader	Coniferous	60 bundles/h.
US	Shredder loaded with a grapple loader	Broad leaf	52 bundles/h.
US	Shredder loaded with a four wheeled front loader	Mixed	70 bundles/h.

Average bundle specifications

Length	3m
Diameter	70 cm
Volume	1,15 m³
Weight	500-700 kg (fresh weight)
Energy (At 50% moist , energy value is on average 2 kWh/kg)	1000-1400kWh/bundle (3,6 GJ-5,04 GJ)
Chips/shred volume per bundle	1,4 m³

4. Physical and chemical properties; crucial factors for future marketing

As the market for solid bio fuels and transition of solid has developed and got more professional over the last decades, also a technical standard was developed for EU. The CEN/TS 14961

Parameters classified and specified are:

- Moist content
- Particle size distribution
- Nitrogen and Chlorine content
- Energy content
- Ash content
- Bulk density

4. Logging residue a special case 1

Taking the requirements of the highest standard into account, harvesting, processing and marketing of logging residues for bio fuel is a special case.

- Tops and branches contain a relative high amount small sized wood particles. (particle size distribution)
- High content of bark and green parts (ash content)
- Pollution with sand and stones (ash)
- High moist content when processed fresh (moist)

4. Logging residue a special case 2

In order to produce high quality bio fuel from logging residue, careful handling and processing is necessary.

- During felling, harvest residue should not be used as ‘pavement’ on hauling tracks (more soil damage)
- In order to separate the desired fractions from sand, stones and green parts, proper screening is required during processing.

5. Moist content; Key factor nr. 1

The most important value of biomass is heat value per tonne as the yield of transition plants depend on this factor.

The net heat value of bio fuel, as unit to determine the price will become common practise in future.

5. Net heat value and moist content of wood

Coniferous			Broadleaf		
Moist %	Kg/m³	KWh/kg	Moist %	Kg/m³	KWh/kg
0	148-160	5,38	0	230-270	5,03
25	197-213	3,86	25	307-360	3,60
40	247-267	2,95	40	383-450	2,74
50	296-320	2,34	50	460-540	2,17
60	370-400	1,73	60	575-675	1,59

5. Air drying; cheap, but simple? 1

- Forced drying is only feasible in combination with a power plant or other industry when rest heat is used.
- Forced drying in the end has always a negative effect on the yield of any installation.

5. Air drying; cheap, but simple? 2

Air drying of wood in time and quantity depends on:

- Relative air humidity
- Temperature
- Air flow

5. Air drying; cheap, but simple? 3

Relative humidity and equilibrium % moist content

Timber species	40% MA	60% MA	85% MA	90% MA	Saturation point
Scots pine	9-10	12-13	15-18	17-19	30
Spruce	8-9	12-14	18-21	20-23	30
Douglas fir	9-10	12-14	18-21	20-23	29
Oak	9-10	12-13	17-20	19-22	32
Poplar	7-8	11-13	17-20	19-23	32

5. Air drying; cheap, but simple? 4

Equilibrium Moist Content of spruce during the year

jan	feb	mar	apr	may	jun	jul	aug	sept	oct	nov	dec
19,5	18	15	13	12	12	14	14	16	17	19	21

5. Air drying; cheap, but simple? 5

Conclusions.

- In the cost benefit assessment, moist content has an enormous impact on the final results. 1% less moist equals a 5% cost reduction per Giga Joule.
- Optimal drying period is January until August
- Field experiments have proven that a moist reduction of 30 to 50 % is possible. This equals an increase of the net energy value with a factor 2,2

6. Costs

Costs of bundling, transport and processing per oven dry tonne depends for about 60% on the production of the bundles.

In Austria the production was low compared to other tests. (10,9 b/h in Austria and 20b/h in Finland). The cost per oven dry tonne in Austria were €73,33. (Finland €52,--?)

7. Dead wood in the forest

7. Harvest of logging residues and Forest ecology

In the process of deciding, when, where and how the harvest of logging residues is possible, insight in the role of woody debris in the forest ecosystem is important.

Main questions are:

- What is the role of small deadwood in the forest ecosystem? and

- What is the impact on the nutrient balance in the forest?

7. Harvest of logging residues and Forest ecology

- Dead wood is an important part of the forest ecosystem as it is a habitat for a wide array of organisms and after humification an important component of forest soil.
- Key indicators within the forest ecosystem, telling something about the quality of the deadwood situation are; insects, fungi and mosses.
- Many research has been on Coarse Woody Debris (CWD), >10 cm
- As biomass removal became more important in the last decades, the ecological functions of Fine Woody Debris (FWD), 5-9 cm is studied as well

7. Insects

7. Insects

- FWD spread through the forest results in a big variation in gradients of moisture and temperature > more different habitats, high species richness
- Some insects, especially beetles are specialised in using FWD
- A difference in species composition on CWD and FWD has been found
- Harvesting broadleaved species has bigger implications for species richness, as coniferous logging residues are less species rich

7. Fungi

7. Fungi

- Fungal species composition depends on the years since the last forestry intervention
- Fungi migrate easy over long distances
- Deciduous trees are richer in fungal diversity
- Ascomycetes depend more on Fine Woody Debris than basidiomycetes.
- Ectomycorrhiza perform better on nutrient poor sites where logging residues are removed
- Availability of dead woody debris in a wide range of different characteristics and stage of decay in time, allocated in one forest is a more important factor for the presence of fungi than the quantity of deadwood.

Mosses

7. Mosses

- Few mosses have a preference for dead wood, but need it to establish when other substrates as embankments and ridges are absent
- Course Woody Debris is more important for mosses

7. Biodiversity - Conclusion

- CWD is more species rich when equal number of logs are compared
- FWD is more species rich when equal volumes are compared
- Deciduous dead wood seems to be more species rich
- Availability of deadwood with different characteristics and stage of decay rather than large quantities of deadwood is the key factor for an optimal composition of the fungi community.
- Rare species perform better on CWD

8. Harvest of logging residues and nutrient balance

In natural forests the nutrient cycle is more or less closed.

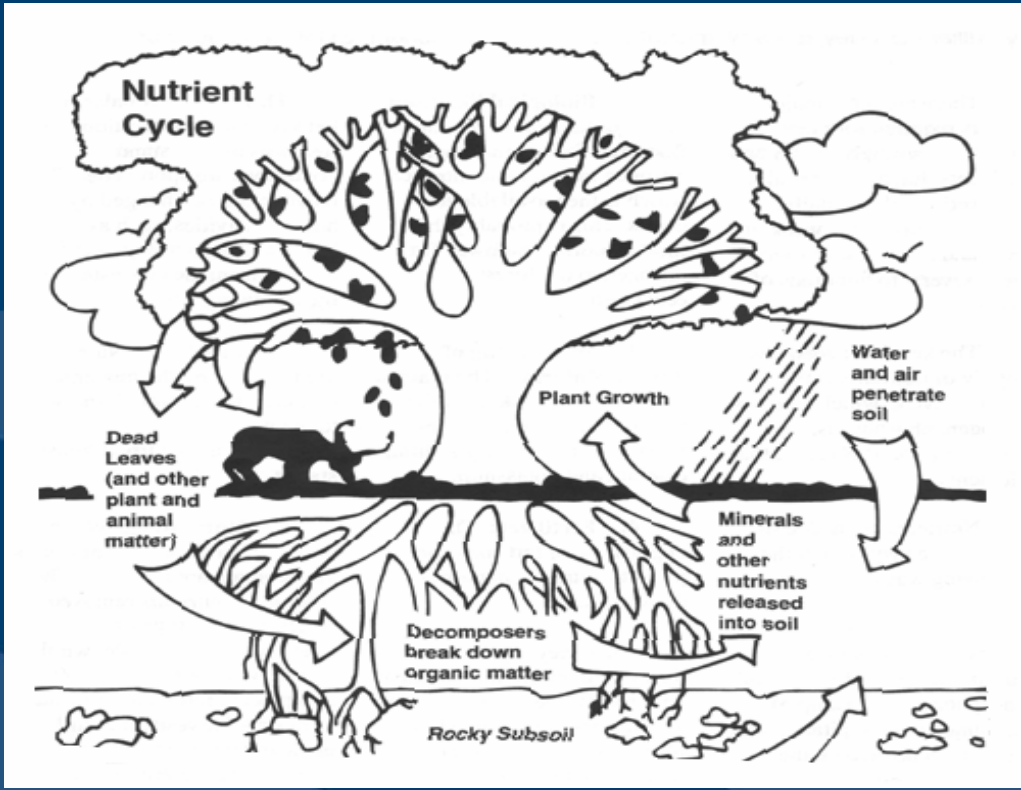
In managed forests were timber is harvested nutrients are removed.

What is the impact on the nutrient balance harvesting logging residues as well?

8. Soil fertility and nutrient removal

- Branches, twigs and needles make up 6% of the dry mass of a tree, but contain 70-90% of the mineral contained within the tree
- Removing the whole tree (WTH_{green})*during* harvest results in 20-75% more nutrient removal compared to leaving the tops and branches to dry for one growing season
- WTH_{green} results in a short term decrease in volume increment

8. Nutrient cycle



8. Soil fertility and nutrient removal

- An idea of how much more nutrients are removed with whole-tree harvesting:
- Ratio nutrient concentration stem vs. whole tree (kg/ton)

	Nitrogen		Calcium		Kalium	
	stem	tree	stem	tree	stem	tree
Douglas fir	1	1,7	1	1,9	1	1,6
Norway spruce	1	2,4	1	1,7	1	2,0
Scots pine	1	2,1	1	1,2	1	1,7
European beech	1	2,5	1	1,9	1	1,7

8. Ash recycling

- The composition of the wood ash depends on the nature of the wood fuel
- The ash of hardwood species contains more nutrients
- > 5 ton ash/ha affects ground flora vegetation
- High N pollution + ash -> N leaching

Ash recycling in the Netherlands

- Recycling of wood ash in the Netherlands is assessed but is not feasible.
- In the Netherlands it is not possible yet to track and trace all flows in order to create a close recycling system from source back to source.
- Current application techniques are not favourable in the Dutch situation. Recreation is one of the major functions of the Dutch forests.

Ash recycling in the Netherlands

- In case the harvest of logging residue is applied on a large scale and more frequent in time (every thinning), ash recycling is an important factor to consider in the nutrient balance of the forest.
- Application techniques need improvement.

8. Ash recycling

. Harvest of logging residue and the mpact on forest regeneration 1

- Leaving logging residues:

  - increases the amount of nutrients on a site > favouring *Rubus spp.*

  -acts as a physical barrier for grasses and browsers of tree saplings

  -results in a higher biomass of the trees. (better growth)

. Harvest of logging residue and the mpact on forest regeneration 2

- Removing logging residues:

  -pine and birch regenerate better, because of the disturbed humus layer

  -*Calluna* and lichens perform better

- The environmental conditions and required microclimate for saplings of the site are important in deciding to harvest logging residues.

10. Harvesting logging residues in the Netherlands 1

Harvesting logging residues in the Dutch forests with respect to responsible stewardship is possible in situations when:

- Forest management is aiming for forest transformation from foreign species to indigenous species.
- Forest management is aiming for site conditions where pioneer species prosper and invasive herbs like rubus etc. are less wanted.

10. Harvest of logging residues in the Netherlands 2

- Harvesting of logging residues is applied in winter time.
- Logging residues from coniferous trees are left in the forest for at least one year to release the needles. Most nutrients are stored in leaves and needles.
- Clean sweeping of the forest floor is prevented at all time.

10. Harvesting logging residue in the Netherlands 3

- When harvesting logging residues for energy production becomes common practise, the extra amount of biomass harvestable in the Netherlands is estimated 15% of the regular round wood harvest. In 2006 it was estimated on 140.000 m³ round wood equivalents.
- As a handy rule for field assessments, German estimations show that per 100 m³ standing timber on average 20-35 m³ fresh chips can be harvested in addition to the regular round wood assortments.

10. Harvesting logging residues in the Netherlands 4

- Logging residues can be harvested and processed on site when large clear cuts are applied.
- Harvesting logging residues from small scale clear cut and thinning is feasible when the residue is collected, dried and processed elsewhere.


Thank You