RESIDUES TO COMMODITIES

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Biobased Products Innovation Plant

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How to match the surplus biomass in remote locations with the demand here?

Large volume of lignocellulisic biomass resources, i.e.:

- Agroresidues/waste
- process residues/waste
- post-consumer residues/waste
- lignocellulosic crops (cultivated and marginal lands)

Can be made available if we have the right demand, production chains and technology

We need biomass resources of the right quantity **AND quality** for an acceptable price @ the right time @ the right place for being refined into a portfolio of **biobased products and energy and energy carriers**

We need BIOBASEDCOMMODITIES and a related international trade market

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Herbaceous biomass is underutilized – Often causing pollution problems – how much can be used for biobased applications?

Top 10 crops in the world		Total field	Total mill
	Million hectares	Million ton DM crop residue per year	
Maize	185	1,038	
Rice, paddy	163	816	
Wheat			
Sugar cane			
Oil Palm			
Barley			
Sorghum			
Sunflower seed	25	66	8
Millet	31	43	
Seed cotton	35	35	
Sum:	**800**	**3,459**	**316**
All crops worldwide:	1,414		

What part can we mobilize?
Can we recycle the nutrients?
What part is needed for the soil?

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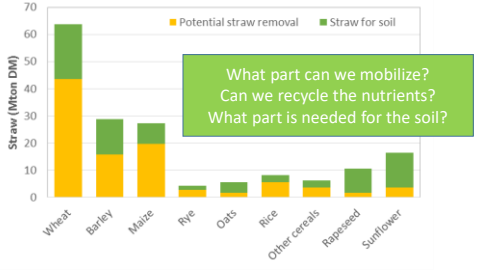
Results – Straw potential per crop



What part can we mobilize?
Can we recycle the nutrients?
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Ukraine . Field residue production and potential availability

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Challanges for using herbaceous biomass

- Biomass is variable in composition:
  - Ash: 1 to 20%
  - N: 0.5 to 2%
  - K: 0.5 to 2%
  - Lignin: 5 to 45%
- Biomass availability scale is rel. small: 20.000 to 100.000 tons per year:
- The biomass has a value for the soil: nutrients and carbon

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Lignocellulosic biomass potential in EU27

	Current potential	Used potential
	Million tons dry matter per year	
Wood from forests	325	350
Other forest biomass (forest industries)	185	140
Agricultural residues (field and agro-industries)	**342**	**15**
Waste	89	60
Cropped biomass	152	2

Panoutsou et al., 2016

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Biomass vision - where should a lignocellulose Biorefinery be located?

Location: / Factor	Near the biomass	At a logistical hub (harbour)
Cost of biomass	+	-
Biomass security of supply	-	+
Availability of Infrastructure	-	+
Maximum scale	-	+
Efficiency of conversion	-	+
Availability of personnel / expertise	-	+
Value or residues	-	+
Sum	1+	6+

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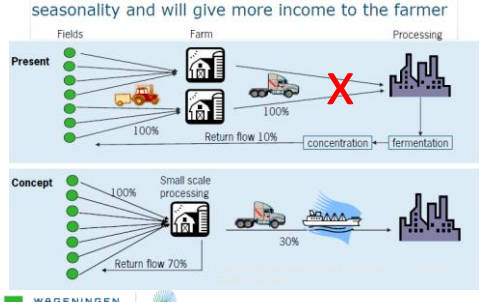
Biomass scale does not fit processing scale

Forward integration reduces tranport cost and seasonality and will give more income to the farmer



Ref. Sanders.

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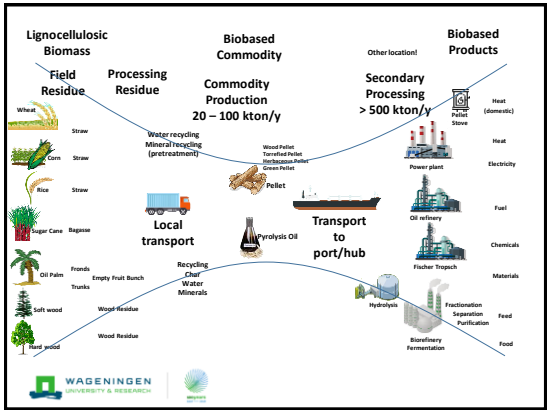

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What is a real biomass commodity?

Real commodity	Not a commodity
Easy to store and transport → high energy density, dry, low volume, low ash, nutrient depleted	**Not easy to transport**
Fungible → "exchangeable" = standard quality	**Not fungible**
	No broad standards
Standardised transport, contracting, standard insurance, etc.	**No functioning markets or trade**
Standard conversion systems	**Trust needed between producer and buyer**
Functioning markets:	**One on one relations between producer and buyer**
Trade systems, Financial instruments (futures, etc.)	**Vertical integration**
High tradability	**Less security of supply lager**
Sustainability	**High transaction costs**
Standard certification systems	**Inefficient**

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Counter current extraction

2 to 3 liter of water to extract 1 kg of biomass

To lower K or Cl by 95% we need more water or more stages

First estimate of cost for 40.000 ton (DM) per year of biomass will cost 6.5 €/ton, which equals 8 US$/ton

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Results for oil palm residues (EFB)

EFB		Before	After
Ash (550 °C)	(% of DW)	4.64	1.85
Ash (815 °C)	(% of DW)	3.77	1.73
S	(% of DW)	0.063	0.023
Cl	(% of DW)	0.38	0.024
SiO_2	(% of ash 815 °C)	30.8	33.5
Al_2O_3	(% of ash 815 °C)	0.53	0.92
TiO_2	(% of ash 815 °C)	< 0,1	< 0,1
P_2O_5	(% of ash 815 °C)	4.87	10.1
SO_3	(% of ash 815 °C)	1.89	9.54
Fe_2O_3	(% of ash 815 °C)	0.99	1.11
CaO	(% of ash 815 °C)	4.35	17.9
MgO	(% of ash 815 °C)	9.51	12.7
Na_2O	(% of ash 815 °C)	2.93	0.78
K_2O	(% of ash 815 °C)	37.8	12.7
Mn_3O_4	(% of ash 815 °C)	0.12	0.26
SST	°C	990	1080
DT	°C	1210	1120
HT	°C	1250	1160

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We need lignocellulose based commodities: Which?

- Candidates:
  - Wood chips?
  - "Straw pellets"?
  - Torrefied pellets?
  - Pellets?
  - Pyrolysis oil?

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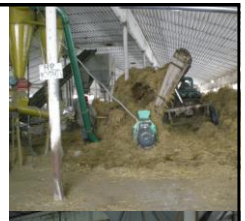
Pellets as Biocommodity?

- Traditionally produced
- Min 25.000 ton per year
- Easy transport
- Easy storage
- Pellet production should costs € 35 to €55,-/ton
- No standards for non-wood?
- No transparent market, cost of transport
- Reliability of transport, contractibility



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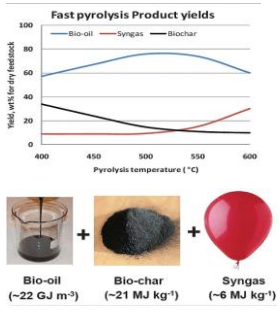
Pyrolysis oil as Biocommodity?

- Lignocellulose to pyrolysis oil:
  - Input is (dry) lignocellulose:
  - Low oxygen + 500 °C
  - Also small scale: 20.000 tons per year
  - Pyrolysis oil (70%) + char (20%?)
  - Pyrolysis oil can be used for heat, electricity, refinery or transport fuels



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How to get there?

- Develop local biorefinery systems with relatively small economy of scale (30.000 ton per year) to remove nutrients, protein and water and produce a lignocellulosic commodity
- Define only a few biomass commodities that cover
  - All lignocellulosic biomass types (wood, EFB, trunks, grass, straw, bagasse, etc.)
  - All applications: heat, co-firing, biorefinery, etc.
- Set wide standards (if possible) and avoid frivolous demands
- Involve all players in the production chain (biomass producers, machine builders, regulators, insurers, bankers, transport, final users)

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END

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Questions

- How much biomass will we need? 2020? 2030? 2050?
- How should the biomass be used in 2020? 2030? 2050?
- What are the biomass commodities we should focus on?
- How do we mobilize this biomass? From where?
- Shoudl we trun Dutch biomass into commodities?

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Thank you for your attention!

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Trash vs Bagasse quality

	Trash			Bagasse
	Dry leaves	Green leaves	Tops	
	% of DM weight			
Ton DM per hectare	11.8	1.6	0.3	
Moisture content	13.5	67.7	82.3	50.2
Ash	3.9	3.7	4.3	2.2
Fixed carbon	11.6	15.7	16.4	18.0
Volatile matter	84.5	80.6	79.3	79.9
C	46.2	45.7	43.9	44.6
H	6.2	6.2	6.1	5.8
N	0.5	1.0	0.8	0.6
O	43.0	42.8	44.0	44.5
S	0.1	0.1	0.1	0.1
Cl	0.1	0.4	0.7	0.02
	g/kg DM			
P2O5	0.5	2.0	2.5	0.5
K2O	2.7	13.3	29.5	1.7
CaO	4.7	3.9	2.6	0.7
MgO	2.1	2.2	2.5	0.5
Fe2O3	0.9	0.5	0.2	2.3
Al2O3	3.5	1.4	0.5	2.3

Hasuani et al 2005

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