Utilization of wood ash, sewage sludge and digestate in short rotation bioenergy plantation in Latvia

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Problem description

- Wood ash and digestate could become an important industrial problem as biomass is increasingly used as an energy source, as landfill capacity for wastes becomes limited, and as disposal costs rise.
- The most widely used outputs of wastewater sludge in European countries are agriculture, landfilling and land reclamation.
- In spite of the long history of the problem the demand for new methods to dispose these waste products in a cost-effective and environmentally acceptable manner is still growing.
- According to the EU soil policy guidelines plantation forests is one of the most promising solutions, not only as a source of wood, but also as sewage sludge and wood ash use direction that causes the least impact on the environment, allowing to significantly increase forest productivity and increase energy stock.

Wood ash and sewage sludge production - current situation in Latvia

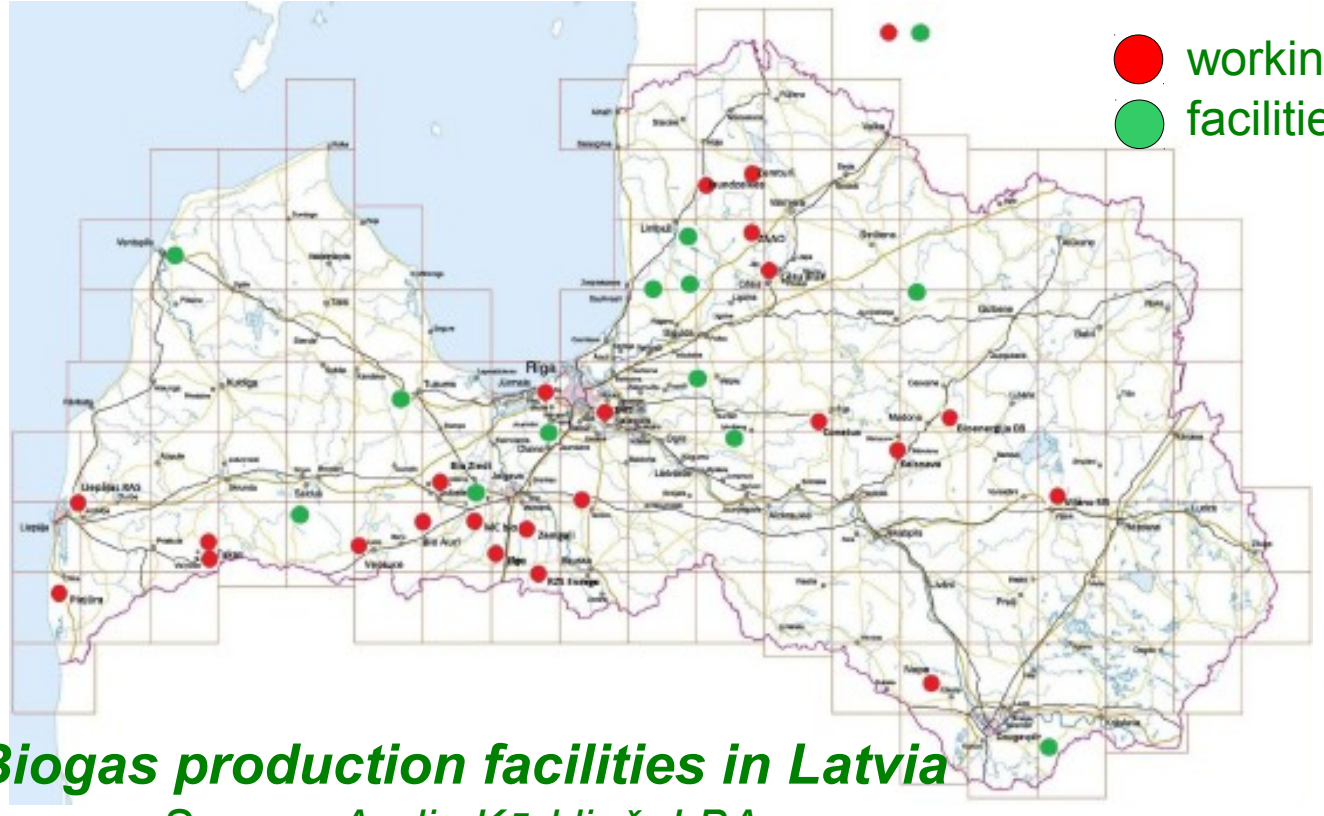
Potential ash amount from households and industry consumers in 2010:	
Fuel type	**Ash amount, t yr^{-1}**
Firewood	113 563
Wood residues	52 455
Pellets	152
SUM	**166 170**

Ash utilization:

- deposited in landfills;
- there is some enthusiasts who try to stabilize and sell ash as a fertilizer;
- no clear recording and information.

- Annual production of dry sewage sludge in Latvia is approximately 23 thousand tons.
- Significant quantities of sewage sludge is used as fertilizer on agricultural land, nurseries, urban green zones (composted) and elsewhere, but most of these are in temporary storage in sludge urban wastewater treatment facilities area.

Digestate – biogas production residual



Biogas production facilities in Latvia

Source: Andis Kārkliņš, LBA

- On average, one biogas facility produces up to 50 000 tonnes digestate per year.
- Chemical content of digestate depends on the chemical composition of used raw materials and technological process.

The aim of the study

The aim of this study is to evaluate possibilities of utilization of waste products (wood ash, wastewater sludge and biogas production residual – digestate) in short rotation bioenergy plantation in Latvia.

The study was conducted within the European Regional Development Fund's project Nr. 2010/0268/2DP/2.1.1.1.0/10/APIA/VIAA/118 “Elaboration of models for establishment and management of multifunctional plantations of short rotation energy crops and deciduous trees”. Project leader: Dr. silv. Dagnija Lazdiņa.

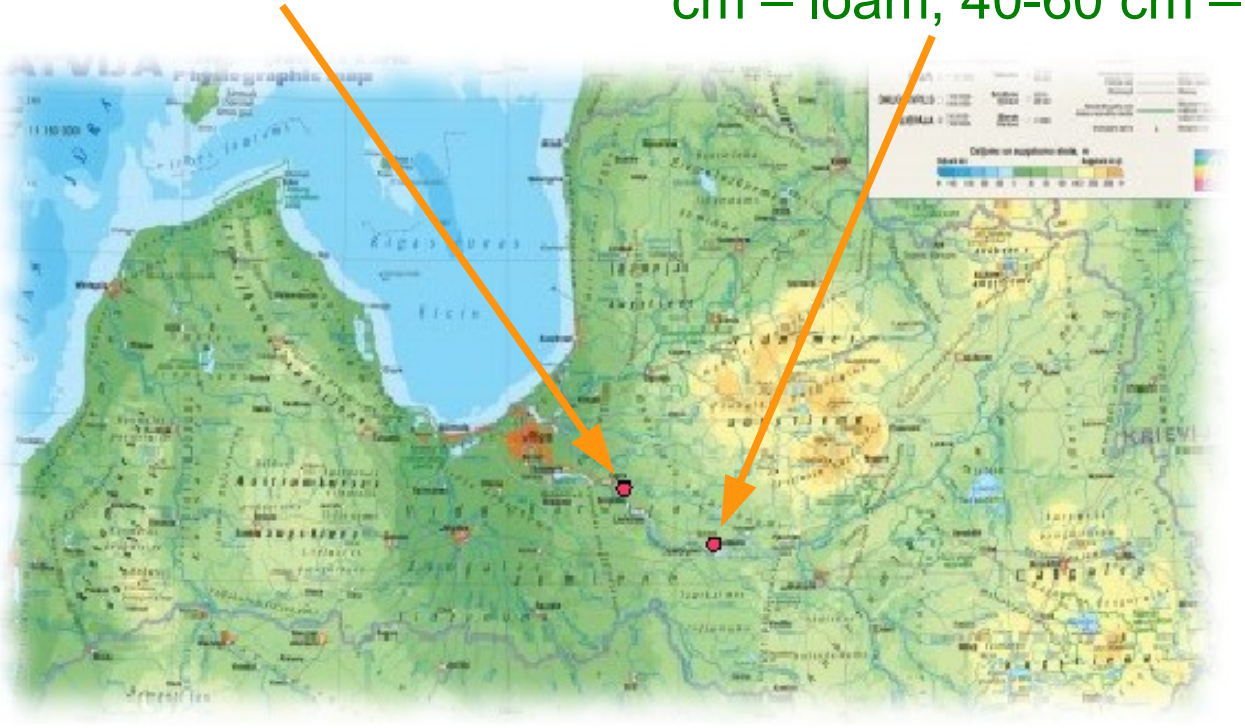
Experimental plots

Rembate

Hybrid aspen (*Populus tremuloides x Populus tremula*) experimental plantation on agriculture land established in 2010. Soil texture: loam.

Skrīveri

Large scale (plot area 16 ha) multifunctional experimental plantations of short rotation energy crops and deciduous trees on agriculture land established in 2011. Soil texture: 0-40 cm – loam; 40-60 cm – sandy loam.



Experimental plot in Rembate

Effect of fertilization on growth of hybrid aspen

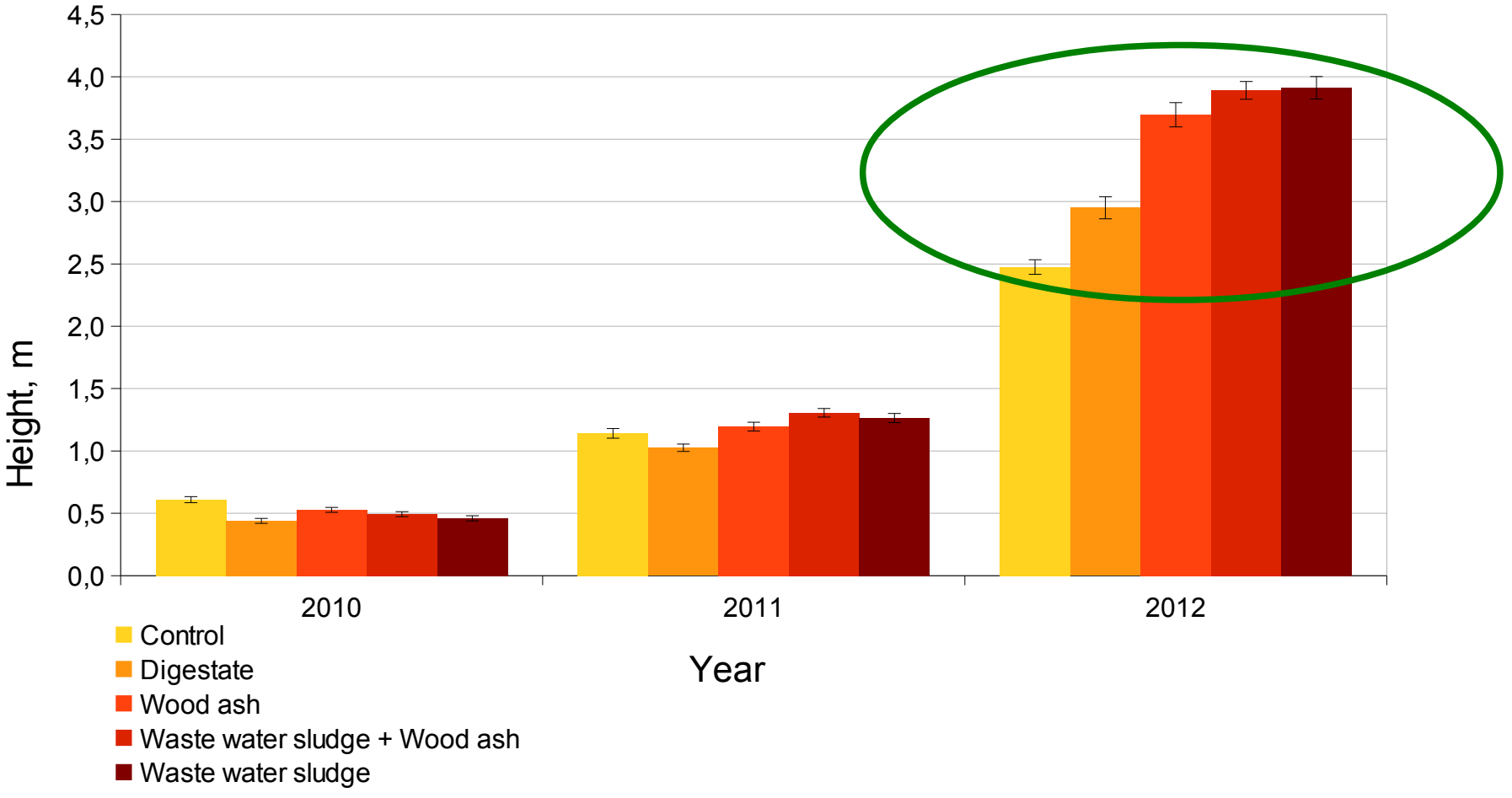
- Clone 4 of hybrid aspen was planted on agriculture land in middle of Latvia in 2010.
- Different waste products were used as fertilizer.
- Each plant of bare root hybrid aspen was planted in pit (depth 10 - 30 cm) with fertilizer.

Fertilizer	Amount of nutrients turned in by fertilizers		
	N, kg ha^{-1}	P, kg ha^{-1}	K, kg ha^{-1}
Wood ash (3 t_{DM} ha^{-1})	0,7	**19,3**	**164,7**
Waste water sludge (10 t_{DM} ha^{-1})	324,8	136,0	19,6
Wood ash (1,5 t_{DM} ha^{-1}) mix with waste water sludge (5 t_{DM} ha^{-1})	**162,8**	77,7	**92,2**
Digestate (25 t ha^{-1})	9,8	**19,0**	70,0
Optimum	***100-200***	***20-40***	***100-200***

Experimental plot in Rembate

Effect of fertilization on growth of hybrid aspen

Comparison of hybrid aspen height in plots were different fertilizers were used



Experimental plot in Rembate

Effect of fertilization on growth of hybrid aspen

Correlations coefficients between soil chemical properties and plant increments after first vegetations season:

Chemical properties	Soil depth				
	0-10 cm	10-20 cm	20-30 cm	30-40 cm	40-60 cm
N(total), g kg^{-1}	**0,73**	0,45	**0,51**	0,14	0,19
$N\text{-}NO_3^-$, mg kg^{-1}	**0,64**	**0,80**	**0,68**	**0,65**	**0,74**
$P\text{-}PO_4^{3-}$, mg kg^{-1}	0,32	0,34	0,31	**0,56**	**0,60**
Exchangeable K mg kg^{-1}	-0,37	-0,17	-0,26	-0,27	-0,28
pH($CaCl_2$)	0,00	0,21	0,08	-0,04	-0,05

Correlations coefficients between soil chemical properties and plant increments after third vegetations season:

Chemical properties	Soil depth				
	0-10 cm	10-20 cm	20-30 cm	30-40 cm	40-60 cm
N(total), g kg^{-1}	**0,78**	**0,50**	**0,55**	0,25	0,25
$N\text{-}NO_3^-$, mg kg^{-1}	**0,65**	**0,63**	**0,55**	**0,55**	**0,69**
$P\text{-}PO_4^{3-}$, mg kg^{-1}	0,36	0,38	0,35	**0,62**	**0,61**
Exchangeable K mg kg^{-1}	-0,40	-0,20	-0,25	-0,23	-0,36
pH($CaCl_2$)	-0,06	0,15	-0,02	-0,14	-0,16

Experimental plot in Skriveri

Effect of fertilization on fast growing deciduous tree species

Fast growing deciduous tree species:

- hybrid aspen;
- poplar clones (AF 2, 6, 7, 8);
- gray alder (excellent local stand);
- silver birch;
- black locust;
- willow clones (selected in Sweden and local material);
- wild cherry tree;
- maple;
- lime.

Experimental plot in Skriveri

Effect of fertilization on fast growing deciduous tree species

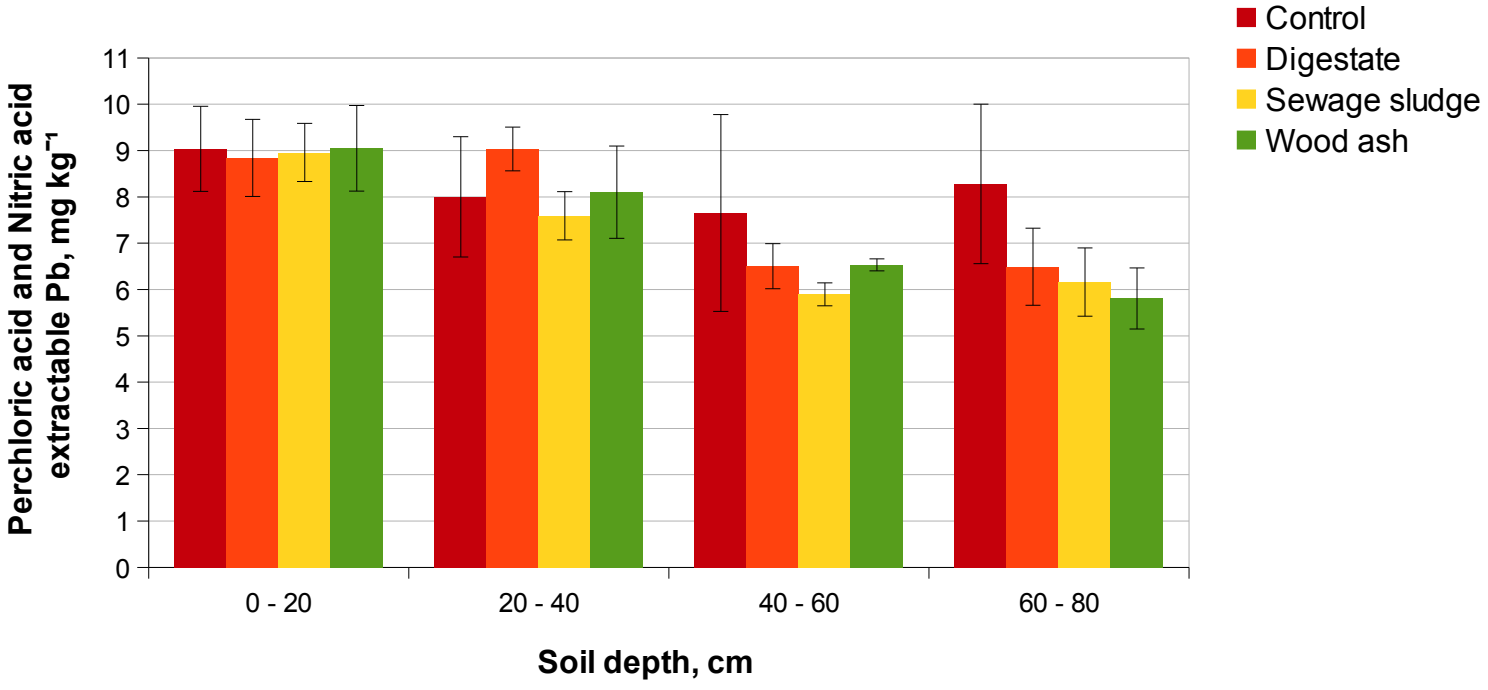
Doses of spreaded fertilisers:

- I class (according to regulations of the Cabinet of Ministers No. 362) sewage sludge (10 t_{DM} ha^{-1}) from “Aizkraukles ūdens”;
- Stabilized wood ash from the boiler house in Sigulda (6 t_{DM} ha^{-1});
- Digestate (30 t ha^{-1}) from the methane reactor in Vecauce district.

Results of effect of fertilization on fast growing deciduous tree height and biomass will follow...

Experimental plot in Skriveri

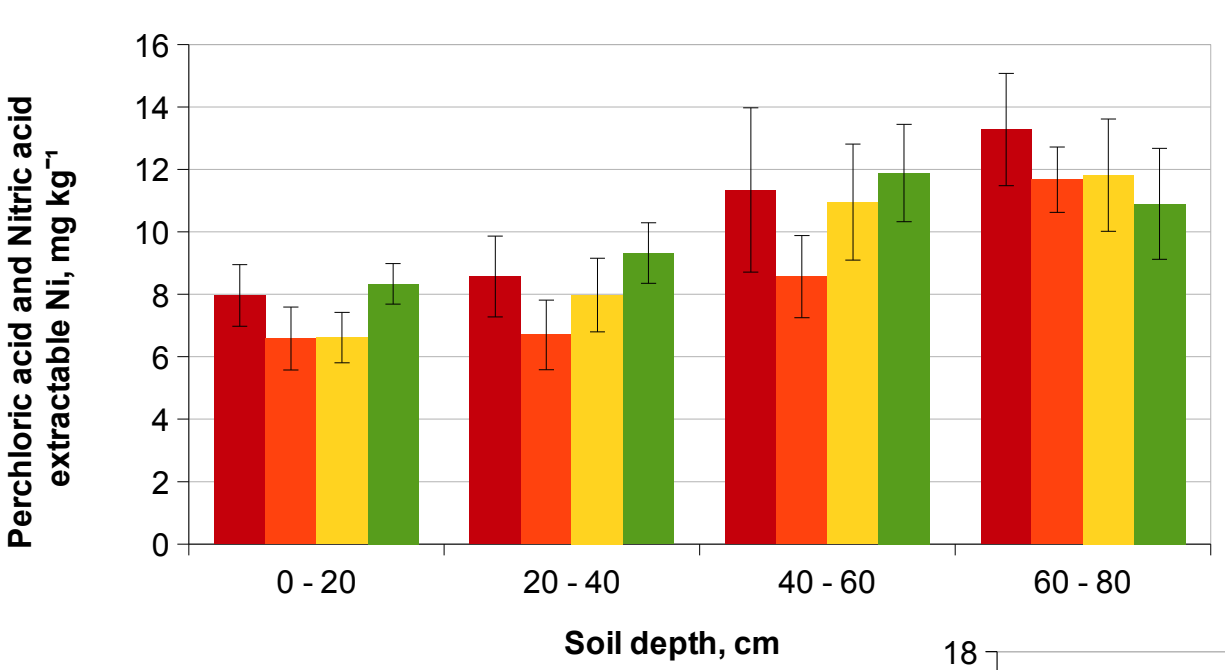
Risk of soil contamination with heavy metals



Lead target value (16 mg Pb kg^{-1} in loam soils and 13 mg Pb kg^{-1} in sandy loam soils) and critical or "toxic" content of Pb (100 - 400 mg kg^{-1}) is not exceeded in investigated soils.

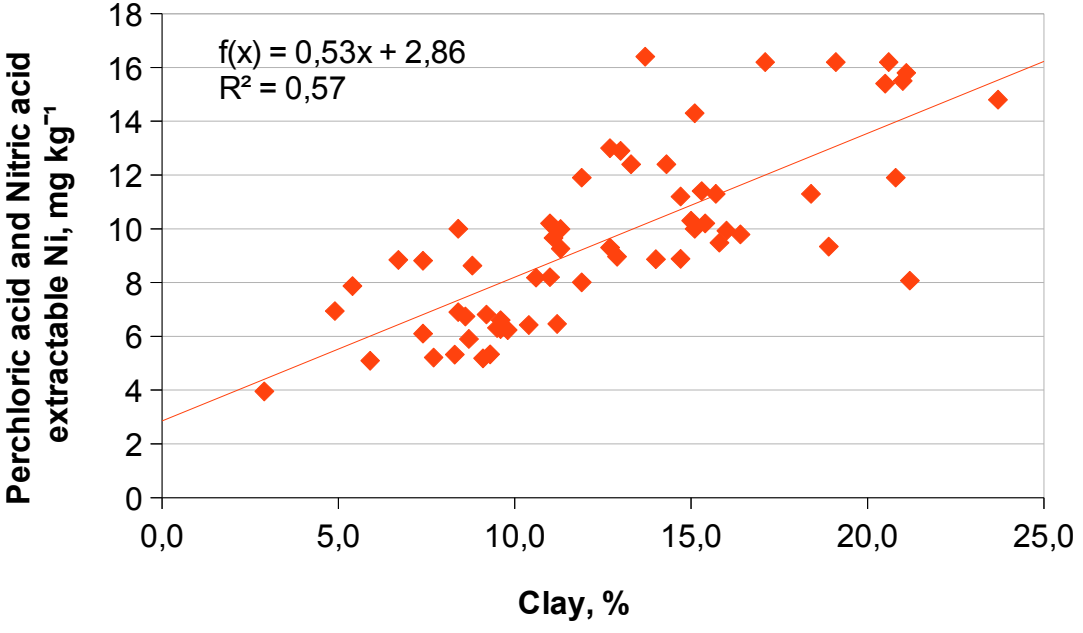
Experimental plot in Skriveri

Risk of soil contamination with heavy metals



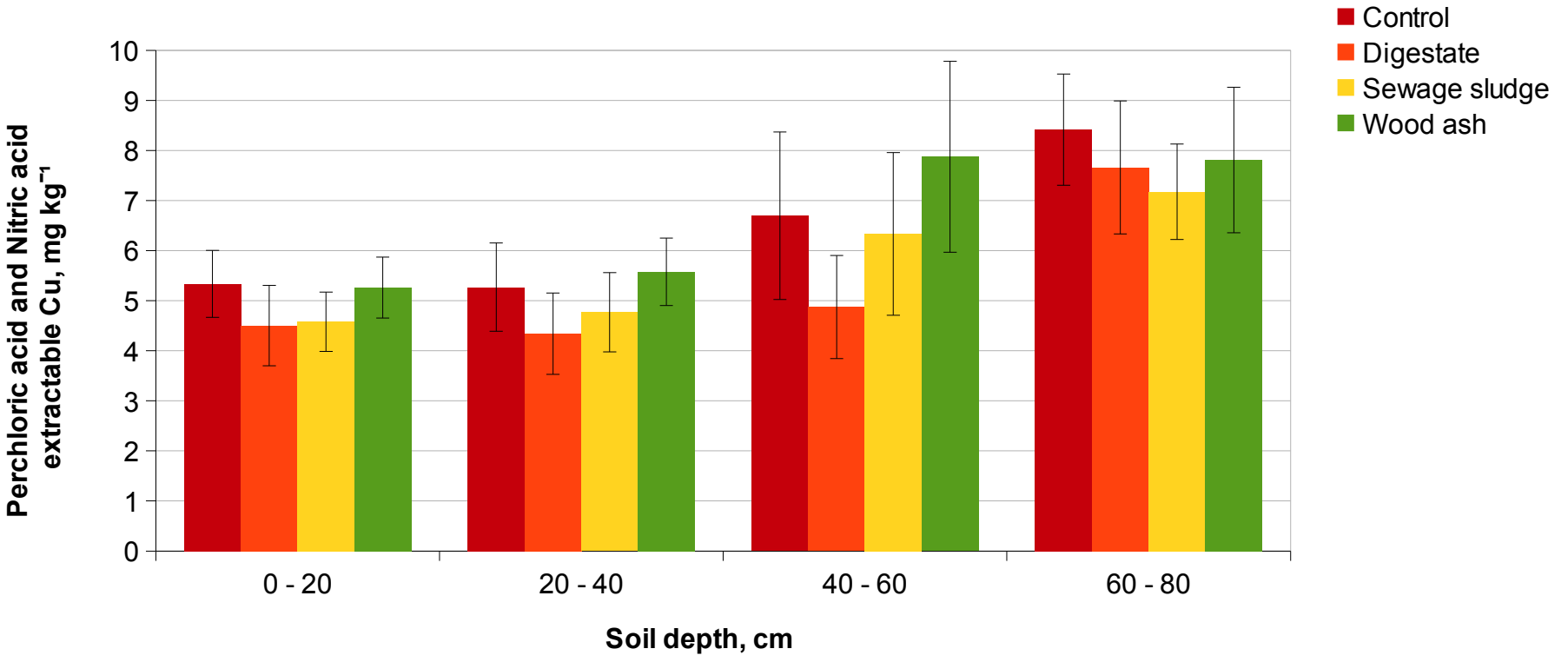
Nickel target value (16 mg kg^{-1}) in loam soils, precautionary limit (75 mg kg^{-1}) in sandy loam soils and critical or "toxic" content of Ni (95 mg kg^{-1}) is not exceeded in investigated soils.

Correlations between Ni content in soil and content of clay particles, coefficient of correlation is 0,76.



Experimental plot in Skriveri

Risk of soil contamination with heavy metals



Copper target value (12 mg kg^{-1}) in loam soils, precautionary limit (40 mg kg^{-1}) in sandy loam soils and critical or "toxic" content of Cu (60 mg kg^{-1}) is not exceeded in investigated soils.

Thank you for your attention!

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