

Environmental impacts of SRC in Europe

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Overview of this presentation

- Short presentation of SLU
- Short description of the current situation for SRC in Sweden
- Aspects of environmental impact of SRC
- SRC and treatment/utilisation of residues
- Environmental impact of such practices

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- **Umeå**
Faculty of Forest Sciences
- **Uppsala**
Faculty of Natural Resources and Agricultural Sciences
- Faculty of Veterinary Medicine and Animal Science
- **Alnarp**
Faculty of Landscape Planning, Horticulture and Agricultural Science

SLU



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SLU facts (2006):

- Staff: 2900
- Annual turnover 256 M Euro
- 292 Professors
- 717 PhD students
- 3450 full-time students

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Dep. of Crop Production Ecology

- Research and teaching for all crops with economical interest in Sweden (food, fodder, energy)
- Section of Energy Crops
 - Mainly *Salix* but also *Populus* and other energy crops
 - Ecological characterisation
 - Stand dynamics
 - Management
 - System analyses
 - Economy
 - Multifunctional environmental uses of *SRF*

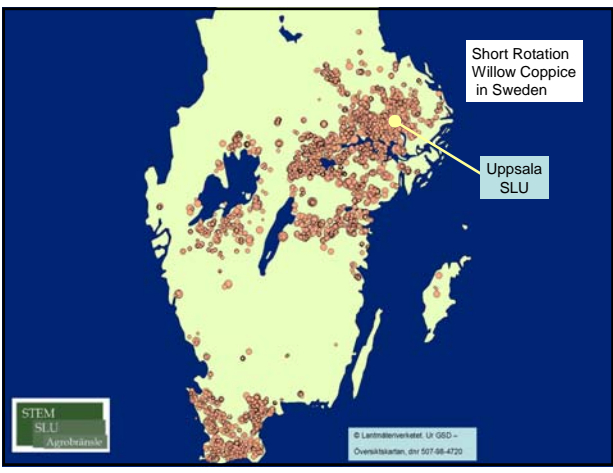
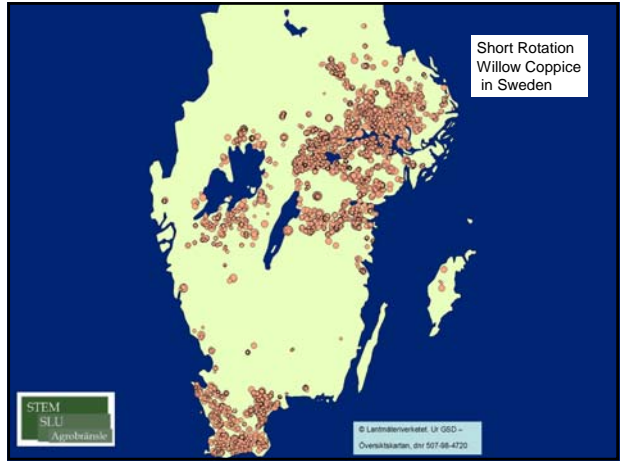
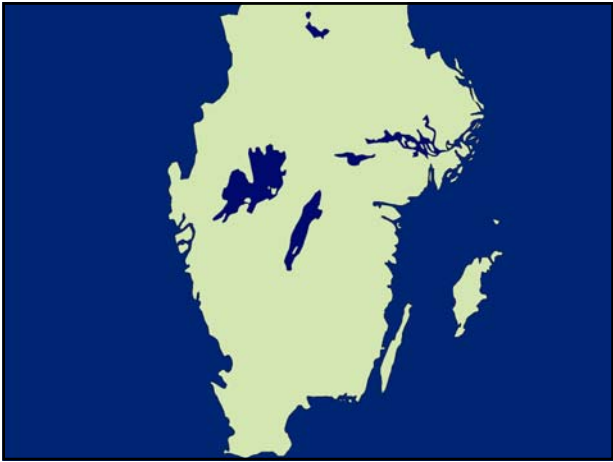
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Short-Rotation Willow Coppice for energy in Sweden

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Short Rotation Coppice in Sweden

- ❑ Ca. 16 000 ha are currently cultivated in Sweden for energy
- ❑ Predictions for rapid increase (Ministry of Agriculture, 2006)
- ❑ Grown on agricultural land
- ❑ Double-row system, fertilisation, weed control
- ❑ Harvested every 3-4 years, life span app. 25 years
- ❑ Average production: 6-10 t DM/ha/yr

Short Rotation Coppice in Sweden

- ❑ SRC cultivated area has remained almost stable during the last 10 years, the predictions have not become true...
- ❑ ...farmers do not usually fertilise and biomass production is therefore lower...
- ❑ ...the current high cereal prices give negative signs for area increase...
- ❑ ...in some cases SRC plantations did not get permission to be established due to landscape issues...

Environmental impact growing SRC plantations related to:

- Landscape

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Environmental impact growing SRC plantations related to:

- Landscape
- Biodiversity

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Photo: Nils-Erik Nordh



Photo: Nils-Erik Nordh



Photo: Nils-Erik Nordh

Environmental impact growing SRC plantations related to:

- Landscape
- Biodiversity
- Management
- Water
- Soil

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Management of SRC

- SRC is an agricultural crop but...
- ...lower input of herbicides and pesticides...
- Fertilisation is needed for high biomass production...
- ...and leaching losses are said to be lower...
- ...but at the moment biomass prices are low and do not compensate for the increased effect of fertilisation...
- ...therefore alternative fertilisation means are used when available

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SRC for treatment and utilisation of municipal and industrial residues in Sweden

- Municipal wastewater
- Landfill leachate
- Log-yard runoff
- Sewage sludge

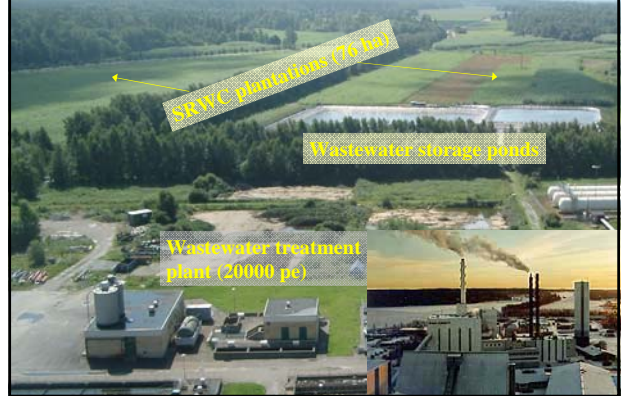
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Wastewater treatment in Enköping



Wastewater treatment in Enköping



Wastewater treatment in Enköping

Wastewater	N-tot (mg/l)	N-NH ₄ (mg/l)	P (mg/l)
Treated water	35	32	0.22
From dewatered sludge after sedimentation	925	639	21
From dewatered sludge after centrifuge	801	475	10.4

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Wastewater treatment in Enköping

- 25% of all N of the WWTP is N-rich wastewater from sludge dewatering
- Irrigation with around 2.5 mm per day for around 120 days on 76-ha SRWC
- Ca 150 kg N/ha yr
- N-rich wastewater is diluted by 75% with conventionally treated wastewater
- 11 t N and 0.2 t P are treated after irrigation with 20 000 m³ N-rich water after sludge dewatering, total irrigation: 200 000 m³

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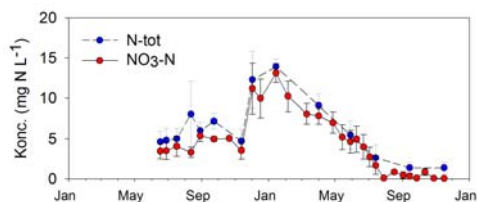
Potential environmental hazards and SLU research activities

- N-leaching to the groundwater
- Toxicity effects on willow plants (lower biomass production)
- Greenhouse gas losses (mainly N₂O) to the atmosphere
- Pathogens in the groundwater

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NO₃-N in the groundwater in Enköping

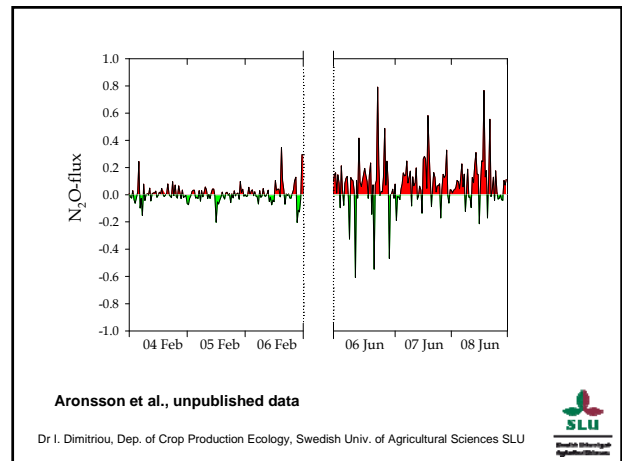
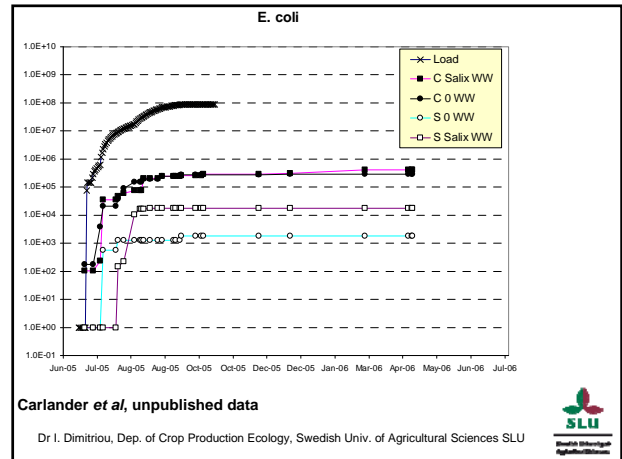
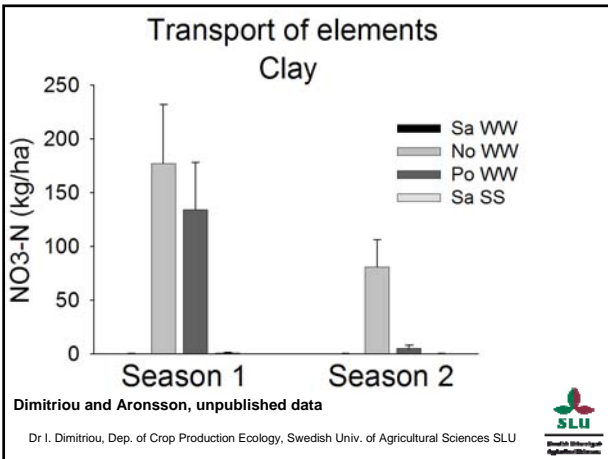
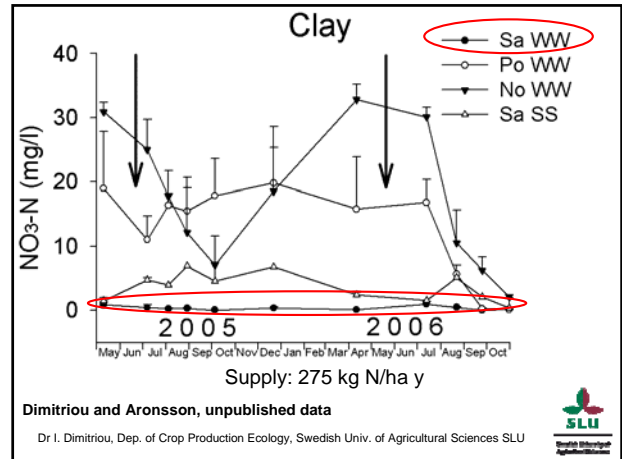


Supply: 150 kg N/ha y

Aronsson *et al*, unpublished data

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Research results

- N-leaching: negligible after the establishment year
- N amounts in groundwater very low due to high evapotranspiration
- N₂O emissions to the atmosphere occur, vary within a year but are low (10 kg ha⁻¹ yr⁻¹, Aronsson, unpublished data)
- Under worst-case conditions, pathogens were present in the groundwater but no pathogens were measured after the end of irrigation

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Photo: Ragnsells Avfallsbehandling AB

Sewage sludge application on SRC

- Today 80% of the total SRC plantations (ca. 10 000 ha) are fertilised after harvest with sludge (mixed with wood-ash where available)
- The cost to the municipalities for sludge spreading on SRC varies from 9-32 Euro/ton (in comparison to 0 – 64 Euro/ton for green areas or ca. 500 SEK/ton for burning or ca. 55 Euro/ton for landfilling (for 2004, Svenskt Vatten)
- 22 or 35 kg P ha⁻¹ yr⁻¹ for a cutting cycle
- Willow is reported to efficiently take up metals, mainly Cd (ca. 10 g/ha/yr)

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Heavy metal regulations for sludge use in agricultural land

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Max. conc. in sludge (mg/kg DM) (1998:944)	2	100	600	2.5	50	100	800
Max. supply (g/ha/yr) (1994:2)	0.75	40	300	1.5	25	25	600
Max. conc. in soil (mg/kg DM)	0.40	60	40	0.3	30	40	100*
Normal conc. in topsoil (mg/kg DM)	0.22	16	15	0.10	9	16	77

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Sludge fertilisation on SRWC: Is it sustainable?

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	Treatments											
	sl+ash		(sl+ash)x2		sl		ash		control			
Harvest interval (yrs)	1	3	1	3	1	3	1	3	1	3	1	3
Cd												
Supply	1.2		2.5		1.2		1.3		7		0	
Potential output	5.6	5.2	8.9	7	8	5.7	6.9	7	6.7	5.2		
Change	-4.4	-4	-6.4	-4.5	-6.8	-4.5	-5.6	-5.7	-6.7	-5.2		
Cu												
Supply	303		606		500		106		0		0	
Potential output	28	14	48	18	34	14	39	14	30	12		
Change	275	289	558	588	466	486	67	92	-30	-12		
Ni												
Supply	18		38		13		25		0		0	
Potential output	12	7	15	6	12	5	11	5	10	6		
Change	6	11	23	32	1	8	14	20	-10	-6		
Zn												
Supply	449		899		569		330		0		0	
Potential output	243	245	359	330	308	284	258	273	240	213		
Change	206	204	540	569	261	285	72	57	-240	-213		

Table. Balance between supply via sludge+ash application and potential output via willow plantation harvest (in g ha⁻¹ yr⁻¹), for the various treatments, if a potential harvest occurred annually or every three years. The potential output with a stem harvest was calculated for a 30:70 bark:wood ratio for year 1 and a 25:75 bark:wood ratio for year 3. Changes indicate potential changes in the soil pool

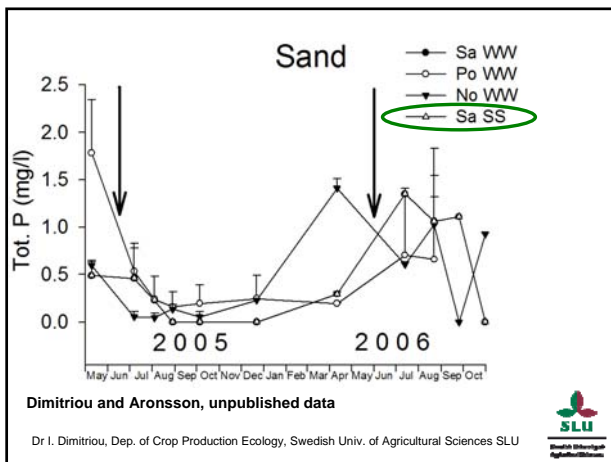
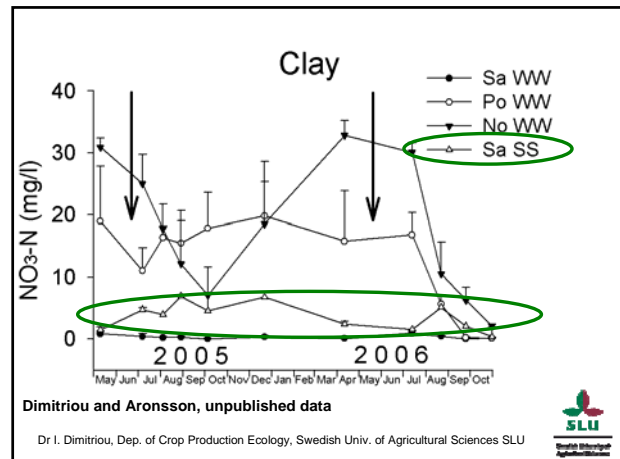
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	Total in 0–15 cm (kg ha ⁻¹)	Change in total metal amounts in soil after 25 years' application of 'sl+ash' (%)		Number of years to double the total amounts in soil after 'sl+ash'	
		no SRWC	with SRWC	no SRWC	with SRWC
Cd	0.36	+8.3	-26	+300	-95
Cr	92.6	+0.81	<+0.81	+3068	>+3068
Cu	59.1	+12.8	+12.2	+195	+204
Ni	53.4	+0.85	+0.51	+2966	+4854
Pb	43.3	+0.92	<+0.92	+2706	>+2706
Zn	225	+5	+3	+501	+833

Total metal amounts in the soil at Lundby, and the calculated increase (%) in the 0–15 cm soil layer after 25 years for 'sl+ash', without or with SRWC cultivation. The last two columns show the number of years required to double the total amounts of metal in the soil, if 'sl+ash' were applied at Lundby, without or with SRWC cultivation, respectively

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- ### Conclusions about environmental impact of SRC
- Landscape and biodiversity issues proved rather subjective, careful planning needed
 - Low input of pesticides and herbicides
 - Negligible leaching even under "worst-case"
 - Certain heavy metals as Cd reduced even after sludge application
 - Pathogens after wastewater in groundwater need to be considered
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