Willow Short Rotation Coppice impact on water and soil quality

Ioannis Dimitriou, Blas Mola, Pär Aronsson

Poplars and Willows on the Prairies - Joint Conference of Poplar Council of Canada, IPC Environmental Applications Working Party and Poplar Council of the United States, Edmonton, Canada, 18-24/9/2011

SRC willow in Sweden

- Ca. 12 500 ha are currently cultivated commercially in Sweden for energy
- Grown on agricultural land
- Double-row system, fertilisation, weed control
- Average production: 6-10 t DM/ha/yr
- Almost 85% of all SRC applied with sludge
- Predictions for increase to 30 000 ha in the near future (Ministry of Agriculture, 2006)

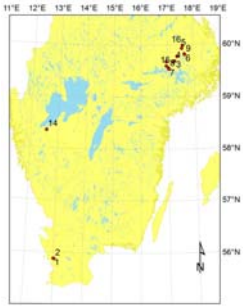
Why is Rating-SRC needed?

- A shift on agricultural land-use to SRC in areas adjacent to "wood-fuel" power stations (small or large) is anticipated…⇒
- Implications (positive and negative) to environmental parameters (soil, water, biodiversity, landscape) in micro- (near the field) and macro- (regional) scale need to be evaluated (further use by decision-makers)
- Environmental advantages of SRC a means for balance to elevated grain prices
- SRC as sustainable energy generation system: recycling of wood-ash and sewage sludge should be considered

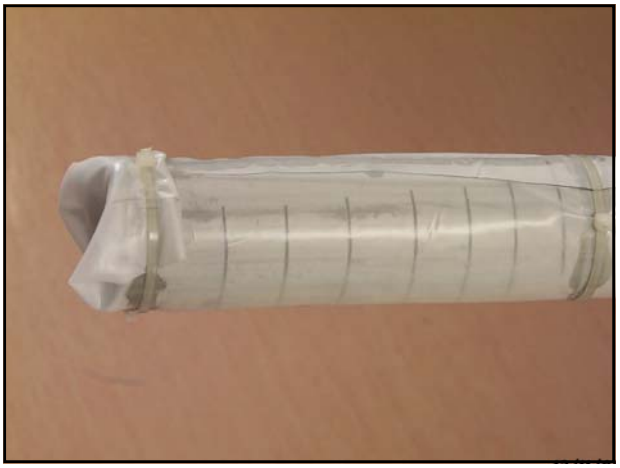
Poplars and Willows on the Prairies - Joint Conference of Poplar Council of Canada, IPC Environmental Applications Working Party and Poplar Council of the United States, Edmonton, Canada, 18-24/9/2011

Central question

- If there will be a **rapid increase** of biomass production for energy in agricultural soils (as projected), what would be the **impact on water and soil quality**?



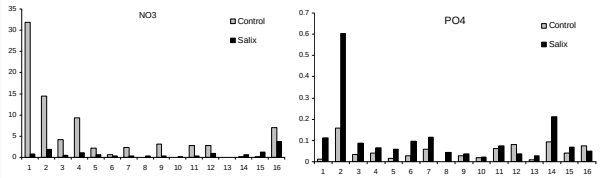
Name	Planted	Clones	Ref. field	Sludge	Ash
French Trial	1994	16 dif. (78021)	winter wheat (eco)	No	No
Kurths trial	1993	Clone mixture	winter wheat (eco)	No	No
Åsby	1996	Tora	winter wheat	Once (first year)	No
Forkarby	1997	78101, 78112	winter wheat	No	No
Sävja	1993	Rapp, Orm	pasture	Yes, 2 times	No
Djurby Gård	1996	78101, 78021	winter wheat, rye	Yes (3 times)	No
Skolsta	1993	78021, Rapp	winter wheat	Yes, once (2004)	Yes
Lundby Gård I	2000*	Tora	winter wheat	Yes	Yes
Lundby Gård II	1996	78021	winter wheat	No	No
Teda I	2000	Tora	pasture	Yes	Yes
Teda II	1993	78112	pasture	Yes (last 2003)	Yes
Hacksta	1994	Jorr, Rapp	pea/barley	Yes (4 times)	Yes
Hjulsta I	1995	Jorr	No ref	Yes	No
Hjulsta II	1995	Jorr	No ref	No	No
Puckgården	1992	78112	winter wheat	Yes	No
Billeberga I	1994	Rapp	winter wheat	Yes	No
Billeberga II	1994	Jorr	winter wheat	Yes	No

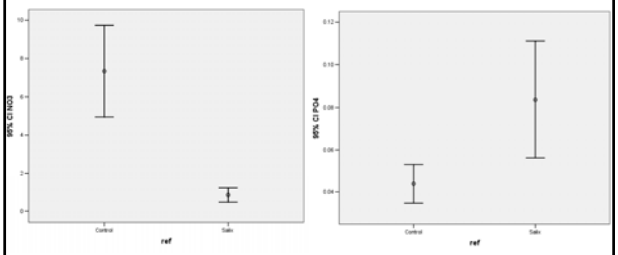


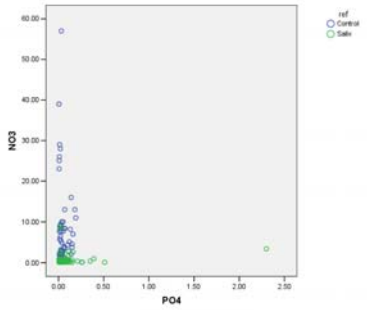
Groundwater pipe depths (m)

		Depth (m)
Franska	1	1.6
	2	1.4
	3	1.46
	4	1.62
Kurths	1	1.57
	2	1.62
Åsby	1	1.28
	2	1.46
	3	1.4
	4	1.23
Forkarby	1	1.4
	2	1.42
Säva	1	1.46
	2	1.48
	3	1.45
Djurby Gård	1	1.4
	2	1.48
	3	1.45
	4	1.45
	5	1.4
	6	1.45

		Depth (m)
Skolsta	1	1.5
	2	1.5
	3	1.42
Lundby Gård	1	1.37
	2	1.47
	3	1.52
	4	1.63
	5	1.45
	6	1.46
	7	1.48
	8	1.38
Teda	1	1.57
	2	1.5
	3	1
Hacksta	1	1.63
	2	1.57
	3	1.5
Hjulsta	1	1.6
	2	1.5
Billeberga I	1	1.37
	2	1.14
Puckgården	1	1.43
	2	1.42
	3	1.42
	4	1.4



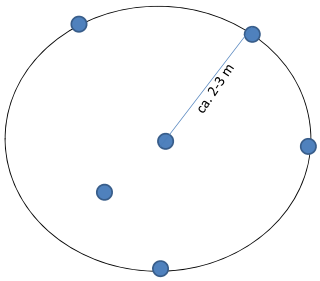




Groundwater quality Salix vs conventional crops

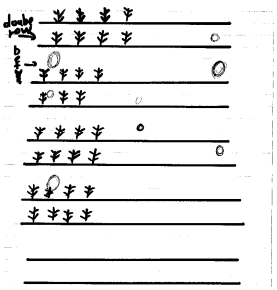
- Lower NO_3-N concentrations in the groundwater from Salix fields (not surprisingly)
- Higher PO_4-P concentrations in the groundwater from Salix fields (surprisingly)

Soil sampling method in reference (0-20 cm - topsoil)



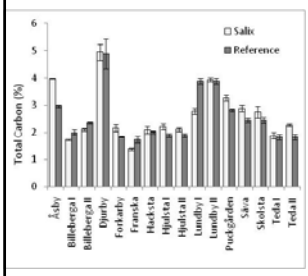
- 6 sub samples merged into 1 sample (becoming e.g. S 1)
- From 40-60 cm (subsoil): 1 sample from each e.g. S 1, S 2, S 3: 3 sub samples merged into 1

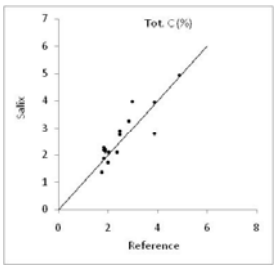
Soil sampling method in Salix (0-20 cm - topsoil)



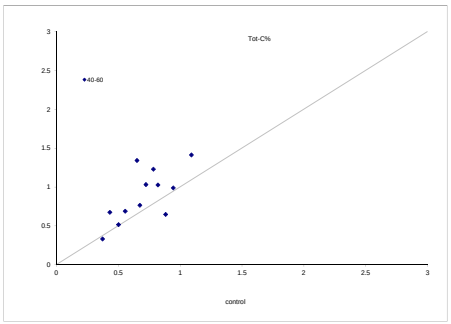
- 6 sub samples merged into 1 sample (becoming e.g. S 1)
- From 40-60 cm (subsoil): 1 sample from each e.g. S 1, S 2, S 3: 3 sub samples merged into 1

Total C in 0-20 cm (%)



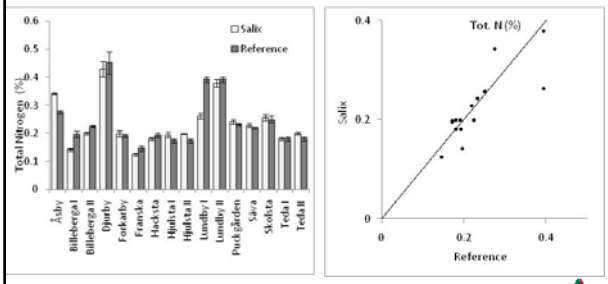


Tot. C in 40-60 cm

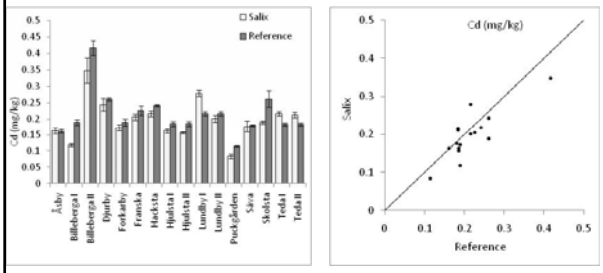


Poplars and Willows on the Prairies - Joint Conference of Poplar Council of Canada, IPC Environmental Applications Working Party and Poplar Council of the United States, Edmonton, Canada, 18-24/9/2011

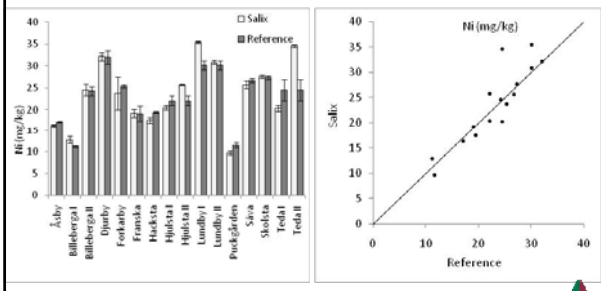
Total N in 0-20 cm (%)



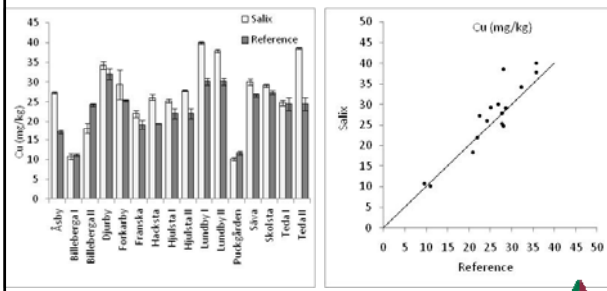
Cd in 0-20 cm (mg/kg)



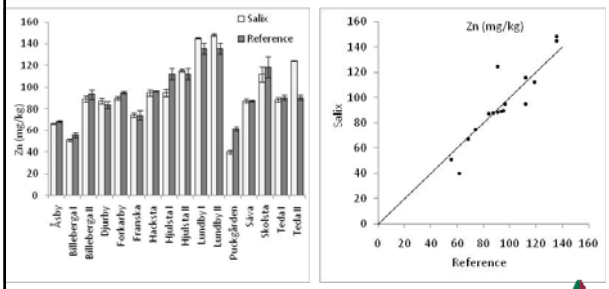
Ni in 0-20 cm (mg/kg)



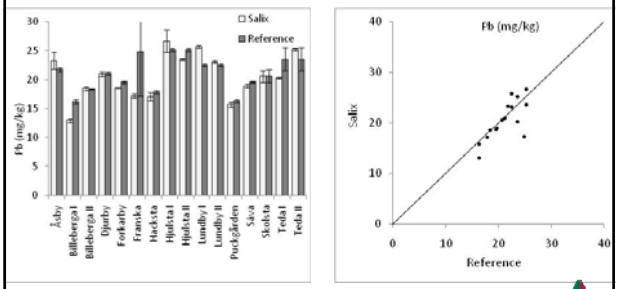
Cu in 0-20 cm (mg/kg)



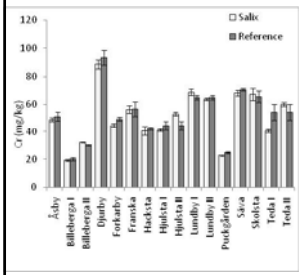
Zn in 0-20 cm (mg/kg)

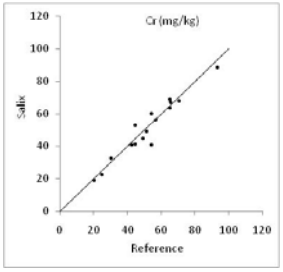


Pb in 0-20 cm (mg/kg)



Cr in 0-20 cm (mg/kg)





Salix vs Reference (0-20 cm)

S/R Top soil (0-20 cm)	Tot-C	Tot-N	pH	Cd	Cr	Cu	Ni	Pb	Zn
Åsby	1.34	1.24	0.91	1.01	0.96	1.21	0.96	1.07	0.98
Billeberga I	0.86	0.72	0.88	0.62	0.95	1.13	1.14	0.80	0.92
Billeberga II	0.89	0.89	1.02	0.84	1.07	0.88	1.01	1.01	0.95
Djurby	1.01	0.95	0.98	0.94	0.95	1.06	1.00	0.99	1.04
Forkarby	1.19	1.04	1.02	0.91	0.91	1.17	0.93	0.95	0.95
Franska	0.79	0.85	1.00	0.91	0.99	1.00	1.01	0.69	1.01
Hacksta	1.04	0.93	0.98	0.90	0.96	1.08	0.90	0.96	0.98
Hjulsta I	1.17	1.12	0.88	0.88	0.92	0.91	0.93	1.06	0.85
Lundby II	1.02	0.96	0.94	0.93	0.98	1.06	1.02	1.03	1.09
Puckgården	1.16	1.04	0.94	0.73	0.92	0.92	0.84	0.97	0.65
Säva	1.17	1.04	1.03	0.98	0.97	1.12	0.96	0.97	1.00
Skolsta	1.12	1.03	0.99	0.72	1.02	1.02	1.01	1.00	0.94
Teda I	1.04	1.00	1.08	1.18	0.75	0.89	0.83	0.86	0.98
Teda II	1.25	1.11	1.02	1.15	1.10	1.37	1.41	1.07	1.37
Average	**1.07**	**0.99**	**0.98**	**0.91**	**0.96**	**1.06**	**1.00**	**0.96**	**0.98**

Salix vs Reference (0-20 cm)

S/R Subsoil (40-60 cm)	Tot-C	Tot-N	pH	Cd	Cr	Cu	Ni	Pb	Zn
Åsby	1.14	1.03	0.95	0.97	0.99	1.02	0.98	1.08	1.05
Billeberga II	1.43	1.29	1.00	0.59	0.81	1.11	0.89	0.86	0.92
Djurby	1.57	1.73	0.97	1.03	1.26	1.12	1.07	1.09	1.04
Forkarby	1.57	1.38	1.03	1.38	1.16	0.99	1.06	0.96	1.00
Franska	2.07	1.53	0.93	1.60	0.86	1.28	0.89	1.11	0.95
Hacksta	0.74	0.62	0.99	0.70	0.79	0.06	0.70	0.07	0.93
Hjulsta I	1.11	1.58	0.98	1.10	1.23	1.17	1.26	1.11	1.11
Lundby II	1.25	1.39	0.97	1.05	0.99	0.97	0.94	1.01	0.96
Puckgården	0.90	0.75	0.98	0.67	1.60	1.25	1.25	1.21	0.86
Säva	1.05	1.01	0.99	0.98	0.97	1.02	0.99	1.04	0.99
Skolsta	1.30	1.28	0.94	0.96	0.93	1.02	0.93	1.03	1.06
Teda I	1.03	1.19	0.94	0.77	0.84	0.80	0.80	0.87	0.89
Average	**1.26**	**1.23**	**0.97**	**0.98**	**1.04**	**1.05**	**0.99**	**1.02**	**0.98**

Soil quality Salix vs conventional crops

- Indications for lower Cd concentrations in the topsoil of Salix (ca. 10% on average on the examined fields – expected, but maybe less pronounced effect)
- Indications for higher tot. C concentrations in the topsoil and especially in the subsoil (expected, but maybe more pronounced effect)

Wastewater treatment in Enköping