THE IMPACT OF WILLOW AND POPLAR SHORT ROTATION CROPS GROWN ON AGRICULTURAL LAND ON WATER AND SOIL QUALITY

Assoc. Prof. Dr. Ioannis Dimitriou
Swedish University of Agricultural Sciences
SLU

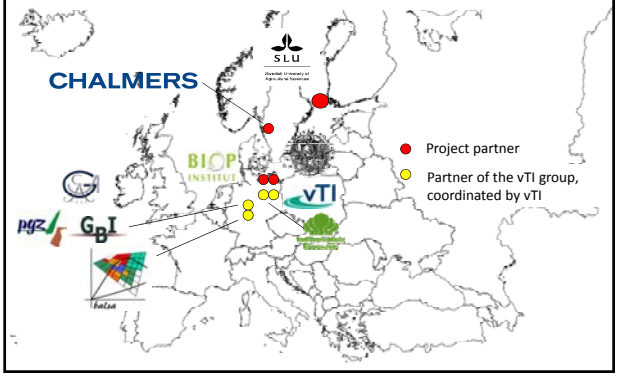
RATING SRC

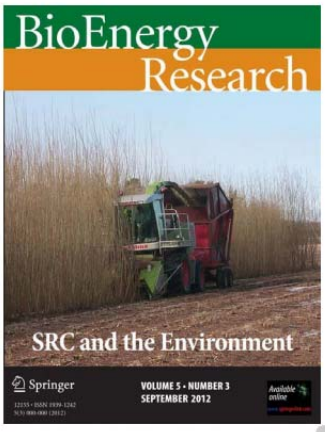
http://www.ratingsrc.eu/

ERA-NET Bioenergy

Swedish Energy Agency

Project consortium





Short Rotation Coppice willow for energy in Sweden

Mechanised planting with approx. 12 000 cuttings/ha

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)

Can the 'value' of SRC improve?

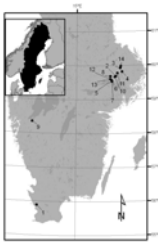
YES!

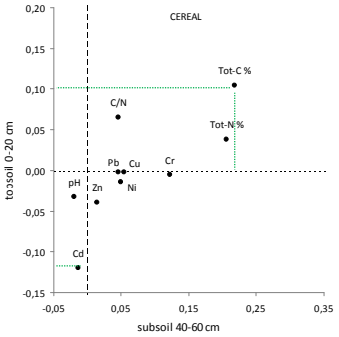
- via environmental services/multifunctionality

Assessment of SRC impact on soil issues

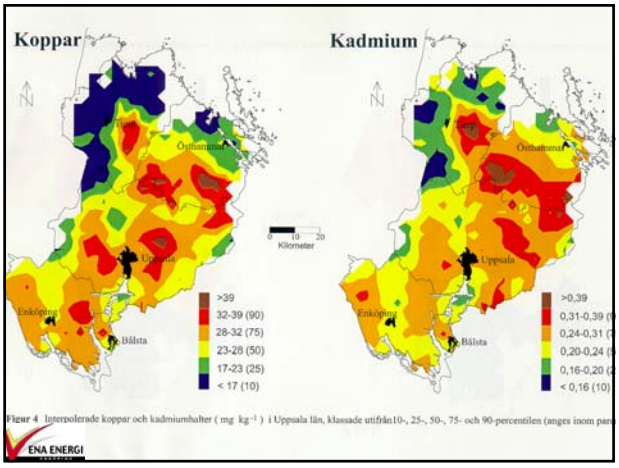
- SRC vs arable fields for tot. C and trace elements
- Soil organic matter quality under SRC

	Site	Year planted	Variety	Reference field crop	Sludge /Ash	Last harvest	Mineral fertilization	Soil texture (0-20 cm)	Biomass 2009	Previous use before SRC
1	Billeberga II	1994	Torhild	Cereals/rape seed	Y/N (3)	Annually	N	loam	2*	Cereals
2	Djurby Gård	1990	78021	Cereals	Y/N (3)	2007/2011 (5)	N	silty clay	5.3	Cereals
3	Forkarby	1991	78021	Cereals	N/N	2008 (5)	Y (2)	silty clay	11	Cereals
4	French Trial	1994	Mixture	Grass	N/N	2007/2010 (5)	Y (8)	clay loam	9.3	Cereals
5	Hacksta	1994	Jorr	Pea/Cereals	Y/Y (4)	2008 (3)	Y (1)	clay loam	4.2	Cereals
6	Hjulsta I	1995	Jorr	Cereals	Y/Y (2)	2008 (3)	N	clay	4.5	Oil crops/cereals
7	Hjulsta II	1995	Jorr	Cereals	N/N	2008 (3)	N	clay	9.6	Oil crops/cereals
8	Lundby Gård II	1995	78021	Cereals	N/N	2005 (2)	N	clay	2.5	Cereals
9	Puckgården	1992	78112	Cereals	N/N	2008 (4)	Y (4)	silty clay	10*	Cereals
10	Skolsta	1993	Orm	Cereals	Y/Y (1)	2004 (2)	Y (2)	silty clay	4	Cereals
11	Säva	1993	Rapp	Grass	Y/N (2)	2007 (3)	N	silty clay	7.4	Cereals
12	Teda I	2000	Tora	Grass	Y/Y (2)	2009 (2)	Y (2)	silty clay loam	8	Cereals
13	Teda II	1993	78112	Grass	Y/Y (2)	2007 (3)	Y (2)	clay	1.7	Cereals/Set-aside
14	Åsby	1996	Tora	Cereals	Y/N (1)	2008 (3)	Y (2)	silty clay	4.2	Cereals





Relative differences between willow SRC plantations versus the reference. The values are the averages for all the locations of the different soil quality parameters investigated in topsoil (0-20 cm) and in subsoil (40-60 cm). Positive values represent higher observations of the studied parameter in the willow SRC plantations, in percentage (Dimitriou et al, Bioenergy Research, 2012).



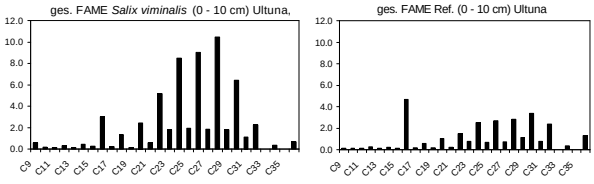
Figur 4. Interpolerade koppar och kadmiumhalter (mg kg^{-1}) i Uppsala län, klassade utifrån10-, 25-, 50-, 75- och 90-percentilen (anges inom par

ENA ENERGI

Effects of SRC on soil organic C stability

(by Dr. C. Baum, Rostock Univ.)

Increased concentrations (µg g^{-1}) of fatty acid methy ester (FAME) in the soil under willows compared to annual arable crops at the test site Ultuna (S) - indication of increased organic matter stability



FAME - fatty acid methyl ester

Summary and conclusions soil organic matter quality
(by Dr. C. Baum, Rostock Univ.)

-increased concentrations of long-chain fatty acids in the organic matter caused by the changed litter quality indicate a higher stability of SOM (lower decomposability) under SRC than under annual arable crops

-higher thermal stability of the alkyl aromatics confirmed this tendency

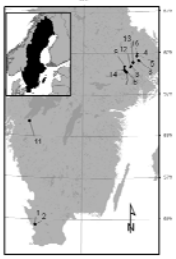
Sustainable increased organic matter concentrations in the soil under SRC can be assumed.

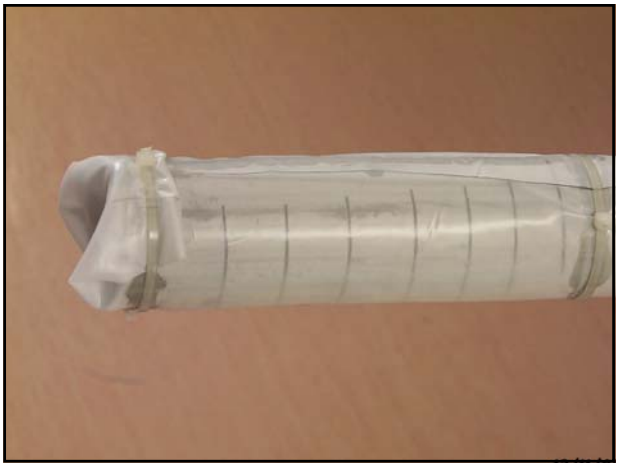
Impact of SRC vs ref on soil

- C storage in soil organic matter is higher under SRC than under conventional agricultural crops
- Soil organic matter stability is higher under SRC than under conventional agricultural crops and supports C sequestration in the soil
- Cd concentrations in the soil under SRC are lower than under conventional agricultural crops (ca. 12% lower in topsoil)

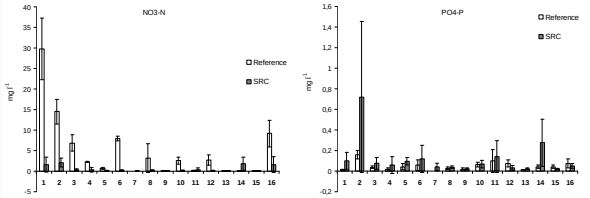
Impact of SRC vs ref on water quality

CODE	Name	Year Planted	Clone	Ref Field	Sludge/ Ash	Harvested	Mineral Fertilization	Soil type (0-20 cm)	Biomass 2009	Previous use
1	Billeberga I	2002	Sven	Cereals	Y/N (1)	2008	N	sandy loam	8.5*	Sugarbeet
2	Billeberga II	1994	Torhild	Cereals/rapeseed	Y/N (3)	Annually	N	loam	2*	Cereals
3	Djurby Gård	1990	78021	Cereals	Y/N (3)	2007/2011	N	silty clay	5.1	Cereals
4	Forkarby	1991	78021	Cereals	N/N	2008	Y (2)	silty clay	11.1	Cereals
5	French	1994	78021	Cereals (eco)	N/N	2007/2010	Y (8)	clay loam	9.3	Cereals
6	Hacksta	1994	Jorr, Rapp	Peas/cereal	Y/Y (4)	2008	Y (1)	clay loam	4.2	Cereals
7	Hjulsta	1995	Jorr	No ref	N/N	2008	N	clay	9.6	Oil crops/cereals
8	Kurth	1992	Ulv/Rapp	Cereals (eco)	N/N	2007/2010	N	clay loam	124	Cereals
9	Lundby Gård I	2000	Tora	Cereals	Y/Y (1)	2005	Y (1)	clay	4.9	Cereals/oil crops
10	Lundby Gård II	1995	78021	Cereals	N/N	2005	N	clay	2.5	Cereals
11	Puckgården	1992	78112	Cereals	N/N	2008	Y (4)	silty clay	10*	Cereals
12	Skolsta	1993	78021, Orm	Cereals	Y/Y (1)	2004	Y (2)	silty clay	4.1	Cereals
13	Sävа	1993	Rapp, Orm	Grass	Y/N (2)	2007	N	silty clay	7.4	Cereals
14	Teda I	2000	Tora	Grass	Y/Y (2)	2009	Y (2)	silty clay loam	8.1	Cereals
15	Teda II	1993	78112	Grass	Y/Y (2)	2007	Y (2)	clay	1.7	Cereals/Set-aside
16	Åsby	1996	Tora	Cereals	Y/Y (1)	2008	Y (2)	silty clay	4.2	Cereals



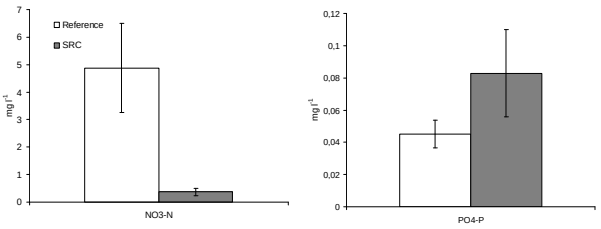


Willow SRC and water



Averages of NO_3-N and PO_4-P concentrations in the groundwater of SRC and reference in each of the different locations throughout the whole experimental period. Numbers correspond to the locations as described in Tab. 1 (Dimitriou et al., Bioenergy Research, 2012).

Willow SRC and water

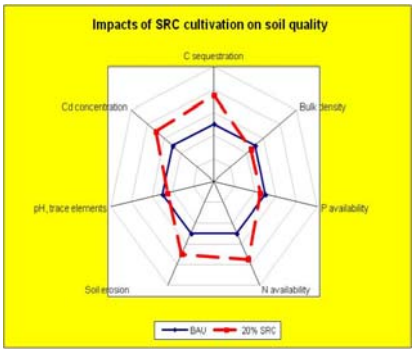


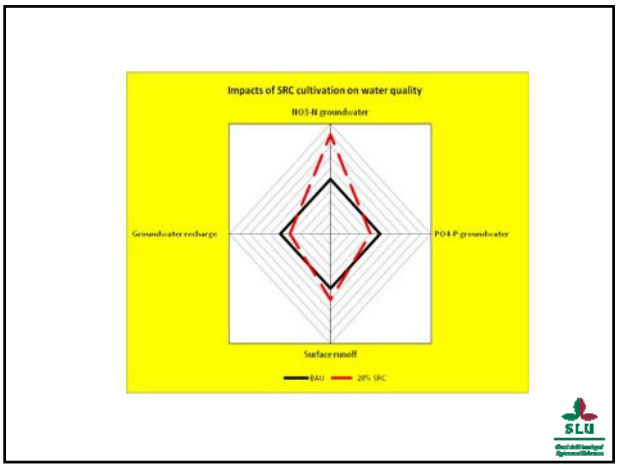
Averages of NO_3-N and PO_4-P concentrations in the groundwater of all fields pooled together for willow SRC and reference fields for the whole experimental period (Dimitriou et al., Bioenergy Research, 2012).

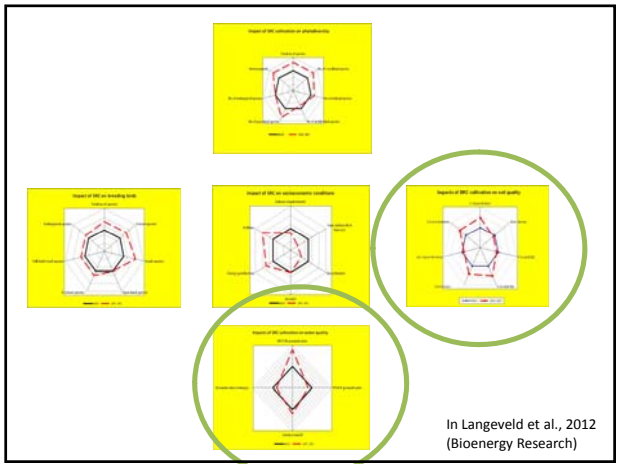
Impact of SRC vs ref on water quality

- Leaching of NO_3-N in the groundwater is substantially lower from SRC
- Leaching of PO_4-P in the groundwater is slightly higher from SRC
- Leaching of PO_4-P in the groundwater was not correlated to sewage sludge applications

To sum up…







In Langeveld et al., 2012
(Bioenergy Research)