

## **SRC economy**

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## **Layout**

- Production costs and profitability
- Risk and risk reduction
- Sludge and wastewater in SRC
- Own calculations (from own farm)

## **Production costs and profitability**

## **Prices of different crops in the coming calculations**

<b>Crop</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
<b>Willow, kr/ton DM</b>	792	858	924	858	836
<b>Reed canary grass, kr/ton DM</b>	747	813	879	906	882
<b>Hemp, kr/ton DM</b>	747	813	879	906	882
<b>Wheat (for bread) kr/ton</b>	1000	1700	1720	1900	1650
<b>Wheat (spring), kr/ton</b>	1400	1800	1900	1950	1700
<b>Barley (fodder), kr/ton</b>	900	1350	1550	1750	1350
<b>Rapeseed, kr/ton</b>	2600	3200	4000	4000	3250

## Yield for the different crops used in the calculations

Crop	Low harvest	Low-middle harvest	Middle-high harvest	High harvest
Willow (fertilised)	4,5	6,0	7,5	9,0
Willow (sludge)	4,5	6,0	7,5	9,0
Willow (cutting cycle)	4,5	6,0	7,5	9,0
Reed canary grass	4,5	5,5	6,8	8,2
Hemp	4,5	5,7	7,0	8,5
Wheat (bread)	4,2	5,5	6,8	8,3
Wheat (spring)	3,5	4,5	5,5	7,0
Barley (feed)	3,0	4,2	5,4	6,9
Rapeseed	1,5	2,3	3,3	4,0

## Costs and income included in the following calculations

- All costs except the costs for land are included, e.g. OH, depreciation, interest rates och own work
- No subsidies are included, except the 5000 t SEK establishment cost subsidy for willow SRC
- Basic Payment Scheme and greening CAP subsidies are not included in the calculations

## Production costs (kr/MWh)

Crop	Low harvest	Low-middle harvest	Middle-high harvest	High harvest
Willow (fertilised)	235	207	190	178
Willow (sludge)	216	192	177	167
Willow (cutting cycle)	173	161	153	148
RCG	279	263	249	239
Hemp	436	390	358	333
Wheat (bread)	447	379	336	304
Wheat	556	467	410	356
Barley (fodder)	645	494	410	346
Rapeseed	716	506	386	338
Straw	161	161	161	161

## Gross margins (kr/ha/yr) in 2011

Crop	Low harvest	Low-middle harvest	Middle-high harvest	High harvest
Willow (fertilised)	-380	145	670	1195
Willow (sludge)	-73	476	1024	1573
Willow (cutting cycle)	634	1230	1825	2421
RCG	-1836	-1920	-2028	-2145
Hemp	-5767	-6018	-6290	-6603
Wheat (bread)	-160	1274	2645	4148
Wheat (spring)	-876	375	1623	3486
Barley (fodder)	-2593	-1323	-59	1513
Rapeseed	-1054	1613	4947	7270

## Gross margins (kr/ha/yr) in 2013

Crop	Low harvest	Low-middle harvest	Middle-high harvest	High harvest
Willow (fertilised)	-731	-362	8	377
Willow (sludge)	-428	-36	356	748
Willow (cutting cycle)	311	727	1143	1559
RCG	-1787	-1832	-1891	-1954
Hemp	-5643	-5863	-6100	-6375
Wheat (bread)	-344	1014	2372	3939
Wheat	-1582	-485	613	2259
Barley (fodder)	-3442	-2362	-1282	68
Rapeseed	-2108	-87	2438	4206

## Cost division in SRC (in SEK)

Willow SRC, production period 22 yr, fertilised only after harvest, new clones

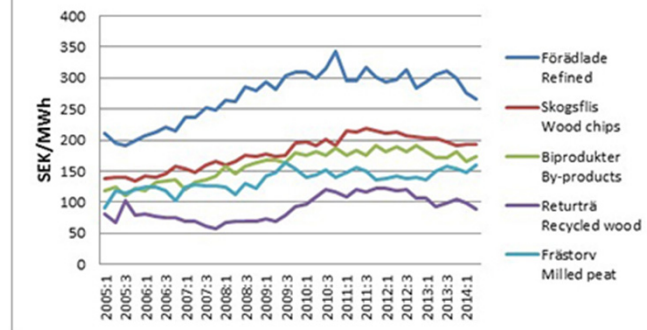
Average harvest (22 yr) = 8,78

Establishment	784	11%
Fertilisation	959	13%
Harvest and field transport	2434	33%
Transport to DHP	1405	19%
Selling costs	351	5%
Termination	91	1%
Management and OH costs	710	10%
Interest rate	674	9%
Sum	7409	100%

## Things that improve profitability

- Engagement in the management/cultivation and selling of chips
- Well-managed crops that result in high yields
- Geographical localisation
- Municipal sludge and/or wastewater
- Collaboration between all parts

## Kvartalspriser för fasta biobränslen, värmeverk



Source: Swedish Energy Administration, 2014

## Price development forest residues

• Yr 2005	137 kr per MWh
• Yr 2006	146 kr per MWh
• Yr 2007	158 kr per MWh
• Yr 2008	167 kr per MWh
• Yr 2009	181 kr per MWh
• Yr 2010	197 kr per MWh
• Yr 2011	214 kr per MWh
• Yr 2012	205 kr per MWh
• Yr 2013	199 kr per MWh
• Yr 2014	194 kr per MWh

## Active farmers are required when selling the harvested chops

- Prices between the offered by middle-man/companies and end users can vary significantly
- Investigations of prices from end users, transportation and harvesters are necessary
- Comparisons of costs when the harvest, transport och selling of wood material is done by one farmer or a farmer cooperative is necessary before deciding!

## SRC can be very appropriate for a farming business when:

- It coincides with the business goals
- Profitability of existing crops is too low
- Parts of the farm have low fertility
- Work inputs are wished to be reduced
- As alternative to lease the land
- Business concepts with energy crops

## Examples of business concepts with energy crops as a base

- Selling heat
- Dry and sell chips
- Briketting av various feedstock
- Take care of sludge or wastewater
- Feed pigs in SRC
- Biogas production

## Fertilisation of willow SRC

Table 6 Number of sites in our fertilization trial where the different fertilization strategies were calculated to be the most profitable at different costs for fertilizer-N, and at different marginal values of the increased yield

Cost for N (Euro kg N <sup>-1</sup> )	Marginal value of increased yield (Euro t DM <sup>-1</sup> )									
	10	20	30	40	50	60	70	80	90	100
0.7	0=4 E=1	E=2 N=2 I=1	E=1 N=2 I=2	E=1 N=1 I=3	E=1 N=1 I=4	N=1 I=4	N=1 I=4	N=1 I=4	N=1 I=4	N=1 I=4
0.9	0=4 E=1	0=3 E=2	E=1 N=2 I=2	E=1 N=2 I=2	E=1 N=1 I=3	N=1 I=4	N=1 I=4	N=1 I=4	N=1 I=4	N=1 I=4
1.1	0=5	0=3 E=2	E=1 N=3 I=1	0=1 N=2 I=2	E=1 N=2 I=2	E=1 N=1 I=3	N=1 I=4	N=1 I=4	N=1 I=4	N=1 I=4
1.3	0=5	0=3 E=2	0=1 E=2 N=2	0=1 N=3 I=1	E=1 N=2 I=2	E=1 N=1 I=2	E=1 N=1 I=3	E=1 N=1 I=3	N=1 I=4	N=1 I=4
1.5	0=5	0=4 E=1	0=3 E=2	0=1 N=3 I=1	E=1 N=2 I=2	E=1 N=2 I=2	E=1 N=1 I=3	E=1 N=1 I=3	N=1 I=4	N=1 I=4

0=no fertilization; E indicates Economy, i.e., a single dose of 160 kg N ha<sup>-1</sup>; N indicates normal fertilization with in total 220 kg N ha<sup>-1</sup> during the cutting cycle; I denotes intensive fertilization with 160 kg N ha<sup>-1</sup> every year. Colours indicate the predominant optimum strategy

Aronsson, P., Rosenqvist, H., Dimitriou, I., 2014. Impact of nitrogen fertilization to short-rotation willow coppice plantations grown in Sweden on yield and economy. *Bioenergy Research*, 7: 993-1001.

## Results from fertilisation trials

- An increase of 59% in yield when new clones were tested (even with low N nitrogen)
- With a netto value for chips of ca 300 kr per t DM it is profitable to fertilise newer clones
- With a netto value for chips of ca 500 kr per t DM it is profitable to fertilise non-bred clones

## Greening of CAP

To top up the Basic Payment Scheme, 3 basic measures are foreseen:

- maintaining permanent grassland
- crop diversification
- maintaining an “ecological focus area” of at least 5% of a farm area which is > 15 ha (excluding permanent grassland) – i.e. field margins, hedges, trees, fallow land, landscape features, biotopes, buffer strips, afforested area (this figure will rise to 7% in 2017)
- ... but SRC factor in Sweden is 0.3... and fields must not be fertilised with inorganic N and not using herbicides

## Sludge and wastewater application

## Gross margins of SRC cultivation

Increased biomass (better sorts/clones; better management; better soils etc)

Price (€/GJ)	Yield level (t DM per hectare)							
	5	6	7	8	9	10	11	12
2	-291	-306	-322	-337	-352	-368	-383	-398
3	-226	-228	-230	-233	-235	-237	-239	-242
4	-161	-150	-139	-128	-117	-107	-96	-85
5	-96	-72	-48	-24	0	24	48	72
6	-30	7	44	81	118	154	191	228
7	35	85	135	185	235	285	335	385

Gross margin of SRC (EUR/ha) for a range of yields and wood chip prices (for Swedish conditions in 2009; 1 MWh = 3.6 GJ, 1 t DM = 15.8 GJ). In: Dimitriou and Rosenqvist (Biomass and Bioenergy, 2011)



## Gross margins of SRC cultivation when sewage sludge is applied

Price (€/GJ)	Yield level (t DM/ha)							
	5	6	7	8	9	10	11	12
2	-263	-276	-288	-301	-313	-326	-338	-351
3	-198	-197	-197	-196	-196	-195	-195	-194
4	-133	-119	-105	-92	-78	-65	-51	-37
5	-67	-41	-14	13	39	66	92	119
6	-2	38	77	117	157	196	236	276
7	63	116	169	221	274	327	380	432

Gross margin of SRC (EUR/ha) for a range of yields and wood chip prices (for Swedish conditions in 2009; 1 MWh = 3.6 GJ, 1 t DM = 15.8 GJ) when sewage sludge is applied. In: Dimitriou and Rosenqvist (Biomass and Bioenergy, 2011)



## Sludge application to SRC

- Receiving sludge in SRC fields increase the economy of SRC
- Compensation varies
- A common increase on farm profitability is ca 500 SEK/ha/yr...
- ...but there are broader margins if you consider the alternative ways to treat sludge in ww treatment plants



## Wastewater application

- 85-90% saving costs for the wastewater treatment plants (per treated kg N)
- Increased biomass production (fertigation) and saving fertilisation costs (ca 15%)





## Gross margins of SRC cultivation when wastewater is applied

Price (€/GJ)	Yield level (t DM/ha)							
	8	9	10	11	12	13	14	15
2	-242	-249	-256	-264	-271	-278	-286	-293
3	-137	-131	-126	-120	-114	-109	-103	-97
4	-33	-14	5	23	42	61	80	98
5	72	103	135	167	199	231	262	294
6	176	221	266	311	355	400	445	490
7	280	338	396	454	512	570	628	686

Gross margin of SRC (EUR/ha) for a range of yields and wood chip prices (for Swedish conditions in 2009; 1 MWh = 3.6 GJ, 1 t DM = 15.8 GJ) when wastewater is irrigated. In: Dimitriou and Rosenqvist (Biomass and Bioenergy, 2011)



## Rosenqvist's own willow SRC field

- Agricultural soil, 110 ha
- Good soil: 85 ha
- Less good soil: 25 ha
- Forest: 80 ha
- Willow SRC: 6 ha
- Willow on the worst part
- Planted 1994
- Older clones with low production
- Not fertilised
- Harvested 3 times
- Last harvest: January 2009

## Harvest in January 2009

- Harvest: 16.4 ton DM after 4 years
- Price per ton DM: 673 kr (150 kr per MWh)
- Income: 10 985 SEK/ha
- Harvest costs: 5 079 SEK/ha
- Transport (65 km): 2 349 SEK/ha
- Loading: 813 SEK/ha
- Netto per ha: 2 745 kr/ha

## Mistakes made

- Too small turning points for the harvest equipment
- Two different clones with different yields
- Too humid at a small part in a small part of the field



**TACK!**

**Kostnader per ton avvattnat slam  
för svenska reningsverk.  
Kostnaderna är exkl. spridning**

Metod	Antal	Genomsnittlig Kostnad, SEK
Anläggningsjord	68	239
Deponi inkl. skatt	12	657
Förbränning	2	559
Jordbruk	14	226
Salix	9	221

**Kostnader avloppsbevattning**

- Investering för bevattning ca 50 000 kr per hektar vid 10 hektars bevattning
- Driftskostnad ca 50 – 60 öre per kubikmeter vatten