

Beyond monetary Cost-Benefit Analyses: Combining Economic, Environmental and Social Analyses of Short Rotation Coppice Poplar Production in Slovakia

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Table S1. Data and costs of poplar SRC Production assumed for the analyses.

<i>Item/Operation</i>	<i>Unit</i>	<i>Value</i>	<i>Year of operation</i>	<i>Data source</i>	<i>Notes</i>
Land Agreement	euros ha ⁻¹	190.00	1 – 20	Average 0 - 100 km Land Calculator project Dendromass4Europe (https://dendromass4europe.eu/calculator/de/) verified by Interview (SRC Manager), April 2021	
Overhead	euros ha ⁻¹	150.00	1 – 20	Average from [1-3] verified by Interview (SRC Manager), April 2021	
Land Pre-Preparation (grass cutting, mulching, heavy disking, ploughing)	euros ha ⁻¹	100.00	1	Average from [1-6] verified by Interview (SRC Manager), April 2021	
Land Final-Preparation (harrowing)	euros ha ⁻¹	40.00	1	Average from [1-6] verified by Interview (SRC Manager), April 2021	
Poplar cuttings	euros c utting ⁻¹	1.00	1	Mean of Max 1, 3, 4 clones from the LignoPlant Webshop: https://www.lignoplant.com	
Transport of cuttings	euros ha ⁻¹	300.00	1	LignoPlant Webshop: https://www.lignoplant.com	
Planting	euros ha ⁻¹	500.00	1	Average from [1-6] verified by Interview (SRC Manager), April 2021	
Maintenance (mechanical weed control)	euros ha ⁻¹	80.00 ^a ; 40.00 ^b	1 – 3; 6 – 8; 11 – 13; 16 – 18	Average from [1-3] verified by Interview (SRC Manager), April 2021	
Fencing	euros ha ⁻¹	20.00	N/A	Average [2] verified by Interview (SRC Manager), April 2021	Operation broken down on an annual average as fencing is only applied on fields required (due to game damage)
Singling/Pruning	euros ha ⁻¹	60.00 ^c ; 40.00 ^d	2; 3; 6; 7; 11; 12; 16; 17	Average verified by Interview (SRC Manager), April 2021	
Full-stem harvesting	euros ha ⁻¹	276.00 ^e ; 331.20 ^f	5; 10; 15; 20	[7]	Price increase for the 2 nd to 4 th harvesting season due to estimated yield increase

Log transport to plant (wood industry)	euros bdt ⁻¹	15.70	5; 10; 15; 20	Average verified by Interview (SRC Manager), April 2021	Average transportation distance of 90 km assumed
Land reconversion	euros ha ⁻¹	1,200.00	20	Average from [1-4]	
EU field subsidies	euros ha ⁻¹	180.00	1 – 20	Interview (SRC Manager), April 2021	Subsidies for agricultural crop production
Poplar timber	euros bdt ⁻¹	86.06	5; 10; 15; 20	UNECE Export unit values, non-coniferous industrial roundwood poplar; SK 2018	Assumed market value

^a in the 1st, 6th, 11th and 16th year; ^b in the 2nd, 3rd, 7th, 8th, 12th, 13th, 17th, 18th year; ^c in the 2nd, 6th, 11th, 16th year; ^d in the 3rd, 7th, 12th, 17th year; ^e in the 5th year; ^f in the 10th, 15th, 20th year;

Table S2. Data and costs of corn maize production assumed for the analyses.

<i>Item/Operation</i>	<i>Unit</i>	<i>Value</i>	<i>Year of operation</i>	<i>Data source</i>	<i>Notes</i>
Land rent	€ ha ⁻¹	50.26	1 – 20	Average rental price agricultural land SK [8]	
Land pre-preparation (deep grubbing)	€ ha ⁻¹	21.41	1 – 20	KTBL Calculator ¹	
Manure spreading	€ ha ⁻¹	47.05	1 – 20	KTBL Calculator ¹	
Land final-preparation (harrowing)	€ ha ⁻¹	22.38	1 – 20	KTBL Calculator ¹	
Fertilizer (Diammon Phosphate, 18 % N, 46 % P₂O₅)	€ ha ⁻¹	33.60	1 – 20	KTBL Calculator	80 kg ha ⁻¹
Fertilizing	€ ha ⁻¹	1.75	1 – 20	KTBL Calculator ¹	
Corn (hybrid seeds)	€ ha ⁻¹	220.00	1 – 20	KTBL Calculator	2 U ha ⁻¹
Precision seeding	€ ha ⁻¹	32.24	1 – 20	KTBL Calculator ¹	
Water	€ ha ⁻¹	1.08	1 – 20	KTBL Calculator	0,6 m ³ ha ⁻¹
Water transport	€ ha ⁻¹	2.33	1 – 20	KTBL Calculator ¹	
Herbicide (Intensity Level 1)	€ ha ⁻¹	82.70	1 – 20	KTBL Calculator	
Herbicide application	€ ha ⁻¹	10.82	1 – 20	KTBL Calculator ¹	
Recording weeds	€ ha ⁻¹	0.54	1 – 20	KTBL Calculator ¹	
Fertilizer (Calcium Ammonium Nitrate, 27 % N)	€ ha ⁻¹	32.20	1 – 20	KTBL Calculator	140 kg ha ⁻¹
Fertilizing	€ ha ⁻¹	2.05	1 – 20	KTBL Calculator ¹	
Harvesting	€ ha ⁻¹	122.91	1 – 20	KTBL Calculator ¹	Combine harvester 300 kW
Corn transport	€ ha ⁻¹	13.89	1 – 20	KTBL Calculator ¹	
Storage and drying	€ ha ⁻¹	216.46	1 – 20	KTBL Calculator ¹	
Fertilizer (Calcium Carbonate)	€ ha ⁻¹	40.70	1 – 20	KTBL Calculator	1 t ha ⁻¹
Calcium Carbonate spreading	€ ha ⁻¹	2.51	1 – 20	KTBL Calculator ¹	
Land recultivation (grubbing)	€ ha ⁻¹	14.77	1 – 20	KTBL Calculator ¹	
Insurance (hail)	€ ha ⁻¹	8.94	1 – 20	KTBL Calculator	1,210.00 € ha ⁻¹
Services	€ ha ⁻¹	1.80	1 – 20	KTBL Calculator ¹	
Labour costs fixed	€ ha ⁻¹	61.82	1 – 20	KTBL Calculator ²	4.6 man-hours ha ⁻¹ ₁
EU field subsidies for agricultural crop production	€ ha ⁻¹	180.00	1 – 20	Interview (SRC Manager), April 2021	
Corn maize	€ t ⁻¹	240.25	1 – 20	Maize stock market prize, November 2021	Assumed market value

¹ price adjusted according to the EUROSTAT 2020 price level indices for consumer goods and services (Germany - Slovakia); ² price adjusted according to OECD Average annual wages (2020), wage difference of 36 % (Germany - Slovakia) [9];

Table S3. Data and costs of winter rye production assumed for the analyses.

<i>Item/Operation</i>	<i>Unit</i>	<i>Value</i>	<i>Year of operation</i>	<i>Data source</i>	<i>Notes</i>
Land rent	€ ha ⁻¹	50.26	1 – 20	Average rental price agricultural land SK [8]	
Land pre-preparation (deep grubbing)	€ ha ⁻¹	21.41	1 – 20	KTBL Calculator ¹	
Phosphorus Potassium fertilizer (Diammon Phosphate, 18 % P ₂ O ₅ , 10 % K ₂ O)	€ ha ⁻¹	44.00	1 – 20	KTBL Calculator	220 kg ha ⁻¹
Fertilizing	€ ha ⁻¹	2.59	1 – 20	KTBL Calculator ¹	
Winter Rye Z-seeds	€ ha ⁻¹	63.60	1 – 20	KTBL Calculator	120 kg ha ⁻¹
Transport of seeds	€ ha ⁻¹	1.37	1 – 20	KTBL Calculator ¹	
Sowing	€ ha ⁻¹	31.17	1 – 20	KTBL Calculator ¹	Rotary Harrows and Precision Seeder
Recording weeds	€ ha ⁻¹	0.54	1 – 20	KTBL Calculator ¹	
Water	€ ha ⁻¹	1.08	1 – 20	KTBL Calculator	0,6 m ³ ha ⁻¹
Water transport	€ ha ⁻¹	2.33	1 – 20	KTBL Calculator ¹	
Herbicide (Intensity Level 1)	€ ha ⁻¹	42.60	1 – 20	KTBL Calculator	
Growth Regulator (Intensity Level 1)	€ ha ⁻¹	11.90	1 – 20	KTBL Calculator	
Herbicide application	€ ha ⁻¹	5.41	1 – 20	KTBL Calculator ¹	
Fertilizer (Calcium Ammonium Nitrate, 27 % N)	€ ha ⁻¹	50.60	1 – 20	KTBL Calculator	220 kg ha ⁻¹
Fertilizing	€ ha ⁻¹	3.80	1 – 20	KTBL Calculator ¹	
Fungicide (Intensity Level 1)	€ ha ⁻¹	36.50	1 – 20	KTBL Calculator	
Fungicide application	€ ha ⁻¹	5.41	1 – 20	KTBL Calculator	
Harvesting	€ ha ⁻¹	83.44	1 – 20	KTBL Calculator ¹	Combine harvester 300 kW
Corn transport	€ ha ⁻¹	6.37	1 – 20	KTBL Calculator ¹	
Storage and drying	€ ha ⁻¹	47.94	1 – 20	KTBL Calculator ¹	
Fertilizer (Calcium Carbonate)	€ ha ⁻¹	40.70	1 – 20	KTBL Calculator	1 t ha ⁻¹
Calcium Carbonate spreading	€ ha ⁻¹	2.95	1 – 20	KTBL Calculator ¹	
Land recultivation (grubbing, flat)	€ ha ⁻¹	14.77	1 – 20	KTBL Calculator ¹	
Land recultivation (grubbing, deep)	€ ha ⁻¹	15.86	1 – 20	KTBL Calculator ¹	
Insurance (hail)	€ ha ⁻¹	4.52	1 – 20	KTBL Calculator	550.00 € ha ⁻¹
Services	€ ha ⁻¹	0.98	1 – 20	KTBL Calculator ¹	
Labor costs fixed	€ ha ⁻¹	26.88	1 – 20	KTBL Calculator ²	2.0 man hours ha ⁻¹
EU field subsidies for agricultural crop production	€ ha ⁻¹	180.00	1 – 20	Interview (SRC Manager), April 2021	
Winter rye	€ t ⁻¹	293.75	1 – 20	Wheat stock market prize, November 2021	Assumed market value

¹ price adjusted according to the EUROSTAT 2020 price level indices for consumer goods and services (Germany - Slovakia); ² price adjusted according to OECD Average annual wages (2020), wage difference of 36 % (Germany - Slovakia) [9];

Table S4. Climate data used for Carbon turnover model (Source: Experimental data).

Date	Average Mean Temperature (°C)	Average Mean Precipitation (mm)	Average Mean ETP Penman-Monteith (mm)
May 18	20.400	1.000	4.107
June 18	20.070	1.073	4.039
July 18	20.955	1.239	4.002
Aug. 18	22.610	1.058	3.751
Sep. 18	16.037	3.567	2.024
Oct. 18	12.042	0.406	0.924
Nov. 18	9.020	0.473	0.341
Dec. 18	1.340	1.213	0.090
Jan. 19	0.171	1.516	0.437
Feb. 19	2.432	0.636	0.367
Mar. 19	7.174	0.761	0.973
Apr. 19	11.483	0.793	2.307
May 19	12.229	4.168	2.298
June 19	22.023	1.067	4.568
July 19	20.361	1.129	3.787
Aug. 19	21.174	1.697	3.250
Sep. 19	15.020	1.727	1.834
Oct. 19	10.868	0.929	0.688
Nov. 19	8.773	1.480	0.330
Dec. 19	2.529	1.652	0.165
Jan. 20	1.145	0.613	0.273
Feb. 20	5.590	1.000	0.849
Mar. 20	5.858	0.761	1.392
Apr. 20	10.380	0.260	2.888
May. 20	12.948	1.968	3.292
June 20	18.167	3.160	3.277
July 20	19.684	0.368	3.781
Aug. 20	20.661	0.039	3.071
Sep. 20	15.617	1.880	1.841
Oct. 20	10.865	4.052	0.666
Nov. 20	5.957	0.620	0.378
Dec. 20	3.606	1.084	0.384

Table S5. Share of total discounted costs of poplar SRC production system.

Item/Operation	Discounted Costs (euros ha ⁻¹)	Share
Poplar Rods	1,667	16.59 %
Transportation of Poplar Rods	440	4.38 %
Land Agreement	2,582	25.70 %
Overhead	2,039	20.29 %
Land Pre-Preparation	96	0.96 %
Land Final-Preparation	38	0.38 %
Planting	481	4.79 %
Maintenance	456	4.54 %
Fencing	272	2.71 %
Singling/Pruning	285	2.84 %
Full-stem harvesting	786	7.82 %
Log transport to plant	358	3.56 %
Land reconversion	548	5.45 %
Total	10,048	100 %

Table S6. Share of total discounted costs of corn maize production system.

Item/Operation	Discounted Costs (euros ha ⁻¹)	Share
Land Rent	683	4.81 %
Land Pre-Preparation	291	2.05 %
Manure Spreading	639	4.50 %
Land Final-Preparation	304	2.14 %
Fertilizer (Diammon Phosphate 18 % N, 46 % P ₂ O ₅)	457	3.22 %
Fertilizing	24	0.17 %
Corn (Hybrid Seeds)	2,990	21.07 %
Precision Seeding	438	3.09 %
Water	15	0.11 %
Water-Transport	32	0.23 %
Herbicide (Intensity Level 1)	1,124	7.92 %
Herbicide Application	147	1.04 %
Recording Weeds	7	0.05 %
Fertilizer (Calcium Ammonium Nitrate 27 % N)	438	3.09 %
Fertilizing	28	0.20 %
Harvesting	1,670	11.77 %
Transport of corn	189	1.33 %
Storage/Drying	2,942	20.73 %
Fertilizer (Calcium Carbonate)	553	3.90 %
Calcium Carbonate Spreading	34	0.24 %
Land Recultivation (grubbing)	201	1.42 %
Insurance (hail)	121	0.85 %
Services	24	0.17 %
Labor costs fix	840	5.92 %
Total	14,191	100 %

Table S7. Share of total discounted costs of winter rye production system.

Item/Operation	Discounted Costs (euros ha ⁻¹)	Share
Land Rent	683	8.09 %
Land Pre-Preparation	291	3.45 %
Fertilizer (Diammon Phosphate 18 % P ₂ O ₅ , 10 % K ₂ O)	598	7.08 %
Fertilizing	35	0.41 %
Winter Rye Z-Seeds	864	10.23 %
Transport of Seeds	19	0.23 %
Sowing (Rotary Harrows and Precision Seeder)	424	5.02 %
Recording Weeds	7	0.08 %
Water	15	0.18 %
Water Transport	32	0.38 %
Herbicide (Intensity Level 1)	741	8.78 %
Growth Regulator (Intensity Level 1)	74	0.88 %
Herbicide Application	688	8.15 %
Fertilizer (Calcium Ammonium Nitrate 27 % N)	28	0.33 %
Fertilizing	52	0.62 %
Fungicide (Intensity Level 1)	496	5.88 %
Fungicide Application	74	0.88 %
Harvesting	1,134	13.43 %
Corn Transport	87	1.03 %

Storage and Drying	651	7.71 %
Fertilizer (Calcium Carbonate)	553	6.55 %
Calcium Carbonate Spreading	40	0.47 %
Land Recultivation (grubbing, flat)	201	2.38 %
Land Recultivation (grubbing, deep)	216	2.56 %
Insurance (hail)	61	0.72 %
Services	13	0.15 %
Labor costs fix	365	4.32 %
Total	8,442	100 %

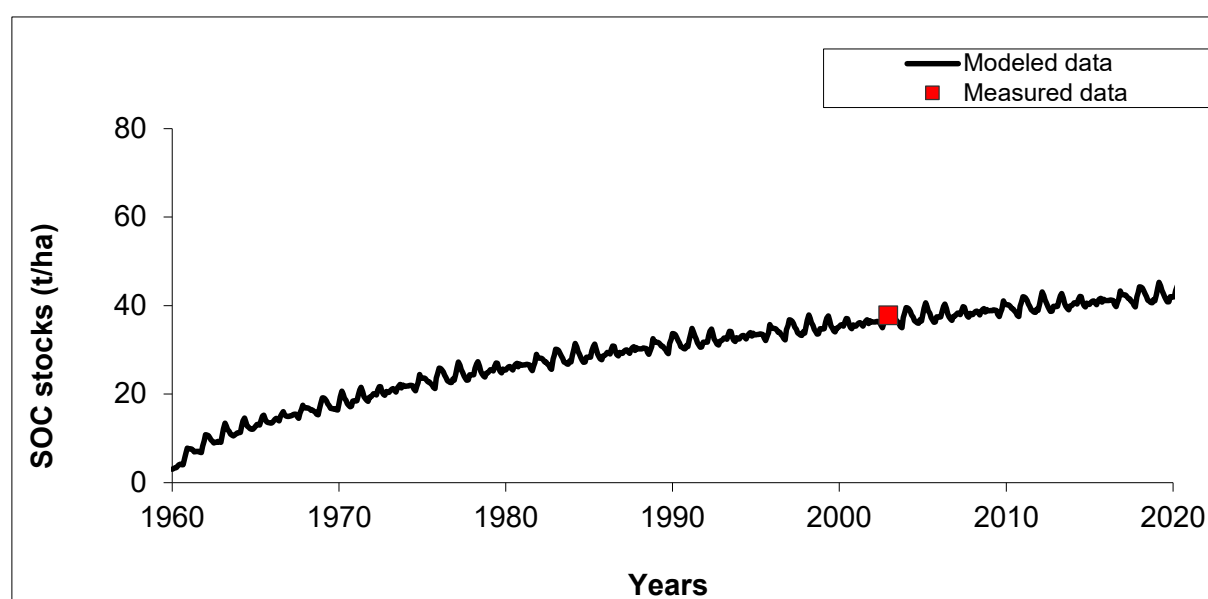


Figure S1. Calibration of RothC model for poplar SRC in Western Slovakia.

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