EcoWillow v1.2 (Beta) – An Economic Analysis Tool for Willow Short-Rotation Coppice for Wood Chip Production

Short Rotation Woody Crops (SRWC) are being developed as a sustainable source of biomass for the production of bioenergy, biofuels and bioproducts. SRWC are fast-growing, hardwood species with the ability to regrow after each harvest (coppice). Shrub willow is an emerging SRWC for North America that has been studied for more than then 20 years at the State University of New York College of Environmental Science and Forestry (SUNY-ESF) and over 30 years in Europe. The shrub willow cropping system that has been developed involves establishing willow on marginal soils and growing it with low labor, machinery, fertilizer, or herbicide input relative to traditional agricultural crops. After the establishment year, the willow is cutback near the ground to promote sprouting and then harvested during the dormant season every 3-4 years. After each harvest the willow resprouts and produces a new crop for at least seven harvest cycles.

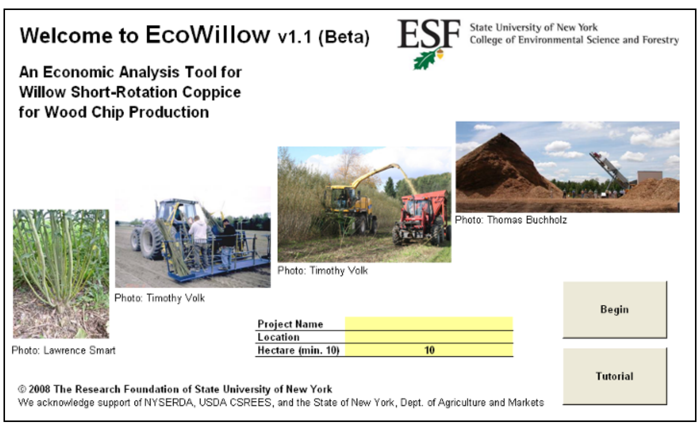


Figure 1: Welcome Sheet of the EcoWillow v 1.0 (Beta) economic model.

The use of shrub willow crops can also provide an array of environmental benefits such as improved soil and water quality, reduced CO_2 emissions, and enhanced biodiversity. The economic performance of SRWC is a key to their widespread deployment. In order to facilitate assessments of the economic potential of shrub willow crops, SUNY-ESF has developed the EcoWillow v1.2 (Beta) budget model.

Users, model structure, and scope

EcoWillow v1.2 (Beta) can be downloaded free-of-charge from the internet (www.esf.edu/willow) and should be useful for farmers, land owners, agricultural extension workers, or project developers. The model allows users to calculate how yield, management options, and a variety of cost factors influence the cash flow and internal rate of return of willow biomass crops.

The budget model is designed based on experience establishing and maintaining over 500 acres of willow biomass crops in Upstate New York. The model is flexible enough so it can be applied across the range of sites where shrub willow might be grown. EcoWillow v1.2 (Beta) allows the user to vary input variables and to calculate cash flow and profits throughout the entire production chain from site preparation and crop establishment to the delivery of wood chips to an end user. EcoWillow v1.2 (Beta) runs in Microsoft Excel 2003 and consists of a tutorial sheet explaining the use of the model and nine other worksheets including a Welcome sheet, Input/Output sheet, four sheets with output graphs, and three sheets with submodels on planting, harvesting, and transportation costs.

Welcome and Input/Output sheet

The *Welcome Sheet* (Fig. 1) allows the user to name the project being assessed and specify the total acreage planned for willow cultivation and provides links to the Tutorial and Input/Output Sheets.

The *Input/Output Sheet* is the core of the model and asks for general inputs such as rotation length, expected biomass yields, costs for land rent, insurance, crop establishment, subsidies (establishment grants and yearly incentive payments), as well as costs for maintenance including administration, pest control, and fertilization. The model provides for different loan schemes for startup capital. Output numbers for the financial analysis include Internal Rate of Return (IRR), Net Present Value (NPV) both calculated for the own capital only, as well as total startup costs. Results are given for crop lifetimes of 13 and 22 years. The Input/Output Sheet provides values on production costs, revenues, earnings, and profits on a 'per ton' and 'per acre' basis, as well as total interest paid. The projected cash flow for the crop is bracketed by estimating NPV for a best-case (revenues increased by 10%, costs decreased by 10%) and a worst-case scenario (revenues decreased by 10%, costs increased by 10%).

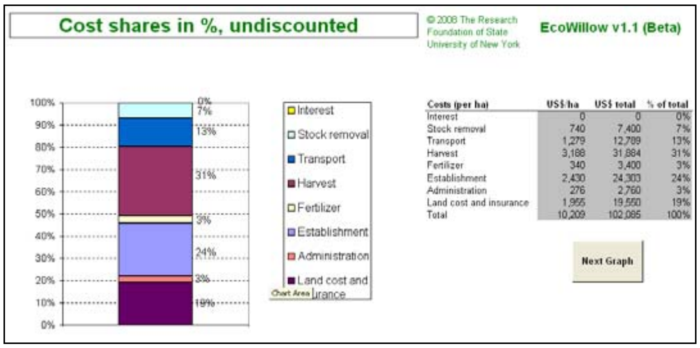
Output Graphs

The *Cash Flow Diagram Sheet* shows the cash flow over the total project lifetime of 22 years on a per acre basis and for the total land area in the project. The values inserted into the Input/Output Sheet, and the Planting, Harvest, and Transport sheets feed into this cash flow diagram.

The *Cost Distribution Sheet* summarizes visually and numerically how costs are allocated to different parts of the willow production system (Figure 2). The cost categories include establishment, harvest, transportation, fertilizer, willow crop removal, land cost and insurance, administration, and interest payments.

The *Yearly Cash Flow Sheet* shows the yearly balance of revenues and expenses in one graph over the total project life on a 'per acre' basis.

The *Accumulated Cash Flow Sheet* shows the accumulated cash flow on a per acre basis over the total project life. The payback period can be identified on this sheet. The best-case (revenues increased by 10%, costs decreased by 10%) and a worst-case scenario (revenues decreased by 10%, costs increased by 10%) are also plotted on this figure.



Costs (per ha)	US$/ha	US$ total	% of total
Interest	0	0	0%
Stock removal	740	7,400	7%
Transport	1,279	12,789	13%
Harvest	3,188	31,884	31%
Fertilizer	340	3,400	3%
Establishment	2,430	24,303	24%
Administration	276	2,760	3%
Land cost and insurance	1,955	19,550	19%
Total	10,209	102,085	100%

Figure 2: Cost share sheet with cost shares over total project life.

Planting Submodel

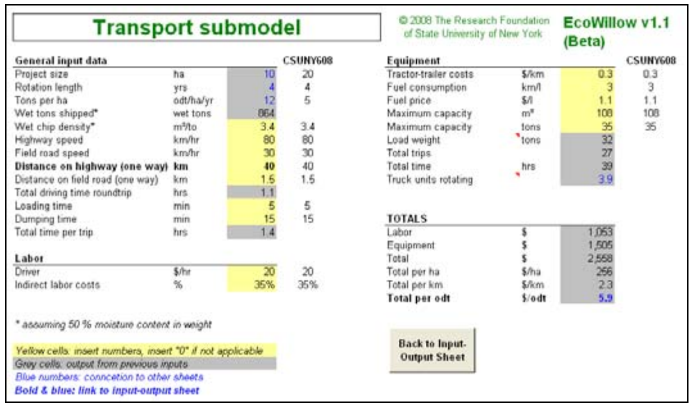
The *Planting Sheet* allows users to modify establishment cost inputs, reports planting costs per acre, and feeds output to the Input/Output Sheet. It considers variables such as labor, travel, equipment, and supply costs. The sheet is designed to calculate the costs of using a four-row Salixphere Step planter.

Harvest Submodel

Harvest costs in 'US$ per dry ton' are separately calculated in the *Harvest Sheet*. Results feed into the Input/Output page. The harvest submodel is designed for a cut and chip harvester based on a New Holland forage harvester with a specialized cutting head. Harvest costs include in field transportation of wood chips with tractors and forage or dump wagons to the roadside and loading chips into a tractor-trailer using a corn silage blower. Important input values include row length and turning times at the ends of the rows, as well as labor, fuel, travel, and equipment costs.

Transportation Submodel

The *Transportation Sheet* (Fig. 3) calculates transportation costs by truck in 'US$ per dry-ton'. Results feed into the Input/Output Sheet. This submodel allows for calculation of total road transportation units required based on capacity and considers general variables, as well as fuel, labor and equipment costs. On-field storage and loading of chips is not considered as the budget model assumes that trucks are loaded directly from forage or dump wagons.



Transport submodel

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EcoWillow v1.1 (Beta)

General input data			CSUNY608
Project size	ha	10	20
Rotation length	yrs	4	4
Tons per ha	odt/ha/yr	12	5
Wet tons shipped*	wet tons	864	
Wet chip density*	m³/to	3.4	3.4
Highway speed	km/hr	80	80
Field road speed	km/hr	30	30
Distance on highway (one way)	**km**	**40**	40
Distance on field road (one way)	km	1.5	1.5
Total driving time roundtrip	hrs	1.1	
Loading time	min	5	5
Dumping time	min	15	15
Total time per trip	hrs	1.4	
Labor			
Driver	$/hr	20	20
Indirect labor costs	%	35%	35%

Equipment			CSUNY608
Tractor-trailer costs	$/km	0.3	0.3
Fuel consumption	km/l	3	3
Fuel price	$/l	1.1	1.1
Maximum capacity	m³	108	108
Maximum capacity	tons	35	35
Load weight	tons	32	
Total trips		27	
Total time	hrs	39	
Truck units rotating		3.9	
TOTALS			
Labor	$	1,053	
Equipment	$	1,505	
Total	$	2,558	
Total per ha	$/ha	256	
Total per km	$/km	2.3	
Total per odt	**$/odt**	**5.9**	

* assuming 50 % moisture content in weight

Yellow cells: insert numbers, insert "0" if not applicable
Grey cells: output from previous inputs
Blue numbers: connection to other sheets
Bold & blue: link to input-output sheet

Back to Input-Output Sheet

Figure 3: Transport submodel calculating transport costs in 'US$ per dry ton'.

Additional Resources

Feedback from users is appreciated and will be incorporated into future versions of the model. Support for the development of this model has been provided by NYSERDA, USDA CSREES, and NYS Department of Agriculture and Markets.

- ESF woody biomass website, with link to download EcoWillow v1.2 (Beta) and link to the ESF Willow Biomass Producers Handbook website: http://www.esf.edu/willow/
- Double A Willow nursery website: http://www.doubleawillow.com/

SUNY-ESF Willow Biomass Program

http://www.esf.edu/willow/

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