

Sustainable biofuels in Minnesota: Opportunities of small-scale on-farm biofuel production

Seth Fore & Paul Porter
University of Minnesota
Clean Energy Resource Teams

Benefits and drivers of small-scale biofuel production



- Benefits and drivers are diverse
 - Energy autonomy, self sufficiency
 - Reduced exposure to market volatility
 - Environmentally sustainable alternative to petroleum fuels
 - Biofuels are carbon neutral
 - Reduced emission profile compared to petroleum-based alternatives
 - Economic advantage

Vegetable oil based biofuels



- Scalable production platform
- Numerous feedstock sources
 - Oilseed crops: sunflower, soybean, canola, jatropha, camelina, and others
 - Virgin or used vegetable oil
- Usable in multiple forms
 - Biodiesel or straight vegetable oil (SVO)
- Usable in multiple applications
 - Internal combustion engines, heating fuel

Economics of small-scale biodiesel production



- Feedstock acquisition
 - Raw oilseeds, used vegetable oil
- Oil extraction
- Biofuel processing
 - Methanol
 - Catalyst
 - Electricity
- Labor
- Capital



Economic assumptions



- Major operating costs of small-scale biodiesel production are considered
- However, labor and capital costs have been excluded

Factor	Value
Canola, \$ cwt ⁻¹	12.56
Soybean, \$ bu ⁻¹	4.80
Virgin soy oil, \$ gal ⁻¹	2.51
Waste vegetable oil, \$ gal ⁻¹	0.25
Methanol, \$ gal ⁻¹	3.00
Potassium hydroxide, \$ lb ⁻¹	3.27
Electricity, \$ kWh ⁻¹	0.10

Small-scale biodiesel operating costs



Inputs	Canola	Soybean	Virgin soy oil	Waste SVO
	\$ gal ⁻¹			
Feedstock	3.30	4.67	2.51	0.25
Oil extraction	0.17	0.37	-	-
Biofuel processing				
Methanol	0.62	0.62	0.62	0.62
Catalyst	0.25	0.25	0.25	0.25
Electricity	0.02	0.02	0.02	0.02
Total operating cost	4.35	5.92	3.39	1.13
Meal credit	-1.65	-5.25	-	-
Total cost	2.70	0.68	3.39	1.13
Total cost energy equivalent gallon	2.90	0.73	3.64	1.21

Small-scale biodiesel operating costs



Inputs	Canola	Soybean	Virgin soy oil	Waste SVO
	% of total operating cost			
Feedstock	76%	79%	74%	22%
Oil extraction	4%	6%	0%	0%
Biofuel processing				
Methanol	14%	10%	18%	55%
Catalyst	6%	4%	7%	22%
Electricity	0%	0%	0%	1%
Total operating cost, \$ gal ⁻¹	4.35	5.92	3.39	1.13

Economic considerations



- Relatively few inputs comprise the majority of input expense – volatility in those inputs results in large changes in the cost of production
- Capital and labor costs based on equipment configuration and time availability are substantial
- Maintenance and repair costs deserve consideration

Oilseed presses



- Numerous manufacturers
 - Range in price from \$4,000 to \$18,000
 - Range in capacity from 1 to 2 tons d⁻¹, but can get much larger



Biodiesel processors



- Prefabricated processors generally range from \$4,000 to \$9,000
- Home built processors can be constructed under \$1,000



SVO utilization: The European small-scale alternative to biodiesel



- Virgin SVO can be used in certain modified diesel engines or for space heat
- Certain processing and capital costs are forgone
- Reduced input costs increase the likelihood of cost competitive biofuel production



The SVO conversion system



- Two tank fuel system
 - Engine starts and shuts down on diesel fuel
 - SVO is burned only under load
- SVO is heated to near viscosity of diesel fuel to promote proper atomization, minimizing polymerization on cylinder walls



SVO biofuel considerations



- SVO has only marginally been accepted in the US unlike Europe, and the debate continues as to its overall mechanical suitability
- Only certain engines can be converted
- Oil chemical composition based on extraction method and species appears to impact mechanical durability



(Fendt, 2009)

Opportunities of small-scale biofuel production



- Reduce reliance on petroleum fuels
- On-farm production cycles energy, nutrients, and value within the farm gate
- Mitigate CO₂ emissions stemming from petroleum fuel use
- Add value to products or waste streams that can enhance profitability

Thanks...



Contact information:

Seth Fore

fore0046@umn.edu

701.212.6625