RUNNING THE TRACTOR ON SVO AND BIODIESEL FROM OIL CROPS

Winter Crops for Bioenergy and More
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Penn State Experiences

- Biodiesel blends and B100
- Straight vegetable oil (SVO)
1900
- Rudolph Diesel demonstrates his new engine at the World’s Fair in Paris, running on peanut oil.

1908
- Henry Ford unveils his Model T, designed to run on either gasoline or ethanol, “the fuel of the future.”
US opts for petroleum instead of plant-based fuels.
Biodiesel & SVO

- Testing 100% biodiesel and SVO in agricultural tractors
Biodiesel -or- SVO

Animal Fat or Vegetable Oil

Transesterification using alcohol & catalyst

Biodiesel

Straight Vegetable Oil (SVO)
## Comparison of fuels

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>BTU/US gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular gasoline</td>
<td>125,000</td>
</tr>
<tr>
<td>Ethanol</td>
<td>84,600</td>
</tr>
<tr>
<td>Methanol</td>
<td>64,600</td>
</tr>
<tr>
<td>Gasohol (10% ethanol)</td>
<td>120,900</td>
</tr>
<tr>
<td>Kerosene</td>
<td>135,000</td>
</tr>
<tr>
<td>#2 Diesel</td>
<td>138,700</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>126,200</td>
</tr>
<tr>
<td>Straight vegetable oil (SVO)</td>
<td>123,000</td>
</tr>
</tbody>
</table>
In collaboration with New Holland, four new tractors ran 3 years on B100 – these have been returned to New Holland for evaluation.

- 2 new pieces of equipment running SVO
- Exploring long term effects of biodiesel and SVO
Penn State University converted diesel fuel station for all diesel fuel to B20 in 2006

New Holland endorses B100 in 2007

- NH Tier IV engines required in 2011 in over 175 HP off road equipment no longer endorsing B100 use – B20 the maximum
New Holland TC40 injectors after 2 years on B100
Straight Vegetable Oil (SVO) Use at Penn State Farm Operations

From the Fryer to the Fuel Tank
The Complete Guide to Using Vegetable Oil as an Alternative Fuel

Joshua Tickell
Straight Vegetable Oil

- May require engine modifications
- Heated to change the viscosity
- Start engine on petro-diesel fuel
- Shut down on petro-diesel fuel
Engine deposit buildups after running on straight soybean oil
Kinematic Viscosity of Rapeseed Oil and Diesel Fuel

Rapeseed Oil
„Triglyceride“

Diesel Fuel
„Hydrocarbon Chains“

85°C = 185°F
KernKraft Oilseed Press
KernKraft Oilseed Press
Straight Vegetable Oil Fuel
Case 621E Loader
(146 net HP)
(109 net kW)

New Holland T7060
(180 PTO HP)
(134 PTO kW)
Fuel Schematic
for New Holland T7000 series
Our challenges with the SVO systems

NH T7060
• SVO too hot from heat exchanger – engine depowering
• SVO filter clogging
• Low temperatures – mix with petroleum diesel

Case 621E
• Engine coolant not reaching operating temperature
• SVO filter clogging
• Low temperatures – mix with petroleum diesel
• Power supply – 12V vs. 24V
• Fuse location in control box
## Oil Seed Crop Yield

<table>
<thead>
<tr>
<th>Plant</th>
<th>Yield (seed) lbs/acre</th>
<th>Oil Yield gal/acre</th>
<th>Plant</th>
<th>Yield (seed) lbs/acre</th>
<th>Oil Yield gal/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>7800</td>
<td>18</td>
<td>Safflower</td>
<td>1500</td>
<td>83</td>
</tr>
<tr>
<td>Oats</td>
<td>3600</td>
<td>23</td>
<td>Rice</td>
<td>6600</td>
<td>88</td>
</tr>
<tr>
<td>Cotton</td>
<td>1000</td>
<td>35</td>
<td>Sunflower</td>
<td>1200</td>
<td>100</td>
</tr>
<tr>
<td>Soybean</td>
<td>2000</td>
<td>48</td>
<td>Peanut</td>
<td>2800</td>
<td>113</td>
</tr>
<tr>
<td>Mustard</td>
<td>1400</td>
<td>61</td>
<td>Rapeseed</td>
<td>2000</td>
<td>127</td>
</tr>
<tr>
<td>Camelina</td>
<td>1500</td>
<td>62</td>
<td>Coconut**</td>
<td>3600</td>
<td>287</td>
</tr>
<tr>
<td>Crambe</td>
<td>1000</td>
<td>65</td>
<td>Oil palm**</td>
<td>6251</td>
<td>635</td>
</tr>
</tbody>
</table>

** Yield given in lbs of oil/acre

Source: Biofuel Variety Trials Factsheet, USDA-ARS and WSU, Prosser, WA
## Overall SVO vs. Petro-diesel usage at Penn State

<table>
<thead>
<tr>
<th></th>
<th>NH T7060 (1370 hours)</th>
<th>Case 621E (1118 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% SVO used of total fuel use</td>
<td>85%</td>
<td>53%</td>
</tr>
<tr>
<td>Total SVO used</td>
<td>3428 gallons</td>
<td>796 gallons</td>
</tr>
<tr>
<td>Total diesel used</td>
<td>628 gallons</td>
<td>701 gallons</td>
</tr>
</tbody>
</table>
NH 7060: Power vs. RPM for Diesel and SVO
December, 2010

Rated Power - 134 kW (180 HP)

- Diesel Power (kW)
- SVO Power (kW)
## Canola Meal Analysis

### Crude Protein
- Value: 33.9%

### Crude Fat
- Value: 16.9%
PSU Cold-pressed Canola Oil
Penn State Canola Oil Cycle

- Canola
- Canola seed
- Oilseed press
- Used fryer oil
- Biodiesel processor

Canola meal

Oil

Fryer oil