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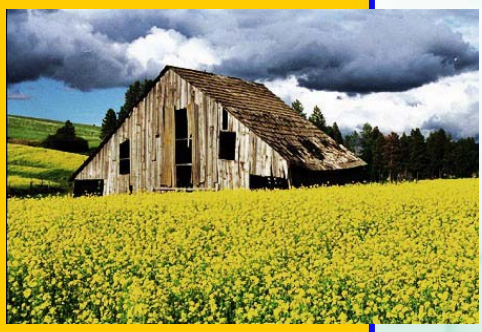
BIOFUELS IN WASHINGTON

An Agricultural Perspective



Peter Moulton
Climate Solutions

Harvesting CLEAN ENERGY

Types of Biofuels

- **ETHANOL: Fermented plant sugars**
  - 90% corn, also wheat, barley, potatoes, beets
  - Washington's future: cellulosic feedstocks
- **BIODIESEL: Esterified plant oils, rendered fats and waste grease**
  - Primarily soy, some waste grease
  - Washington's future: *Brassica* oilseeds
- **"NATURAL" GAS: Refined methane from decay of carbon-rich material**
  - Landfills
  - Animal waste
- **FUTURE OPTIONS…**
  - Biomethanol & Biobutenol
  - "Syn Gas" (gasification) & "Bio Oil" (pyrolysis)

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Biofuel Uses

- **Transportation**
  - Public & Private Fleets
  - Personal Vehicles
  - Maritime
  - Rail
  - Agriculture
- **Heating**
- **Power**

Why Biofuels?

- **Renewable**
  - More carbon neutral
- **Domestically Grown**
  - Reduced reliance on imports
  - Enhanced national security
  - Economic opportunity, esp. rural areas
- **Reduced Emissions**
- **Biodiesel**
  - Biodegradable (nontoxic)
  - Safer (less flammable)
  - Increased lubricity

Reality Check

- **Only part of the solution!**
  - **All vegetable oils and animal fat in US converted to biodiesel would only supply 13-14% of current diesel use**
- **Efficiency**
  - **CAFE standards**
- **Conservation**
  - **Transit, telecommuting, etc**

Energy Balance Debate

Does biofuel production use more energy than it produces?

UC Berkeley Survey (*Science*, Jan 2006)

- **Six major energy balance studies by national labs and universities**
- **Pimentel & Patzek "studies stand apart from the others"**
  - ✓ no energy value for co-products
  - ✓ obsolete manufacturing productivity data
  - ✓ pessimistic feedstock yield projections

Energy Balance Debate

- **Corn-based Ethanol** (UC Berkeley)
  - **21% positive net energy balance**
  - **Reduces oil use 95%**
- **Cellulosic Ethanol** (UC Berkeley)
  - **8.4 units of energy delivered**
  - **Reduces oil use 92%**
- **Biodiesel** (NREL)
  - **3.2 units of energy delivered**
  - **Reduces oil use 95%**

Is Agriculture Even Interested?

Nationwide survey by Farm Foundation on priorities for reauthorization of federal Farm Bill:

- Bioenergy *highest fundamental goal*
- Biofuels and renewable energy *highest research funding priority*

Agriculture community wants to reduce nation's dependence on non-renewable energy, and understands it has an crucial role to play…

Washington-Grown Biofuels

- **Biodiesel**
  - Virgin oil, primarily from *Brassica* family (canola, rapeseed, mustard)
  - Waste grease and rendered fats (only 10 mgy)
- **Ethanol**
  - Corn first, cellulosic soon (3-5 yrs?)
  - Producers designing for conversion

Options for Oilseed Crops

Crambe

Mustard

Rapeseed

Safflower

Flax

Sunflowers

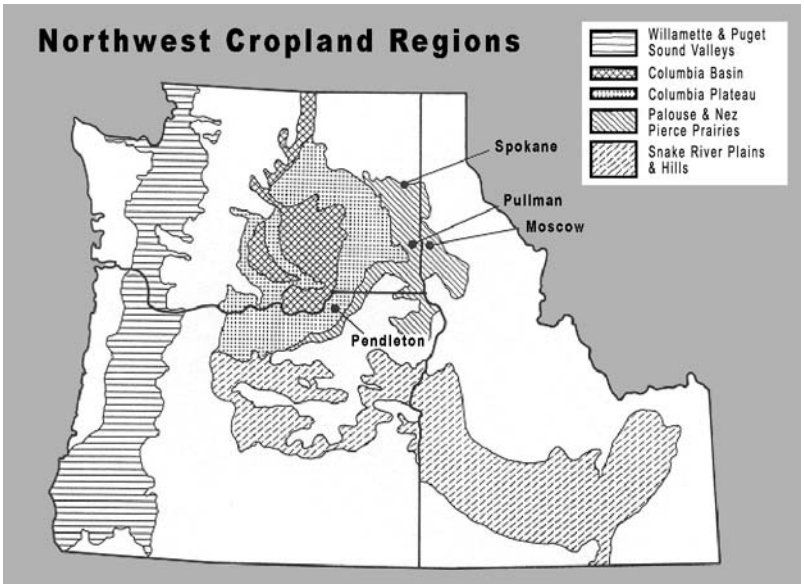
Soybean

Why Brassicas?

- **High oil content** (40% vs 18% for soy)
- **Well-adapted to climate** (soy is not)
- **Produces higher quality fuel than soy**
- **Canola and rapeseed relatively high yielding, particularly winter varieties**
- **Mustard better for harsh climates, resistant to pests, but lower yielding** (higher value co-product potential)
- **Focus on canola** (30 years experience, markets for edible oil and animal feed)

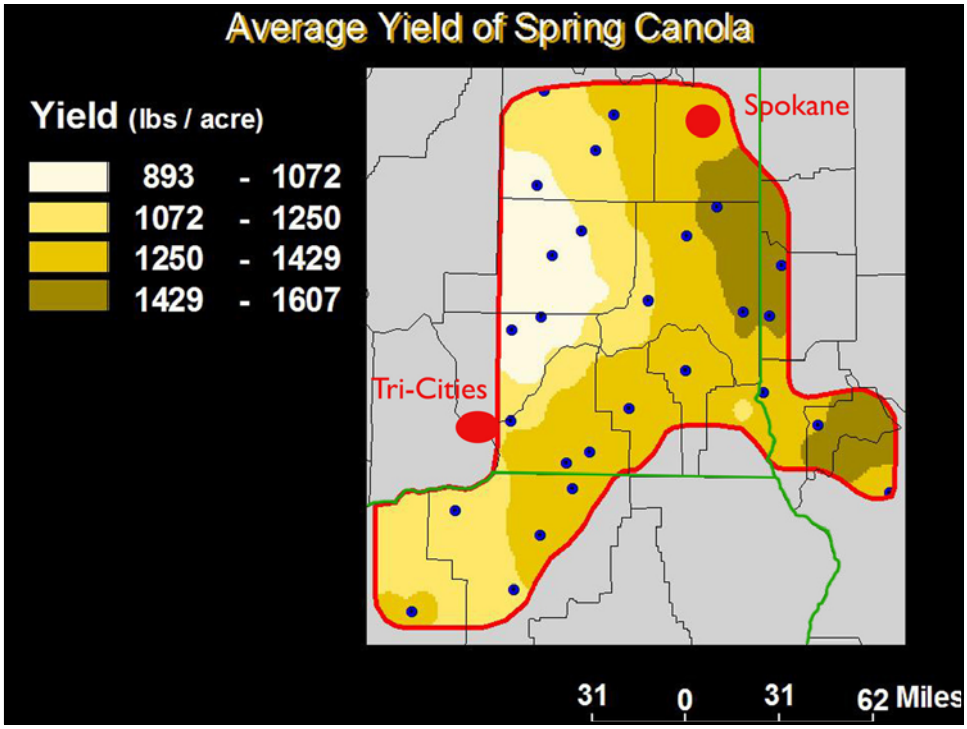
Canola Propagation

- **Annual crop seeded in spring or fall for late summer harvest**
- **Grown in 3-4 year rotations with winter and spring wheat, barley and other crops**
- **Historically dryland areas of Palouse and Columbia Plateau** (13-24" rainfall)
- **New opportunities in Columbia Basin for winter canola using deficit irrigation** (12-17" water applied at times not needed by higher value crops such as fruit trees)



Primary Oilseed Growing Regions

1) Palouse (dryland, "high" rainfall)
2) Columbia Plateau (dryland, low rainfall)
3) Columbia Basin (irrigated)
4) Northwest Coastal Plain



Canola Benefits for Growers

- Reduces weed problems
- Disrupts disease regime
- Deep taproots loosen hardpan, improve water retention, reduce irrigation
- Yield gains of ~20% in following wheat or potato crops
- Spreads labor over time (planting and harvesting times differ from wheat)
- Washington is feedstock deficient, so meal will reduce feed imports
- Price for organic canola meal booming, 3-4 times higher due to organic dairies

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How Much Can We Grow?

- **In 2006, ~10,000 acres in Washington**
- **> 6 million acres of potential cropland, most too arid to be economically viable**
- **Start with ~2.4 million acres of wheat**
  - Grow in four year rotation
  - ~600,000 acres in production each year
- **Productivity varies (rainfall, soils, season)**
  - ~1000 lb/ac for spring crops in drier areas
  - ~4000 lb/ac for winter crops in irrigated areas
  - Drier areas more common, assume 2000 lb/ac average
  - Equivalent to 100 gal/ac
  - Potential yield 60 mgy (6% current diesel usage in state)
- **Predictions call for 750,000 acres of oilseeds in tri-state area**

Oilseed Yields

Anticipated yields under irrigation

	Biodiesel gal/acre	# of acres for 10 mgy facility
Soybean	**100**	**100,000**
Spring Mustards / Canola	**125**	**80,000**
Safflower / Winter Canola	**200**	**50,000**

Barriers to Brassicas

- Growers need 11-15¢/lb to break even – market prices are rising, but have averaged below break-even prices for last several years
- Riskier than many alternatives – more sensitive to heat, cold and drought stress
- Farmers would likely plant only a small percentage of their farm due to risk issues

Seed Prices Drive the Process

Seed price/lb	Irrigated acres	Gallons produced	Pump price	% WA diesel
$0.10	<80,000	15 MGY	$1.80 - $1.90	<2%
$0.14	~180,000	35 MGY	$2.15 - $2.25	<4%
$0.20	>500,000	100 MGY	$2.60 - $2.70	10%

Getting Farmers to Grow

- **Reducing growing costs**
  - Biosolids as a source of nitrogen
  - Improved varietals for unique microclimates
- **Farmer ownership of "Value Chain"**
  - Co-op/LLC hybrids
  - Discounted fuel for growers
  - Community-scale efficiencies
- **Support for co-product R&D and market development**
  - High quality bio-lubricants
  - Refined glycerol
  - Nutritional supplements

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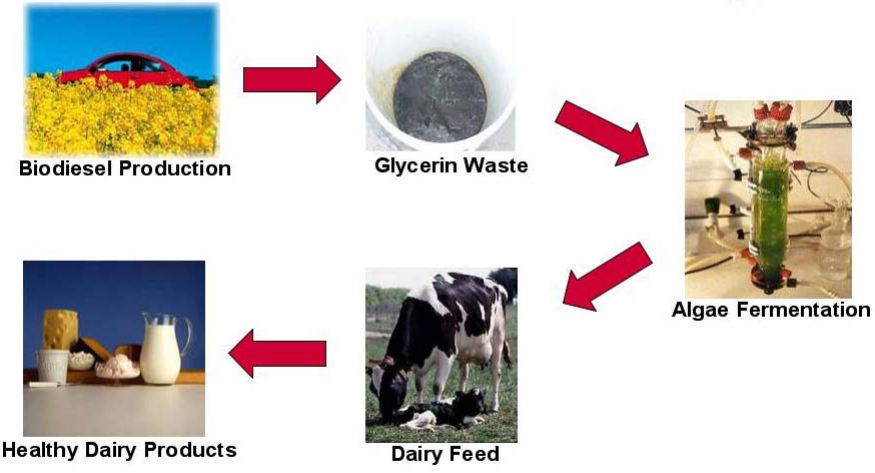
WSU Bioproducts & Biorefining



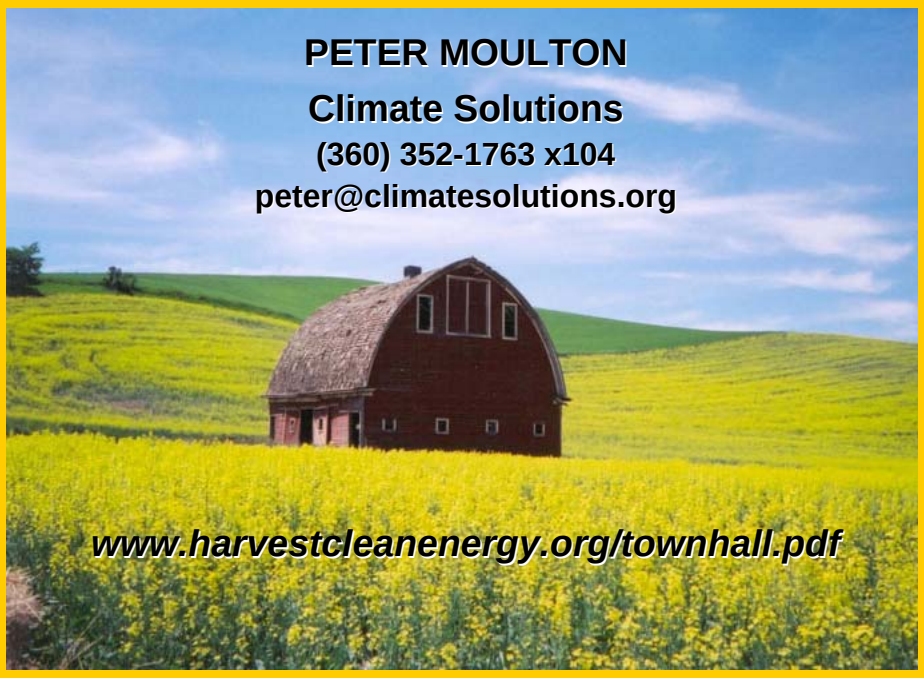
Omega-3 Fatty Acids from Glycerin Waste

Cellulosic Ethanol: The Big Promise

- **Diverse and abundant feedstocks offer Washington State unique position in evolving industry:**
  - **Wheat straw**
  - **Switchgrass**
  - **Woody debris**
- **Technology rapidly becoming competitive, major focus of federal R&D funding**

Sustainability Questions Remain

- **Consequences of using genetically modified seed** (Roundup Ready)
- **Aggressive cross-pollination has potential to harm lucrative vegetable seed industry**
- **Soil management conflicts** (harvesting cellulosic material vs no-till farming practices)
- **New demands on limited water supplies for irrigation and production** (esp. ethanol)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