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# **Alternative Feedstocks and Biodiesel Production**

Presented at the

**Practical Biodiesel Blueprint Conference**

in

**Kuala Lumpur, Malaysia**

**January 23 & 24, 2007**

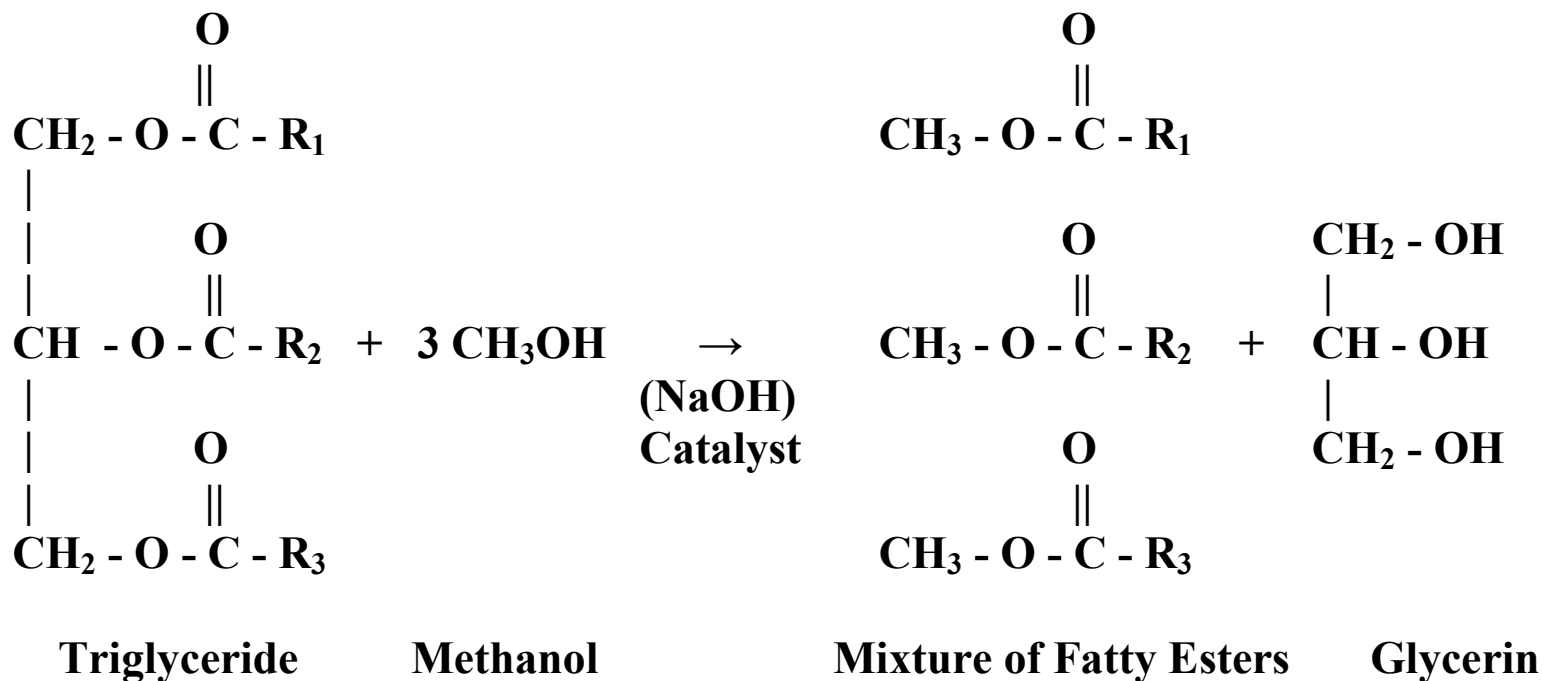
by

**Rudy Pruszko**

**Center for Industrial Research and Service**

**Iowa State University Extension**

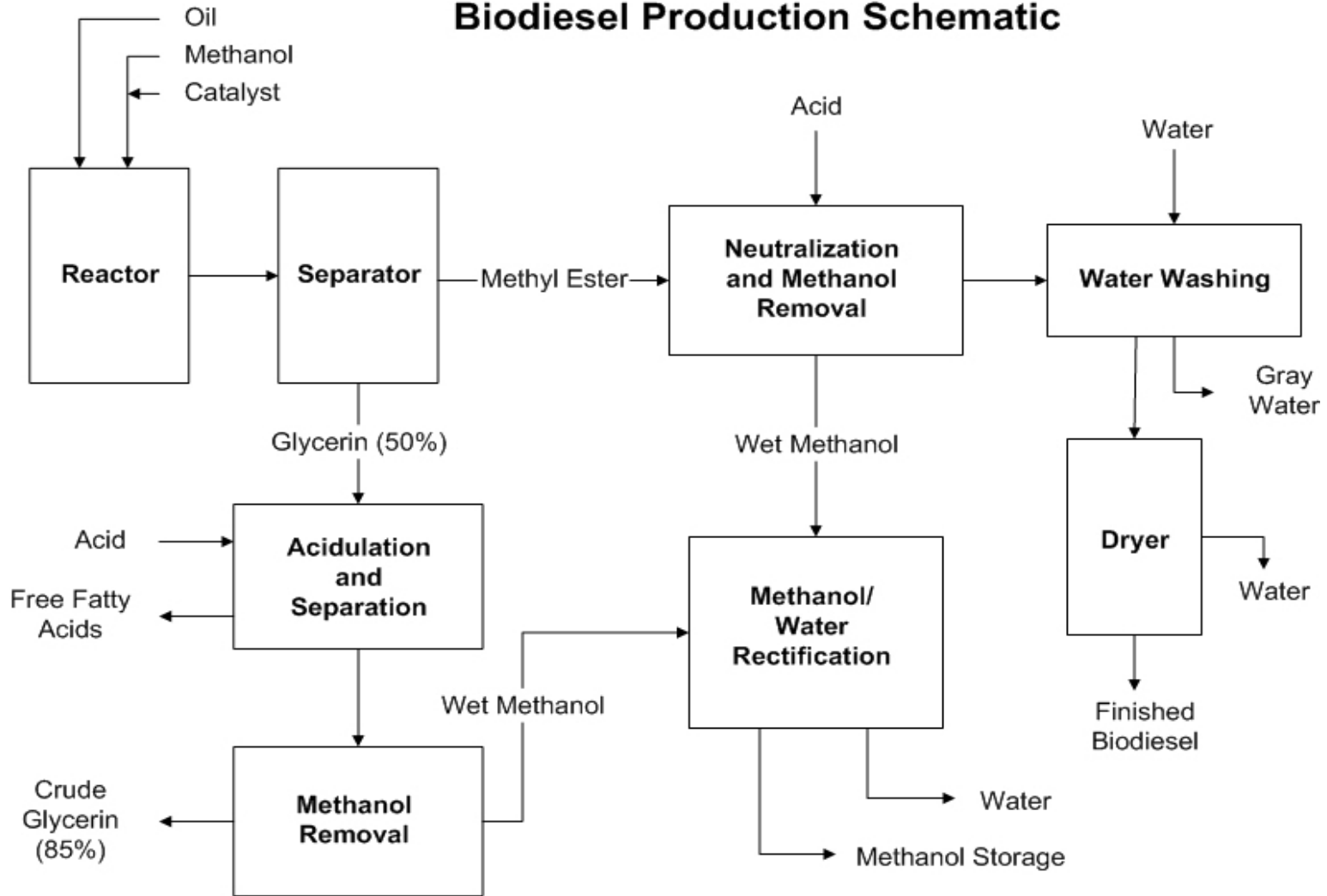
# Transesterification





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## Biodiesel Production Schematic





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# Feedstock Supply

- Supply and demand principle
- Meal constraint on additional crush
  - Ethanol industry
  - Export markets
- Competition with food industry
  - Cost differential with food grade
  - Oil is a small part of the cost in food production
- Oil imports (competition and biodiesel)



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# Why Feedstock Price is Important

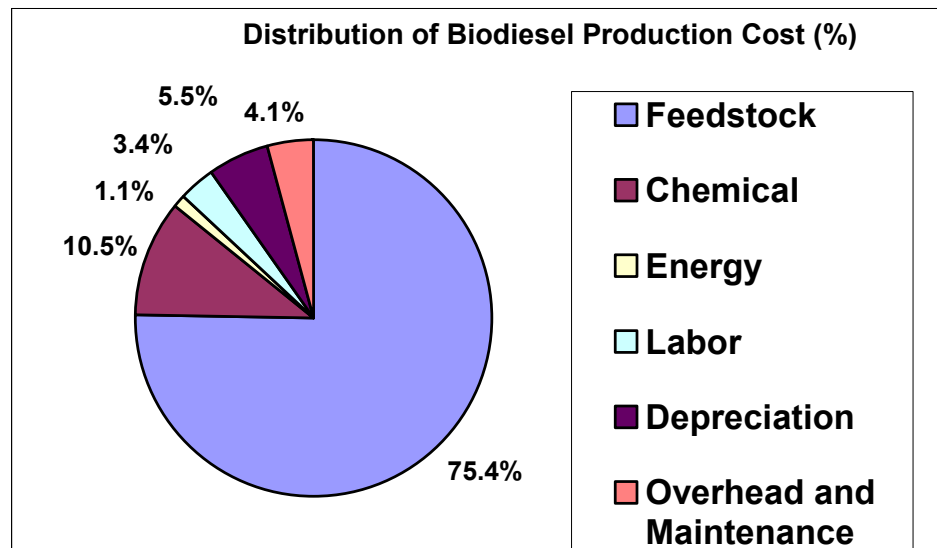
## 5 mm gpy Biodiesel Production Cost

### Biodiesel Production Cost Summary

Customer: CIRAS Iowa State University

Case: Product cost with \$0.22/lb Soybean Oil feed (5 mm gpy plant size)

Biodiesel Production Cost	Cost/gal (\$)	Cost/liter (\$)	% of Total
Cost of Feedstock	1.672	0.442	72.1%
Cost of Feedstock Transport	0.076	0.020	3.3%
Cost of Acid	0.011	0.003	0.5%
Cost of Base Catalyst	0.108	0.029	4.7%
Cost of Sodium Hydroxide	0.001	0.000	0.1%
Cost of Methanol	0.122	0.032	5.3%
Cost of Heat Energy	0.022	0.006	0.9%
Cost of Electricity	0.004	0.001	0.2%
Cost of Labor	0.079	0.021	3.4%
Depreciation	0.128	0.034	5.5%
Cost of Maintenance	0.040	0.011	1.7%
Cost of Admin and Overhead	0.025	0.007	1.1%
Cost of Marketing	0.030	0.008	1.3%
<b>Total</b>	<b>2.320</b>	<b>0.613</b>	<b>100.0%</b>





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# Why Feedstock Price is Important

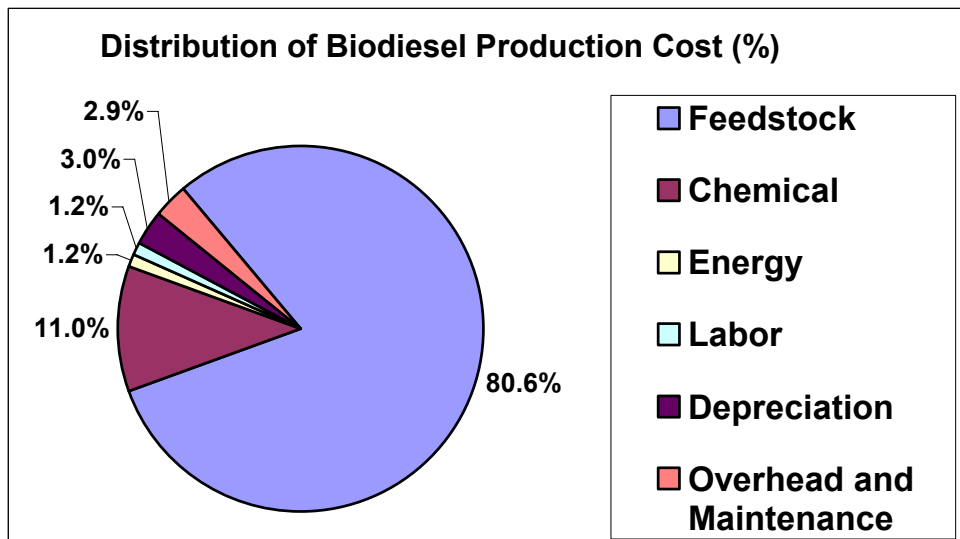
## 30 mm gpy Biodiesel Production Cost

### Biodiesel Production Cost Summary

Customer: CIRAS Iowa State University

Case: Product cost with \$0.22/lb Soybean Oil feed (30 mm gpy plant size)

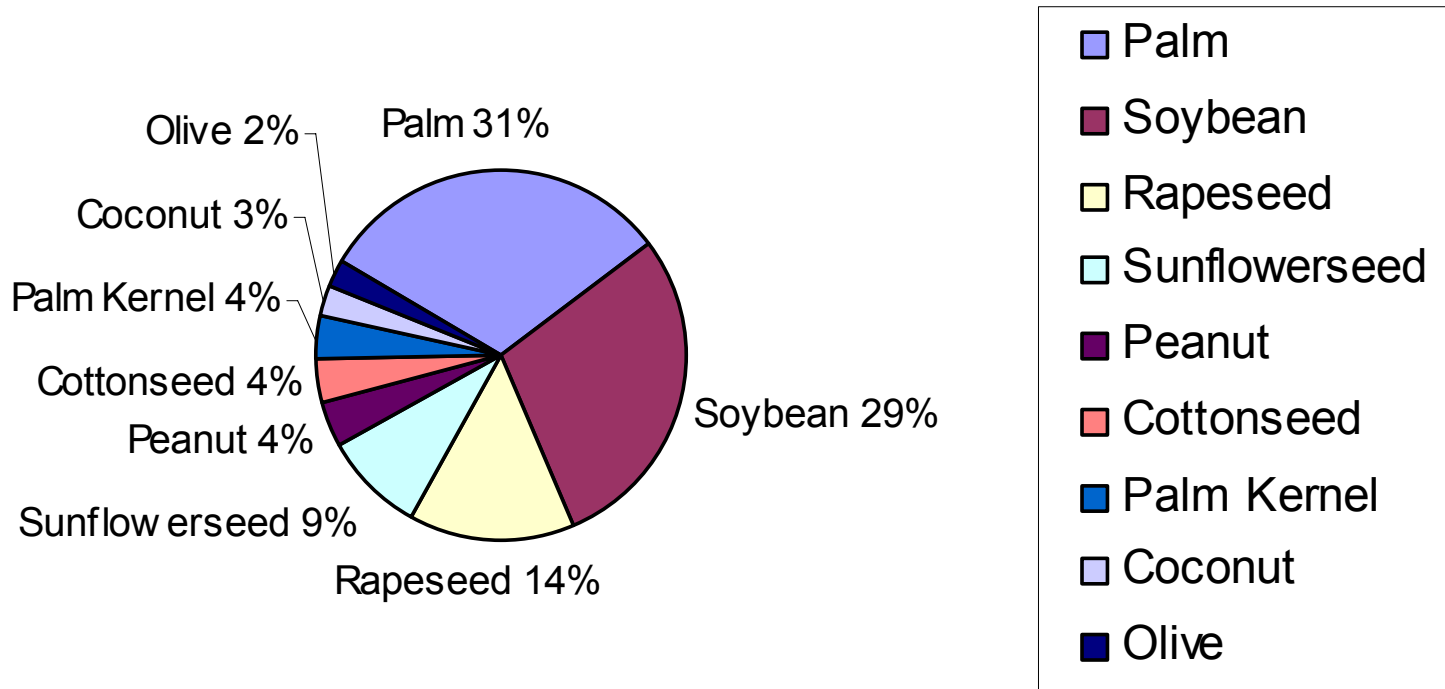
Biodiesel Production Cost	Cost/gal (\$)	Cost/liter (\$)	% of Total
Cost of Feedstock	1.672	0.442	77.1%
Cost of Feedstock Transport	0.076	0.020	3.5%
Cost of Acid	0.011	0.003	0.5%
Cost of Base Catalyst	0.103	0.027	4.8%
Cost of Sodium Hydroxide	0.001	0.000	0.1%
Cost of Methanol	0.122	0.032	5.6%
Cost of Heat Energy	0.022	0.006	1.0%
Cost of Electricity	0.004	0.001	0.2%
Cost of Labor	0.026	0.007	1.2%
Depreciation	0.066	0.017	3.0%
Cost of Maintenance	0.028	0.007	1.3%
Cost of Admin and Overhead	0.006	0.002	0.3%
Cost of Marketing	0.030	0.008	1.4%
<b>Total</b>	<b>2.168</b>	<b>0.573</b>	<b>100.0%</b>



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## Major World Vegetable Oil Supply

Foreign Agriculture Service USDA 10/06-9/07 Projections







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# **Major World Vegetable Oil Pricing**

**10/06 – 9/07 Projections  
(\$/metric ton)**

Coconut	\$616	Peanut	\$996
Cottonseed	\$587	Rapeseed	\$679
Palm	\$465	Soybean	\$469
Palm Kernel	\$629	Sunflower	\$638

**Source: Food and Agricultural Policy Research Institute (FAPRI)**

# Animal Feedstocks

- Tallow
- Yellow Grease (Recycled Waste Vegetable Oil)
- Poultry Fat
- Brown Grease
- Pork Fat - White Grease
- Lard
- Fish Oil

# Feedstock Type Comparison

## Animal fats

- Less expensive  
\$0.14/lb average
- Higher sulfur
- FFA 5-50%
- Less available
- Higher gel temp.
- More stable

## Seed oil

- More expensive  
\$0.22/lb average
- Lower or no sulfur
- FFA <5%
- More plentiful
- Lower gel temp
- Less stable

# Alternative Feedstocks

## Seed Oil Crops

- Soybean (375 Kg oil/ha)
- Mustard (481 Kg oil/ha)
- Camelina (490 Kg oil/ha)
- Jatropha (1590 Kg oil/ha)
- Nuts (Brazil, Pecan...) (405-2010 Kg oil/ha)
- Chinese Tallow/Popcorn Tree (4000 Kg oil/ha)
- Oil Palm (5000 Kg oil/ha)
- Algae (up to 8000 Kg oil/ha)



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# Alternative Feedstocks

## Seed Oil Crops Derivatives

- Crude Palm Oil
- RBD Palm Oil
- RBD Palm Olean
- RBD Palm Stearin
- Palm Fatty Acid Distillate (PFAD)
- Crude Kernel Palm Oil
- RBD Kernel Palm Oil
- RBD Kernel Palm Olean
- RBD Kernel Palm Stearin
- Palm Kernel Expeller

# Alternative Feedstocks

## Concerns

- Free Fatty Acid (FFA) content
- Waxes (Corn, Sunflower, Chinese Tallow)
- Moisture/Water content
- Insoluble, Unsaponifiable, Impurity content
- Color bodies

# Alternative Feedstocks

## Desirable Characteristics

- Low cost
- High purity level
- Low Moisture/Water content
- Steady and reliable supply
- Can be processed with current plant equipment
- Edible or Inedible

# Alternative Feedstocks

## Biodiesel Production Strategy

- Pretreatment of the Feedstock
  - Feedstock supplier's plant
  - Biodiesel plant
- Post treatment of Biodiesel
- Combination strategy
- Feedstock Cost vs. Production Cost



# Innovations in Feedstocks

- Plant genetics - Biotechnology
- Designer Biodiesel
  - Pick feedstocks to determine biodiesel properties or characteristics desired
- Separation of fatty acids
- Chemically modifying fatty acid chains
- Utilizing waste streams

# Innovations in Technology

## Pretreatment Technologies

- Chemical Treatment
  - Caustic to remove FFA
  - Acid catalysis/esterification
  - Solid catalyst
  - Glycerolysis
  - Enzymatic
  - De-gumming

# Innovations in Technology

## Pretreatment or Post Treatment Technologies

- Separation
  - Centrifuges
  - Absorbents
  - Resins
  - Molecular sieves
  - Chilling/cryogenics
  - Carbon treatment
  - Distillation
  - Flash evaporation
  - Gravity settling
  - Filtration
  - Water Washing



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# Summary

- Cost of the Feedstock determines your profits
- Alternative feedstocks are available
- Understand the cost and technology associated with processing alternative feedstocks
- Pretreatment is preferred to Post treatment

# Summary

- Be aware of the properties of the biodiesel made from alternative feedstocks
- Install the equipment needed to process alternative feedstocks
- Test the new feedstock in the lab first

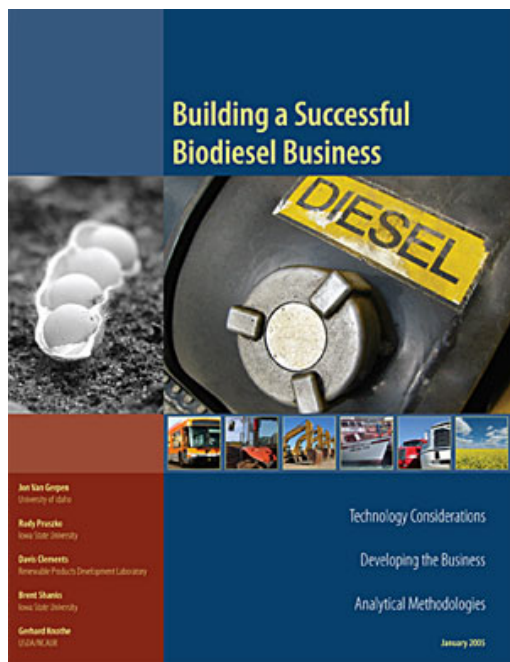


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## Resources

- Biodiesel Workshop, material from the Biodiesel Production, Analytical, and Business workshops, Iowa and Idaho, 2005, <http://www.me.iastate.edu/biodiesel>
- National Biodiesel Board, <http://www.biodiesel.org>
- USDA
- CIRAS and Iowa State University

# Resources



Rudy Prusko, John Van Gerpen, Davis Clements, Brent Shanks, and Gerhard Knothe, *Building a Successful Biodiesel Business*, 2006, Iowa.

Available from

<http://www.biodieselbasics.com>



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# **Rudy Pruszko**

**Center for Industrial Research and Service  
(CIRAS)**

c/o NICC Town Clock Center

680 Main Street

Dubuque, Iowa 52001 USA

Phone 563-557-8271 ext 251

Email: [rpruszko@iastate.edu](mailto:rpruszko@iastate.edu)

CIRAS website: <http://www.ciras.iastate.edu>