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EFPRA Congress 2013

How the North American Renderers Association Supports Research and Education

Charles H. Gooding, PhD, PE

Associate Director, ACREC

Professor of Chemical Engineering

What is ACREC?

Animal Co-Products
Research & Education Center
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- Created in collaboration with Clemson University by the FATS and PROTEINS RESEARCH FOUNDATION, Inc. February 2003
- Formed to solve problems facing the rendering industry and to provide opportunities for students to learn about the industry's activities and benefits to society
- Primary emphasis is on three specific areas:
  - ✓ Development of new non-feed products and markets
  - ✓ Improvements in biosecurity
  - ✓ Environmental protection

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How does ACREC work?

- Over 10 years proposals have been submitted by more than 40 Clemson researchers from various disciplines, including animal science, architecture, bioengineering, biological sciences, chemical engineering, chemistry, environmental engineering, experimental statistics, food science, materials science and engineering, microbiology, and packaging science)
- FPRF has provided over $2 million in research support
- More than 300 Clemson University students have been involved in research and class projects on topics relevant to the rendering industry

New Products

Polymer Liner Development and Confirmation for Animal Co-Product Bins

Dr. Andrew Hurley

Assistant Professor

Packaging Science

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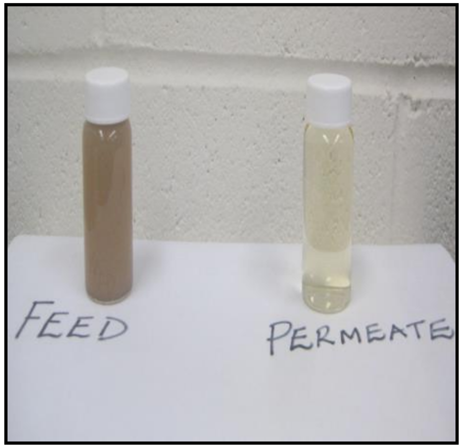
Environmental Protection

Membrane Purification of Rendering Facility Wastewater



Dr. Scott Husson

Professor

Chemical Engineering

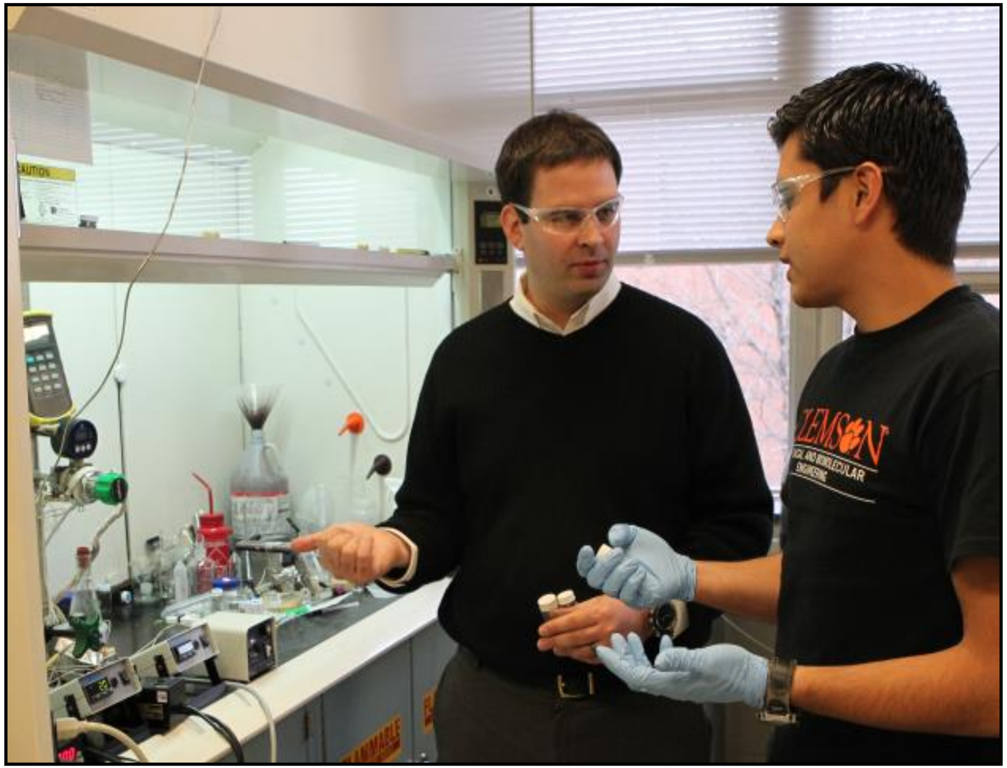
Improved Operations

Economic Separation of Fat Components from Rendered Materials

Dr. Christopher Kitchens

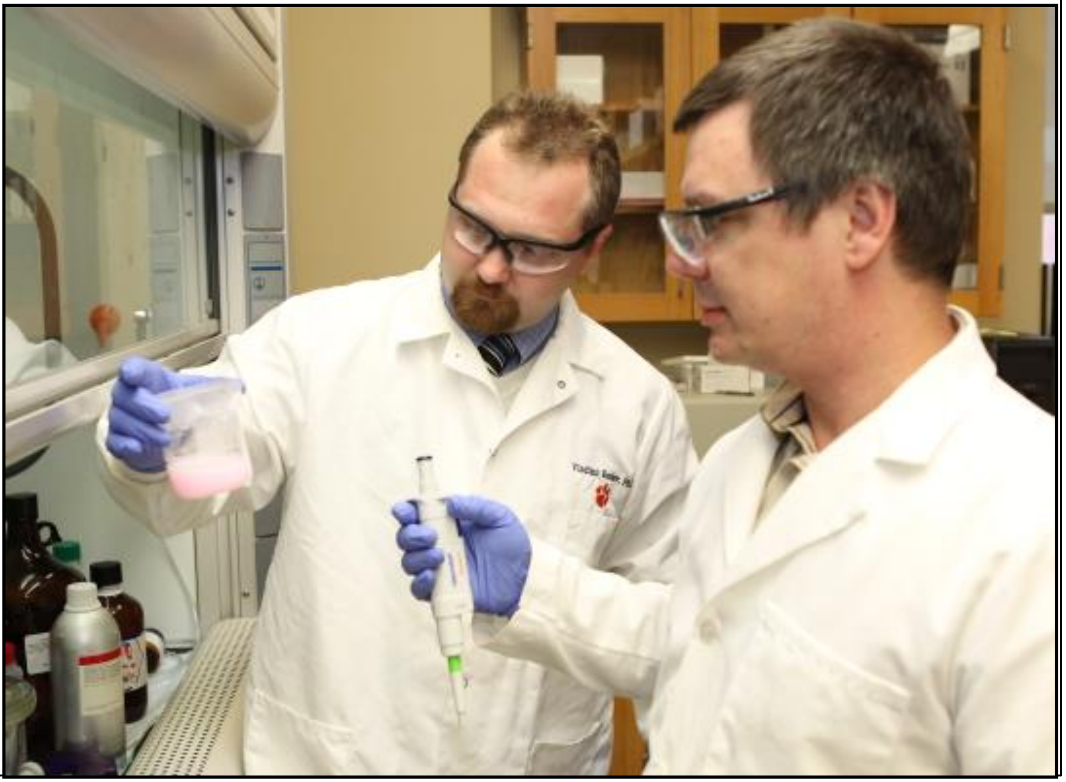
Associate Professor

Chemical Engineering



New Products

Livestock Feed Preservatives Based on Antioxidants Extracted from Animal Co-Products



Dr. Vladimir Reukov

Research Assistant Professor

Bioengineering

Dr. Alexey Vertegel

Professor

Bioengineering

Environmental Protection

Biodegradable Nanoparticles for the Destruction of Malodorous Organics

Dr. Daniel C. Whitehead	Dr. Frank Alexis
Assistant Professor	Assistant Professor
Chemistry	Bioengineering
	

Product Quality Verification

Further Assessment of PPCPs in Feed Grade Chicken Feather Meal Including Potential Sources

(co-funded with the Poultry Protein and Fat Council)

Dr. Joseph Thrasher

Professor

Chemistry

Pilot Study of Applying *Salmonella*-Specific Bacteriophages in a Rendering Environment

Dr. Xiuping Jiang
Professor
Microbiology
Food Science

Dr. Annel K. Greene
Professor
Animal & Veterinary Science
Microbiology
Food Science

Biosecurity

Validation of Thermal Destruction of Pathogenic Bacteria in Rendered Animal Products

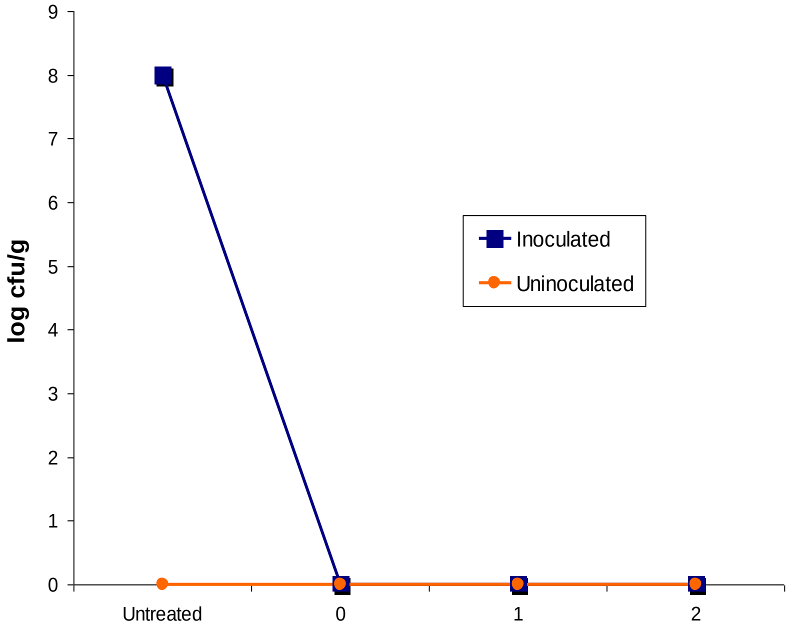
Microbiologists
Dr. Annel K. Greene

Dr. Xiuping Jiang

Ms. Melissa Hayes

Statistician
Dr. William C. Bridges, Jr.

Destruction of Salmonella at 240F



240ºF for 0 min (heat-up time approximately 8 minutes)

Environmental Protection
New Products

Development of a Carbon Footprint Calculator for Rendering Operations

Life Cycle Assessment of Rendering Operations and Products

High Value Products from Rendered Fat

Dr. Charles H. Gooding
Professor (Emeritus)
Chemical Engineering

Carbon footprint calculator

- Excel spreadsheet platform
- User inputs annual data on:
  - ➢ Raw material processed or products made (=> CO_2 avoidance)
  - ➢ Raw material transportation (=> CO_2 emissions)
  - ➢ Process fuel used (=> CO_2 emissions)
  - ➢ Electricity used (=> indirect CO_2 emissions)
  - ➢ Wastewater treatment (=> CO_2 and/or CH_4 emissions)
  - ➢ Worker commuting (=> CO_2 emissions)
- Output includes
  - ➢ CO_2 emissions attributed to each category
  - ➢ CO_2 reduction ratio = CO_2 avoided / CO_2 emitted
  - ➢ Breakdown by GHG Protocol Scopes 1, 2, and 3

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Charles H. Gooding, PhD, PE
for the Carbon Footprinting of Rendering Operations
J. Industrial Ecology, **16**(2), 223-230 (2012).

In one year an average-sized rendering plant in North America processes 100,000 tonnes of meat byproducts, fallen animals, and restaurant grease and produces 40,000 tonnes of marketable fats and proteins. A plant of this size emits directly about 20,000 tonnes of carbon dioxide, mostly by burning fuels to operate cookers that destroy pathogens, drive off moisture, and separate the fat and protein. Another 4000 tonnes of CO_2 is emitted by utility companies to provide electricity for the rendering process. These direct and indirect emissions are equivalent to about 30% of the carbon dioxide that would released if all of the carbon in the rendered raw material were decomposed into CO_2.

Life Cycle Assessment of Rendering Operations

(going beyond carbon footprints)

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What is the problem?

The industry is under pressure from various sources to prove that rendering is a “green” process compared to alternative technologies.

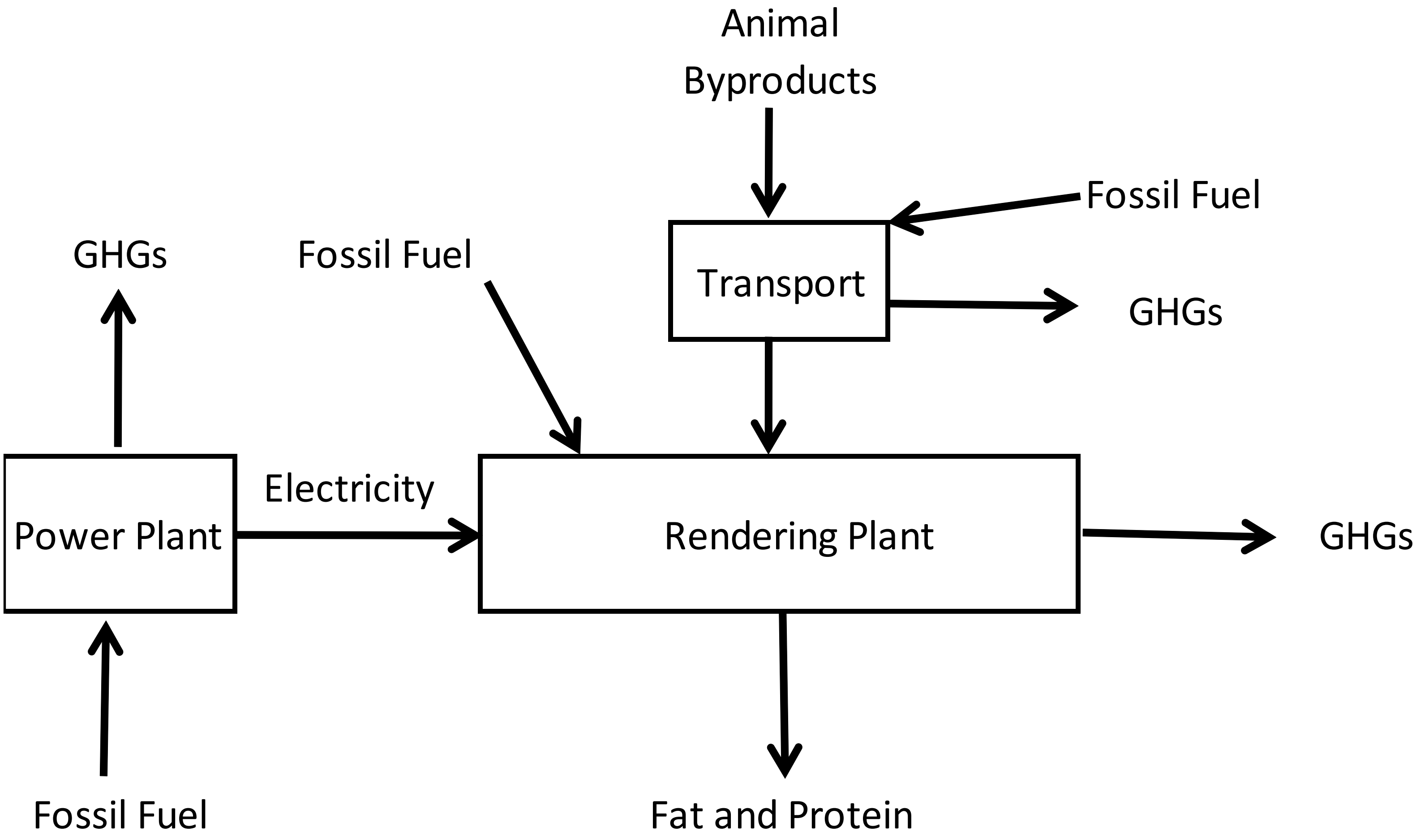
Raw material providers compare rendering to other methods of handling animal byproducts, such as composting.

End product customers compare rendered fat and protein to plant oils and meals.

What can the industry do about this?

- Develop life cycle assessments to compare rendering to alternative means of animal byproduct disposal and to alternative means of producing oils and proteins.
- Focus initially on greenhouse gas emissions and fossil energy use because they are important issues and data are available.

Rendering Inventory



Animal Byproducts

Fossil Fuel

Transport

GHGs

GHGs

Fossil Fuel

Power Plant

Electricity

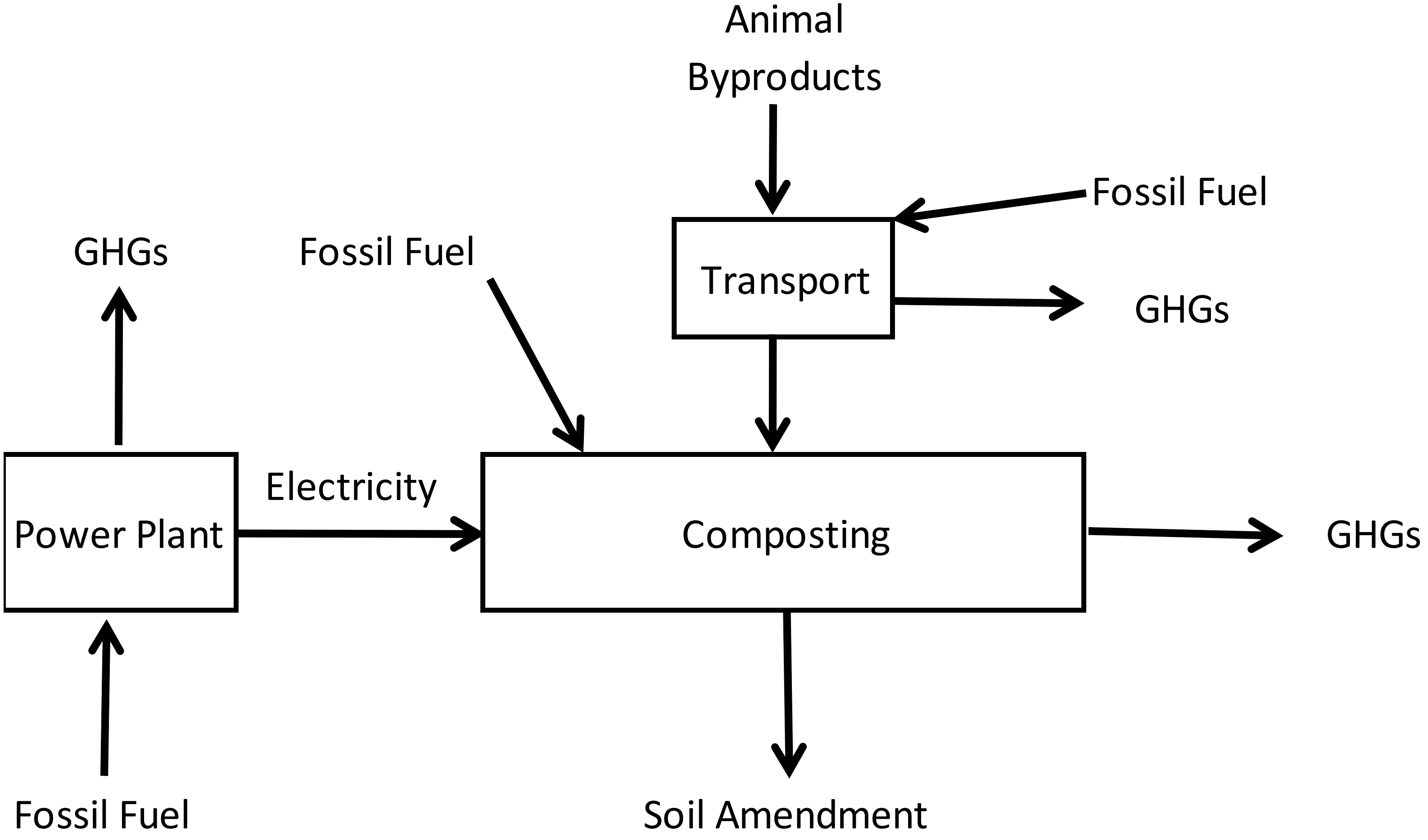
Rendering Plant

GHGs

Fossil Fuel

Fat and Protein

Composting Inventory



Animal Byproducts

Fossil Fuel

GHGs

Fossil Fuel

Transport

GHGs

Power Plant

Electricity

Composting

GHGs

Fossil Fuel

Soil Amendment

Gate-to-gate life cycle assessment for 100,000 MT animal byproducts processed

Rendering

- Produces 20,000 MT fat and 22,000 MT protein meal
- Consumes 220,000 GJ of fossil fuel
- Releases 16,000 MT CO_2e

  (nearly all of this is CO_2)

Composting

- Produces soil amendment containing 1500 MT total N

  (250 MT NH_4^+ and 300 MT NO_3^-)
- Consumes 23,000 GJ of fossil fuel
- Releases 300,000 MT CO_2e

  (15% as CO_2, 20% as CH_4, 65% as N_2O)

High Value Products from Rendered Fat

Charles H. Gooding, Ph.D., P.E.
Department of Chemical Engineering

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What’s the problem?

The value of inedible fat tracks with…

- the price of corn (energy for animals), or
- the price of biodiesel (energy for cars/trucks), or
- the price of other commodity oils.

If you sell rendered fat, somebody downstream determines the price, makes a finished product, and gets a disproportionate share of the profit.

So what can you make easily from fat and keep more of this profit?

High value products that can be made from tallow

Primary product	Value* $/kg	Yield kg/kg	Demand MT/yr	Byproducts	Notes
purified free fatty acids	1.20	0.9	10,000,000	glycerin	difficult separations, limited product flexibility, low margin
plasticizers (epoxilated, unsat'd methyl esters)	2.00	0.5	5,000,000	glycerin, saturated FFAs	must separate sats/unsats, only 50% unsat in feed
di-carboxylic acids	4.00	0.5	3,000,000	mixed olefins, FFAs glycerin	Elevance starting 180,000 MT/yr plant; difficult separations
fatty alcohols	2.00	0.8	2,000,000	glycerin	limited product flexibility, low margin
synthetic cocoa butter	6.00	1.2	1,000,000	replaced FA	food/cosmetic use, expensive process
		requires reaction with stearic acid			
polyol ester biodegradable lubricant	2.00	1.0	500,000 biolubes	glycerin	industrial lubricant market: 10,000,000 MT/yr global market all lubricants: 40,000,000 MT/yr
glyceryl mono & diesters	3.00	up to 1	100,000	unused FFAs	difficult separation, limited market
calcium salt of stearic, myristic & palmitic acid	2.00	0.5	100,000	glycerin, unsaturated FFAs	difficult separations
methyl ester sulfonate	3.00	1.5	100,000	glycerin	
fatty amides (lubricants, slip agents)	5.00	0.2	100,000	other FFAs	
azaleic&nonanoic acids	6.00	0.6	100,000	glycerin, sat'd FFAs	ozonation, limited market
ethylene glycol diester	2.00	0.9	20,000	glycerin	

* Estimated market value of product that meets minimum specifications. Higher specifications and values exist.

Why polyol ester lubricants?

- The chemistry is simple so fixed capital investment should be relatively low.
- Demand for biodegradable lubricants from renewable sources is growing.
- The first step of lube production can be the biodiesel process <u>or</u> the Colgate-Emery reaction TG -> FFAs.
- Addition of the lube process to a biodiesel plant can increase profitability or hedge against low fuel prices.
- A wide range of lube applications and formulations => niche markets for small investment, higher values.
- The huge global market for lubricants => lubes could become a dominant outlet for rendered fats.

Financial Estimates (20,000 MT fat/yr)

Process scenario	via FAME	FAME add-on	via FFA
Lube Product	tallowate	tallowate	oleate & stearate
Capital Investment, $M	4.9	2.1	6.2
Revenue, $M/yr	44	44	55
COMd, $M/yr	39	39	36
Gross profit $M/yr	5	5	19

Operating cost (COMd) is dominated by raw materials.

- Rendered fat costs the process $1.00/kg or $20M/yr
- Other raw materials, primarily TMP, cost $8 to 10M/yr

Lubes values: tallowate $2.00/kg; stearate $2.50/kg; oleate $2.80/kg

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thanks the

FATS and PROTEINS RESEARCH FOUNDATION, Inc.

for more than $2 million in research support that has enabled over 300 students to participate in research and class projects, solving problems and creating opportunities for the rendering industry