Biodiesel Feedstock Overview

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September 2018
U.S. Biodiesel & Renewable Diesel Market
(millions of gallons)
Source: EPA EMTS*

*Volumes reported under the RFS in the D4, D5, and D6 categories.
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(millions of gallons)

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Biodiesel Has Expanded and Diversified Production Capacity

- Biodiesel production has expanded beyond the Midwest
- New capacity closer to other markets uses diversified feedstocks
Feedstock Options
EPA approved pathways

- Distillers Corn Oil
- Soybean Oil
- Yellow Grease
- Camelina
- Animal Fats
- Canola Oil
2017 Fats & Oils Use

Biomass-based Diesel

- Soybean Oil: 46%
- Distillers Corn Oil: 15%
- Yellow Grease: 15%
- Canola Oil: 11%
- Animal Fats: 13%
Feedstock Options
EPA approved pathways

- Soybean production is forecast at a record 4.69 billion bushels.
- Yields are expected to average a record high 52.8 bushels per acre.
- Soybean yields consistently above trend line.
- Project ending stocks this marketing year are 450 million bushels greater than ending stocks last year. This equates to a potential of 675 million gallons of additional biodiesel from the oil in those additional beans alone.
Feedstock Options
EPA approved pathways

- LMC international projects that the global waste oil supply will grow from 29.0 million metric tons in 2017 to 31.9 million metric tons in 2020. 31.9 million metric tons of waste oil would be enough to create 9.6 billion gallons of biomass-based diesel.
- Changing consumer demand for vegetarian fed meat has decreased feed demand for yellow grease and UCO. Industry indicates this trend is forecasted to continue.
Feedstock Options
EPA approved pathways

- Prior to commercialization of the biodiesel market, DCO was not generated in the US in significant quantities.
- DCO output saw rapid growth between 2010 and 2017, as most ethanol plants invested in extraction capacity and improvements in technology increased yields.
- LMC International estimates output reached almost 4 billion pounds in 2017 and is expected to exceed 4.4 billion pounds in 2018 (over 500 million gallons).
Feedstock Options
EPA approved pathways

- USDAs Economic Research Service reported the pork industry has been setting quarterly inventory records almost since 2015.
- This trend exists for the beef and poultry industry as well.
- Animal fat supplies are directly correlated with meat production and US processing capabilities.
- Longer term, the National Renderers Association projects rendered fat supplies (animal fats and used cooking oil) to increase by 14% over the next decade.
Feedstock Options

EPA approved pathways

- Continues to be an important feedstock for biodiesel production. Some expansion of acreage in Great Plains.
- US Canola Association goal to reach more than 3.5 million acres vs. ~2 million currently.
Feedstock Options
EPA approved pathways

Distillers Corn Oil
Soybean Oil
Animal Fats
Camelina
Canola Oil

Approved EPA pathway, but limited commercial use.
Looking Beyond Current Supplies
Feedstock Options
Pathways with Petitions

- Corn Oil from Wet Milling
- Cottonseed Oil
- Brassica carinata
- Field Pennycress
New Winter Annuals
Field Pennycress

• Significant Opportunity
  – As a winter annual, could be planted on millions of acres in the Midwest typically left underutilized during the winter.
  • Key will be harvest window and yield impact on the following soybean crop.

• Key Research Questions
  – Risk management by producers
  – Line improvement (yield)
New Winter Annuals

Brassica carinata

- *Brassica carinata* (also called Ethiopian mustard), is closely related to rapeseed and prefers cooler weather, making it a suitable crop to grow during the winter months in the southeast US.
- Carinata grain is approximately 45% oil, and the seed meal is approximately 43-46% protein with a low fiber content.
- Per acre production goals are 3,500 pounds of seed.
- Future goals for acreage expansion are ~850,000+ acres in the Southeast United States by 2022 with early maturity and frost tolerance.
Future Innovation
Private Equity Investment in Yield Technology

Significant that soybean yields have been above trend line the past five years.
Lipid Content in Soy?

Oil content (%)
* represent significant differences.
Values are means ± se (n=12, P ≤ 0.05)

Soy protein content (%) quantified by N content.

Slides courtesy of Dr. Sam Wang, DPSC
Lipid content in corn?

Corn Kernel Composition

- Endosperm
- Pericarp
- Germ
- Tip Cap

7% Oil
**PROCESS DESCRIPTION**

Simplified flow diagram of the process:

**0% LIPID, CONVENTIONAL SUGARCANE**
- Fiber: 58%
- Sucrose: 25%
- Ash: 1%
- Others: 6%
- Oil: 10%

**2% LIPID CANE**
- Fiber: 73%
- Sucrose: 25%
- Ash: 1%
- Others: 6%
- Oil: 20%
Future Sources & Innovation

• Algal production
• Lipids in leaves
• Interceptor Grease
• Lipids from by-products (meat/bone meal)
• Lipids as co-product of integrated cellulosic bio-refinery process
• Others??????
Near-term Goals

4 Billion Gallons by 2022
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