Agricultural Biomass and the BioEconomy

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Accredited Member

LEE ENTERPRISES CONSULTING, INC.

Background: 30+ years C -level experience in project development, technology commercialization and biomass supply chain logistics

Performing consulting services and advisor to developers and investors both in the US and internationally

Expertise: World's largest bioeconomy consulting group - over 100 subject matter experts (SME's)- all areas of the bioeconomy.

Approach: Project interdisciplinary teams to meet exact needs of specific projects.

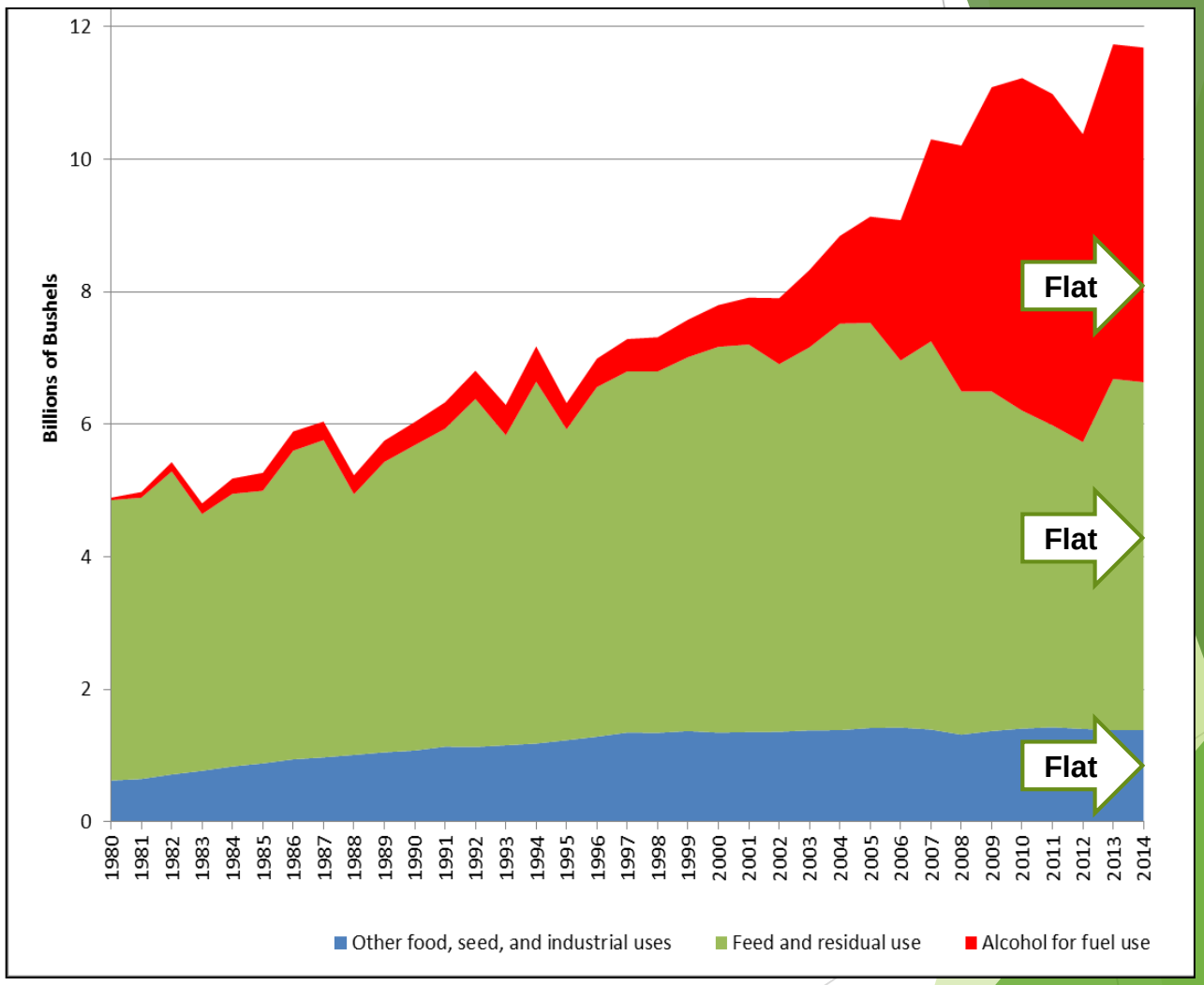
POC: Handle projects with one agreement and single point of contact.

Cost Advantage: Single POC = lower administrative costs = lower project cost.

“The fuel of the future is going to come from fruit like that sumac out by the road, or from apples, weeds, sawdust – almost anything. There is fuel in every bit of vegetable matter that can be fermented.” – *Henry Ford, 1925*

Historical Perspective

- **Observations/Findings**
- To this point, ag biomass has been heavily weighted towards the use of corn for ethanol
  - Strongly influenced by the Energy Policy Act of 2005
- Energy Independence and Security Act (EISA) of 2007 started a move towards cellulosic ethanol
- Exports are a major influence on ethanol production and profitability
- Corn ethanol is effectively capped
- As demand for ethanol grows the feedstock will be materials such as MSW, woody biomass, ag waste and purpose grown crops
  - Influenced by EISA, EU Renewable Aviation Fuel Standard, DOD Renewable Requirements and Societal Demands
- Technological advancement is moving the industry rapidly towards other products such as drop in fuels and chemicals
  - Much better demand and profitability



The Industry Today

POET's Project Liberty – Emmetsburg, IA

- ✓ 3 projects built to produce cellulosic ethanol
  - POET's project in Emmetsburg, IA (corn stover) – still in ramp up phase
  - Dupont's project in Nevada, IA (corn stover) – project closed and Dupont/Dow exited business – project being sold to Verbio
  - Abengoa's in Hugoton, KS (corn stover and wheat straw – Abengoa filed for bankruptcy and project sold to Synata Biofuels
- ✓ 1 project in late stage development in Canada
  - Comet Biorefining's project in Sarnia, Ontario – producing industrial sugars from corn stover for the chemical industry
  - There are other projects using ag and ag waste materials to produce pellets for both feed and fuel.

One would think there is an overall lack of activity in the cellulosic biomass space but this presentation is devoted to agricultural biomass. There are many projects using other biomass materials in all phases of development and or production indicating an overall healthy and robust industry.

Ag Waste and Purpose Grown Crops*

Switchgrass

Corn Stover

Biomass Sorghum

Wheat Straw

Ag biomass is required to feed projects like this to reach the DOE target of A One Billion Ton biomass driven bioeconomy

Energy Cane

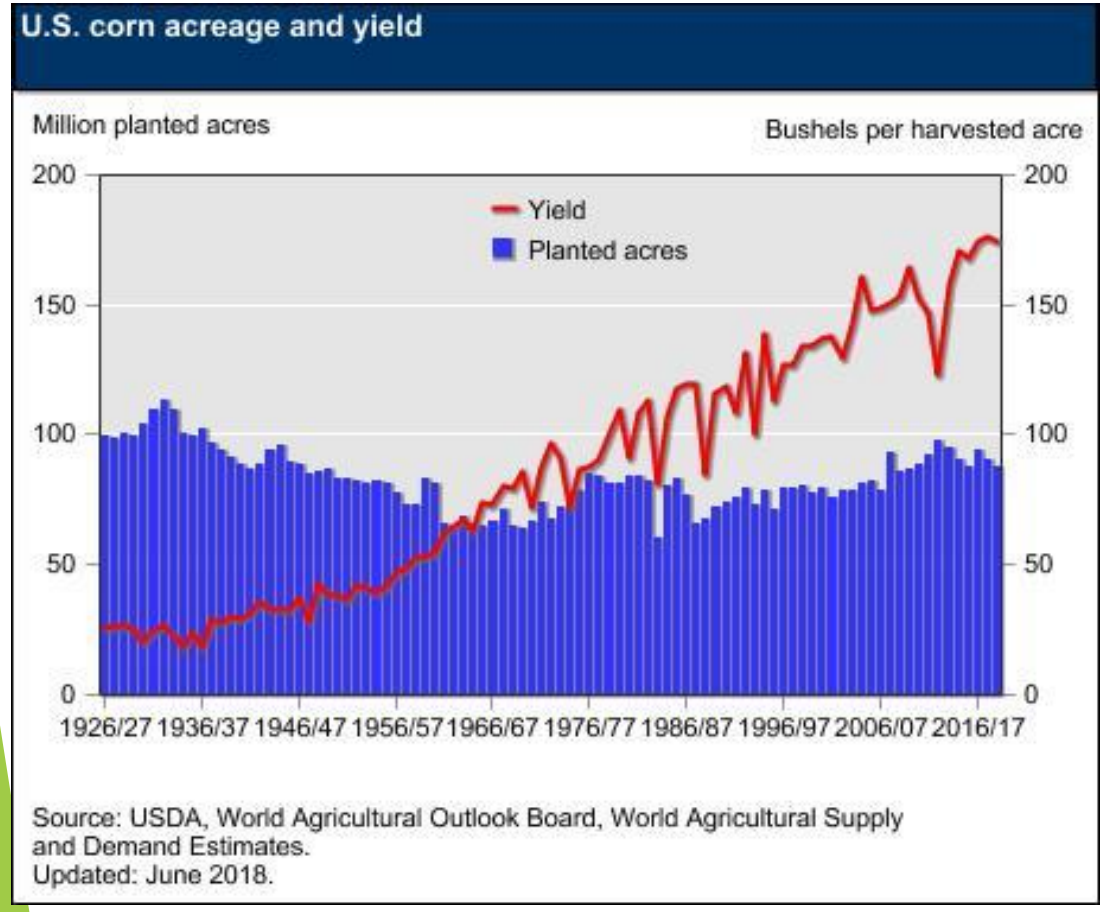
Miscanthus

* This not an exhaustive list of the available ag waste and purpose grown crops.

Some of the Competing Uses for These Materials

- Corn stover is used for animal feed and bedding
- Miscanthus is used in building materials such as insulation board and bio-concretes and bio-plastics
- Wheat straw can be used for making paper, as thatching material, basket making, fuel and animal bedding

The Future of Ag Waste and Purpose Grown Crops



- Corn hovers between 85 and 95 million acres in the US

Yields are steadily rising and estimated to be 300 bushels per acre by 2035

- This is driven by the need for food and animal feed as populations grow

Corn stover will grow as well

- Stover mass and grain mass are directly related

The benefits of partial removal of corn stover from the land are well known

- **Faster warming of land in the spring**
- **Better soil to seed contact**
- **Healthier early growth**
- **Less tillage necessary**
- **Less early nitrogen applications needed**

All this creates higher yields such that there could be a supply push rather than a demand pull for projects that use corn stover.

The Future of Ag Waste and Purpose Grown Crops

- Conversion technology is rapidly evolving for the production of higher value products such as chemicals and drop in fuels
- Alternate uses apart from energy and chemicals is becoming more attractive and creating demand for these crops
- This will accelerate the planting of high yielding crops such as miscanthus, switchgrass, energy cane and sorghum
  - A project can be supplied by much fewer acres compared to waste materials
  - These plants can be grown on marginable lands that are not currently productive
  - The perennial nature of many of these crops makes for a longer economic cycle

Challenges to Growing the Production and Use of These Feedstocks

- There is no infrastructure to support the industry
  - The grain industry had a support system to aid in the rapid growth of grain to ethanol, while the ag waste and crops have no such system in place
    - ✓ An elevator system for storage
    - ✓ A commodities market
    - ✓ Several decades of experience growing, harvesting, storing and moving the product

Additional Challenges

VERY FEW FARMERS HAVE EVER SEEN MUCH LESS GROWN CROPS LIKE MISCANTHUS, ENERGY CANE OR SWITCHGRASS

TOUGH ECONOMICS FOR THE FARMER IN PRE-HARVEST YEARS; NEED NEW FINANCING MECHANICS

FARMING COMMUNITY IS CONSERVATIVE WHEN ADOPTING NEW CONCEPTS

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Indirect Challenges - Role of the OEM

- **Planning for the production of thousands of pieces of equipment that represent new business;**
  - Potential new manufacturing facilities
  - Hiring and training of hundreds of new workers
- **Development of new business models**
  - New demands on our model; Can our dealer system work?
  - Where will we get all the service technicians needed?
- **Research and Development**
  - Should involve close collaboration between technology and OEM's
  - Hopefully will involve use of existing infrastructure
  - Where should our focus lie? To lower costs is a given!

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