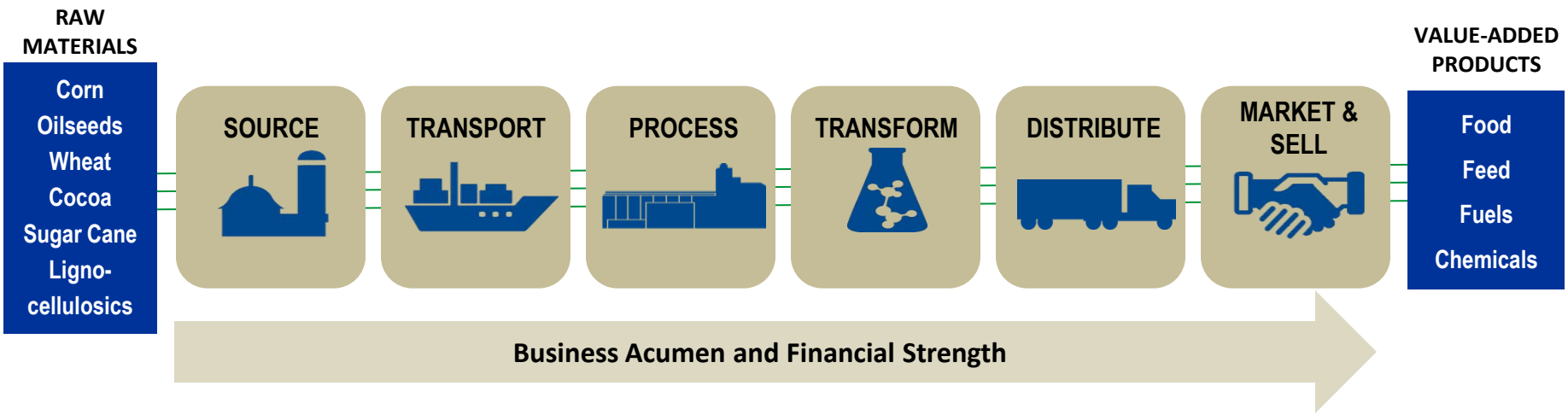
Evolution Chemicals™
Chemistry from nature by ADM

ADM

Utilizing the Entire Barrel
Utilizing the Entire Corn Plant
An Opportunity to Change the Game

Todd Werpy, Ph.D. – Vice President Research, Archer Daniels Midland

The ADM Value Chain



Technology Is Key Across the Value Chain

Feedstocks Sourcing and Transportation
- New Traits
- New Feedstocks

Process & Transform
- Efficiency
- New Products
- Sustainability

Distribute, Market & Sell
- Product Safety
- Applications Research
- Quality

Microbiology, Chemistry, Process and Chemical Engineering, Separation, Food Science and Animal Science

ADM: A History of Biorefinery Innovation

- **$62B in net sales FY10, 60 Countries, 240 Processing facilities, 29k employees**
  - **Headquarters in Decatur, IL**
  - **Founded in 1902 as a linseed crushing operation**
- **Stable earnings from a broad product portfolio**
  - **Four traditional business platforms: Food, Feed, Fuel, Industrial Products**
- **ADM Global Daily Processing Capacity**

Source: 2010 ADM 10-K	Number	MT	Bushels
Oilseed crushing plants	45	95,000	3.5 MM
Corn milling plants	9	66,000	2.6 MM (11 ac/min)
Wheat flour mills	48	28,000	1.0 MM
Cocoa processing plants	18	3,000	NA.

Archer-Daniels-Midland

(Before 1962)

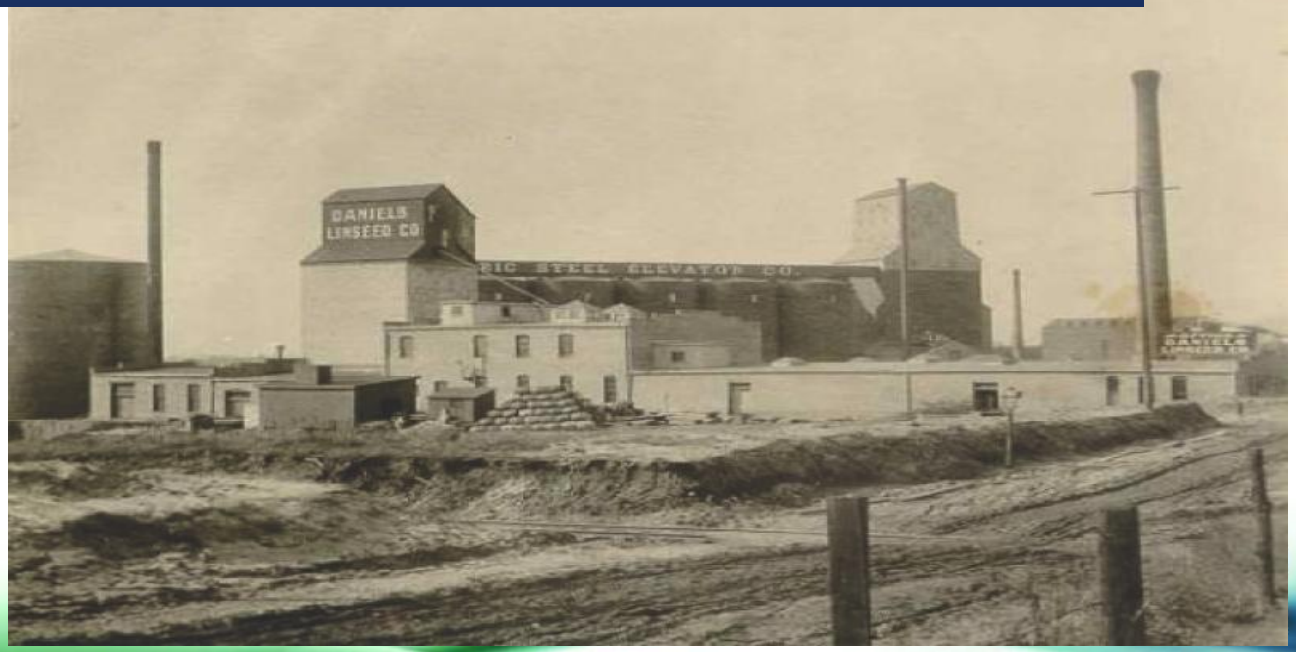
ADM

Supermarket to the world

(1962-2001)

ADM®

current



We see three trends shaping world demand; agriculture will play a growing role in satisfying all three

- We see opportunities in all three trends, and we are investing to meet growing demand

Ligno-cellulose to fuels and chemicals:

- Ligno-cellulose is designed to be a stable structural material
- Natural processes for its conversion are slow
- The acme of biological ligno-cellulose conversion is the ruminant employing mechanical grinding, multiple enzymatic systems with simultaneous separation
- The ruminant uses both the fermentation product (VFA) and the cell mass to maximize efficiency

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Biomass to animal feed – Another Paradigm
Maximizing efficiency with supply and demand

Rather than sending corn to animal feed use, can we replace corn starch with treated biomass to produce a balanced cattle ration?

If we can, less corn is fed to animals, more is available for processing and just as much meat is produced

Treated Biomass + DDG + CGM + CGF

Starch or Biomass
By treating and feeding biomass to ruminants, we feed the animals a diet similar to their historical rations and likely reduce cost to the producer

At the same time, we obtain access to the pure carbohydrates best suited for conversion to industrial chemicals

Added benefit: Starch and biomass come from same land

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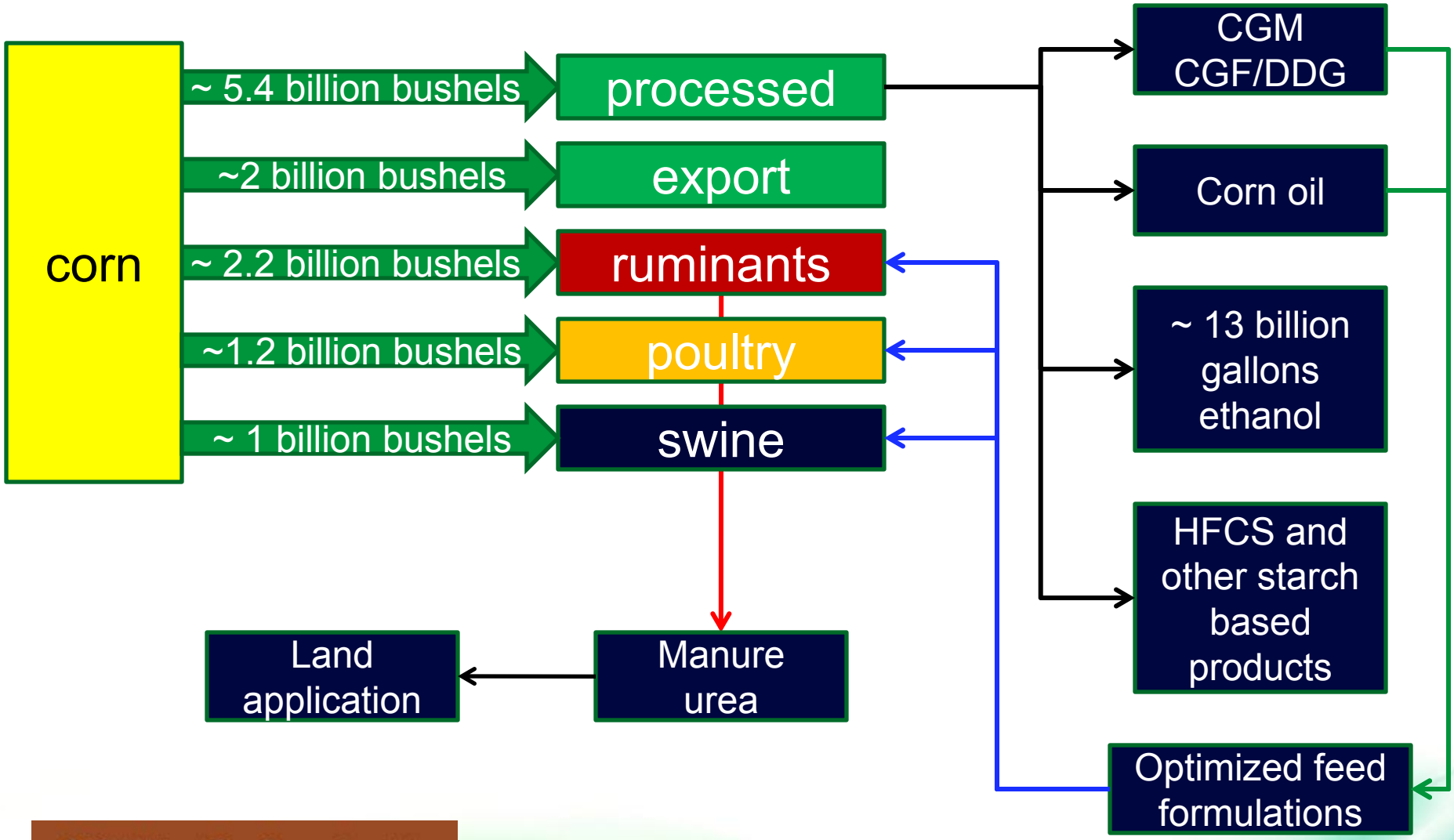
Fate of corn produced in the US in 2010



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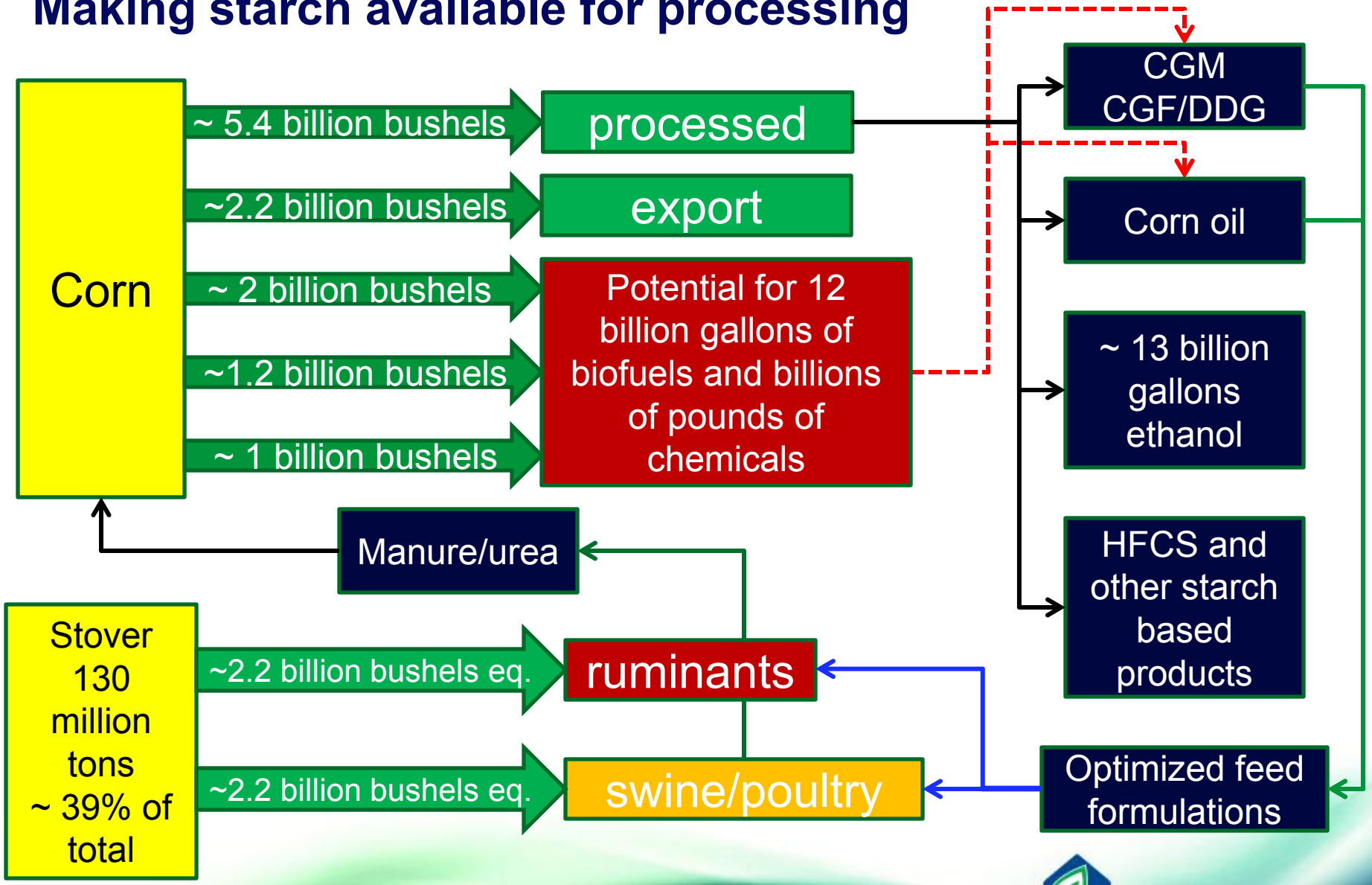
A more efficient use of ligno-cellulose
Making starch available for processing



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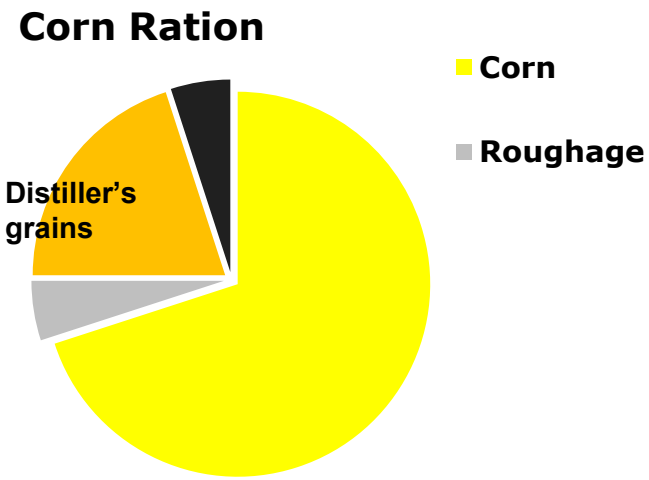
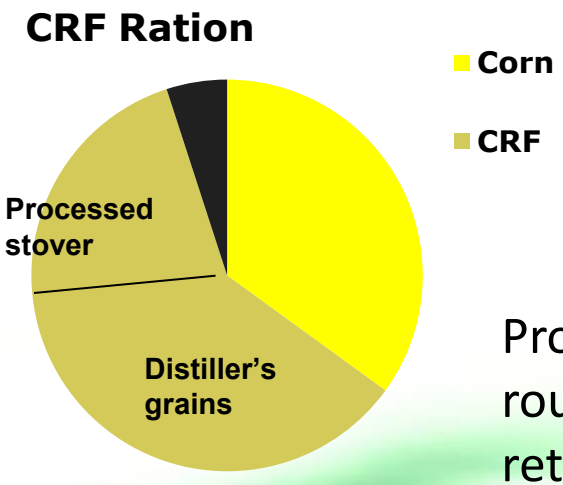
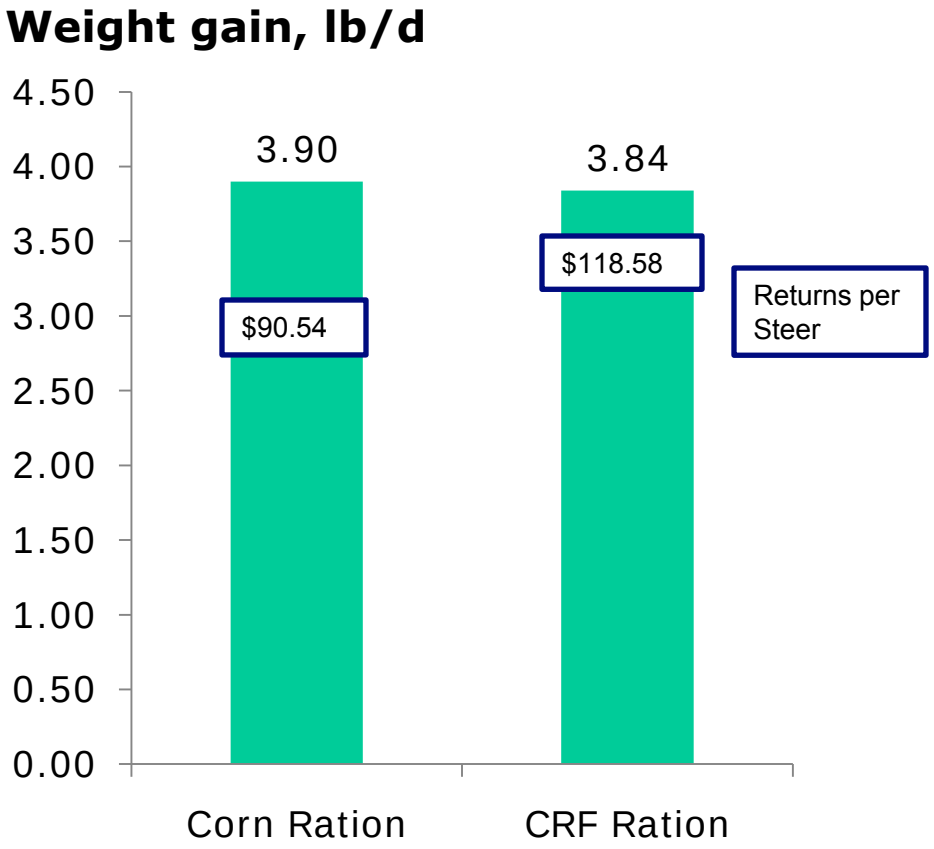
Biomass to Animal Feed – Another Paradigm
Initial results







Processed stover and co-products can displace grain and roughage with similar cattle performance and better returns per steer (ISU trial)

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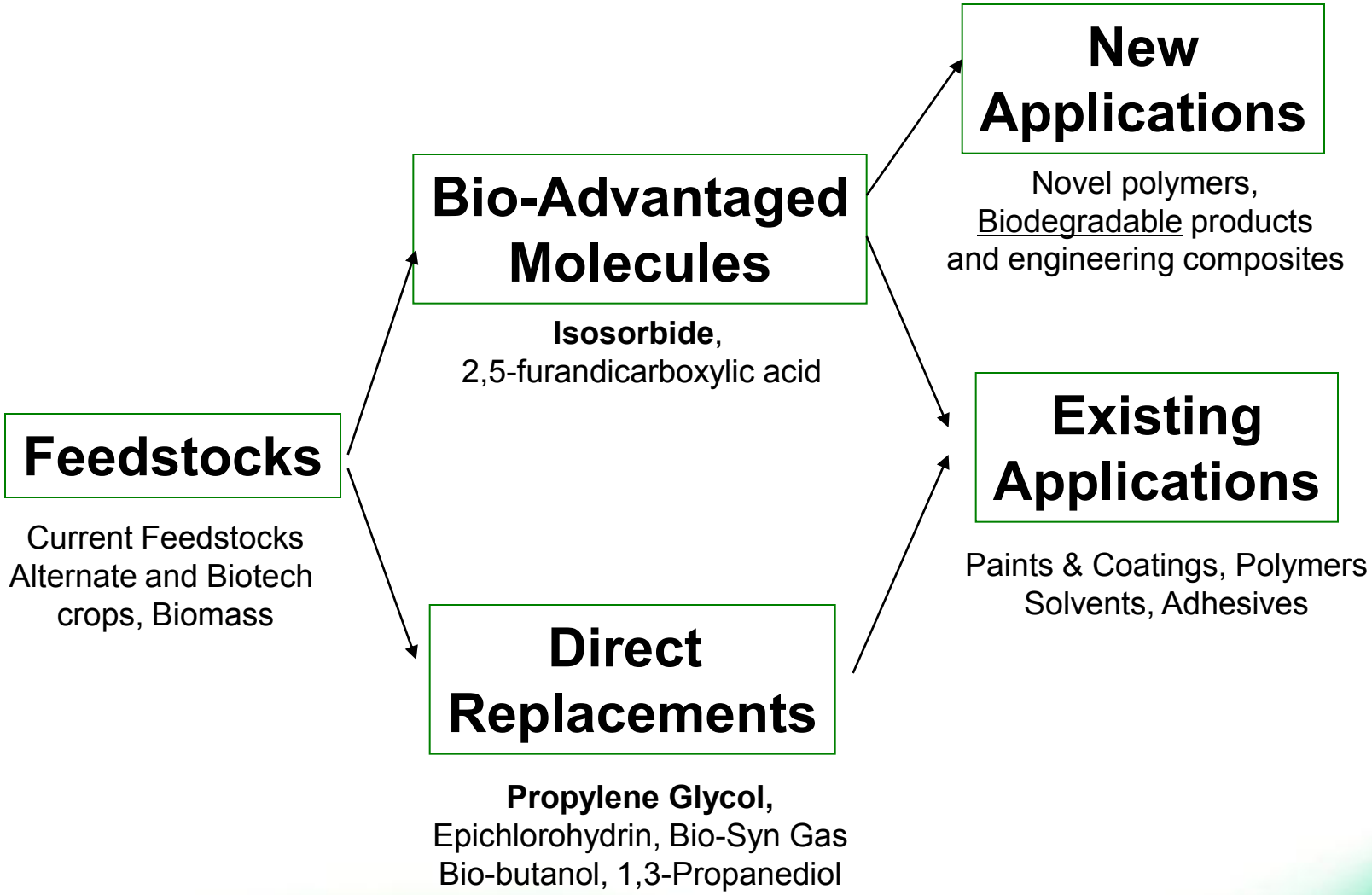
Technology Pathways



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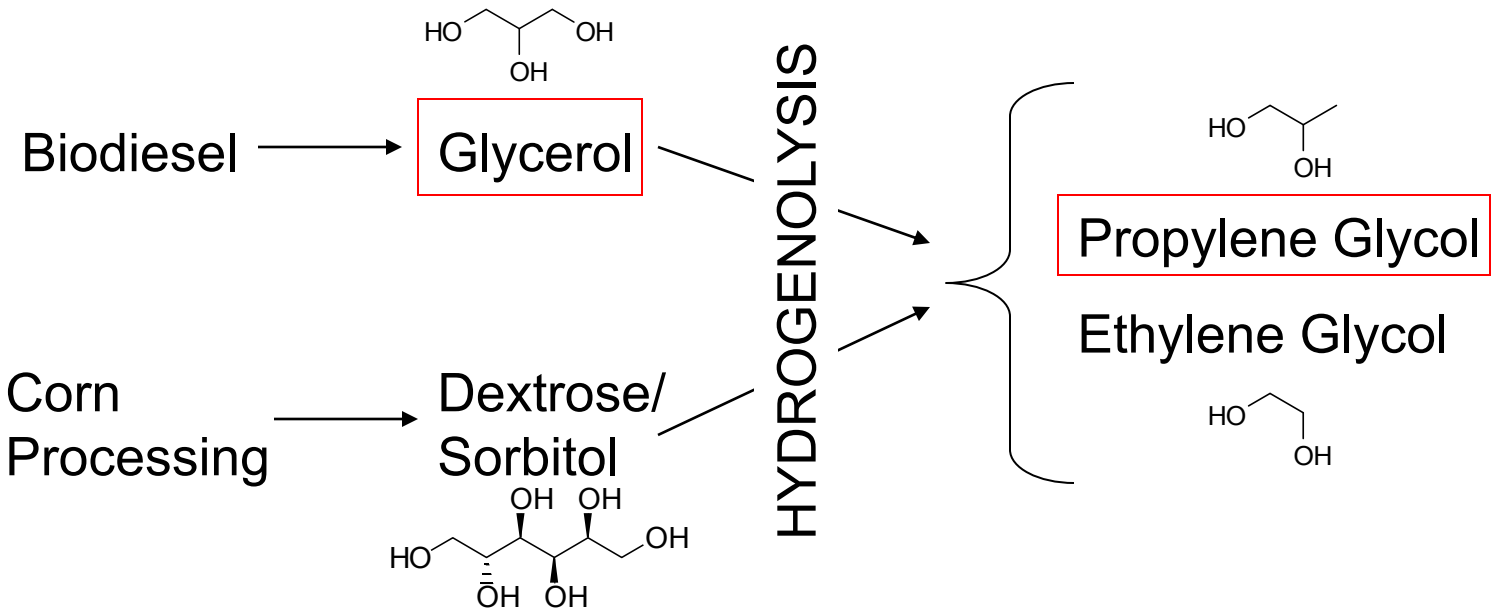
Direct Replacement: Propylene Glycol



- Use glycerol co-product from Biodiesel
- Flexible feedstock – Carbohydrates, Oilseeds
- USP and industrial grades
- 100% biobased – use to formulate products
  - ASTM D6866-08 **Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis**

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ADM is Piloting Our Next Direct Replacement - Acrylic Acid

- ADM awarded US DOE pilot plant grant for $25 million; ADM will invest $11 million.
- This project uses proprietary technology to separate cellulose, hemi-cellulose and lignin into individual components; these components are then utilized for fuels and chemicals production
- The ADM facility will produce cellulosic ethanol and **acrylic acid/esters**.
- The process will also recover minerals and salts from the biomass that can be returned to the soil.

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DOE-ADM Integrated Biorefinery Benefits and Expected Outcomes

Consume

- Less than four (4) gallons of water per gallon of biofuel produced
- Less than 10,000 BTU of fossil energy per gallon of fuel produced

Demonstrate

- Process for separation of cellulose, hemicellulose and lignin
- Viability of current organisms to effectively ferment xylose
- 80% selectivity of glycerol to acrylic acid

Produce

- 75 gallons of ethanol per ton of biomass
- Design data for full scale commercial plant

Validate

- Quality of the final fuel and chemical
- Material and Energy balance

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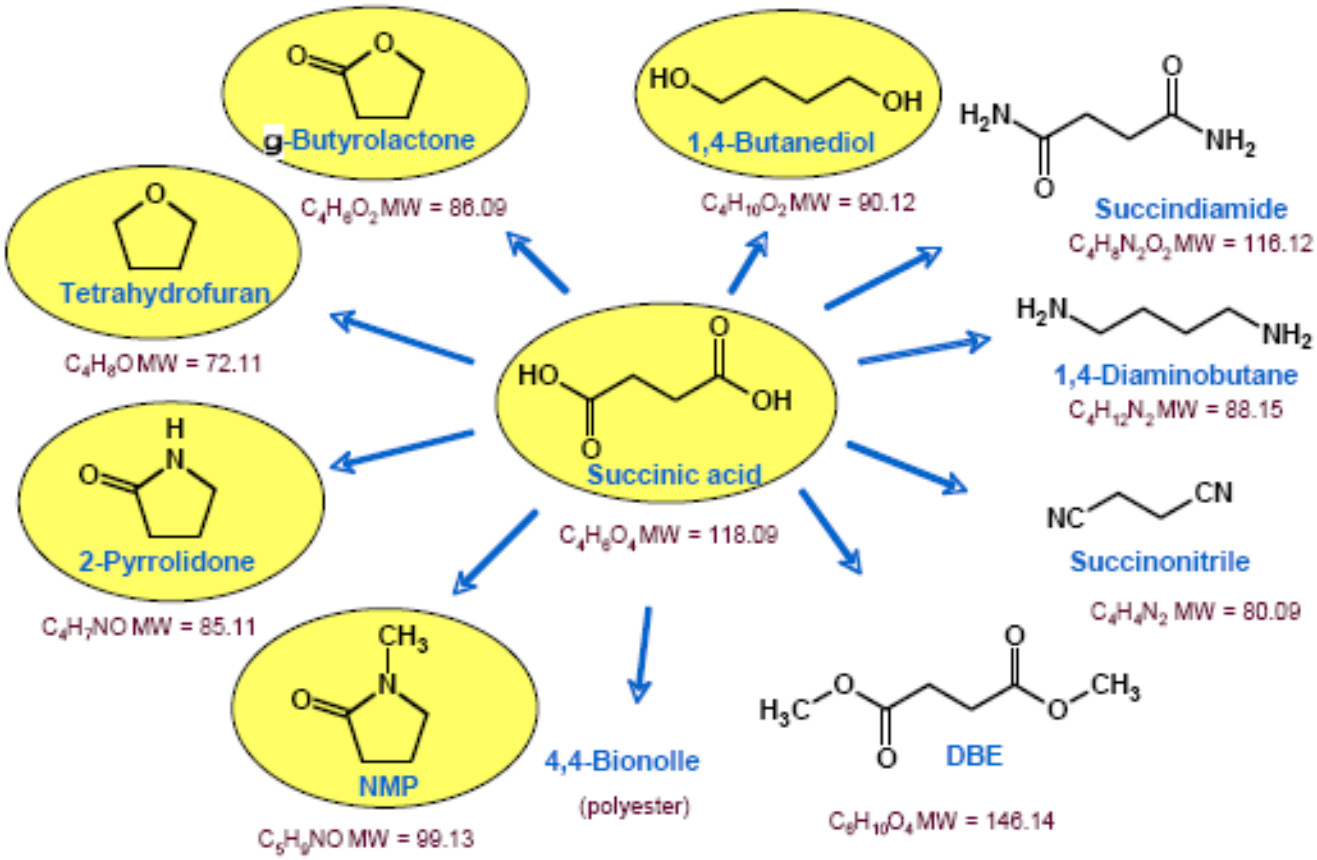
Under Development
C4 Platform – Di-acids and Derivatives



Source: DOE Top Chemicals from Biomass

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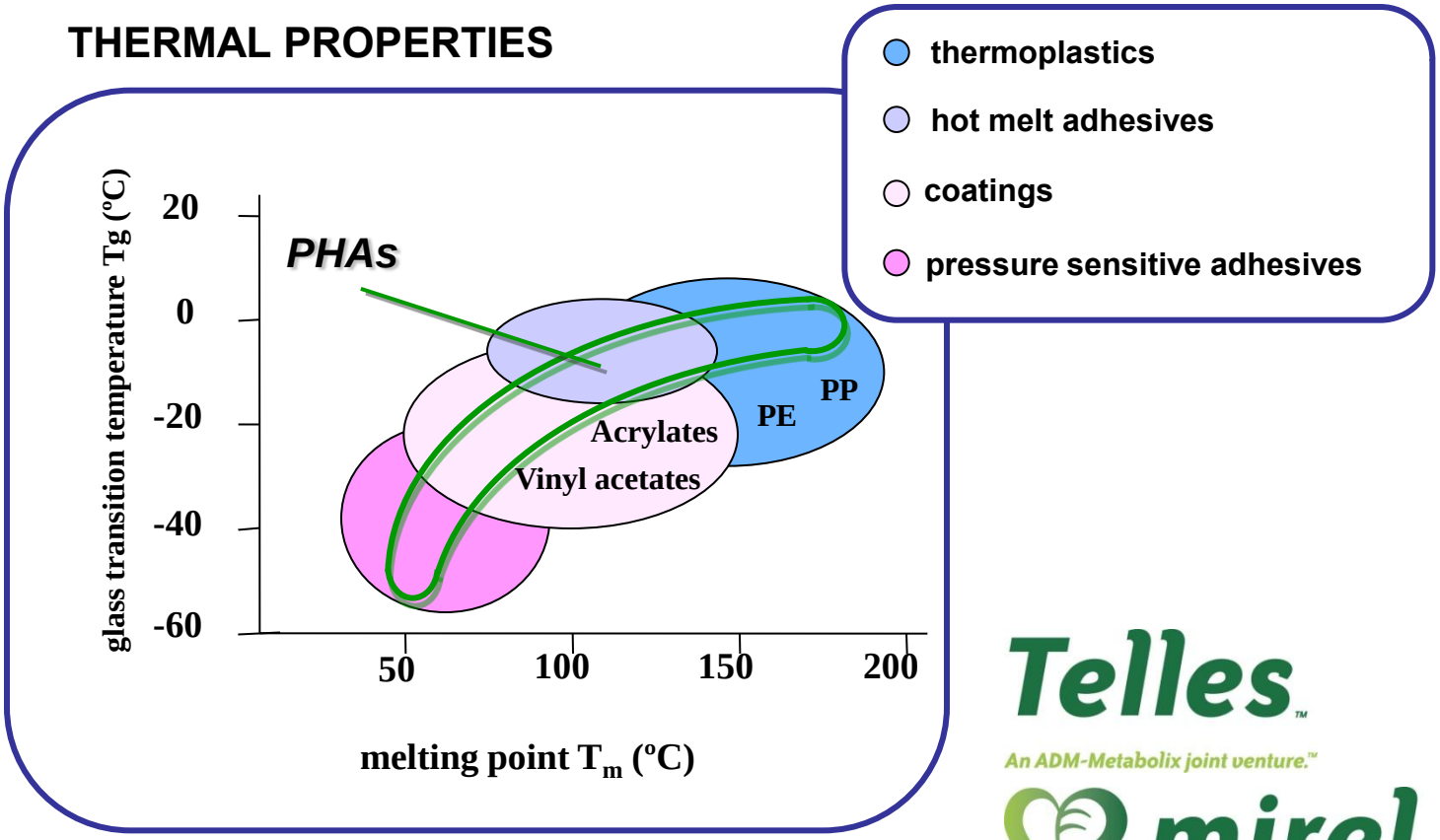
Bio-Advantaged Molecules

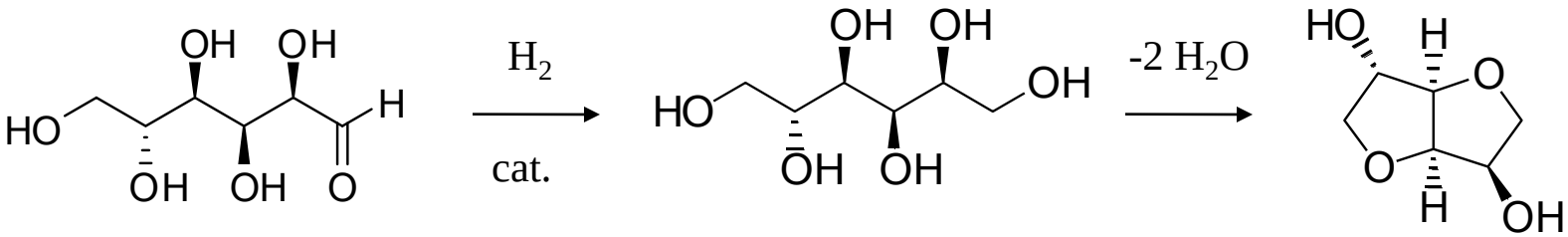
PHA Property Space

Broad Property Space Now Economically Accessed



Telles™
An ADM-Metabolix joint venture.™
mirel™
High Performance Natural Plastics™
ADM

Bio-Advantaged: Isosorbide

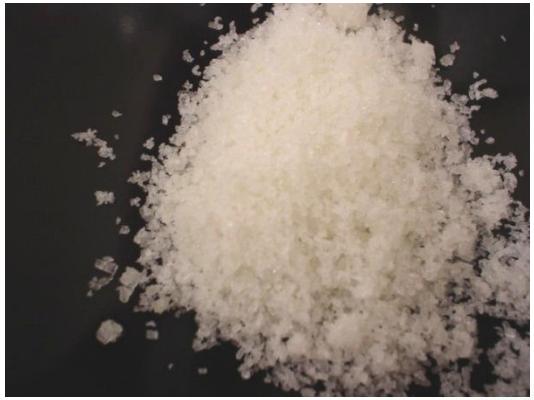


Glucose
(C6 sugars)

Sorbitol
(C6 sugar polyols)

Isosorbide
(dianhydrohexitols)

- ADM is a leading producer of sorbitol
- ADM granted US Patents 6,849,748 and 7,439,352 titled "Process for the production of anhydrosugar alcohols" that covers isosorbide
- Potential replacement for Bisphenol-A
- Currently Producing Commercial Quantities



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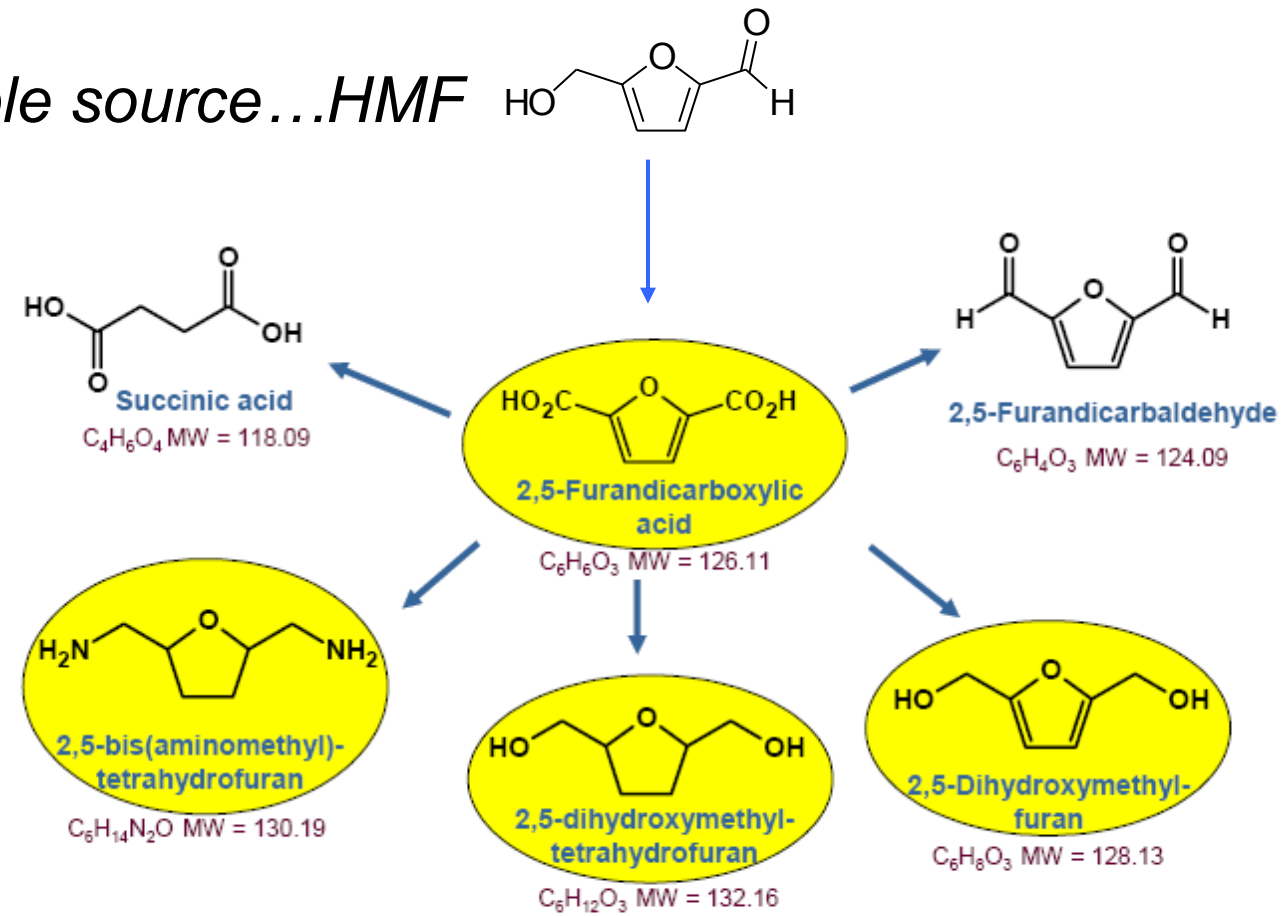
In Development: C6-Furanics Platform

Probable source…HMF



<u>Diols, diacids, diamines all have clear potential applications</u>

Adapted from: DOE Top Chemicals from Biomass

What will it take to build a secure, sustainable future?

An ADM perspective

- **Continued innovation**. Oil and gas have a half-century head start. Biofuel and biobased chemicals have just restarted after a major delay-we need continued innovation and collaboration.

- **Diversity of supply**. Biofuels won't be the total answer. We'll need other renewable, sustainable energy: wind, solar, hydroelectric, geothermal.

- **Continued advances on the farm**. Regionally appropriate approaches to improve water utilization, to ensure that fertilizers and pesticides are used efficiently to achieve desired productivity gains while minimizing environmental impacts.

- **Continued investment** in infrastructure to transport, process and store tomorrow's larger crops.

- **Dialogue, collaboration and a shared sense of possibility and purpose.**