PRIME BioSolutions

National Association of State Energy Officials

Washington, DC

February 8, 2012

PRIME is:

Dave Hallberg

Bump Kraeger

Dave Hallberg

David Hallberg has been involved with public policy and alternative fuels commercialization in the U.S. and worldwide for more than thirty years. He spent time in the Middle East region shortly after the 1973 Arab/Israeli War, after which he graduated from the Johns Hopkins School of Advanced International Studies in Washington, DC, with an M.A. degree in International Relations and Economics. From 1976 - 1981, Hallberg served as a legislative aide in the U.S. Senate and House of Representatives, and was actively involved in the drafting and enactment of the formative legislation that catalyzed the commercialization of the U.S. biofuels industry.

In January 1981, Hallberg left Capitol Hill to form the Renewable Fuels Association, and served as its president/CEO until 1985. During his tenure, the industry increased its domestic production capacity by more than 500%.

Hallberg is the inventor of three US patents dedicated to the cost effective production of low carbon fuels and reduced carbon footprints: US Pat.#5,070,061 (December 1991); US Pat.#6,355,456 (March 2002); and US Pat.#7,381,550 (April 2008). In addition to his public policy and business activities, Hallberg has also been active in the global climate change area. In February 2000, he was a member of the U.S. Government delegation to the G8 Forum on Climate Change Best Practices in Shonan Village, Japan, where he was appointed chair of the Working Group on Agriculture, Land Use, and Forestry.

Hallberg is a former Director of the Nebraska Ethanol Board; as well as the National Ethanol Vehicle Coalition; and the American Coalition for Ethanol (ACE), and was winner of its Grassroots Award; a member of the Governor's Carbon Sequestration Advisory Committee; a member of the Governors' Biofuels Coalition's Advisory Committee; and served as Co-Chair of the Western Governors' Association's Biomass Task Force of the Clean and Diversified Energy Advisory Committee. Hallberg has represented clients from the US and worldwide, including Brazil; Australia; Europe; and the Caribbean.

Bump Kraeger

Bump Kraeger received his B.S. in Animal Science from the University of Nebraska – Lincoln, where he studied under Dr. Terry Klopfenstein, widely regarded as one of the world's leading experts on ruminant animal nutrition. As production manager at feedyards of twenty to thirty thousand cattle, Kraeger was one of the early practitioners of the use of wet distillers' byproducts in beef cattle rations. He has also been responsible for permitting and environmental compliance, specifically related to nutrient management. From 1996 to 2001, Kraeger served as an advisor to the Lower Platte North Natural Resources District.

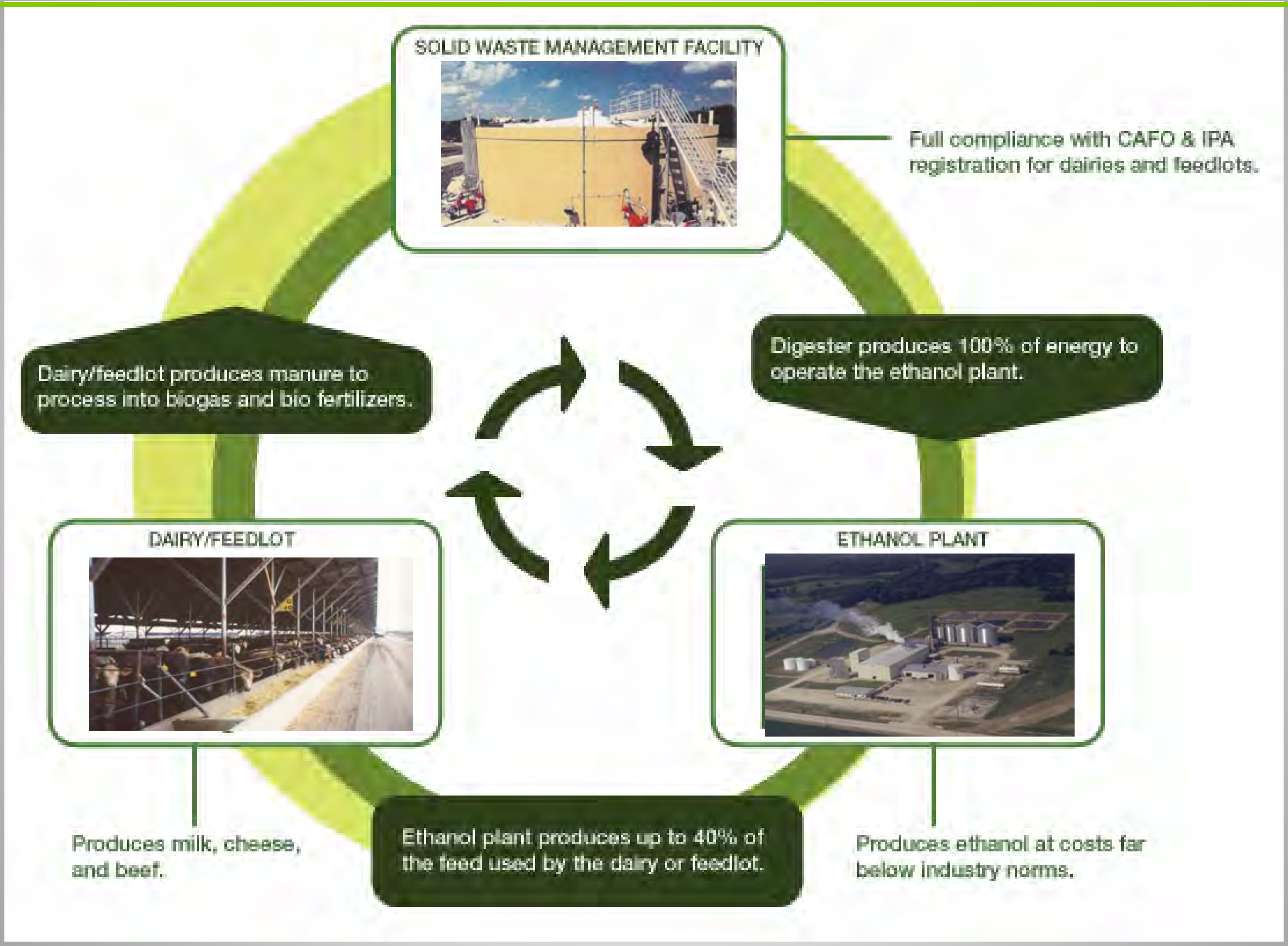
Kraeger's involvement with biofuels began in 1998 when he helped to develop the technology associated with the integration of ethanol production, cattle feeding, and anaerobic digestion of animal wastes. Most recently, Kraeger has helped to improve commercial processes in the area of nutrient separation and capture (biofertilizers), as well as algae production for use in producing biodiesel and cattle feed. He serves on the board of Nebraska Green Fuels Cooperative, a biofuels and technology marketing cooperative, and is PRIME's principal contact with UN-L researchers in a joint venture to demonstrate advancing technologies in low carbon fuels production.

- University of Nebraska - Lincoln

Dr. George Oyler, MD Phd

George Olyer is the Director of the UNL-led Multi-Institutional Algal BioEnergy Alliance (ABA) and Research Associate Professor of Biochemistry at the University of Nebraska-Lincoln. He graduated Cum Laude with a BSE in Chemical Engineering in 1984 from Princeton University, obtained a PhD in cell and molecular biology in 1989 from Penn State University, and earned his MD in medicine also from Penn State University in 1991. He served his residency and postdoctoral fellowship at Johns Hopkins. Dr. Olyer has received numerous grant awards and has published forty research articles in prestigious journals. He is also the founder and current president of Synaptic Research, LLC, and Clean Green Chesapeake, LLC, both in Baltimore, Maryland.

Integrated BioRefinery – “IBR”



Ethanol Plant

- **Projected plant size is 2 - 50 million gallons of ethanol per year**
- **Primary input will be grain (Barley, Grain Sorghum, Corn)**
- **Outputs**
  - Wet distillers grains / stillage – used in adjacent cattle operation
  - Thin stillage / syrup – used as feedstock for AD unit
- **Fueled by biogas from AD unit**
  - Replaces 90% -100% of natural gas
- **Processing steps and cost of drying wet stillage are reduced**

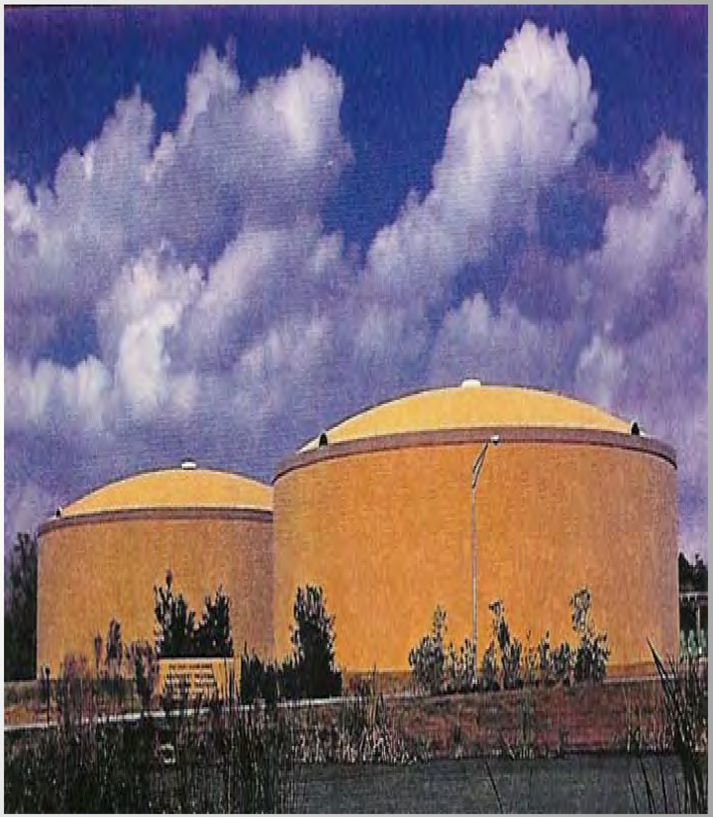
** Pictured is an ethanol plant that is not a IBR. It is not owned, or proposed to be owned by PRIME Biosolutions.*

Cattle Operation

- Adjacent cattle operation – confined beef production
- Cattle operation uses wet stillage output of ethanol plant
- Cattle waste moved to AD to produce methane gas

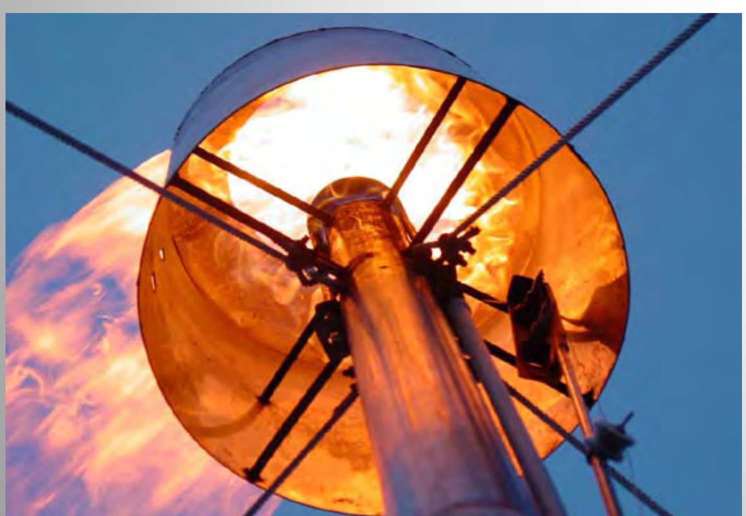
Anaerobic Digester – “AD”

- **Proven stand-alone technology**
- **Fueled by biomass**
  - Manure from the feedlot
  - Thin stillage from the ethanol plant
  - Waste heat from the ethanol plant
- **We believe this is the best available technology**
  - Patented process train
  - Expected to replace nearly all natural gas needs
    - Second largest operating cost
  - Expected economic removal of effluents
    - Nitrogen
    - Phosphorus
  - Expected to assist in Concentrated Animal Feeding Operation (“CAFO”) compliance
  - **Greatly reduces or eliminates odors**



** Pictured above is a digester not owned, or proposed to be owned by PRIME Biosolutions.*

Biogas Powers the Ethanol Plant



** Pictured above is equipment associated with the AD. Not owned, or proposed to be owned by PRIME Biosolutions.*

- **Generate steam for ethanol production**
- **Displace natural gas**
  - 2nd largest cost factor in ethanol production
- **Derived from volatile organic solids**
  - Material responsible for odor of animal and other waste streams
- **Methane gas mixed with CO_2 and moisture**

PRIME BioSolutions

Patented IBR involves involves co-locating a dry mill ethanol plant with a confined cattle operations and a specialized anaerobic digester ("AD") in a "closed loop" system.

- Conventional ethanol plant - will use grain as the primary feedstock
- Cattle operation – an adjacent confined cattle feeding operation uses ethanol byproduct as feed
- Anaerobic digester - converts cattle waste to methane (replacing costly natural gas) and other environmentally improved outputs.

- **We project that IBR is a more efficient method to produce ethanol**
  - IBR has a projected Net Fossil Energy Ratio of 5:1 (ratio of BTU output per BTU input)
  - Conventional ethanol plant has a ratio of 2:1

(Based on study by National Commission on Energy Policy)

Take Away Points

- Location
  - No need for rail
  - No need for natural gas
- Size the facility according to the ethanol market within trucking/pumping distance

Ethanol Market

- Component of Gasoline
  - Octane
    - Toluene
    - Benzene
- Clean Air Act – 1990
  - EPA Enforcement – focused on vehicles…
    - But it's the fuel!!!

Back to the Closed Loop

- Method Patents

United States Patent 6,355,456

- **Hallberg, et al. March 12, 2002** Process of using wet grain residue from ethanol production to feed livestock for methane production
- **Abstract**
  - An integrated continuous process for the production of ethanol and a bio-gas containing methane is disclosed. The process comprises the following steps. First, grain is fermented in an aqueous medium to produce ethanol in the medium which contains a wet distillers' grain with solubles as a wet grain residue and carbon dioxide. Next, the wet grain is feed to livestock in a feedlot which has slatted floors. The wet grain residue constitutes 25-80% of a feed ration of the livestock on a dry weight basis. The feed ration consists essentially of the 25-80% wet grain residue and grain. Third, the manure from the livestock is collected from beneath the slatted floor. Fourth, the collected manure is digested anaerobically with microorganisms to produce the bio-gas containing methane and, as a residue, a bio-fertilizer. Fifth, the bio-gas is combusted to produce heat. Sixth, the grain is dry milled utilizing heat produced by the combustion.
- Inventors: **Hallberg; David E.** (N/A)**, Schlesinger; Victor W.** (both of Omaha, NE) Assignee: **Dakota Ag Energy, Inc.** (Sioux Falls, SD) Appl. No.: **09/487,604** Filed: **January 19, 2000**

United States Patent 7,381,550

- **Hallberg, et al. June 3, 2009** Integrated process for producing “clean beef” (or milk), ethanol, cattle feed and bio-gas/bio fertilizer.
- **Abstract**

  - An ethanol unit and anaerobic digestion/bio-fertilizer unit are integrated with a cattle feedlot (or dairy operation), wherein a continuous, balanced process yields a sanitary, low- to zero-pollution, and economically efficient production of "clean beef" (or milk), fuel ethanol, and bio-gas/bio-fertilizer. Fossil fuel consumption is substantially reduced, even eliminated, and 100% of the cattle waste is treated in digesters wherein it is converted into medium-BTU gas (bio-gas), organic fertilizer and bio-compost. The ethanol unit serves the purposes of ethanol production, grain pretreatment to produce feed for the cattle and production of a thin stillage which is fed to the digesters. The grain is first processed in the ethanol unit, where the starch portion is converted into ethanol and CO.sub.2. The remaining portion is separated into the thin stillage and a wet cake which is fed directly to cattle as a superior ruminant animal ration which displaces certain traditional feed components, alters the standard starch to protein ratio, and significantly improves conversion efficiencies and meat/milk quality.

- Inventors: **Hallberg; David E.** (Omaha, NE)**, Schlesinger; Victor W.** (Omaha, NE) Assignee: **Prime Bioshield, LLC.** (Omaha, NE) Appl. No.: **10/752,531** Filed: **January 8, 2004**

Summary of Environmental Benefits

- Dramatically less Fossil Fuels; renewable biogas produced on site.
- 95% or greater reduction in odors
- GHG reductions
- No dryers and thermal oxidizers like in a normal ethanol plant.
- Digestion of the waste and separation and recovery of the nutrients
- Minimal dust and particulates
- For every 2 gallons of water used, we are able to recover more than 1 gallon to be used again either as irrigation water or as process water.

IBR Operating Cost Advantages

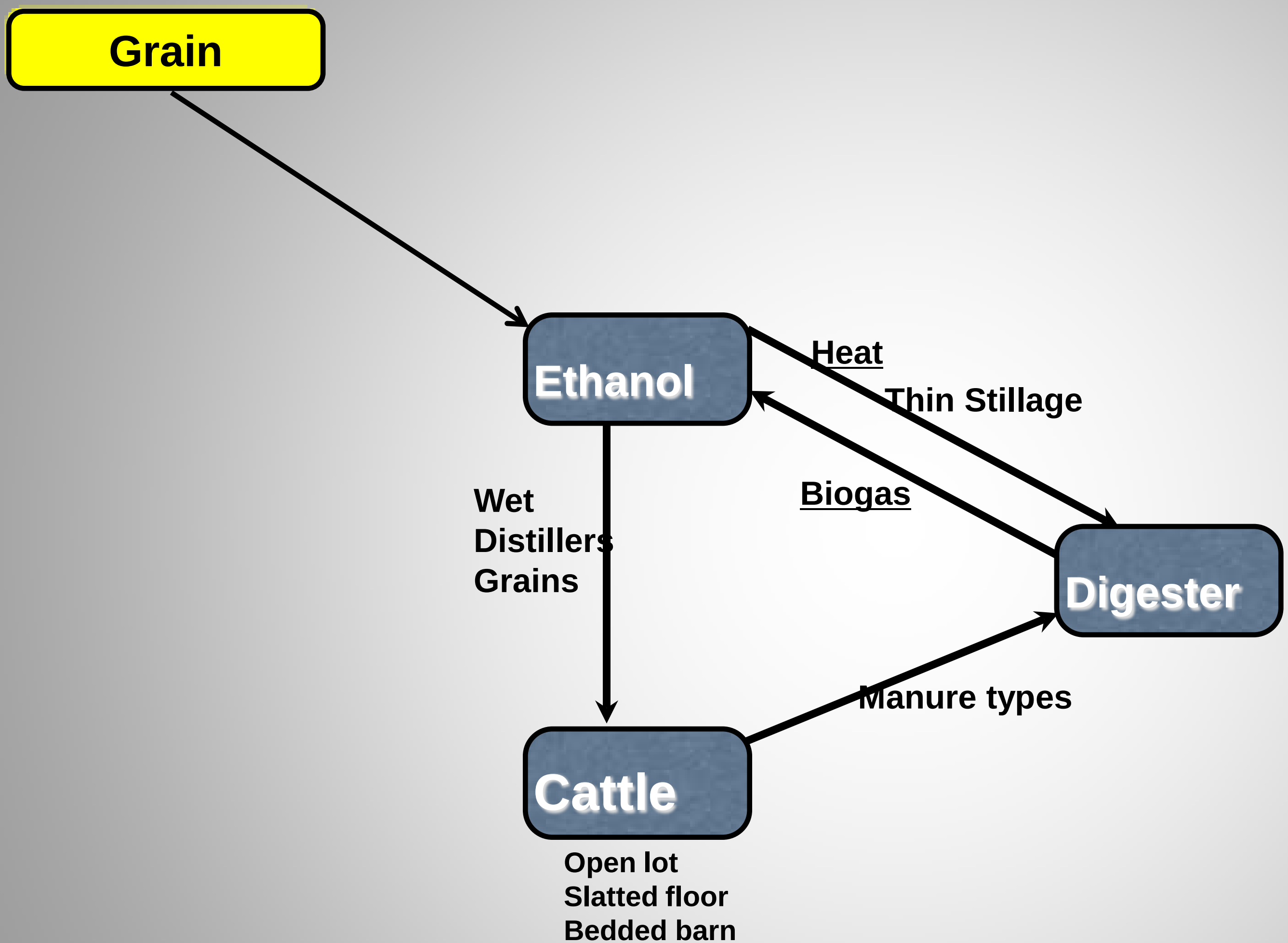
- **The IBR system will reduce key production costs, allowing it to be a lower cost producer of ethanol**
  - Energy cost should be reduced because natural gas (the second largest cost component) will be replaced by methane gas produced from cattle waste in the AD
  - Net grain cost (the largest production cost component of ethanol) should be reduced
    - the output from grain fermentation (wet stillage) will be used as cattle feed on the adjacent cattle operation without the additional cost to dry the stillage and transport it
  - IBR Qualifies for Industrial Revenue Bond (IRB) Financing

Definition Advantages

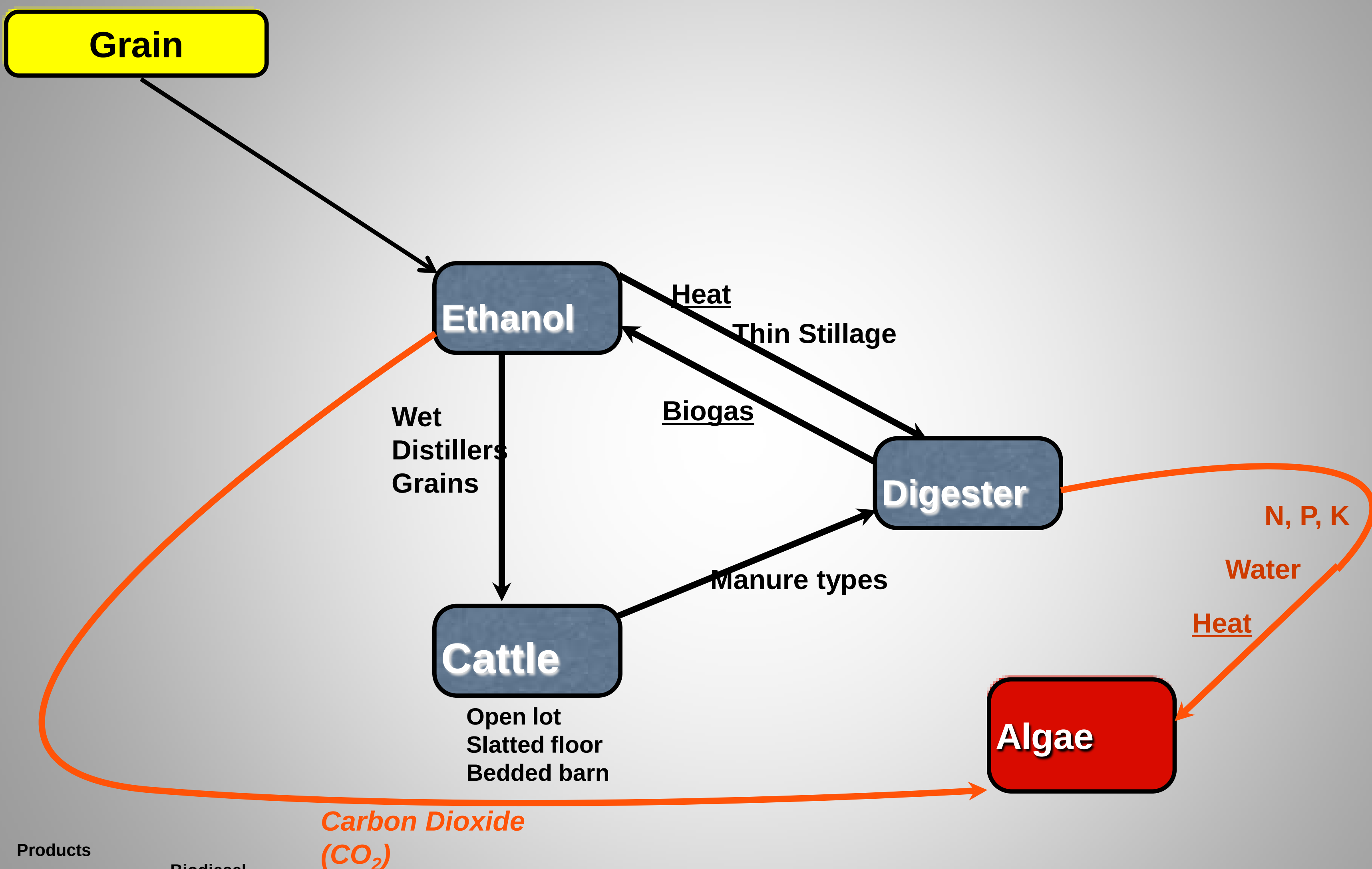
- Advanced Ethanol
  - Barley
  - Grain Sorghum

- Low Carbon Fuel
  - GREET & BESS Models
  - > 80% Carbon reduction compared to gasoline
  - California Air Resources Board

UNL PRIME ICM Superloop Biorefinery



UNL PRIME ICM Superloop Biorefinery



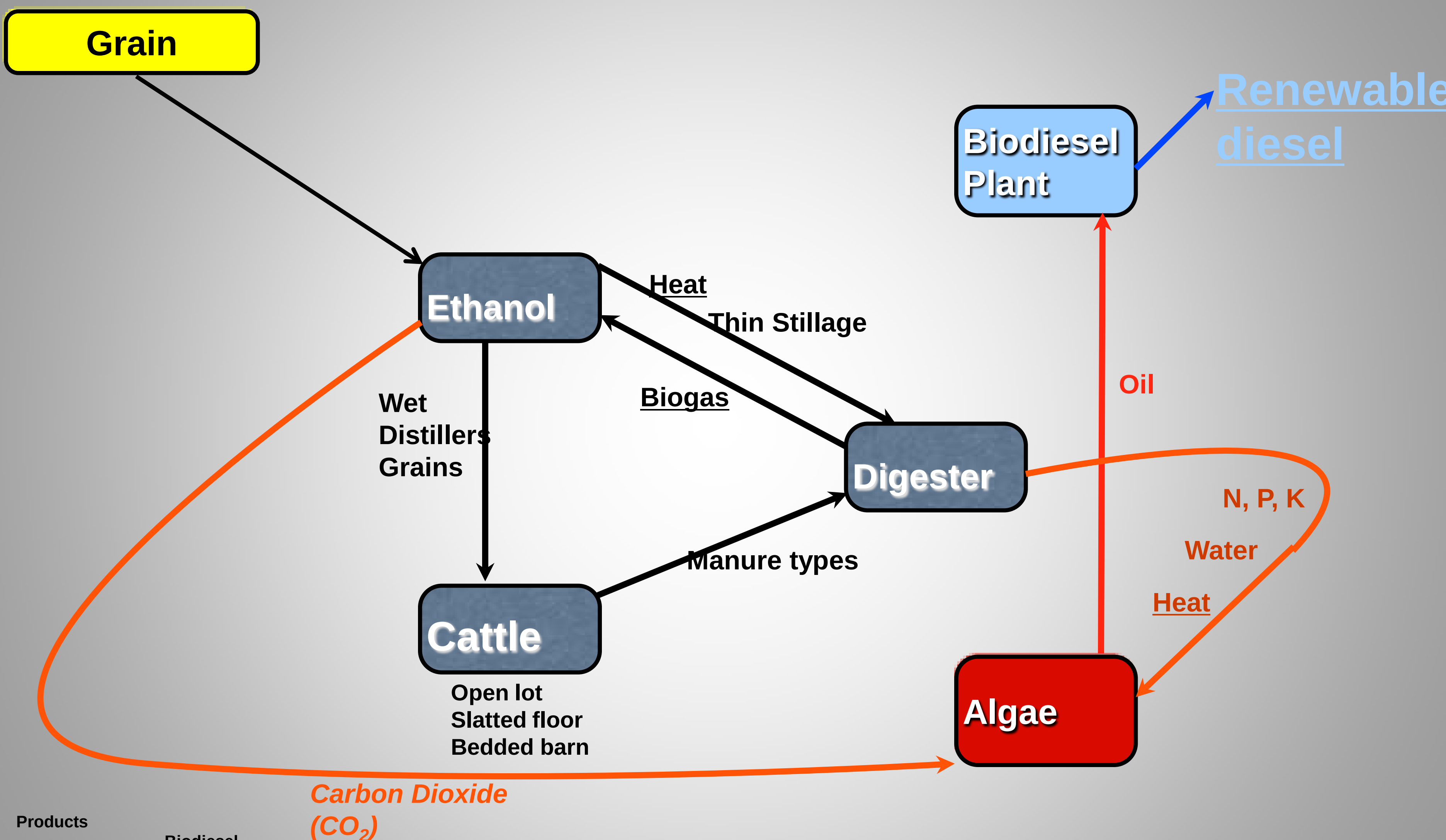
Products

- Biodiesel
- Ethanol
- NPK fertilizer
- Beef

Inputs

- Grain sorghum
- Cattle

UNL PRIME ICM Superloop Biorefinery



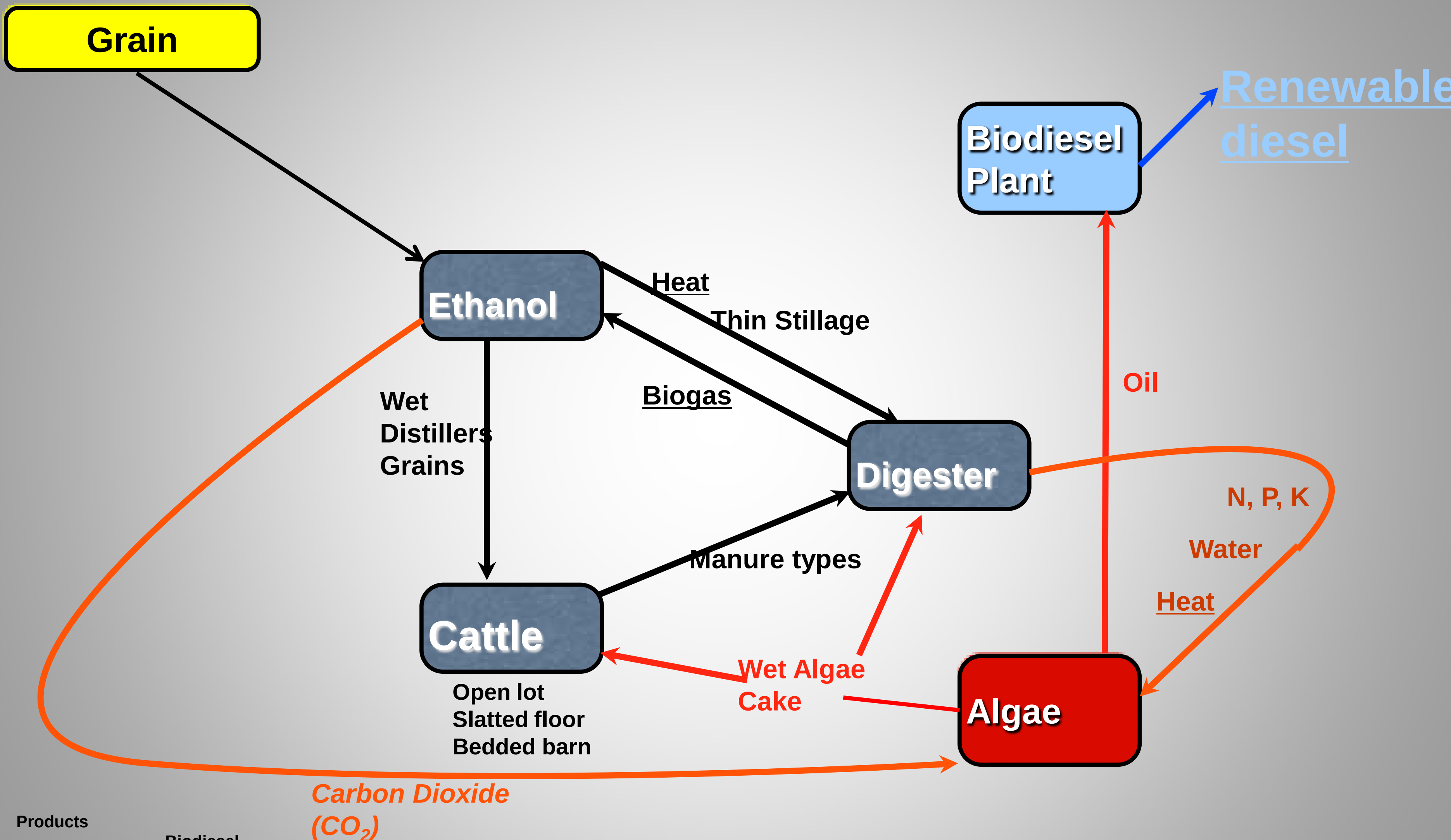
Products

- Biodiesel
- Ethanol
- NPK fertilizer
- Beef

Inputs

- Grain sorghum
- Cattle

UNL PRIME ICM Superloop Biorefinery



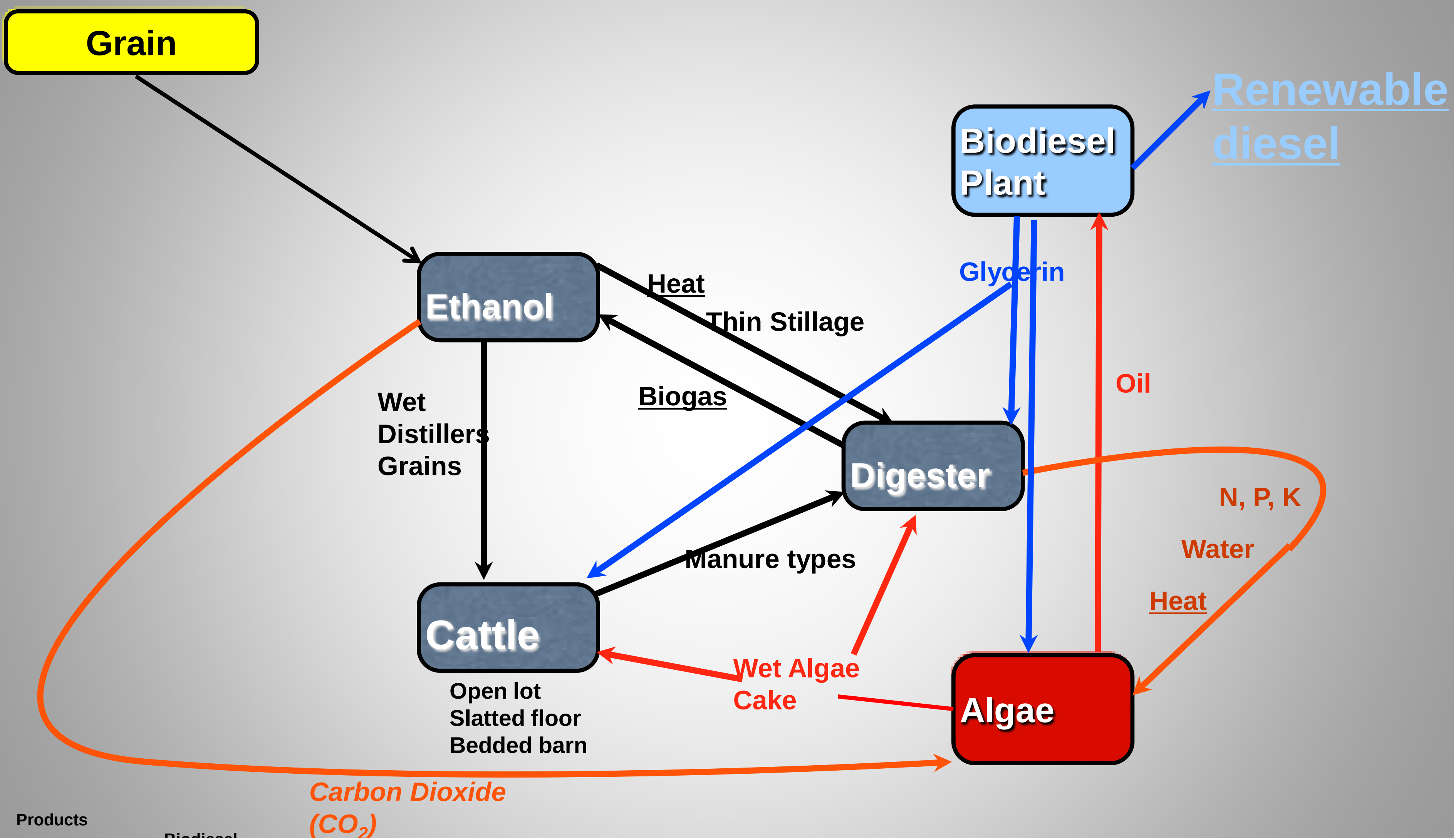
Products

Biodiesel
Ethanol
NPK fertilizer
Beef

Inputs

Grain sorghum
Cattle

UNL PRIME ICM Superloop Biorefinery



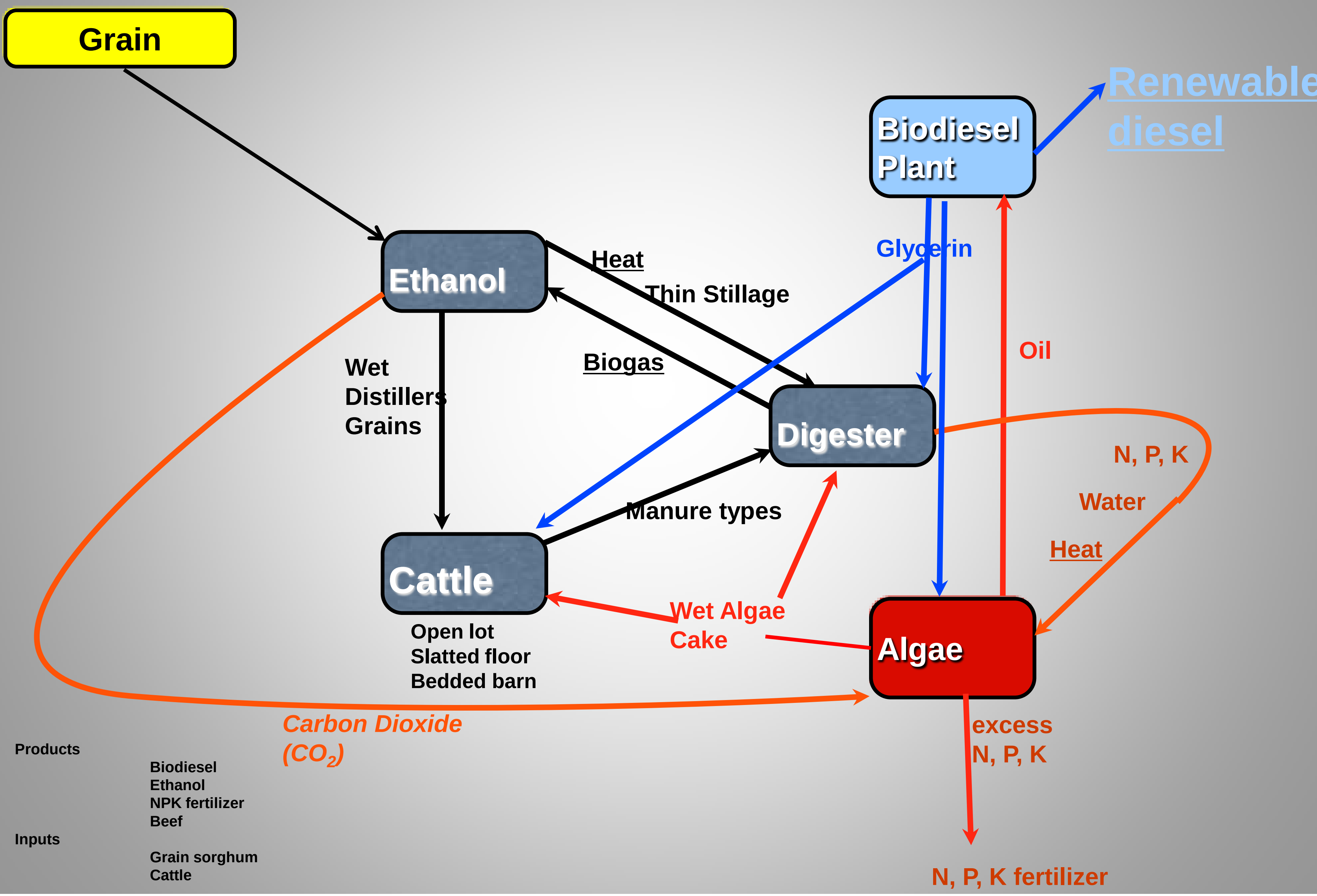
Products

- Biodiesel
- Ethanol
- NPK fertilizer
- Beef

Inputs

- Grain sorghum
- Cattle

UNL PRIME ICM Superloop Biorefinery



Products

- Biodiesel
- Ethanol
- NPK fertilizer
- Beef

Inputs

- Grain sorghum
- Cattle

Recycle System

- Water
- Nitrogen
- Phosphorus

Cascade System

- Heat
- Energy

Energy Cascade

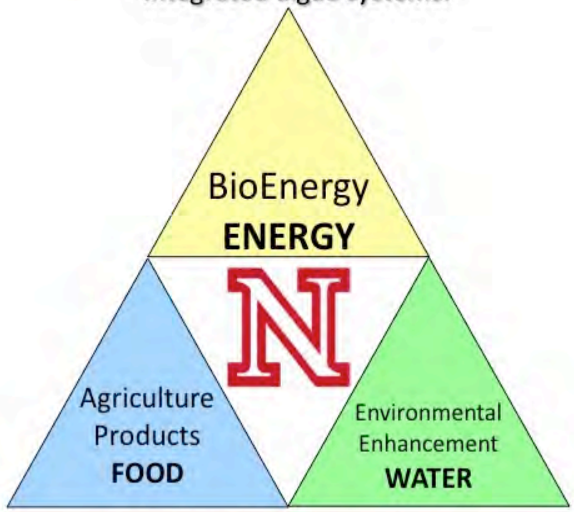
- Solar Energy collected in grain
- First cut converted to ethanol
- Next cut converted to beef
- Next cut converted to biogas
- Next cut is foundation for algae growth – combined with new Solar Energy

Summary

- Solar Energy Harvesting
  - Grain – ethanol – cattle feed – anaerobic digestion – algae – nutrient recovery/recycle
- Transportation is Expensive
  - Co-locate, Co-manage
- Quality of Life
  - "Small industrial scale"
  - Think Local!!!

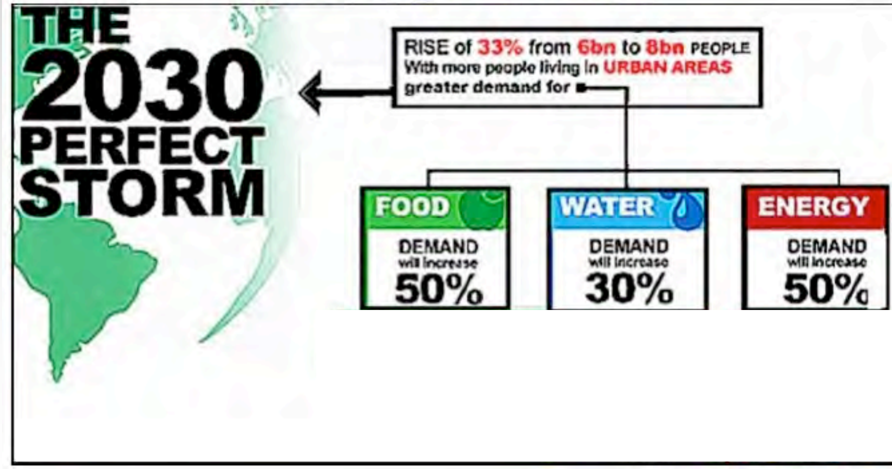
Algae – A Crop for the 21st Century?

Apex = Transformative integrated algae systems.



Base of pyramid: Basic Life Science and Agricultural Strengths of UNL

Nexus of Food – Water – Energy
The Algae Solution

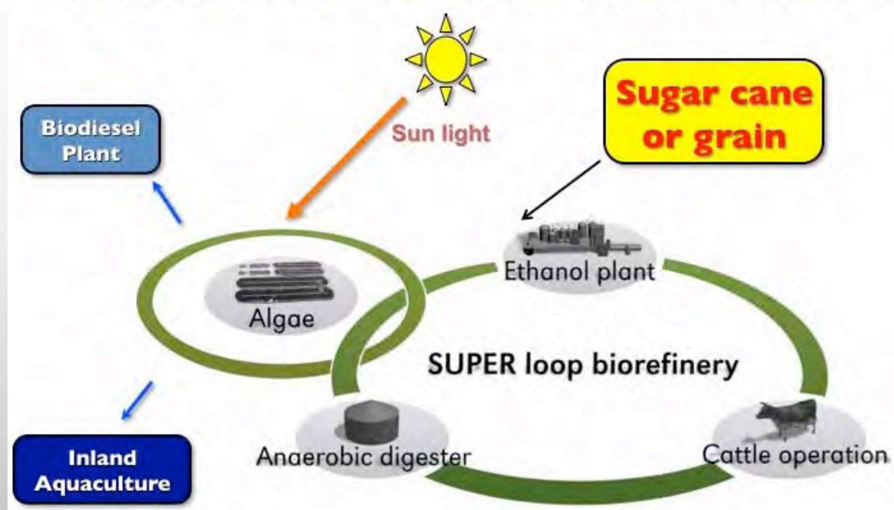


Algae have the great potential biofuels yield

Table 1 Potential oil yields per acre per year

Crop	Gallons of oil/acre/year
Soybeans	43
Sunflower	86
Canola	171
Jatrjopha	214
Palm oil	641
Microalgae	up to 6,000 (with future technology)

UNL / Prime BioSolutions / CGC Superloop Biorefinery

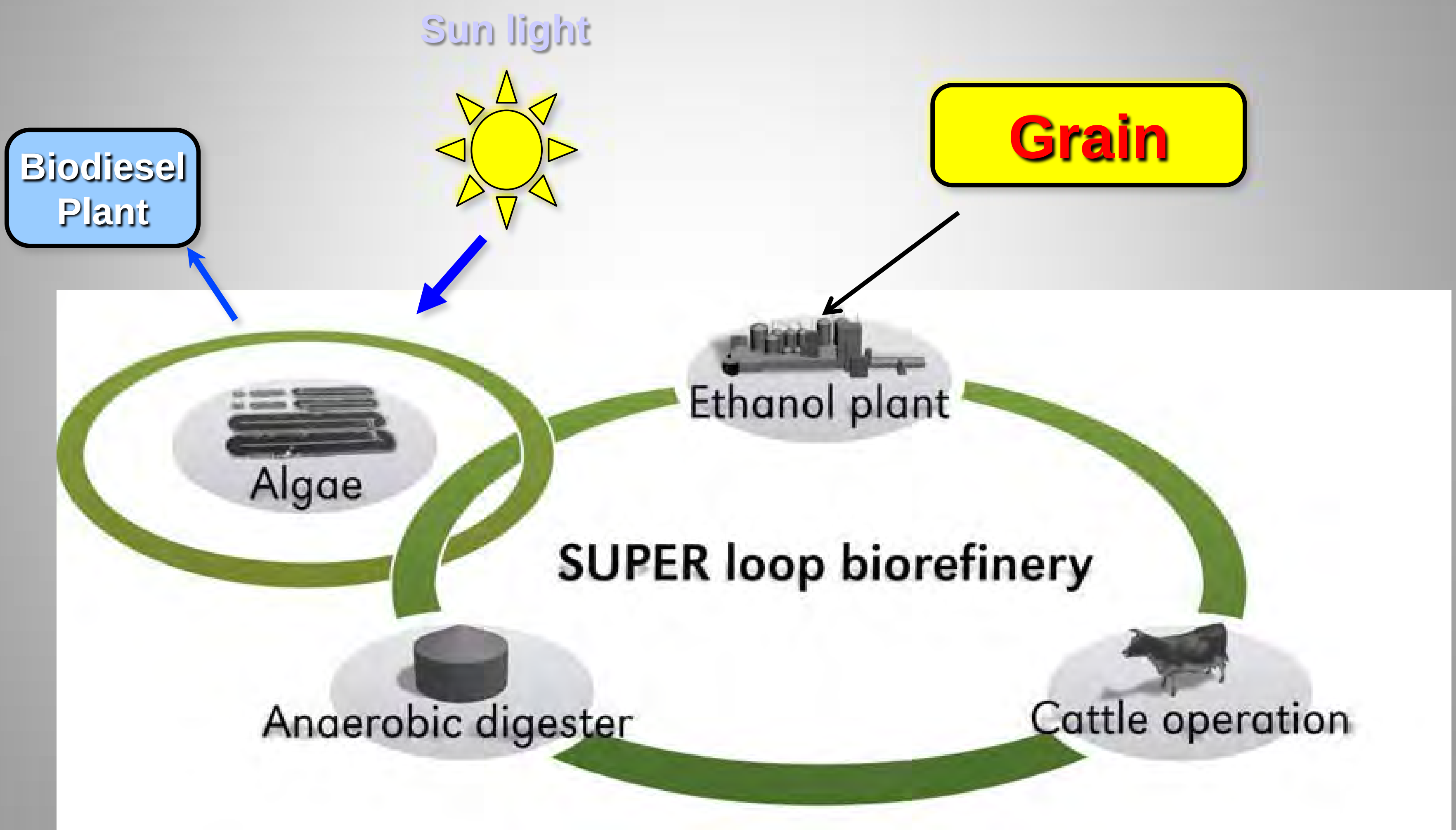


Why Algae for Biofuels?

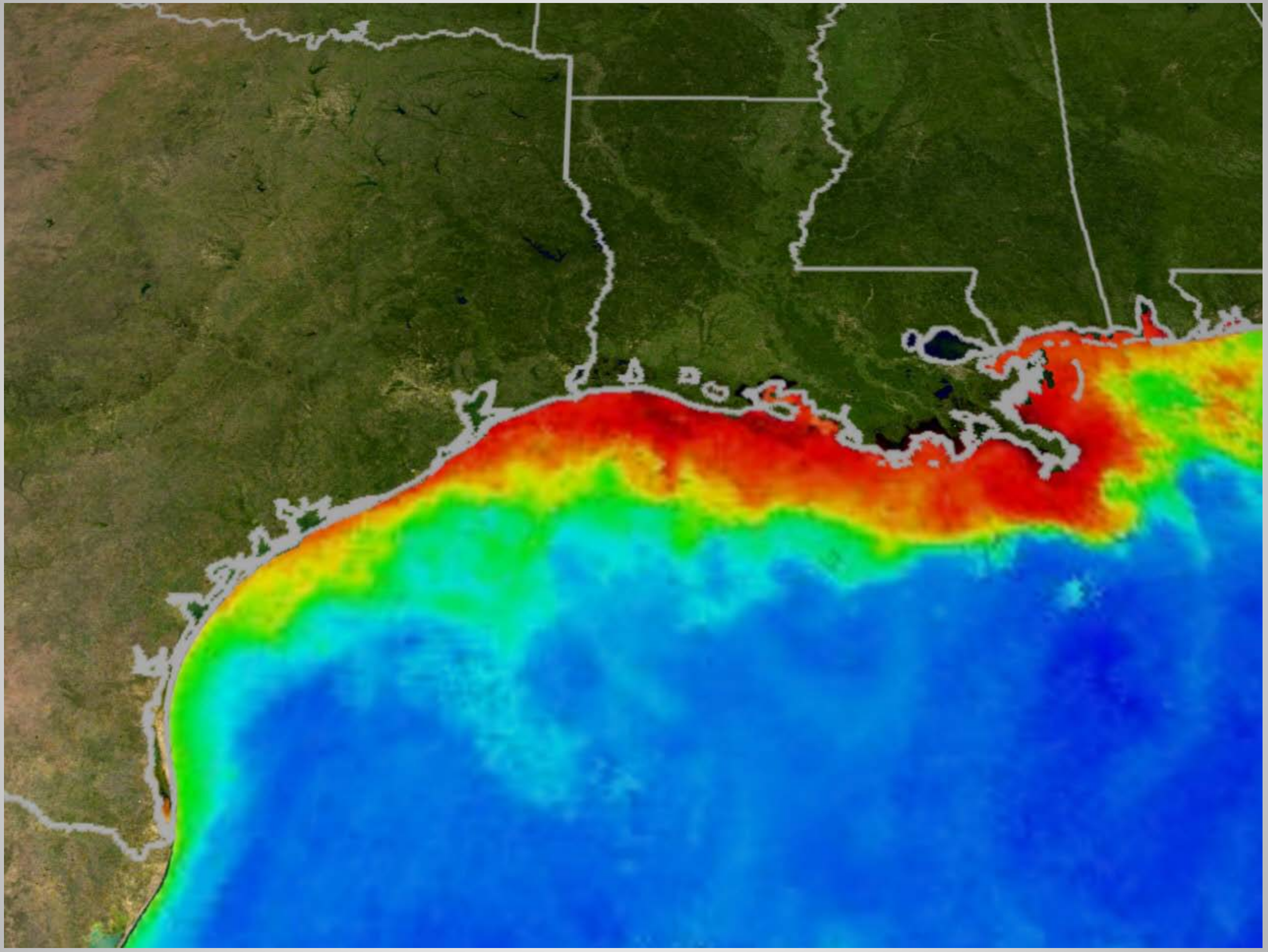
Algae have great potential in biofuels and GHG abatement

- Algae have extremely high productivity.
- Algae are photosynthetic and sequester CO_2.
- Algae do not compete with food crops.
- Algae do not require farm land.
- Algae can remediate water.
- Use of algae for wastewater treatment offers huge value added potential.

UNL Prime BioSolutions Superloop Biorefinery
Example of Integrated AD, Algae, Animal and Aquaculture Feed System

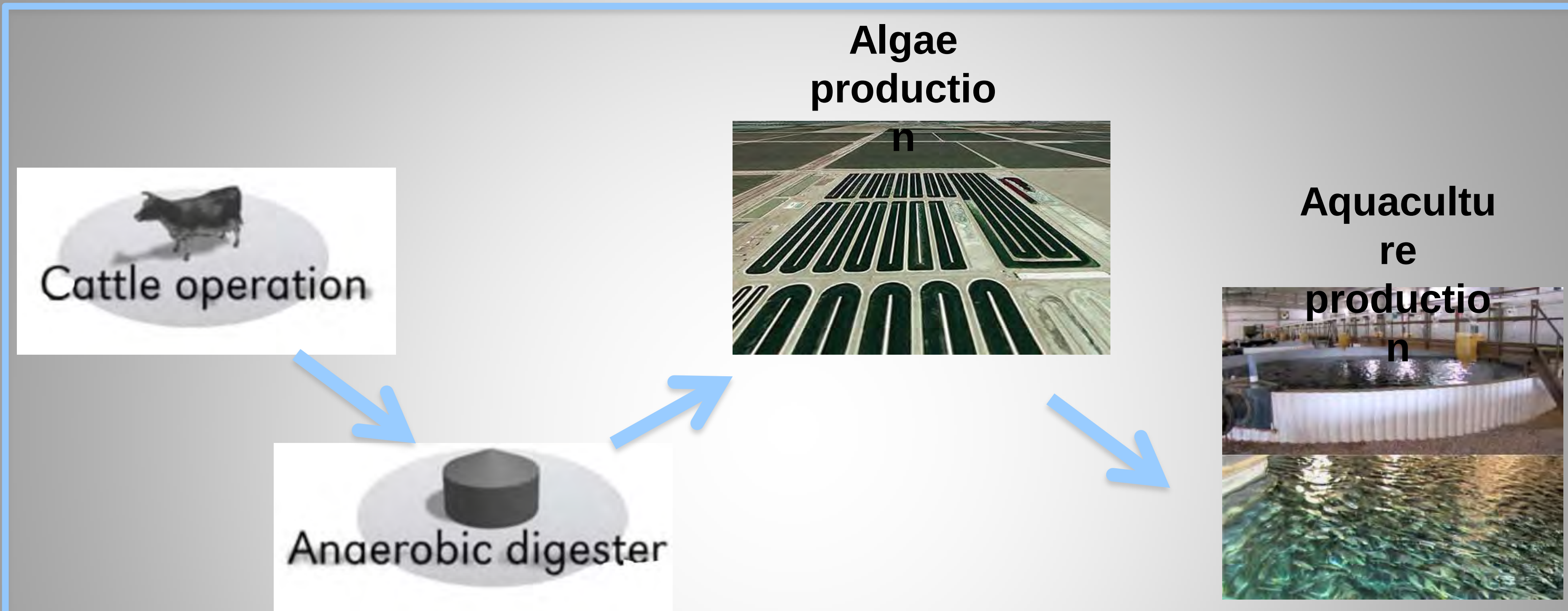


Eutrophication is a major challenge for the Midwest and world agriculture



Hypoxic zones are a world problem

Algae can be combined with animal agriculture, AD, and Aquaculture - an integrated industry for Nebraska and throughout USA



Summary

- The integrated biorefinery concept when coupled with animal agriculture and algae systems can substantially improve the economics, environmental, and food impact of ethanol bioenergy.
- Global C/N/P needs and the fuel/food/water triad must be considered in bioenergy plans – Superloop achieves these goal