MICHIGAN STATE UNIVERSITY

# Feed Protein Coproduction with Large Scale Biofuels: Some Land Resource Perspectives & Likely Economic Impacts

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# Presentation Overview

- Perspectives on animal feed/human food needs in the U. S.:  protein and calories
- Current U. S. production of plant proteins: acreage, amounts & value of protein
- Protein production in large scale perennial grass agriculture for biofuels: land displacement & economic impacts
- Protein recovery in a large scale biofuels industry
- Analytical approach within the RBAEF project

# Will People Go Hungry with Large Scale Biofuels?

- Macronutrients: 2500 kcal & 60 gm protein per person per day
- Total U.S. human demand: 240 trillion kcal & 5.8 trillion grams protein/yr (6.4 million tons/year)
- Three major U.S. crops *alone* (corn, soy, wheat) produce 1300 trillion kcal & 51 trillion grams protein/yr (56 million tons)
- Could meet U.S. human demand for protein & calories with 25 million acres of corn
- *Most U. S. grains are fed to animals-- i.e., we are meeting <u>their</u> protein/calorie needs from grains. Their needs are:*
  - 2100 trillion kcal/yr
  - 50 trillion gm protein/yr (55 million tons)
- Animal demands in U. S. for protein/calories approx. 10x basic human demands

# Coproducing Feeds and Fuels in Biorefineries

- *Unless human diets change significantly,* the "food vs. fuel" issue in the U. S. context is therefore to produce animal feeds:
  - more efficiently (less land, other inputs) and
  - with less environmental impact
- Must supply animals (fish, poultry, swine, cattle) with:
  - *Calories (food energy), and*
  - *Protein*
- Corn wet and dry mills already coproduce protein and energy feeds along with fuels and chemicals
- Biomass-based biorefineries will also make protein and energy feeds: economic, social & environmental reasons
- Focus on protein feeds

# Current U.S. Production of Plant Protein for Animal Feeds

- Soybeans
  - 74 million acres, 2.9 billion bu/yr, 27.2 million tons protein/yr
  - Current price approx. $250/ton 44% meal, or $0.28/lb protein and trending up ("mad cow" effect)
  - Soybean meal sets market price for protein
- Corn
  - 70 million acres, 9.9 billion bu/yr, 21.4 million tons protein/yr
- Alfalfa (and other forages)
  - 60 million acres of cropland used for pasture, 150 million tons forages/yr, 18 million tons protein/yr
  - Forages not widely traded: much of it grazed, not fed
- Neglect all other feed protein sources

# Protein Coproduction with Perennial Grasses: Land Use & Economic Impacts

- Switchgrass yield 10 tons/acre/yr
  - 10% protein (1st cut of two cut system-67% of total yield)
  - 80% protein recovery gives 1070 lb protein/acre/yr
- 51 million acres switchgrass replaces protein from 74 million acres soybean
- Some corn acreage could also be replaced– produce more protein with less total acres plus ethanol
- 100 gal liquid fuels/ton average from first and second cuts gives 52 billion gallons/yr
- Protein reduces switchgrass cost to refinery by about $30 per ton: eg, from $50/ton to $20/ton
  - $0.28/lb x 1070 lb = $300 total protein credit/acre
  - Divided by 10 tons grass/acre = $30/ton (less protein recovery costs)

# How Might Protein Be Recovered?

- From dry switchgrass
  - Leaf/stem separation by air classification: established, inexpensive technology
  - Extract protein by warm, dilute alkaline solutions, recover by heat/pH adjustment: straightforward, done at pilot scale
- From green, fresh switchgrass
  - Grind, squeeze protein rich juice and recover by heat/pH adjustment: formerly practiced in U.S., commercial in Europe

# Analytical Framework for Protein Coproducts Evaluation I

- Establish sizes of U.S. feed protein markets for various animals
- Determine major plant protein sources meeting these animal needs and cost of protein in these diets
- Establish nutritional adequacy of leaf protein in different animal diets
- Evaluate properties, likely economic value of proteins resulting from different recovery options

# Analytical Framework for Protein Coproducts Evaluation II

- Develop protein recovery modules for ASPEN model of switchgrass biorefinery-focus on pretreatment effects
- Estimate costs of protein recovery from these modules
- Determine net protein credit (protein value less cost to produce it) to overall biorefinery operations:
  - Per ton of biomass delivered
  - Per gallon of liquid fuels