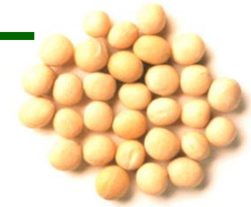
NDSU
Agribusiness and Applied Economics Department

Economic Feasibility of Supplementing Corn Ethanol Feedstock with Fractionated Dry Peas: A Risk Perspective

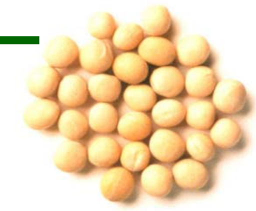
By
Cole Gustafson
Scott Pryor
Dennis Wiesenborn
Abhisek Goel
Ron Haugen
Andrew Wilhelmi

Risks That ND Ethanol Plants Face



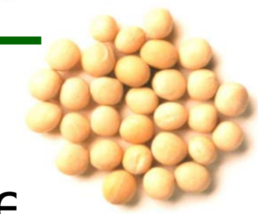
- Rising corn prices reduce ethanol plant profitability
- Uncertainty of corn availability in North Dakota.
- Problems of increasing ND corn production
  - Lack of moisture and early/late frost
  - Limited availability of corn varieties tailored to the state’s arid and northern climate.

Research Objective



Develop stochastic simulation model of a typical 100 mgy ND ethanol plant to evaluate the profitability and risk of using dry peas as a 10 %supplement for corn in ethanol production.

Dry Peas as a Producer of Starch

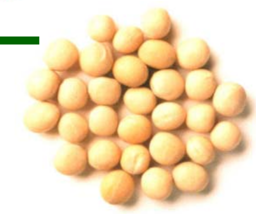


- Dry Peas starch is hydrolyzed into glucose using conventional enzymes and that the resulting sugars are easily fermented to ethanol (Nichols, Dien et al. 2005).

- Developed a process model based on the dry milling process, in which the key step is the dry pea fractionation by air classification (Wilhelmi et al. 2007).

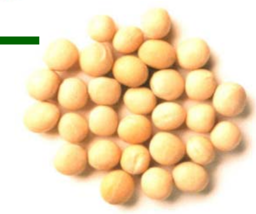
- Supplementation of dry pea starch increased the rate of fermentation (Pryor, 2007).

Alternative Feedstock's Have Potential to Reduce Corn Supply and Price Risks



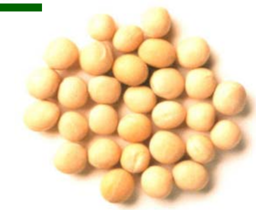
- Price correlation with corn < +1.0
- Local availability reduces corn supply risk/transportation costs
- More stable supply from native crops tailored to region
- Diversified feedstocks reduce mono-system agriculture
    - natural pest, weed, and disease protection

Dry Peas are Ideal Ethanol Feedstock



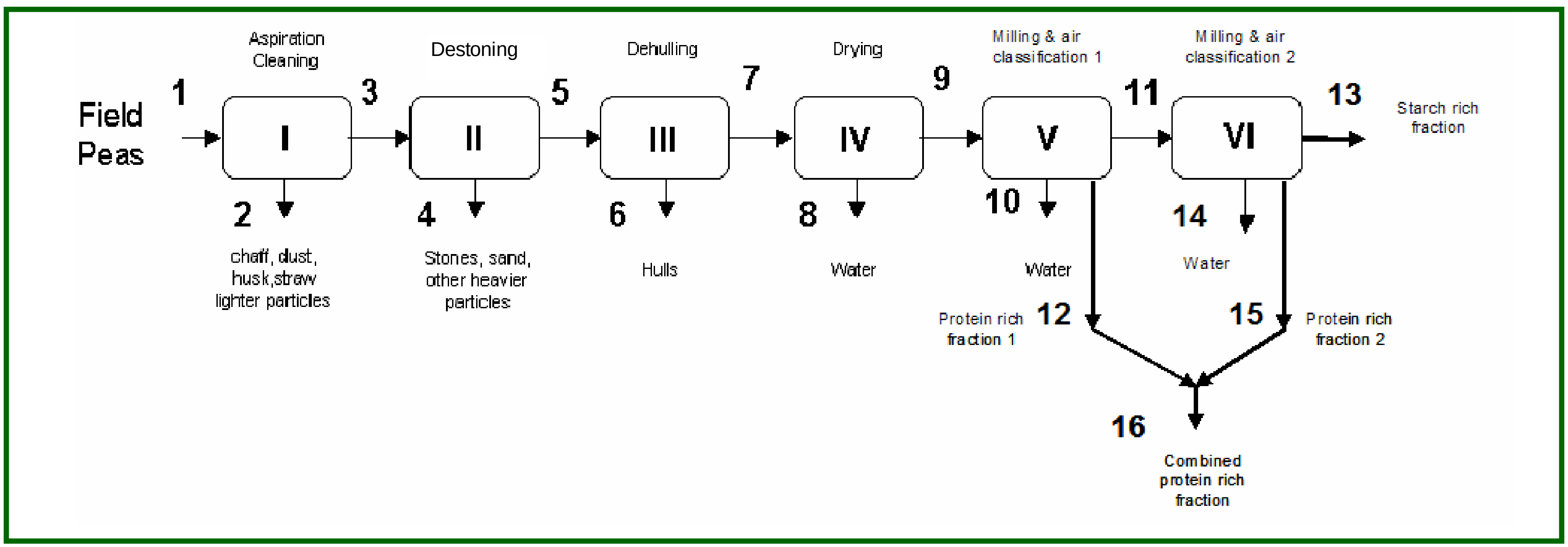
- Nitrogen fixing, low input cost
- Excellent rotational crop with small grains (break DON disease cycle)
- Protein byproduct is valuable for livestock/human consumption

Literature Review

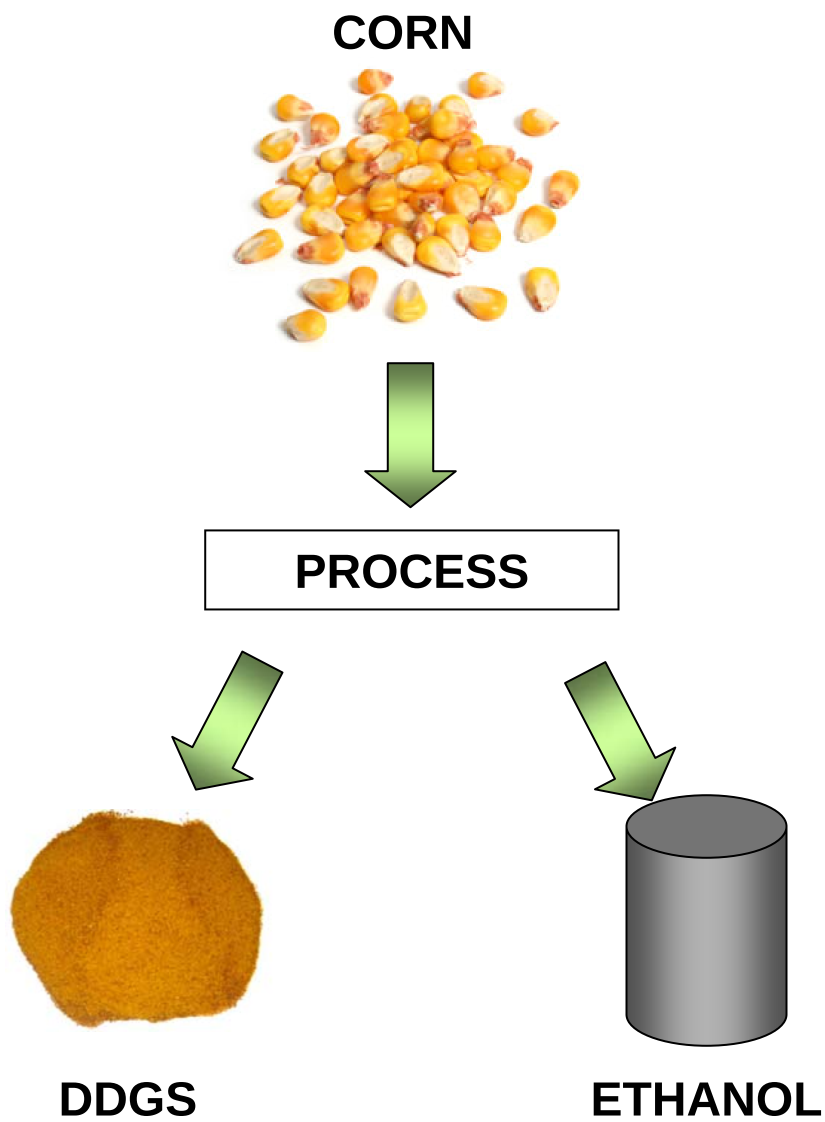


Dry Mill method of Fractionation of dry pea
(Wilhemi et al. 2007)

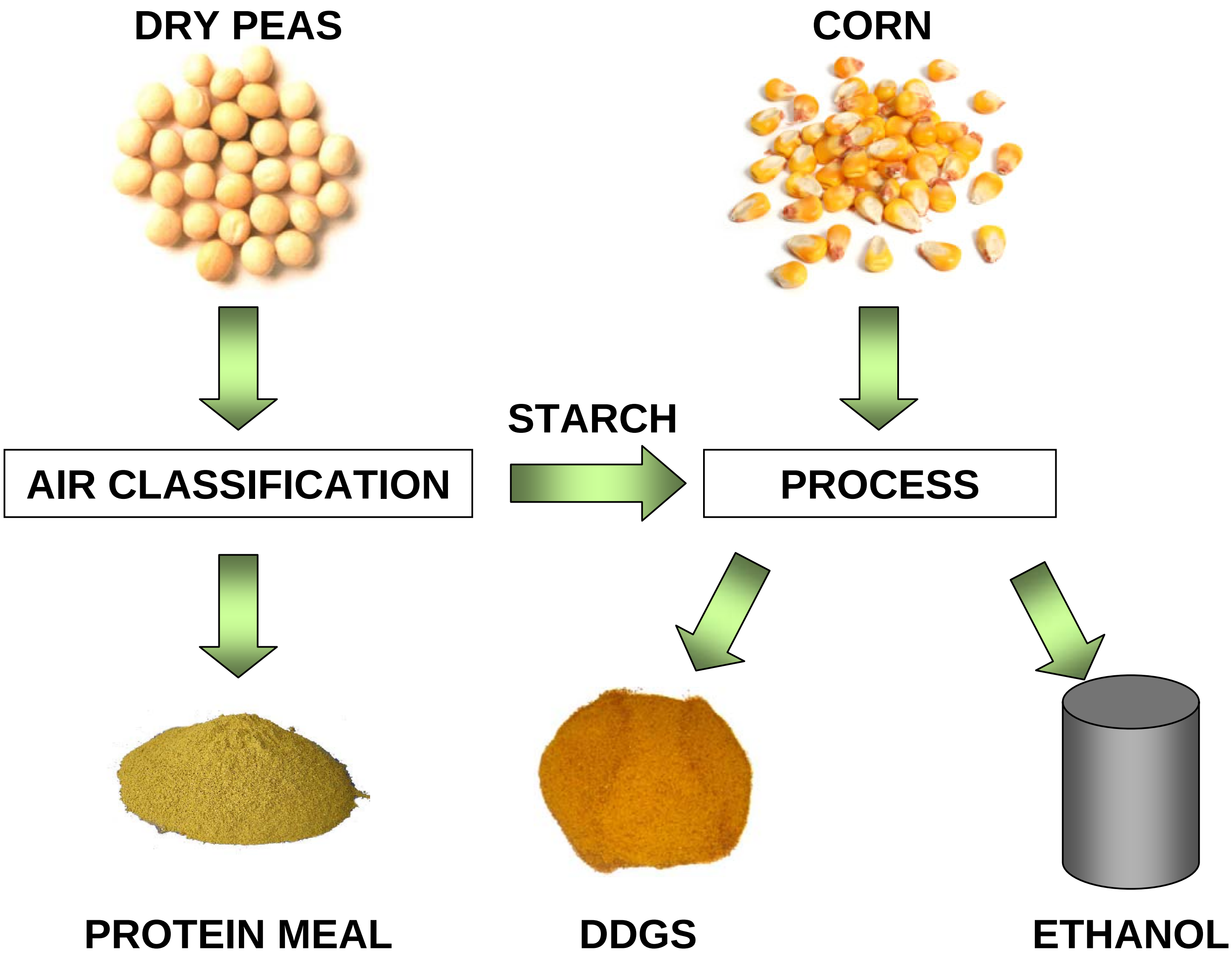
- Air classification separate protein and parts rich in starch.
- Protein part is sold as dry peas meal (contains 53.5% protein)
- Fermentation results show 10% higher efficiency in time taken to produce ethanol (Pryor, 2007).



100% Corn Process



Corn/Peas Process



Theoretical Model

Profit model (McConnell and Brue, 2006):

$$\hat{\Pi} = \hat{P}Q - \hat{C}(Q) - B$$

where: Q output, P price, B fixed cost, [C (Q)] variable cost

Gross revenue

$$\hat{G}\hat{R} = \hat{P}_1 Q_1 + \hat{P}_2 Q_2 + \hat{P}_3 Q_3$$

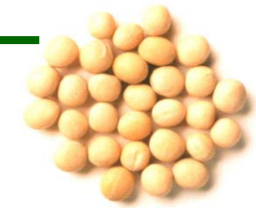
Total cost (TC) is calculated by adding fixed cost (B) and variable cost [C(Q)]:

$$B = D_1 + I_1$$

(^) indicates the variable is random and a distribution is used for its value

$$\hat{C}(Q) = Q * (\hat{W}_1 + \hat{W}_2 + \hat{W}_3 + E_1 + E_2 + L_1 + Y_1 + C_1 + L_1 + A_1 + M_1 + M_2 + R_1 + L_1)$$

Data and Simulation Procedure



Assumptions

- Geographic location: Jamestown, ND.
- Plant corn source: 70% locally within 60 miles radius.
- Corn supply risk: Balance 30% from Fargo, ND (100 miles). Hauling cost $0.20/bu
- Dry peas: Delivered by farmers.

Data and Simulation Procedure

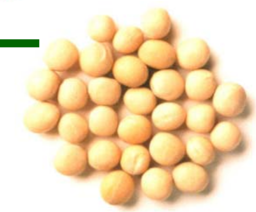
Variable	Distribution and Values ($)	Logic
Price of Corn	**Risk Logistic (3.60, 0.2025)**	Average annual prices received by farmer in North Dakota from 1985 -2006 (NASS, USDA).
Corn Produced	**Risk Normal (35454433, 14667356)**	Annual production around 60 miles of Jamestown, ND from1998 -2006 (NASS,USDA)
Price of Dry Peas	**Risk Extreme (8.08, 0.893)**	Average annual prices received by farmers in North Dakota from 1995-2006 (Dry Peas Council).
Dry Peas Meal Prices	**Risk Normal (284.45, 33.18)**	Average annual prices at Illinois from 1983-2006 (ERS,USDA).
Price of Ethanol	**Risk Log Logistic (0.919, 0.362, 2.586)**	Annual average prices at Omaha, Nebraska from 1982 – 2006 (Nebraska State Government Energy Office).
Price of DDGS	**Risk Normal (112.84, 24.64)**	Annual average prices at Lawrenceburg, Indiana from 1982 – 2006 (ERS, USDA).

RESULTS

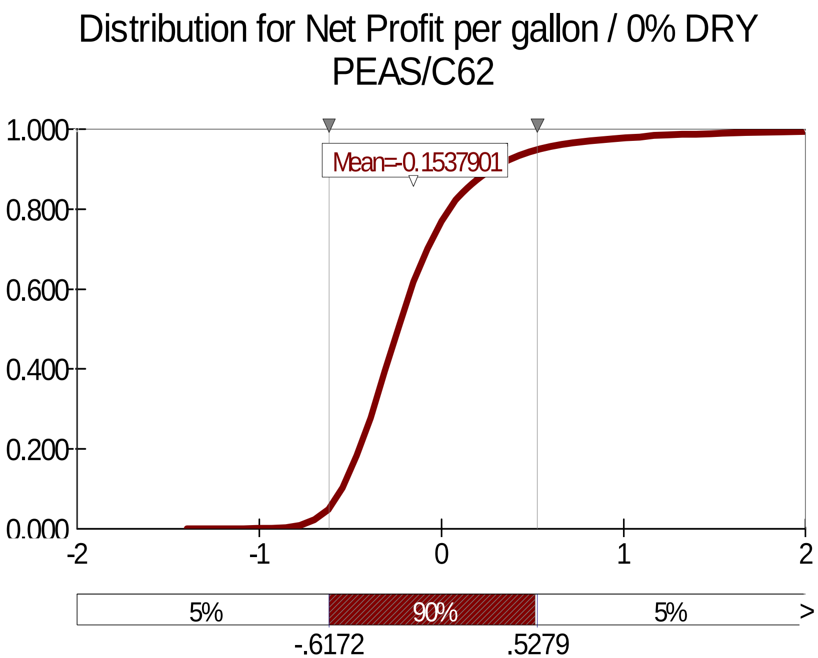
Base Results

	Mean net profit/gallon ($)	90% Probability interval profit/gallon ($)	Supply risk/gallon ($)
100 % Corn	-0.15	-0.61 - 0.52	0.009
10 % Dry peas	-0.43	-0.90 - 0.26	0.008

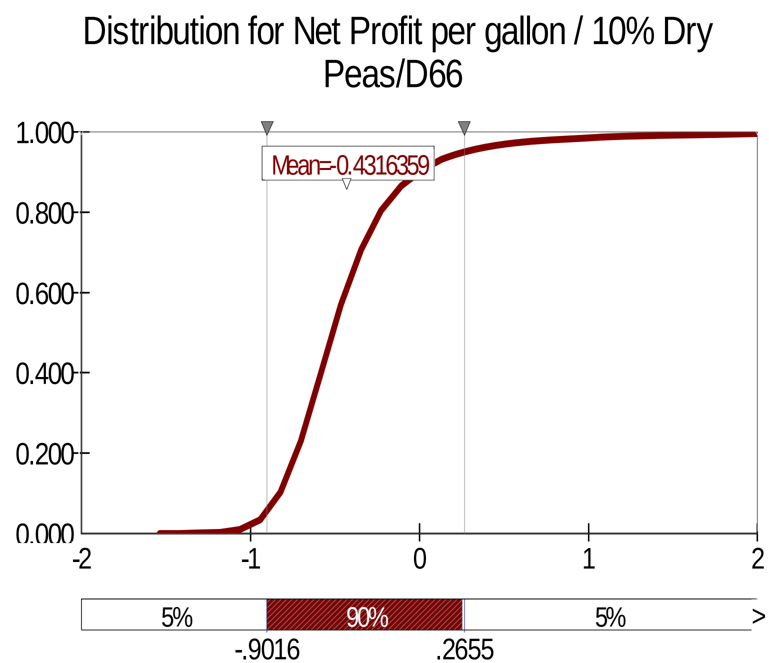
Base Profit Results



100% Corn net profit/gallon distribution

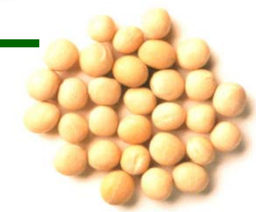


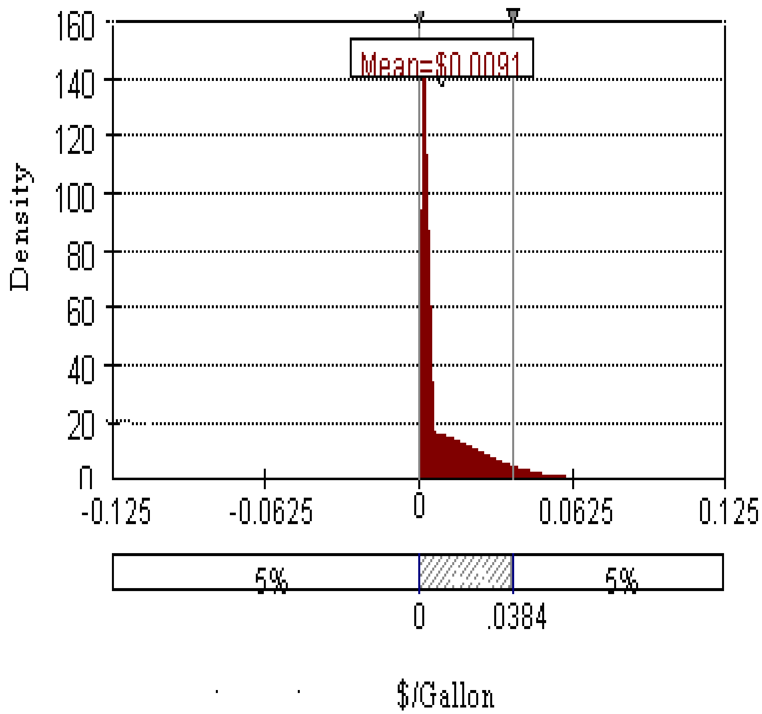
Net profit/gallon distribution



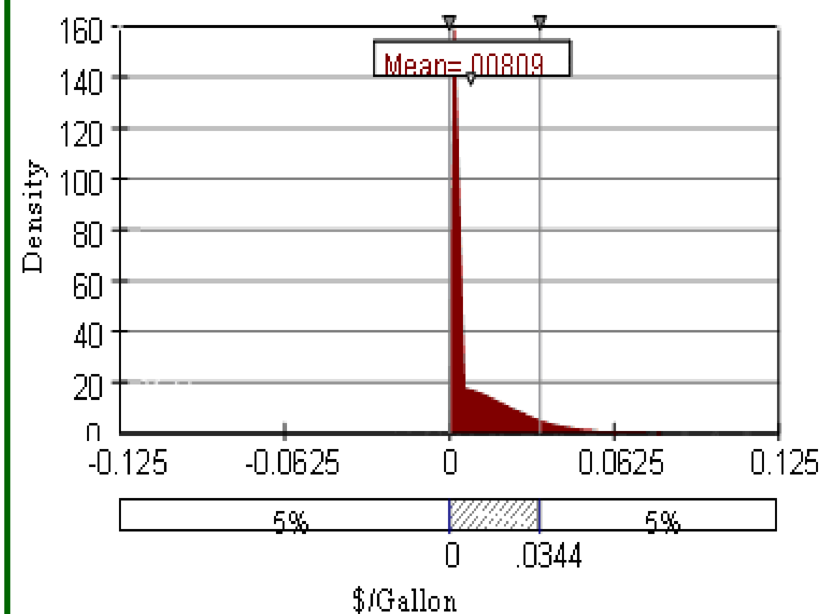
10% Dry pea net profit/gallon distribution

Corn Supply Risk





100% Corn Supply Risk
Profit/gallon distribution



Corn Supply Risk/gallon

10% Dry Peas Corn Supply Risk

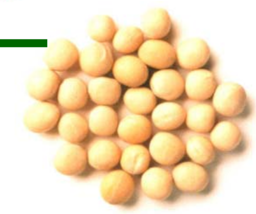
Sensitivity Analysis: Corn Prices

Corn prices ($/bushel)	Net income ($/gallon)	Net income ($/gallon) 10% dry peas/90% Corn
$2.16 (Base -40%)	0.412	0.068
$2.52 (Base -30%)	0.273	-0.056
$2.88 (Base -20%)	0.134	-0.181
$3.24 (Base -10%)	-0.005	-0.306
$3.60 (BASE)	**-0.144**	**-0.431**
$3.96 (Base +10%)	-0.283	-0.556
$4.32 (Base +20%)	**-0.422**	-0.681
$4.68 (Base +30%)	-0.561	-0.806
$5.04 (Base +40%)	-0.700	-0.932

Sensitivity Analysis: Investment Cost

Investment cost	10%Dry peas net income ($/gallon)
Base -90%	-0.339
Base -80%	-0.402
Base -70%	-0.406
Base -60%	-0.409
Base -50%	-0.413
Base -40%	-0.417
Base -30%	-0.420
Base -20%	-0.424
Base -10%	-0.428
Base ($28 Million)	-0.431

Conclusions



10% Dry peas

- Replacement of 10% corn with dry peas resulted in lower profits.
- Net profit/gallon of ethanol produced declined to - $0.43.
- Corn prices would have to rise more than 20% before dry peas would be breakeven.
- Alternative scenarios with decreasing investment cost of pea fractionation equipment improved profitability only marginally.

Thank you

For more information please contact the senior author at
cole.gustafson@ndsu.edu