

Nutritional Testing of Grains at the University of Minnesota Soil Testing & Research Analytical Laboratories

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With approximately 3.97 billion bushels of soybeans produced and 1.7 billion bushels exported in 2014, the United States accounts for nearly 34% of the world's total production and is the world's largest soybean producer¹. Minnesota is the third highest ranked state in soybean production with an approximate value of \$14.6 billion produced and \$1.8 billion exported annually². Near-infrared Spectroscopy (NIRS) is commonly used for nutritional evaluation of soybeans and is used to set prices for Minnesota soybeans and soy meal. NIRS requires accurate and precise wet chemical analysis for calibration equations, which were previously performed at laboratories outside Minnesota. Starting in 2013, the Soil Testing and Research Analytical Laboratory (STRAL), in collaboration with the NIR laboratory at the University of Minnesota, began work to create a Nutritional Analysis Laboratory (NAL) capable of performing moisture, protein, oil, crude fiber, fatty acid, carbohydrate, and amino acid analyses and quantification. The NAL will ensure faster turn around and lower cost for these measurements for Minnesota's soybean researchers and farmers. Participation in certification programs and co-laboratory studies are important to ensure the accuracy and validity of the testing methodology and results. STRAL is now an approved soybean analysis laboratory certified through the American Oil Chemists' Society's (AOCS) laboratory proficiency program (LPP), and has participated in several co-laboratory studies successfully correlating this suite of measurements. Additionally, STRAL has invested substantially in state of the art technology and equipment to meet the goal of creating a NAL which will satisfy the needs of Minnesota researchers and farmers who require these measurements to determine various soybean varieties' nutritional status.

Methods:

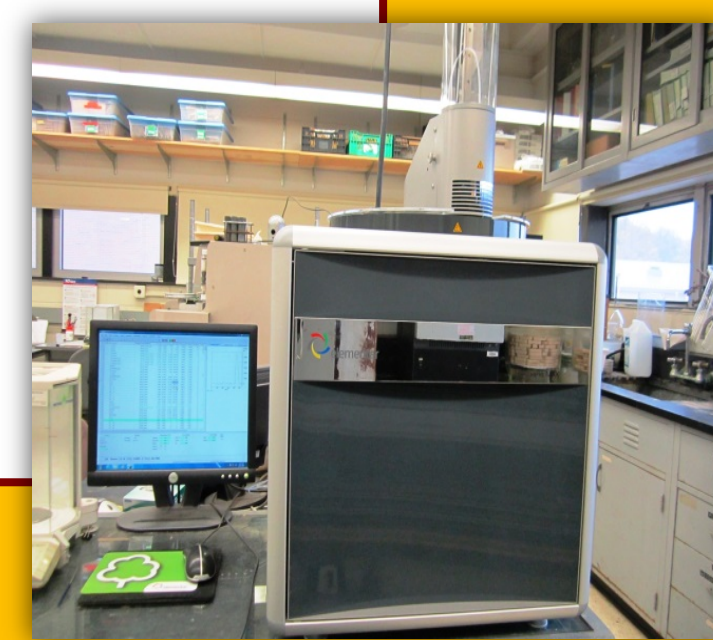
% Moisture (AOCS Official Method Ba 2a-38)

- 5g ground or 10g whole beans weighed in covered moisture tins
- 130 ± 3°C for 2 h ground or 3 h whole beans, uncovered
- Covered and cooled in desiccator and re-weighed
- $\% \text{ Moisture} = \left(\frac{\text{loss in mass, g}}{\text{mass, g of sample}} \right) \times 100$



% Nitrogen (AOCS Official Method Ba 4e-93)

- 0.2g sample combusted at 1110°C in an oxygen rich environment
- Isolation and conversion of NO₂ to N₂
- Detection of N₂ by a thermal conductivity detector
- $\% \text{ Protein} = \% \text{ N} \times 6.25$



% Oil (AOCS Official Method Ac 3-44)

- 2g sample extracted with 140mL of petroleum ether
- Soxhlet type extraction at 150°C: 30min "wet" and 70min "vapor" extraction
- $\% \text{ Oil} = \left(\frac{\text{mass, g of oil}}{\text{mass, g of sample}} \right) \times 100$



% Crude Fiber (AOCS Official Method Ba 6a-05)

- 1g of de-fatted sample in sealed filter bag
- H₂SO₄ and NaOH extractions at 100 °C
- Dried, weighed, and ash samples at 485 °C
- $\% \text{ C.F.} = \left(\frac{100 \times (\text{loss in wt, g} - (\text{bag wt, g} \times \text{bag correction factor}))}{\text{mass, g of sample}} \right) \times 100$

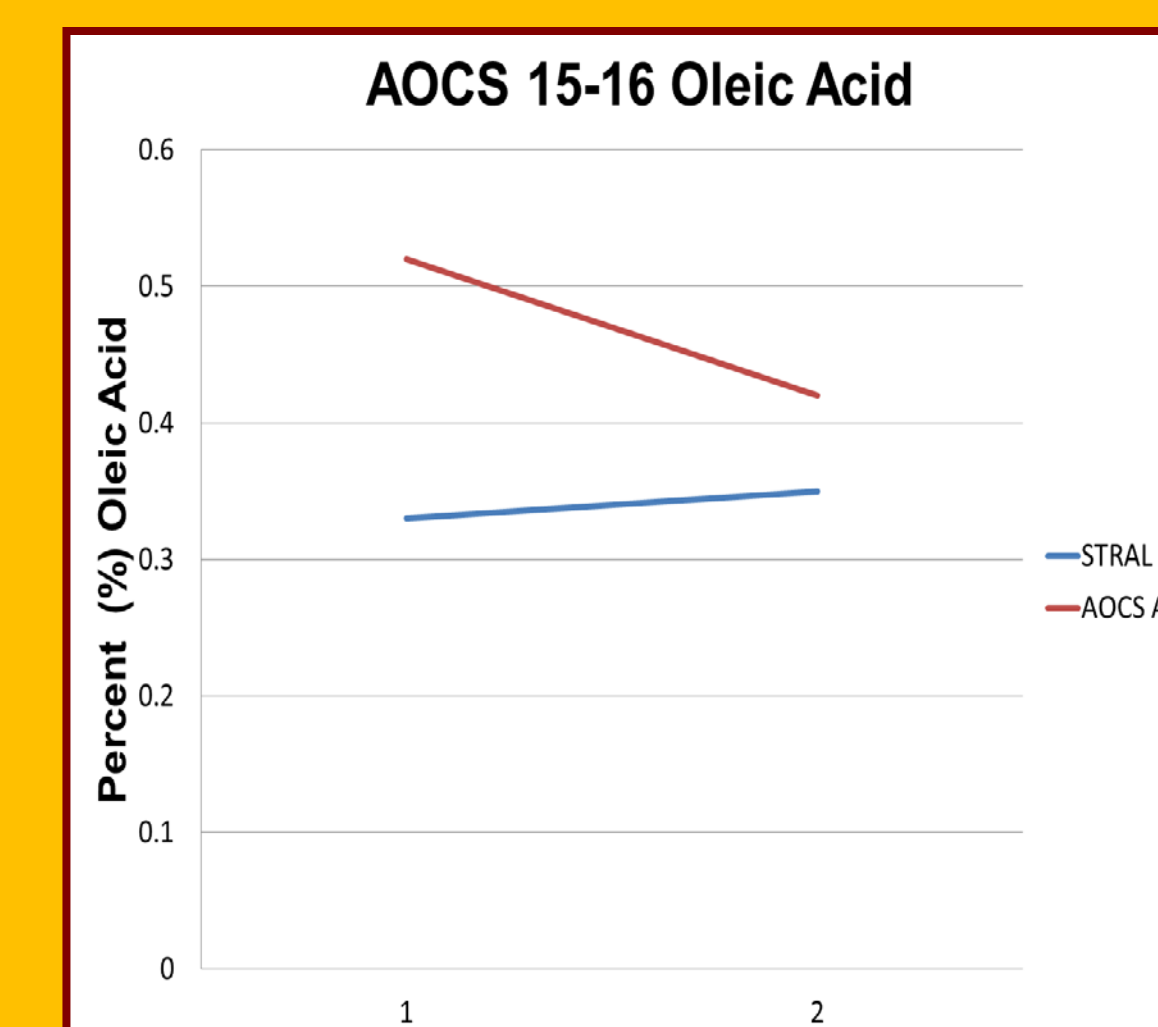
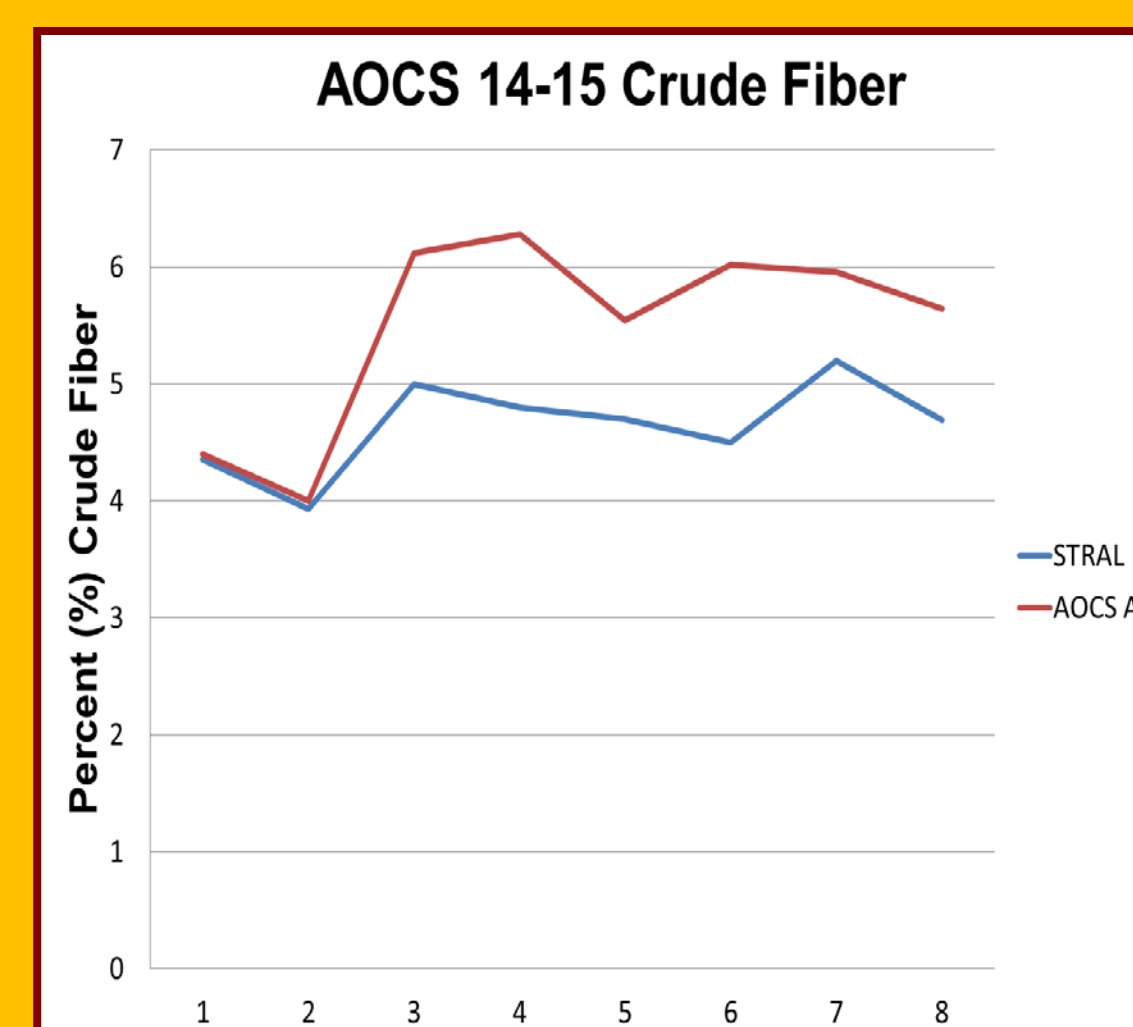
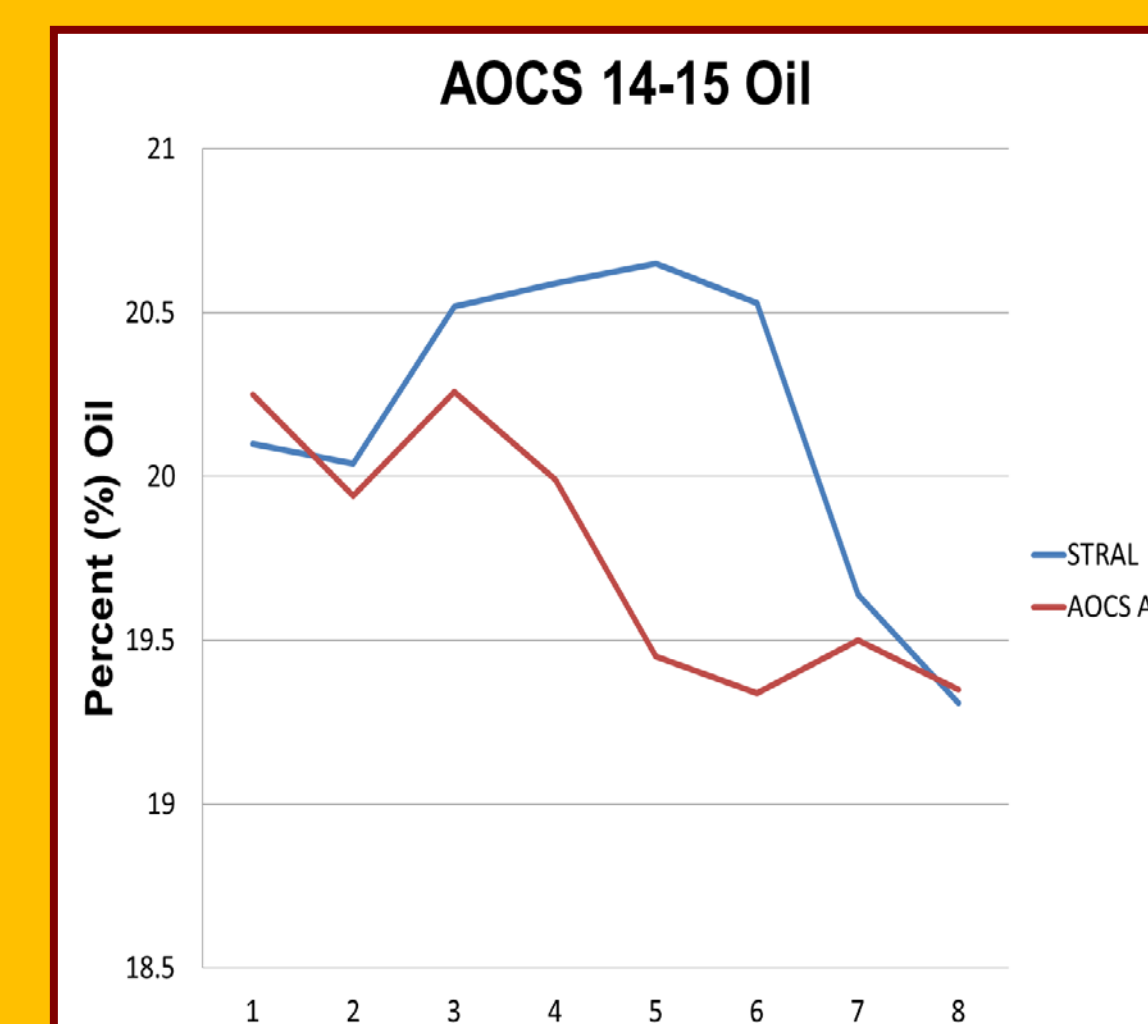
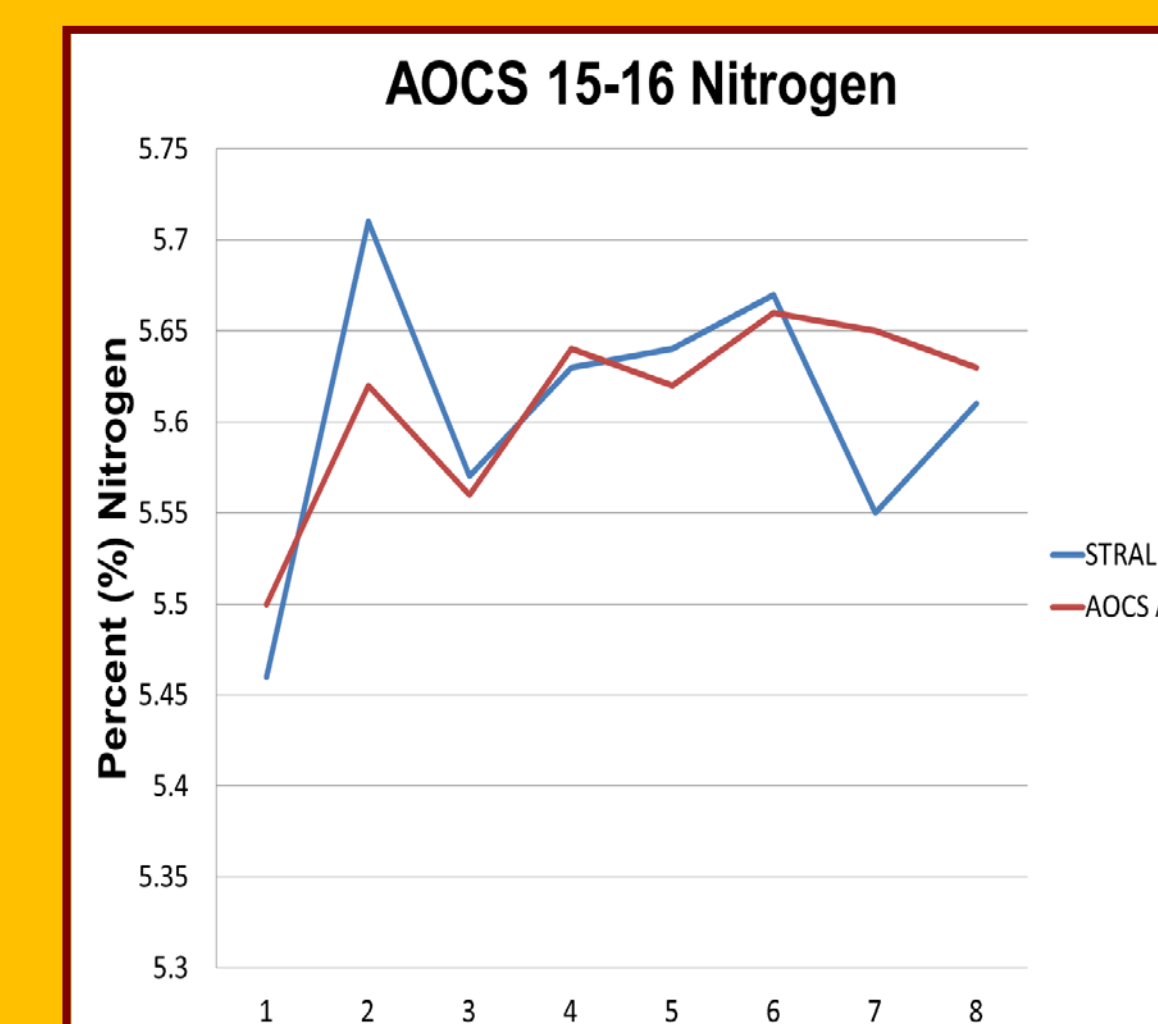
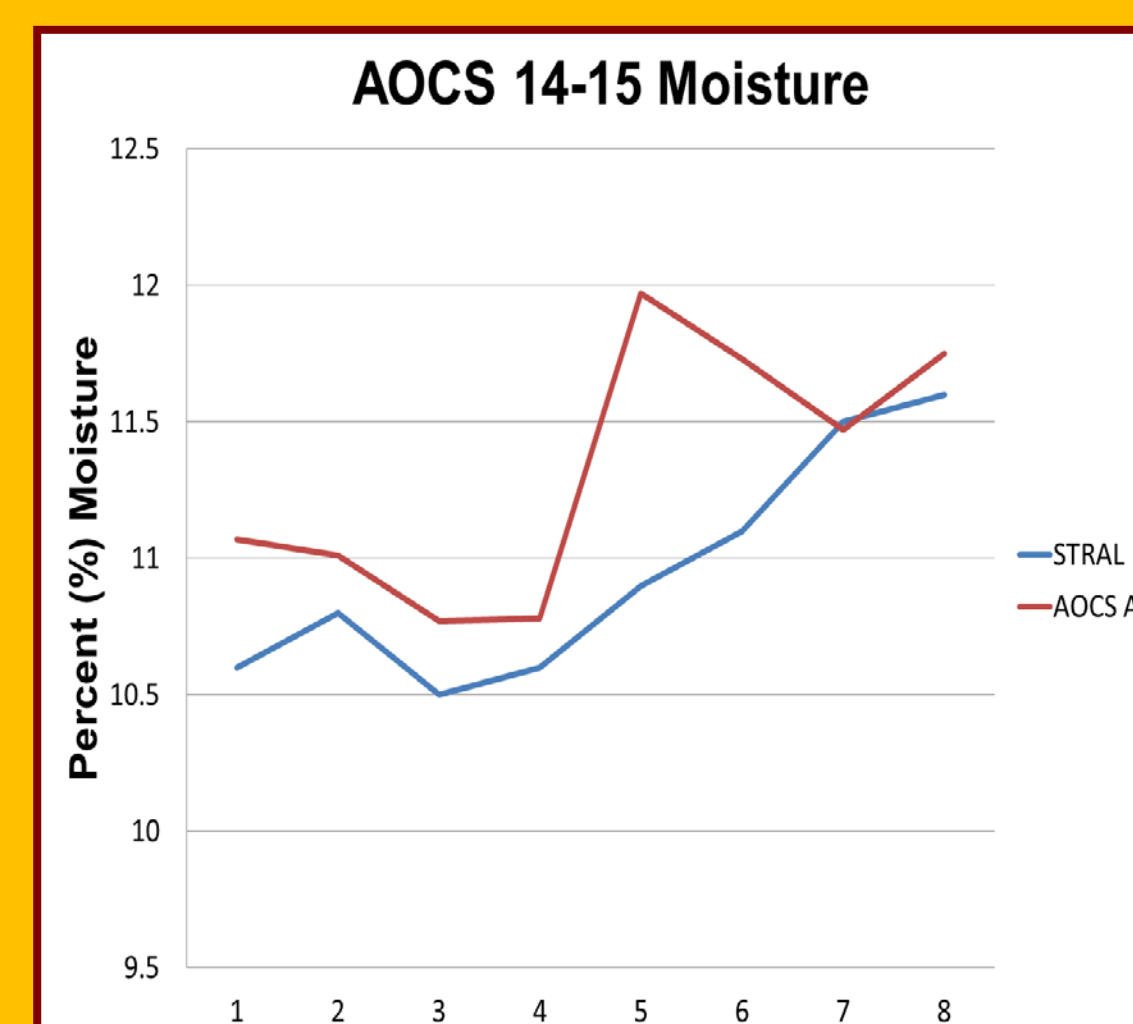


Free Fatty Acids (AOCS Official Method Ce 2-66)

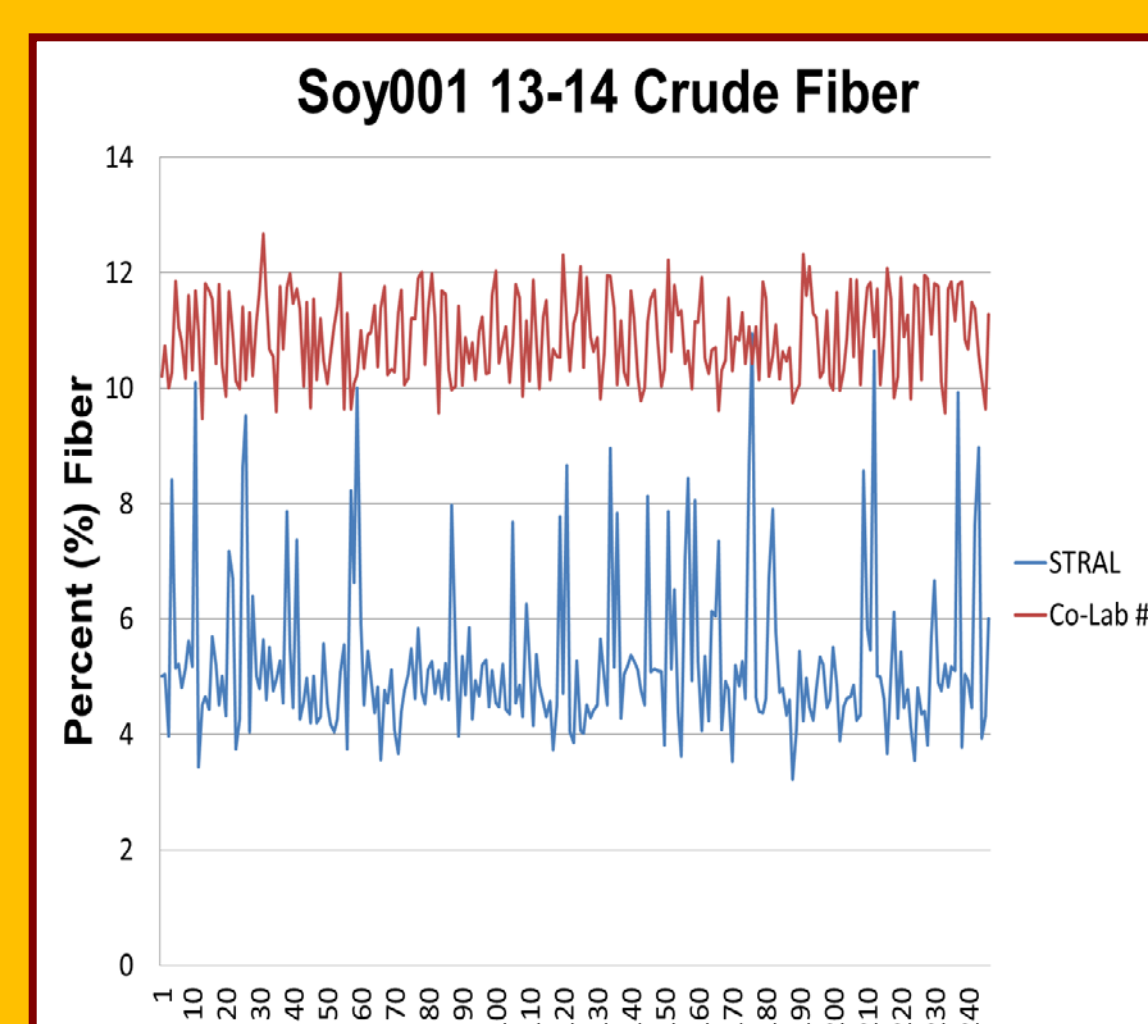
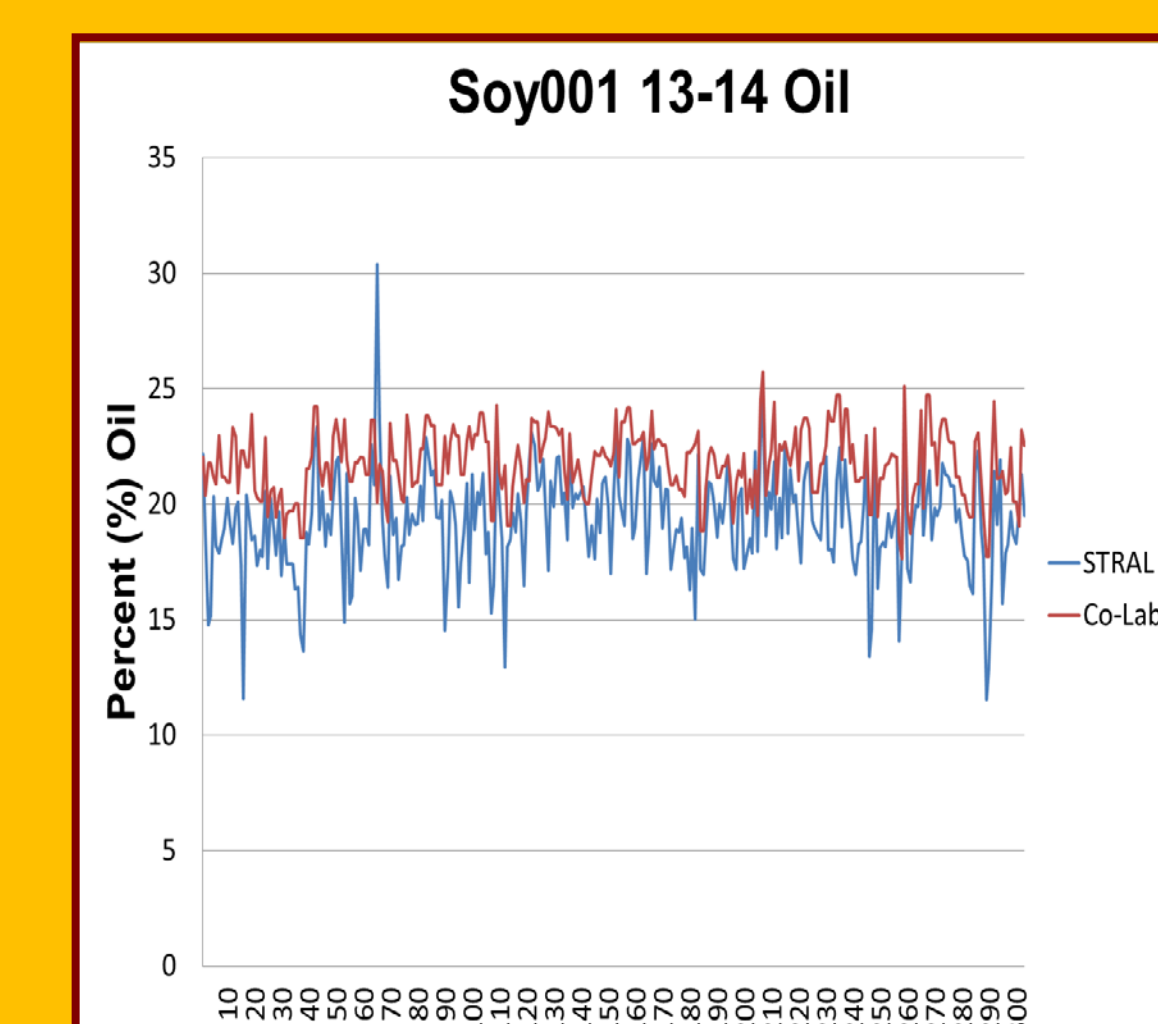
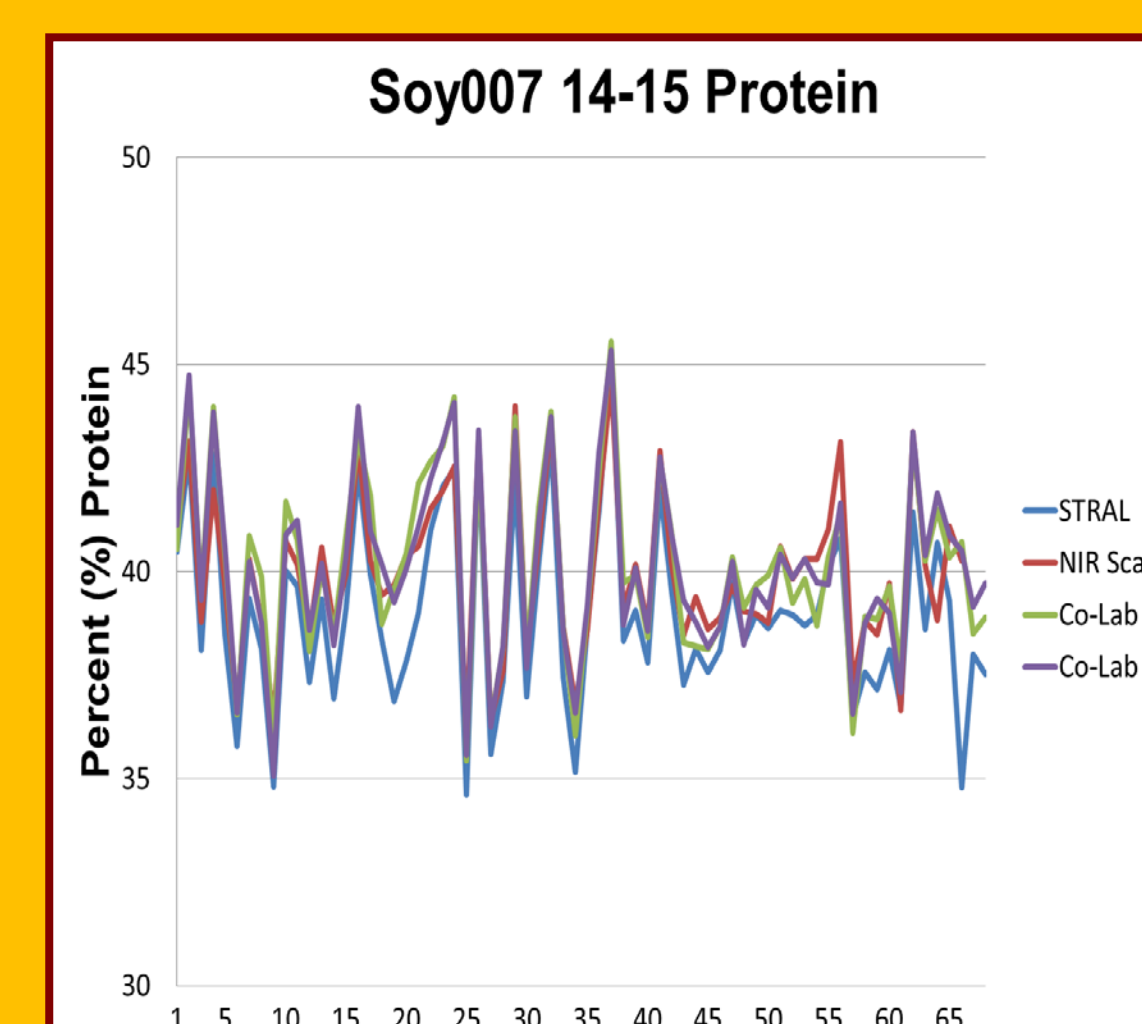
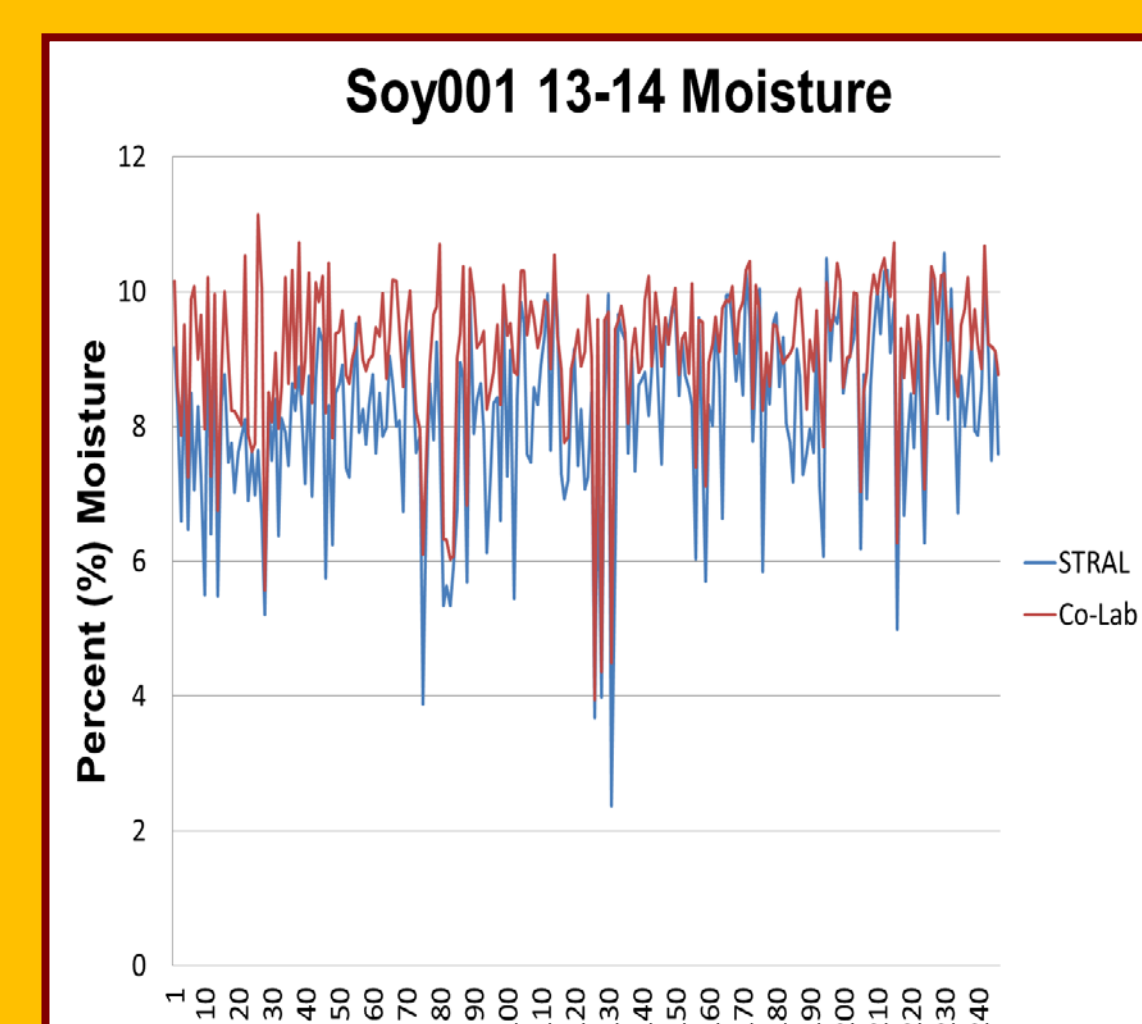
- 0.200g of extracted oil
- 2mL Hexane and 0.1mL methanolic KOH additions
- 0.1mL of upper layer diluted to 1mL with Hexane
- Fatty Acid Methyl Esters analyzed by GM-MS



AOCS LPP Results:



Co-Laboratory Studies:



Conclusions:

- STRAL is now certified by AOCS as an approved laboratory for soybean measurements.
- Wet chemistry results from STRAL can now be used for the accurate calibration of NIRS instrumentation.
- STRAL will continue to validate methods for fatty acids, sugars, and amino acids, and continue participation in co-lab studies and AOCS LLP certification.
- Wet chemistry soybean methods can be applied to other grain and feed sample types including corn, barley, canola, and pennycress.
- STRAL is ready to accept grain and feed job requests. <http://ral.cfans.umn.edu/>

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1. Ye, Su. "Why the Export Market Is Important for U.S. Soybeans." *Economic Analysis and Market Research*. Minnesota Department of Agriculture, 2015. Web. 8 October 2015. < www.mda.state.mn.us/food/business/~media/Files/food/business/economics/exports-soybeans.ashx >.
2. Ye, Su. "Minnesota Crops Profile." *Economic Analysis and Market Research*. Minnesota Department of Agriculture, 2015. Web. 8 October 2015. < www.mda.state.mn.us/food/business/~media/Files/food/business/economics/mncropsprofile.ashx >.



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