Quality of the United States Soybean Crop: 2021

Seth Naeve and Jill Miller-Garvin
University of Minnesota
Outline

• 2021 Weather highlights
• Historical protein and oil variation
• 2021 Soybean Survey results
  – Protein and Oil
  – Physical Characteristics
  – Amino Acids
  – Sucrose
• 2021 Food Soybean Survey results
CRITICAL WEATHER EVENTS
Environmental impacts on soybean Protein and oil

- Location-specific environmental impacts (latitude, climate, and soil type) affect long-term quality trends
- However, annual variation in weather patterns affects year-over-year variation in soybean quality
- Rainfall patterns appear to have the greatest impact on soybean quality
- Excessive rainfall early in the season appears to reduce protein deposition in the seed
- Drought conditions during the seed-filling stages exacerbate this condition
2021 Weather and Soybean Production

- Unusually dry spring weather in the Western Corn Belt and Illinois allowed for very early planting
- Planting in most other states proceeded normally
  - Early planting was delayed in Ohio, but finished normally
- A severe and chronic drought affected many of the Western Corn Belt states throughout the summer
- Rains provided some relief very late in the summer season.
2021 Progress: Planting and Harvesting

USDA-NASS Crop Progress

https://usda.library.cornell.edu/concern/publications/8336h188j?locale=en
Calculated Soil Moisture Anomaly (mm)

SEP, 2021

QUALITY OF THE UNITED STATES SOYBEAN CROP: 2021
HISTORICAL PROTEIN AND OIL VARIATION
2021 SURVEY RESULTS
**2021 Survey Methods**

- In August, sample kits were mailed to 5,828 soybean producers based on soybean production by state.
- By 26 October 2021, 1,160 samples were returned for analysis.

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**Image:**

2021 SOYBEAN QUALITY SURVEY

Town nearest field sampled (zip code or name): ________________

Variety (company and variety name): ________________

If specialty variety, please check below:

- [ ] High oleic
- [ ] Food grade
- [ ] Non-GMO

Questions? Call Dr. Seth Naevé (612) 625-4298 or email at naeve002@umn.edu

Please note changes to name or address:

- [ ] Mike Oliver
- [ ] 2333 194th St
- [ ] Logan, IA
- [ ] 51546-6051

PLEASE SEND SAMPLES BY OCTOBER 23 FILL BAG TO HERE
2021 Survey Methods - Protein and Oil

- Samples were analyzed for protein and oil concentration by Near Infrared Spectroscopy (NIRS) using a PerkinElmer diode array instrument.
- Average protein and oil values were determined by state.
- Regional and US average values were determined by weighting averages based on estimated 2021 production.
PROTEIN AND OIL
<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Samples</th>
<th>Protein (13%)</th>
<th>Change from 2020</th>
<th>Oil (13%)</th>
<th>Change from 2020</th>
<th>Seed Weight (g/100 seeds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Average</td>
<td>1,160</td>
<td>33.3</td>
<td></td>
<td>20.2</td>
<td></td>
<td>16.8</td>
</tr>
<tr>
<td>Average of 2021 Crop†</td>
<td></td>
<td>33.4</td>
<td>-0.5</td>
<td>20.2</td>
<td>+0.7</td>
<td>16.5</td>
</tr>
<tr>
<td>US 2011-2020 Average†</td>
<td></td>
<td>34.3</td>
<td></td>
<td>19.0</td>
<td></td>
<td>19.0</td>
</tr>
</tbody>
</table>

†US average values weighted based on estimated production by state, as estimated by USDA, NASS Crop Production Report (October, 2021)
USB SPROC Processing Model – Assumes uniform 6.2% hull removal

Protein vs Oil
by Production & Meal Protein

Meal Protein % (12%)

49
48
47
46
45
USB SPROC Processing Model – Assumes uniform 6.2% hull removal
Protein vs Oil by Production & Meal Yield

USB SPROC Processing Model – Assumes uniform 6.2% hull removal
PHYSICAL CHARACTERISTICS
Better Measures of the Value of Soybeans

- Soybeans & soybean meal have been valued primarily on an indirect measure of protein – ‘crude protein’

- Crude protein is probably not the best measure of a soybean (or a soybean meal’s) value
  - Overestimates total amino acids (true protein) at higher protein levels
  - No information on protein QUALITY (relative balance of amino acids)

- Both formal and informal feeding trials in destination countries have repeatedly shown that meal from US soybeans performs better than expected based on protein levels
BETTER MEASURES OF QUALITY:
AMINO ACIDS
BETTER MEASURES OF QUALITY: SOLUBLE SUGARS

Sucrose

Raffinose

Stachyose
Quality of the United States Food Soybean Crop: 2021

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University of Minnesota
2021 Food Soybean Survey Methods

- In September and October, 611 sample kits were mailed to 26 US soybean exporters.
- By October 29, 208 samples were returned for analysis.

*Please send samples by October 25*

**2021 Food Soybean Quality Survey**

Contracting company: ____________________________________________

Field location (state): _______ Co. internal field code (optional): ________________

Variety: __________________________ Maturity Group: ________________

Intended use:

☐ Tofu  ☐ Natto  ☐ Miso  ☐ Soy milk  ☐ Soy sauce  ☐ High oleic  ☐ Tempeh

☐ Low lipoxygenase (low beany flavor)  ☐ Other: __________________________

Production type:

☐ Non-GM  ☐ Organic

Questions? Call Dr. Seth Naeve at (612) 819-2338
Specialty Soy Database

- Annual program
- Developed in conjunction with U.S. industry and international buyers
- Catalogue of commonly contracted U.S. soyfood beans (120+ varieties)
- Include information pertaining to:
  - Production year, commercial variety name, GM/non GMO/Organic, maturity group, state or area grown, soybean seed type (tofu, soymilk, natto, miso, indeterminate, etc.), photo of the sample
Tested Attributes and Characteristics

- Protein
- Oil
- Hilum color
- Seed size
- Sucrose
- Oligosaccharides
- Total free sugars
- Amino acid profile
- Total carbohydrates
- Fatty acid profile (high oleic)
- Total isoflavones
- Soymilk and tofu yields
2020 FOOD SOYBEAN SURVEY RESULTS
<table>
<thead>
<tr>
<th>State (# of samples)</th>
<th>Region</th>
<th>Protein * (%)</th>
<th>Regional Protein Average</th>
<th>Oil * (%)</th>
<th>Regional Oil Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota (10)</td>
<td>WCB</td>
<td>35.5</td>
<td></td>
<td>19.4</td>
<td></td>
</tr>
<tr>
<td>North Dakota (3)</td>
<td>WCB</td>
<td>35.2</td>
<td></td>
<td>18.7</td>
<td></td>
</tr>
<tr>
<td>South Dakota (1)</td>
<td>WCB</td>
<td>34.8</td>
<td>35.4</td>
<td>20.6</td>
<td>19.3</td>
</tr>
<tr>
<td>Illinois (76)</td>
<td>ECB</td>
<td>35.5</td>
<td></td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Indiana (4)</td>
<td>ECB</td>
<td>34.6</td>
<td></td>
<td>19.6</td>
<td></td>
</tr>
<tr>
<td>Michigan (40)</td>
<td>ECB</td>
<td>36.5</td>
<td></td>
<td>19.3</td>
<td></td>
</tr>
<tr>
<td>Ohio (28)</td>
<td>ECB</td>
<td>37.8</td>
<td></td>
<td>19.5</td>
<td></td>
</tr>
<tr>
<td>Wisconsin (46)</td>
<td>ECB</td>
<td>35.4</td>
<td>36.0</td>
<td>19.8</td>
<td>19.7</td>
</tr>
</tbody>
</table>

Data as of October 29, 2021

\* WCB: Western Corn Belt; ECB: Eastern Corn Belt
\* 13% moisture basis
<table>
<thead>
<tr>
<th>Region</th>
<th>Seed Size</th>
<th>Number Samples</th>
<th>Seed Size (g/100 seeds)</th>
<th>Protein* (%)</th>
<th>Oil* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCB</td>
<td>Small</td>
<td>1</td>
<td>9.9</td>
<td>35.3</td>
<td>17.3</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>9</td>
<td>19.5</td>
<td>35.2</td>
<td>19.4</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>4</td>
<td>24.8</td>
<td>35.8</td>
<td>19.6</td>
</tr>
<tr>
<td>ECB</td>
<td>Small</td>
<td>5</td>
<td>7.0</td>
<td>36.6</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>140</td>
<td>18.4</td>
<td>35.7</td>
<td>19.9</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>9</td>
<td>23.4</td>
<td>36.8</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Data as of October 29, 2021
Small seed: ≤13.0 g/100 seeds; Average: 13.1-21.0 g/100 seeds; Large: >21 g/100 seeds (unofficial categories)
WCB: Western Corn Belt (Minnesota, North Dakota, and South Dakota); ECB: Eastern Corn Belt (Illinois, Indiana, Michigan, Ohio, and Wisconsin)
* 13% moisture basis
<table>
<thead>
<tr>
<th>Region</th>
<th>Seed Size</th>
<th>Number Samples</th>
<th>Seed Size (g/100 seeds)</th>
<th>Sucrose (% DM)</th>
<th>Raffinose (% DM)</th>
<th>Stachyose (% DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCB</td>
<td>Small</td>
<td>1</td>
<td>9.9</td>
<td>5.80</td>
<td>0.92</td>
<td>3.80</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>9</td>
<td>19.5</td>
<td>5.80</td>
<td>0.92</td>
<td>3.80</td>
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<tr>
<td></td>
<td>Large</td>
<td>4</td>
<td>24.8</td>
<td>4.97</td>
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<tr>
<td>ECB</td>
<td>Small</td>
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<td>7.0</td>
<td>4.42</td>
<td>0.86</td>
<td>3.92</td>
</tr>
<tr>
<td></td>
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<td>140</td>
<td>18.4</td>
<td>4.41</td>
<td>1.01</td>
<td>4.04</td>
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<td>49</td>
<td>23.4</td>
<td>4.37</td>
<td>1.00</td>
<td>3.97</td>
</tr>
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<tr>
<th>Region</th>
<th>Seed Size</th>
<th>Number Samples</th>
<th>Seed Size (g/100 seeds)</th>
<th>Protein* (%)</th>
<th>Lysine (% of 18 AAs)</th>
<th>Five Limiting Essential¶ Amino Acids (% of 18 AAs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>1</td>
<td>9.9</td>
<td>35.3</td>
<td>6.8</td>
<td>14.8</td>
</tr>
<tr>
<td>WCB</td>
<td>Average</td>
<td>9</td>
<td>19.5</td>
<td>35.2</td>
<td>6.8</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>4</td>
<td>24.8</td>
<td>35.8</td>
<td>6.7</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>Small</td>
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<td>6.7</td>
<td>14.7</td>
</tr>
<tr>
<td>ECB</td>
<td>Average</td>
<td>140</td>
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<td>35.7</td>
<td>6.7</td>
<td>14.7</td>
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<td>6.7</td>
<td>14.7</td>
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* 13% moisture basis
¶ Five limiting essential amino acids: cysteine, lysine, methionine, threonine, and tryptophan
This work was made possible only through the generous support of the United Soybean Board
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