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

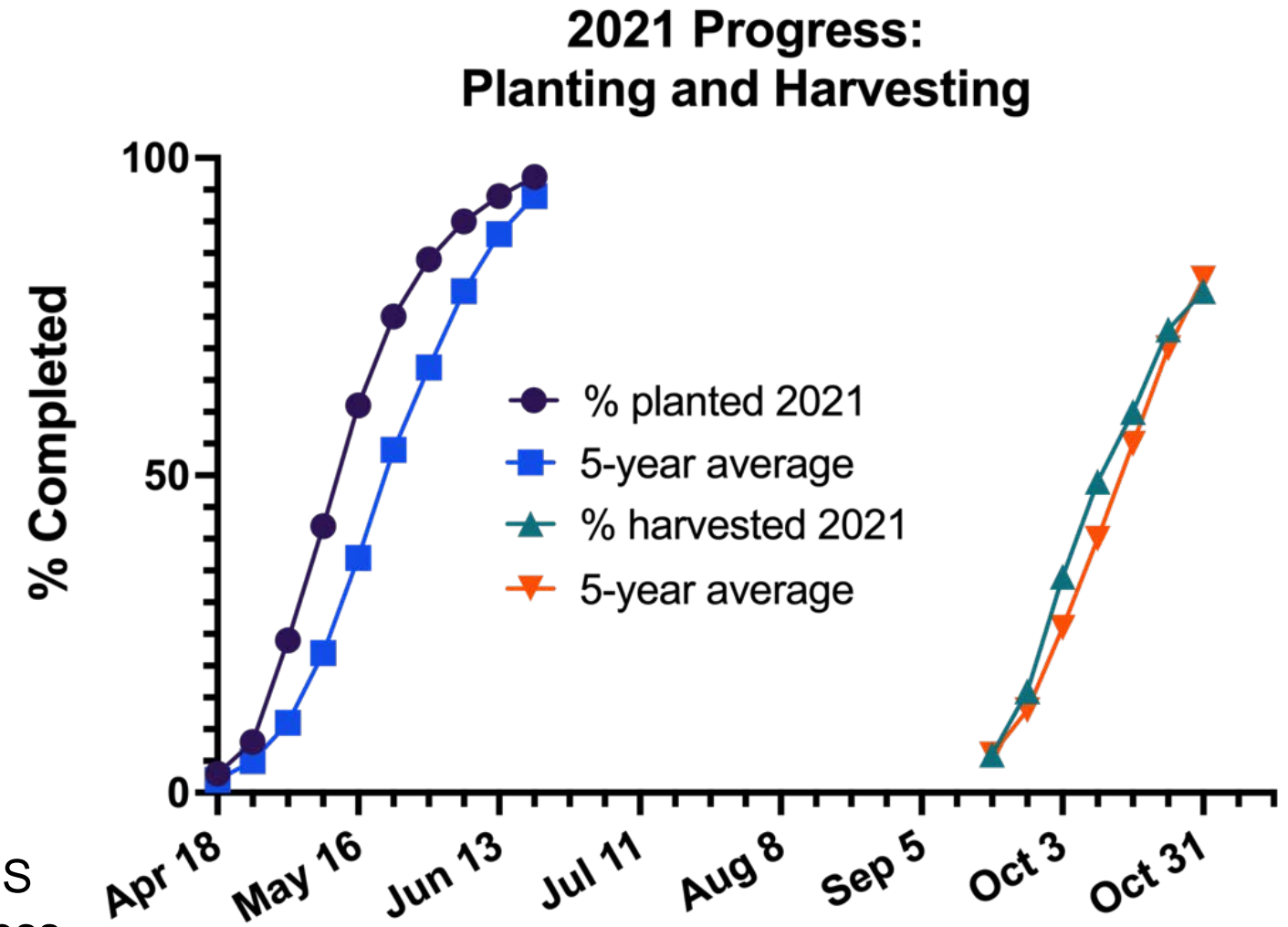

CRITICAL WEATHER EVENTS

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

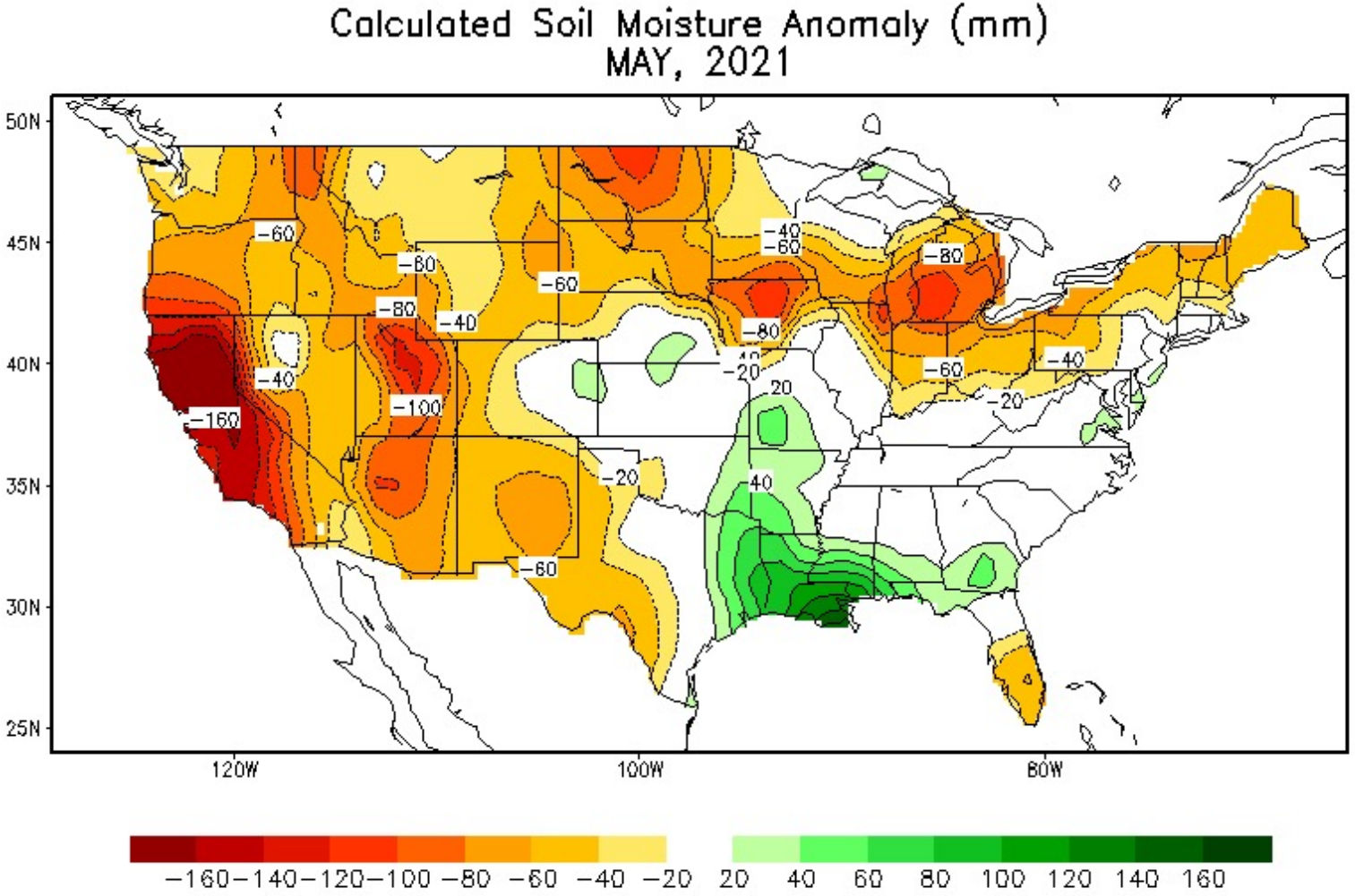
2021 Weather and Soybean Production

- 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.



USDA-NASS
Crop Progress

https://usda.library.cornell.edu/concern/publications/8336h188j?locale=en



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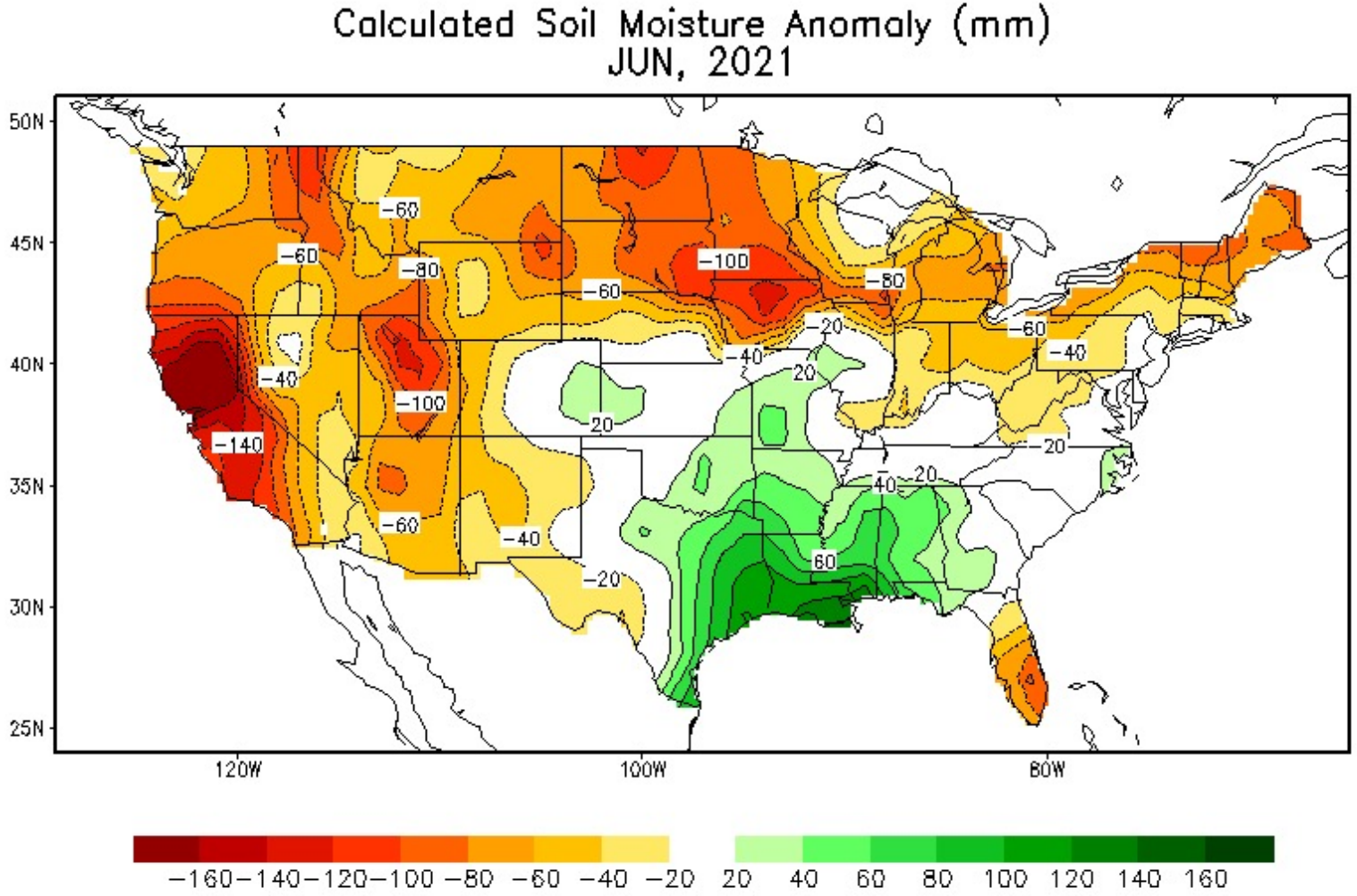

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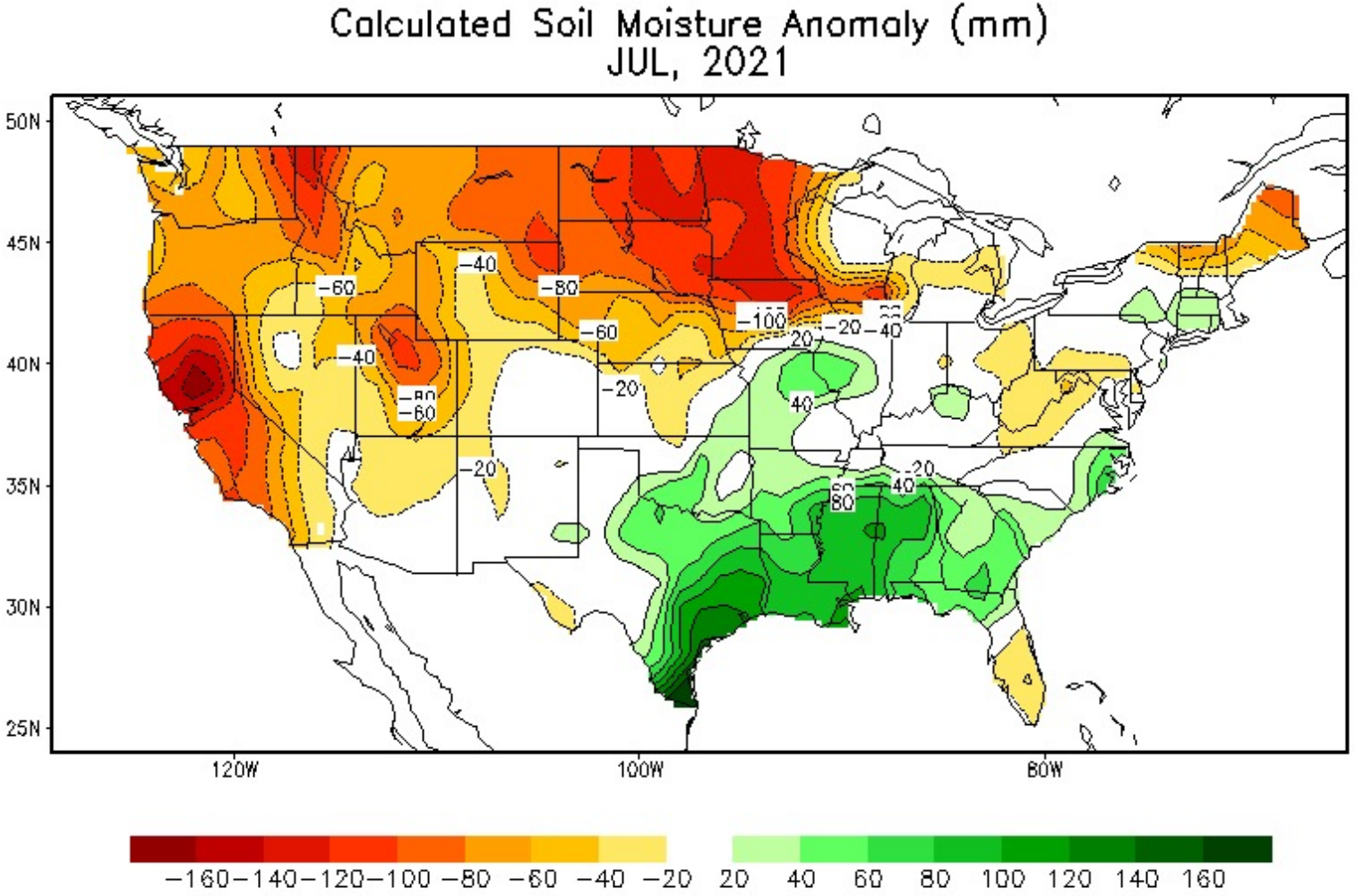

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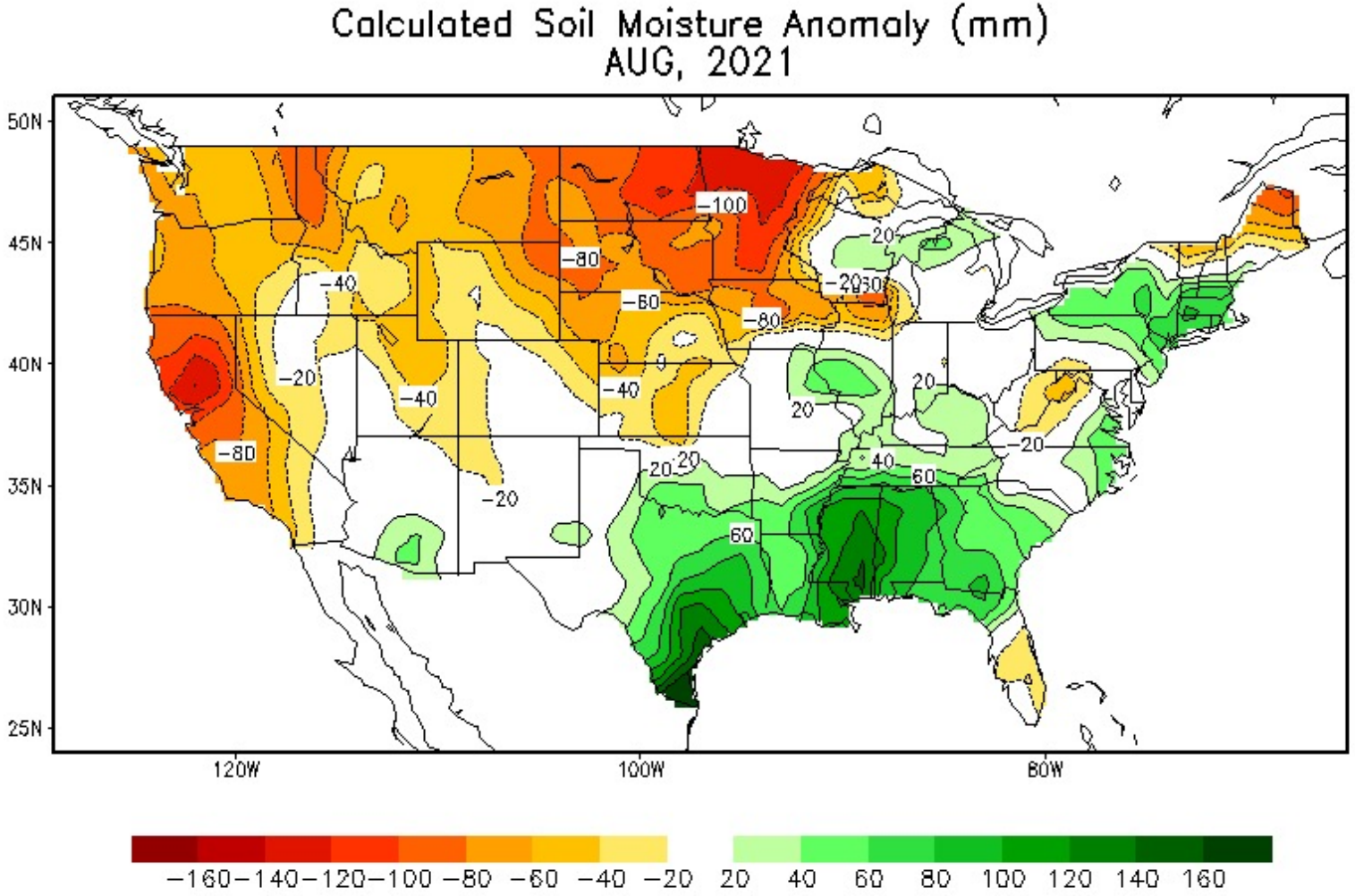

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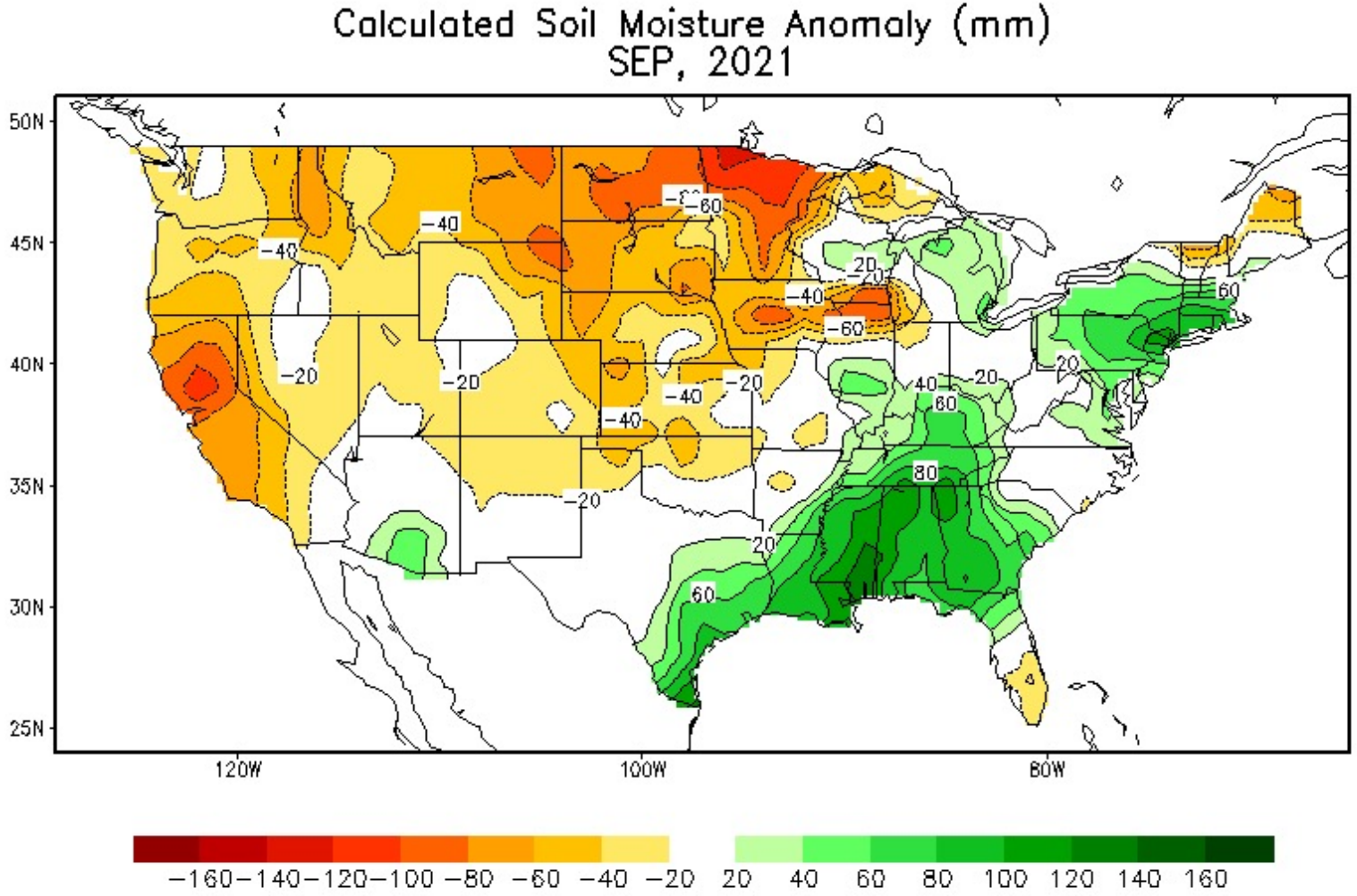

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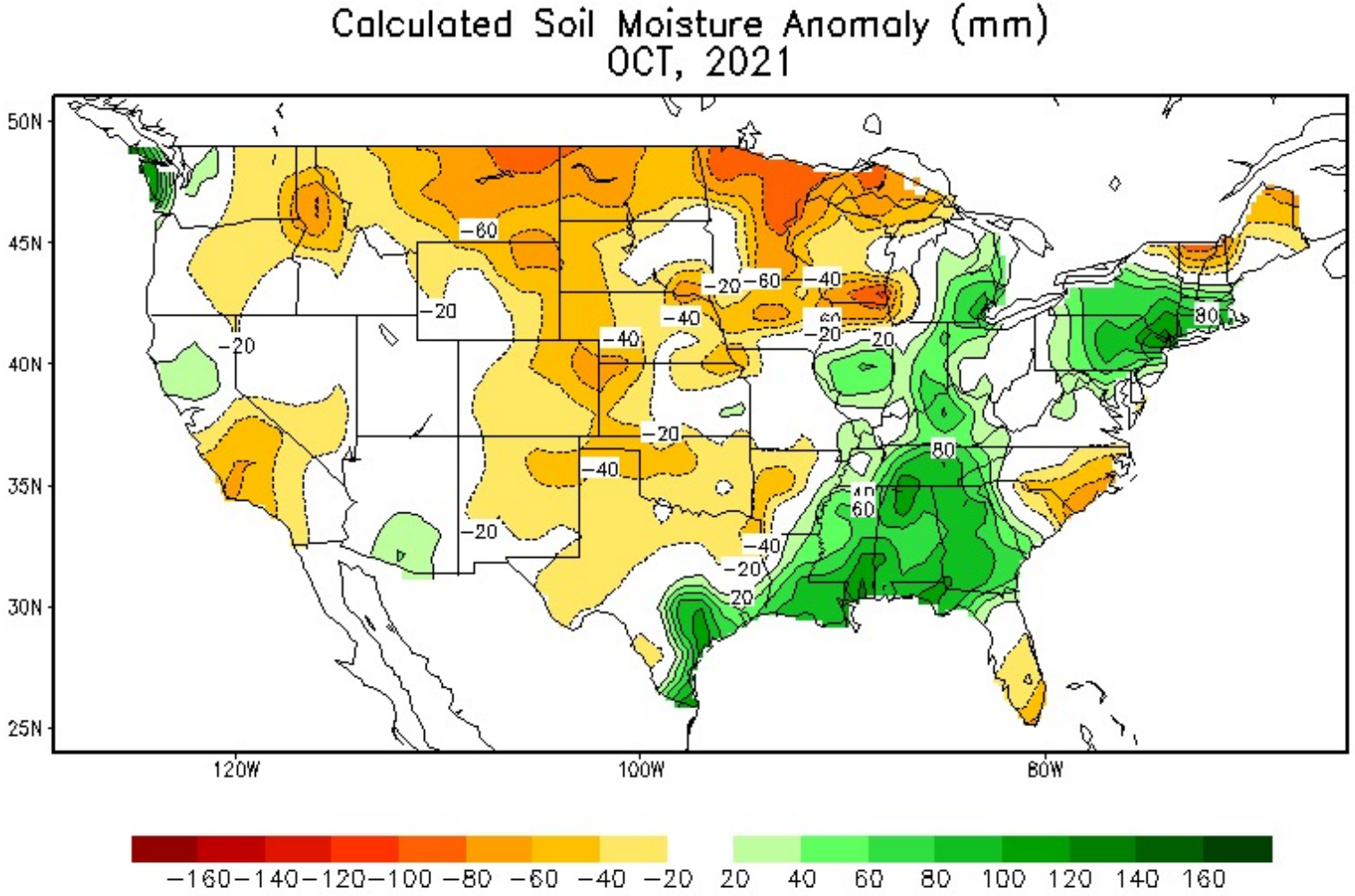

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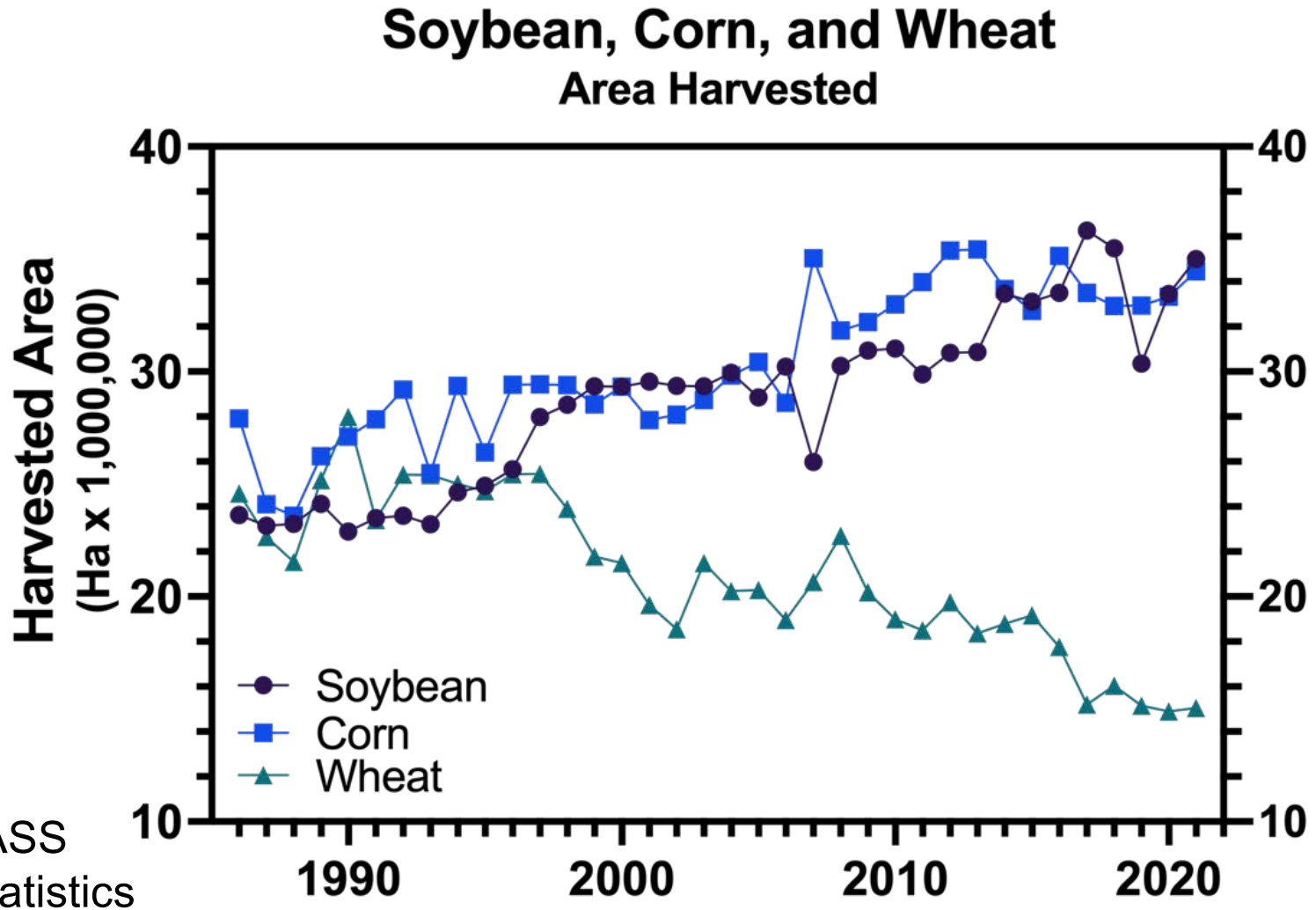


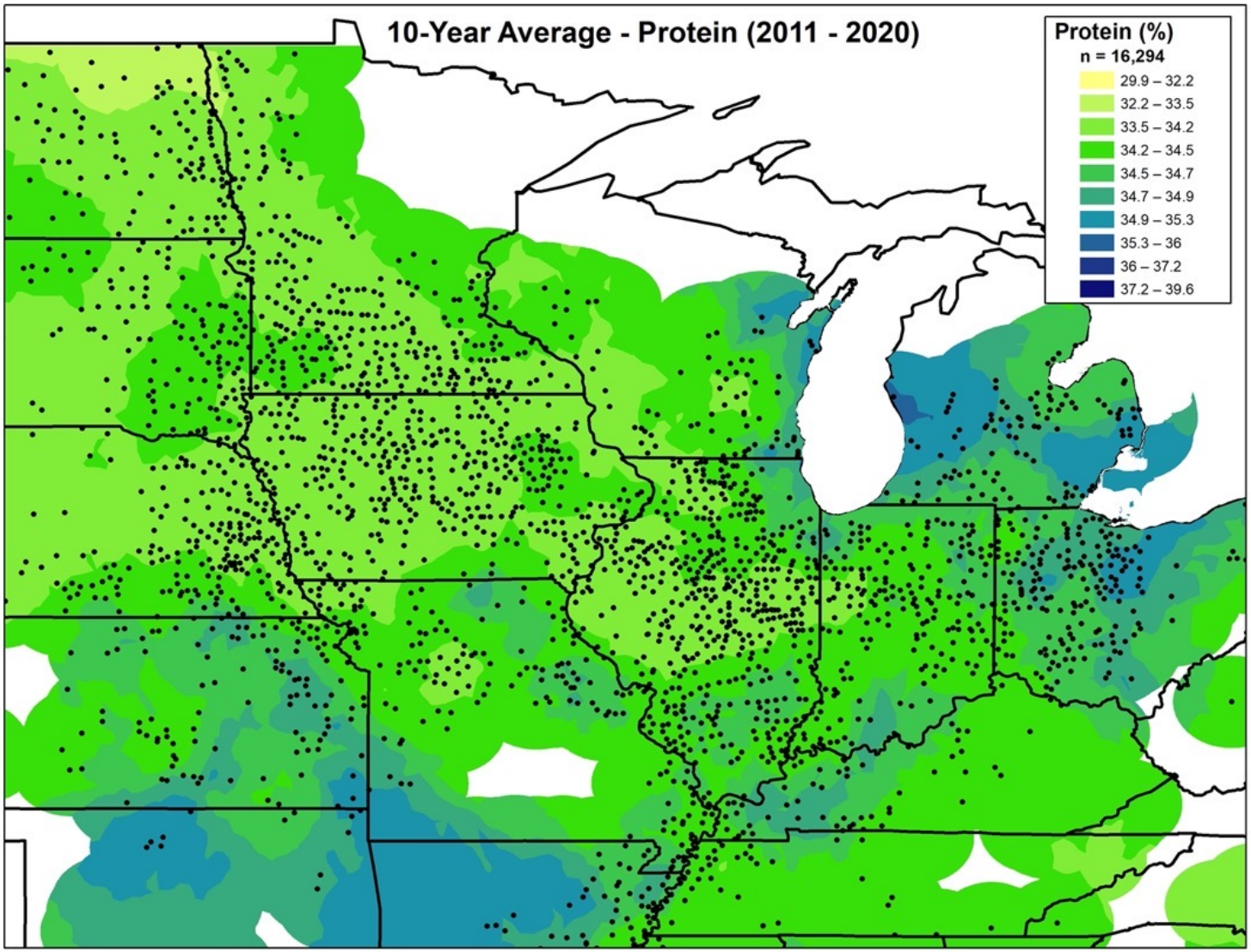
USDA-NASS
Data & Statistics

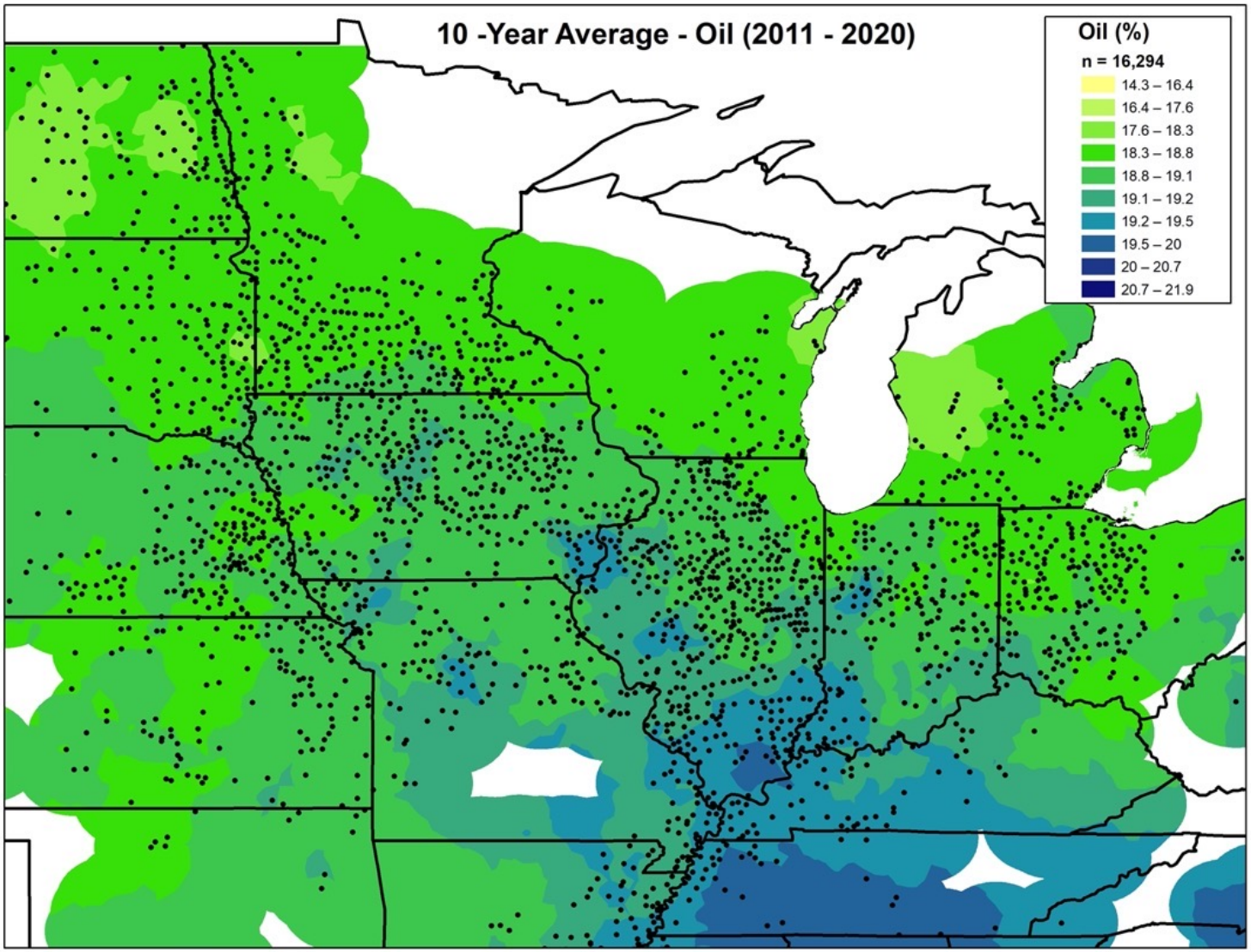
https://www.nass.usda.gov/Statistics_by_Subject/index.php?sector=CROPS

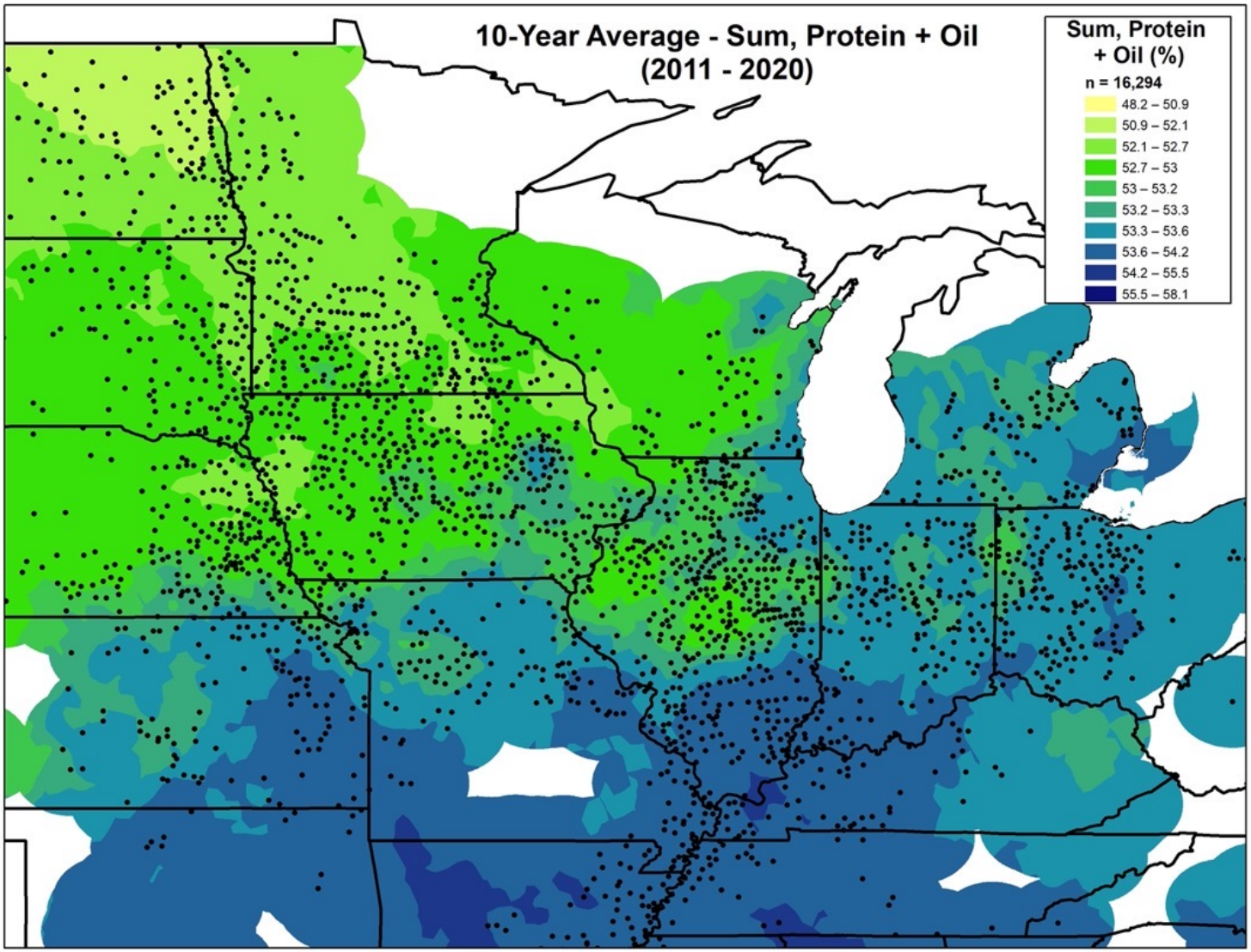
QUALITY OF THE UNITED STATES SOYBEAN CROP: 2021

UNIVERSITY OF MINNESOTA


HISTORICAL PROTEIN AND
OIL VARIATION


10-Year Average - Protein (2011 - 2020)
Protein (%)
n = 16,294
29.9 – 32.2
32.2 – 33.5
33.5 – 34.2
34.2 – 34.5
34.5 – 34.7
34.7 – 34.9
34.9 – 35.3
35.3 – 36
36 – 37.2
37.2 – 39.6

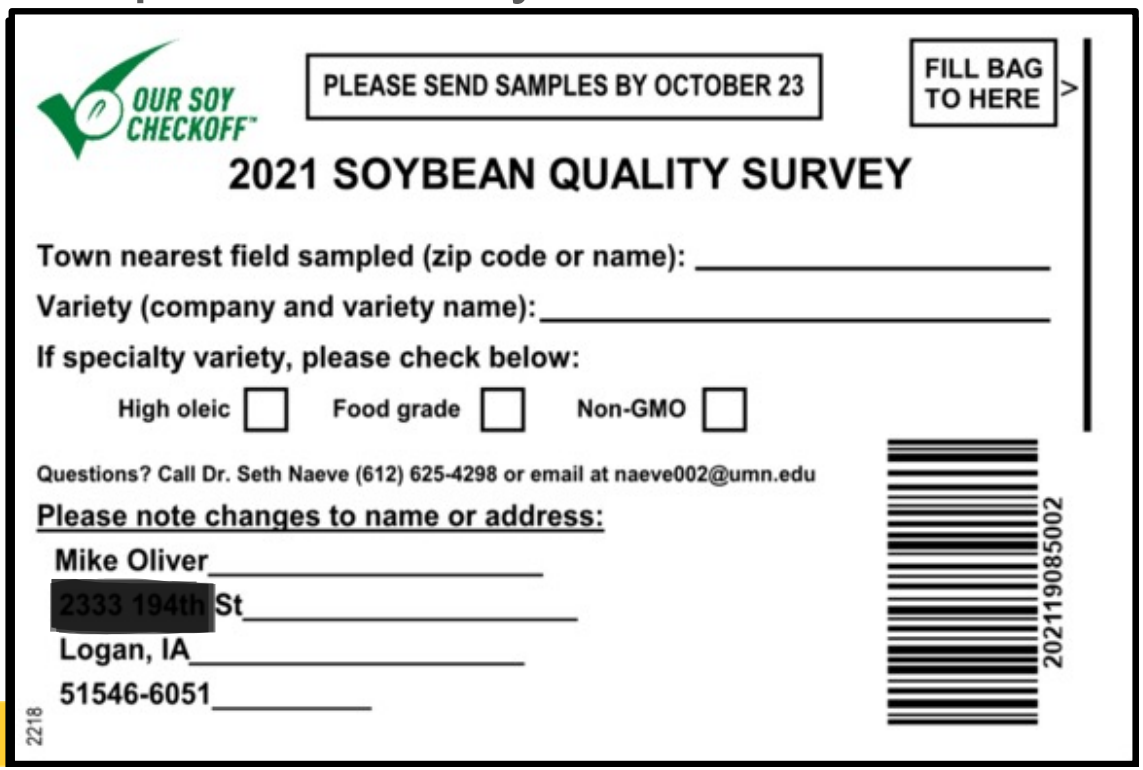

10 -Year Average - Oil (2011 - 2020)
Oil (%)
n = 16,294
14.3 – 16.4
16.4 – 17.6
17.6 – 18.3
18.3 – 18.8
18.8 – 19.1
19.1 – 19.2
19.2 – 19.5
19.5 – 20
20 – 20.7
20.7 – 21.9


10-Year Average - Sum, Protein + Oil
(2011 - 2020)
Sum, Protein + Oil (%)
n = 16,294
48.2 – 50.9
50.9 – 52.1
52.1 – 52.7
52.7 – 53
53 – 53.2
53.2 – 53.3
53.3 – 53.6
53.6 – 54.2
54.2 – 55.5
55.5 – 58.1

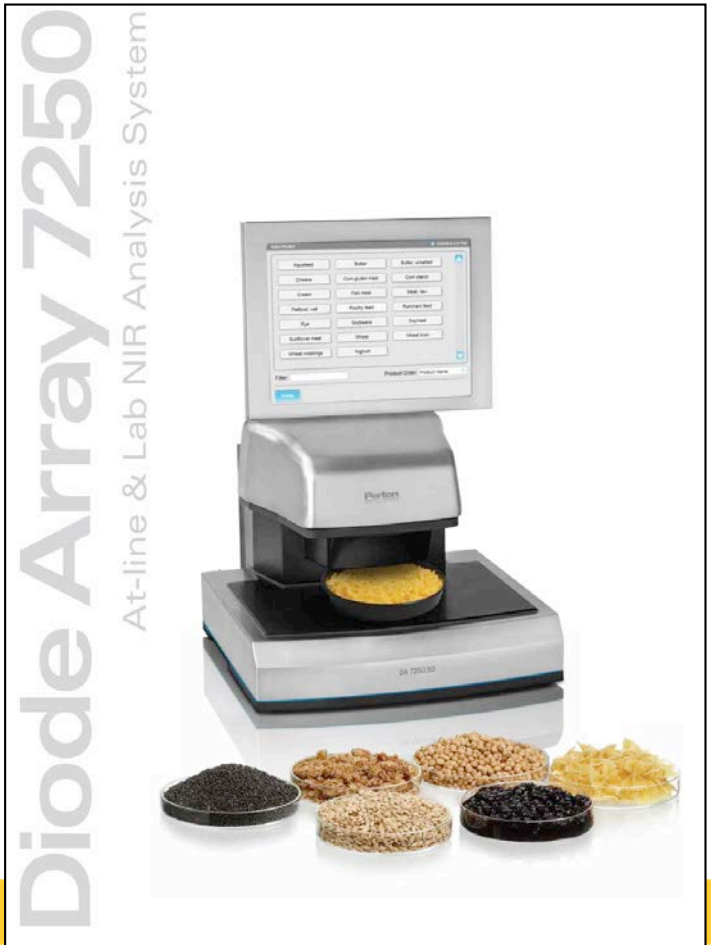

2021 SURVEY RESULTS
Voyager Pro
WEIGHING
UNITS
11/30/64 20:43:40
2nd UNITS
CALIBRATE
1.29835 lb
588.92 g
On/Off
Menu
Print
Mode
Enter
OHAUS
USSEC
2008 Food Soybean
Quality Survey
Variety (name/number and company):
Intended use:
Tofu
Natto
Miso
Other
Additional characteristics:
Special oil
Non-GMO
Organic
Field location (zip code or town, state):
Producer name or specific field identifier:
Contracting company:
Questions? Call Dr. Seth Naeve at (612) 625-4298

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



2021 Survey Methods - Protein and Oil

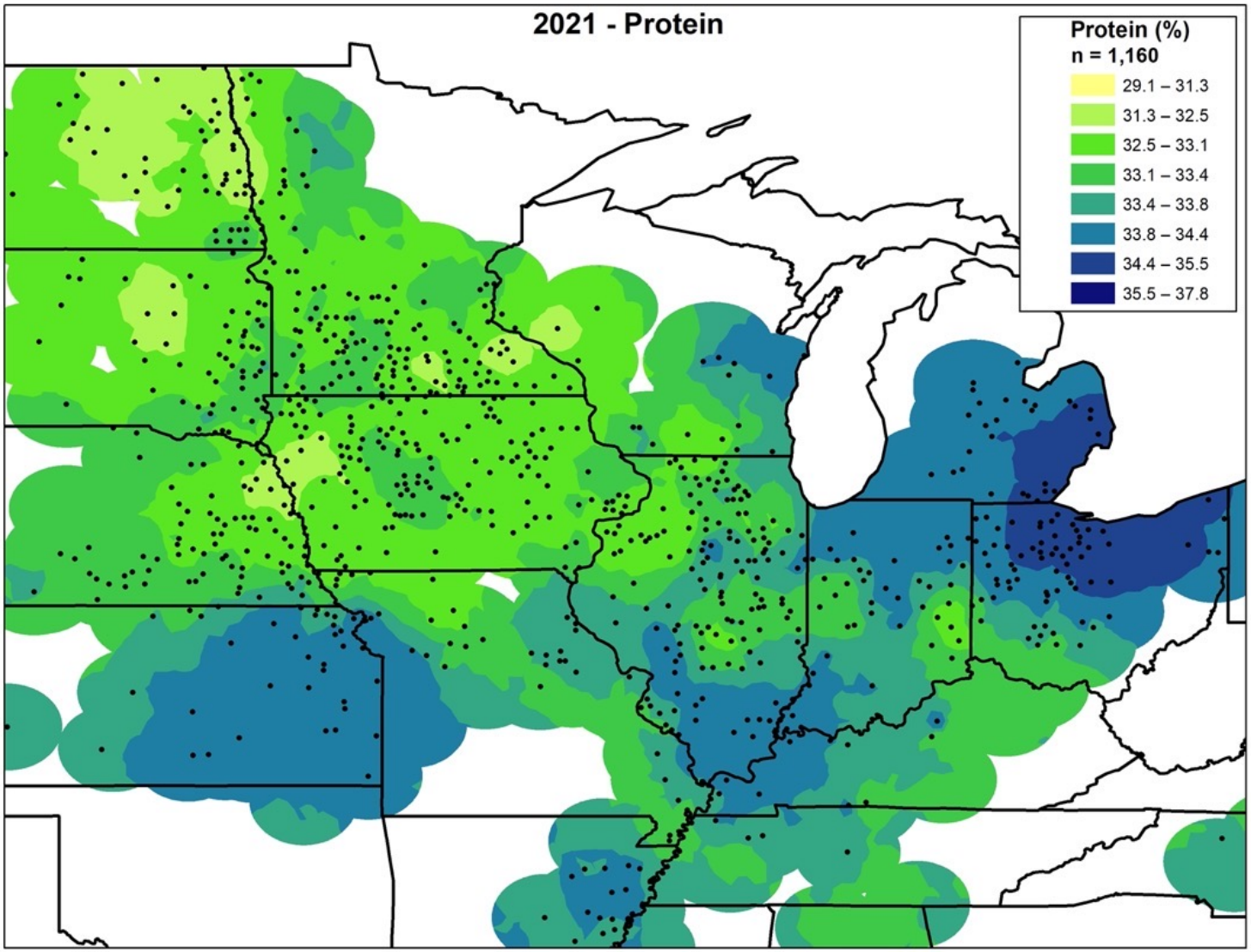


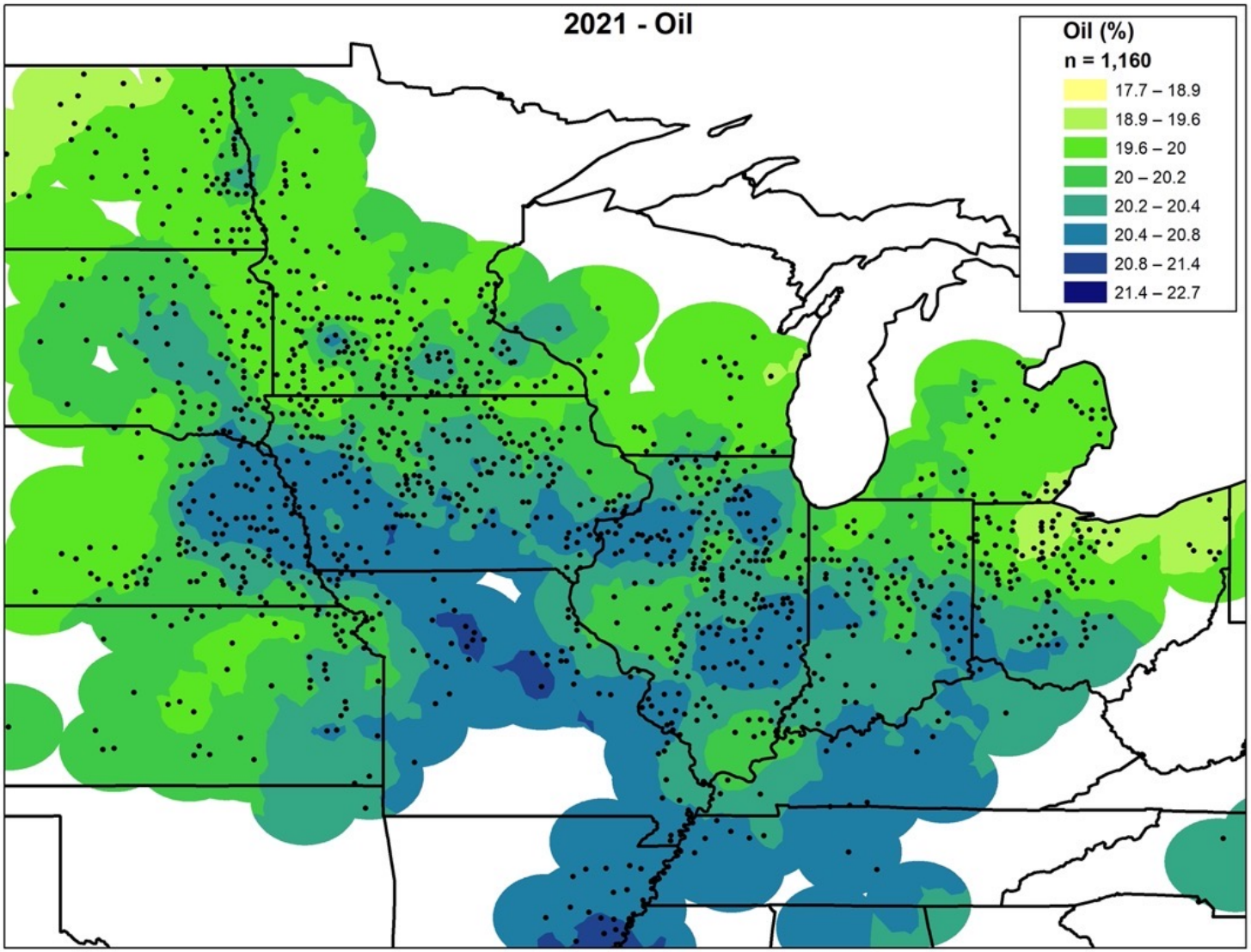
- Samples were analyzed for protein and oil concentration by Near Infrared Spectroscopy (NIRS) using a PerkinElmer diode array instrument
- Average protein and oil values were determined by state
- Regional and US average values were determined by weighting averages based on estimated 2021 production

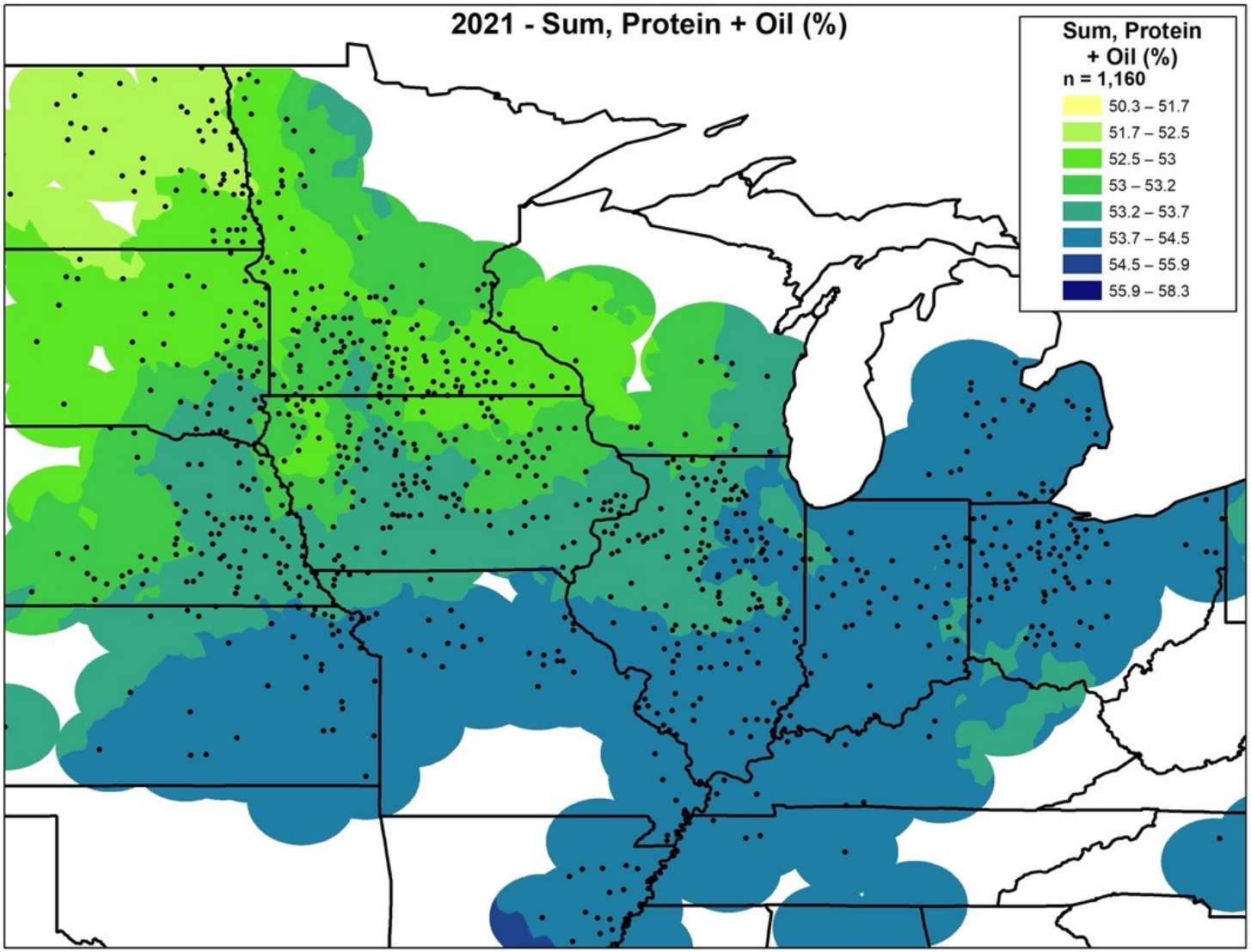

PROTEIN
AND OIL

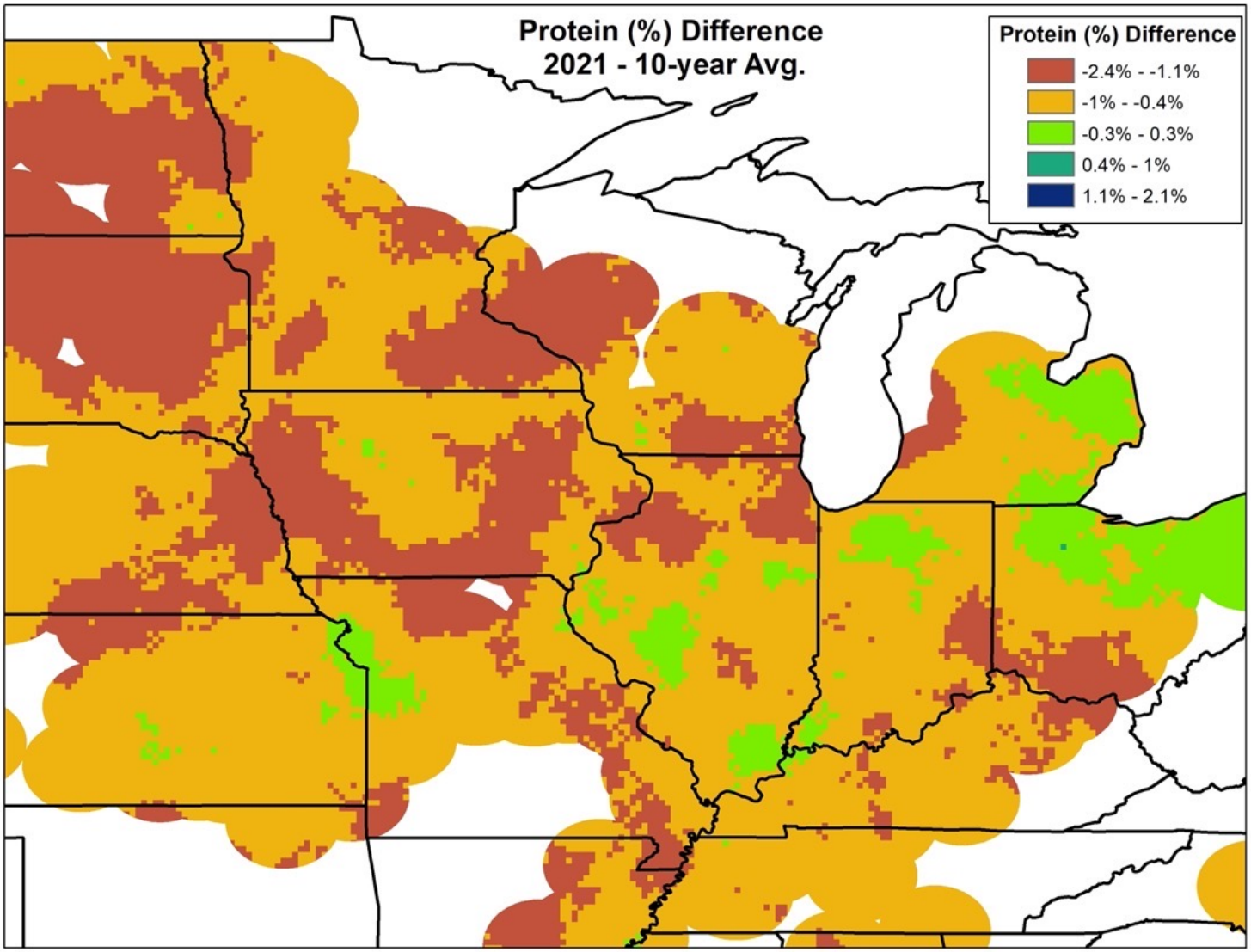
Region	Number of Samples	Protein (13%)	Change from 2020	Oil (13%)	Change from 2020	Seed Weight (g/100 seeds)
US Average	1,160	33.3		20.2		16.8
Average of 2021 Crop†		33.4	-0.5	20.2	+0.7	16.5
US 2011-2020 Average†		34.3		19.0		

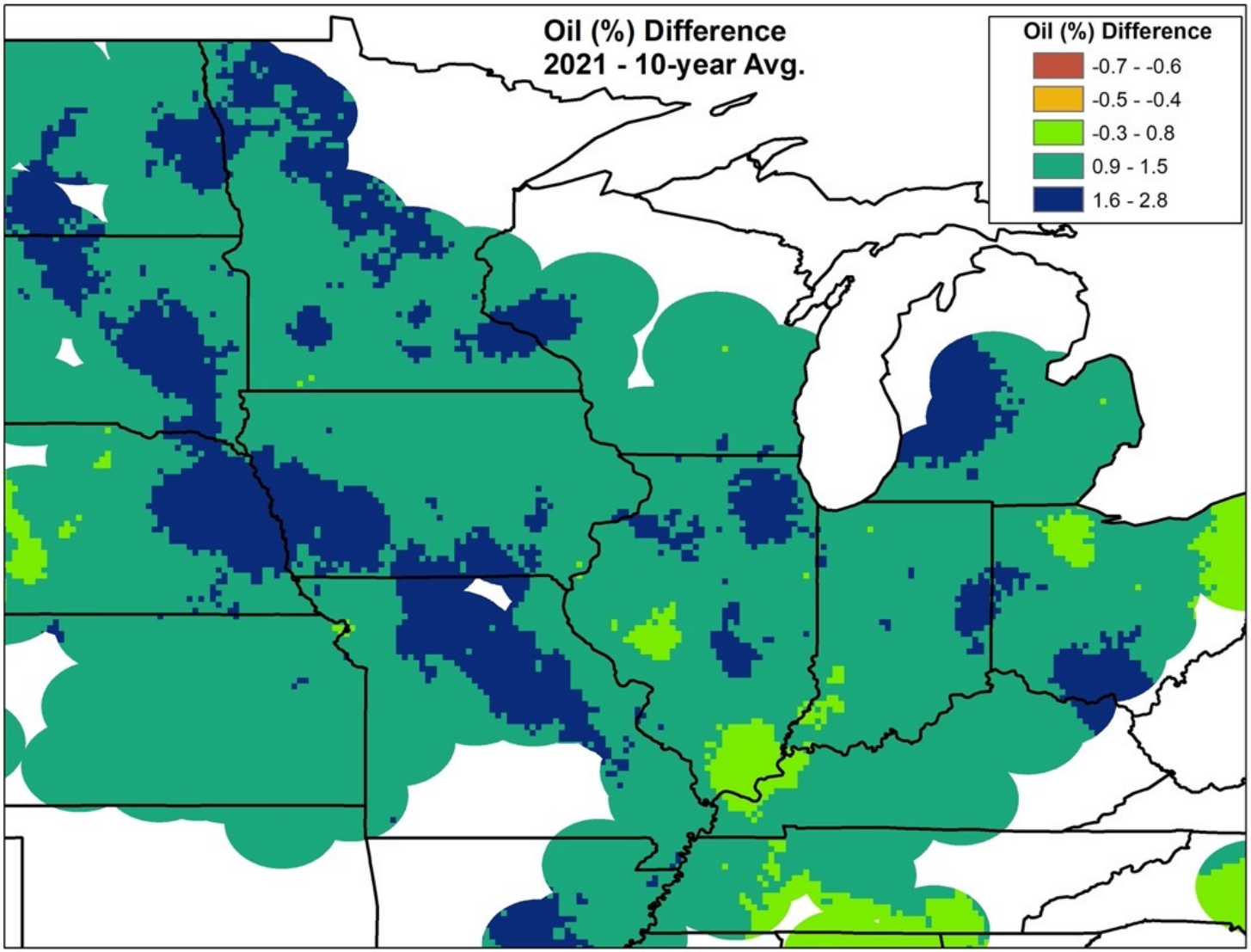
†US average values weighted based on estimated production by state, as estimated by USDA, NASS Crop Production Report (October, 2021)

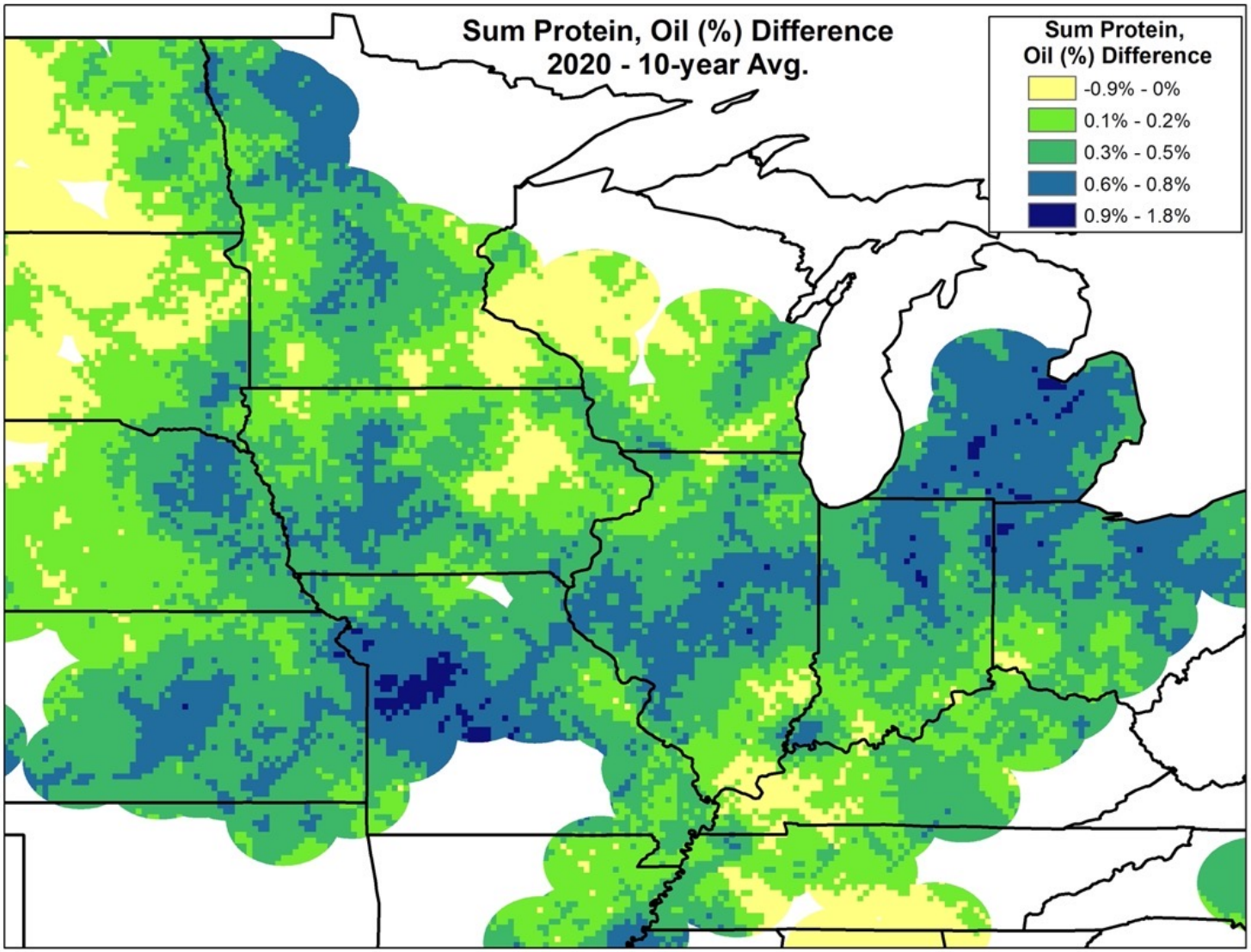

2021 - Protein
Protein (%)
n = 1,160
29.1 – 31.3
31.3 – 32.5
32.5 – 33.1
33.1 – 33.4
33.4 – 33.8
33.8 – 34.4
34.4 – 35.5
35.5 – 37.8

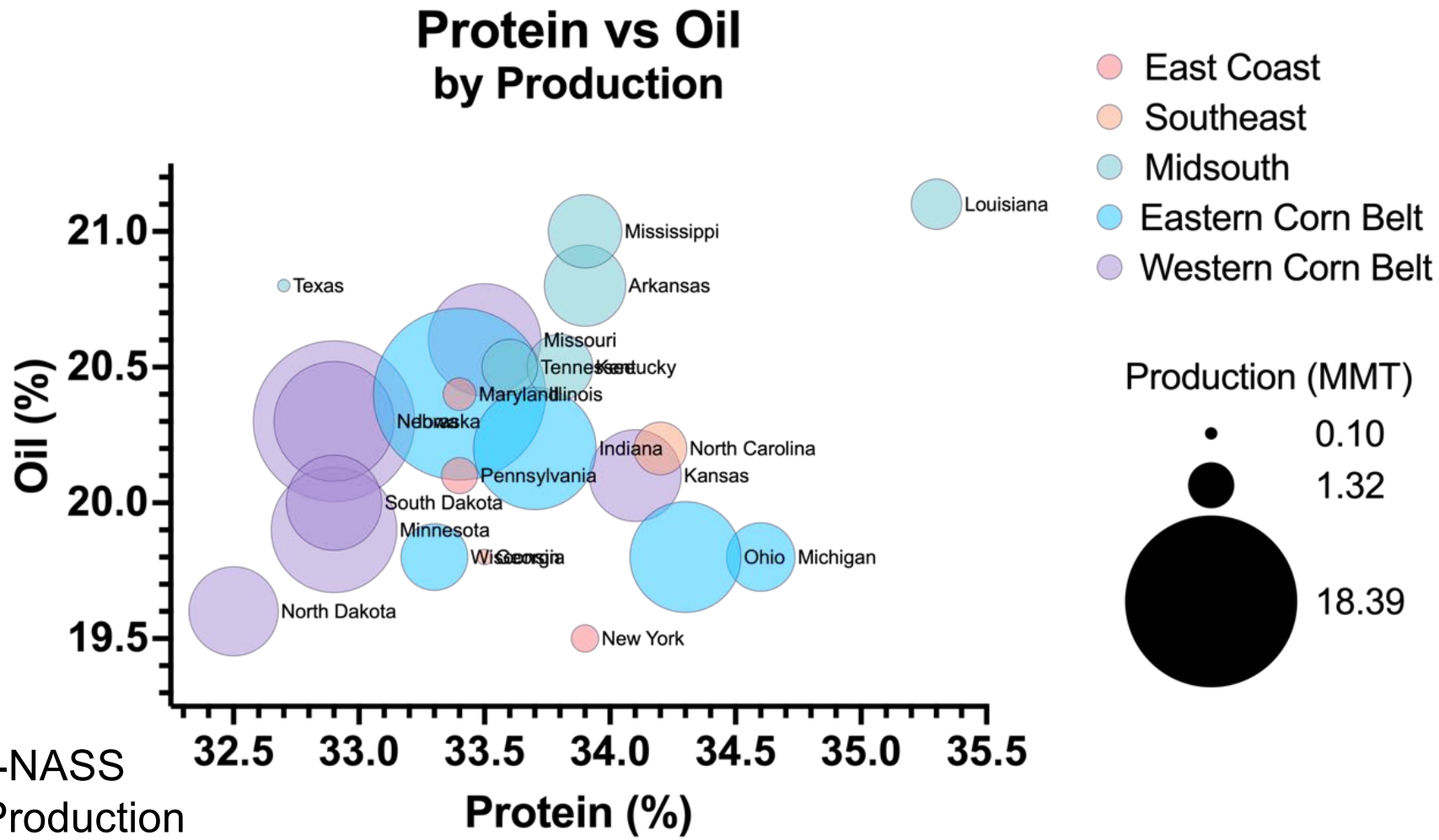

2021 - Oil
Oil (%)
n = 1,160
17.7 – 18.9
18.9 – 19.6
19.6 – 20
20 – 20.2
20.2 – 20.4
20.4 – 20.8
20.8 – 21.4
21.4 – 22.7


2021 - Sum, Protein + Oil (%)
Sum, Protein + Oil (%)
n = 1,160
50.3 – 51.7
51.7 – 52.5
52.5 – 53
53 – 53.2
53.2 – 53.7
53.7 – 54.5
54.5 – 55.9
55.9 – 58.3


Protein (%) Difference
2021 - 10-year Avg.
Protein (%) Difference
-2.4% - -1.1%
-1% - -0.4%
-0.3% - 0.3%
0.4% - 1%
1.1% - 2.1%

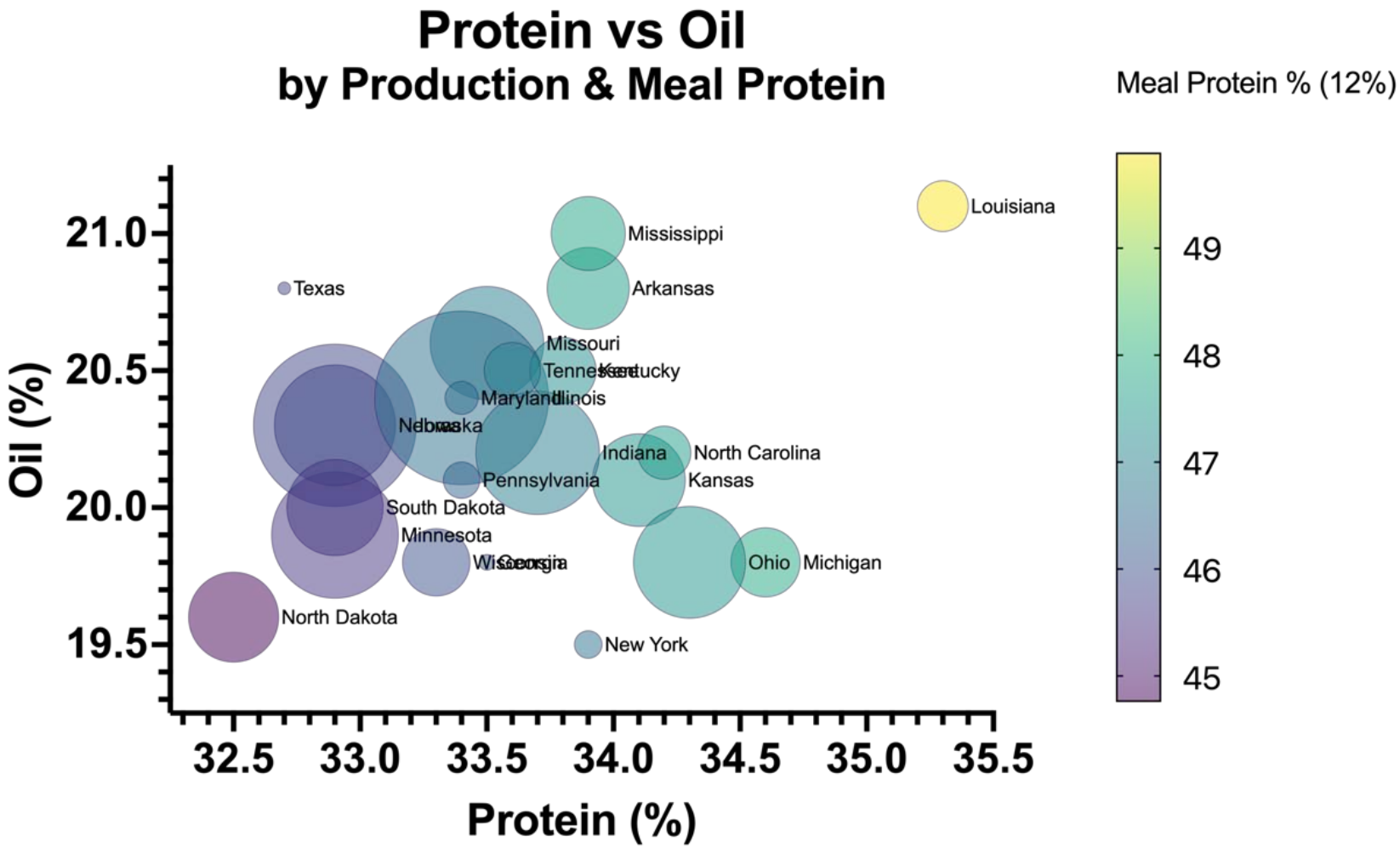

Oil (%) Difference
2021 - 10-year Avg.
Oil (%) Difference
-0.7 - -0.6
-0.5 - -0.4
-0.3 - 0.8
0.9 - 1.5
1.6 - 2.8


Sum Protein, Oil (%) Difference
2020 - 10-year Avg.
Sum Protein,
Oil (%) Difference
-0.9% - 0%
0.1% - 0.2%
0.3% - 0.5%
0.6% - 0.8%
0.9% - 1.8%

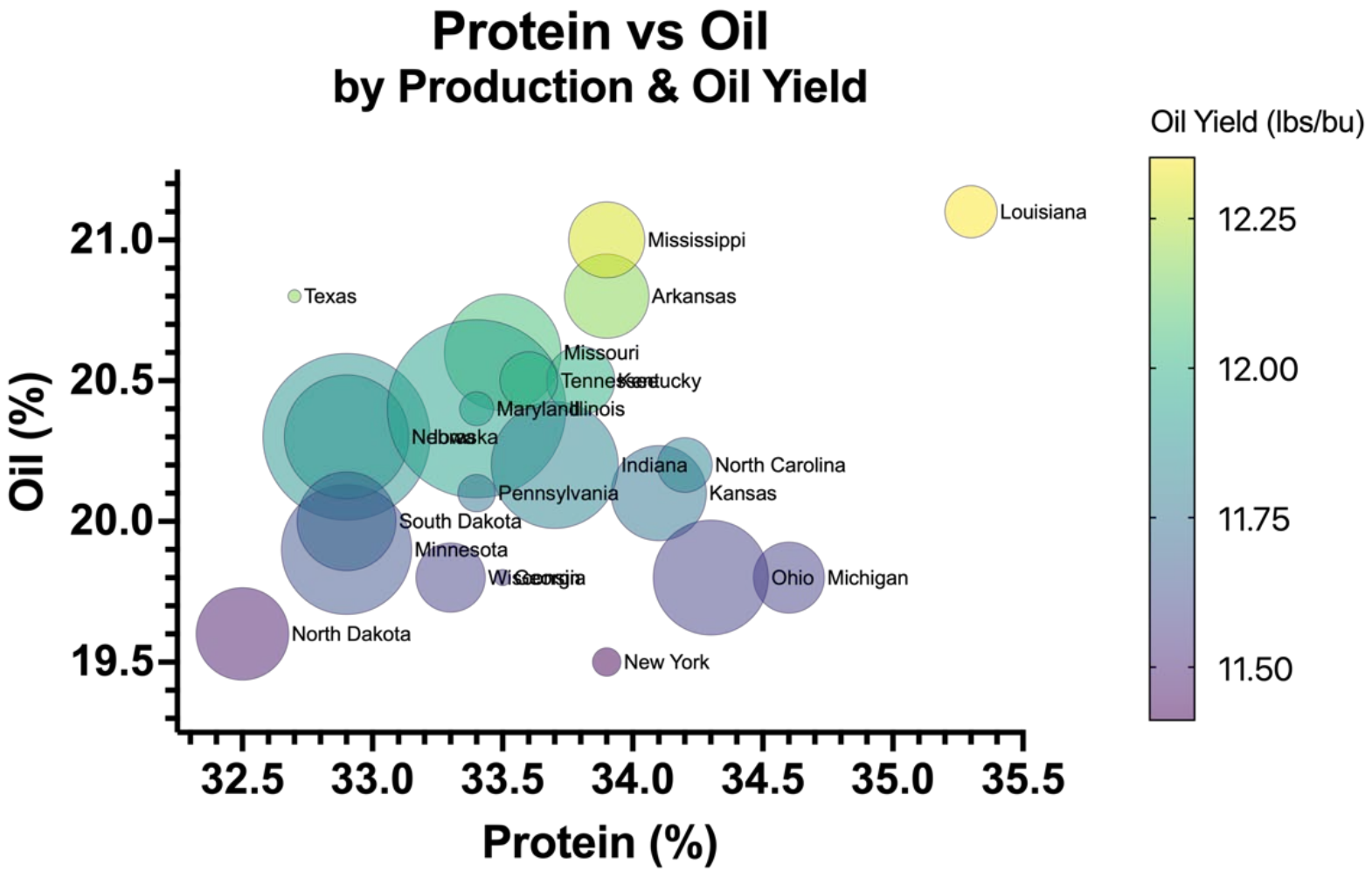


USDA-NASS
Crop Production

https://usda.library.cornell.edu/concern/publications/tm70mv177



USB SPROC Processing Model – Assumes uniform 6.2% hull removal



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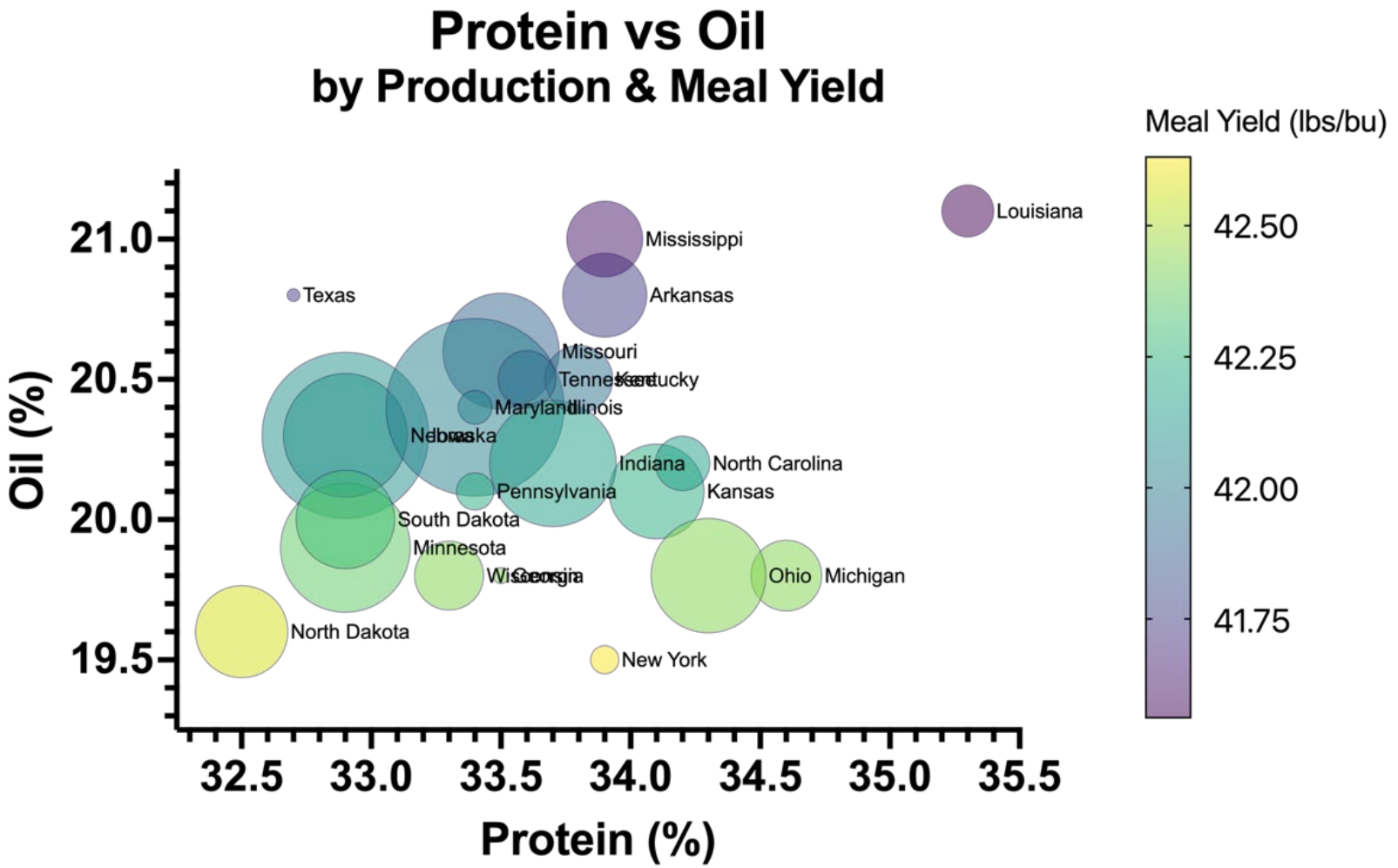

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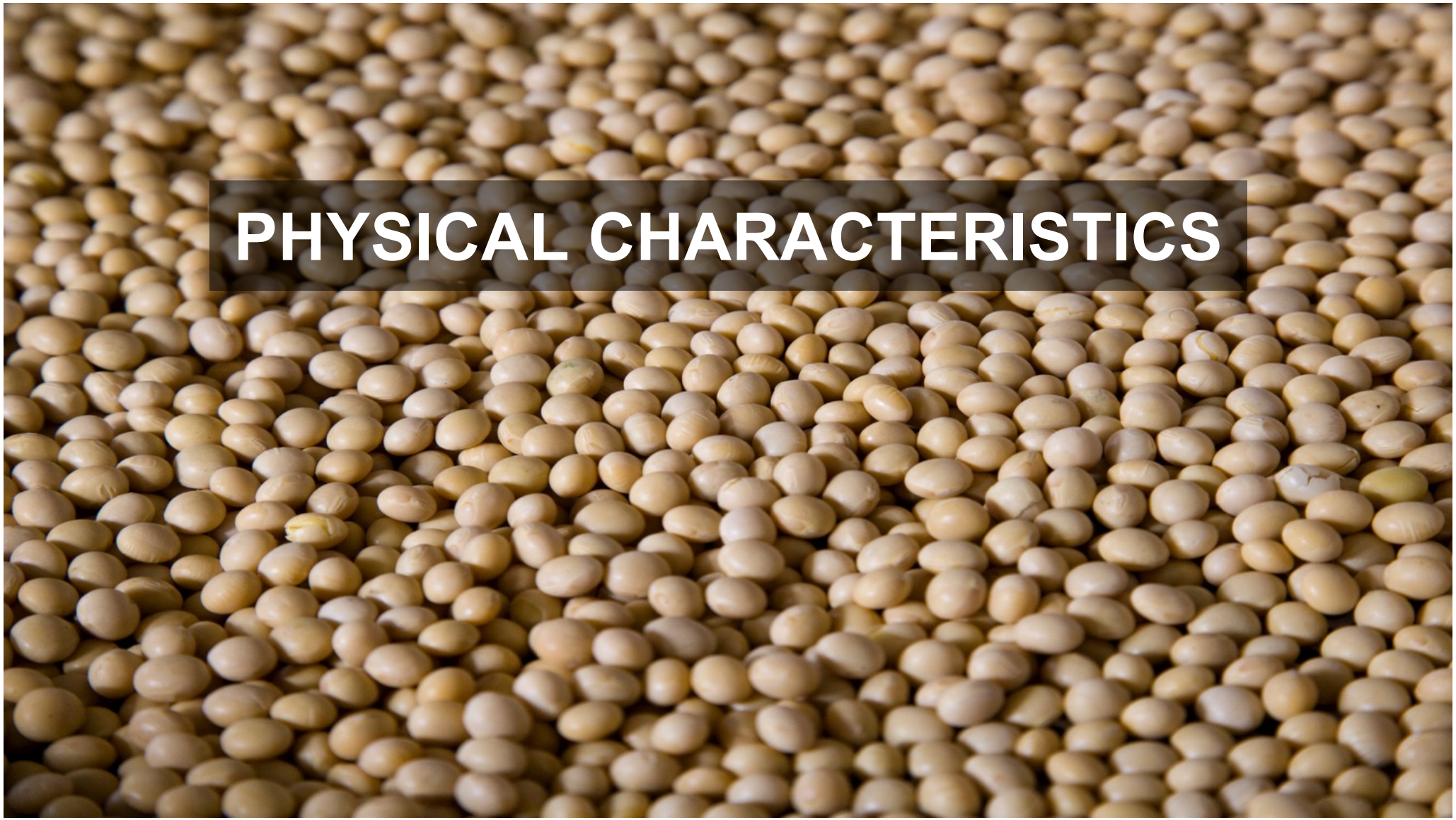
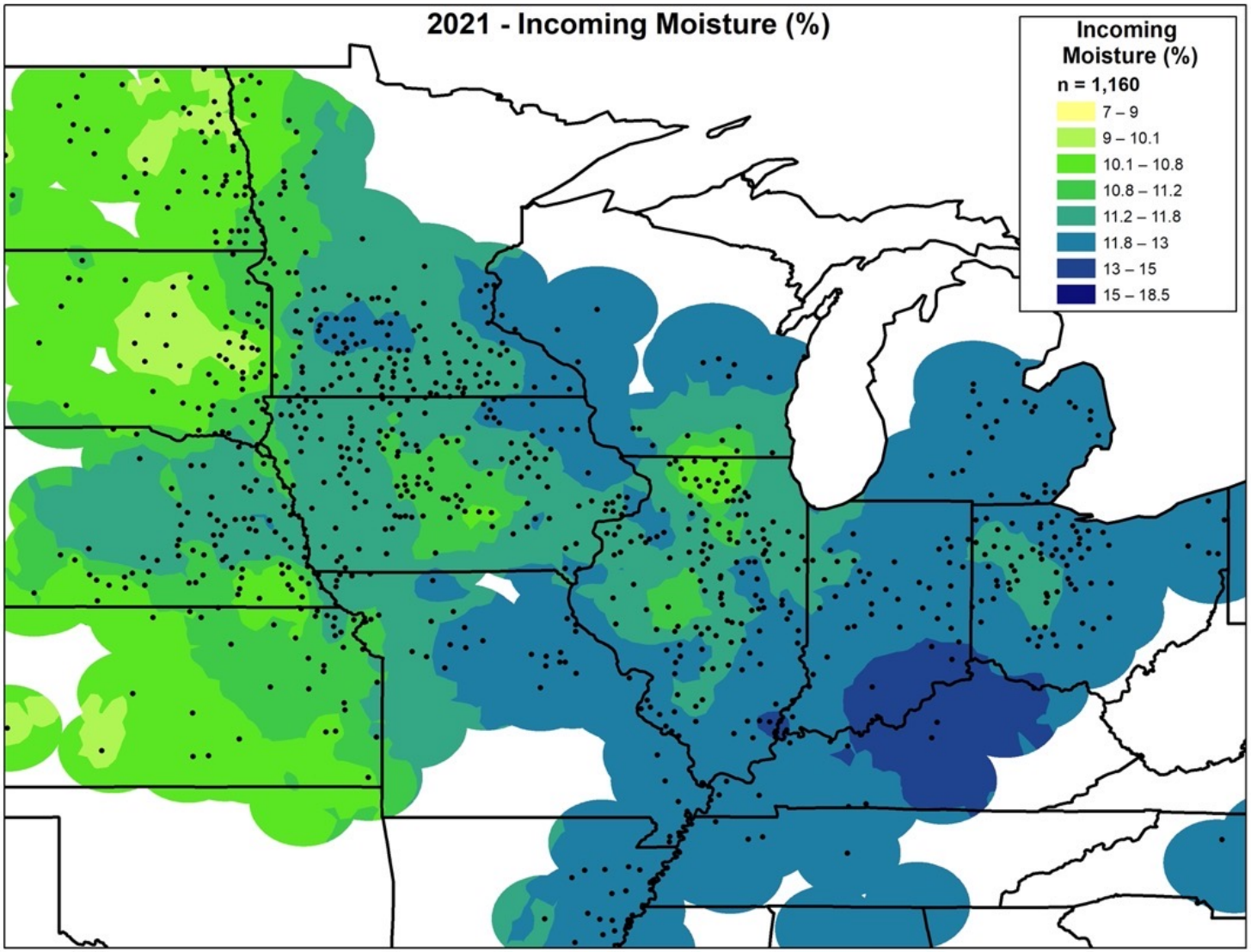
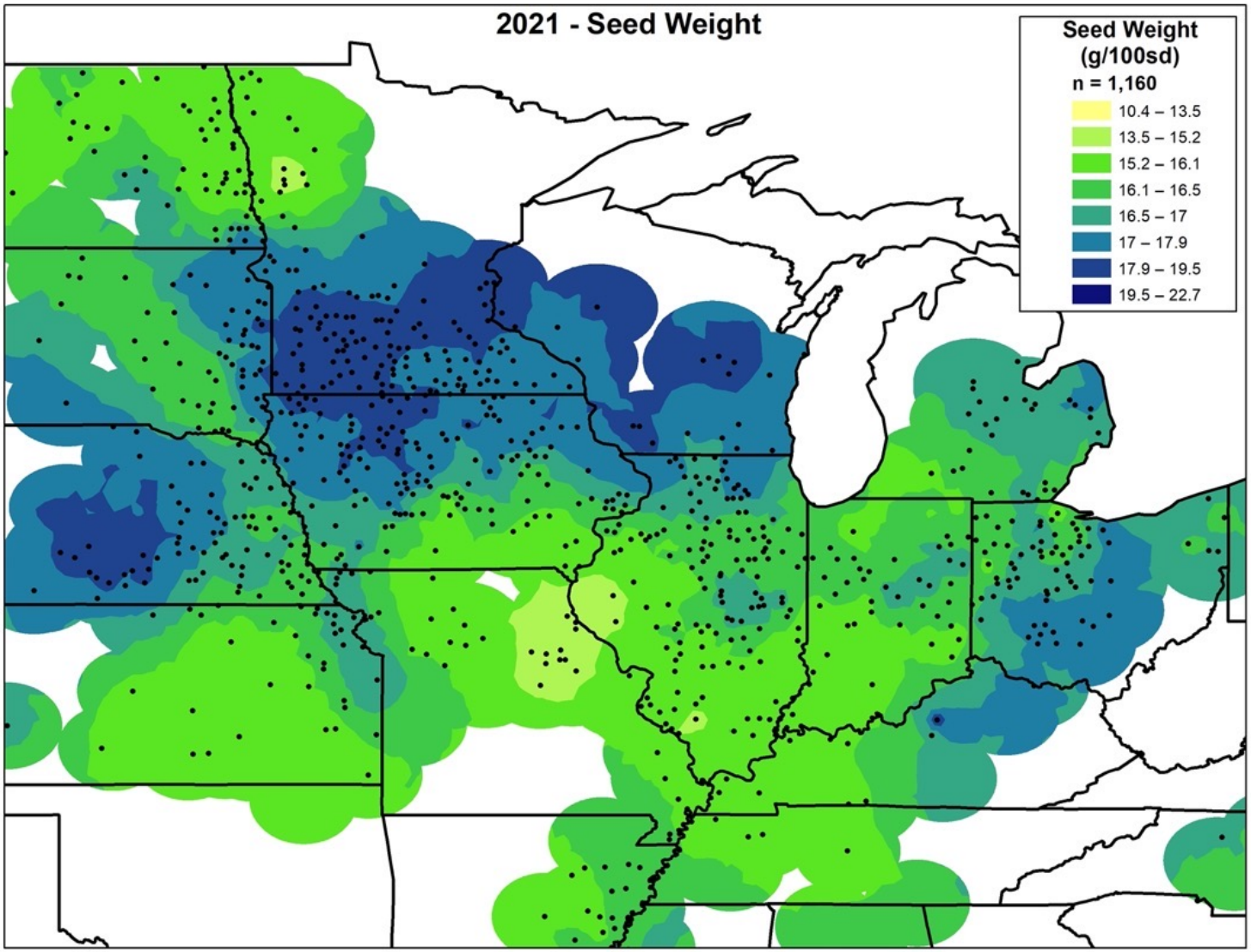
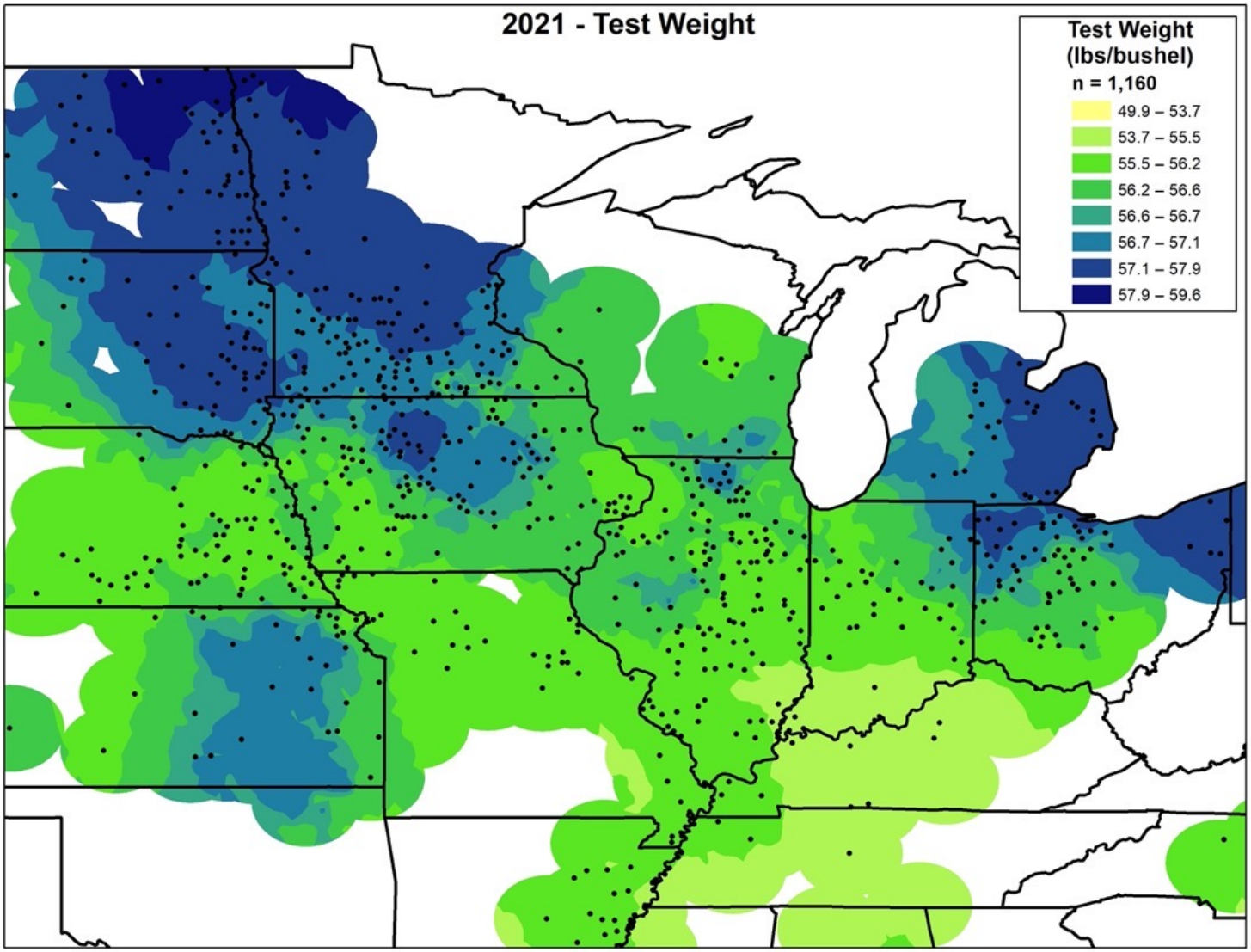
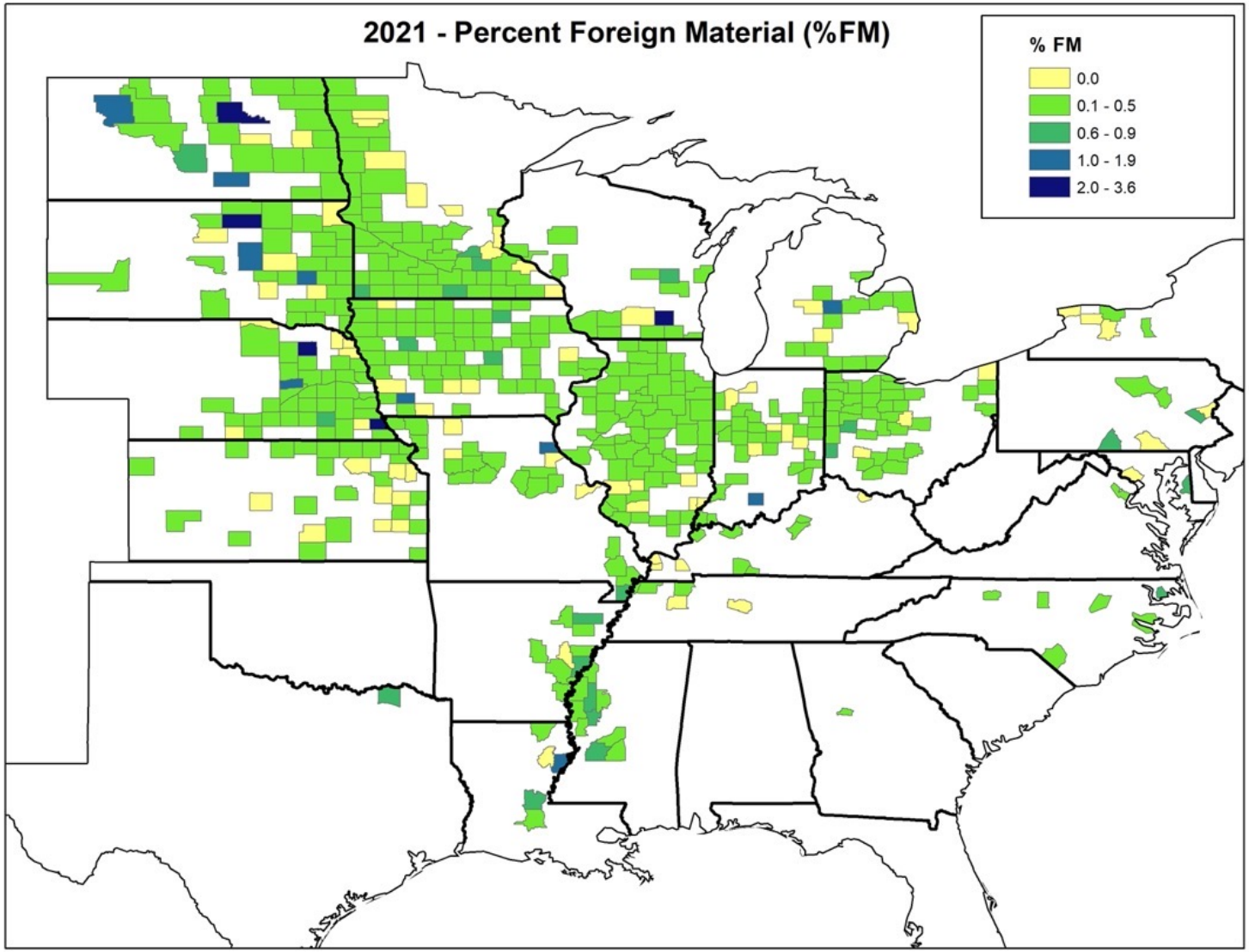

PHYSICAL CHARACTERISTICS


2021 - Incoming Moisture (%)
Incoming Moisture (%)
n = 1,160
7 – 9
9 – 10.1
10.1 – 10.8
10.8 – 11.2
11.2 – 11.8
11.8 – 13
13 – 15
15 – 18.5


2021 - Seed Weight
Seed Weight
(g/100sd)
n = 1,160
10.4 – 13.5
13.5 – 15.2
15.2 – 16.1
16.1 – 16.5
16.5 – 17
17 – 17.9
17.9 – 19.5
19.5 – 22.7

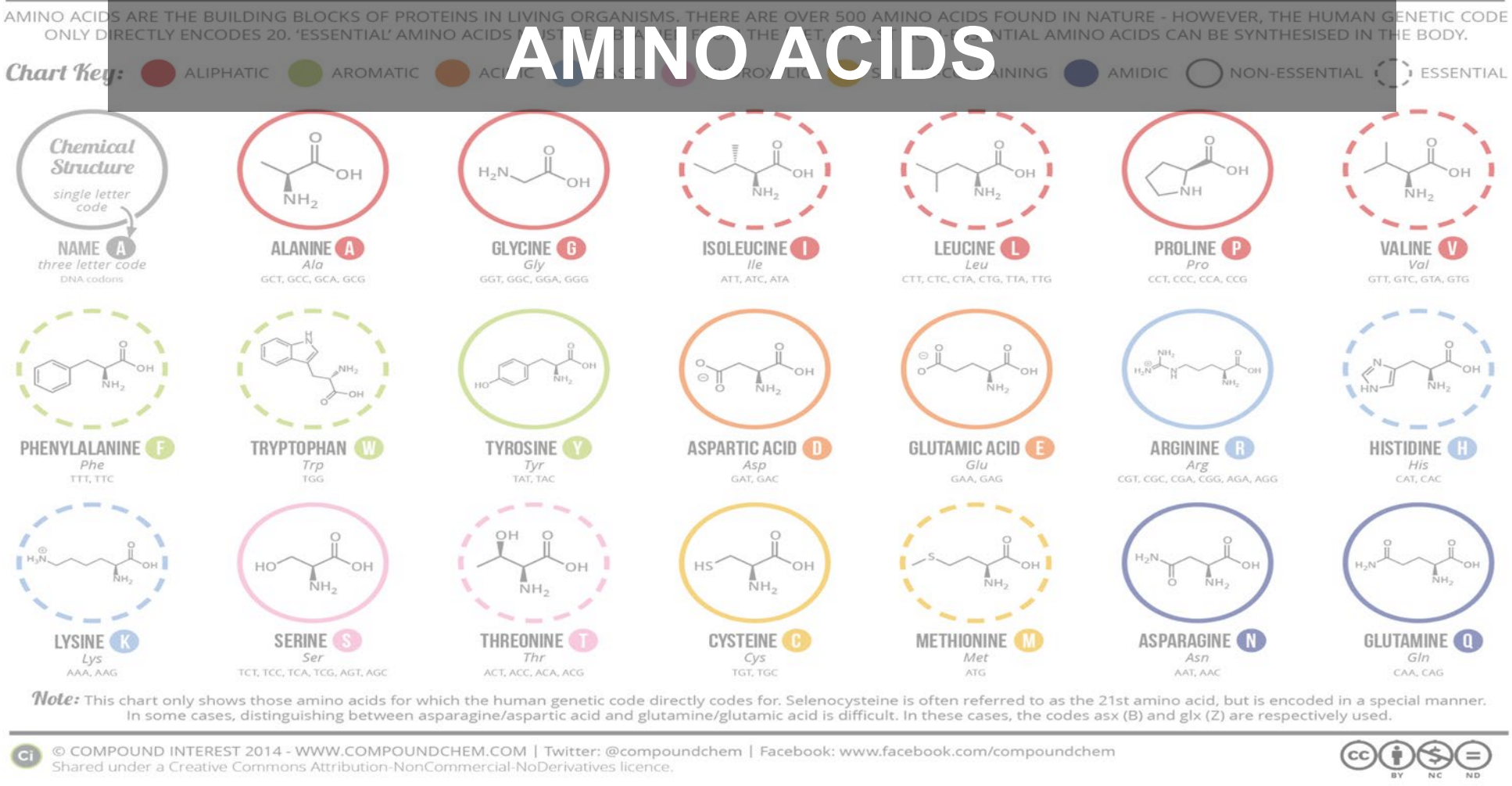

2021 - Test Weight
Test Weight
(lbs/bushel)
n = 1,160
49.9 – 53.7
53.7 – 55.5
55.5 – 56.2
56.2 – 56.6
56.6 – 56.7
56.7 – 57.1
57.1 – 57.9
57.9 – 59.6

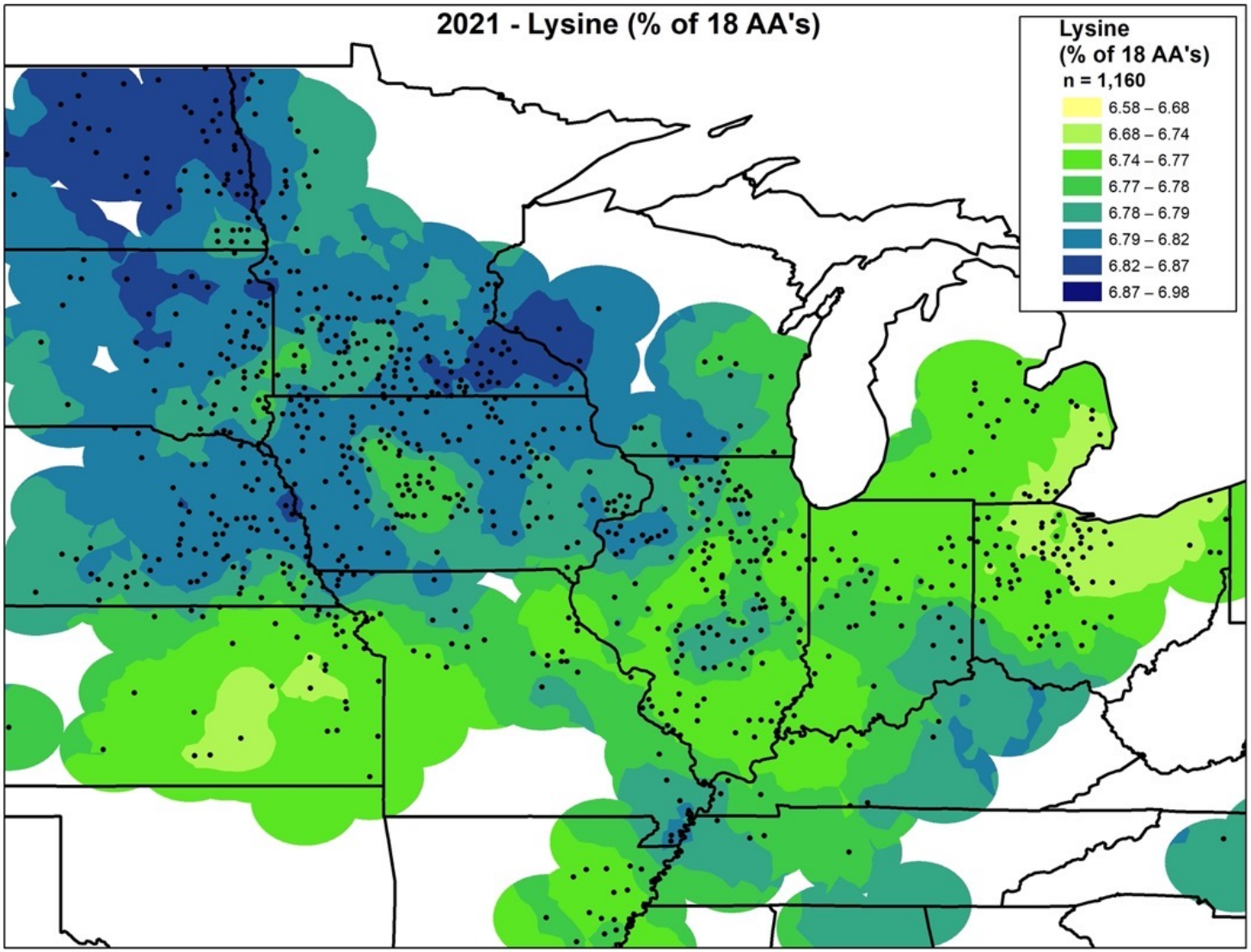

2021 - Percent Foreign Material (%FM)
% FM
0.0
0.1 - 0.5
0.6 - 0.9
1.0 - 1.9
2.0 - 3.6

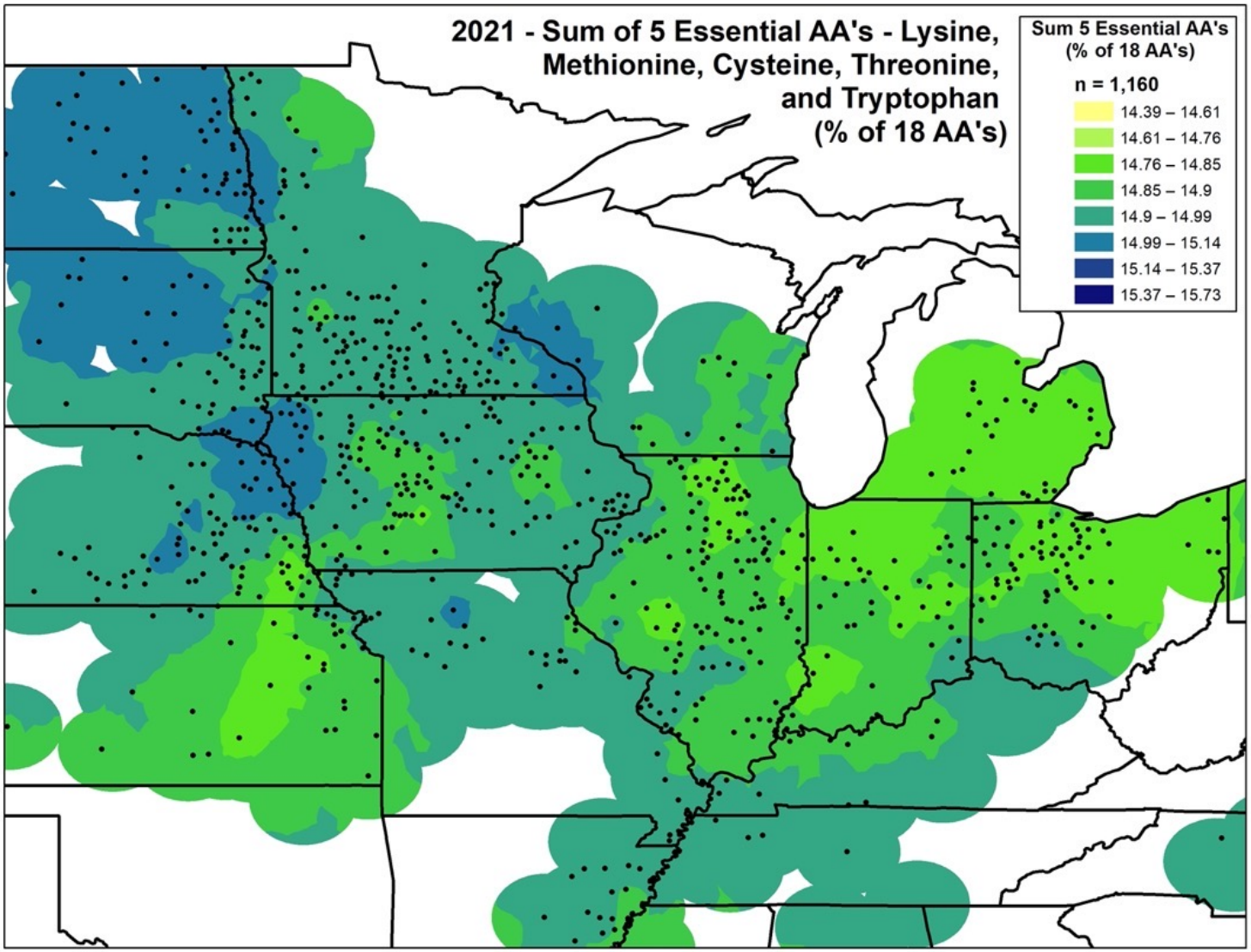
Better Measures of the Value of Soybeans

- 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

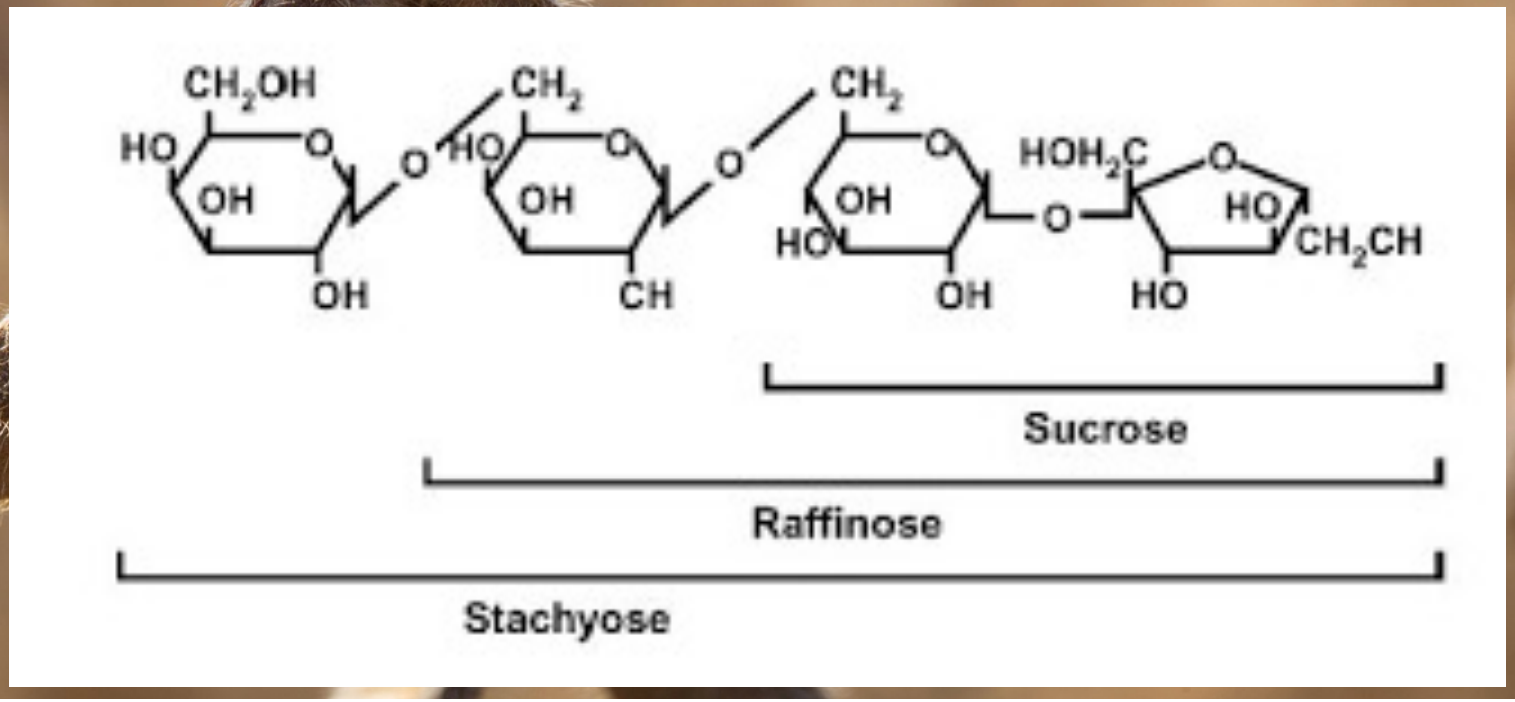
BETTER MEASURES OF QUALITY: AMINO ACIDS

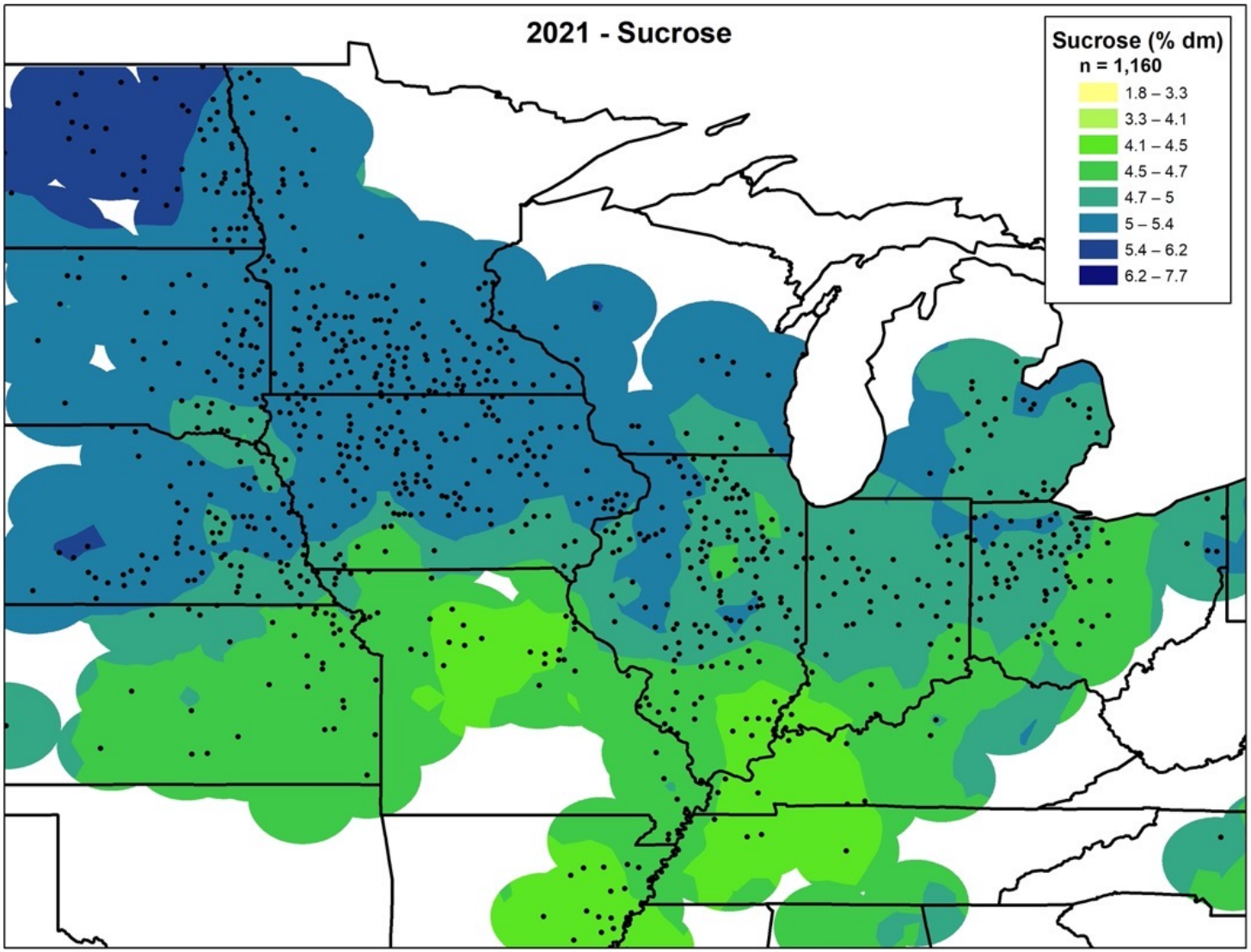



2021 - Lysine (% of 18 AA's)
Lysine
(% of 18 AA's)
n = 1,160
6.58 – 6.68
6.68 – 6.74
6.74 – 6.77
6.77 – 6.78
6.78 – 6.79
6.79 – 6.82
6.82 – 6.87
6.87 – 6.98


2021 - Sum of 5 Essential AA's - Lysine, Methionine, Cysteine, Threonine, and Tryptophan (% of 18 AA's)
Sum 5 Essential AA's (% of 18 AA's)
n = 1,160
14.39 – 14.61
14.61 – 14.76
14.76 – 14.85
14.85 – 14.9
14.9 – 14.99
14.99 – 15.14
15.14 – 15.37
15.37 – 15.73

BETTER MEASURES OF QUALITY: SOLUBLE SUGARS




2021 - Sucrose
Sucrose (% dm)
n = 1,160
1.8 – 3.3
3.3 – 4.1
4.1 – 4.5
4.5 – 4.7
4.7 – 5
5 – 5.4
5.4 – 6.2
6.2 – 7.7

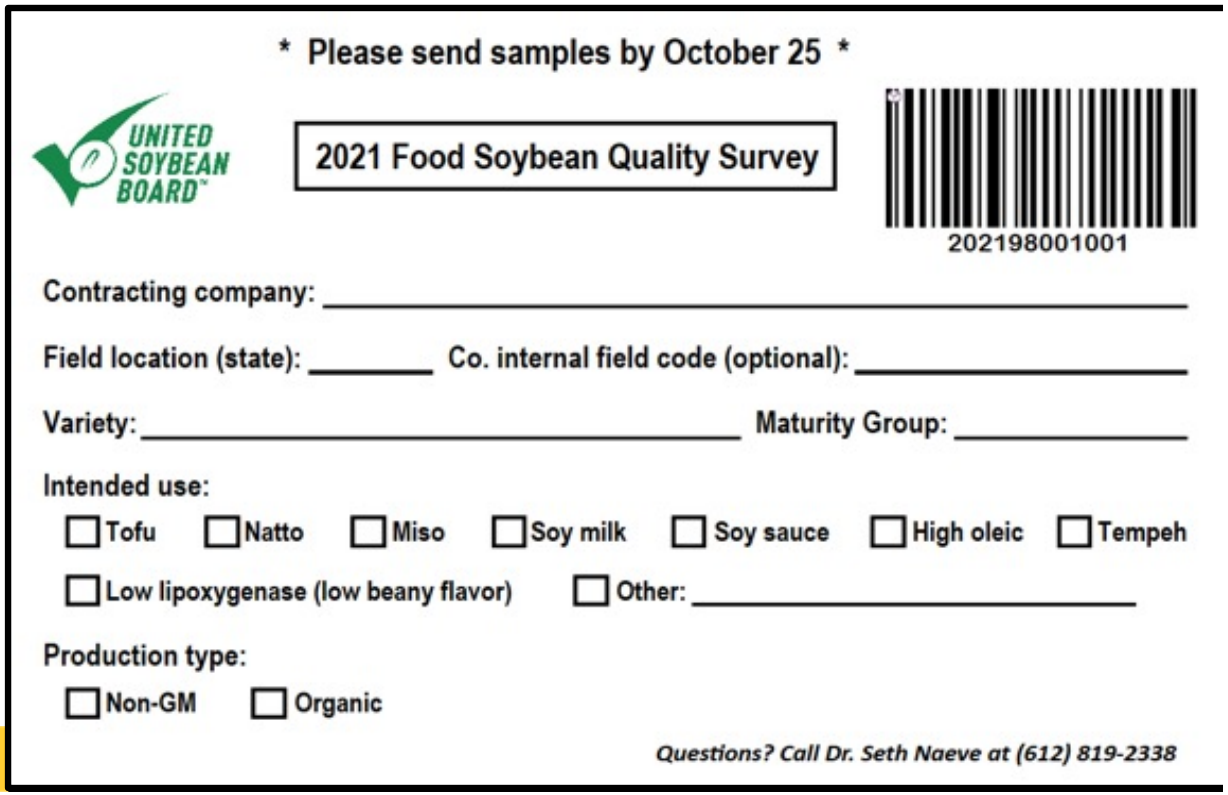
Quality of the United States Food Soybean Crop: 2021

Seth Naeve and Jill Miller-Garvin
University of Minnesota

UNIVERSITY OF MINNESOTA
Driven to Discover®

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 *

UNITED SOYBEAN BOARD

2021 Food Soybean Quality Survey

202198001001

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

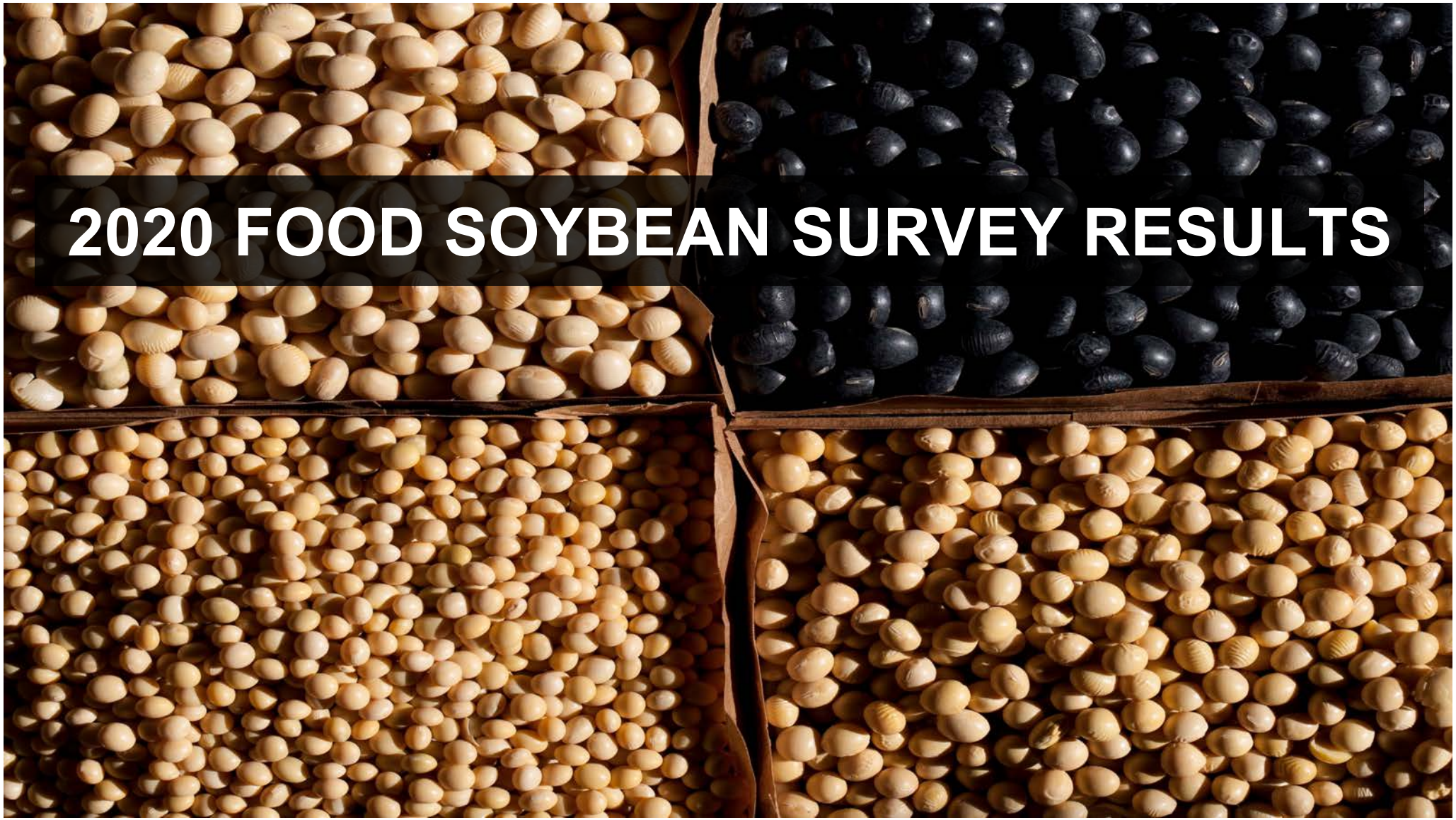
Questions? Call Dr. Seth Naeve at (612) 819-2338

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

State (# of samples)	Region	Protein * (%)	Regional Protein Average	Oil * (%)	Regional Oil Average
Minnesota (10)	WCB	35.5		19.4	
North Dakota (3)	WCB	35.2		18.7	
South Dakota (1)	WCB	34.8	35.4	20.6	19.3
Illinois (76)	ECB	35.5		20.0	
Indiana (4)	ECB	34.6		19.6	
Michigan (40)	ECB	36.5		19.3	
Ohio (28)	ECB	37.8		19.5	
Wisconsin (46)	ECB	35.4	36.0	19.8	19.7

Data as of October 29, 2021

§ WCB: Western Corn Belt; ECB: Eastern Corn Belt

* 13% moisture basis

Region	Seed Size	Number Samples	Seed Size (g/100 seeds)	Protein* (%)	Oil* (%)
WCB	Small	1	9.9	35.3	17.3
	Average	9	19.5	35.2	19.4
	Large	4	24.8	35.8	19.6
ECB	Small	5	7.0	36.6	18.2
	Average	140	18.4	35.7	19.9
	Large	9	23.4	36.8	19.3

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

Region	Seed Size	Number Samples	Seed Size (g/100 seeds)	Sucrose (% DM)	Raffinose (% DM)	Stachyose (% DM)
WCB	Small	1	9.9	5.80	0.92	3.80
	Average	9	19.5	5.80	0.92	3.80
	Large	4	24.8	4.97	0.91	3.81
ECB	Small	5	7.0	4.42	0.86	3.92
	Average	140	18.4	4.41	1.01	4.04
	Large	49	23.4	4.37	1.00	3.97

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)

Region	Seed Size	Number Samples	Seed Size (g/100 seeds)	Protein* (%)	Lysine (% of 18 AAs)	Five Limiting Essential¶ Amino Acids (% of 18 AAs)
WCB	Small	1	9.9	35.3	6.8	14.8
	Average	9	19.5	35.2	6.8	14.8
	Large	4	24.8	35.8	6.7	14.8
ECB	Small	5	7.0	36.6	6.7	14.7
	Average	140	18.4	35.7	6.7	14.7
	Large	49	23.4	36.8	6.7	14.7

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
¶ Five limiting essential amino acids: cysteine, lysine, methionine, threonine, and tryptophan

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