

2020 NORTH DAKOTA SOYBEAN QUALITY SURVEY

Northern Crops Institute



FUNDING PROVIDED BY

North Dakota Soybean Council



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SUMMARY

North Dakota generally experienced fair to good weather conditions for soybean crops throughout 2020. Much of North Dakota saw below average precipitation following the previous wet fall harvest. Spring started the year off on the cool side with precipitation slightly below average. Spring planting was somewhat delayed which resulted in later than average emergence. Summer brought warmer and slightly wetter conditions allowing for crops to bloom, set pods and drop leaves at rates similar to five-year averages. Weather conditions continued to be favorable into the fall which allowed for a swift soybean harvest ending in late October.

With generally favorable conditions from planting to harvest, acres harvested, yield, production and test weight all increased from 2019. Moisture, fatty acids and soluble sugars were generally lower than 2019 while protein, oil, fiber, ash, stearic acid, oleic acid and raffinose essentially were the same.

In comparison to the 10-year average, 2020 soybeans had higher test weight and fiber, fatty acids, (especially oleic, linoleic and linolenic) and soluble sugars were lower than the 10-year average. Protein, oil, ash, stearic acid and raffinose were essentially at 10-year average levels.

The total amino acids were similar to the 10-year average and higher than in 2019. The Critical Amino Acid Value (CAAV) of the 2020 soybean crop is slightly higher than the previous year and the same as the 10-year average.

New to 2020 is a comparison of U.S. Pacific Northwest (PNW) soybeans to those collected at ports in the Gulf.

SAMPLE COLLECTION

Nine agricultural districts serve as the basis for a comparison of crop quality data (Figure 1). A total of 210 samples were collected from 40 counties and nine agricultural districts in North Dakota by the United States Department of Agriculture-National Agricultural Statistics Service (USDA-NASS). The number of samples collected from each county is determined based on the soybean production from previous year which is calculated by the NASS.

Additionally, 15 samples were collected from both the PNW and Gulf ports. Gulf samples were randomly selected during the months of September through December 2020. PNW samples were various composite samples from vessels loaded October through December 2020.

North Dakota
Agricultural Statistics Districts

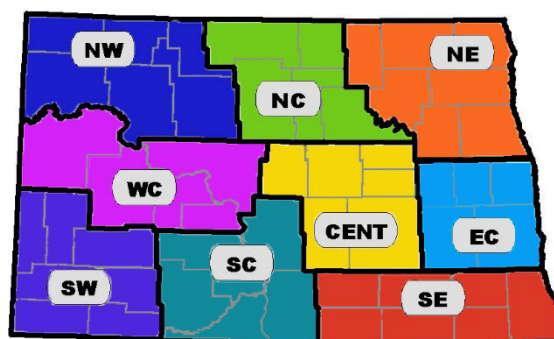


Figure 1. North Dakota agricultural districts

District	Abbreviation	Number of Sample	% Distribution
Central	CENT	19	9
East Central	EC	42	20
North Central	NC	24	11
North East	NE	37	18
North West	NW	15	7
South Central	SC	12	6
South East	SE	48	23
West Central	WC	9	4
South West	SW	4	2
	Total	210	100

Table 1. North Dakota agricultural districts, number of samples and percent distribution

ANALYSIS METHOD

Moisture, color, test weight, proximate (protein, oil, ash, and fiber), soluble sugar, fatty acid profile, and amino acid profile were analyzed as quality attributes that characterize North Dakota soybeans. Test weight and moisture were analyzed using a DICKEY-John Grain Analysis Computer GAC 2500 UGMA (Auburn, IL), employing the AACC method 55-10 (AACC, 1999). These tests were analyzed immediately after the soybean samples were received.

Color analyses were performed with a Minolta Color Analyzer CR-410 (Ramsey, NJ). CIE 1976 (L*, a*, b*) color space, where brightness (L*), redness (a*) and yellowness (b*) values were determined. Proximate, soluble sugar, fatty acid and amino acid profiles were evaluated using a Perten DA7250 Near-Infrared Analyzer (NIRS) (Huddinge, Sweden), with a calibration developed at the University of Minnesota and funded by the United Soybean Board. Submitted soybean samples were ground into coarse flour using a Perten Laboratory Mill 3600, and analyzed on the NIR to obtain proximate, soluble sugar, fatty acid and amino acid profiles.

Whole beans were used to obtain initial moisture, test weight and color. The NIR method was also utilized by Miller-Garvin and Naeve (2019) for the United States Soybean Crop Quality Report funded by the United States Soybean Export Council (USSEC). Through a collaborative effort as a soybean consortium, the North Dakota soybean quality data collected from the Perten DA 7250 contributes to the soybean calibration along with various universities in the nation. The calibration is updated annually reflecting the data collected from the previous crop year's samples.

2020 SOYBEAN PRODUCTION

According to the USDA National Agricultural Statistics Service (USDA-NASS), national soybean production for 2020 was 4.1 billion bushels (Bu) or 112.6 million metric tons (MT), which is 16% higher than the previous year and 93% of the 2018 record production. Nationally, soybean acres planted increased 9% from the previous year to 83.1 million Bu or 33.6 million hectare (HA) and acres harvested increased 10% from the previous to 82.3 million Bu (33.3 million HA).

Soybean yields in the U.S. had been steadily increasing since 2013 to a record high in 2016 at 51.9 bushels per acre. The national soybean yield average in 2020 was 50.2 bushels per acre compared to 47.4 acres in 2019 and 50.6 bushels per acre in 2018.

Volume, yield and acres harvested in North Dakota for 2020 followed national soybean harvest trends. The 2019 North Dakota production quantity, harvested acres, and yield data are presented in Figure 2. North Dakota soybean production in 2020 was 191 million Bu or 5.2 million MT which is a 12% increase from 2019. Acres planted was 5.75 million (2.31 million HA), an increase of 2.6% from 2019 and acres harvested was 5.7 million Bu or 2.41 million HA, an increase of 5.6% from the previous year. This increase resulted in a yield of 33.5 Bu per acre (2.3 MT per HA), an increase of 6% from the previous year. In 2020, North Dakota remained in 9th place among states in soybean production, 5th in acres of soybeans harvested, and dropped to 28th in bushels per acre. (USDA-NASS, 2020)

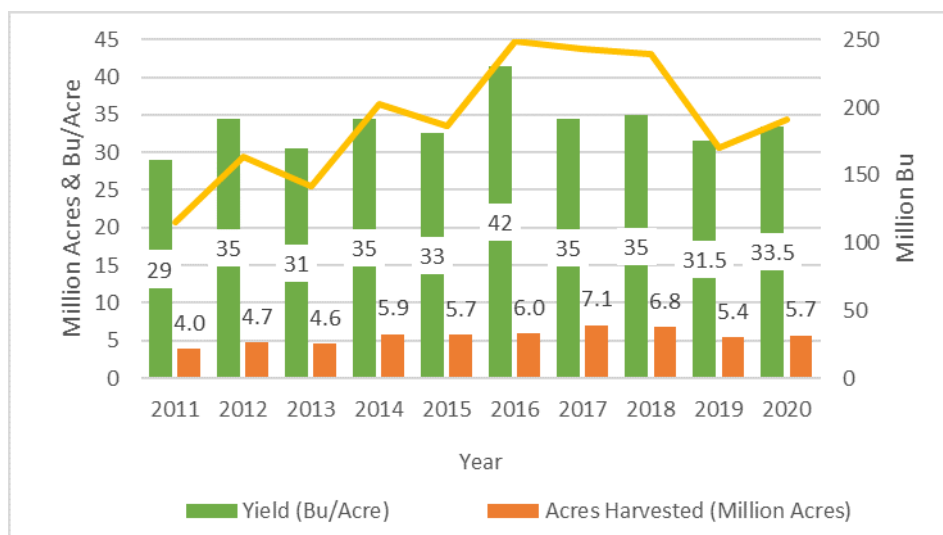


Figure 2. North Dakota soybean yield, harvest and production data between 2011 and 2020

2020 NORTH DAKOTA WEATHER AND CROP SUMMARY

While the southeastern U.S. experienced above average precipitation in 2020, Figure 3 below (National Oceanic and Atmospheric Administration - NOAA) shows that much of North Dakota saw below average precipitation, a contrast from the much above average precipitation in the previous year.

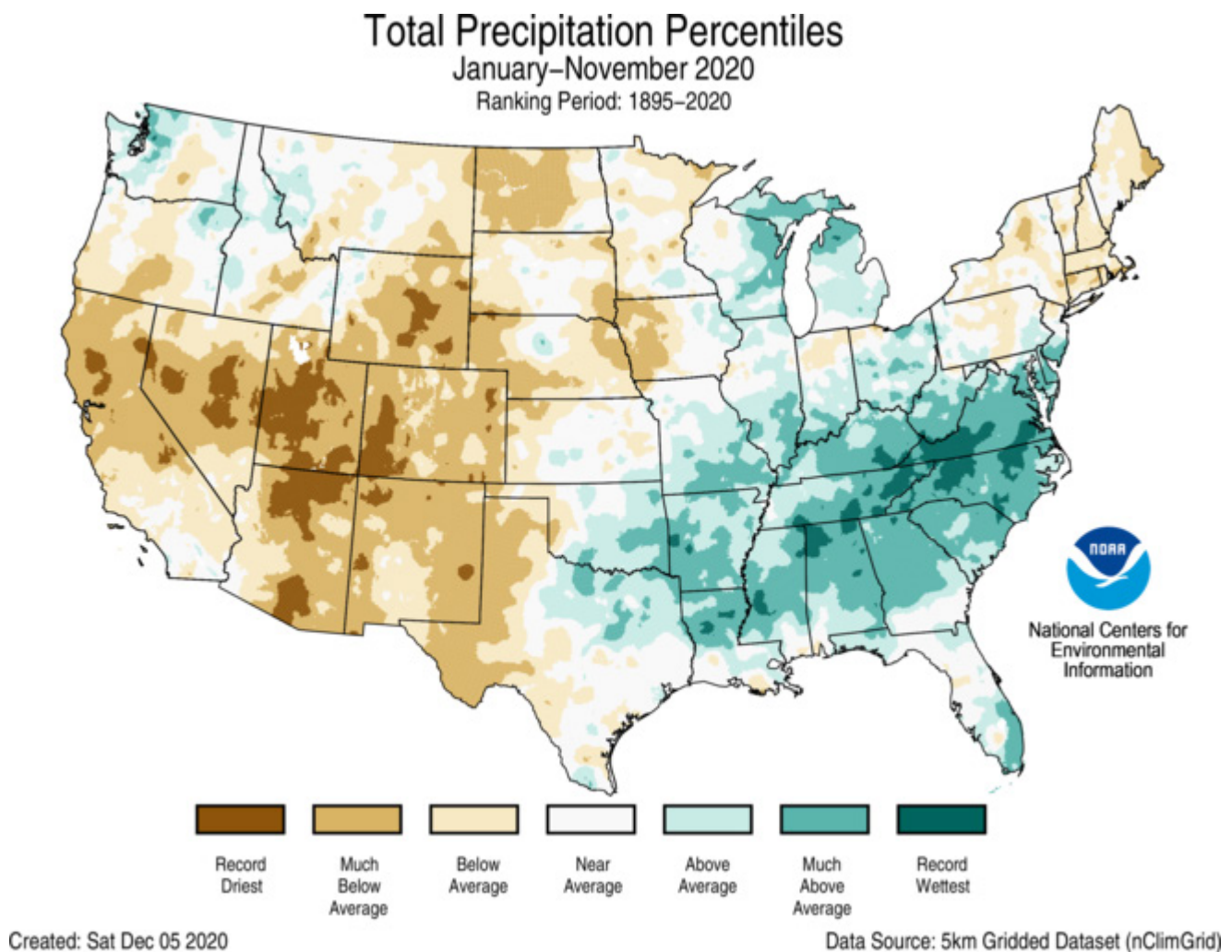


Figure 3. 2020 Percent Precipitation Compared to Long-Term Average

According to the USDA-NASS Crop Progress and Condition report, North Dakota generally experienced fair to good weather conditions throughout the year. The 2020 season started with a cool and dry spring. According to the North Dakota State Climate Office (NDSCO), the average temperature of 2020 spring was 40°F (4.4°C), which was 1.3°F (0.8°C) cooler than the 29-year average from 1981 to 2010. The average precipitation was 2.44 inches (6.20cm), which was 2.14 inches (6.4cm) less than the 29-year average. Summer months brought warmer temperatures. The average temperature and precipitation of 2020 summer were 68.9°F (20.5°C) and 8.39

inches (21.31cm) which were 2.2°F (1.2°C) warmer and 0.09 inch (0.23 cm) more than the 29-year average, respectively (NDSCO). The average fall temperature and precipitation was 42.3°F (5.7°C) and 1.22 inches (3.10 cm), which were 0.3°F (0.2°C) cooler and 2.63 inches (6.67 cm) less than the 29-year average, respectively.

Soybean planting progress lagged behind the 5-year average in most areas as shown in Figure 4. According to the USDA-NASS, June 7, 2020 Crop Progress and Condition Report, soybeans at that time were 74% planted, compared to 89% the previous year and 81% five-year average. Emergence also lagged behind with the USDA-NASS June 28 Crop Progress Report showing 89% of the soybeans emerged, which is 93% of the previous year and 92% of the five-year average.

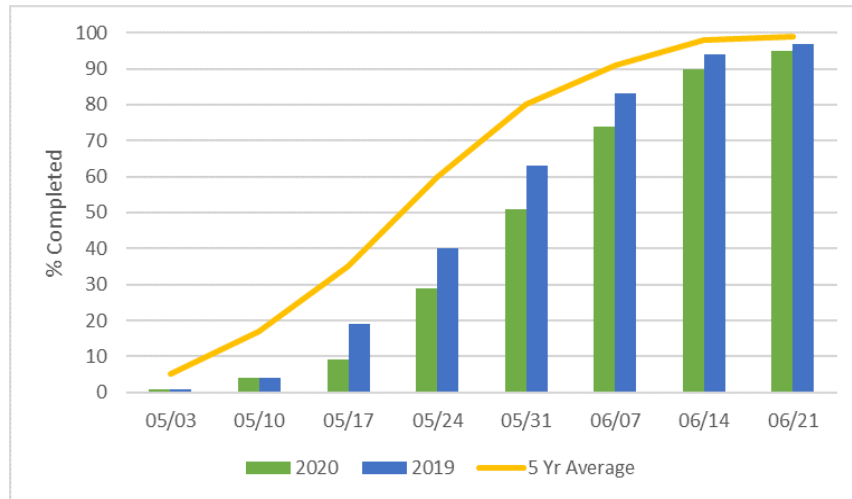


Figure 4. Planting progress of 2020 North Dakota soybeans presented by % completion

During the warmer than average summer season, crops showed quick progress with bloom, setting of pods and dropping leaves all nearing five-year averages. This was followed by a swift harvest. According to the USDA-NASS November 1 Crop Progress Report, harvest was 100% completed, which was 52% further progressed than the previous year and 15% further than the five-year average (Figure 5).

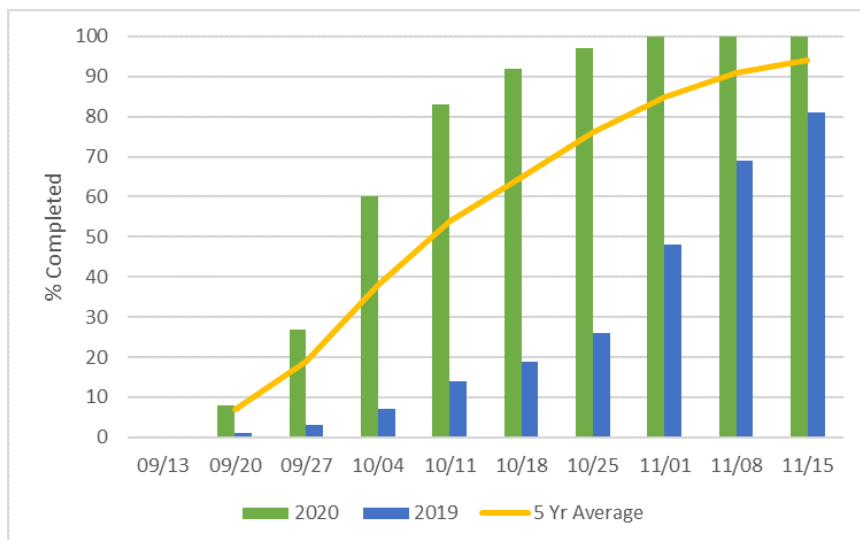


Figure 5. Harvest progress of 2020 North Dakota soybeans presented by % completion

2020 NORTH DAKOTA SOYBEAN QUALITY RESULTS

A summary of the 2020 North Dakota soybean quality result is presented in Table 2 with average, maximum, minimum and standard deviation (STDEV) of each parameter. The initial moisture content of samples received varied from a minimum of 7.0% to a maximum of 18.7%, with three samples above 15% moisture content.



Image 1. Analysis of moisture and test weight of soybeans using a DICKEY-John Grain Analysis Computer

Proximate	Average	Maximum	Minimum	STDEV
Moisture (%)	10.5	18.7	7.0	1.81
Test weight (lb/bu)	58.3	61.6	55.1	1.18
Protein ¹	33.8	37.3	28.3	1.26
Oil ¹	18.2	21.5	15.3	0.85
Fiber ²	5.8	6.5	5.3	0.24
Ash ²	5.0	5.5	4.8	0.11
Color				
L*	61.7	65.2	57.1	1.28
a*	2.7	5.0	-0.4	1.00
b*	19.2	23.1	15.0	1.28
Fatty Acid				
Palmitic acid ²	11.1	12.1	9.7	0.45
Stearic acid ²	4.4	5.2	3.7	0.28
Oleic acid ²	18.7	27.5	13.6	2.45
Linoleic acid ²	53.6	58.5	47.2	2.22
Linolenic acid ²	8.8	10.7	5.6	0.96
Soluble Sugars				
Sucrose ²	4.9	6.2	3.3	0.57
Raffinose ²	0.5	0.7	0.3	0.07
Stachyose ²	3.5	4.4	2.8	0.27
Amino Acid				
Aspartic acid ²	4.3	4.7	3.5	0.18
Threonine ²	1.5	1.6	1.2	0.05
Serine ²	1.7	1.9	1.4	0.07
Glutamic acid ²	6.7	7.4	5.2	0.33
Proline ²	1.9	2.1	1.5	0.08
Glycine ²	1.6	1.8	1.4	0.06
Alanine ²	1.6	1.8	1.4	0.05
Cysteine ²	0.6	0.7	0.5	0.02
Valine ²	1.9	2.1	1.6	0.07
Methionine ²	0.5	0.6	0.5	0.02
Isoleucine ²	1.9	2.0	1.6	0.06
Leucine ²	2.9	3.2	2.4	0.11
Tyrosine ²	1.4	1.5	1.2	0.05
Phenylalanine ²	2.0	2.2	1.7	0.08
Lysine ²	2.6	2.8	2.2	0.08
Histidine ²	1.0	1.1	0.9	0.04
Arginine ²	2.8	3.2	2.1	0.15
Tryptophan ²	0.4	0.5	0.4	0.02
¹ -13% moisture basis, ² -percent dry matter basis				

Table 2. Summary of 2020 North Dakota soybean with average, maximum, minimum and standard deviation (STDEV)

SOYBEAN QUALITY RESULTS COMPARISON BY YEAR

Comparison of soybean quality by crop year from 2011 to 2020 is presented in Table 3. Average moisture of initially submitted 2020 crop is 10.5%, 27.6 and 9.9% lower than the previous year and the 10-year average, respectively. Test weight is 58.2 pounds per Bu (754 Kg/m³), 1.7 and 1.3% higher than the previous year and the 10-year average, respectively. Protein content is 33.8%, which is 0.8 and 0.7% higher than the previous year and the 10-year average respectively. Oil content is 18.2%, 0.9% higher than the previous year and 1.4% higher than the 10-year average.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	AVG ³	STDEV
Proximate												
Moisture (%)	9.7	9.2	13.2	12.7	10.6	12.3	11.5	12.3	14.5	10.5	11.7	1.7
Test weight (lb/bu)	57.2	57.1	56.8	57.6	57.6	57.8	57.3	57.4	57.2	58.2	57.4	0.4
Protein¹	34.6	33.2	32.9	33.7	33.4	33.7	33.5	33.2	33.5	33.8	33.5	0.5
Oil¹	18.1	18	18.1	16.5	17.1	16.8	19.4	16.6	18	18.2	17.7	0.9
P + O average¹	52.7	51.2	51	50.2	50.6	50.5	52.9	49.8	51.5	51.9	51.2	1
Fiber²	5.1	5.6	11.4	13.7	7	6.9	6.4	7.9	5.5	5.8	7.5	2.8
Ash²	5.2	5	5.3	5.1	5.4	5.1	5.1	4.9	5.1	5	5.1	0.1
¹-13% moisture basis, ²-Percent dry matter basis ³-10-year average												

Table 3. Proximate, fatty acid and soluble sugar content of 2020 North Dakota soybean between 2011 and 2020 with average and standard deviation (STDEV)

AMINO ACIDS

Comparison of 18 amino acids between 2019 and 2020 along with 10-year average and standard deviation (STDEV) are presented in Table 4. Table 8 presents amino acids by North Dakota agricultural districts. Table 4 presents total amino acids as well as sums of 5 and 10 essential amino acids (EAA) and Critical Amino Acid Value (CAAV). The formulae for the amino acid calculations are as follows:

5-EAA = Sum of % Threonine, % Cysteine, % Methionine, % Lysine, % Tryptophan,

10-EAA = Sum of the 5-EAA plus % Valine, % Isoleucine, % Leucine, % Phenylalanine and % Histidine,

CAAV = % Lysine + % Threonine + % Tryptophan + (% Methionine + % Cysteine) divided by (/) Total Amino Acids = Critical Amino Acid Value (CAAV)

These values can be used as an indicator of protein quality whereas crude protein percentage indicates protein quantity.

Northern-grown soybeans tend to have a favorable essential amino acid profile. Research indicates that soybeans with lower crude protein content tend to have a higher proportion of 5 critical amino acids (5-EAA: Threonine, Cysteine, Methionine, Lysine, and Tryptophan) (Miller-Garvin and Naeve, 2020). The combined sum for 5-EAA in 2020 is 15.0% which is 4.4% lower than 2019 and 1.2% higher than the 10-year average. Crude protein is 2.8% higher than the 10-year average. The CAAV is 2.2% higher than the previous year and 1.4% higher than the 10-year average.

	2019	2020	AVG ⁵	STDEV
Aspartic acid¹	4.0	4.3	4.3	0.2
Threonine¹	1.4	1.5	1.5	0.0
Serine¹	1.7	1.7	1.7	0.1
Glutamate¹	6.0	6.7	6.7	0.5
Proline¹	1.6	1.9	1.9	0.1
Glycine¹	1.5	1.6	1.6	0.1
Alanine¹	1.6	1.6	1.7	0.1
Cysteine¹	0.5	0.6	0.6	0.1
Valine¹	1.8	1.9	1.9	0.1
Methionine¹	0.5	0.5	0.5	0.0
Isoleucine¹	1.6	1.9	1.8	0.1
Leucine¹	2.7	2.9	3.0	0.2
Tyrosine¹	1.3	1.4	1.4	0.1
Phenylalanine¹	1.8	2.0	2.0	0.1
Lysine¹	0.9	2.6	2.5	0.2
Histidine¹	2.5	1.0	1.0	0.1
Arginine¹	0.5	2.8	2.8	0.2
Tryptophan¹	0.5	0.4	0.4	0.1
Total AA²	34.4	37.5	37.4	1.7
5-EAA³ (% of 18 AA)	15.7	15.0	14.8	0.4
10-EAA⁴ (% of 18 AA)	41.3	41.0	40.9	0.6
Critical amino acid value⁶	4.4	4.5	4.5	0.2

¹-Percent dry matter basis, ²-Sum of 18AA, ³-Sum of threonine, cysteine, methionine, lysine, tryptophan, ⁴-Sum of the 5-EAA plus valine, isoleucine, leucine, phenylalanine and histidine, ⁵-10-year average ⁶-Sum of lysine, threonine, tryptophan plus the sum of methionine and cysteine divided by total AA.

Table 4. Amino acid contents of 2020 North Dakota soybean in 2019 and 2020 with average and standard deviation (STDEV)

PROTEIN

A summary of crude protein percentages between 2011 and 2020 along with 10-year average of the U.S. and North Dakota soybeans is presented in Figure 6. Soybean protein content in 2020 by agricultural districts is shown in Table 5. The 2020 soybean protein content average was 33.8% which is 0.3% higher than both the previous year and the U.S. average.

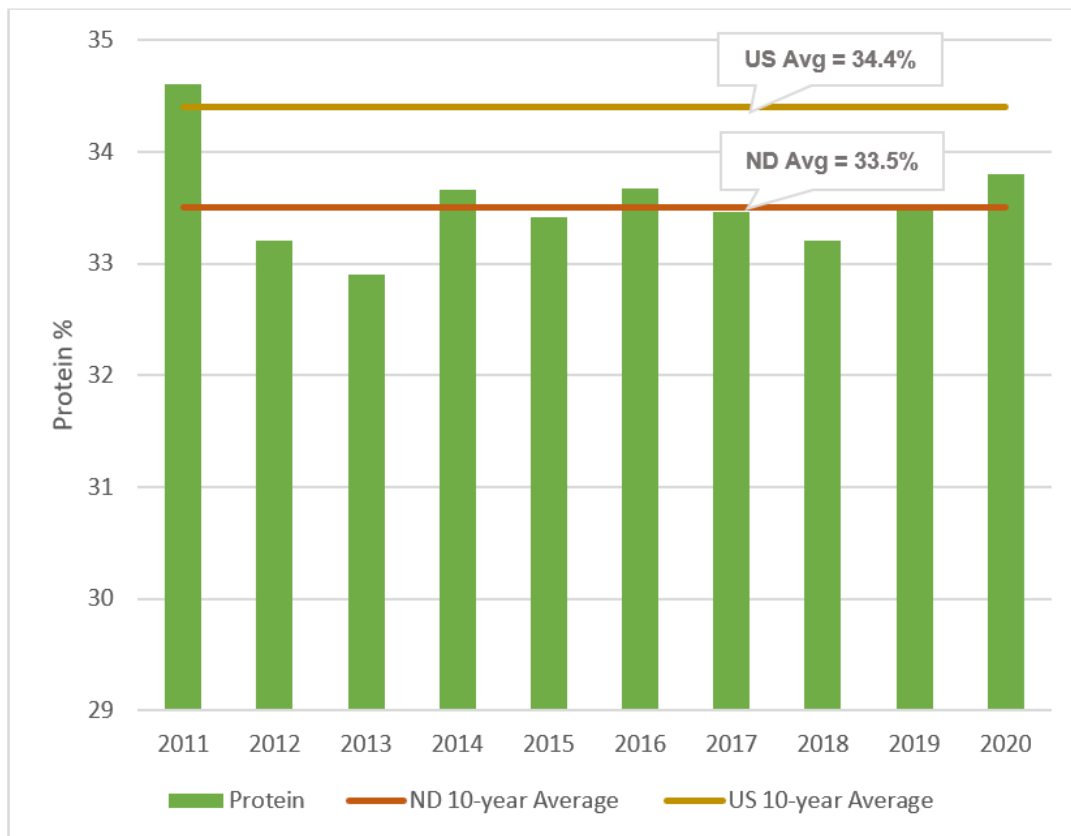


Figure 6. Percent protein (13% moisture basis) of North Dakota soybean between 2011 and 2020 and the 10-year average of North Dakota and the U.S.

OIL

A summary of oil content between 2011 and 2020 along with the 10-year average of the U.S. and North Dakota soybeans is presented in Figure 7. Soybean oil content in 2020 by agricultural districts is shown in Table 5. The difference between the U.S. and North Dakota average is 1.2 percentage points and the 2020 oil content is 8.2% which is 0.2% higher than samples measured in 2019.

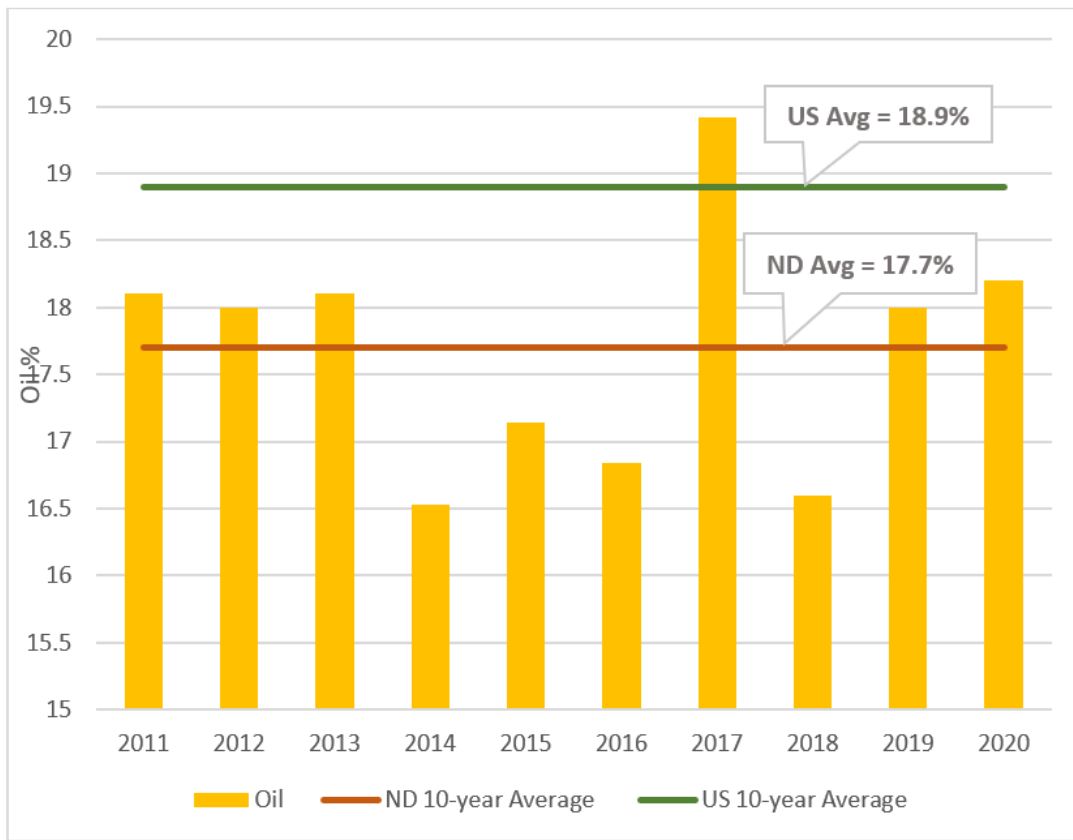


Figure 7. Percent oil (13 % moisture basis) of North Dakota soybean between 2011 and 2020 and the 10-year averages of North Dakota and the U.S.

FATTY ACIDS

Table 5 indicates the 2020 crop has a decrease in palmitic, linoleic and linolenic fatty acid contents compared to the previous year. Palmitic acid is 11.3% lower than the previous year and 6.0% lower than the 10-year average. Linoleic acid is 9.7% less than the previous year and 1.4% less than the 10-year average. Linolenic acid is 28.6% less than the previous year and 7.5% less than the 10-year average. Oleic acid has an increase of 0.3% from the previous year and is 5.5% less than the 10-year average.

Unsaturated fatty acids (oleic, linoleic and linolenic) are the major fatty acids that impact nutrition through the consumption of soybeans (Huth, 1995). Unsaturated fatty acids were more variable across districts than the saturated fatty acids (palmitic and stearic).

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	AVG ²	STDEV
Fatty Acids												
Palmitic¹	11	12.4	11.4	11	12.4	12.6	11.4	12.2	12.5	11.1	11.8	0.7
Stearic¹	4.9	5	4.6	3.8	4.3	5.3	4.7	5.3	4.4	4.4	4.7	0.5
Oleic¹	20	21.8	19.2	15.8	20.3	20.8	19.5	22.9	18.6	18.7	19.7	1.9
Linoleic¹	53.2	52	51.9	55	51.5	59	50.9	57.4	59.4	53.6	54.4	3.2
Linolenic¹	9.9	7.7	9.4	10.7	8.4	9.5	8.8	9.4	12.3	8.8	9.5	1.3
¹ -Percent dry matter basis ² -10-year average												

Table 5. Fatty Acid content of 2020 North Dakota soybean between 2011 and 2020 with average and standard deviation (STDEV)

SOLUBLE SUGARS

Soluble sugars in 2020 are lower than the previous year and the 10-year average. Sucrose content was 4.9%, 30.1% less than the previous year and 23% less than the 10-year average. Stachyose content was 3.5%, 14.0% less than the previous year and 12.9% less than the 10-year average. Raffinose content was 0.5%, 20.3% less than the previous year and 11.1% less than the 10-year average. Comparison by districts shows sucrose values of 2020 crops ranged from 3.9 - 5.3%, stachyose values ranged from 3.2 - 3.6% and raffinose was the same at 0.5%.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	AVG ²	STDEV
Soluble Sugars												
Sucrose¹	6.6	5.5	6.1	7.3	6.1	6.4	6.4	7.2	7	4.9	6.4	0.7
Raffinose¹	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.1
Stachyose¹	5.5	1.8	5.9	3.6	2.8	4.3	2.9	6	4.1	3.5	4	1.4
¹ -Percent dry matter basis ² -10-year average												

Table 6. Soluble Sugar content of 2020 North Dakota soybean between 2011 and 2020 with average and standard deviation (STDEV)

2020 NORTH DAKOTA SOYBEAN QUALITY RESULTS BY AGRICULTURAL DISTRICTS

	District	CENT	EC	NC	NE	NW	SC	SE	SW	WC
Sucrose ²	2020	4.7	4.9	5.3	5.1	4.9	4.7	4.7	3.9	4.5
	Average ³	6.4	6.3	6.6	6.6	6.7	6.3	6.2	5.5	6.4
	STDEV	0.8	0.7	0.7	0.6	0.9	0.8	0.7	1.6	1.0
Raffinose ²	2020	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Average ³	0.5	0.5	0.6	0.5	0.6	0.6	0.5	0.5	0.6
	STDEV	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1
Stachyose ²	2020	3.5	3.6	3.4	3.6	3.5	3.3	3.6	3.4	3.2
	Average ³	4.2	4.2	4.3	4.2	4.1	4.2	4.2	3.6	4.2
	STDEV	1.6	1.6	1.5	1.5	1.6	1.6	1.6	0.3	1.6

¹-13% moisture basis, ²- Percent dry matter basis ³-10-year average

Table 7. Proximate of 2020 North Dakota soybeans as well as 10-year average and standard deviation (STDEV) by the North Dakota agricultural districts

	Districts	CENT	EC	NC	NE	NW	SC	SE	SW	WC
Palmitic ²	2020	11.1	11.1	11.0	11.2	11.3	10.8	11.2	11.1	10.7
	Average ³	11.8	11.8	11.7	11.7	11.9	11.8	11.9	11.9	11.7
	STDEV	0.6	0.6	0.7	0.8	0.8	0.7	0.6	0.7	0.6
Stearic ²	2020	4.5	4.3	4.6	4.4	4.7	4.6	4.3	4.8	4.6
	Average ³	4.7	4.6	4.8	4.7	4.8	4.7	4.6	3.1	4.7
	STDEV	0.4	0.5	0.5	0.5	0.6	0.5	0.4	1.6	0.5
Oleic ²	2020	19.3	17.5	18.7	17.1	19.8	21.7	18.9	19.1	20.7
	Average ³	19.6	19.5	19.6	19.3	19.3	20.6	19.8	19.6	20.0
	STDEV	2.0	2.2	2.4	2.1	2.4	2.5	1.6	0.5	2.2
Linoleic ²	2020	53.2	54.7	52.9	54.4	51.9	51.4	54.1	53.4	52.5
	Average ³	54.4	54.6	54.2	54.6	54.6	53.7	54.5	56.1	54.0
	STDEV	2.9	3.2	3.1	3.2	2.8	3.0	3.0	2.7	2.9
Linolenic ²	2020	8.6	9.2	9.0	9.3	8.6	7.7	8.6	7.1	7.5
	Average ³	9.6	9.4	9.6	9.7	9.7	9.2	9.4	9.5	9.4
	STDEV	1.3	1.3	1.2	1.1	1.1	1.3	1.3	2.4	1.3

¹-13% moisture basis, ²- Percent dry matter basis ³-10-year average

Table 8. Fatty acids of 2020 North Dakota soybeans along with 10-year average and standard deviation (STDEV) by North Dakota agricultural districts

	District	CENT	EC	NC	NE	NW	SC	SE	SW	WC
Sucrose ²	2020	4.7	4.9	5.3	5.1	4.9	4.7	4.7	3.9	4.5
	Average ³	6.4	6.3	6.6	6.6	6.7	6.3	6.2	5.5	6.4
	STDEV	0.8	0.7	0.7	0.6	0.9	0.8	0.7	1.6	1.0
Raffinose ²	2020	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Average ³	0.5	0.5	0.6	0.5	0.6	0.6	0.5	0.5	0.6
	STDEV	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1
Stachyose ²	2020	3.5	3.6	3.4	3.6	3.5	3.3	3.6	3.4	3.2
	Average ³	4.2	4.2	4.3	4.2	4.1	4.2	4.2	3.6	4.2
	STDEV	1.6	1.6	1.5	1.5	1.6	1.6	1.6	0.3	1.6

¹-13% moisture basis, ²- Percent dry matter basis ³-10-year average

Table 9. Soluble sugar of 2020 North Dakota soybeans as well as 10-year average and standard deviation (STDEV) by North Dakota agricultural districts

	District	CENT	EC	NC	NE	NW	SC	SE	SW	WC
Aspartic acid ²	2020	4.4	4.3	4.2	4.3	4.4	4.2	4.4	4.3	4.2
	Average ³	4.3	4.3	4.3	4.3	4.2	4.3	4.3	4.2	4.3
	STDEV	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2
Threonine ²	2020	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4
	Average ³	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.5
	STDEV	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Serine ²	2020	1.8	1.8	1.7	1.7	1.8	1.7	1.8	1.8	1.7
	Average ³	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
Glutamic acid ²	2020	6.8	6.7	6.6	6.7	6.8	6.5	6.8	6.7	6.4
	Average ³	6.7	6.7	6.6	6.6	6.5	6.6	6.6	6.3	6.7
	STDEV	0.4	0.4	0.4	0.5	0.3	0.5	0.3	0.3	0.5
Proline ²	2020	1.9	1.9	1.9	1.9	1.9	1.8	1.9	1.9	1.8
	Average ³	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.7	1.9
	STDEV	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1
Glycine ²	2020	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	Average ³	1.6	1.7	1.6	1.6	1.6	1.7	1.7	1.6	1.6
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Alanine ²	2020	1.7	1.6	1.6	1.6	1.7	1.6	1.7	1.6	1.6
	Average ³	1.7	1.7	1.6	1.6	1.7	1.6	1.7	1.6	1.6
	STDEV	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
Cysteine ²	2020	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average ³	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	STDEV	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1
Valine ²	2020	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8
	Average ³	1.9	1.9	1.9	1.9	3.4	1.9	1.9	1.8	1.9
	STDEV	0.1	0.1	0.1	0.1	4.0	0.1	0.1	0.1	0.1
Methionine ²	2020	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Average ³	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	STDEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Isoleucine ²	2020	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8
	Average ³	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.7	1.8
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Leucine ²	2020	3.0	3.0	2.9	2.9	3.0	2.9	3.0	2.9	2.8
	Average ³	3.0	3.0	3.0	3.0	2.9	3.0	3.0	2.8	3.0
	STDEV	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2
Tyrosine ²	2020	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
	Average ³	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.4
	STDEV	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Phenylalanine ²	2020	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9
	Average ³	2.0	2.0	2.0	1.9	1.9	2.0	2.0	1.8	2.0
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lysine ²	2020	2.6	2.6	2.5	2.6	2.6	2.5	2.6	2.5	2.5
	Average ³	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.6
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
Histidine ²	2020	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Average ³	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Arginine ²	2020	2.9	2.8	2.8	2.8	2.9	2.7	2.8	2.8	2.7
	Average ³	2.8	2.8	2.7	2.7	2.7	2.8	2.8	2.7	2.8
	STDEV	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2
Tryptophan ²	2020	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.4
	Average ³	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4
	STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1

¹-13% moisture basis, ²- Percent dry matter basis ³-10-year average

Table 10. Amino acid of 2020 North Dakota soybean as well as 10-year average and standard deviation (STDEV) by North Dakota agricultural districts

2020 PNW AND GULF SOYBEANS

Table 11 indicates that PNW soybeans are higher than Gulf soybeans in Phenylalanine, Lysine, Histidine and Tryptophan and Total AA, 5-EAA, 10-EAA and CAAV.

Proximate	PNW				Gulf			
	Average	Max	Min	STDEV	Average	Max	Min	STDEV
Aspartic acid ¹	4.3	4.4	4.3	0.03	4.4	4.4	4.2	0.05
Threonine ¹	1.5	1.5	1.5	0.01	1.5	1.5	1.5	0.01
Serine ¹	1.8	1.8	1.7	0.02	1.8	1.8	1.7	0.03
Glutamic acid ¹	6.7	6.8	6.6	0.06	6.7	6.9	6.5	0.09
Proline ¹	1.9	2.0	1.9	0.01	1.9	2.0	1.9	0.02
Glycine ¹	1.6	1.7	1.6	0.01	1.7	1.7	1.6	0.02
Alanine ¹	1.7	1.7	1.6	0.01	1.7	1.7	1.6	0.02
Cysteine ¹	0.6	0.6	0.6	0.01	0.6	0.6	0.6	0.01
Valine ¹	1.9	1.9	1.9	0.01	1.9	1.9	1.9	0.02
Methionine ¹	0.5	0.6	0.5	0.00	0.5	0.6	0.5	0.01
Isoleucine ¹	1.9	1.9	1.8	0.02	1.9	1.9	1.8	0.01
Leucine ¹	3.0	3.0	3.0	0.02	3.0	3.0	2.9	0.03
Tyrosine ¹	1.4	1.4	1.4	0.01	1.4	1.5	1.4	0.01
Phenylalanine ¹	2.0	2.1	2.0	0.01	1.5	2.0	2.0	0.02
Lysine ¹	2.6	2.6	2.6	0.01	1.4	2.6	2.5	0.03
Histidine ¹	1.0	1.1	1.0	0.01	0.0	1.1	1.0	0.01
Arginine ¹	2.8	2.9	2.8	0.02	2.8	2.9	2.7	0.05
Tryptophan ¹	0.5	0.5	0.5	0.01	0.4	0.5	0.4	0.01
Amino Acid Calculations		PNW			Gulf			
Total AA ²		37.9			35.1			
5-EAA value (% of 18 AA) ³		15.1			12.8			
10-EAA value (% of 18 AA) ⁴		41.1			36.3			
Critical Amino Acid Value ⁵		4.6			3.4			
¹ -Percent dry matter basis, ² -Sum of 18AA, ³ -Sum of threonine, cysteine, methionine, lysine, tryptophan, ⁴ -Sum of the 5-EAA plus valine, isoleucine, leucine, phenylalanine and histidine, ⁵ -Sum of lysine, threonine, tryptophan plus the sum of methionine and cysteine divided by total AA.								

Table 11. Amino acid contents and calculations of 2020 PNW and Gulf ports soybeans



Image 2. Soybeans loaded on cargo ship in Port of Louisiana | Photo credit: United Soybean Board

Table 12 indicates that PNW soybeans had a higher test weight and lower moisture, oil and fiber content compared to Gulf soybeans. PNW samples were higher in brightness and yellowness color and lower in redness color. Comparing fatty acid profiles, PNW soybeans were lower in palmitic, stearic and oleic acids and higher in linoleic and linolenic acids. PNW soybeans were lower than Gulf soybeans in all soluble sugars.

Proximate	PNW				Gulf			
	Average	Max	Min	STDEV	Average	Max	Min	STDEV
Moisture (%)	10.3	10.6	9.5	0.31	11.6	12.9	10.4	0.59
Test weight (lb/bu)	57.9	58.8	57.4	0.40	57.0	57.6	56.0	0.45
Protein ¹	34.3	34.7	33.7	0.28	34.3	34.8	33.3	0.35
Oil ¹	18.4	19.0	17.8	0.31	19.0	19.7	18.5	0.30
Fiber ²	5.3	5.4	5.1	0.10	5.4	5.6	5.2	0.12
Ash ²	5.0	5.0	4.9	0.03	5.0	5.2	4.8	0.08
Color								
L*	63.5	64.5	62.5	0.48	62.9	64.3	62.1	0.77
a*	2.8	3.6	2.5	0.28	3.7	4.2	3.2	0.31
b*	18.5	19.2	18.0	0.38	17.5	19.0	16.5	0.77
Fatty Acid								
Palmitic acid ²	10.6	10.9	10.2	0.22	11.4	11.9	10.8	0.27
Stearic acid ²	3.8	3.9	3.7	0.07	4.4	4.6	4.3	0.07
Oleic acid ²	19.7	20.6	17.9	0.86	19.9	20.6	18.6	0.56
Linoleic acid ²	52.6	53.6	51.2	0.69	52.2	53.2	51.2	0.52
Linolenic acid ²	9.5	10.1	9.0	0.34	9.0	10.0	8.4	0.48
Soluble Sugars								
Sucrose ²	4.4	5.2	3.8	0.45	4.5	5.3	3.4	0.40
Raffinose ²	0.3	0.4	0.3	0.03	0.4	0.4	0.3	0.04
Stachyose ²	3.3	3.6	2.8	0.19	3.7	4.1	2.9	0.26

¹-13% moisture basis, ²-percent dry matter basis

Table 12. Proximate, color, fatty acid and soluble sugar content of 2020 PNW and Gulf soybeans



Image 3. Cargo ship in the Pacific Northwest (PNW) | Photo credit: North Dakota Soybean Council

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2020 NORTH DAKOTA SOYBEAN QUALITY SURVEY

Northern Crops Institute



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