2017 North Dakota Soybean Quality Survey

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Funding Provided by the North Dakota Soybean Council

Table of Contents

Summary

On both the national and state level, 2017 was another **record year**. Planted and harvested soybean acreage has **remarkably expanded** compared to previous years which subsided the **lowered yield**. The 2017 North Dakota Soybean Survey collected **record number of samples** as 248 samples were collected from 40 counties and eight agricultural districts. In spite of **severe drought condition**, the 2017 crop year produced soybeans with a **similar quality** to previous year with slightly lowered protein and slightly higher oil content. Among fatty acids, linoleic acid was slightly reduced compared to the previous year and the 10-year average. Soluble sugar content was similar to the previous year except for the stachyose content was considerably reduced.

Sample Collection

Nine agricultural districts serve as the basis for a comparison of crop quality data (Figure 1). A total of 248 samples were collected from 40 counties and eight agricultural districts in North Dakota by the United States Department of Agriculture-National Agricultural Statistics Service (USDA-NASS). Due to the lack of soybean production in the Southwest district, no sample was collected.

As presented in Table 1, more than 50 percent of North Dakota soybean production is concentrated in Eastern North Dakota. Counties that samples were not collected from either had few or no soybean production this year. Sample distribution by districts along with the percent distribution are presented in Table 1.

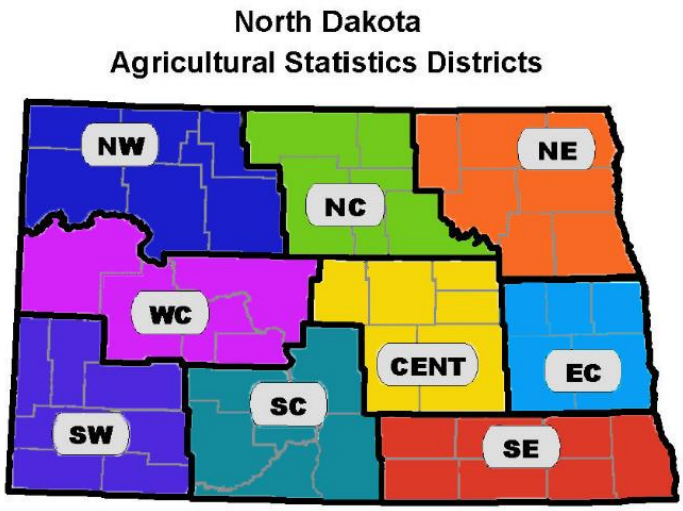

Figure 1: North Dakota agricultural districts

Table 1: North Dakota agricultural districts, number of sample collected and percent distribution from each district

District	Abbreviation	Number of sample	% distribution of sample
Central	CENT	39	15.7
East Central	EC	53	21.4
North Central	NC	26	10.5
North East	NE	35	14.1
North West	NW	19	7.7
South Central	SC	9	3.6
South East	SE	59	23.8
West Central	WC	8	3.2
South West	SW	0	0
	Total	**248**	**100**

Analysis Method

Moisture, proximate (protein, ash, oil and fiber), color, test weight, soluble sugar, fatty acid profile and amino acid profile were analyzed as quality attributes of North Dakota soybeans. Test weight and moisture were analyzed by the DICKEY-john Grain Analysis Computer GAC 2500 UGMA (Auburn, IL), based on the AACC method 55-10 (AACC, 1999). This was done immediately after the soybean samples were received. Color analysis was performed with a Minolta color analyzer CR-410 (Ramsey, NJ). CIE 1976 (L*, a*, b*) color space, with which brightness (L*), redness (a*) and yellowness (b*) values were determined. Proximate, soluble sugar, fatty acid and amino acid profile were evaluated using Perten DA7250 Near-InfraRed Spectroscopy (NIRS) (Huddinge, Sweden) with a calibration developed at the University of Minnesota and funded by the Minnesota Soybean Research and Promotion Council. The soybeans collected were ground into coarse flour using Perten Laboratory Mill 3600, and analyzed on the NIR to obtain proximate, soluble sugar, fatty acid and amino acid profile. Whole beans were used to obtain initial moisture, test weight and color. This NIR method was also utilized by Miller-Garvin and Naeve (2017) 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.

2017 Soybean Production

According to the USDA-NASS, the national soybean production of 2017 was 4.4 billion bushels (120 million metric tons) which was the highest volume on the record surpassing the last years' record by 3%. It is noteworthy to mention that the yield of the 2017 crop was 49.5 bu/acre (3.3 MT/Ha) which was 4.8% lower than the previous year. This was the first time it dropped since

2012. Increased planted and harvested acreage, both highest on the record, however, helped boost the production and thus recording the highest again this year.

Similar trend was observed within the state data. The 2017 North Dakota soybean production, harvest and yield data are presented in Figure 2. North Dakota production was similar to the 2016 crop year, yet slightly less at 248.50 million bushels (6.76 Million MT). The area harvested recorded a remarkable 18 % increase of 7.1 million acres (2.9 million Ha). This supplemented the low yield which was 15.7 % lower than the 2016 crop at 35 bu/acre (2.4 MT/Ha). North Dakota is the fourth largest soybean producing state in the nation and placed after Illinois, Iowa and Minnesota. North Dakota reported the fourth largest increase of harvested acreage after Kansas, Oklahoma and Texas (USDA-NASS, 2017).

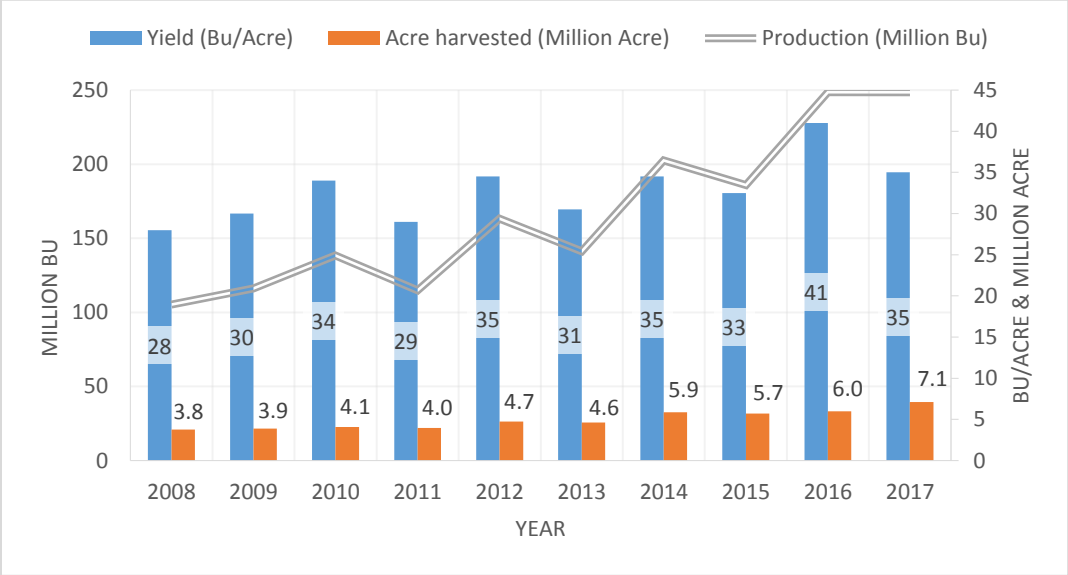

Figure 2: North Dakota soybean yield, harvest and production data between 2008 and 2017

2017 North Dakota Weather and Crop Summary

The 2017 crop year suffered severe drought throughout the season that was especially serious in the Western North Dakota. Spring began with relatively wet condition followed by a quick change to drought condition. Precipitation pattern changed in March, yet moisture trapped in the soil and cooler temperature delayed the start of planting as well as the onset of the drought (Akyüz et al. 2017). The drought condition intensified by the end of spring due to limited precipitation and high temperature which continued through summer and fall. North Dakota experienced the driest summer and fall since 2006 and 2014, respectively (Akyüz et al. 2017). It was not until August when the above average precipitation was recorded, which was too late for the most of the agricultural development with some impacts being irreversible (Akyüz et al. 2017). The impact of the damage prolonged into the fall months even though above average precipitation was experienced.

According to the USDA-NASS weekly progress report, North Dakota's soybean planting started the week of May 8 which was later than the previous year and the average (Figure 3). The planting was completed by the week of June 12, yet the progress for the rest of the season was slightly delayed than the previous year or the average. Due to a dry fall, harvest started the week of September 18 and was completed by the week of October 30, which was close to the previous year and the average (Figure 4).

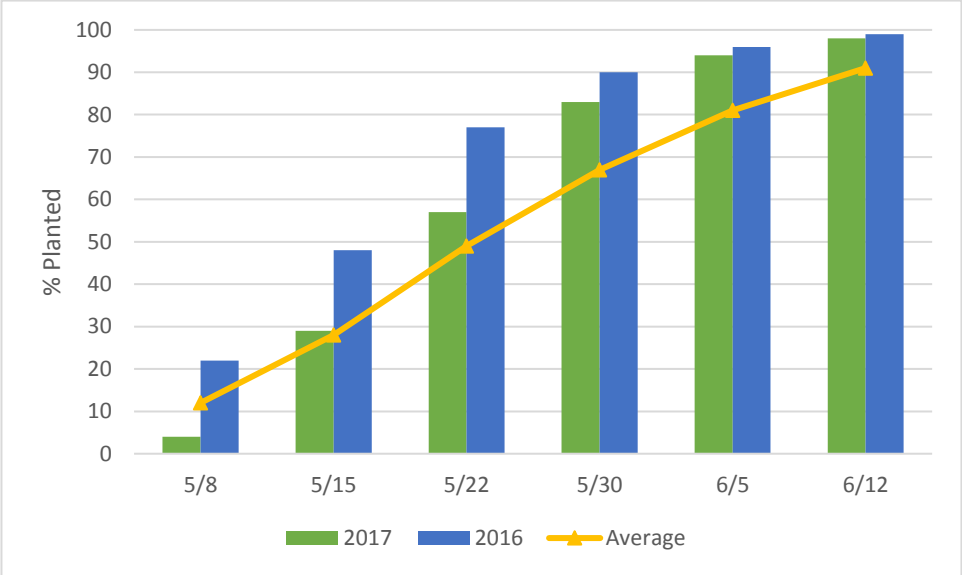

Figure 3. Planting progress of the 2017 North Dakota soybeans

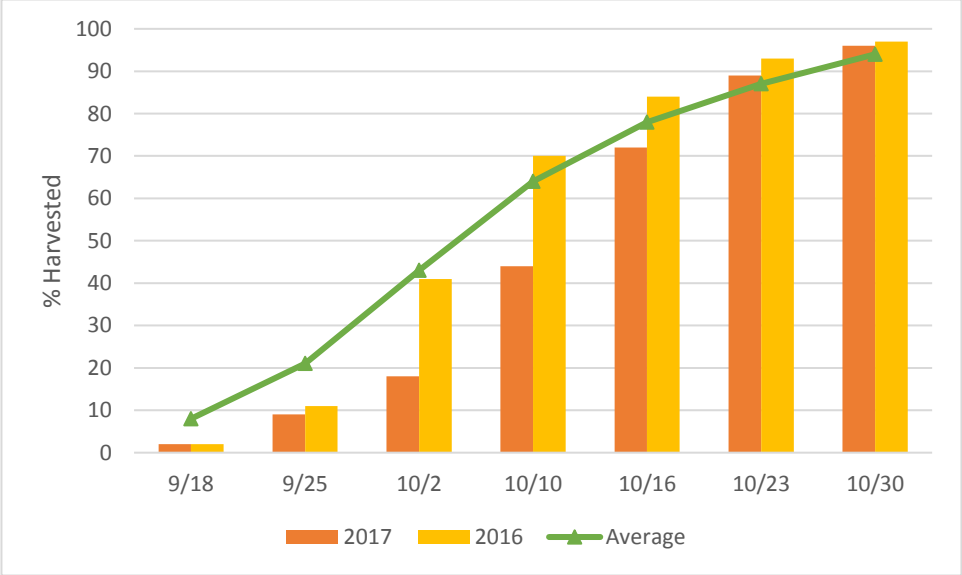

Figure 4. Harvest progress of the 2017 North Dakota soybeans

2017 North Dakota Soybean Quality Results

A summary of the 2017 North Dakota soybean quality is presented in Table 2 with average, minimum, maximum and standard deviation of each parameter.

Table 2: Summary of 2017 North Dakota soybean quality data

Proximate	Average	Maximum	Minimum	Standard Deviation[3]
Moisture	11.5	20.0	8.1	1.9
Test weight (lb/bu)	57.3	66.2	52.4	1.3
Protein[1]	33.5	37.4	26.5	1.4
Oil[1]	19.4	22.1	17.6	0.6
Fiber[2]	6.4	7.0	5.9	0.2
Ash[2]	5.1	5.4	4.8	0.1
Color				
L*	60.8	64.6	55.6	1.4
a*	3.9	5.2	2.1	0.5
b*	19.5	23.9	12.9	1.7
Fatty acid				
Palmitic acid[2]	11.4	13.4	10.1	0.4
Stearic acid[2]	4.7	7.1	3.1	0.7
Oleic acid[2]	19.5	25.8	9.9	2.2
Linoleic acid[2]	50.9	59.6	43.3	2.4
Linolenic acid[2]	8.8	11.1	6.0	0.7
Soluble Sugar				
Sucrose[2]	6.4	8.7	4.7	0.7
Raffinose[2]	0.5	0.7	0.4	0.1
Stachyose[2]	2.9	3.7	1.9	0.3
Amino Acid				
Aspartic acid[2]	4.4	4.7	3.5	0.2
Threonine[2]	1.5	1.6	1.3	0.0
Serine[2]	1.7	1.9	1.4	0.1
Glutamic acid[2]	6.8	7.4	5.3	0.3
Proline[2]	1.9	2.1	1.6	0.1
Glycine[2]	1.6	1.8	1.4	0.1
Alanine[2]	1.7	1.8	1.4	0.1
Cysteine[2]	0.6	0.7	0.5	0.02
Valine[2]	2.0	2.1	1.6	0.1
Methionine[2]	0.5	0.6	0.5	0.02
Isoleucine[2]	1.9	2.0	1.5	0.1
Leucine[2]	3.0	3.2	2.4	0.1
Tyrosine[2]	1.7	1.9	1.4	0.1
Phenylalanine[2]	2.0	2.1	1.6	0.1
Lysine[2]	2.6	2.8	2.2	0.1
Histidine[2]	1.0	1.1	0.8	0.04
Arginine[2]	2.8	3.2	2.1	0.2
Tryptophan[2]	0.3	0.4	0.3	0.02

[1]-13% moisture basis, [2]-Percent dry matter basis, [3]- Calculated within overall samples

Soybean Quality Result Comparison by Year

Comparison of soybean quality by crop year is presented in Table 3. Moisture was 0.8 percentage point lower than the previous year. Test weight was 0.5 percentage point lower than the 2016, yet 0.1 percentage point higher than the average. Protein was the same as the 10-year average, but 0.2 percentage point lower than the 2016. In contrast, there was a 2.6 percent increase of oil content from the 2016 as well as 1.4 percent higher than the 10-year average. This resulted in higher protein plus oil content, which was 2.4 and 1.4 percent higher than the 2016 and the 10-year average, respectively. Fatty acid content overall declined from previous year. Especially notable was 8.1 percent reduction of linoleic acid from the previous year which was also 2.5 percent lower than the 10-year average. Soluble sugar showed similar to average result except stachyose content, which was 1.4 and 1.0 percent lower than the 2016 and the 10-year average, respectively.

Table 3: North Dakota soybean quality data between 2008 and 2017

Proximate	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	AVG[3]	STDEV[3]
Moisture (%)	-	14.6	9.8	9.7	9.2	13.2	12.7	10.6	12.3	11.5	11.0	2.3
Test weight (lb/bu)	-	55.8	57.6	57.2	57.1	56.8	57.6	57.6	57.8	57.3	57.2	0.6
Protein[1] (%)	33.5	34.9	31.4	34.6	33.2	32.9	33.7	33.4	33.7	33.5	33.5	0.9
Oil[1] (%)	18.5	19	18.6	18.1	18	18.1	16.5	17.1	16.8	19.4	18.0	0.9
Protein+Oil[1] (%)	52	53.9	50	52.7	51.2	51	50.2	50.6	50.5	52.9	51.5	1.3
Fiber[2] (%)	5	5.2	5.7	5.1	5.6	11.4	13.7	7.0	6.9	6.4	7.2	3.0
Ash[2] (%)	-	5.5	4.2	5.2	5	5.3	5.1	5.4	5.1	5.1	5.1	0.4
Fatty Acid												
Palmitic[2] (%)	-	12.9	11.3	11	12.4	11.4	11.0	12.4	12.6	11.4	11.8	0.7
Stearic[2] (%)	-	4.7	4.1	4.9	5	4.6	3.8	4.3	5.3	4.7	4.6	0.5
Oleic[2] (%)	-	17.7	20.9	20	21.8	19.2	15.8	20.3	20.8	19.5	19.5	1.8
Linoleic[2] (%)	-	53.4	54	53.2	52	51.9	55.0	51.5	59.0	50.9	53.4	2.5
Linolenic[2] (%)	-	9.7	8.7	9.9	7.7	9.4	10.7	8.4	9.5	8.8	9.2	0.9
Soluble Sugar												
Sucrose[2] (%)	6.1	4.7	6.5	6.6	5.5	6.1	7.3	6.1	6.4	6.4	6.2	0.7
Raffinose[2] (%)	0.6	0.5	0.4	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.1
Stachyose[2] (%)	3.8	4.2	4.1	5.5	1.8	5.9	3.6	2.8	4.3	2.9	3.9	1.2
[1]-13% moisture basis, [2]-Percent dry matter basis, [3]- Calculated by the 10-year average												

Amino Acids

Comparisons of 18 amino acids between 2016 and 2017 crop years along with 10-year average and standard deviation are presented in Table 4. Table 8 presents the amino acids by districts. Soybeans with lower crude protein content tend to have a higher proportion of the five essential amino acids (threonine, cysteine, methionine, lysine and tryptophan) (Miller-Garvin and Naeve, 2017). Sum of the five essential amino acids was reduced by 0.2 and 0.1 percentage point from the previous year and the 10-year average, respectively. Sum of 10 essential amino acids (the five essential amino acids plus valine, isoleucine, leucine, phenylalanine and histidine) was 0.6 percentage point higher than the previous year and equaled to the 10-year average.

Table 4: Percent amino acids of North Dakota soybean from 2016, 2017, 10-year average and standard deviation.

Amino Acids	2016	2017	10-yr avg.	Standard deviation
Aspartic[2] (%)	4.2	4.4	4.3	0.2
Threonine[2**] (%)	1.5	1.5	1.6	0.2
Serine[2] (%)	1.7	1.7	1.9	0.5
Glutamate[2] (%)	6.6	6.8	6.5	0.8
Proline[2] (%)	2.0	1.9	2.0	0.2
Glycine[2] (%)	1.6	1.6	1.9	0.5
Alanine[2] (%)	1.6	1.7	1.8	0.2
Cysteine[2**] (%)	0.5	0.6	0.5	0.2
Valine[2***] (%)	1.9	2.0	2.1	0.2
Methionine[2**] (%)	0.5	0.5	0.6	0.1
Isoleucine[2***] (%)	1.9	1.9	1.9	0.1
Leucine[2***] (%)	3.0	3.0	3.0	0.2
Tyrosine[2] (%)	1.4	1.7	1.5	0.2
Phenylalanine[2***] (%)	2.0	2.0	1.9	0.2
Lysine[2**] (%)	2.6	2.6	2.5	0.3
Histidine[2***] (%)	1.0	1.0	1.0	0.1
Arginine[2] (%)	2.7	2.8	2.9	0.2
Tryptophan[2**] (%)	0.4	0.3	0.4	0.1
5 AA (% of 18 AA)	14.8	14.6	14.5	0.1
10 AA (% of 18 AA)	41.0	40.4	40.4	0.1
[2]-Percent dry matter basis, [**]-5 essential amino acids, [**]&[***] - 10 essential amino acids				

Protein

A summary of protein content between 2008 and 2017 along with 10-year average is presented in Figure 5. Comparing the U.S. and North Dakota 10-year average, there was 0.6 percentage point difference. The difference has become smaller compared to the previous year possibly due to decreased protein content on the national level. 2017 soybean protein content by districts is shown in Table 5. Soybean protein content in 2017 was slightly lower than the 2016, and equal to the North Dakota 10-year average data.

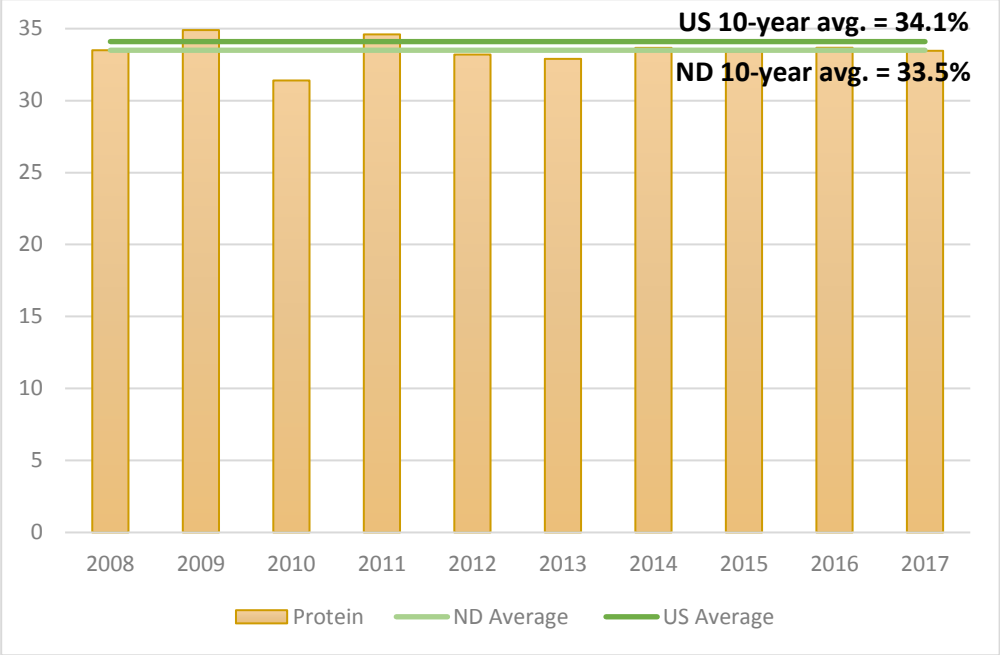

Figure 5: Percent protein (13 percent moisture basis) of North Dakota soybean between 2008 and 2017 and 10-year average

Oil

A summary of oil content between 2008 and 2017 along with the 10-year average is presented in Figure 6. There was a 1.1 percent difference between the U.S. and the North Dakota 10-year average and the gap between these two averages remained the same as last year. Higher oil content on the national level is possibly the main reason for this, even though the 2017 North Dakota soybean crop experienced relatively higher oil content. Soybean oil content in 2017 by districts are shown in Table 5. The 2017 average surpassed both 2016 and North Dakota 10-year average.

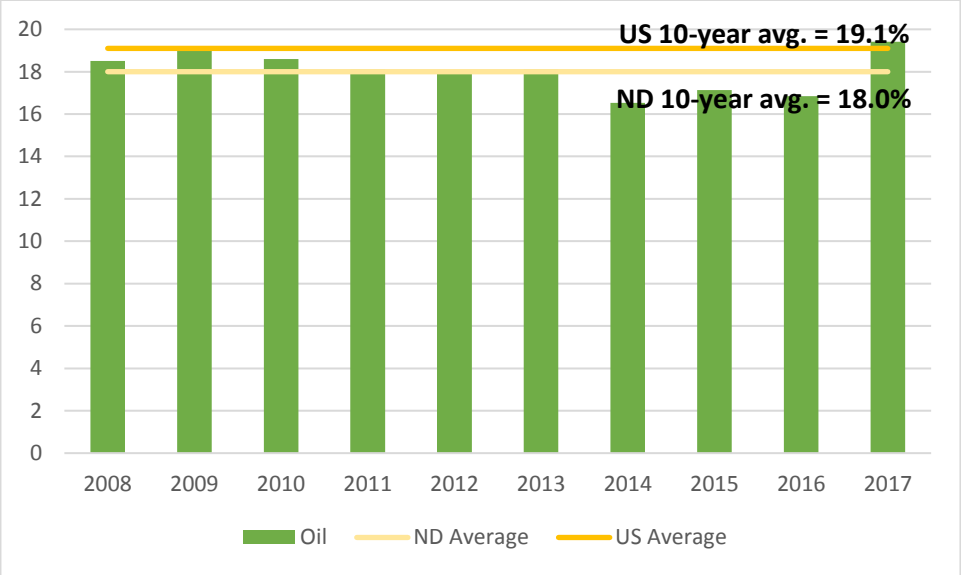

Figure 6: Percent oil (13 percent moisture basis) of North Dakota soybean between 2008 and 2017 and 10-year average

Fatty Acids

Almost all fatty acids of the soybean samples collected were lower than the 2016 crop and the 10-year average; however, the 10-year average of stearic acid was 0.1 percentage point lower. Table 6 provides a summary of fatty acids of the 2017 crop as well as 10-year average by North Dakota agricultural districts. Unsaturated fatty acids (Oleic, Linoleic and Linolenic) take up a major portion compared to saturated fatty acids (Palmitic and Stearic). The lowest and the highest stearic acids were 4.4 percent and 5.5 percent found at the SE and the NW districts, respectively. The lowest oleic acid was found at the SE and the SC districts at 18.9 percent while the highest was found at 20.8 percent at the NW district. The lowest and the highest linoleic acids were found at the NC and the SE districts at 49.7 percent and 51.8 percent, respectively. The lowest and the highest linolenic acids were found at the NW, and both the NE and the CENT districts at 7.9 percent and 9.0 percent, respectively.

Soluble Sugars

Table 7 presents a summary of soluble sugars of the 2017 crop along with 10-year average and standard deviation by districts. Sucrose and raffinose remained the same as the previous year while stachyose reduced by 1.4 percent. Northern grown soybeans are known for its higher sucrose concentration than soybeans grown in the Southern regions (Miller-Garvin and Naeve, 2017). The lowest sucrose content was found at the SE district while the highest was at the NW district at 6.0 and 7.0 percent, respectively. Both raffinose and stachyose contents by districts were mostly consistent throughout the regions.

2017 North Dakota Soybean Quality Results by District

Quality results by districts are presented in Table 5, 6, 7 and 8 below.

Table 5: Proximate of 2017 North Dakota soybean, average and standard deviation by the North Dakota agricultural districts

Proximate	Districts	CENT	EC	NC	NE	NW	SC	SE	WC
Protein[1] (%)	2017	33.5	33.9	33.3	32.9	31.4	33.8	34.1	33.6
	Average[3]	33.7	33.6	33.2	33.4	33.1	32.7	33.6	33.4
	SD	0.8	1.0	1.3	1.0	1.1	1.3	1.0	1.6
Oil[1] (%)	2017	19.4	19.3	19.4	19.2	20.2	19.5	19.4	19.5
	Average[3]	18.2	18.4	18.5	18.3	17.7	18.7	18.5	18.0
	SD	1.3	1.3	1.5	1.3	1.5	1.7	1.4	1.7
Fiber[2] (%)	2017	6.5	6.4	6.4	6.4	6.4	6.3	6.4	6.4
	Average[3]	7.4	7.4	7.3	7.4	6.9	7.3	7.4	7.4
	SD	2.9	2.9	2.9	2.8	2.8	2.9	2.9	3.1
Ash[2] (%)	2017	5.1	5.1	5.0	5.0	5.0	5.0	5.2	5.1
	Average[3]	5.1	5.1	5.1	5.1	5.0	5.1	5.1	5.1
	SD	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3

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

Table 6: Percent fatty acids of 2017 North Dakota soybean, average and standard deviation by the North Dakota agricultural districts

Fatty acid	Districts	CENT	EC	NC	NE	NW	SC	SE	WC
Palmitic[2] (%)	2017	11.4	11.5	11.5	11.3	11.3	11.3	11.4	11.6
	Average[3]	11.8	11.8	11.8	11.6	11.9	12.0	11.9	11.9
	SD	0.7	0.7	0.8	0.8	1.0	0.9	0.7	1.0
Stearic[2] (%)	2017	4.7	4.5	5.0	5.2	5.4	4.7	4.4	4.8
	Average[3]	4.6	4.6	4.7	4.6	4.7	4.6	4.6	4.6
	SD	0.4	0.4	0.5	0.5	0.7	0.5	0.4	0.5
Oleic[2] (%)	2017	19.2	19.2	20.3	19.7	20.8	18.9	18.9	20.4
	Average[3]	19.6	19.7	19.2	19.5	18.5	19.7	19.8	19.2
	SD	2.0	2.1	2.0	1.8	2.3	2.7	1.8	2.1
Linoleic[2] (%)	2017	51.0	50.8	49.7	50.6	50.3	51.4	51.8	49.8
	Average[3]	53.8	53.8	53.7	53.9	54.0	53.4	53.7	53.2
	SD	2.6	2.6	2.6	2.8	2.2	2.3	2.4	2.3
Linolenic[2] (%)	2017	9.0	8.9	8.7	9.0	7.9	8.6	8.9	8.2
	Average[3]	9.3	9.0	9.5	9.3	9.6	9.2	9.0	9.6
	SD	0.9	0.9	1.0	0.8	0.9	1.0	0.9	1.0

[2]-Percent dry matter basis, [3]- 10-year average

Table 7: Percent soluble sugars of 2017 North Dakota soybean, average and standard deviation by the North Dakota agricultural districts

Sugar	Districts	CENT	EC	NC	NE	NW	SC	SE	WC
Sucrose[2] (%)	2017	6.4	6.2	6.7	6.8	7.0	6.3	6.0	6.4
	Average[3]	6.2	6.1	6.4	6.3	6.7	6.3	6.0	6.5
	SD	0.7	0.7	0.9	0.7	0.9	0.7	0.7	0.8
Raffinose[2] (%)	2017	0.5	0.5	0.6	0.5	0.6	0.6	0.5	0.6
	Average[3]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	SD	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Stachyose[2] (%)	2017	2.8	2.9	3.1	2.9	2.9	3.1	2.9	3.2
	Average[3]	4.0	4.0	4.2	4.1	4.0	4.1	4.0	4.2
	SD	1.5	1.5	1.5	1.5	1.6	1.6	1.5	1.6

[2]-Percent dry matter basis, [3]- 10-year average

Table 8: Percent amino acids of 2017 North Dakota soybean, average and standard deviation by the North Dakota agricultural districts

Amino acid	Districts	CENT	EC	NC	NE	NW	SC	SE	WC
Aspartic[2] (%)	2017	4.4	4.4	4.3	4.3	4.1	4.4	4.4	4.3
	Average[3]	4.3	4.3	4.2	4.3	4.2	4.2	4.3	4.3
	SD	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.3
Threonine[2] (%)	2017	1.5	1.5	1.5	1.5	1.4	1.5	1.5	1.5
	Average[3]	1.5	1.6	1.5	1.6	1.5	1.5	1.6	1.5
	SD	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1
Serine[2] (%)	2017	1.7	1.7	1.7	1.7	1.6	1.7	1.8	1.7
	Average[3]	1.9	1.9	1.9	1.8	1.8	1.9	1.9	1.8
	SD	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Glutamate[2] (%)	2017	6.8	6.9	6.7	6.6	6.3	6.8	6.9	6.7
	Average[3]	6.4	6.3	6.2	6.3	6.3	6.1	6.7	6.4
	SD	1.0	1.0	1.0	0.9	0.7	1.3	0.2	1.2
Proline[2] (%)	2017	1.9	1.9	1.9	1.9	1.8	1.9	1.9	1.9
	Average[3]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	SD	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2
Glycine[2] (%)	2017	1.6	1.7	1.6	1.6	1.6	1.7	1.7	1.6
	Average[3]	1.9	1.9	1.9	1.9	1.8	1.9	1.9	1.8
	SD	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.4
Alanine[2] (%)	2017	1.7	1.7	1.7	1.6	1.6	1.7	1.7	1.7
	Average[3]	1.7	1.8	1.7	1.7	1.7	1.7	1.8	1.7
	SD	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Cysteine[2] (%)	2017	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average[3]	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6
	SD	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2
Valine[2] (%)	2017	2.0	2.0	2.0	1.9	1.9	2.0	2.0	2.0
	Average[3]	2.1	2.1	2.1	2.0	2.0	2.1	2.1	2.0
	SD	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2

Amino acid	Districts	CENT	EC	NC	NE	NW	SC	SE	WC
Methionine[2] (%)	2017	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Average[3]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	SD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Isoleucine[2] (%)	2017	1.9	1.9	1.8	1.8	1.8	1.9	1.9	1.8
	Average[3]	1.9	1.9	1.8	1.9	1.8	1.8	1.9	1.8
	SD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Leucine[2] (%)	2017	3.0	3.0	2.9	2.9	2.8	3.0	3.0	3.0
	Average[3]	3.0	3.0	2.9	3.0	2.9	2.9	3.0	2.9
	SD	0.2	0.3	0.3	0.2	0.3	0.4	0.2	0.3
Tyrosine[2] (%)	2017	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.4
	Average[3]	1.5	1.5	1.5	1.5	1.4	1.5	1.5	1.4
	SD	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1
Phenylalanine[2] (%)	2017	2.0	2.0	2.0	1.9	1.8	2.0	2.0	1.9
	Average[3]	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0
	SD	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.2
Lysine[2] (%)	2017	2.6	2.6	2.6	2.6	2.5	2.6	2.6	2.6
	Average[3]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6
	SD	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3
Histidine[2] (%)	2017	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Average[3]	1.0	1.0	1.0	0.9	1.1	1.0	1.0	1.1
	SD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Arginine[2] (%)	2017	2.8	2.9	2.8	2.8	2.6	2.9	2.9	2.8
	Average[3]	2.8	2.8	2.8	2.8	2.8	2.7	2.8	2.8
	SD	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Tryptophan[2] (%)	2017	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4
	Average[3]	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	SD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

[2]-Percent dry matter basis, [3]- 10-year average

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