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UNITED STATES SOYBEAN QUALITY

ANNUAL REPORT 2024

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TABLE OF CONTENTS

2024 QUALITY REPORT

SUMMARY

The American Soybean Association (ASA), United Soybean Board (USB), and U.S. Soybean Export Council (USSEC) have supported a survey of the quality of the U.S. soybean crop since 1986. This survey funded by USB project # 2422-206-0101 and is intended to provide new crop quality data to aid international customers with their purchasing decisions.

SOYBEAN PLANTING AND HARVEST PROGRESS

A relatively dry and warm winter allowed soybean planting to begin early in the Corn Belt states. Among the three primary soybean producing states of Illinois, Iowa, and Minnesota, soybean planting began early at a rapid pace (Figure 1). These three states had around 20% of their soybeans planted by the third week of April, a record early pace for Iowa and Minnesota. However, rains began in late April and halted planting. Planting resumed the second week of May, but this delay put planting progress behind the normal rapid pace in Iowa and Illinois. The date of 50% planted was nearly one week behind normal in Iowa and about on pace in Illinois and Minnesota.

In the Eastern Corn Belt states of Ohio, Michigan, and Indiana, planting progress followed a normal pace. In the West, Nebraska was affected by the rains that hit Iowa and Indiana delaying planting there. In the far Northwest, North Dakota soybean planting was ahead of the historical trend throughout the spring due to warm and dry weather. When averaged across the entire U.S., soybean planting followed the normal pace but was behind the very rapid pace of 2023.

In Illinois, although overall planting was far behind the record pace of 2023 and on an average pace, late spring conditions pushed the crop, and blooming and pod set were ahead of last year and far ahead of the average. Development in Iowa was on an average pace in 2024, but

Minnesota soybeans stalled and development to flowering and pod set stages was delayed. Eastern Corn Belt states had soybeans that were ahead of average for development, and those in the western Corn Belt were delayed.

As mentioned in the weather section below, ample early rainfall in the central and Western Corn Belt turned to widespread drought conditions that was especially severe in the Eastern Corn Belt. Ohio, Kentucky, and Tennessee were especially hit by the drought that significantly reduced crop condition and ultimately yields in those states. USDA rated crop conditions in these states at the end of the season as the lowest in recent history.

Across the U.S., the pace of harvest was at or near a record with 94% of the crop harvested by 4 November. Due to extreme late season drought, soybeans in Ohio began maturing nearly two weeks ahead of normal and harvest began similarly early. However, remnants of hurricane Helene dropped significant rain on a parched Ohio delaying harvest and reducing the record pace. Hurricane Helene affected soybean crops in South Carolina, North Carolina, Tennessee, Kentucky, and Ohio. While late season hurricanes are relatively common in Gulf and Mississippi Delta states, the relative rarity and overall strength of Helene caused significant damage to maturing soybean crops in the Southeast and Eastern Corn Belt. Other than delays caused by Helene, soybean harvest in nearly all states progressed ahead of schedule due to extended dry conditions.

2024 AREA, YIELDS, AND TOTAL PRODUCTION

According to the USDA's October 11, 2024 Crop report, total U.S. soybean production is forecasted to be a record high of 125 MMt. This is up slightly from the 114 MMt forecast earlier and up 10% from 2023. If realized, this production record of will be the result of increased area and record yields (3.57 Mt per Ha). Average yield is expected to increase by 0.16 Mt per Ha over that achieved in 2023. Area is expected to increase 5% over 2023 to 34.9 M Ha.

The state of Illinois is expected to produce an estimated 19.6 MMt of soybean, up 11% over 2023. This would come from 4.4 M Ha and a yield of 4.5 Mt per Ha. Both area and yields represent an increase of around 4% over last year. Predicted yields increased by 0.14 MT per Ha from the previous report. Iowa, the U.S.'s second largest soybean producing state is expecting to produce 17.4 MMt from 4.0 M Ha and yields of 4.3 MT per Ha in 2024. This too is an 11% increase over 2023. Yields there increased by 0.17 Mt per Ha from the earlier USDA report.

States directly to the East and West (Indiana and Nebraska) will both produce about 4 MMt per Ha soybean crops in 2024. Nebraska's yields are expected to be 15% larger than in 2023. Nebraska's neighbor, Kansas is expected to increase yields by 50% over 2023 to 2.6 Mt per Ha. In the north, Michigan may increase yields by 13% to 3.5 Mt per Ha while its neighbor to the south, Ohio, will see yields decrease by 10% to the same 3.5 Mt per Ha average yields.
Minnesota saw yield expectations decline from 3.3 to 3.2 from September to October reports. Despite producing soybeans on nearly 3 million Ha, Minnesota will produce a mere 9.6 MMt in 2024. Likewise, North Dakota will produce soybeans on 2.7 M Ha, but with yields estimated at only 2.6 MT per Ha, total production will be 6.8 MMt. Missouri will harvest 8.1 MMt from 2.4 M Ha with 3.4 MT per Ha yields. On the other hand, Indiana will produce 9.4 MMt from 2.3 M ha and 4.0 Mt per Ha.

Ohio, Kentucky and Tennessee saw that greatest yield declines over 2023 due primarily to extended and severe drought conditions late in the growing season. Minnesota and North Dakota yields suffered due to excessive rainfall throughout the early season and dry conditions late in the year. Although there were local weather extremes in the central Corn Belt states, Nebraska, Iowa, Illinois and Indiana benefited from abundant rainfall early with relatively little drought stress later in the season.

QUALITY OF THE 2024 U.S. SOYBEAN CROP

Sample kits were mailed to 3,721 producers that were selected based on total land devoted to soybean production, so that response distribution would closely match that of soybean production at a fine geographical resolution. By 25 October 2024, 1,130 samples were received. This report will serve as the initial report of the 2024 U.S. soybean crop. A final report will be released late in 2024.

Samples were analyzed for protein, oil, amino acid, and sugar concentration by near-infrared spectroscopy (NIRS) using a PerkinElmer DA7250 diode array instrument (PerkinElmer Inc., Waltham, MA, U.S.A.) and a FOSS Infratec Nova whole grain analyzer (FOSS, Foss Allé 1, DK-3400 Hilleroed, Denmark). The DA7250 unit was equipped with calibrations developed in collaboration with PerkinElmer while the Infratec Nova was equipped with the calibrations developed by FOSS that have been approved for official testing by FGIS for soybean protein & oil as "official criteria" authorized under section 7(b) of the USGSA, as amended. A subset of samples was sent to two commercial laboratories for assessment by AOCS-approved analytical chemical methods in order to validate NIR quality constituent predictions. Regional and national average quality values were determined by computing weighted averages using state and regional soybean production estimates, so that average values best represent the crop as a whole.

PROTEIN AND OIL

Overall, the quality of the 2024 crop appears to be quite good. Leading with protein, the average protein level of the 2024 crop is expected to be 34.0% (Table 2a). This is three tenths of a point (0.3) higher than 2023 (Table 5), the highest average protein level since 2019, and similar to the average of the previous ten years. Oil averaged 19.9% in 2024. Like protein, oil levels averaged three tenths of a point higher than in 2023. This is the highest oil level since 2021 and six tenths of a point higher than the previous ten-year average.

With protein and oil values increased, the sum of these two values increased significantly in 2024 to 53.9%. This is slightly higher than the previous ten-year average and the highest value since 2015. The sum value represents an index for the processed value of soybean since the protein and oil fractions are the valuable components of soybean.

At the regional scale, the 2024 crop continued the trend of a geographical flattening of regional protein and oil levels. As is routine over years, the Western Corn Belt (WCB) had the lowest regional protein level at 33.8%; however, the Eastern Corn Belt (ECB) was only slightly higher at 34.0%. The Midsouth (MDS) region had an average protein level of 34.5% and the East Coast (EC) was 35.2%. The Southeast (SE) region had delayed harvest, and so far, only North Carolina contributed samples to this survey. More samples will be submitted for this region over the next months so that the final report will include a full representation of all soybean producing states. Like protein, oil levels in the WCB were lower at 19.7% compared with the ECB (20.0%) and the MDS (20.8%). The EC had the lowest oil levels at 18.7%.

Within region variation in protein year-over-year was more nuanced. In the WCB, Missouri, Minnesota, North Dakota and South Dakota all produced soybeans with higher protein in 2024 than in 2023. North Dakota increased by 0.7 points to 33.7%. Missouri increased by 0.6 points to 34.2. South Dakota and Minnesota increased by 0.5 and 0.2 points to 34.5% and 33.7%, respectively. Nebraska, Kansas and Iowa had lower protein in 2024 than in 2023 by 0.6, 0.4 and 0.2 points to 33.6, 33.7, and 33.5% respectively.

In the ECB, protein levels increased or maintained 2023 levels in all states. Michigan and Indiana showed increases of 0.9 and 0.8 points to 34.4 and 34.3% respectively. Illinois and Ohio had increases of 0.4 and 0.3 points to 33.7 and 34.3%, respectively. Midsouth states also increased. The biggest changes were in Louisiana and Mississippi that increased protein levels by 0.8 and 0.7 points over 2023 to 35.1 and 35.0% protein. Kentucky increased protein by 0.6 to 34.6%.

Oil values increased modestly in most major soybean producing states. In the WCB, Kansas and Nebraska saw oil levels increase by 0.6 and 0.5 points to 19.7 and 19.5% respectively. Iowa and Missouri increased slightly to 20.1 and 20.2% oil. In the ECB, drought conditions led to increased oil levels in Ohio, where oil increased by 0.6 points to 19.8%. Illinois produced soybean with 20.3% oil supporting this region's strong average oil levels. The MDS states increased oil by nearly one point over 2023 to a very high 20.8%. Together these small and large increases in oil levels over 2023 led to the high average oil concentration noted in U.S. Soybeans in 2024.

PHYSICAL CHARACTERISTICS

SEED MOISTURE

The unusually dry conditions that were noted during the latter half of the growing season extended into the fall harvest season across broad ranges of the U.S. soybean production area. This was especially and uniformly true across the Western portions of the Corn Belt. Sates from Kansas to North Dakota and Missouri to Minnesota saw very unusually dry weather up to and throughout harvest. This led to extremely low moisture in the harvested crop. While this region tends to harvest soybeans at lower moisture levels that Eastern Corn Belt states in most years, the 2024 crop was unusually and extremely dry. This was most evident in the westernmost states of Kansas and Nebraska where average moisture levels were 8.7 and 9.7% respectively (Table 2b). Harvested soybeans from the WCB averaged 9.9% moisture.

In addition, early harvested soybeans in Ohio and Eastern Indiana where extreme drought reigned late in the season, were also extremely dry. Ohio averaged 10.3% moisture, and the ECB averaged 10.7%. Unfortunately, later harvested soybeans in Ohio were hit by the remnants of hurricane Helene. Heavy soaking rains on mature and drought-stricken soybeans can have a large negative effect on soybean quality. Some farmers in Ohio did have physical seed quality issues. Reports of seeds sprouting in pods and some damage in harvested soybeans were noted in Ohio in 2024. Some damaged seeds were identified in samples from this state by this survey.

Overall average moisture from the 2024 crop was determined to be 10.3%. This is the lowest average moisture noted in recent memory. Again, apart from Ohio, soybeans from the EC, SE, and MDS regions tended to be less dry than those from the Western part of the Western Corn Belt.

Soybeans are traded on a 13% moisture basis and priced by weight. Therefore, purchasers buying soybeans at moisture levels below 13% are purchasing less water and more protein and oil. For instance, a 10% moisture soybean lot with 33% protein and 20% oil (on a 13% moisture basis) would have protein and oil concentrated by ~3.5% to 34.1% and 20.7% respectively, on an as-is basis. See Table 2b for as-is protein and oil levels in U.S. soybeans across states and regions.

Higher as-is protein levels increase the soybean meal and oil yields for processors purchasing these soybeans. While dry soybeans may present more challenges for the trade in increased seed coat cracking, seed splitting, and issues with dehulling, the economic value of low moistures generally far outweigh the negative impacts of this condition. Be prepared for lower moisture soybeans in new crop soybean shipments from the U.S.

SEED WEIGHT

Seed weight in soybean is important for some food uses but tends to have little impact on the value of conventionally processed soybeans. However, seed weight does help provide insight into the production environment and potential yield-limiting phases in crop growth. Seed weight is an indicator of the relative differences in growing environment in midsummer vs. late summer. Preharvest yield estimates are primarily based on counts of seeds per unit of area. These estimates are not able to include seed weight as this is determined late in the soybean's growth cycle. Improved yield estimates would be possible with better estimates of seed size.

Seed size increased significantly in Kanas and Nebraska relative to 2003 (Table 3). This follows the protein and oil value changes noted in these states relative to last year. This change is really a story about 2023 where late season drought reduced yields, seed size, and quality of the crop there. Overall, this year returned a more normal crop. In the ECB, drought had a negative effect on seed size in Ohio, Michigan, and Wisconsin. Ohio seeds were around one gram per 100 seed smaller than in 2024. Even larger reductions in seed size were noted in neighboring Kentucky in the MDS. Seed size there decreased by 1.7 g to 14.6 g per 100 seed, relative to 2023. This again highlights the drought conditions that were centered in OH, extended into neighboring states, and led to significantly reduced yields there.

TEST WEIGHT

Test weight (TW) is a measure of density of grains. It is an important quality factor in cereals, but it affects soybean quality little and is not a good indicator of value to the processor. We report it here as it is often measured and reported with little context. Test Weight was mostly unchanged from 2023 with the U.S. average grain density decreasing by only 0.2 pounds per bushel to 56.5 (Table 3). Ohio, Arkansas and Kentucky all showed lower test weights in 2024 than the previous year. Drought in Ohio and Kentucky certainly led to this slight reduction there. Arkansas saw a reduction of 1.7 pounds per bushel to 54.3. This may be due to extended periods of high temperatures experienced in soybean production areas of the state.

FOREIGN MATERIAL

The 2024 Soybean Quality Survey again validated that U.S. Soybean farmers are able to harvest soybeans with very low levels of foreign material. Foreign material tends to increase incrementally as grains pass through the value chain. At each point of transfer, there is an opportunity for contamination with other grains, or other forms of FM. Soybeans sampled by farmers at the time of harvest again averaged 0.2% FM in 2024 (Table 3). Soybeans from the ECB averaged 0.2%, while those from the WCB averaged 0.3%. Missouri and Nebraska had average FM levels of 0.4%. While higher than the U.S. average, this level of FM is functionally very low. Midsouth states tended to have more FM leading to an average value of 0.6% for this region. Of 1,130 samples, only 6 had FM levels of greater than 2% and 32 had FM levels between 1-2%. In total, 96.6% of samples (1,092 of 1,130) contained FM of 1% or less.

SUCROSE

Soybean meal provides not only protein, and therefore amino acids, for animal feed, but it also adds to a ration's energy (Stein et al., 2008). Sucrose in soybean and soybean meal contributes to total Metabolizable Energy (ME) in livestock feed. Although soybean meal is an important contributor to a ration's total ME, nutritionists often use 'book values' for energy from soybean meal that does not differ across soybean origins. Our work highlights the potential variation in ME in soybean meal based on varying sucrose levels in soybeans. This variation tends to have a strong geographical basis to it. We have found that soybeans from the U.S. have higher sucrose than soybeans from Brazil (Naeve, unpublished data), which is desirable since sucrose is positive for ME. In studies of soybean meal quality by origin, the apparent ME in U.S. soybean meal was significantly higher than that in meal from Argentina and Brazil, and the higher sugar level in U.S. soybean meal is likely a primary driver of differences in metabolizable energy (Ravindran et al., 2014).

Average U.S. sucrose levels, at 4.3% in 2024 (Table 3), were significantly lower than those in 2023 (5.4%). Last year's crop had unusually high sucrose levels due to cooler conditions in the late season. Like large-scale differences between tropical and subtropical environments found in Brazil versus the U.S., we have found that soybeans produced in cooler regions of the U.S. also have lower protein without offsetting increases in oil, but higher sucrose levels. This trend was noted again in 2024. Far North states of North Dakota, Wisconsin, and New York had the greatest sucrose concentrations. Sucrose certainly shows some trade-offs with protein, expressing higher concentrations where protein is lower. Although the gradient is small, sucrose tended to be inversely related to protein levels across regions. The WCB had the highest overall sucrose levels (4.4%). The EC was 4.2% and the MDS was 4.0%.

AMINO ACIDS

Amino acids are the "building block" organic compounds linked in various combinations to form unique proteins. Optimal animal performance occurs when the feed protein contains an ideal amount and proportion of all essential amino acids (those amino acids which cannot be produced by animals).

In whole soybeans, lower crude protein translates to a higher relative proportion of the five most critical essential amino acids (lysine, cysteine, methionine, threonine, and tryptophan), indicating that meal made from those soybeans will likely be of higher feed quality for a given feed ration than meal made from higher crude protein soybeans (Thakur and Hurburgh, 2007; Medic et al., 2014; Naeve, unpublished data). We have even detected this relationship in the thousands of samples from highly variable U.S. regions, varieties, and management tactics.

The relative abundance of lysine (expressed as a percent of the 18 primary amino acids) within the soybean protein fraction remained virtually the same in 2024 as it was in 2023 (6.8%) (Table 4). The WCB retained the 6.8% average that was noted in 2023. Other regions decreased very slightly to 6.7% in 2024. As with 2023, there was little variation in the relative abundance of Lys across states. All states averaged either 6.7 or 6.8%.

Similarly, the sum of the five essential amino acids (5 EAAs, expressed as a percent of the 18 primary amino acids) decreased from 14.8% in 2023 to 14.6% in 2024. There was relatively little variation between states or regions for this measure of protein quality. More northern states tended to have slightly higher concentrations of the five amino acids. However, the geographical variation in this measure of protein quality is relatively low. The flattening of geographical variation in amino acids follows the same trend noted with sucrose, protein, and oil over the past three years. The geographical variation in these quality measures has been dampened over time as protein levels have receded in the Central Corn Belt.

CORRELATIONS

Understanding how soybean compositional factors are related to one another can help one understand not only the trade-offs between attributes, but it can also lead to a better understanding of the fundamental biology behind these factors. The relatedness of two factors can be measured by the Pearson correlation coefficient expressed as a number between +1 and -1, where 1 is a perfect positive linear correlation, 0 is no linear correlation, and −1 is a perfect negative linear correlation. Correlations do not demonstrate causation. Correlations between factors can be found in the correlation matrix on page 14. Note that these correlations are very similar to those noted in 2023. This is an indicator that many of the same drivers of soybean composition, as well the trade-offs between components, were similar across these two years. Because most of the attributes that we describe here are expressed on a percentage basis, trade-offs between factors naturally result in negative correlations. As expected, protein and oil were negatively correlated (r = -0.5), but because this is not a perfect correlation, it is possible to find soybeans that have both high protein and oil or that are low in both. As is often the case, the sum of protein and oil was much more highly correlated with protein than with oil. Numerically, protein has a greater opportunity to drive this sum value. However, it appears that the greater variation in protein over all environments is the root of these correlations. Variation in protein leads to variation in the residual (mostly carbohydrate) fraction of soybeans.

Sucrose is part of the residual fraction in soybean and therefore tends to be negatively correlated with both protein and oil. Soybeans that are lower in both protein and oil tend to have higher sucrose levels. Sucrose was negatively correlated with protein and oil at r = -0.29 and -0.45, respectively, and highly negatively correlated with the sum of the two constituents (r = -0.69).

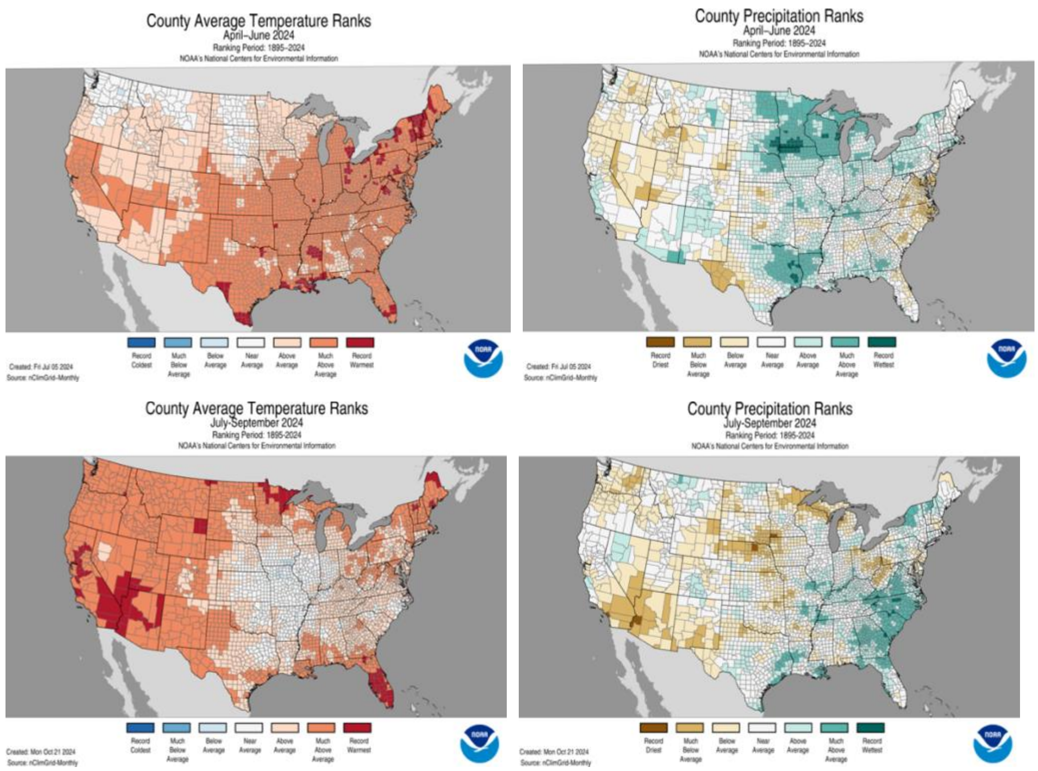
Historically, we have noted that the 5 EAAs value is negatively correlated with protein. This has also been supported by experimental research (Pfarr et al., 2018) where lower protein soybeans produce protein that is enriched in these five essential amino acids. There is clearly a trade-off between protein quantity and quality. In 2024, protein (quantity) was correlated with 5 EAAs (quality) at r = -0.51, and lysine at r = -0.70. Lysine is correlated with the 5 EAAs at r = 0.51, so while it is a mathematically big contributor to the sum of these five amino acids, the other four certainly play their own independent roles in affecting protein quality.

Test weight continued the trend seen in previous years of a negative correlation with oil (r = -0.38) and a moderately positive correlation with sucrose (r = 0.27). Surprisingly, seed size does not correlate well with most of our measured seed constituents. Only sucrose is somewhat correlated with seed size (R = 0.27). This indicates that factors driving seed size do not differentially affect deposition of protein and oil. For instance, when conditions are favorable for producing more yield through larger seeds, neither protein nor oil seem to be primarily responsible, or vice versa.

CORRELATION MATRIX

	Protein (13%)	**Oil** (13%)	**Protein + Oil** (13%)	**Sucrose** (Db)	**Lysine** (%18 AAs)	**5 EAAs** (%18 AAs)	**TW** (lb/bu)	**Seed Weight** (g 100 seeds^{-1})
Protein (13%)	1	-0.51	0.72	-0.29	-0.70	-0.51	0.09	-0.05
Oil (13%)		1	0.24	-0.45	0.20	0.17	-0.38	-0.05
Protein + Oil (13%)			1	-0.69	-0.63	-0.44	-0.20	-0.10
Sucrose (Db)				1	0.38	0.22	0.27	0.27
Lysine (%18 AAs)					1	0.60	0.01	0.06
5 EAAs (%18 AAs)						1	-0.08	-0.02
TW (lb/bu)							1	-0.02
Seed Weight (g 100 seeds^{-1})								1

WEATHER AND CROP SUMMARY



Source: NOAA - https://www.ncei.noaa.gov/access/monitoring/us-maps/

The dry and warm winter ceded to a spring which, due to a lack of winter snowpack and widespread warmth, had warmer than normal soils. Active weather starting in late March, with multiple waves of storms, brought snow to large portions of the Upper Midwest as well as rain into Iowa. While March was wet to the north and dry to the south, April was normal to above normal region wide, except for Kansas and western North Dakota, which remained dry. The early spring precipitation pulled Iowa out of drought and lead Ohio to record high rain levels in April, and Indiana recording their 5th wettest April. Severe storms, including hail and tornados, plagued the entire Midwest region throughout May. The 4th wettest spring on record was recorded for Iowa, Minnesota and Wisconsin. Row crops that were planted before the onset of the spring rains were in good condition, but planting was delayed for others because of excessively wet field conditions in April and May. As a result of the mild winter and wet spring, there were increased insect and weed pressures across the Midwest.

In addition to the unusual wetness, spring temperatures were 1-4F above normal across the northwestern Midwest and even higher in the eastern half of the Midwest and the Great Lakes region. Overall, the Midwest tied for its 4th warmest spring on record, with Illinois, Indiana, and Missouri experiencing their 3rd warmest on record, and Ohio and Kentucky experiencing their 2nd warmest.

By the summer months of June and July, extreme rainfall and damaging winds plagued central and upper Midwest regions, but the eastern edge of the region remained dry, as did west in the Dakotas and Nebraska. Flooding rain was an issue in late June across Minnesota, northern Iowa and Wisconsin. Hurricane Beryl impacts on the region brought 2-9 inches of rain from southern Missouri to eastern Michigan in early July and Chicagoland was beset with tornados. Despite the wet spring and early summer pulling most areas out of drought, August was dry and extreme drought blanketed southern Ohio and areas in the SE of Ohio had their 2nd driest summer in 120 years and the state overall had its 7th driest summer.

Temperatures were mostly mild, with only a few hot and humid days in mid-June and late August. In the central and eastern regions of the Midwest temps were 2-4F above normal and closer to average in the Great Plains. Although August began with adequate moisture, by mid-August conditions were becoming much drier in the Midwest overall, leading to near record dry conditions in September in Minnesota. Drought conditions expanded across Minnesota, Missouri and Illinois, as well as parts of Wisconsin, Michigan, Iowa and Indiana in October and parts of the High Plains saw abnormal dryness to extreme drought as well.

Overall, conditions were mostly favorable for row crop producers despite early rains slowing planting and crop development in norther Iowa, the Dakotas, and Minnesota. Ohio was a clear outlier to this trend, though, with significant negative impacts from drought.

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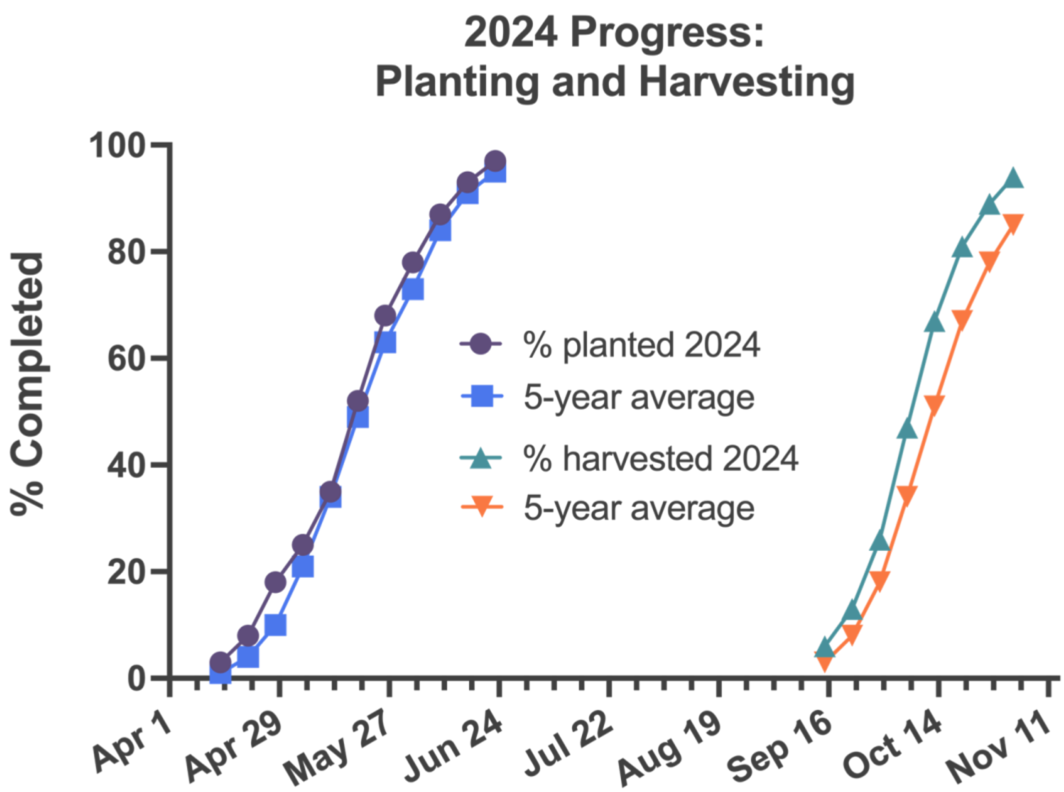
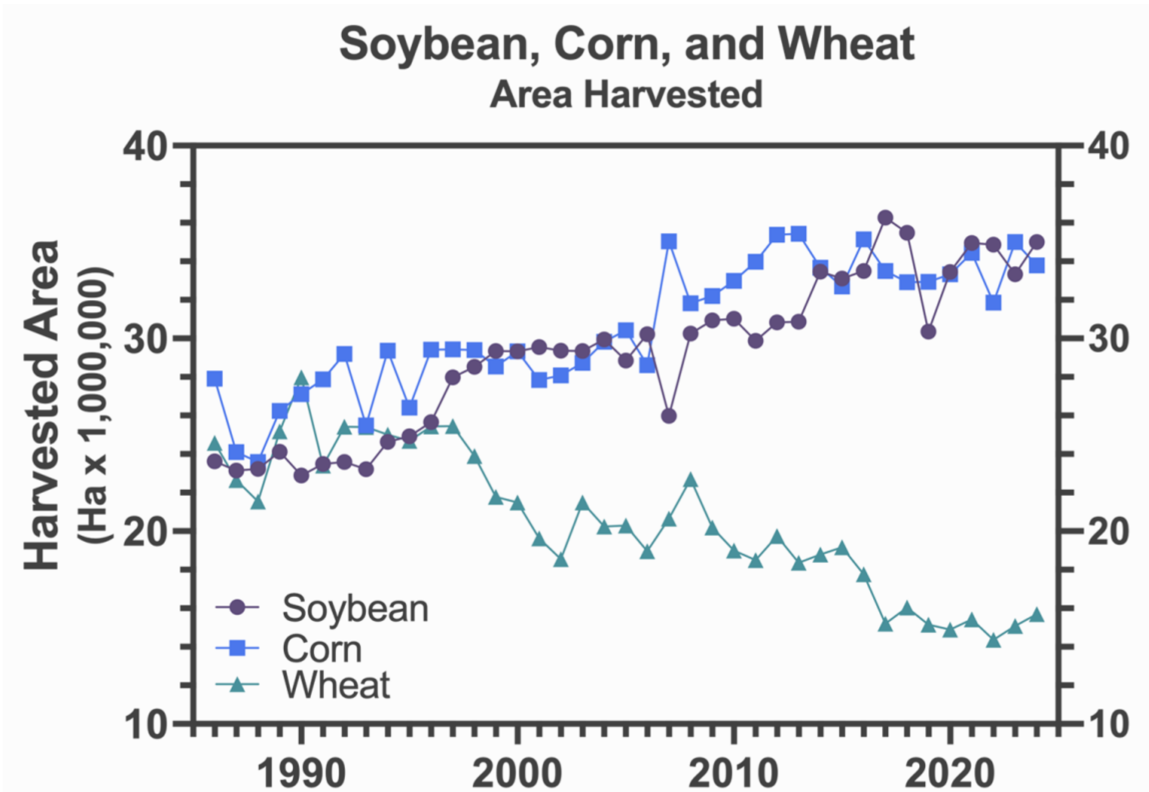
FIGURES

Figure 1: U.S. Soybean Planting and Harvest Progress



Source: USDA NASS

Figure 2: U.S. Soybean, Corn, Wheat Harvested Area



Source: USDA NASS

Figure 3: U.S. Protein and Oil State/Regional Summary

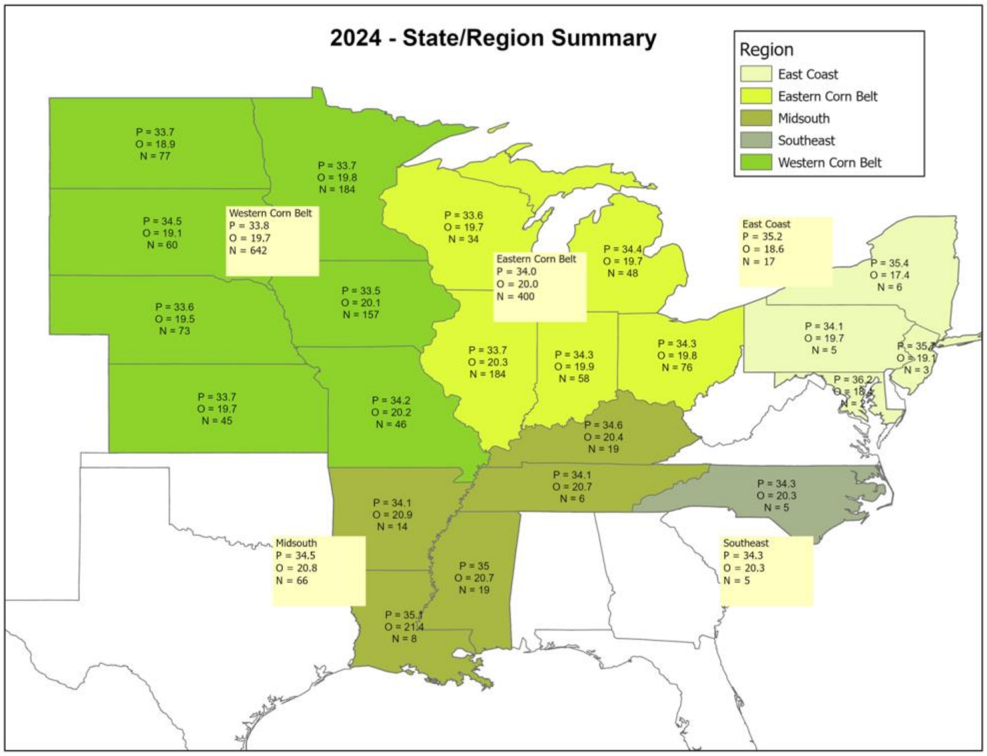


Table 1: Production Data for the United States, 2024 Crop

Table 1. Soybean production data for the United States, 2024 crop

Region	State	Yield (MT ha^{-1})	Area Harvested (1000 ha)	Production (MMT)
Western Corn Belt (WCB)	Iowa	4.3	4,038	17.4
	Kansas	2.6	1,814	4.8
	Minnesota	3.2	2,969	9.6
	Missouri	3.4	2,361	8.1
	Nebraska	4.0	2,126	8.4
	North Dakota	2.6	2,673	6.8
	South Dakota	3.2	2,187	6.9
	Western Corn Belt	3.3	18,168	62.0
				49.7%
Eastern Corn Belt (ECB)	Illinois	4.5	4,354	19.6
	Indiana	4.0	2,341	9.4
	Michigan	3.5	883	3.1
	Ohio	3.5	2,037	7.1
	Wisconsin	3.6	859	3.1
	Eastern Corn Belt	3.8	10,473	42.3
				33.9%
Midsouth (MDS)	Arkansas	3.7	1,223	4.5
	Kentucky	3.4	826	2.8
	Louisiana	3.5	429	1.5
	Mississippi	3.9	919	3.6
	Oklahoma	1.7	184	0.3
	Tennessee	3.2	729	2.3
	Texas	2.7	32	0.1
	Midsouth	3.2	4,344	15.1
				12.1%
Southeast (SE)	Alabama	2.1	144	0.3
	Georgia	2.6	67	0.2
	North Carolina	2.5	656	1.6
	South Carolina	2.6	154	0.4
	Southeast	2.4	1,021	2.5
				2.0%
East Coast (EC)	Delaware	2.7	62	0.2
	Maryland	3.1	196	0.6
	New Jersey	2.6	42	0.1
	New York	3.7	148	0.5
	Pennsylvania	2.8	243	0.7
	Virginia	3.0	243	0.7
	East Coast	3.0	934	2.8
				2.3%
US 2024		3.6	34,940	124.8
US 2023		3.4	33,530	112.5

Source: United States Department of Agriculture, NASS 2024 Crop Production Report (October 2024)

Table 2a: Quality Survey, Protein & Oil Data

Table 2a. USB 2024 Soybean Quality Survey Data - Protein & Oil at 13% Moisture

Region	State	Number of Samples	Protein (%)*	Std. Dev.	Oil (%)*	Std. Dev.
Western Corn Belt (WCB)	Iowa	157	33.5	1.1	20.1	0.6
	Kansas	45	33.7	1.2	19.7	0.7
	Minnesota	184	33.7	1.1	19.8	0.7
	Missouri	46	34.2	2.1	20.2	1.2
	Nebraska	73	33.6	1.1	19.5	0.7
	North Dakota	77	33.7	1.1	18.9	0.8
	South Dakota	60	34.5	1.2	19.1	0.7
Averages†	Western Corn Belt	642	33.8	1.3	19.7	0.8
Eastern Corn Belt (ECB)	Illinois	184	33.7	1.1	20.3	0.7
	Indiana	58	34.3	1.4	19.9	1.1
	Michigan	48	34.4	1.8	19.7	0.8
	Ohio	76	34.3	1.2	19.8	1.0
	Wisconsin	34	33.6	1.4	19.7	0.9
Averages†	Eastern Corn Belt	400	34.0	1.3	20.0	0.9
Midsouth (MDS)	Arkansas	14	34.1	1.7	20.9	1.0
	Kentucky	19	34.6	1.1	20.4	1.1
	Louisiana	8	35.1	1.4	21.4	0.5
	Mississippi	19	35.0	1.1	20.7	0.8
	Oklahoma	0				
	Tennessee	6	34.1	1.2	20.7	0.8
	Texas	0				
Averages†	Midsouth	66	34.5	1.3	20.8	0.9
Southeast (SE)	Alabama	0				
	Georgia	0				
	North Carolina	5	34.3	0.8	20.3	0.7
	South Carolina	0				
Averages†	Southeast	5	34.3	0.8	20.3	0.7
East Coast (EC)	Delaware	1				
	Maryland	2	36.2	0.4	18.4	0.2
	New Jersey	3	35.7	0.7	19.1	0.4
	New York	6	35.4	1.8	17.4	2.0
	Pennsylvania	5	34.1	0.8	19.7	1.6
	Virginia	0				
Averages†	East Coast	17	35.2	1.0	18.6	1.2
USA	Averages	1,130	33.9		19.8	
	Average of 2024 Crop†		**34.0**	**1.3**	**19.9**	**0.8**
	US 2014-2023 avg.		34.1	1.1	19.3	0.8

* 13% moisture basis

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (October 2024)

Table 2b: Quality Survey, Protein & Oil on an As-Is basis

Table 2b. USB 2024 Soybean Quality Survey Data - Protein & Oil on an As-Is basis

Region	State	Number of Samples	Incoming Moisture	Protein (%) As-Is		Oil (%) As-Is	
Western	Iowa	157	10.0	34.7		20.7	
Corn Belt	Kansas	45	8.7	35.4		20.7	
(WCB)	Minnesota	184	10.1	34.8		20.4	
	Missouri	46	10.5	35.2		20.8	
	Nebraska	73	9.7	34.9		20.3	
	North Dakota	77	10.0	34.9		19.6	
	South Dakota	60	9.0	36.0		20.0	
Averages†	Western Corn Belt	642	9.9	35.0		20.4	
Eastern	Illinois	184	10.6	34.7		20.8	
Corn Belt	Indiana	58	10.8	35.2		20.4	
(ECB)	Michigan	48	11.5	35.1		20.0	
	Ohio	76	10.3	35.4		20.4	
	Wisconsin	34	11.2	34.3		20.1	
Averages†	Eastern Corn Belt	400	10.7	34.9		20.5	
Midsouth	Arkansas	14	12.5	34.3		21.0	
(MDS)	Kentucky	19	11.5	35.2		20.7	
	Louisiana	8	11.6	35.6		21.8	
	Mississippi	19	11.5	35.6		21.1	
	Oklahoma	0					
	Tennessee	6	11.6	34.6		21.0	
	Texas	0					
Averages†	Midsouth	66	11.8	35.0		21.0	
Southeast	Alabama	0					
(SE)	Georgia	0					
	North Carolina	5	11.4	34.9		20.7	
	South Carolina	0					
Averages†	Southeast	5	11.4	34.9		20.7	
East	Delaware	1					
Coast	Maryland	2	10.5	37.3		19.0	
(EC)	New Jersey	3	10.0	36.9		19.8	
	New York	6	13.3	35.3		17.3	
	Pennsylvania	5	12.2	34.5		19.9	
	Virginia	0					
Averages†	East Coast	17	11.8	35.7		18.9	
USA							
	Average of 2024 Crop†		**10.4**	**35.0**	**(As-Is)**	**20.5**	**(As-Is)**
	Average of 2024 Crop*			34.0	(13%)	19.9	(13%)
	US 2014-2023 avg.*			34.1		19.3	

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (October 2024)

* 13% moisture basis - US average values weighted based on estimated production by state

Table 3: Quality Survey, Seed Data

Table 3. USB 2024 Soybean Quality Survey Data - Seed Data & Surcose

Region	State	Number of Samples	Seed Weight (g 100 seeds-1)	Test Weight (lb bu^{-1})	Foreign Material (%)	Sucrose (db)
Western Corn Belt (WCB)	Iowa	157	16.1	56.7	0.2	4.4
	Kansas	45	15.3	57.3	0.2	4.0
	Minnesota	184	16.2	56.8	0.2	4.4
	Missouri	46	15.3	56.1	0.4	3.7
	Nebraska	73	16.3	56.4	0.4	4.7
	North Dakota	77	16.3	57.8	0.2	4.9
	South Dakota	60	15.8	56.8	0.3	4.4
Averages†	Western Corn Belt	642	16.0	56.8	0.3	4.4
Eastern Corn Belt (ECB)	Illinois	184	16.2	56.5	0.2	4.1
	Indiana	58	15.9	56.5	0.2	4.1
	Michigan	48	16.3	56.9	0.2	4.3
	Ohio	76	15.4	56.7	0.2	4.2
	Wisconsin	34	16.0	56.6	0.2	4.6
Averages†	Eastern Corn Belt	400	16.0	56.6	0.2	4.2
Midsouth (MDS)	Arkansas	14	15.3	54.3	0.5	3.2
	Kentucky	19	14.6	55.1	0.3	3.6
	Louisiana	8	16.1	54.5	0.5	2.6
	Mississippi	19	14.6	54.7	0.4	3.0
	Oklahoma	0				
	Tennessee	6	14.2	55.1	0.3	3.5
	Texas	0				
Averages†	Midsouth	66	14.9	54.7	0.4	3.2
Southeast (SE)	Alabama	0				
	Georgia	0				
	North Carolina	5	16.9	56.6	0.2	4.0
	South Carolina	0				
Averages†	Southeast	5	16.9	56.6	0.2	4.0
East Coast (EC)	Delaware	1				
	Maryland	2	14.3	59.2	0.2	3.7
	New Jersey	3	18.8	57.6	0.1	4.3
	New York	6	16.7	56.7	0.1	5.1
	Pennsylvania	5	17.5	56.7	0.1	4.2
	Virginia	0				
Averages†	East Coast	17	16.3	57.5	0.1	4.3
US	Averages	1,130	16.0	56.6	0.2	4.3
	Average of 2024 Crop†		**15.9**	**56.5**	**0.2**	**4.2**

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (October 2024)

Table 4: Quality Survey, Amino Acid Data

Table 4. USB 2024 Soybean Quality Survey Data - Amino Acid (AA) Data

Region	State	Number of Samples	Protein (%)*	Lysine (%18 AAs)	5 EAAs‡ (%18 AAs)
Western Corn Belt (WCB)	Iowa	157	33.5	6.8	14.7
	Kansas	45	33.7	6.8	14.7
	Minnesota	184	33.7	6.8	14.7
	Missouri	46	34.2	6.7	14.6
	Nebraska	73	33.6	6.8	14.7
	North Dakota	77	33.7	6.8	14.7
	South Dakota	60	34.5	6.7	14.6
Averages†	Western Corn Belt	642	33.8	6.8	14.7
Eastern Corn Belt (ECB)	Illinois	184	33.7	6.8	14.6
	Indiana	58	34.3	6.7	14.6
	Michigan	48	34.4	6.7	14.5
	Ohio	76	34.3	6.7	14.6
	Wisconsin	34	33.6	6.8	14.6
Averages†	Eastern Corn Belt	400	34.0	6.7	14.6
Midsouth (MDS)	Arkansas	14	34.1	6.7	14.6
	Kentucky	19	34.6	6.7	14.6
	Louisiana	8	35.1	6.7	14.6
	Mississippi	19	35.0	6.7	14.5
	Oklahoma	0			
	Tennessee	6	34.1	6.8	14.7
	Texas	0			
Averages†	Midsouth	66	34.5	6.7	14.6
Southeast (SE)	Alabama	0			
	Georgia	0			
	North Carolina	5	34.3	6.7	14.6
	South Carolina	0			
Averages†	Southeast	5	34.3	6.7	14.6
East Coast (EC)	Delaware	1			
	Maryland	2	36.2	6.6	14.6
	New Jersey	3	35.7	6.7	14.5
	New York	6	35.4	6.7	14.6
	Pennsylvania	5	34.1	6.8	14.6
	Virginia	0			
Averages†	East Coast	17	35.2	6.7	14.6
US	Averages	1,130	33.9	6.8	14.6
	Average of 2024 Crop†		**34.0**	**6.8**	**14.6**

* 13% moisture basis

‡ Five essential amino acids (also known as CAAV): cysteine, lysine, methionine, threonine, and tryptophan

† Regional and US average values weighted based on estimated production by state as estimated by USDA, NASS Crop Production Report (October 2024)

Table 5: Historical Summary of Yield & Quality Data – U.S. Soybeans

Table 5. Historical Summary of Yield and Quality Data for US Soybeans

Year	Yield (kg ha^{-1})	Protein* (%)	Oil* (%)	Sum† (%)	Harvested (M ha^{-1})	Production (M MT)	Protein Std. Dev.	Oil Std. Dev.
1986	2241	35.8	18.5	54.3	23.6	52.9	1.4	0.7
1987	2281	35.5	19.1	54.6	23.2	52.8	1.6	0.7
1988	1817	35.1	19.3	54.4	23.2	42.2	1.5	0.8
1989	2173	35.2	18.7	53.9	24.1	52.4	1.5	0.8
1990	2295	35.4	19.2	54.6	22.9	52.5	1.2	0.7
1991	2301	35.5	18.7	54.1	23.5	54.1	1.4	0.9
1992	2530	35.6	17.3	52.8	23.6	59.7	1.4	1.0
1993	2194	35.7	18.0	53.8	23.2	50.9	1.2	0.9
1994	2786	35.4	18.2	53.6	24.6	68.5	1.4	0.9
1995	2375	35.5	18.2	53.6	24.9	59.2	1.4	0.9
1996	2530	35.6	17.9	53.5	25.7	64.8	1.3	0.9
1997	2618	34.6	18.5	53.0	28.0	73.2	1.5	1.0
1998	2618	36.1	19.1	55.3	28.5	74.7	1.5	0.8
1999	2463	34.6	18.6	53.2	29.3	72.3	1.9	1.1
2000	2564	36.2	18.7	54.9	29.3	75.1	1.7	0.9
2001	2665	35.0	19.0	54.0	29.6	78.7	2.0	1.1
2002	2557	35.4	19.4	54.8	29.4	75.1	1.6	0.9
2003	2281	35.7	18.7	54.3	29.4	66.8	1.7	1.2
2004	2840	35.1	18.6	53.7	30.0	85.1	1.5	0.9
2005	2900	34.9	19.4	54.3	28.9	83.6	1.5	0.9
2006‡	2887	34.5	19.2	53.7	30.2	87.1	1.6	1.0
2007‡	2806	35.2	18.6	53.9	26.0	72.9	1.2	0.8
2008‡	2671	34.1	19.1	53.2	30.2	80.8	1.4	0.8
2009‡	2961	35.3	18.6	53.9	30.9	91.6	1.2	0.9
2010‡	2927	35.0	18.6	53.6	31.0	90.7	1.4	1.2
2011‡	2826	34.9	18.1	53.0	29.9	84.4	2.2	1.8
2012‡	2692	34.3	18.5	52.8	30.8	82.9	1.6	0.9
2013‡	2961	34.7	19.0	53.7	30.9	91.4	1.1	1.0
2014‡	3196	34.4	18.6	53.0	33.5	107.0	1.3	0.9
2015‡	3230	34.3	19.8	54.1	33.1	107.0	1.1	0.8
2016‡	3492	34.5	19.3	53.8	33.5	117.0	1.2	0.7
2017‡	3317	34.1	19.1	53.2	36.3	120.2	1.2	0.9
2018‡	3405	34.1	19.0	53.1	35.5	120.6	1.1	0.7
2019‡	3190	34.1	19.0	53.1	30.4	96.8	1.1	0.6
2020‡	3432	33.9	19.5	53.4	33.5	114.9	1.1	0.7
2021‡	3479	33.5	20.0	53.5	35.0	121.6	1.2	0.8
2022‡	3351	33.9	19.5	53.4	34.9	116.3	1.1	0.7
2023‡	3358	33.7	19.6	53.3	33.5	112.5	1.1	0.9
2024‡	3573	34.0	19.9	53.9	34.9	124.8	1.3	0.8
Averages (2013-2023)	**3366**	**34.0**	**19.4**	**53.4**	**34.0**	**114.4**	**1.2**	**0.8**
Averages (1986-2023)	**2789**	**34.9**	**18.9**	**53.7**	**29.2**	**83.0**	**1.4**	**0.9**

Sources: US Dept. of Agriculture, Iowa State University, and University of Minnesota
*Protein and oil concentrations expressed on a 13% moisture basis
†Sum represents sum of protein and oil concentrations
‡2006 - 2024 quality estimates are weighted by yearly production estimates by state

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