

Predicting Crop Yields

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Predicting crop yields

One of the USDA datasets that is the most up-to-date is the crop condition index

- Data is collected on the weekends and is reported on Monday afternoons
- As of 2022, USDA was collecting data from 43 states
- Crop condition reports go back to 1986
- Corn and soybean reports start around Memorial day
- Wheat reports start for most states in April
 - There are usually some reports in the fall for most winter wheat states
 - There are some reports during the winter but not consistently for all states and all winter weeks
- The USDA report on crop conditions is at the state level
- There are five levels of crop conditions
 - Excellent
 - Good
 - Fair
 - Poor
 - Very poor
- The USDA estimates the percentage of the state crop within each crop condition level
- The levels are mutually exclusive so the total across levels = 100%



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Using the USDA data to predict yields

Using the Bain and Fortenbery model (2013)

- Use an index of crop conditions reports (CCIndex) to estimate yield
- There is a weight assigned to each crop condition
 - $CCIndex = (\% \text{ acreage Excellent}) * 1 +$
 - $(\% \text{ acreage Good}) * 0.75 +$
 - $(\% \text{ acreage Fair}) * 0.50 +$
 - $(\% \text{ acreage Poor}) * 0.25 +$
 - $(\% \text{ acreage Very poor}) * 0$
- Possible values range from
 - 100 – if all the crop acres are excellent
 - 0 – if all the crop acres are very poor
- A score of 50 would indicate the average crop condition for the state is in fair condition



Procedure

Crop condition reports for a specific week are used to construct a CCI index for the last 30 years.

These 30 CCI scores are then used in regression analysis to estimate the deviation from the trend line crop yield

Because the yield estimate is based on a specific week, the model has to be rerun for each week of the growing season



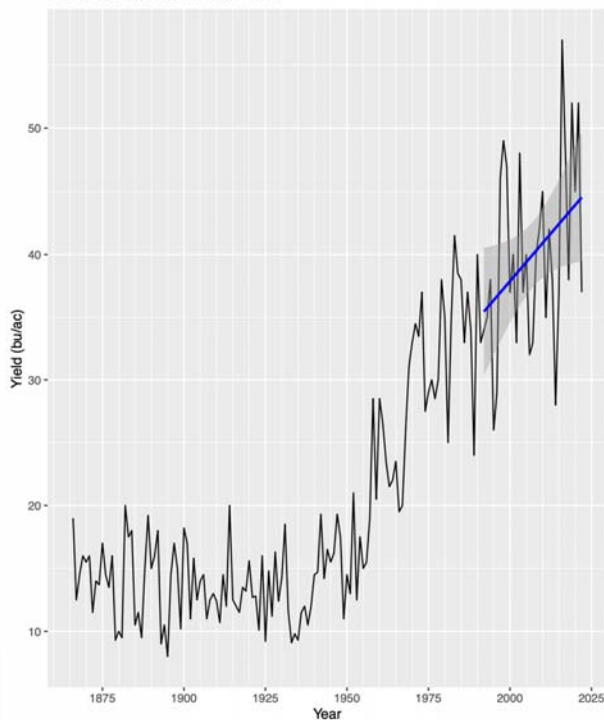
Wheat estimate

The last estimate I ran for Kansas was on April 23

- This is before any other estimates were available.
- My estimate was for 36.2 bu/ac
- Wheat estimates typically have a low R-squared value (i.e., ability to predict)
 - My model had an R-squared value of 0.32
 - Wheat crops can often look poor but end up yielding well and vice versa
- As a result, the confidence interval of the estimate is large
 - My model had a range from 31.1 to 41.4



Historical Kansas Wheat Yields



Wheat yields can be highly variable from year to year

There is a long history of state wheat yields available

The yield trend line is in blue

- Strong evidence that yields are getting better over time

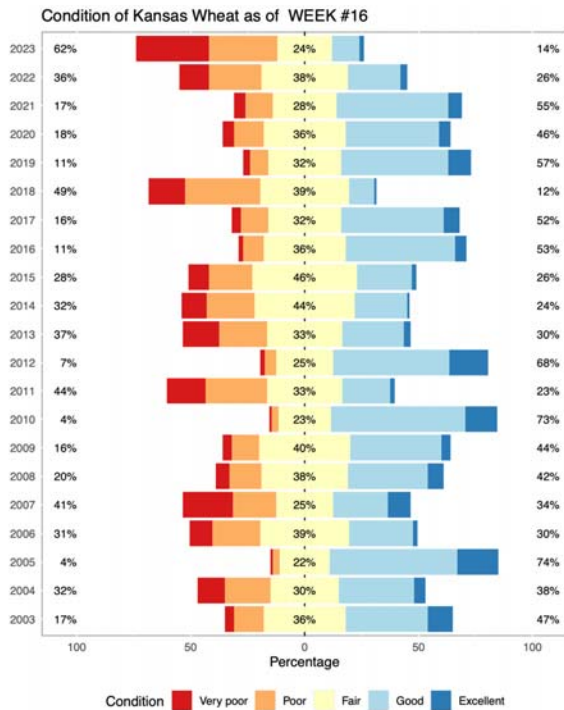


Figure 2. Historical Crop Conditions for Wheat in Kansas - 4/23/23

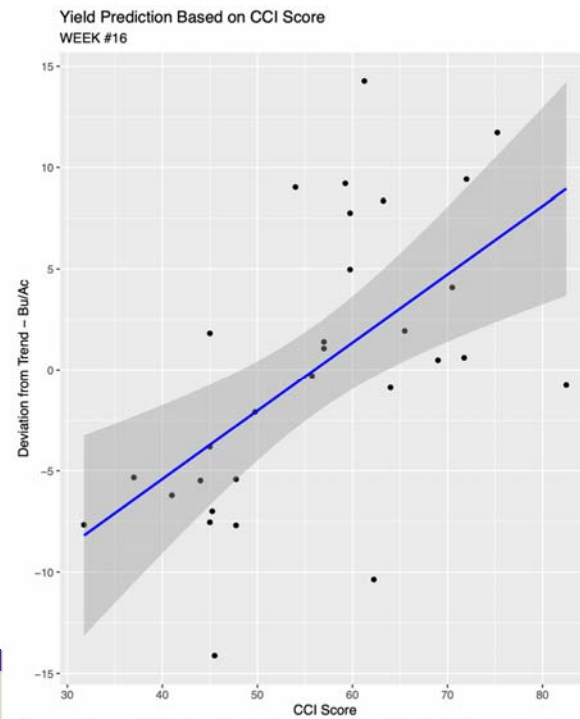


Figure 3. Expected Yield (Trend Deviation) for Various CCI Index Values - 4/23/23

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Corn and Soybean predictions

These are as the crop reports from 8/13/23

Based on PLANTED acres

- A future estimate will use the last crop report on acres

Corn Yields per Acre by State - 8/13/23

Bushels per harvested acre

State	Last year	2023 prediction			R squared
		Lower CI	Predicted	Upper CI	
Colorado	121.0	128.9	133.8	138.8	0.00
Illinois	214.0	199.3	203.3	207.3	0.66
Indiana	190.0	189.1	192.7	196.2	0.71
Iowa	200.0	195.6	199.8	203.9	0.59
Kansas	115.0	120.7	124.6	128.4	0.55
Kentucky	156.0	180.5	184.0	187.5	0.82
Michigan	168.0	168.1	170.5	172.9	0.53
Minnesota	195.0	178.7	184.3	189.8	0.54
Missouri	161.0	142.6	147.2	151.8	0.78
Nebraska	165.0	185.5	188.5	191.4	0.59
North_Carolina	126.0	140.0	143.2	146.5	0.82
North_Dakota	131.0	138.3	142.9	147.6	0.31
Ohio	187.0	190.6	194.5	198.4	0.73
Pennsylvania	140.0	162.5	166.5	170.6	0.71
South_Dakota	132.0	153.7	157.6	161.6	0.51
Tennessee	130.0	169.3	173.1	176.8	0.82
Texas	95.0	127.6	131.3	134.9	0.57
Wisconsin	180.0	168.6	172.1	175.7	0.53

Corn Harvested Acres by State - 8/13/23

1,000 acres

State	Last year	Planted acres	2023 harvest estimate			R squared	
			Lower CI	Predicted	Upper CI		
Colorado	980	1,250	1,048	1,069	1,091	0.59	
Illinois	10,600	11,500	11,268	11,302	11,336	0.13	
Indiana	5,130	5,500	5,337	5,350	5,363	0.04	
Iowa	12,400	13,400	12,922	12,983	13,045	-0.03	
Kansas	4,440	5,500	4,932	4,987	5,042	0.65	
Kentucky	1,350	1,550	1,422	1,431	1,441	-0.03	
Michigan	2,000	2,400	2,061	2,084	2,106	-0.01	
Minnesota	7,490	8,400	7,570	7,670	7,770	0.47	
Missouri	3,120	3,650	3,413	3,455	3,497	-0.02	
Nebraska	8,820	9,500	9,058	9,095	9,131	0.78	
North_Carolina	785	990	894	906	919	-0.03	
North_Dakota	2,670	3,900	3,311	3,450	3,590	-0.04	
Ohio	3,180	3,500	3,269	3,283	3,296	0.17	
Pennsylvania	840	1,240	854	868	882	0.52	
South_Dakota	5,010	6,200	5,469	5,559	5,649	0.55	
Tennessee	795	1,000	906	918	929	-0.05	
Texas	1,610	2,500	2,134	2,175	2,216	0.38	
Wisconsin	3,030	4,000	3,036	3,087	3,137	-0.03	
sum	—	74,250	85,980	78,905	79,673	80,441	—

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Total Corn Production by State - 8/13/23

1,000,000 bushels

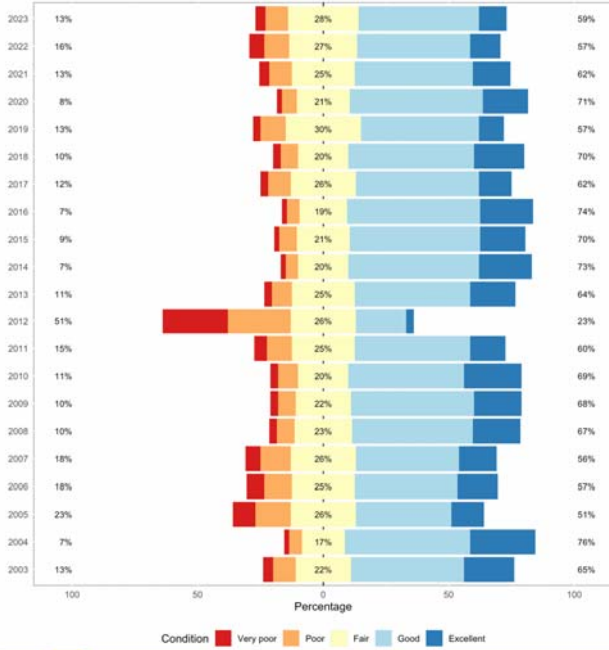
State	Last year	2023 prediction			
		Lower CI	Predicted	Upper CI	
Colorado	119	135	143	151	
Illinois	2,268	2,246	2,297	2,350	
Indiana	975	1,009	1,031	1,052	
Iowa	2,480	2,528	2,594	2,660	
Kansas	511	595	621	647	
Kentucky	211	257	263	270	
Michigan	336	346	355	364	
Minnesota	1,461	1,353	1,413	1,475	
Missouri	502	487	508	531	
Nebraska	1,455	1,680	1,714	1,748	
North_Carolina	99	125	130	135	
North_Dakota	350	458	493	530	
Ohio	595	623	638	654	
Pennsylvania	118	139	145	150	
South_Dakota	661	841	876	913	
Tennessee	103	153	159	164	
Texas	153	272	285	299	
Wisconsin	545	512	531	551	
sum	—	12,941	13,759	14,198	14,644

Total Corn Production

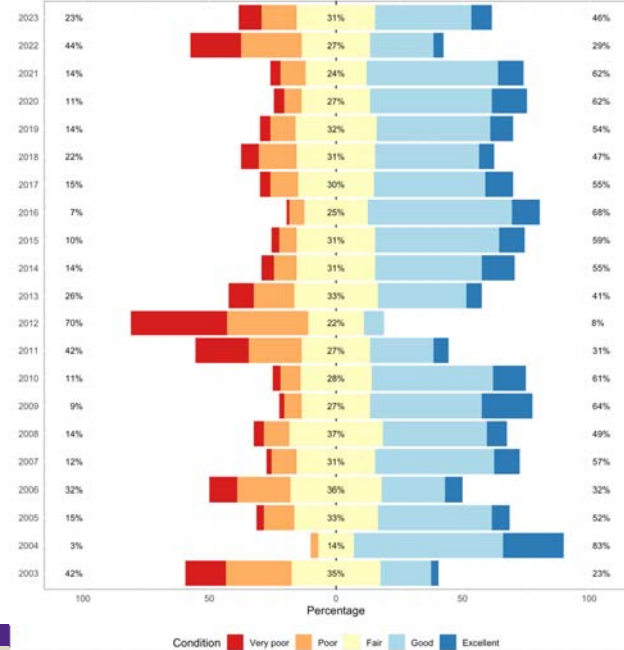
Estimate from 18 leading corn states

Based on planted acres

Condition of US Corn as of 8/13/23



Condition of Kansas Corn as of 8/13/23



Soybean Yields per Acre by State - 8/13/23

Bushels per harvested acre

State	Last year	2023 prediction			R squared
		Lower CI	Predicted	Upper CI	
Arkansas	52.0	54.6	56.1	57.6	0.42
Illinois	63.0	60.1	61.5	62.9	0.23
Indiana	57.5	57.5	58.7	59.8	0.45
Iowa	58.5	55.7	57.4	59.1	0.26
Kansas	27.5	35.4	37.4	39.3	0.42
Kentucky	51.0	52.9	54.6	56.3	0.44
Louisiana	47.0	51.4	52.7	54.1	0.45
Michigan	47.0	46.2	47.7	49.3	0.07
Minnesota	50.0	45.7	47.5	49.3	0.28
Mississippi	54.0	56.7	57.7	58.7	0.63
Missouri	45.5	44.9	46.1	47.2	0.56
Nebraska	49.0	58.5	59.7	60.8	0.55
North_Carolina	38.5	37.8	38.7	39.6	0.63
North_Dakota	35.0	31.3	33.4	35.5	0.09
Ohio	55.5	56.3	57.7	59.1	0.46
South_Dakota	38.0	43.0	44.5	46.0	0.23
Tennessee	48.0	50.7	52.4	54.1	0.64
Wisconsin	54.0	44.8	47.7	50.7	0.08

Soybean Harvested Acres by State - 8/13/23

1,000 acres

State	Last year	Planted acres	2023 harvest estimate			R squared	
			Lower CI	Predicted	Upper CI		
Arkansas	3,150	2,900	2,843	2,856	2,869	0.14	
Illinois	10,750	10,000	9,902	9,929	9,956	-0.03	
Indiana	5,830	5,500	5,463	5,472	5,480	-0.01	
Iowa	10,030	9,700	9,608	9,629	9,651	-0.02	
Kansas	4,810	4,250	4,063	4,110	4,158	0.08	
Kentucky	1,940	1,900	1,873	1,878	1,884	-0.03	
Louisiana	1,210	1,120	998	1,032	1,066	0.15	
Michigan	2,240	2,050	2,034	2,037	2,040	-0.03	
Minnesota	7,390	7,500	7,342	7,370	7,398	0.43	
Mississippi	2,290	2,300	2,240	2,254	2,268	-0.02	
Missouri	6,060	5,600	5,444	5,502	5,559	-0.03	
Nebraska	5,680	5,500	5,422	5,435	5,448	0.05	
North_Carolina	1,690	1,650	1,587	1,600	1,612	0.03	
North_Dakota	5,670	5,650	5,538	5,568	5,598	-0.03	
Ohio	5,080	4,900	4,871	4,880	4,889	-0.01	
South_Dakota	5,070	5,300	5,211	5,232	5,253	-0.01	
Tennessee	1,620	1,600	1,550	1,557	1,563	0.16	
Wisconsin	2,150	2,100	2,061	2,070	2,079	-0.04	
sum	—	82,660	79,520	78,051	78,411	78,770	—

Total Soybean Production by State - 8/13/23

1,000,000 bushels

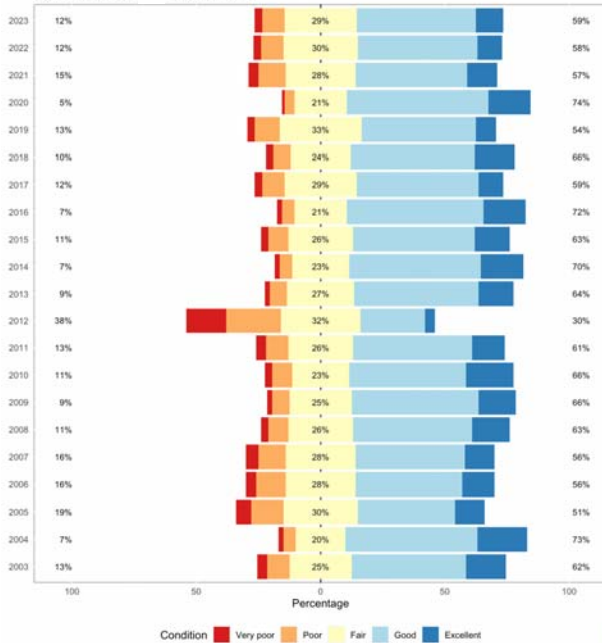
State	Last year	2023 prediction		
		Lower CI	Predicted	Upper CI
Arkansas	164	155	160	165
Illinois	677	596	611	626
Indiana	335	314	321	328
Iowa	587	535	553	570
Kansas	132	144	154	164
Kentucky	99	99	103	106
Louisiana	57	51	54	58
Michigan	105	94	97	101
Minnesota	370	336	350	364
Mississippi	124	127	130	133
Missouri	276	244	253	263
Nebraska	278	317	324	331
North_Carolina	65	60	62	64
North_Dakota	198	173	186	199
Ohio	282	274	282	289
South_Dakota	193	224	233	241
Tennessee	78	79	82	85
Wisconsin	116	92	99	105
sum	—	4,136	4,053	4,192

Total Soybean Production

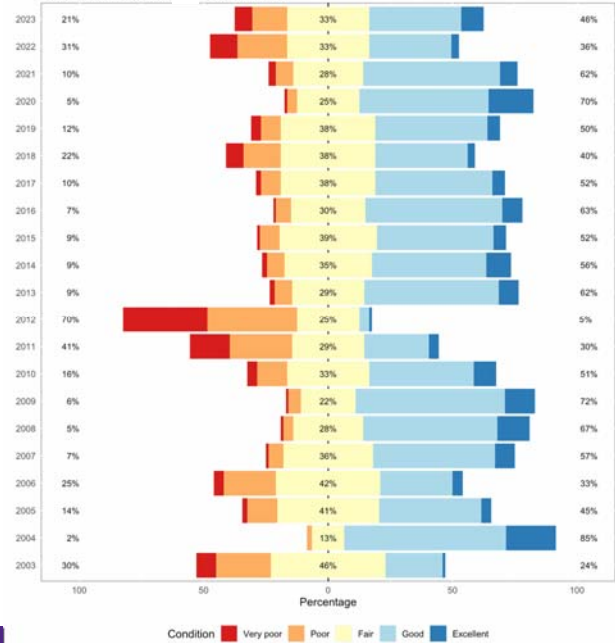
Estimate from 18 leading soybean states

Based on planted acres

Condition of US SB as of 8/13/23



Condition of Kansas SB as of 8/13/23



Thank you!

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