



A Kriging Approach for Representing Crop Progress and Condition at Small Domains

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Disclaimer

The Findings and Conclusions in This Preliminary Presentation Have Not Been Formally Disseminated by the U. S. Department of Agriculture and Should Not Be Construed to Represent Any Agency Determination or Policy





Outline

- Overview of NASS Crop Progress and Condition
- Description of issues faced by users
- Introduction of new small domain product
- Data access details





NASS Crop Progress and Condition Survey

Crop Progress and Conditions



The Crop Progress and Conditions survey provides frequent and timely updates on harvesting, progress of crops through various phenological stages of development during the growing season.

All states participate in the survey. Each state maintains a list of reporters, largely Agency staff, who report progress and conditions of selected crops in their area. Every state has at least one reporter. Reports returned each week account for all major agricultural commodities.

Respond Online
Click here to [complete your survey online](#). Remember, you will need to have Java installed on your computer to respond online.

Get the Data **Charts and Maps** **About the Survey**

Get the data from the results of this survey.

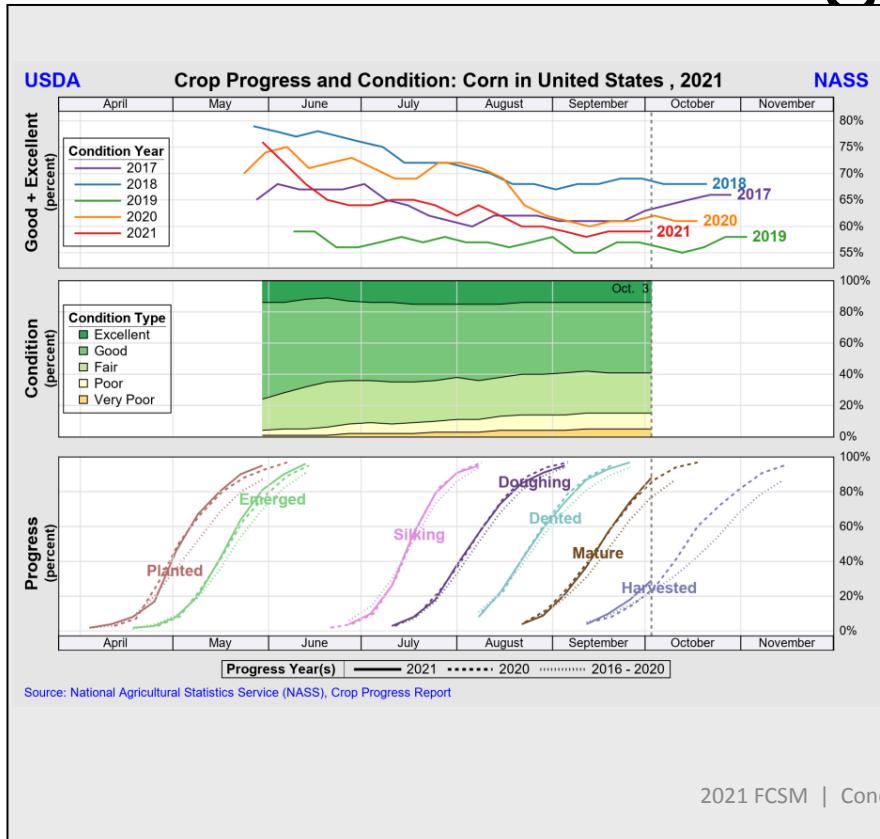
Publications:
The [Crop Progress](#) report is released at 4:00 PM on the first business day of each week. This issue has crop progress tables for major crops and may have as many as 17 issues per year. Each progress table lists the current week, previous week, previous month, and the U.S. The condition tables list the percent rated very poor, poor, fair, good, and excellent for each crop in each county and the U.S. Printed copies of the report are distributed to representatives of the

- The USDA National Agricultural Statistics Service (NASS) provides crop progress and condition estimates for selected crops on a weekly basis during crop specific growing seasons
- Crop progress and condition estimates are obtained from data provided by the **non-probability** crop progress and condition survey of crop experts (not farmers)
- Approximately 3600 experts participate in the survey annually, representing the 3108 agricultural counties in the lower 48 United States





NASS Crop Progress and Condition Survey



- Based on standard definitions, the expert respondents subjectively estimate:
 - **Progress** of crops through various stages of observed development as well as by producer activities
 - **Condition** of crops through visual evaluation and interaction with crop producers.
- Weekly reports are reviewed for reasonableness and consistency, and data is **aggregated to state and national levels** using weights derived from historical NASS acreage estimates





Current Data Format

Crop Condition:

- Condition for any given crop is reported as a breakdown of:
 - **Very Poor**
 - **Poor**
 - **Fair**
 - **Good**
 - **Excellent**
- Condition for a crop is expressed in terms of percentages within each category, always adding up to 100%
- **Ranges from 100% very poor to 100% excellent**

Iowa

Crop Condition as of September 29, 2019

Item	Very poor (percent)	Poor (percent)	Fair (percent)	Good (percent)	Excellent (percent)
Corn	2	7	26	54	11
Soybeans	2	7	28	52	11
Pasture and range	4	11	40	38	7





Current Data Format

Crop Progress:

- Progress also uses a percentage-in-category system like crop condition, but the categories vary by crop. The corn crop within a county can be some percent of each category, **ranging from 0% planted to 100% harvested:**

Corn Progress Categories

- Planted
- Emerged
- Silked
- Doughed
- Dented
- Matured
- Harvested

Iowa

Item	Districts									State			
	NW	NC	NE	WC	C	EC	SW	SC	SE	This week	Last week	Last year	5-yr average
Corn dented	(percent)												
Corn mature	88	93	95	85	93	95	90	85	81	90	82	99	98
Corn mature	30	16	42	34	58	27	36	43	42	36	18	86	74
Hay, alfalfa, third cutting.....	97	97	96	96	99	92	90	76	83	89	87	98	96
Soybeans coloring.....	80	98	94	83	94	78	72	62	66	83	65	96	95
Soybeans dropping leaves.....	44	72	63	53	64	41	31	25	30	49	22	86	77





Current Data Format: Issues

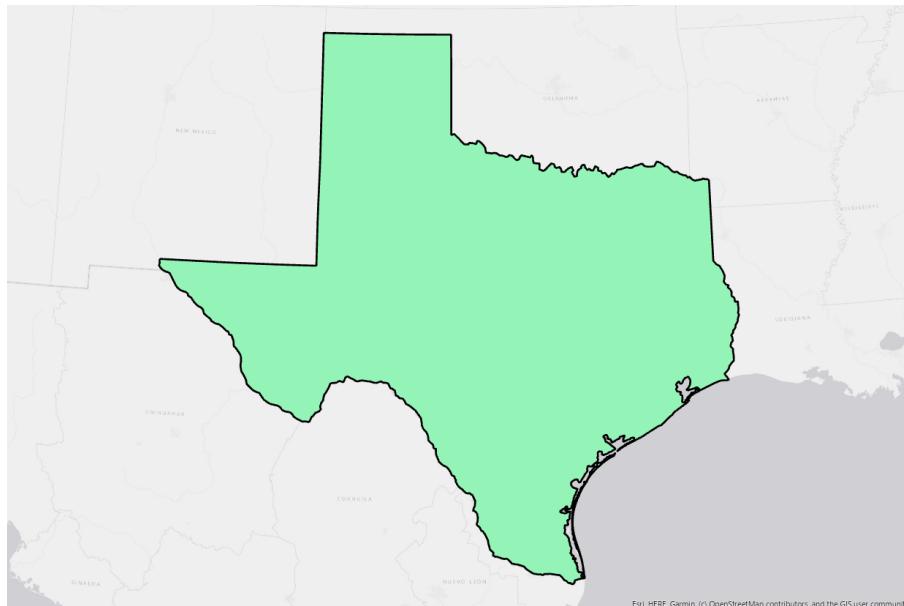
Progress and Condition is **aggregated at the state and national levels for public use**. This is done to protect the confidentiality of producers, and to enhance stability of estimates. However, this presents issues for data users:

- State summaries do not represent within-state trends and variability
- There is no indication which counties or regions within the state actually contribute to reports

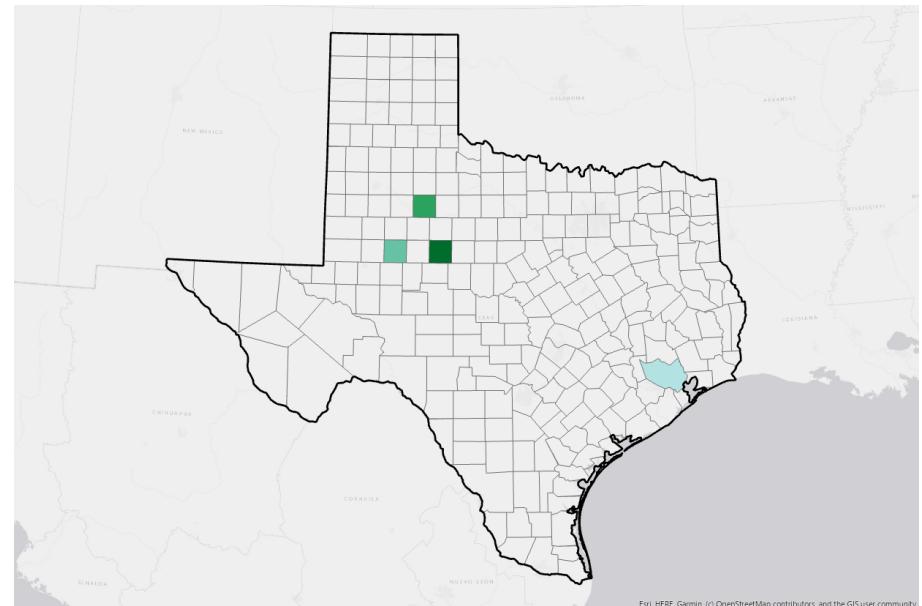


Exaggerated Example

One estimate for the state...



...from sparse and geographically biased inputs





New Product for Smaller Domains

The new **Crop Progress and Condition Gridded Layers** addresses these issues by representing trends in condition and progress of major commodity crops throughout the growing season, while obscuring the actual county-level data.

This is achieved in two main steps:

1. Represent county progress and condition as simplified numeric indices or percentages based on the original percent-in-category data.
2. Interpolate these values across the lower 48 states as a continuous raster surface, independent of county boundaries.





Step 1: Reduce Original Data Into Numeric Indices





Condition Index

- Crop Condition Index combines all categorical condition percentages into single number:

Corn Condition Index =

$$\text{Corn Condition Index} = (5*\text{excellent} + 4*\text{good} + 3*\text{fair} + 2*\text{poor} + \text{very poor})/100$$

- Values **range from 1 to 5**, where 1 is 100% “Very Poor”, and 5 is 100% “Excellent”





Condition Index

County	Excellent	Good	Fair	Poor	Very Poor	Con. Index
05029	100%	0%	0%	0%	0%	5
05031	80%	20%	0%	0%	0%	4.8
05033	25%	20%	50%	5%	0%	3.65
05035	0%	50%	50%	0%	0%	3.5
05037	20%	20%	30%	20%	10%	3.2
05039	0%	60%	25%	15%	0%	3.45
05041	20%	75%	5%	0%	0%	4.15
05043	40%	50%	10%	0%	0%	4.3
05045	10%	40%	50%	0%	0%	3.6
05047	30%	32%	17%	21%	0%	3.71
05049	28%	41%	20%	10%	1%	3.85
05051	36%	36%	28%	0%	0%	4.08
05053	36%	36%	28%	0%	0%	4.08
05055	30%	50%	20%	0%	0%	4.1
05057	10%	10%	40%	30%	10%	2.8
05059	36%	36%	28%	0%	0%	4.08
05061	10%	10%	40%	30%	10%	2.8
05063	44%	39%	16%	1%	0%	4.26
05065	28%	41%	20%	10%	1%	3.85
05067	0%	75%	25%	0%	0%	3.75
05069	10%	50%	30%	10%	0%	3.6
05071	0%	0%	0%	100%	0%	2

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Progress Index

- Proposed crop progress index combines all categorical progress percentages into a single number. This would be based on different categories depending on the crop.

Winter Wheat Progress Index =

Wheat Progress Index = (harvested + heading + emerging + planting)/400

- Values **range from 0 to 1**, where 0 represents 0% planted and 1 represents 100% harvested





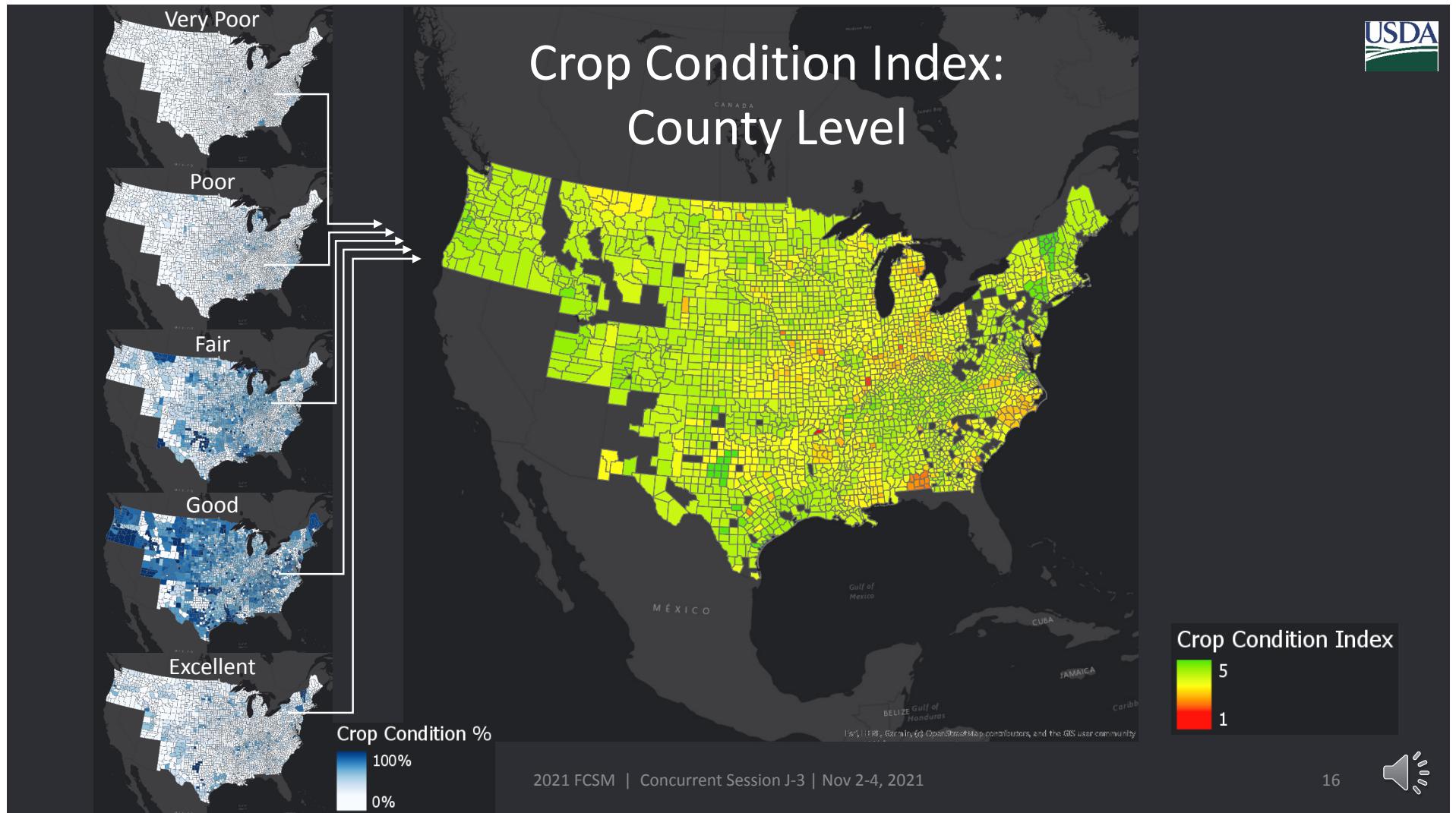
Progress Index

Counties		Growing Season																								
28001	0.00	0.08	0.12	0.13	0.20	0.25	0.26	0.27	0.27	0.27	0.37	0.40	0.40	0.41	0.45	0.57	0.63	0.67	0.73	0.81	0.85	0.92	0.94	0.96	0.98	0.99
28003	0.00	0.01	0.01	0.02	0.06	0.08	0.20	0.21	0.26	0.29	0.29	0.40	0.40	0.41	0.44	0.68	0.71	0.73	0.77	0.81	0.82	0.85	0.89	0.94	0.99	1.00
28005	0.00	0.08	0.12	0.13	0.20	0.25	0.26	0.27	0.27	0.27	0.37	0.40	0.40	0.41	0.45	0.57	0.63	0.67	0.73	0.81	0.85	0.92	0.94	0.96	0.98	0.99
28007	0.02	0.05	0.09	0.11	0.11	0.14	0.14	0.14	0.29	0.29	0.29	0.32	0.34	0.39	0.41	0.50	0.55	0.60	0.66	0.72	0.74	0.84	0.91	0.93	0.98	1.00
28009	0.01	0.01	0.02	0.05	0.11	0.21	0.29	0.29	0.29	0.29	0.30	0.34	0.38	0.46	0.71	0.79	0.86	0.86	0.88	0.93	0.97	1.00	1.00	1.00	1.00	1.00
28011	0.04	0.05	0.06	0.07	0.15	0.24	0.26	0.26	0.28	0.28	0.29	0.34	0.36	0.43	0.59	0.73	0.80	0.86	0.88	0.90	0.92	0.99	1.00	1.00	1.00	1.00
28013	0.01	0.04	0.09	0.13	0.15	0.18	0.24	0.26	0.28	0.29	0.29	0.34	0.37	0.39	0.58	0.62	0.66	0.78	0.82	0.86	0.94	0.98	0.99	1.00	1.00	1.00
28015	0.02	0.02	0.02	0.05	0.05	0.09	0.10	0.17	0.27	0.27	0.29	0.34	0.36	0.42	0.43	0.53	0.75	0.81	0.87	0.88	0.89	0.93	1.00	1.00	1.00	1.00
28017	0.10	0.15	0.26	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.31	0.32	0.38	0.40	0.52	0.62	0.69	0.71	0.74	0.77	0.84	0.90	0.92	0.96	0.96	0.96
28019	0.02	0.05	0.09	0.10	0.10	0.10	0.12	0.12	0.29	0.29	0.29	0.32	0.32	0.37	0.43	0.66	0.69	0.69	0.71	0.74	0.76	0.81	0.86	0.88	0.98	0.99
28021	0.00	0.08	0.12	0.13	0.20	0.25	0.26	0.27	0.27	0.27	0.37	0.40	0.40	0.41	0.45	0.57	0.63	0.67	0.73	0.81	0.85	0.92	0.94	0.96	0.98	0.99
28023	0.07	0.11	0.11	0.14	0.16	0.19	0.19	0.20	0.20	0.20	0.27	0.28	0.33	0.39	0.41	0.69	0.71	0.77	0.82	0.92	0.94	0.96	0.98	0.99	1.00	1.00
28025	0.10	0.10	0.11	0.16	0.16	0.26	0.27	0.27	0.28	0.29	0.31	0.33	0.33	0.38	0.43	0.59	0.68	0.74	0.81	0.83	0.90	0.95	0.99	1.00	1.00	1.00
28027	0.02	0.04	0.04	0.06	0.18	0.27	0.29	0.29	0.29	0.29	0.30	0.33	0.39	0.41	0.63	0.74	0.80	0.82	0.87	0.93	0.98	0.98	0.99	1.00	1.00	1.00
28029	0.09	0.09	0.14	0.20	0.26	0.27	0.29	0.29	0.29	0.29	0.37	0.37	0.40	0.49	0.66	0.71	0.76	0.82	0.88	0.91	0.99	1.00	1.00	1.00	1.00	1.00
28031	0.01	0.03	0.05	0.09	0.14	0.17	0.21	0.21	0.31	0.32	0.33	0.38	0.52	0.54	0.59	0.66	0.75	0.84	0.85	0.85	0.92	0.94	0.98	0.98	0.98	0.99
28033	0.01	0.07	0.16	0.19	0.24	0.26	0.28	0.29	0.29	0.31	0.33	0.37	0.39	0.61	0.64	0.71	0.76	0.81	0.86	0.89	0.97	0.99	1.00	1.00	1.00	1.00
28035	0.06	0.10	0.12	0.18	0.18	0.18	0.18	0.18	0.19	0.26	0.28	0.32	0.40	0.47	0.49	0.73	0.76	0.84	0.90	0.96	0.98	0.99	1.00	1.00	1.00	1.00
28037	0.05	0.09	0.16	0.17	0.26	0.27	0.29	0.29	0.29	0.37	0.40	0.43	0.49	0.57	0.74	0.86	0.86	0.91	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00
28039	0.07	0.11	0.14	0.20	0.25	0.27	0.29	0.29	0.31	0.36	0.40	0.47	0.51	0.54	0.77	0.80	0.84	0.89	0.93	0.94	0.99	1.00	1.00	1.00	1.00	1.00
28041	0.11	0.15	0.17	0.22	0.22	0.22	0.23	0.23	0.30	0.32	0.32	0.40	0.47	0.49	0.73	0.76	0.84	0.90	0.96	0.98	0.99	1.00	1.00	1.00	1.00	1.00
28043	0.03	0.04	0.05	0.06	0.08	0.09	0.09	0.09	0.10	0.11	0.11	0.22	0.22	0.33	0.39	0.63	0.69	0.73	0.80	0.85	0.86	0.91	0.95	0.99	1.00	1.00
28045	0.11	0.15	0.17	0.22	0.24	0.24	0.25	0.25	0.31	0.41	0.43	0.50	0.51	0.54	0.63	0.65	0.68	0.73	0.80	0.81	0.83	0.83	0.88	0.92	0.93	0.93
28047	0.11	0.15	0.17	0.22	0.24	0.24	0.24	0.25	0.25	0.31	0.38	0.40	0.48	0.51	0.51	0.81	0.82	0.89	0.92	0.96	0.98	0.99	1.00	1.00	1.00	1.00
28049	0.00	0.06	0.09	0.10	0.14	0.22	0.23	0.25	0.26	0.26	0.35	0.37	0.37	0.39	0.44	0.63	0.66	0.70	0.78	0.86	0.96	0.99	1.00	1.00	1.00	1.00
28051	0.02	0.03	0.08	0.10	0.10	0.13	0.13	0.24	0.27	0.27	0.32	0.34	0.39	0.41	0.51	0.57	0.58	0.70	0.81	0.88	0.96	0.99	1.00	1.00	1.00	1.00
28053	0.11	0.14	0.20	0.20	0.21	0.26	0.27	0.28	0.29	0.29	0.32	0.36	0.41	0.45	0.47	0.70	0.75	0.78	0.85	0.91	0.96	0.98	0.99	1.00	1.00	1.00
28055	0.12	0.16	0.23	0.23	0.23	0.26	0.26	0.28	0.29	0.31	0.36	0.39	0.41	0.41	0.60	0.84	0.87	0.93	0.96	0.99	0.99	1.00	1.00	1.00	1.00	1.00
28057	0.00	0.00	0.00	0.00	0.01	0.01	0.07	0.07	0.12	0.21	0.27	0.30	0.31	0.34	0.64	0.65	0.67	0.70	0.74	0.80	0.86	0.92	0.96	1.00	1.00	1.00
28059	0.11	0.15	0.17	0.22	0.24	0.24	0.25	0.25	0.31	0.33	0.37	0.46	0.51	0.51	0.73	0.76	0.84	0.90	0.96	0.98	0.99	1.00	1.00	1.00	1.00	1.00



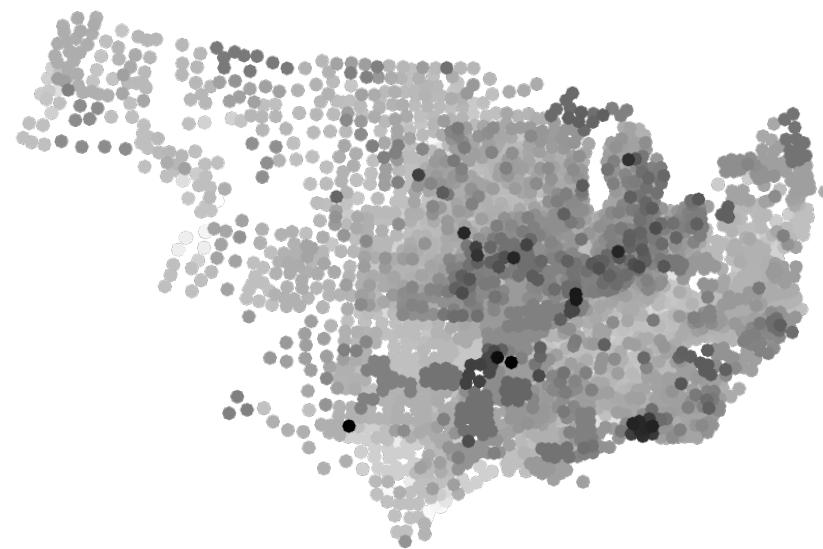


Crop Condition Index: County Level





Step 2: Interpolating County-Level Numeric Data



Corn Progress, Week 27, 2019
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Geostatistical Approach

Kriging Model

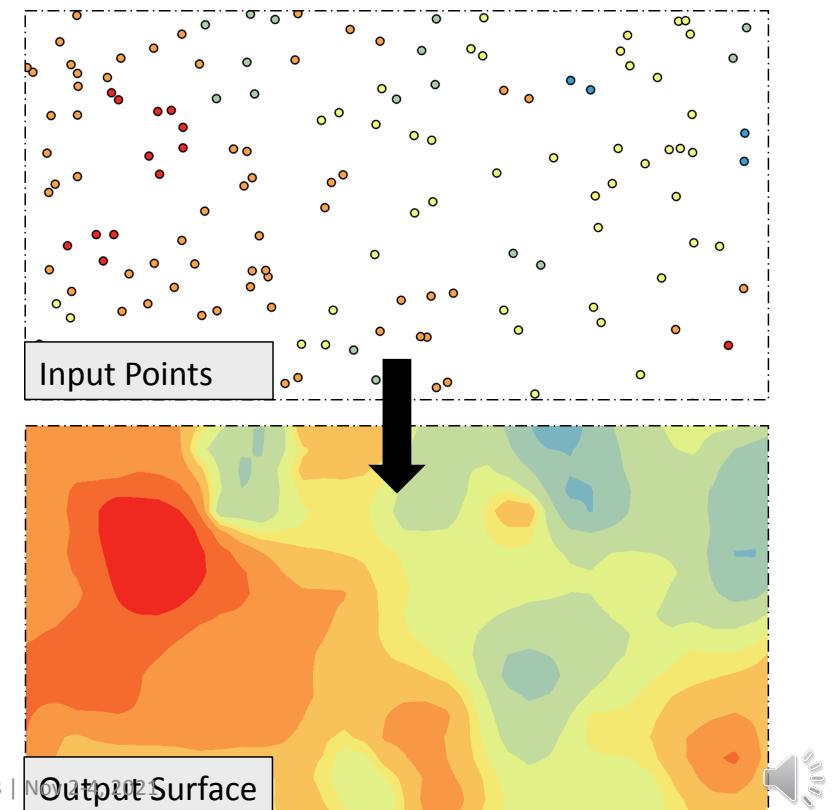
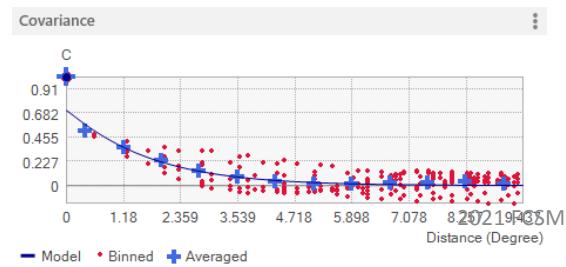
General formula for prediction surface is:

$$\hat{Z}(s_0) = \sum_{i=1}^N \lambda_i Z(s_i)$$

Where:

- $Z(s_i)$ = the measured value at the i th location
- λ_i = model weight for the measured value at the i th location
- s_0 = the prediction location
- N = the number of measured values

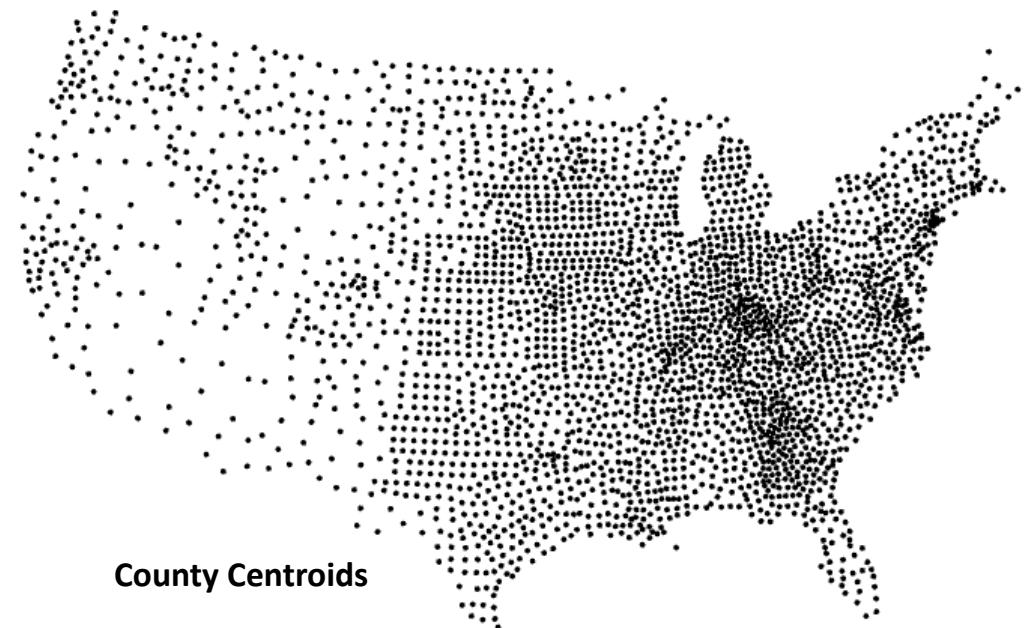
A covariance model is used to derive final model weights



Geostatistical Approach

Kriging Input

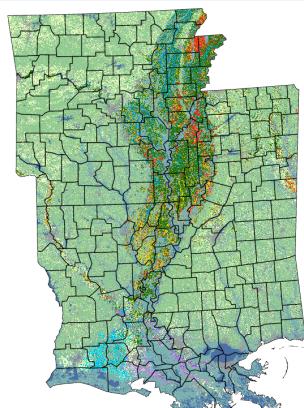
- Need a set of input points to run kriging algorithm
- Could use county centroids, but they do not represent crop acreage or location across the US
- Therefore, an input point schema representing crop acreage was devised





Derive Crop Area/Location Based Sampled Points

Determine known areas from Cropland Data Layer (CDL)

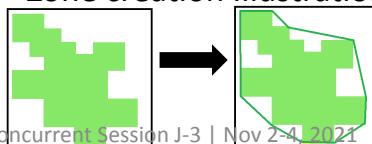


Agriculture	
Pasture/Grass	Oats
Corn	Durum Wheat
Soybeans	Sunflower
Winter Wheat	Canola
Fallow/Wild Cropland	Peas
Other Hay/Non Alfalfa	Peanuts
Alfalfa	Almonds
Spring Wheat	Other Crops
Cotton	Grapes
Sorghum	Sugarbeets
Dbl Crop Win/Wht/Soybeans	Sugarcane
Barley	Sod/Grass Seed
Rice	Sugarcane
Dry Beans	

Create “zones” of crop area within counties, based on CDL information



Zone creation Illustration



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Create sample of random lat/long points within each county zone, proportional to planted acres



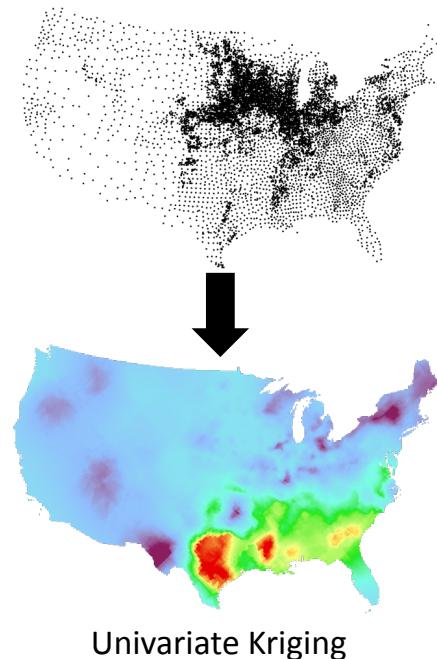
Density and location of points corresponds with cropland of interest

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Kriging Input Point Schema

Acreage/Location Based Points
Merged with County Centers



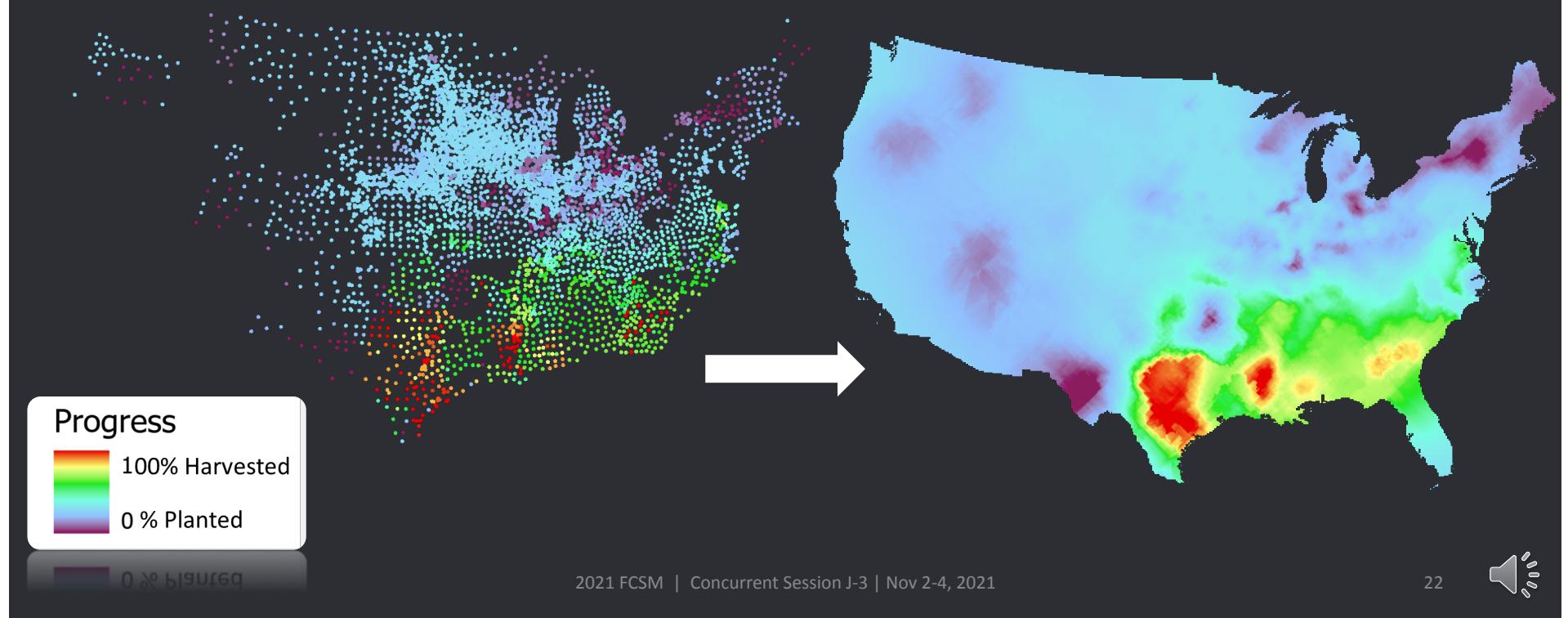
- Using this point dataset as input for kriging allows us to:
 - Weigh the county contribution by planted acres
 - Use points which represent the probable location of planted crops
 - Perform univariate kriging, where all input points are based on the original reported data





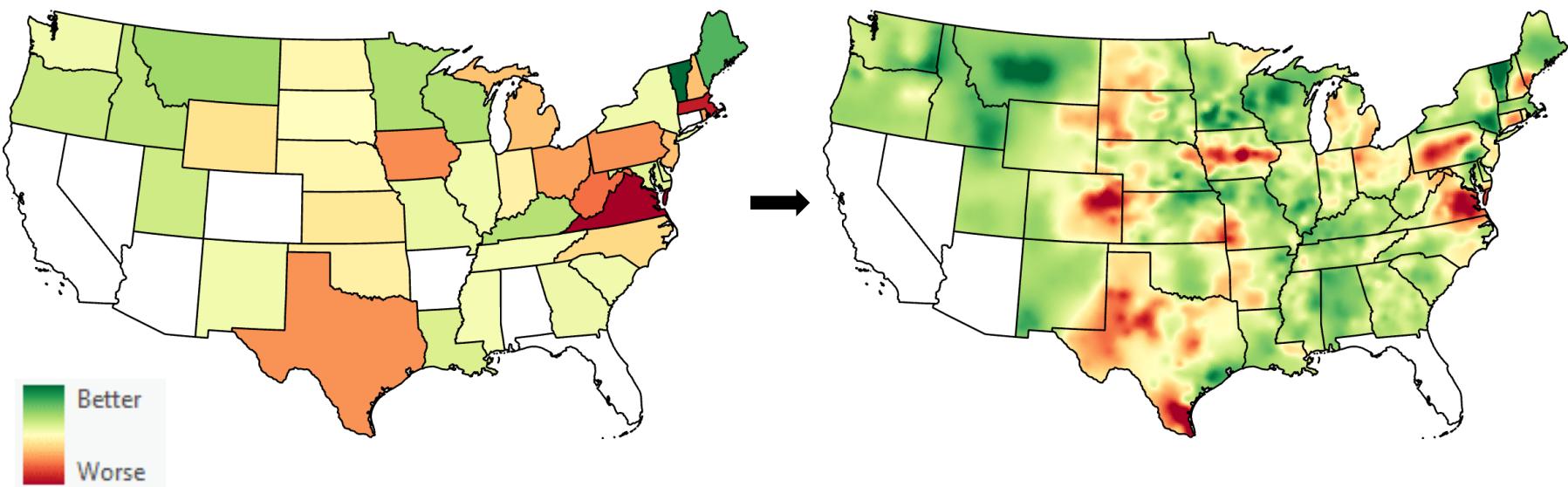
Kriged Surface

US corn progress, week 27 of 2019



Resolution of New Data

US corn condition, week 34 of 2020





Data Availability

- Raster datasets representing both progress and condition for each:
 - Corn
 - Soy
 - Winter Wheat
 - Cotton (2022)
- Data format is **9km raster geoTIFF files** covering the contiguous United States
- Each new dataset is released within a day of NASS progress and condition data becoming available
- Data archive to be created for Crop Progress and Condition data, 2015-Present





Data Availability

[https://www.nass.usda.gov/Research and Science/Crop Progress Gridded Layers/index.php](https://www.nass.usda.gov/Research_and_Science/Crop_Progress_Grided_Layers/index.php)

The screenshot shows the official website of the United States Department of Agriculture's National Agricultural Statistics Service (NASS). The header includes the USDA logo, the NASS logo, and links for Data & Statistics, Publications, Newsroom, Surveys, Census, About NASS, Contact Us, and Help. Social media icons for Twitter, YouTube, RSS, Flickr, and Facebook are also present. A search bar is at the top right. The main content area shows the user is on the 'Crop Progress and Condition Gridded Layers' page under the 'Research and Science' category. The page describes the datasets as synthetic representations of county-level data for corn, soybeans, cotton, and wheat, spanning from 2015 to present. It includes a 'NOTES' section with a bulleted list of updates and download links for various years from 2015 to 2021. The footer indicates the page is from the 2021 FCSM concurrent session.

You are here: Home / Research and Science / Crop Progress Gridded Layers

Statistics by State

Related Topics

- Research Fellow and Associate Program
- Seasonal Summary of Crop Progress and Condition

Geospatial Data

- CropScape
- Cropland Data Layer
- VegScape
- Crop-CASMA
- Crop Progress & Condition Gridded Layers
- Disaster Analysis
- Land Use Strata for Selected States

Research and Science

Crop Progress and Condition Gridded Layers

The Crop Progress and Condition Layers are gridded geospatial datasets which are fully synthetic representations of confidential, county level data. These new data are available for U.S. corn and soybeans, and eventually cotton and wheat. The current archive of these datasets span growing-season weeks for all years from 2015 to present. This [Crop Progress and Condition](#) document serves as an introduction of these data and is intended to give a useful overview of their origins, as well as their characteristics and limitations. The metadata for this dataset is posted below.

NOTES:

- 2021 soybean extents updated on 9/8/2021.
- All historic year datasets updated on 4/7/2021.
- Read the [documentation](#) carefully before use.

- Download the Crop Progress and Condition [2021 dataset](#)
- Download the Crop Progress and Condition [2020 dataset](#)
- Download the Crop Progress and Condition [2019 dataset](#)
- Download the Crop Progress and Condition [2018 dataset](#)
- Download the Crop Progress and Condition [2017 dataset](#)
- Download the Crop Progress and Condition [2016 dataset](#)
- Download the Crop Progress and Condition [2015 dataset](#)

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Thank You

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[https://www.nass.usda.gov/Research and Science/Crop Progress Gridded Layers/index.php](https://www.nass.usda.gov/Research_and_Science/Crop_Progress_Grided_Layers/index.php)

