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In-Season Corn and Soybean Forecast of Soil Water-Nitrogen and Yields for Central and Northwest Iowa: A Pilot Project

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Abstract
A team of Iowa State University Department of Agronomy faculty and staff specialists in crops, soils and climate have begun an innovative pilot project to provide an in-season crop and soil water-nitrogen status and an end-of-season yield forecast. The approach combines use of the Agricultural Production Systems sIMulator (APSIM) cropping systems model, the Weather Research and Forecast Model (WRF), and parallel in-field data collection to verify model predictions.

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In-Season Corn and Soybean Forecast of Soil Water-Nitrogen and Yields for Central and Northwest Iowa: A Pilot Project

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A team of Iowa State University Department of Agronomy faculty and staff specialists in crops, soils and climate have begun an innovative pilot project to provide an in-season crop and soil water-nitrogen status and an end-of-season yield forecast. The approach combines use of the Agricultural Production Systems slMulator (APSIM) cropping systems model, the Weather Research and Forecast Model (WRF), and parallel in-field data collection to verify model predictions.

This pilot project focuses on two locations, two crops, and two planting dates (Table 1). In-field data collection is generated from replicated experimental plots at ISU Research Farms near Ames (central Iowa) and Sutherland (northwest Iowa) and are managed following standard practices for these regions to represent reality better. Data collection includes sensors for data logging of soil water, soil temperature, and groundwater; soil sampling for nitrate- and ammonium-nitrogen; plant sampling for leaf area index, biomass accumulation, nitrogen uptake; and crop staging. All the information on soil, crop, climate, and management is integrated into APSIM to perform the systems analysis and generate a forecast.

Information to date shows that corn and soybean growth is slightly below normal due to cooler conditions and that there were 21 rain events over the last 45 days (May 1 to June 15) at both locations. The frequent rain events have kept soil moisture at near-field capacity which is ideal for plant growth but, at the same time, the cloud cover reduced solar radiation needed for photosynthesis and lowered air temperatures as compared to historical years. The reduced temperatures have impacted soybean more than corn.

The soils have adequate water and nitrogen (nitrate- and ammonium-nitrogen) to sustain high crop growth over the forecasted period (Tables 2 and 3). In a scenario analysis for early planted corn in Ames, we found that an additional application of nitrogen has less than a 20% chance of increasing yield enough to pay for the additional nitrogen. Everything depends on how crop growth continues through the summer.

From current weather, crop and soil information, crop yields will be close to normal yields levels except for early planted soybean yields at the Sutherland location (Table 4). At Sutherland, air temperatures reached near-frost levels twice in May. Early planted crops lost growth and yield potential but there is still potential for high yields if weather conditions become more favorable. The simulated forecasts have high uncertainty early in the growing season and this is evident in the large differences between the 10% and 90% probabilities. The uncertainty in yield prediction will get lower as the growing season progresses.

These are the first results from the pilot project and should be interpreted as such. Cropping system forecasts are highly dependent on weather forecasts. Simulations and predictions will be updated frequently as new information on climate, soil, and crop information becomes available for model analysis. The forecast provided by this pilot project is valid at the time the forecast was completed (June 15, 2015). Additional forecasts will be made throughout the growing season to update the information provided in this ICM Newsletter article.

Table 1. Information on the eight cropping systems used in the pilot project.

Cropping system	Location	Crop	Planting date (E or L)	Maturity[1]	Nitrogen rate (lbs N/ac)	Seeding rate (seeds/ac)
ACE	Ames	Corn	April 23 (E)	108 RM	150	32,000
ACL	Ames	Corn	May 21 (L)	108 RM	150	32,000
SCE	Sutherland	Corn	April 30 (E)	104 RM	200	32,000
SCL	Sutherland	Corn	May 19 (L)	104 RM	200	32,000
ASE	Ames	Soybean	May 1 (E)	2.6 MG	0	140,000
ASL	Ames	Soybean	June 1 (L)	2.6 MG	0	140,000
SSE	Sutherland	Soybean	May 1 (E)	2.2 MG	0	140,000
SSL	Sutherland	Soybean	June 1 (L)	2.2 MG	0	178,000

[1] RM, corn hybrid relative maturity; MG, soybean cultivar maturity group

Table 2. Current status of crop stage, soil water and soil nitrogen as of the June 15, 2015 forecast date.

Location/ cropping system	Crop Stage[1]	Available water in soil profile	Plant available water to roots	Available N in soil profile[2]	Plant available N to roots
		inches	inches	lbs N/acre	lbs N/acre
ACE	V8	14.5	6.7	199	181
ACL	V4	14.6	2.9	234	143
SCE	V6	15.0	7.1	330	301
SCL	V3	15.3	3.9	339	245
ASE	V4	14.6	8.7	59	56
ASL	V2	14.9	3.5	63	30
SSE	V3	15.0	9.3	166	160
SSL	VC	13.9	1.8	183	71

[1] crop staging is using standard vegetative (V) stages found in the Soybean Field Guide and Corn Field Guide available through the ISU Extension and Outreach Store
[2] plant available nitrogen consists of the inorganic nitrogen (nitrate-nitrogen and ammonium-nitrogen) in the soil

Table 3. Predicted cumulative rainfall, water and nitrogen use, nitrogen mineralization and crop growth from June 15, 2015 to June 25, 2015 based on the forecasted weather.

Location / cropping system	Forecasted cumulative rainfall	Cumulative soil water evaporation	Cumulative crop water use	Cumulative crop N use	Cumulative net soil N mineralization	Average crop growth rate[1]
	inches	inches	inches	lbs N/acre	lbs N/acre	lb DM/ac/d
ACE	1.74	0.56	0.68	35.7	9.3	106
ACL	1.74	1.23	0.15	9.2	10.4	31
SCE	1.13	0.95	0.57	34.1	9.6	86
SCL	1.13	1.23	0.15	13.2	8.2	31
ASE	1.74	0.80	0.28	10.9	6.2	27
ASL	1.74	1.18	0.07	2.1	6.8	33
SSE	1.13	1.33	0.09	3.4	8.5	56
SSL	1.13	1.65	0.07	2.3	10.1	29

[1] DM, above ground dry matter (lb DM/ac/d, pounds of above ground dry matter per acre per day)

Table 4. End-of season yield forecast using current crop management practices, current weather to June 15, 2015; forecasted weather to June 25, 2015; and historical weather (1980 to 2014) thereafter. Forecasted yields are attainable yields predicted by APSIM that account for water and nitrogen limitations to crop growth but do not account for pest limitations.

Location / cropping system	90% probability to exceed	50% probability to exceed	10% probability to exceed	Relative yield change to historical climate[1]
	bu/ac	bu/ac	bu/ac	%
ACE	131	235	250	2.9
ACL	108	205	248	2.2
SCE	166	219	249	1.5
SCL	187	212	243	-0.9
ASE	51	60	72	-3.0
ASL	47	60	67	-0.1
SSE	43	54	59	-15.8
SSL	44	59	67	-4.6

[1] Relative yield change is calculated as the ratio of the average yield simulated for 2015 and the average site yield. The average site yield is determined from APSIM using the 2015 management, soil and crop information and the 1980 to 2014 historical weather data.

Click on each table to enlarge. The Soybean Field Guide and Corn Field Guide are available through the ISU Extension and Outreach Store.

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