

The ISU Coles Memorial Farm: Nutrient Management and Research

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Background. The Coles Memorial Farm was given to Iowa State University College of Agriculture in 1974. The farm consists of about 285 acres in Williams Township, Hamilton County, one-half mile east of Williams, Iowa.

Proceeds from the farm operations have funded a variety of research priorities including assistantship stipends and research equipment, plus research station facilities and improvements.

Soils. The Coles Farm has typical-to-wet soils for the Clarion-Nicollet-Webster soils association. The overall CSR is 85.70. The farm has 41 percent Canisteo soils, 31 percent Clarion soils, 12 percent Nicollet soils, 8 percent Webster soils, 6 percent Harps soils, < 2 percent Okoboji soils, and < 2 percent Knoke soils. Most of these soils are poorly drained, heavy, wet soils that benefit from field tile drainage.

Nutrient management. From 1974 through 2015, the farm generally was in a corn-soybean rotation with conventional tillage. In order to demonstrate strategic nutrient management strategies, the ISU Coles Farm operation was shifted to a custom farming arrangement with several new practices. A corn-soybean rotation was continued.

The overall goal is to employ practices of the latest known science and GPS technologies to reduce nutrient losses from the Coles Farm

and to demonstrate these techniques to the agriculture of the area. It is expected the practices will have no or little impact on the farm's grain yield.

Advanced research flux towers. In 2016, advanced research was added to the Coles Farm. This advanced research included USDA and ISU instrument towers. The USDA National Laboratory for the Environment (NLAE), Ames, Iowa, installed two energy balance and flux towers at the Coles Farm.

According to Jerry Hatfield, affiliate professor, NLAE, flux towers were installed to collect a series of detailed measurements on the carbon, water, and energy balance over corn and soybean crops prior to change in the management systems. In fall 2016, a series of soil cores were collected at 150-ft grid points to a depth of 4 ft. These were used to characterize the field and evaluated at 6-in. depth increments to determine the vertical and horizontal changes across the field. After management changes were in place for the 2017 growing season, the soil was sampled at these same grid points to a depth of 12 in. to determine if there were changes in the carbon content and the aggregate structure after one year. The intent is to sample at these grid intervals each year for the first five years to evaluate the changes induced by management, and to compare with the conventional system on the carbon and water balance.

In 2017, an additional set of instruments was added in each field to record the depth of the water table. This was to address questions about how water table depth affected water use and productivity of corn and soybean crops. In a cooperative study with NASA-Jet Propulsion Laboratory, UCLA, and CalTech,

a solar-induced fluorescence instrument was placed in the cornfield to record the fluorescence of the corn crop throughout the day and over the growing season. These data are related to the changes in the carbon dioxide uptake and water use by the crop during the growing season. An overflight was conducted in August in a period of low rainfall to determine the spatial pattern of crop stress across the field. Flights were made on five consecutive days during this period. This instrument will be redeployed in this field during 2018. These measurements are related to the carbon dioxide values obtained from the OCO-2 satellite data obtained during the growing season. Throughout the growing season, reflectance measurements were collected to quantify these changes relative to growth, and to link with Landsat and MODIS data to extend these results from an individual field to a larger area of the Midwest.

All of these data are being analyzed and compiled into a database for this field. Some of the preliminary results assembled include: 1) the introduction of the cover crop into the corn and soybean crops coupled with no-till has altered the carbon balance of the overall system with a more positive carbon balance compared with conventional tillage systems; 2) the use of cover crops has affected the upper layer of the soil with a change in soil aggregates even after the first year; 3) solar-induced fluorescence is a predictor of crop stress and an earlier predictor than canopy temperature; and 4) spatial analysis of the gridded soil samples showed a legacy effect of management practices placed in the fields from 50 years ago. These results have begun to show the richness of the data collected in this field and compare with other field-scale observations in the Des Moines lobe area.

Advanced research – cosmic-ray neutron probe. Brian Hornbuckle, ISU associate professor of agronomy, continues to utilize a cosmic-ray neutron probe at the Coles Farm. This instrument detects neutrons liberated from atmospheric gases by cosmic rays originating in outer space, which are constantly bombarding Earth's atmosphere. These free neutrons then rain down on Earth's surface and are absorbed by hydrogen atoms. Because much of this hydrogen is associated with soil water, when the soil is wet, fewer neutrons escape the soil and are detected by a cosmic-ray neutron probe mounted on a pole about 5 ft above the soil surface.

The most unique feature of this new instrument is that it samples a large area, about 80 acres, as compared with existing sensors only providing information at a single point. Hornbuckle's research group is working to determine whether cosmic-ray neutron probes can be used to simultaneously measure both soil water and crop productivity, since crops accumulate hydrogen in carbohydrates making up their stems, leaves, and reproductive organs.

They have been and will continue to take soil and crop measurements throughout the growing season to test their hypothesis.

The new farming practices and advanced research implemented at the ISU Coles Farm will maximize its value to ISU and Iowa agriculture.