MISSISSIPPI'S CENTENNIAL ROTATION – 2004-2018

M. Wayne Ebelhar
Richard E. Turner
Mississippi State University
Stoneville, MS

Abstract

Crop rotations in various forms have been around for centuries. Some of the earliest research at the oldest experiment station in Rothamsted (England), founded in 1843, dealt with cropping systems and green manures for optimizing yields. Some of the earliest research at the Delta Branch Experiment Station (Delta Research and Extension Center) which dates back to 1904 dealt with crop rotations in the Mid-South and Southeast USA. Before the discovery of synthetic nitrogen fertilizer materials, legumes were the primary nitrogen source for crops that followed. Crop rotation was often overlooked and the practice was abandoned in the 1960's to 1990's as mono-crop cotton production became the most economical cropping system. Corn and soybean production was secondary even though soybean production reached 4 million acres in the early 1980's. The current research on crop rotations began in the mid-to-late 1990's. As irrigation expanded and early soybean production systems were developed, soybean became a profitable crop and gained in importance and average yields grew from a meager 10-15 bu/acre to more than 75-80 bu/acre with some field topping 100 bu/acre in some parts of the South. In 1980, there were far less than 100,000 corn acres with grain yields of less than 100 bu/acre. For the last 35+ years, average corn yields have increased at an average of 3 bu/acre/year bringing average yield to nearly 190 bu/acre. State average yields for the last two years were 189 and 188 bu/acre. With these type of advances in yields, crop rotations with grain crops has become an accepted practice and bring profitability to farming operations, especially when grain prices were good. Record corn and soybean prices as well as good yields have resulted in some producers moving completely away from cotton. As the grain price have dropped the interest in returning to cotton has grown among traditional cotton farmers.

Long-term crop rotation research at the Delta Research and Experiment Station (DREC) originated in 2000 with trials on the station at Stoneville and at the satellite farm (TSF) near Tribbett, MS. The initial research project was designed to evaluate a factorial arrangement of potassium (K) rates and nitrogen (N) rates for corn, cotton following corn, and cotton following corn. The DREC location was planted on a Bosket very fine sandy loam (Mollic Hapludalfs) and the TSF study planted on a Forestdale and Dundee silty clay loam (Typic Endoaqualfs). Remote imagery taken in June of 2003 showed a distinct line between the two sections planted to cotton one of which followed corn while the other followed cotton. By season's end, lint yields (averaged across N rates, K rates, and replications) were 230 lb lint/acre higher favoring the cotton following corn. This difference has been termed the rotation effect since all inputs were the same except one followed corn and the other followed cotton. The rotation effect became the focus of the long-term studies at each location. The rotation effect at DREC ranged from -14.9% to +65.4% with an overall average of +17.1% (139 lb lint/acre/year). Negative rotation effects were observed in two of twelve years but could be explained by an examination of rainfall data (amounts and distribution) for the growing season. One of the negative response (-8.1%) was observed in 2004 where rainfall totals surpassed 29.0 inches in April through September with 12.45 inches measured in June alone. Better growing plants following corn can lead to boll rot when plants get too big. Overall lint yields were lower at TSF as expected and the rotation effect was smaller. The response ranged from -5.1 to +50.1 with a 14-year average of 8.9% increase (90.2 lb lint/acre/year). The silty clay loam soils have a higher available water content and can actually hold up better under drought conditions.

During the 100th anniversary of the experiment station in the Mississippi Delta, a major rotation effort originated on the Delta Research and Extension Center in 2004 with the establishment of the Centennial Rotation to commemorate the founding of the experiment station in 1904. The Centennial Rotation was uniquely different from many other long-term systems around the country in that it had every crop in the rotation grown each year and every system was replicated four times. Each system (treatment) was made up of 8-row plots on 40-in centers, 215 ft in length. The area was divided into four subplots and harvested as such. Each crop in each rotation system has been grown each year and all systems are replicated four times. Both cotton and corn have been grown in single-row planting systems with conventional tillage. Soybean production has migrated to twin-row planting as the accepted system in much of the Delta. The center two rows of each 4-row subplot has been harvested with a plot harvested and samples collected for laboratory analysis. Grain yields are adjusted to standard moisture levels (15.5% for corn and 13% for soybean). Nutrient (nitrogen, phosphorus, potassium, and sulfur) update and removal are estimated based on yield with long-term levels being tabulated.

At the time of the initial experiment design, cotton was still king (dominated the landscape) and the only continuous crop grown. The rotations were various combinations of cotton, corn, and soybean with 2-yr, 3-yr, and 4-yr rotations compared to continuous cotton. After twelve years (2015), the 2-yr systems had cycled six time, the 3-yr systems had cycled four time and the 4-yr systems had cycled three times. In the 13th year all systems are back to the beginning. With the design just describe, direct comparisons of cotton following corn can be made with continuous cotton. In the first twelve years (11 years for comparisons), the rotation effect has average 22.0% (222 lb lint/acre/year) with no negative response years. The range of rotation response was +8.8 to 39.5%. In one of the highest cotton yielding season, 2013, continuous cotton yield was 1452 lb/acre which surpassed any other continuous cotton yield. However, in that same year, cotton following corn had lint yields of 1952 lb/acre, an increase of 500 lb/acre. After 15 years, the rotation response for cotton following corn has ranged from 1.0 to 39.4%. The least responsive year was 2017 which saw a relatively high rainfall during much of the growing season. In previous research, there was negative responses in similar years.

A major emphasis in the Centennial Rotation has been the estimation and summation of nutrient (N, P, K, and S) uptake and removal. Including grain crop in a rotation results in greater uptake and greater removal. With soybean, most of the removal comes from symbiotic fixation rather than fertilizer applications. In comparing a corn/soybean rotation (all grain crops) to continuous cotton, after twelve years the grains had removed 225% more N, 151% more P, 78% more K, and 82% more S than the continuous cotton system. In comparing continuous cotton to a cotton/corn rotation, 91% more N, 111% more P, 28% more K and 81% more S was removed with the corn/cotton rotation system. The take home point to be made is that the rotation effects are real and that soil testing to monitor soil nutrient levels are critical for optimizing yields when grains are part of the system. Through the initial 12 years, corn following soybean has surpassed corn following cotton by 12.7 bu/acre providing a 6.5% increase.

As grain prices continue to fall, tough markets make farming and rotations more of a challenge. However, with the rotation effect that have been shown, extra income becomes possible. Rotations' impact on nematodes and other pathogens, weeds and insects can be managed with the rotation. The process still requires sound production practices, soil testing, and wise marketing.