MISSISSIPPI'S CENTENNIAL ROTATION TWELVE YEAR CYCLE COMPLETE

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AFTER YEARS OF BEING PLANTED IN THE SAME CROPS, FIELDS BECOME DEFICIENT IN MANY WAYS. THIS ROTATION STUDY HELPS US LOOK AT CHEMISTRIES FOR DISEASES AND INSECTS, DIFFERENT ROOT STRUCTURE BENEFITS, AND DIFFERENT LEVELS OF NUTRIENT REMOVAL. COLLECTIVELY THAT MEANS PROFIT AND THAT'S WHAT WE TRY TO DELIVER TO THE LOCAL PRODUCERS.

Long-term crop rotation studies can be useful tools in studying the effects of various practices over an extended period of time. Crop rotation has been used in farming systems for hundreds of years with modern rotations (green manures) begun as early as 1730 in England. Benefits from crop rotation can be divided into three major areas. These include: a) maintenance of crop yields; b) control of diseases, insects, weeds, and other pests; and c) prevention of soil erosion. Before the widespread use of chemical fertilizers, maintenance and/or improvement of crop yields were best accomplished by improving the base fertility of the soil where the crop was to be grown. This usually required growing a legume crop to promote nitrogen (N) fixation or applying manure to provide additional organic nutrients. For some of the old studies, time is the only replication and allows for evaluating trends. In 2004, the Centennial Rotation was initiated to commemorate the 100-year anniversary of the experiment station. Early research at DREC revolved around crop rotation. The station continues to meet the original objective of the experiment station and land-grant institution – that is to make agriculture a profitable enterprise. Early research included simple rotations and the use of manure on fields that had been used for cotton production. Mechanization shifted the agricultural industry from hand labor to machines and chemicals. That shift continues with the introduction and acceptance of biotechnology.

The shift from rotation to mono-cultural and gradually back to rotation brings us to the 21st century. New technologies are rapidly being introduced and adopted and could also be evaluated in these long-term rotations. As production in the Mid-south moved into the 21st century, cotton was still the main crop for sandy soils. However, with the emphasis on bio-energy and bio-fuels, corn and soybean gained in prominence and prices increased. With increased grain prices, corn production in the Mid-south became more profitable. This influence, along with with a shift in infrastructure, corn began replacing cotton on many farms. Cotton, corn, and soybean were included in the various rotational schemes in the Centennial Rotation. The systems included 2-year, 3-year, and 4-year rotations all compared to continuous cotton. At the initiation of the study a corn/soybean system was also included. All crops within a rotation system are grown each year allowing for direct comparisons of crops for a given year. In certain years with high corn prices, there could be an advantage to growing corn but the field was scheduled to be planted to cotton in the rotational scheme. The fifteen "treatments" are replicated four times with each one consisting of four 4-row subplots. The center rows are harvested to avoid border effects and samples taken at harvest in order to determine harvest moisture, bushel test weigh, and seed index of the grain crops and lint percentage and lint yield of the cotton plots. Once yields are calculated, total plant nutrient uptake and removal can be estimated based on standards. As would be expected the highest nutrient removal has been observed in the grain systems. For cotton over time, the lint yields have been much lower than the yield of cotton following corn. Nutrient removal for the continuous cotton system of N and phosphorus (P) was 25 to 40% of the grain crop systems. Soil samples taken following harvest are used to monitor soil nutrient levels and the basis for P and potassium (K) applications. The corn crop returns far greater levels of residue to the soil than continuous cotton and should aid in the buildup of organic matter. In the 13th season, all system will be back to the same starting point as the first season and will start over. The cropping sequences are shown in Table 1 for the first 12 years.

CENTENNIAL ROTATION STUDY												
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
System	1	2	3	4	5	6	7	8	9	10	11	12
1	CT	CT	CT	CT	CT	CT	CT	CT	CT	CT	CT	CT
2	CT	CR	CT	CR	CT	CR	CT	CR	CT	CR	CT	CR
3	CR	CT	CR	CT	CR	CT	CR	CT	CR	CT	CR	CT
4	CR	CT	CT	CR	CT	CT	CR	CT	CT	CR	CT	CT
5	CT	CR	CT	CT	CR	CT	CT	CR	CT	CT	CR	CT
6	CT	CT	CR	CT	CT	CR	CT	CT	CR	CT	CT	CR
7	CR	SB	CR	SB	CR	SB	CR	SB	CR	SB	CR	SB
8	SB	CR	SB	CR	SB	CR	SB	CR	SB	CR	SB	CR
9	SB	CR	CT	SB	CR	CT	SB	CR	CT	SB	CR	CT
10	CT	SB	CR	CT	SB	CR	CT	SB	CR	CT	SB	CR
11	CR	CT	SB	CR	CT	SB	CR	CT	SB	CR	CT	SB
12	SB	CR	CT	CT	SB	CR	CT	CT	SB	CR	CT	CT
13	CT	SB	CR	CT	CT	SB	CR	CT	CT	SB	CR	CT
14	CT	CT	SB	CR	CT	CT	SB	CR	CT	CT	SB	CR
15	CR	CT	CT	SB	CR	CT	CT	SB	CR	CT	CT	SB
CT = Cotton		CR = Corn		SB = Soybean								

Table 1: *Cropping sequence for long-term cotton-based rotation cropping system. All crops in each sequence to be grown each year.*

The first 12 years of the Centennial Rotation program was completed in 2015. The project was setup as a cotton-based system due the historic significance of cotton to this region of the US. Treatments 7 and 8 do not contain cotton and are included to document the long standing advantages of corn/soybean rotation. With recent shifts to grain production, this system has become quite important. The yield summary from the first 12 years are shown in Table 2. Cotton yields in the continuous cotton area have the overall lowest yields for cotton compared to the other systems.

The lint yields in continuous systems have ranged from 718 to 1452 lb lint/ac over the last 12 years with much of the variation related to environmental conditions. Weather problems such as hurricanes have caused some problems (lodging) but the yields have still been harvestable. Timely irrigation is a key to successful and consistent corn production as evident in 2011. Timing of the first irrigation is critical. Corn yields continued to climb through 2014 but were off some in 2015. Lint and grain yields are used to estimate nutrient uptake and nutrient removal based on the yields and crop being grown within the cycle.

Soil samples are taken following the crop harvest and then used to determine fertilizer needs for the upcoming year. Following the 2015 harvests, soil samples were taken from all subplots within the study area and will be used for future nutrient additions. Economic analysis of the results from the first 12 years will examine the overall impact of the rotations systems over time.

CENTENNIAL ROTATION STUDY - SUMMARY OF CROP YIELDS (LB or BU/ACRE)

Rotation System	Rotation Sequence	2004 Crop Yield	2005 Crop Yield	2006 Crop Yield	2007 Crop Yield	2008 Crop Yield	2009 Crop Yield	2010 Crop Yield	2011 Crop Yield	2012 Crop Yield	2013 Crop Yield	2014 Crop Crop	2015 Crop Yield
1	Continuous CT	1430.5	1101.8	978.9	718.5	927.6	877.6	1039.4	843.2	1076.4	1452.1	1122.1	948.7
2	CT-CR	1470.9	204.6	1185.4	200.8	1218.9	182.4	1185.6	61.6	1237.4	216.8	1221.2	217.3
3	CR-CT	201.2	1334.3	185.1	942.2	194.9	961.3	194.7	965.4	242.6	1952.1	236.1	1323.0
4	CR-CT-CT	197.2	1298.4	988.0	219.4	1314.9	975.3	201.8	982.2	1098.1	228.8	1184.0	1048.0
5	CT-CR-CT	1509.4	213.3	1202.1	866.7	206.8	984.7	1148.2	73.8	1194.3	1691.6	259.5	1421.0
6	CT-CT-CR	1525.1	1148.8	191.1	909.3	982.5	194.8	1234.7	841.9	244.7	1803.8	1192.5	221.2
7	CR-SB	193.9	57.8	199.3	78.4	205.8	73.3	207.2	52.6	241.3	58.3	241.3	42.2
8	SB-CR	60.3	212.3	62.5	208.8	56.1	205.1	65.7	101.8	42.9	232.5	56.6	221.5
9	SB-CR-CT	61.4	212.6	1206.2	75.5	197.6	994.5	70.6	113.7	1105.0	72.1	250.0	1365.2
10	CT-SB-CR	1447.5	61.5	194.6	1019.2	60.4	209.4	1199.0	47.9	244.0	1902.2	57.3	230.2
11	CR-CT-SB	195.9	1268.2	64.4	207.6	1222.3	66.3	209.0	963.0	46.6	234.2	1285.6	41.1
12	SB-CR-CT-CT	60.4	199.0	1152.6	852.2	57.5	195.9	1239.2	849.3	45.6	229.2	1255.9	1095.4
13	CT-SB-CR-CT	1402.7	52.3	191.2	929.5	978.7	69.8	208.0	1059.2	1052.8	66.9	252.8	1292.9
14	CT-CT-SB-CR	1446.6	1148.2	58.1	223.4	1240.5	929.3	66.8	105.0	1194.0	1529.9	59.5	235.9
15	CR-CT-CT-SB	200.5	1359.4	947.2	81.5	199.9	992.6	1026.1	50.4	242.3	1857.7	1069.4	46.2

NOTE: Cotton Yield reported in lb lint/acre, Corn Yield reported in bu/acre @15.5%, Soybean Yield reported in bu/acre @ 13%

Table 2: *Summary of crop yields from the Centennial Rotation Study (2004-2015).*

A key area of interest in the long-term rotation study deals with nutrient uptake and removal. Nitrogen (N), phosphorus (P), potassium (K), and sulfur (S) uptake and removal are being calculated for each of the systems. Only the grain portion of corn and soybean are removed and the seed and lint portion of cotton along with some vegetative materials. Soybean removes the largest percentage of N and K while corn removes the largest percentage of P. Standard values have been used to estimate nutrient uptake and removal for the crop sequences that have been grown to date. The continuous cotton system has resulted in the lowest nutrient removal for N, P, K, and S. After ten years, the greatest N uptake and removal has occurred in the corn/soybean rotation system (Treatments 7 and 8) where each crop has been grown five times. The two treatments are different because yields have been different from year to year. Much of the N that is removed in the CR/SB system comes from symbiotic N fixation when soybean is grown, Also, higher N fertilizer rates are used for corn compared to cotton. Producers should take extra steps to insure adequate fertility when shifting from cotton production to rotations with grain crops. Nutrient removal, especially N, can be 3 to 4 times higher than continuous cotton. The P and K removal rates are also highest for the CR/SB system. When examining uptake and removal, N uptake can be as much as 300 lb N/ac depending on the crop and yield. As long as the residue is returned to the soil and not burned, most of the nutrients not removed in the grain or seed can be recycled and thus reused for future crops. If residue is removed for feed stocks related to bio-energy, the available nutrient pool in the soil and organic matter can be further reduced as well.