Agronomic and Economic Effects of Irrigation and Rotation in Peanut-based Cropping Systems

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ABSTRACT

Although the Southeast U.S. receives an average annual precipitation of 1300 mm, crop yields are often limited by erratic seasonal rainfall distributions. Studies were conducted from 2001 through 2017 at the USDA/ARS Multi-crop Irrigation Research Farm in Shellman, GA (84°36′ W, 30°44′ N) on a Greenville fine sandy loam (fine, kaolinitic, thermic Rhodic Kandiudults). The objective of this long-term study is to evaluate the effects of irrigation and crop rotation sequencing consisting of peanut, corn, and cotton on yield and net economic returns to both variable and total costs. Analysis included the entire study period and was also separated for years with below and above average rainfall. When averaged across all years, irrigation increased peanut, corn, and cotton yield and net returns compared with non-irrigation. Six different rotation sequences were addressed inclusive of continuous peanut, one year out of peanut with corn or cotton, and two years out of peanut with combinations of corn and cotton. In both irrigated and non-irrigated peanuts, the least and greatest yields were from continuous peanut and the two year out rotations, respectively. No peanut yield difference resulted with corn or cotton rotation partners for the rotation sequence. Length of rotation between peanut years did influence peanut yield and net returns. Profitability and optimal rotation sequence within any cropping system depended on irrigation, yield, crop price, and production costs for peanut, corn, and cotton.

Key Words: Peanuts, corn, cotton, cropping systems, rotation, profitability, irrigation

The dominant row crops in the coastal plain of Georgia consist of peanut (*Arachis hypogaea* L.), cotton (*Gossypium hirsutum* L.), and corn (*Zea mays* L.) (UGA, 2018). In 2017, Georgia produced peanuts on 336,642 hectares with a yield of 5,025 kg/ha and a farm gate value of $825 million. Cotton hectares were 519,224 with average yield of 978 kg/ha with a value of $901 million. Corn was produced on 131,220 hectares with an average yield of 11,362 kg/ha and a value of $244 million. Combined the farm gate value of these crops totaled $1.97 billion in Georgia. Since cotton and corn are the most common rotation partners in peanut-based cropping systems, profitability hinges on the effects of weather on yield and quality, irrigation, commodity prices, and cost of production. A North Carolina cropping systems study showed the main effect of rotation was significant in three of four experiments (Jordan *et al.*, 2009). In a 3-yr cropping systems study in Georgia, peanut, corn, and cotton irrigated yields were significantly increased, along with greater economic returns compared with non-irrigated production. Increased net returns in irrigated production were related to rotation length as net returns in two-year out rotations with cotton and corn were significantly greater than one-year out rotations. However, increased net returns did not hold true in the non-irrigated rotations where periods of drought led to reduced yields and net returns. Irrigation improved the probability that increased yield and economic returns would meet their breakeven level to cover both variable and fixed costs across all commodity prices. It must be noted that price is an important factor in determining optimal rotation sequences. In low and medium commodity price scenarios, breakeven yields were twice as likely to be achieved for peanut, corn, and cotton in irrigated compared with non-irrigated production. In a high commodity price scenario, the breakeven non-irrigated yields were obtained 80% of the time compared with 100% when irrigated (Lamb *et al.*, 2006; Karlen and Camp, 1985; Nuti *et al.*, 2009). The objective of this research is to evaluate the effects of rainfall, irrigation and crop rotation sequencing on yield and net economic returns to six peanut, corn, cotton cropping systems over the 2001-2017 crop years.

Materials and Methods

Field research was conducted at the USDA/ARS National Peanut Research Laboratory's (NPRL) Multi-crop Irrigation Research Farm in

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Shellman, GA, USA (84° 36′ W, 30° 44′ N) on a Greenville fine sandy loam (fine, kaolinitic, thermic Rhodic Kandiudults). Six cropping sequences including peanut, cotton, and corn were addressed consisting of 1) continuous peanut, 2) cotton-peanut, 3) corn-peanut, 4) cotton-cotton-peanut, 5) cotton-corn-peanut, and 6) corn-corn-peanut. For each crop, plots consisted of 18 rows established on 0.91-m spacing with a plot length of 18 m with a 1.9-m border/buffer between treatments. A randomized block design was used to compare sprinkler irrigation with a non-irrigated control during the 2001-2017 crop years with three replications of each crop within each rotation sequence. Irrigation was the main plot factor and crop rotations were randomly assigned to subplots with 3 replicates of each crop rotation. Land and equipment resources were not available to allow each crop rotation to be simultaneously present in the study each year. Where appropriate rotation sequences 2 and 3 were combined and cropping systems 4, 5, and 6 if no differences in yield for differing partners resulted. Long-term data will allow the average assessment of irrigation and rotation effects over the 17-yr period and also separated by below and above normal rainfall years. Year was regarded as random with fixed treatments and the main effects and interactions were tested using appropriate error terms.

Peanut, Corn, and Cotton Production System

Peanut, corn, and cotton were produced in irrigated and non-irrigated environments. Conventional tillage practices were followed for peanut, corn, and cotton. Although slight variations existed in certain years due to weather or equipment availability. Tillage operations basically consisted of disking, subsoiling, S-tine field cultivating, rototill to establish seed beds, and planting.

Corn was generally planted about 1 April at 6.5 seeds m^{-1}. Corn varieties changed over the duration of the project and were selected based on university yield trials, recommendations, and seed availability. Nitrogen (28-0-0-5) was side-dressed twice for a yearly total of 235 kg N/ha. Phosphorous, Potassium, and minor elements were applied based on recommended rates from soil analysis conducted by the University of Georgia soil testing laboratory. Best management practices were used for disease, weed, and insect control. A four row combine was used for harvest and a sample was obtained for grain moisture, test weight, and other quality measurements. Moisture was adjusted to 15.5% for final yield determination.

Cotton varieties also changed over the duration of the project and were selected based on university yield trials, recommendations, and seed availability. Cotton was generally planted about 1 May of each year with a seeding rate of 12 seed m^{-1}. Nitrogen was side-dressed in a single application at 82 kg N/ha and other fertilizers were applied based on soil sample recommendations. Pesticides, growth regulators, and defoliants were applied based on field scouting and best management practice recommendations. Plots were harvested using a standard two row spindle picker and samples for yield and quality determination were obtained using bagging attachment or weigh cart. A subsample was collected and lint separated using a table top gin to obtain final lint yield. Lint was sent to the USDA cotton classing office for official grading.

Peanut cultivars consisted of Georgia Green (2001-2008) and GA-06G (2009-2017) planted generally on 1 May with a seeding rate of 19 seed m^{-1} (Branch, 2000; Branch, 2007). Best management practices were followed with respect to fertility and pest management. Harvest date was determined by the peanut maturity profile method which uses mesocarp pod color as a predictor of optimal harvest date (Williams and Drexler, 1981). Peanuts were dug and inverted using a two row inverter and allowed to cure in the field to approximately 18% moisture content. Plots were harvested using a two row pull type peanut thresher with a bagging attachment. After harvest, samples were further cured to around 9% moisture, weighed, and riffle divided to obtain a minimum 1,800 g sample. Each sample was sent to Federal State Inspection Service to obtain peanut grade factors including foreign material, total sound mature kernels, sound splits, other kernels, loose shelled kernels, and damage kernels (USDA-AMS, 2017). Final pod weight was obtained by deducting foreign material and adjusting to 7% kernel moisture content for determining final yield.

Irrigation scheduling (timing and amount) was managed by the Irrigator Pro for Peanut, Corn, and Cotton programs (developed and released by the USDA/ARS NPRL). The model was designed to avoid crop stress while triggering irrigation events at the most efficient timing and volume to avoid over-irrigation. Data required for Irrigator Pro include soil type, planting date, daily rainfall and irrigation amounts, plant growth stage, and soil temperature as an irrigation trigger to maintain temperature in the fruiting zone at recommended levels (Davidson, *et al.*, 2005). Irrigator Pro for Corn and Cotton uses estimated daily crop water use in accordance with established base values within various growth stages. Daily soil water potential at 0.2, 0.4, and 0.6-m depth were entered

Table 1. Average rainfall received and irrigation applied during 2001 to 2017 for peanut, corn, and cotton, for average, below, and above rainfall values at the USDA/ARS Shellman Multi-crop Irrigation Research Farm, Shellman, GA.

	Rainfall	Irrigation	Total Water
	mm		
Peanut			
All Years	521	226	747
Below average rainfall	366	277	643
Above average rainfall	582	180	762
Corn			
All Years	533	338	871
Below average rainfall	417	411	828
Above average rainfall	696	224	919
Cotton			
All Years	498	259	757
Below average rainfall	335	345	681
Above average rainfall	566	224	790

Note: Below and above average rainfall years were determined based on whether a crop received less or greater rainfall compared to the average rainfall during the 2001-2017 crop seasons for the specific crop during each year.

in the program. A weighted system is used to average soil water potential over the 3 depths where the shallowest sensor carries 43% of the average compared to 32% at 0.4 m and 25% at 0.6 m. An average soil water potential will trigger irrigation depending on crop maturity stage (Lamb *et al*., 2011; Lamb *et al*., 2015, Nuti *et al*., 2009).

Cost of Production and Prices for Peanut, Corn, and Cotton

Cost of production estimates for peanut, corn, and cotton were taken from University of Georgia Crop Extension budgets for non-irrigated and irrigated production to provide a standard production cost estimate for each crop. Variable costs for non-irrigated peanuts, corn, and cotton were \$1,323, \$724, and \$1006/ha and fixed costs were \$469, \$237, and \$470/ha, respectively. Irrigated variable costs were \$1,522, \$1,477, and \$1,237 with fixed costs of \$494, \$316, and \$492/ha, respectively (University of Georgia, 2017). Cost for irrigation was based the actual irrigation applied each year at \$50.2/hectare-cm. Irrigated and non-irrigated land charges of \$337 and \$90/ha to reflect regional rates were included for peanut, corn, and cotton. The 5-yr (2011-2015) average price in Georgia for peanuts, corn, and cotton was used in this study at \$545.11 Mg^{-1}, \$1.71 kg^{-1}, and \$223.93 Mg^{-1}, respectively (USDA- NASS, 2018). The average crop prices, production costs, and yields from research plots were incorporated into the analysis to obtain the net returns above variable and total cost to each crop and to each cropping system.

Cropping Systems Analysis

Based on the irrigation and rotation sequences in this study, six different cropping systems (CS) were modelled to address the economic returns (R) and variable costs (VC) to each system. These consist of 1) Continuous Peanut (CS1), 2) Peanut/Corn alternating (CS2), 3) Peanut/Cotton alternating (CS3), 4) Peanut/Corn/Cotton repeating (CS4), 5) Peanut/Cotton/Cotton repeating (CS5), and 6) Peanut/Corn/Corn repeating (CS6). The CS were modelled over a 9-yr horizon to address the returns over Variable Cost (R>VC) and returns above Total Cost (R>TC) for each CS as effected by irrigation and crop rotation for the entire study period (2001-2017). This same procedure was followed for above and below average rainfall years. The 9-yr horizon was utilized to encompass three iterations of each crop within the 3-yr rotation sequences (CS 4, 5, and 6).

Results and Discussion

Rainfall and Irrigation

Rainfall and irrigation during the 2001-2017 growing seasons for peanut, corn, and cotton are provided in Table 1. Differences in rainfall between crops are attributed to differing planting and harvesting dates. Average growing season rainfall for peanuts, corn, and cotton did not vary widely for each crop inclusive of all years and when separated into below and above average rainfall groupings. Corn had the highest amount of irrigation applied with peanuts recording the lowest amount of irrigation (Table 1). Total water received (irrigation plus rainfall) were the same for peanuts and cotton with corn receiving about 15% more.

Yields (Peanut, Cotton, Corn)

The main effect of irrigation was significant for yield for all crops: Peanuts (5,451 kg/ha irrigated vs. 3211 kg/ha non-irrigated ($P<0.001$)); Cotton (1289 kg/ha irrigated vs. 640 kg/ha non-irrigated ($P<0.001$)); and Corn (189 kg/ha irrigated vs. 62 kg/ha non-irrigated ($P<0.001$)) (Table 2). The main effect of year was significant for peanut ($P=0.0097$), corn ($P=0.0443$), and to a lesser degree cotton ($P=0.0614$). The Year by Irrigation effects were significant for peanut, corn, and cotton ($P=0.05$). Rotation length, in terms of number of years out of peanut with either corn or cotton, was significant for peanuts ($P=0.004$) but not significant for cotton and corn. No difference in peanut yield with either cotton or corn in a rotation system

Table 2. Analysis of variance for yield of peanut, cotton, and corn for year (Y), irrigation (I), and crop rotation (R) at the USDA/ARS Shellman Multi-crop Irrigation Research Farm, Shellman, GA (Crop Years 2001-2017).

	Peanut		Cotton		Corn	
Effect	F	P value	F	P value	F	P value
Year (Y)	11.35	0.0097	1.64	0.0614	1.75	0.0443
Irrigation (I)	62.58	<0.0001	235.23	<0.0001	317.06	<0.0001
Y x I	37.32	<0.0001	15.26	<0.0001	39.52	<0.0001
Rotation (R)	4.71	0.004	0.99	0.4128	0.54	0.7086
Y x R	8.92	<0.0001	1.51	0.0852	1.44	0.1152
I x R	16.60	<0.0001	49.91	<0.0001	65.03	<0.0001
Y x I x R	19.74	<0.0001	18.83	<0.0001	33.65	<0.0001

implies that either crop is equally good rotation partner for peanuts and thus data were combined to achieve more replication. With cotton and corn being equal rotation partners, producers have increased flexibility to plant either crop within the system depending on price and expected returns. When further separated into above-average and below-average rainfall groups, the main effect means for irrigation and rotation were significant implying that irrigation and rotation are critical in both wet and dry rainfall years.

Peanut yield and net returns. Over the entire 2001-2017 period, irrigation increased peanut yield compared to non-irrigated yield regardless of length of rotation (Table 3). Across the rotation lengths, irrigated peanut yields were greater than non-irrigated yields in the continuous peanuts (678 kg/ha) compared to one year out of peanuts (1,677 kg/ha) and two years out of peanuts (1,898 kg/ha).

Table 3. Irrigated and non-irrigated peanut yield by length of rotation during the 2001-2017 crop years at the USDA/ARS Multi-crop Irrigation Research Farm, Shellman, GA.

	Length of Rotation out of Peanuts (Years)		
	0	1	2
	kg/ha		
All Years			
Irrigated	4213[b]	5478[a]	5922[a]
Non-irrigated	3535[a]	3801[a]	4024[a]
Difference	678*	1677*	1898*
Above Average Rainfall Years			
Irrigated	4163[b]	5542[a]	5965[a]
Non-irrigated	3938[b]	5006[a]	5640[a]
Difference	225	536*	325
Below Average Rainfall Years			
Irrigated	4239[b]	5449[a]	5859[a]
Non-irrigated	2698[a]	2838[a]	3533[a]
Difference	1540*	2611*	2326*

Letters denote differences with rows specific to grouping (p=0.05)

Asterisks denote differences between irrigated and non-irrigated specific to grouping (p=0.05)

No significant yield differences in peanut resulted in non-irrigated for rotation length out of peanut during the entire study period and below average rainfall years. However peanut yields tended to increase as length of time between peanut crops increased (Table 3). Rotation is important in both irrigated and non-irrigated production systems but yields are limited by drought periods where inadequate water is the limiting factor rather than rotation length. This result is supported by the above average rainfall years where peanut yields were increased by longer rotation lengths in both irrigated and non-irrigated environments where adequate water was not the limiting factor (Table 3). In the below average rainfall years, where drought periods are more frequent and/or extended, non-irrigated yields were not affected by rotation length, but irrigated yields were greater in the 1 and 2 year out of peanut rotations compared to the non-rotated peanuts. Also, in the below average rainfall years irrigation increased peanut yields over non-irrigated yields in all rotation lengths (Table 3). Percent Sound Mature Kernels and Sound Splits (SMKSS) were not affected by rotation. SMKSS were greater with irrigation over the entire study period (72.9 versus 67.8) as well as in years of below average rainfall (71.6 versus 66.1) and above average rainfall (74.8 versus 72.0) similar to previously published data (Lamb *et al.*, 2010).

Net returns greater than variable cost (R>VC) for peanuts were increased by rotation length in both irrigated and non-irrigated production systems over 2001-2017 period compared to continuous peanuts. Irrigated R>VC increased in the one year and two year out of peanut rotations over the non-irrigated peanuts suggesting that irrigation and crop rotation are critical to producers in terms of R>VC. In the continuous peanuts, no differences resulted in R>VC between irrigated and non-irrigated over the entire study period (Table 4).

In the above average rainfall years, there was no difference in R>VC in the rotated peanuts but was

Table 4. Irrigated and non-irrigated net returns greater than variable costs[1] for peanuts by length of rotation during the 2001-2017 crop years at the USDA/ARS Shellman Multi-crop Irrigation Research Farm, Shellman, GA.

	Length of Rotation out of Peanuts (Years)		
	0	1	2
	$/ha		
All Years			
Irrigated	88.14[b]	630.70[a]	823.29[a]
Non-irrigated	152.66[b]	374.88[a]	404.63[a]
Difference	-64.52	255.82*	418.66*
Above Average Rainfall Years			
Irrigated	78.08[b]	721.16[a]	899.07[a]
Non-irrigated	417.67[b]	690.52[a]	926.25[a]
Difference	-339.59*	30.64	-27.18
Below Average Rainfall Years			
Irrigated	100.69[b]	430.35[ab]	763.00[a]
Non-irrigated	-242.28[a]	-185.10[a]	149.96[a]
Difference	342.97*	615.45*	613.03*

[1]Returns are based on Variable Costs including rent for land and irrigation (Fixed Cost are excluded which are $494/ha irrigated and $469/ha non-irrigated: Source UGA Crop Enterprise Budgets)

Letters denote differences with rows specific to grouping (p=0.05)

Asterisks denote differences between irrigated and non-irrigated specific to grouping (p=0.05).

greater than the R>VC in the continuous rotation for both the irrigated and non-irrigated treatments. In wet years revenue from added irrigation was not sufficient to cover the cost even though the total irrigation applied was lower (Table 4).

Irrigated R>VC increased at the below average rainfall years for all rotations compared to non-irrigated (Table 4). R>VC in the irrigated 2 year out rotation was greater than the irrigated continuous peanuts. No difference in R>VC resulted in non-irrigated peanuts for rotation length with negative returns for the non-rotated and one year out rotations due lack of available water (Table 4).

Cotton and corn yield

Rotation had no effect on cotton and corn yield so data were pooled to achieve more replication. Irrigation increased cotton and corn yields across the entire study period as well as in the below and above rainfall years. Irrigated cotton and corn yields were greater than the non-irrigated yield ($p \leq 0.05$) during the 2001-2017 crop years (Table 5). Irrigated cotton and corn yield increased in both the above and below average rainfall years ($p \leq 0.05$) indicating that irrigation is critical even in years of above average rainfall possibly due to erratic rainfall distribution during critical crop growth stages (Table 5). Cotton and corn quality

Table 5. Irrigated and non-irrigated cotton and corn yields during the 2001-2017 crop years at the USDA/ARS Shellman Multi-crop Irrigation Research Farm, Shellman, GA.

	Cotton	Corn
	-kg/ha-	–kg/ha–
All Years		
Irrigated	1,433	12,179
Non-irrigated	724	3,892
Difference	708*	8,286*
Above Average Rainfall Years		
Irrigated	1,355	12,618
Non-irrigated	827	8,224
Difference	471*	4,394*
Below Average Rainfall Years		
Irrigated	1,535	11,802
Non-irrigated	587	1,381
Difference	947*	10,421*

*indicates significant differences between Irrigated and Non-irrigated Yields (p=0.05)

factors were also positively influenced by irrigation across the entire project period and below average rainfall years.

Cropping Systems Returns

Table 6 shows the R>VC and R>TC for a 9-yr horizon for the six cropping systems (CS) tested. Across all years, irrigated R>VC was greater than the non-irrigated R>VC values for all cropping systems except for continuous peanut. R>VC was positive in both irrigated and non-irrigated treatments and for all cropping systems. Even though non-irrigated R>VC were positive, gross revenue was not great enough to cover total costs. Therefore, all non-irrigated R>TC were negative for all cropping systems. Irrigated R>TC across all years were mixed with continuous peanuts at a loss of -$390.51/ha. Cropping systems CS2 and CS6 also had negative returns which only had peanut and corn in the rotation. In contrast, cropping systems that included cotton in the rotation had all positive R>TC values. Peanut yields showed no difference between corn and cotton as rotation partners, however cotton provided greater economic returns than corn within the cropping system. Across all years the greatest R>TC was for CS5 which is a peanut, cotton, cotton rotation at $64.44/ha. However, this return represents only a 3.2% return to total cost for the cropping system providing the greatest net return of all 6 cropping systems analyzed.

In the above average rainfall years, R>VC was positive for all cropping systems in both irrigated and non-irrigated regimes (Table 6). Irrigated R>TC was negative for continuous peanuts (-$398.23/ha) but positive for all other rotations

Table 6. Cropping systems (CS) returns (R) over variable (VC) and total cost (TC) for a 9-year horizon consisting of peanut, corn, and cotton rotation systems.

	All Years		Above Average Rainfall		Below Average Rainfall	
	R>VC	R>TC	R>VC	R>TC	R>VC	R>TC
Irrigated			$/ha			
CS 1[a]	88.14	-390.52	80.43	-398.23	100.69	-377.97
CS 2	438.43	-43.56	535.86	53.87	127.23	-354.76
CS 3	555.88	17.49	580.26	41.88	310.26	-228.07
CS 4	494.57	18.61	535.39	59.45	476.43	0.49
CS 5	582.66	64.44	568.68	50.46	613.72	95.50
CS6	406.45	-27.21	502.11	68.42	339.17	-94.52
Non-Irrigated			$/ha			
CS 1	152.66	-389.36	78.08	-463.93	-242.28	-784.30
CS 2	131.09	-295.36	657.19	230.74	-247.69	-674.14
CS 3	195.98	-305.29	462.74	-39.26	-209.37	-711.08
CS 4	67.78	-357.01	538.68	113.89	-138.55	-563.31
CS 5	116.43	-364.47	392.86	-62.86	-109.81	-589.68
CS6	19.13	-349.55	684.52	315.82	-167.29	-590.74

[a]CS 1-Continuous Peanut
CS 2-Peanut, Corn alternating
CS 3-Peanut, Cotton alternating
CS 4-Peanut, Corn, Cotton repeating
CS 5-Peanut, Cotton, Cotton repeating
CS 6-Peanut, Corn, Corn repeating

ranging from \$41.88 to \$68.42/ha. Non-irrigated R>TC were greatest in CS6 (peanut, corn, corn) and CS2 (peanut, corn alternating) cropping systems during years of above average rainfall. The greatest returns were in cropping systems that had corn in the rotation during above average rainfall years. Abundant rainfall years results in greater than normal yield for corn in dryland regimes which results in greater returns. However, with cotton, abundant rainfall years do not always have increased cotton yields and resultant economic returns.

In the below average rainfall years, R>VC were positive for all irrigated cropping systems. In the non-irrigated treatments, all cropping systems had negative R>VC values. In the irrigated regimes, the R>TC was positive for CS4 and CS5 only. For the non-irrigated regime, all R>TC were negative with losses ranging from -\$563.31 to -\$-\$784.30/ha (Table 6). These results show the stabilizing effect and importance of irrigation in below average rainfall years on crop yield and economic returns. These results parallel a previous study showing cropping system net returns were most influenced by irrigation, crop rotation sequence, and price (Lamb et al., 2006).

Summary and Conclusions

This study provides results from a 17-yr study (2001-2017) on the yield and net economic returns over variable and total cost in non-irrigated and irrigated regimes across six different cropping systems including peanut, cotton, and corn. The analysis does not include provisions for risk management through crop insurance but instead is intended to reflect the returns to production. Irrigation increased peanut yield over non-irrigation across all years regardless of length of rotation. Irrigated yields increased as length of time between peanut increased indicating that proper rotation is essential to maintaining high yields in irrigated peanut production. In above average rainfall years, rotation was the most important factor in terms of both yield and net returns. In below average rainfall years, peanut yield and net returns were most affected by irrigation and to a lesser degree rotation.

Cotton and corn yields were not affected by rotation sequence but yield did increase by irrigation across all years and for both rainfall groups. Peanut yield was not affected by crop companion, either cotton or corn, in the rotation sequence which allows farmers flexibility to select between crops based on expected price and economic return. When viewed across cropping systems, rotation in peanut is essential as the least R>TC always resulted in the continuous peanuts regardless of irrigation and rainfall grouping. Irrigation provided a stabilizing effect on R>VC and R>TC compared to non-irrigated returns. Improvement in economic returns resulted from extending rotation length regardless of the rotation partners in both irrigated and non-irrigated regimes which is an important consideration for producers because it is difficult to predict weather conditions that will prevail during the growing season. Even though percentage returns to irrigation were low, and sometimes even negative at current crop prices and cost of production, irrigation is the most critical component of maintaining peanut yield, quality, and economic stability for peanut, cotton, and corn producers and rural economies where these crops are produced and processed.

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