10th Annual National
Conservation Systems
Cotton & Rice
Conference

COTTON PRESENTATIONS

Adapting The Dryland Wheat-Sorghum Fallow Rotation For Use With Dryland And Deficit Irrigated Cotton

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Dryland crop production on the southern Great Plains is complicated by erratic precipitation, ranging from 16 to 22 in. annually, that occurs primarily during the spring and early summer. Sorghum [*Sorghum bicolor* (L.) Moench] grown in rotation with wheat (*Triticum aestivum* L.) is a successful crop sequence that efficiently uses the spring and summer rain. The resulting Wheat–Sorghum– Fallow, WSF, cropping sequence (Fig. 1) consistently produces two dryland crops in three years and also provides residue to protect the soil and increases precipitation storage in the soil. Other summer crops like cotton (*Gossypium hirsutum* L.) could be substituted for sorghum, but it produces minimal residues to conserve soil and water.

As an alternative to dryland production, many producers in the Texas High Plains supplement growing season rains with irrigation. Cropping sequences with fallow periods were typically replaced with annually grown summer crops such as soybean [*Glycine max* (L.) Merr.] and corn (*Zea mays* L.). Irrigation water in this region is supplied from the Ogallala aquifer, which is declining and, as a result, has problems of decreased irrigation well capacity. Because of the decreased well yields, many Texas High Plains producers can not apply sufficient irrigation water to meet the higher water needs of corn and are growing cotton, which responds to limited irrigation.

Crop residue at the soil surface increases infiltration of rain and reduces evaporation that, consequently, increases storage of precipitation for subsequent crop use in lieu of irrigation. Reducing evaporation of irrigation water with residue cover may increase irrigation efficiency by increasing the portion used by the plant for transpiration. Our objectives were to adapt cotton and wheat to a limited irrigation cropping sequence with fallow periods, and quantify the effect of residue management practices on crop growth and water conservation.

All phases of a Wheat-Cotton-Fallow (WCF) cropping system were installed in 2004 on 18 ac. of Pullman soil (fine, mixed, superactive, thermic Torrertic Paleustoll) that could be irrigated by 300 ft long linear move mid-elevation spray irrigation system. Grain was harvested from uniformly cropped wheat that was sown at 60 lbs/acre during October. Wheat was not fertilized because ~ 50 lbs N/acre is mineralized during fallow and is usually sufficient for dryland wheat crops. Wheat residues were fallowed for ~11 months using disk, stubblemulch (sweep plow), and no –tillage residue management treatments. Fallow weed control in no-till plots was maintained with a one time application of 2.5 lbs a.i. atrazine [6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5 triazine-2,4-diamine] and 1.0 lb/acre a.i. applications of glyphosate [N-(phosphonomethyl) glycine] as needed for weed escapes. After wheat fallow, 100 lbs. N/acre was applied through the irrigation system and cotton was planted with unit planters in rows 30 in. apart at a population of 60,000 seed/acre during mid-May. Weed control for cotton after tilled fallow used 1 lb/acre a.i. trifluralin [2,6-dinitro-N, N-dipropyl-4-(triflouromethyl) benzenamine] and for no-till we used 1.5 lbs/acre a.i. diuron [3-(3,4-dichlorophenyl) 1,1-dimethylurea] mixed with 0.75 lbs/acre a.i. metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy- 1-methylethyl) acetamide] with glyphosate applied to control weed escapes. Growing cotton was irrigated in treatment strips receiving 1 or 2 in. applications that supple-

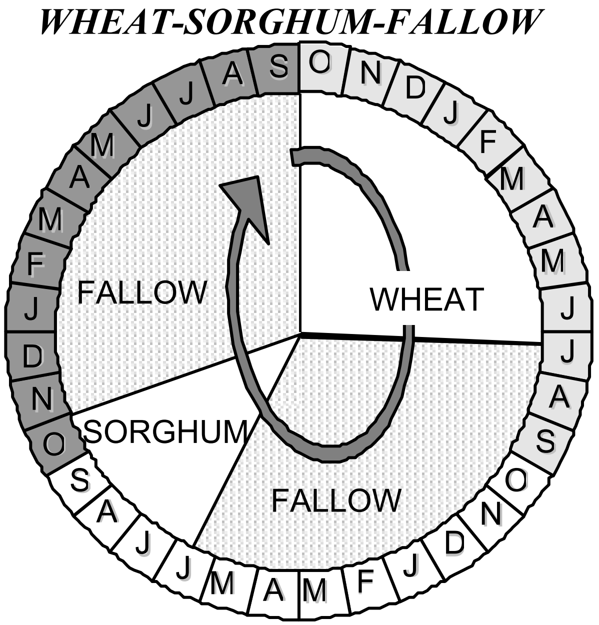

Figure 1. The three-year wheat-sorghum-fallow (WSF) rotation begins with wheat establishment in October. Wheat is harvested 10-months later in July and the soil is fallowed until June of the second year (11-months) when grain sorghum is grown using stored soil water to augment summer rain. After sorghum harvest in November of the third year the soil is again fallowed for 10-months when the sequence is repeated. The modified sequence substitutes cotton for sorghum.

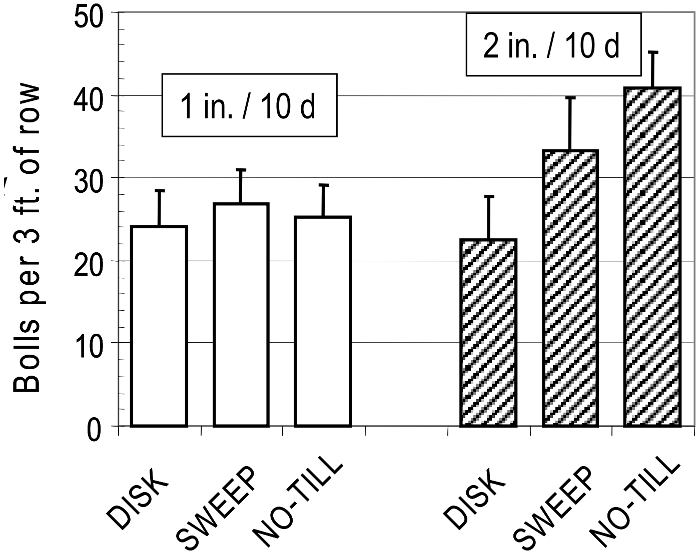

Figure 2. Tillage and irrigation affects on late season open boll counts. Bars represent standard errors.

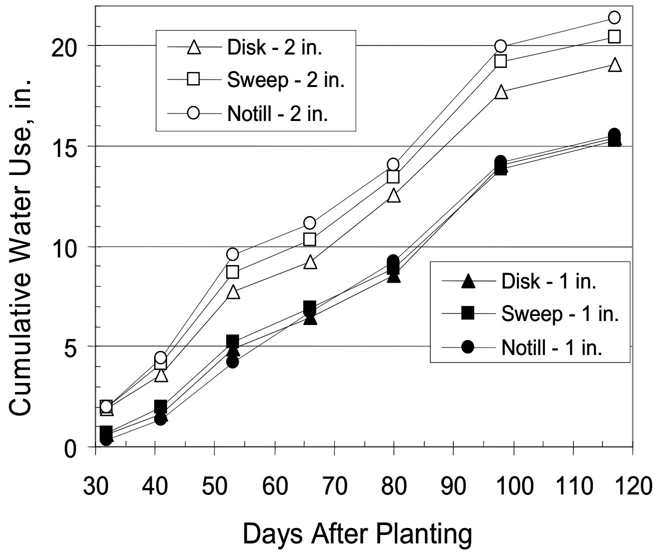

Figure 3. Tillage and irrigation affects on cumulative water use by cotton.

mented rain but did not exceed a 2 or 4 gpm/acre well pumping capacity, common to this region.

Treatment combinations of irrigation levels (2) and tillage residue management practices (3) were replicated 3 times resulting in 18 plots for each rotation phase. Comparisons of effects were according to a randomized complete block split-strip plot arrangement of an analysis of variance (ANOVA). Precipitation and soil water content were measured at planting and harvest for each phase of the rotation to determine tillage/residue effects on storage of precipitation during fallow. Growing season soil water content was measured to 7.5 ft. soil depth using a neutron moisture gage. Cotton water use was calculated as the sum of the measured rain, cumulative irrigation depth, and soil water depletion during the growing season. Cotton growth was recorded during the growing season.

Fallow period storage of rain as soil water increased as the amount of surface residue increased, but this water storage varied with fallow rainfall. For example, during the dry 2005 2006 fallow period that received <3.5 in. rain, available soil water was 5 in. for no-till, 4 in. for sweep till, and 2.5 in. with disk tillage. The overall mean available soil water at planting was about 7 in. for no tillage compared with 6 in. for sweep tillage. Previous studies have shown that increasing soil water storage promotes crop growth and yield for both dryland (unirrigated) and irrigated summer crops.

The timely crop establishment and resulting uniform stands under irrigated conditions highlighted consistent crop growth benefits with water conserving tillage that were masked under more variable dryland conditions. Tillage and irrigation effects on cotton were mapped during the growing season as node number, plant height, and open bolls. For example, mid September node number was not affected by small differences in plant available water due to tillage, but nodes increased 10% with 2 in. / 10 d irrigation treatment compared with the 1 in. / 10 d level. When irrigation increased from 1 to 2 in. every 10 days, increased cotton growth resulted in 10% taller plants (21.7 in. compared with 24.1 in., respectively). Cotton height increased progressively from 21.1 to 22.6 and 25.1 in. as tillage decreased from disk, to sweep and no –tillage. Open bolls during late October were not significantly affected by tillage or irrigation treatments; however, a trend relating increased boll numbers with increased water may emerge (Fig. 2). That is, boll numbrs tended to be higher with increased irrigation and, for the 2 in. / 10 d level, decreased tillage may result in more bolls.

Crop response trends to tillage and irrigation levels may reflect differences in cumulative growing season water use, i.e., evapotranspiration. Significantly less water was used by cotton receiving 1 in. irrigations every 10 days compared with the 2 in. irrigation level (Fig. 3). No differences in cumulative water use was observed among tillage treatments receiving a 1 in.

irrigation every 10 days; however, for the 2 in. / 10 d irrigation level, progressively greater water use was observed with tillage practices that increased residue retention. The tillage effects were only significant later in the season.

In conclusion, residue retaining tillage practices, like no-till, increased crop water use through increased fallow season soil water storage and, possibly, through reduced evaporative losses of irrigation water.

▸ Productivity And Net Returns From Best Management Practices (BMP) Cropping Systems

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Year-round systems with summer crops of cotton, corn, soybeans or grain sorghum and winter crops of wheat, rye or vetch are considered best management practices (BMPs) to protect surface water quality because they reduce soil and nutrient losses into water bodies. Winter crops stabilize the soil and eventually increase soil productivity by increasing organic matter and biological activity. Using no-till tillage systems is one of the most efficient ways to build organic matter in southern soils and, combined with residue from winter crops, provide unparalleled benefits for soil and water quality. In attempting to achieve the positive effects of conservation practices on water quality, economics has been a major concern of farmers because these practices may increase production costs, reduce productivity and may not provide short-term returns to justify increased expenses.

The LSU AgCenter has conducted research for many years on BMP cropping systems to evaluate the yield and economic benefits of these entire-year diverse crop sequences. These studies have evaluated systems that maintain ground cover through the use of crop residues, cover crops and no-till practices. The systems include winter cover crop/cotton, doublecrop wheat/cotton, wheat/soybeans, wheat/grain sorghum and doublecrop wheat/cotton rotated with corn, soybean or grain sorghum. Continuous monocropping/winter fallow of each of the summer crops was included for comparison purposes, though these are not considered BMPs.

Total commodity yield of the doublecrop systems was higher than any of the summer monocrop systems because of the winter wheat yield that averaged 65 bushels per acre. Summercrop yields usually, but not always, sustained yield losses in doublecrop systems. For example, doublecrop cotton yield varied from a 3 percent increase to a 21 percent reduction, and doublecrop soybean varied from a 12 percent increase to a 30 percent reduction. Sorghum produced the same whether planted as a monocrop or doublecrop. Yields of soybean and corn were 10 percent to 16 percent higher in doublecrop rotation systems than in doublecrop systems without rotations, but cotton yields were the same with or without crop rotations. Compared with monocropping, doublecrop cotton yields were reduced an average 67 pounds of lint per acre each year, and doublecrop soybean yields dropped an average of 5 bushels per acre each year. Any yield reduction of the summer crop is a significant economic penalty because it represents direct loss from potential net returns.

The economics of each system relied greatly on the commodity prices received in a given year but enterprise budgets showed some of the most-profitable systems included BMPs. Doublecrop cotton/wheat produced annual net returns that ranged from $164 to $340 per acre from average yields of 65 bushels of wheat per acre and 1,043 pounds of cotton lint per acre. The system of producing three crops of corn-wheat-cotton in two years averaged annual net returns that ranged from $86 to $221 per acre. In comparison, monocrop cotton net returns ranged from $112 to $167 per acre with average yields of 1,110 pounds of per acre. The BMP systems of doublecrop cotton rotated with corn or grain sorghum produced annual net returns that ranged from $101 to $181 per acre -- approaching that of monocrop cotton but less than continuous doublecrop wheat/cotton. Continuous monocrop soybeans, corn or sorghum produced highly variable net returns that ranged from -$40 to $148 per acre and were usually lower than monocrop cotton or BMP systems. Negative returns occurred in some years, usually with monocrop systems and seldom with multicrop systems.

The BMP systems evaluated in LSU AgCenter research programs are highly productive and have potential to improve soil and water quality. Despite their value for environmental protec-