Farm-scale Validation of Conservation Tillage Systems for Sandy Soils on the Texas High Plains

J. W. Keeling, W. M. Lyle, J. R. Supak and J. R. Abernathy[1]

INTRODUCTION

Cotton is the most important agronomic crop on the Texas Southern High Plains (TSHP) in terms of acreage and crop value. Between 2.6 and 3.3 million acres of cotton are planted annually in the 25-county region. Approximately 50% of this acreage is irrigated from the Ogallala aquifer. Since 1973, higher returns from cotton than from alternative crops has led to conventional-tillage cotton monoculture. Conventional-tillage cotton production in this area includes operations for destroying stalks, deep tillage with moldboard or chisel plow, preplant herbicide incorporation, bedding, planting, and cultivation for weed control. Typically, 12 to 15 tillage operations are performed prior to harvest.

Conservation tillage systems have gained increased interest in the TSHP as a means to increase profitability. Conservation tillage can also contribute toward reducing erosion on highly erodible lands as required by Conservation Compliance provisions of the 1985 Food Security Act (1). Final acceptance and widespread use of conservation tillage cotton production systems ultimately will depend on how their economic performance compares with current conventional tillage cotton production practices in this region. Cropping systems research was initiated at Lubbock, Halfway, and Wellman in 1985 in an effort to increase profitability in cotton production while satisfying Conservation Compliance provisions of the 1985 Food Security Act (2). Results from these test plots have shown significant increases in profitability of cotton production (20-40%) under irrigated and dryland conditions (5). However, a need exists to verify this under large scale field conditions in the sandyland areas south of Lubbock.

Traditional furrow irrigation is being replaced with center-pivot sprinkler irrigation systems incorporating the LEPA (Low Energy Precision Application) design. LEPA distributes water directly to the crop furrows through drop tubes and emitters and conserve water resources by minimizing evaporation, run-off and deep percolation. LEPA irrigation also offers potential for chemigation applications of fertilizers, herbicides, and other crop protection chemicals (4). Studies conducted over a four year period at Halfway indicated higher cotton yields, earlier maturity and increased water use efficiency are obtained with high frequency (3-day) deficit (0.4 ET) irrigation (3). In 1988, 1068 lb/A lint yield was produced with only 2.5 inches of irrigation water compared to 400 lb/A dryland. High-frequency deficit LEPA irrigation can make irrigation feasible in marginal water areas.

The objectives of these studies were to evaluate effects on cotton growth, yield, fiber quality and relative profitability of alternative cotton production systems utilizing cover crops, rotations and conservation tillage under irrigated and dryland conditions and integrate high-frequency deficit LEPA irrigation with conservation tillage systems to optimize rainfall and irrigation water resources.

MATERIALS AND METHODS

In 1990, a cooperative project between the Texas Agricultural Experiment Station, Texas Agricultural Extension Service, and Lamesa

[1]Texas Agricultural Experiment Station, Lubbock, TX 79401.

Table 1. Crop yields, value, production costs, and net returne for irrigated and dryland cropping systems at AG-CARES, Lamesa, Texas, 1991.

	Irrigated				Dryland			
cropping system	Yield	Crop Value	Net Returns		Yield	Crop Value	Net Returns	
	-lbs/A-	-$/A-	-$/A-		-lbs/A-	-$/A-	-$/A-	
Continuous Cotton								
Conventional Tillage	674	334	14		392	188	49	
Minimum Tillage	849	424	113		584	280	152	
Terminated Wheat-Cotton	755	376	35		263	134	22	
Conservation Tillage/Rotations								
Sorghum-Cotton	891	444	124	56[1/]	275	140		44[1/]
Cotton-Sorahuq	5012	200	(-11)		4078	163	82	
Wheat-Cotton	963	484	140	21[1/]	448	224	78	18[1/]
Cotton-Wheat	14.4 bu	43	(-98)		3	9	-42	
Cotton-Fallow Wheat[2/]					521	202	119	
Cotton-Fallow-Wheat					---	---	-32	32[1/]
Cotton-Fallow-Wheat					20.8	62	10	

[1/] Average return of enterprises in the rotation.
[2/] Cotton-Fallow-Wheat rotation is dryland only.

Cotton Growers began with the acquisition of a 160 acre farm in Dawson County near Lamesa, Texas. This site, named the Agricultural Complex for Advanced Research and Extension Systems (AG-CARES) provides the opportunity to evaluate conservation tillage cropping systems in large scale plots (25 acres) under real farm conditions. This site is equipped with a center pivot irrigation system to evaluate both irrigated and dryland systems.

Five cropping systems which have shown increased profitability for cotton production at Lubbock, Halfway and Wellman over the last five years were established at AG-CARES in 1990. Circular rows were established for LEPA irrigation, with dryland areas including 30% of the circle and the comers. These irrigated and dryland systems are being compared to conventional tillage cotton production in terms of cotton yield, fiber quality, and net returns per acre.

The cropping systems being evaluated include:

1) Minimum tillage continuous cotton in which stalks are shredded, the old rows are relisted to incorporate a preplant herbicide and cultivated as needed for weed control,

2) Terminated wheat-cotton in which wheat is planted into cotton stalks following harvest and chemically terminated 2-4 weeks prior to cotton planting and cotton is then planted into the wheat residue,

3) Wheat-cotton conservation till rotation in which wheat is grown for grain, the wheat stubble is left standing and cotton is planted into wheat stubble the following year,

4) Sowhum-cotton conservation till rotation in which cotton is planted into the previous sorghum crop residue,

5) Wheat-cotton-fallow which is similar to the wheat-cotton rotation except that the ground is left fallow between cotton harvest and wheat planting the next fall.

Cotton was planted on April 29, 1991. Irrigated cotton received 125 lb N and 37 lb P/Acre. Dryland cotton received 15 lb N and 18 lb P/Acre. Cotton was irrigated on a 3.5 day schedule beginning at the square stage and was based on 0.6X potential evapotranspiration. Total seasonal irrigation was 5.5". Irrigated cotton was harvested October 23 and dryland cotton November 24.

Standard land preparation, tillage practices, herbicides and cultivation were used in the conventional tillage cotton system. In the reduced tillage continuous cotton, deep tillage was eliminated and trifluralin was incorporated with the bedding operation. Winter weeds were controlled in the conservation tillage systems with a 2,4-D. Glyphosate was used to terminate the wheat cover crop as well as control any emerged weeds at planting. Herbicide treatments in the conservation tillage systems included strip-tillage incorporation (13-inch band) and a chemigation application of trifluralin. A layby (July) application of pendimethalin was incorporated by cultivation in the three conservation tillage systems.

RESULTS AND DISCUSSION

The 1991 growing season was characterized by below normal heat unit accumulations during the June through September periods. Insect infestations, including the cotton aphid, were generally light (at least by comparison to some nearby fields). A prolonged period of wet, cool conditions during the latter half of September induced some leaf shedding, slowed boll development, stimulated excessive regrowth and caused some weathering damage to open cotton. The first frost occurred October 30 and was followed by a hard freeze (18°F) November 3. The freeze damaged or destroyed many green bolls, primarily in the dryland crop, that could have contributed to yield.

Irrigated cotton yields ranged from 674 lbs/A for conventional tillage, continuous cotton

to a high of 963 Ibs/A with the wheat-cotton rotation (Table 1). The minimum tillage continuous cotton, terminated wheat-cotton and sorghum-cotton rotation systems all produced higher cotton yields than the conventional tillage system. Dryland cotton yields ranged from 275 lbs/A to 584 lbs/A, with highest yields produced in the minimum tillage continuous cotton system. Lower than expected yields resulted with the terminated wheat-cotton and sorghum-cotton dryland system, mainly due to inadequate early season nitrogen applications. In 1992, earlier applications will be made to avoid any nitrogen stress that would affect yields. Three to four years results from the rotations will be necessary to determine yield and profitability over a wide range of weather conditions. We expect cotton yields in the rotations to improve relative to continuous cotton over this period. From this year's results, higher cotton yields are needed in rotations to offset lower returns from sorghum or wheat, unless high yields of these grain crops are produced, such as with dryland sorghum in 1991 (~4,000 lb/A).

LITERATURE CITED

1. Federal Register. 1987. Highly erodible land and wetland conservation; final ruling and notice of finding no significant impact.

2. Keeling, J.W., E. Segarra, and J.R. Abernathy. 1989. Economic evaluation of conservation tillage cropping system for cotton in the Texas Southern High Plains. J. Prod. Agric. 2:269-273.

3. Lyle, W.M. and J.P. Bordovsky. 1991. High frequency LEPA irrigation. Proceedings of South Texas Irrigation Conf., Texas Ag. Ext. Serv., 71-80.

4 Lyle, W.M. and J.P. Bordovsky. 1989. In-canopy chemigation with multifunction LEPA irrigation systems. Trans. of ASAE 32(6):2009-2014.

5. Segarra, E., J.W. Keeling and J.R. Abernathy. 1991. Tillage and cropping systems effects on cotton yield and profitability on the Texas Southern High Plains. J.Prod. Agric. 4:566-571.