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A Ten Year Comparison of Cropping and Tillage Systems for Dryland Grain Production

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Conservation and
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A TEN YEAR COMPARISON OF CROPPING AND TILLAGE SYSTEMS FOR DRYLAND GRAIN PRODUCTION[1]

Ordie R. Jones and Grant L. Johnson[2]

INTRODUCTION

Water is the primary factor limiting crop production on drylands in the Southern High Plains (SHP). Precipitation averages 16 to 24 inches annually from west to east across the SHP, but only 15 to 20% of the precipitation remains as soil water at the end of a fallow period in a dryland cropping sequence — with 80 to 85% of precipitation lost to evaporation and runoff. Improved soil and water management practices can maintain high infiltration rates and reduce evaporation rates and are important tools in conserving water supplies for use by crops (Unger, 1984). One of these is conservation tillage, which keeps most residues on the soil surface. Crop selection and the sequencing or rotation of crops in the systems are also important to efficient water use because, with less fallow, a higher percentage of precipitation is used by plants and less water is evaporated. Stewart (1985) recognized the three components of a successful dryland management system as 1) retaining precipitation on the land, 2) reducing evaporation, and 3) utilizing crops that have drought tolerance and fit rainfall patterns. The problem dryland producers face, however, is integrating these three components into workable farming systems so that soil water supplies at crop planting are high, yet fallow (non-crop) periods are short enough so that most precipitation is not lost to evaporation. We report on an integrated approach to developing water-efficient farming systems using conservation tillage systems, adapted dryland crop sequences, and land leveling to prevent runoff.

DESCRIPTION AND PROCEDURE

The research was conducted at the USDA Conservation and Production Research Laboratory, Bushland, Texas, from 1984-1993. The soil is a slowly permeable Pullman clay loam that is highly fertile and retains approximately 7 inches of plant available water in the top 4 ft of soil. The slope is 1.5%. Long term average

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[1] Written report of information presented at the 1996 Amarillo Farm and Ranch Show, December 3, 1996, Amarillo, TX.

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precipitation is 18.3 inches/year, with highest rainfall occurring from May through August. During the research period, average rainfall was 20.5 inches/year.

Crop sequence (rotation) and dryland tillage treatments (three replications) were established in 1982 on ⅓-acre contoured plots that were 30 ft wide and 524 ft long and farmed with 15-ft wide equipment. Some of these plots were leveled and had berms on all sides to retain all precipitation. Other plots (non-level) had berms on each side but ends were open so runoff was possible.

The crop sequences (Fig. 1) were wheat-sorghum-fallow (WSF), wheat-fallow (WF), continuous wheat (CW), and continuous sorghum (CS). Wheat-sorghum-fallow is a 3-year sequence having one wheat and one sorghum crop, with an 11-month fallow preceding each crop. A WF sequence produces one crop every 2 years with 15 months of fallow between crops. A crop is grown each year with the CW and CS sequences.

Each crop sequence had no-tillage (NT) and conventional stubble-mulch tillage (SM) treatment plots. No-tillage treatments for each sequence are described in Table 1. With SM, weeds were controlled and seedbeds prepared using a Richardson Sweep Plow[†] with one 5-ft and two 6-ft blades. TAM 107 winter wheat was sown on all wheat plots at 35 lb/acre in late September or early October using an International hoe-type grain drill with a 12-inch row spacing. DeKalb 'DK41Y' hybrid

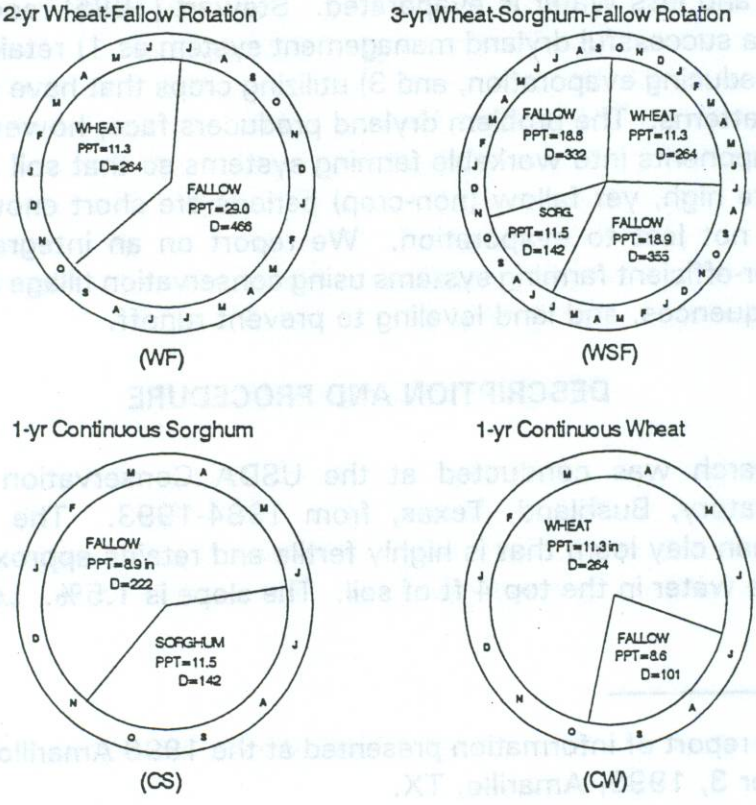

Fig. 1. Calender for crop rotations showing 10 year average precipitation (PPT) and number of days (D) in each rotation phase.

sorghum was planted on all sorghum plots at 32,000 seed/acre in early June with a six-row John Deere Max-Emerge on 30-inch rows. In 1987, crops on CW and CS plots began exhibiting nitrogen deficiency symptoms. Thus, in 1988 and subsequent years, all plots were fertilized with 30 to 40 lb/acre N as ammonium nitrate prior to planting. Normally, dryland WSF and WF systems do not require added fertilizer when using SM tillage on Pullman and similar fertile soils.

Table 1. No-tillage programs for dryland crop sequences, Bushland, Texas.

WHEAT-SORGHUM-FALLOW (3-year sequence)
— Immediately after wheat harvest, apply 2.0 lb/acre atrazine + 0.75 lb/acre 2,4-D.
— At or a few days before sorghum planting, apply 8 to 12 oz/acre Roundup + surfactant.
— After sorghum emergence, apply 1 lb/acre atrazine + crop oil.
— In late February, during fallow after sorghum, apply 0.1 oz/acre Ally + surfactant + 0.25 lb/acre 2,4-D.
— At or a few days before wheat planting, apply 8 to 12 oz/acre Roundup + surfactant.
— Roundup or Landmaster is also used to control weeds and grasses that escape glean or atrazine during fallow.
WHEAT-FALLOW (2-year sequence)
— Apply 0.1 oz/acre Ally + surfactant to growing wheat about March 15.
— Apply 1 lb/acre atrazine + 0.75 lb/acre 2,4-D immediately after wheat harvest.
— Roundup on Landmaster is also used for weeds and grasses that escape Ally or atrazine during the 15-month fallow. One or two applications are usually needed during 2nd summer.
CONTINUOUS WHEAT (annual sequence)
— Apply 54 oz/acre Landmaster after harvest.
— Apply 0.1 oz/acre Finesse about 60 days prior to seeding.
— Apply 12 oz/acre Roundup + surfactant just prior to seeding.
CONTINUOUS SORGHUM (annual sequence)
— Apply 54 oz/acre Landmaster in late spring to control volunteer sorghum and weeds.
— Apply 8 to 12 oz/acre Roundup prior to seeding.
— Plant Concept safened treated seed.
— Apply 1.5 pt/acre Dual + 1 lb/acre Atrazine preemergence.

Data obtained included soil water content to a 6-ft depth by 1-ft increments at crop planting and harvest; precipitation, measured with a standard gauge adjacent to the plots; and combine-harvested grain yield from the total plot area. The experiment was terminated in 1994.

RESULTS AND DISCUSSION

Soil Water Effects

The key to successful production of dryland crops is to have the soil profile wet to a 4- to 6-ft depth at crop planting. As an example, for each additional inch of plant available soil water stored at planting of sorghum, grain yield will be increased by about 385 lbs (Jones, 1975). The Pullman soil can store about 1.75 inches available water per foot of soil depth.

Tillage can have a large effect on how much water is stored in the soil. Keeping crop residues on the soil surface increases soil water storage primarily by reducing evaporation and runoff. Tillage effects on 8-year average soil water contents at planting and harvest of wheat and sorghum for the various sequences are shown in Figs. 2a thru 2e. No-tillage treatment of wheat residues after wheat harvest resulted in consistently higher soil water content at planting of sorghum in a WSF sequence (Fig. 2a), at planting of wheat in CW (Fig. 2c), and even increased soil water content at planting of wheat on WF (Fig. 2e), which had just undergone 15 months of fallow.

Of particular note is the large increase in soil water content at wheat planting in response to NT with CW (Fig. 2c). After only 3 to 4 months of fallow, soil profile water contents averaged 1.4 inches greater on NT than on SM. While the economics of NT-CW are not good (as will be shown later), the positive effects on soil water of maintaining wheat residues on the surface with NT cannot be denied and this effect is occurring early in the fallow period.

Sorghum residues were not as effective as wheat residues in reducing evaporation and increasing soil water content at planting (Fig. 2b and 2d). All of the plots for which data are shown in Figs. 2a-2e were level, so runoff did not occur. The difference in soil water content at crop planting was due to reduced evaporation with NT.

Grain Yields

The 10-year average grain harvest yields reported in Figs. 3, 4, 5, and Table 2 include zero yields in 1989 for wheat (hailed out) and in 1990 for sorghum (planted in July and did not mature before frost).

The maximum average effect of tillage system on yield was about 10% (Fig. 3). No-tillage on WSF increased sorghum yields by 5 bu/acre. Wheat yields on WSF and WF were not affected by tillage system, but wheat yield on CW was increased 3 bu/acre with NT. Sorghum yield on CS was reduced with NT, primarily because of thin stands of sorghum obtained on NT due to herbicide damage from Milocep in the early years of the study.

Wheat does not respond to high soil water contents at planting in the same manner as sorghum. Differences in soil water content at wheat planting are not usually reflected in final wheat yield if sufficient water (soil water and precipitation) is present to get wheat emerged, tillered, and a good root system established. With good wheat establishment, final wheat yields are closely associated with April-May precipitation.

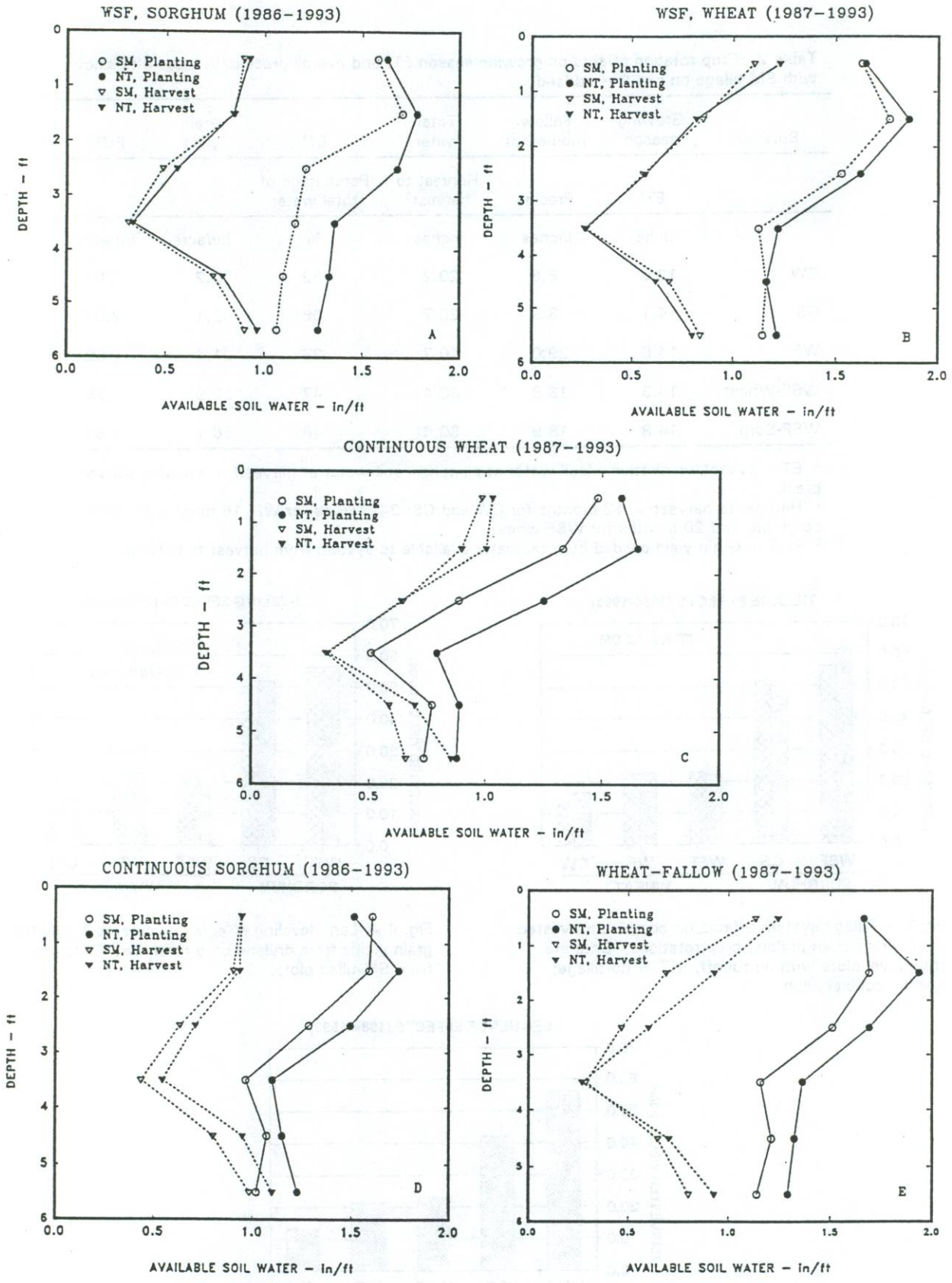

Fig. 2a through 2 e — Tillage effects on soil water contents to a 6-ft depth at crop planting and harvest for dryland crop rotations. Data are from level plots with no runoff. Each data point is an average of 48 gravimetric samples (2 samples/plot x 3 replications x 8 years). NT = no-tillage; SM = stubblemulch.

Table 2. Crop rotation effects on growing season ET, and overall precipitation use efficiency with SM tillage on non-leveled land.

Rotation	Growing season	Fallow (non-crop)	Total water	ET[1]	Grain yield	PUE[3]
	ET[1]	Precip.	Harvest to harvest[2]	Percentage of total water		
	inches	inches	inches	%	bu/acre	bu/acre
CW	12.6	8.6	20.2	62	13.2	0.65
CS	14.1	8.9	20.7	68	42.1	2.03
WF	14.5	29.0	40.7	36	21.4	0.52
WSF-Wheat	14.3	18.8	30.4	47	22.9	0.75
WSF-Sorg.	14.8	18.9	30.6	48	56.1	1.83

[1] ET = Evapotranspiration - (soil water at planting - soil water at harvest) + growing season precip.
[2] Harvest to harvest = 12 months for CW and CS; 24 months for WF; 16 months for WSF-sorghum; and 20 months for WSF-wheat.
[3] PUE = Grain yield divided by total water available to system from harvest to harvest.

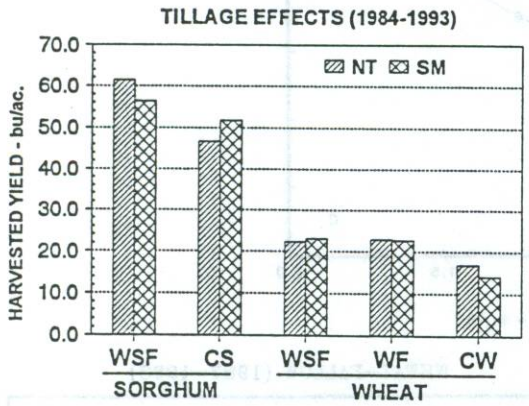

Fig 3 — Tillage system effects on combine harvested grain yields from dryland crop rotations. Data are from level plots with no runoff. NT = no-tillage; SM = stubblemulch.

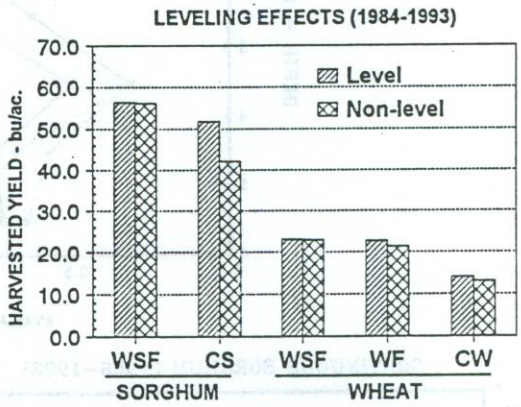

Fig. 4 — Land-leveling effects on combine harvested grain yields from dryland crop rotations. Data are from SM-tilled plots.

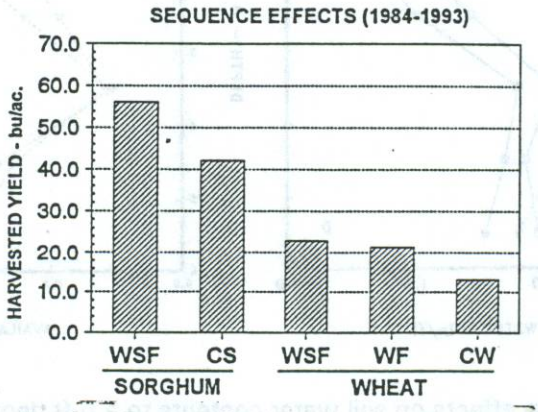

Fig. 5 — Crop rotation (sequence) effects on combine harvested grain yield. Data are from SM-tilled, non-level plots.

Land-leveling retained all precipitation where it fell, but had a positive effect on grain yield only with CS where leveling improved sorghum yield nearly 10 bu/acre (Fig. 4). The fallowing effects with WSF and WF overshadowed soil water benefits obtained with land leveling. Reducing storm runoff with contouring, furrow diking or improved residue management can produce water conservation benefits and yield increases similar to those obtained with land leveling, usually at a much lower cost.

Crop sequence had a large effect on combine-harvested grain yields (Fig. 5). Sorghum yield on WSF (sloping land) with 11 months of fallow was 14 bu/acre greater than yield on CS, a 33% yield increase due to fallowing. Wheat yield with 11 months of fallow (WSF) was slightly greater than with 15 months of fallow (WF), showing that long fallow periods do not result in efficient use of water. Fallowing for 11 months increased wheat yields by 10 bu/acre or 73% in comparison to CW.

Grain Production

Grain production, as differentiated from grain yield, is defined as annual grain produced per system acre, including fallow. For example, with WF, a 22 bu/acre grain yield every other year nets only 11 bu/acre of annual grain production.

Annual production for the 4 cropping systems using SM tillage on non-level plots ranged from 11 bu/acre for WF to 42 bu/acre for CS (Fig. 6, Table 2). Continuous sorghum had the highest grain production, 60% greater than WSF and 400% greater than WF. Thus, while tillage method exerted a 10% effect on grain yield, crop selection and sequencing exerted nearly a four-fold effect on total grain production.

ET, Evaporation, and PUE

Evapotranspiration (ET) is the soil water and precipitation that is used by the crop during the growing season. Evaporation is the water that is lost when a crop is not growing (non crop or fallow period). We get a benefit from ET, a harvestable crop, whereas water evaporated when a crop is not growing is detrimental to efficient use of water for grain production. Average ET for crops grown in the various sequences

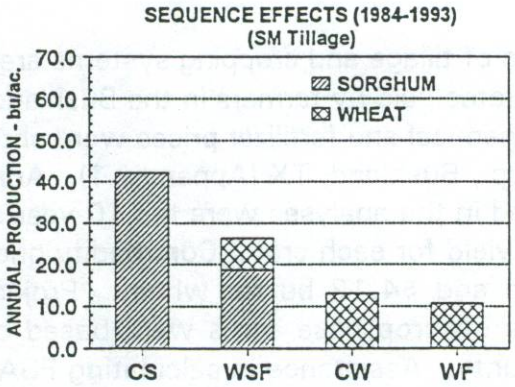

Fig. 6 — Crop rotation (sequence) effects on average annual grain production from one acre in each cropping system (includes fallow) non-level plots.

ranged from 12.6 inches for CW to 14.8 inches for WSF-Sorghum (Table 2). The inefficiency of using fallow is shown vividly in Table 2 where a difference in precipitation of 20 inches during the fallow (non-crop) periods between CW and WF resulted in a difference of only 1.9 inches ET. Thus, only 9% of the additional precipitation that occurred during the longer fallow period was used for ET in the wheat-fallow system. The additional 1.9 inches of ET on WF was very important, however, resulting in a 62% increase in yield. For sorghum, a difference in ET of only 0.7 inches between CS and WSF-sorghum resulted in a yield increase of 33%. The often-times very small increase in ET due to fallowing can have dramatic effects on yield and production. Thus, water management is *extremely* important in dryland crop production.

The percentage of total water utilized by the crop as ET was highest for CW and CS with over 60% of total water supply being used for ET, with evaporation accounting for 32 to 38% (Table 2). For WSF, which is fallow over 60% of the time, ET averaged 48% of total water supply for both wheat and sorghum, thus, 52% of total water evaporated. With WF, nearly 2/3 of total water available to the system was lost to evaporation. Continuous cropping systems utilized more of total precipitation for ET and had less evaporation, yet fallowing is important to obtain increased soil water contents at planting. *It appears that for efficient use of water and high production, a flexible or opportunity cropping system based on soil water content at planting would be best.* Wheat and sorghum would work well with this system, using annual cropping if the soil is wet to 3 or 3½ ft at planting time, or fallowing and planting at the next opportunity if the soil is dry at planting.

Precipitation-use-efficiency (PUE) is an indicator of how efficiently we are utilizing our soil water and precipitation to produce grain and is reported in bushels of grain produced per inch of water used. Precipitation-use-efficiency of sorghum was nearly three times greater than PUE of wheat (Table 2). It is interesting that PUE of WSF-wheat was greater than for CW, thus fallow is not always inefficient. Overall, PUE for both wheat and sorghum grown in WSF rotation compared favorably with PUE for continuous cropping, indicating that *WSF is a very-well adapted dryland sequence that uses water efficiently and produces high yields.*

Economics

Economic analyses of tillage and cropping systems are presented in Table 3 and Fig. 7. Custom farming rates paid by farmers in the Bushland area in 1996 were used in the analyses. Grain, chemical and fertilizer prices were obtained in November 1996, from Bushland Grain Coop., Bushland, TX (Appendix 1). Annual interest was charged at 10%. Crop yields used in the analyses were the 10-year averages from our study, which includes one zero yield for each crop. Commodity prices used were $4.20 cwt ($2.35 bu) for sorghum and $4.12 bu for wheat. Projected 1997 Farm Service Agency (FSA) payments on crop base acres were based on average county yields (dryland) for Randall County. Assistance in calculating FSA payments was provided by Randall County CFSA office. Nitrogen fertilizer costs were charged to CW and CS with 40 lb/acre as NH_3 on SM and 35 lb/acre N as 28-0-0 liquid on NT. Fertilizer costs

were not charged against WSF and WF systems because on Pullman soil, adequate N is mineralized to support anticipated yield levels. An insecticide application to control greenbug was assumed to be required every 3 years on both wheat and sorghum.

Table 3. Tillage and rotation effects on annual income, expenses, and returns (level plots).

Crop rotation[1]	Tillage	Harvest yield	Annual expenses	FSA payment	Grain sales	Annual returns
		bu/acre	$/acre			
CS	SM	51.8	70.36	11.76	121.73	63.13
CS	NT	46.7	82.56	11.76	109.75	38.95
CW	SM	14.1	62.57	11.05	58.09	6.58
CW	NT	16.8	75.96	11.05	69.22	4.30
WF	SM	22.7	39.98	11.05	46.76	19.83
WF	NT	22.9	41.39	11.05	47.17	16.83
WSF	SM	23.0/56.4	47.24	11.41	75.76	39.93
WSF	NT	22.3/61.5	46.01	11.41	78.79	44.07

[1] Wheat yield/sorghum yield.
Grain prices: sorghum $2.35 bu ($4.20 CWT); wheat $4.12 bu.
Cropping rotation: CS = continuous sorghum; CW = continuous wheat; WF = wheat-fallow; WSF = wheat-sorghum-fallow.
Tillage system: SM = stubble mulch tillage with large sweeps; NT = no-tillage using chemicals to control weeds.
Tables showing costs charged for custom farming operations, chemicals, fertilizers, and the spreadsheets used in calculating information in this table are contained in Appendix 1.

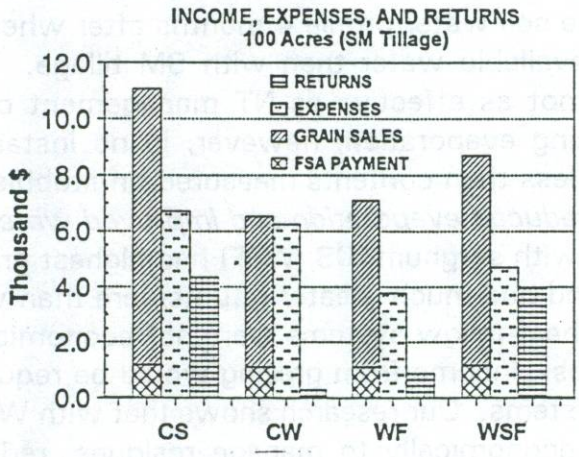

Fig 7 — Crop rotation effects on income, expenses, and returns for a 100-acre field custom farmed using SM-tillage on non-level land.

Annual returns calculated are returns to land, management, and capital. Thus, land rent or payments, land leveling or terracing costs, managerial expenses, and investment returns must be paid out of what we call *returns*. Labor costs are included in the custom farming rates.

Annual returns from leveled land ranged from a high of $63/acre to a low of $4/acre. Greatest annual returns were obtained with CS, followed by WSF, WF, and CW (Table 3). Highest income, expenses, and returns were experienced with the CS system with returns to land, management, and capital being $24/acre greater from SM than from NT. On WSF, NT had a $4/acre greater return than SM. Returns were very low on CW systems.

Tillage or herbicide application expenses were about the same for NT and SM systems with WF and WSF cropping sequences. Costs for NT were considerably greater than for SM on the CS and CW systems. While a total NT system may not be applicable in all cases (particularly with opportunity cropping), inclusion of some herbicides to aid in weed control and maintain residues on the surface can be done economically. Including herbicides in the farming plan can improve soil and water conservation and allow producers to meet conservation plan requirements on highly erodible land.

An economic comparison of cropping sequences for a 100 acre field using SM tillage is shown in Fig. 7. Systems with sorghum had much higher income and greater returns than wheat systems. On the non-level land, annual returns from WSF with SM tillage were nearly as great ($39.61) as from CS with SM tillage ($43.52) (Appendix 1). Thus, WSF competes economically with CS, even though it is a less intensive cropping system. From a grain production standpoint, not considering any grazing benefit, our analyses show that CW and WF systems are uneconomical, even with $4/bu wheat.

SUMMARY AND CONCLUSIONS

No-tillage management of wheat residues increased soil water contents and grain yields. With NT, the soil water profile 4 months after wheat harvest contained 1.4 inches more plant available water than with SM tillage. NT management of sorghum residues were not as effective as NT management of wheat residues in storing water and reducing evaporation; however, in no instance were soil water profile contents with NT less than contents measured on stubble mulch. *Keeping all residues on the surface reduced evaporation and improved water conservation.*

Cropping systems with sorghum (CS, WSF) had highest grain production, used water more efficiently, and had much greater returns/acre than wheat only systems. Continuous wheat and wheat-fallow systems were not economical systems for grain production in our analyses. Income from grazing would be required for CW and WF to be viable production systems. Our research shows that with WSF and WF systems, herbicides can be used economically to manage residues, reduce erosion, reduce evaporation, and improve soil and water conservation.

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CUSTOM FARMING COSTS USED IN ECONOMIC ANALYSES.

Operation:	Unit	Cost/Unit $
Sweep (Blade)	ac	5.00
Cultivation	ac	5.00
Anhydrous Appl.	ac	6.00
Liquid Fert. Appl.	ac	3.50
Ground Spray	ac	3.50
Aerial Spray	ac	4.50
Wheat Sowing	ac	6.00
Sorghum Planting	ac	6.00
Sorghum Seed	lb	1.00
Sorghum Seed (Safened)	lb	1.15
Wheat Seed	lb	0.13

CHEMICAL COSTS

Chemical	Unit	Cost/Unit $
2, 4-D		3.73
Atrazine	lb	3.48
Propazine	lb	7.05
Roundup Ultra	oz	0.44
Landmaster BW	oz	0.175
Glean	oz	14.42
Ally	oz	22.07
Finesse	oz	12.72
Dual	lb	8.53
Crop Oil	qt	1.20
Surfactant	qt	3.60
Anhydrous N	lb	0.15
Liquid N (28-0-0)	lb	0.32
Lorsban	pt	6.28
Parathion	pt	3.55

HARVEST COSTS

Wheat: $13 acre + 13¢ bu over 20 bu/acre + 13¢ bu hauling

Sorghum: 45¢ CWT combining + 20¢ CWT hauling

ESTIMATED COSTS, RETURNS
1 acre of continous sorghum, no-till, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$2.35	46.7	$109.75	
FSA pmt.	ac.	0.42	28	11.76	
			Total Receipts:		121.51
Cash Expenses:					
Roundup Ultra	oz.	$0.44	20	$8.80	
Spray	ac.	3.50	3	10.50	
Dual	pt.	8.53	1.5	12.79	
Atrazine	lb.	3.48	1	3.48	
Planting	ac.	6.00	1	6.00	
Seed	lb.	1.15	2.5	2.88	
Nitrogen	lb.	0.32	35	11.20	
N application	ac.	3.50	1	3.50	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	17.00	1	17.00	
			Total Cash Expense:		78.63
Other expenses:					
		Interest on operating capital: (10% * $78.63 /2)			$3.93
		Total specified expenses:			$82.56
		Return above specified expenses:			$38.95

ESTIMATED COSTS, RETURNS
1 acre of continous sorghum, stubble-mulch, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$2.35	51.8	$121.73	
FSA pmt.	ac.	0.42	28	11.76	
			Total Receipts:		133.49
Cash Expenses:					
SM Sweep	ac.	$5.00	2.5	$12.50	
Planting	ac.	6.00	1	6.00	
Seed	lb.	1.00	2.5	2.50	
Spray	ac.	3.50	1	3.50	
Atrazine	lb.	3.48	1	3.48	
Crop oil	qt.	1.20	1	1.20	
Cultivation	ac.	5.00	1	5.00	
Nitrogen	lb.	0.15	40	6.00	
N application	ac.	6.00	1	6.00	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	18.35	1	18.35	
					67.01
Other expenses:					
		Interest on operating capital: (10% * $67.01 /2)			$3.35
		Total specified expenses:			$70.36
		Return above specified expenses:			$63.13

ESTIMATED COSTS, RETURNS
1 acre of continous sorghum, stubble-mulch, non-level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$2.35	42.1	$98.94	
FSA pmt.	ac.	0.42	28	11.76	
			Total Receipts:		110.70
Cash Expenses:					
SM Sweep	ac.	$5.00	2.5	$12.50	
Planting	ac.	6.00	1	6.00	
Seed	lb.	1.00	2.5	2.50	
Spray	ac.	3.50	1	3.50	
Atrazine	lb.	3.48	1	3.48	
Crop oil	qt.	1.20	1	1.20	
Cultivation	ac.	5.00	1	5.00	
Nitrogen	lb.	0.15	40	6.00	
N application	ac.	6.00	1	6.00	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	15.32	1	15.32	
			Total Cash Expense:		63.98
Other expenses:					
		Interest on operating capital: (10% * $63.98 /2)			$3.20
			Total specified expenses:		$67.17
			Return above specified expenses:		$43.52

ESTIMATED COSTS, RETURNS
1 acre of continous wheat, no-till, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$4.12	16.8	$69.22	
FSA pmt.	ac.	0.65	17	11.05	
			Total Receipts:		80.27
Cash Expenses:					
Spray	ac.	$3.50	3	$10.50	
Finesse	oz.	12.72	0.1	$1.27	
2,4-D	lb.	3.73	0.25	0.93	
Landmaster	oz.	0.18	54	9.45	
Roundup Ultra	oz.	0.44	12	5.28	
Surfactant	gal.	14.42	0.25	3.61	
Planting	ac.	6.00	1	6.00	
Seed	lb.	0.13	35	4.55	
Nitrogen	lb.	0.32	30	9.60	
N application	ac.	3.50	1	3.50	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	15.18	1	15.18	
			Total Cash Expense:		72.34
Other expenses:					
		Interest on operating capital: (10% * $72.34 /2)			$3.62
			Total specified expenses:		$75.96
			Return above specified expenses:		$4.30

ESTIMATED COSTS, RETURNS
1 acre of continous wheat, stubble-mulch, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$4.12	14.1	$58.09	
FSA pmt.	ac.	0.65	17	11.05	
			Total Receipts:		69.14
Cash Expenses:					
SM sweep	ac.	$5.00	3	$15.00	
Planting	ac.	6.00	1	$6.00	
Seed	lb.	0.13	35	4.55	
Nitrogen	lb.	0.15	40	6.00	
N application	ac.	6.00	1	6.00	
Spray	ac.	3.50	1	3.50	
2,4-D	lb.	3.73	0.33	1.23	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	14.83	1	14.83	
			Total Cash Expense:		59.59
Other expenses:					
			Interest on operating capital:		$2.98
			(10% * $59.59 /2)		
			Total specified expenses:		$62.57
			Return above specified expenses:		$6.58

ESTIMATED COSTS, RETURNS
1 acre of continous wheat , stubble-mulch, non-level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$4.12	13.2	$54.38	
FSA pmt.	ac.	0.65	17	11.05	
			Total Receipts:		65.43
Cash Expenses:					
SM sweep	ac.	$5.00	3	$15.00	
Planting	ac.	6.00	1	$6.00	
Seed	lb.	0.13	35	4.55	
Nitrogen	lb.	0.15	40	6.00	
N application	ac.	6.00	1	6.00	
Spray	ac.	3.50	1	3.50	
2,4-D	lb.	3.73	0.33	1.23	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	14.71	1	14.71	
			Total Cash Expense:		59.47
Other expenses:					
			Interest on operating capital:		$2.97
			(10% * $59.47 /2)		
			Total specified expenses:		$62.44
			Return above specified expenses:		$2.99

ESTIMATED COSTS, RETURNS
1 acre of wheat fallow rotation, no-till, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$4.12	22.9	$94.35	
FSA pmt.	ac.	0.65	34	22.10	
		2 Year Total Receipts:			116.45
		Annual Total Receipts:			58.22
Cash Expenses:					
Spray	ac.	$3.50	4	$14.00	
Finesse	oz.	12.72	0.1	$1.27	
Atrazine	lb.	3.48	1	3.48	
2,4-D	lb.	3.73	0.75	2.80	
Landmaster	oz.	0.18	54	9.45	
Roundup Ultra	oz.	0.44	24	10.56	
Surfactant	gal.	14.42	0.3	4.33	
Planting	ac.	6.00	1	6.00	
Seed	lb.	0.13	35	4.55	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	16.35	1	16.35	
		2 Year Total Cash Expense:			75.27
Other expenses:					
Interest on operating capital for 2 year period: (10% * $75.27)					$7.53
2 Year Total specified expenses:					$82.79
1 Year Total specified expenses:					41.40
Return above specified expenses for 2 yr period:					$33.66
Annual Return above specified expenses:					$16.83

ESTIMATED COSTS, RETURNS
1 acre of wheat fallow, stubble-mulch, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$4.12	22.7	$93.52	
FSA pmt.	ac.	0.65	34	22.10	
		2 Year Total Receipts:			115.62
		Annual Total Receipts:			57.81
Cash Expenses:					
SM sweep	ac.	$5.00	7	$35.00	
Planting	ac.	6.00	1	$6.00	
Seed	lb.	0.13	35	4.55	
Spray	ac.	3.50	1	3.50	
2,4-D	lb.	3.73	0.33	1.23	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	16.30	1	16.30	
		2 Year Total Cash Expense:			69.06
Other expenses:					
Interest on operating capital for 2 year period: (10% * $69.06)					$6.91
2 Year Total specified expenses:					$75.97
1 Year Total specified expenses:					37.98
Return above specified expenses for 2 yr period:					$39.66
Annual Return above specified expenses:					$19.83

ESTIMATED COSTS, RETURNS
1 acre of wheat fallow, stubble-mulch, non-level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested	bu.	$3.30	21.4	$70.62	
FSA pmt.	ac.	0.65	34	22.10	
		2 Year Total Receipts:			92.72
		Annual Total Receipts:			46.36
Cash Expenses:					
SM sweep	ac.	$5.00	7	$35.00	
Planting	lb.	6.00	1	$6.00	
Seed	lb.	0.13	35	4.55	
Spray	ac.	3.50	1	3.50	
2,4-D	lb.	3.73	0.33	1.23	
Insecticide	ac.	2.48	1	2.48	
Harvest & Haul	ac.	15.96	1	15.96	
		2 Year Total Cash Expense:			68.72
Other expenses:					
		Interest on operating capital for 2 year period:			$6.87
		(10% * $68.72)			
		2 Year Total specified expenses:			$75.59
		1 Year Total specified expenses:			37.80
		Return above specified expenses for 2 yr period:			$17.13
		Annual Return above specified expenses:			$8.56

ESTIMATED COSTS, RETURNS

1 acre of wheat-sorghum-fallow rotation, no-till, level plots

Operation		Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:						
Grain Harvested				1/3 of		
	Wheat	bu.	$4.12	22.3	$30.63	
	Sorghum	bu.	2.35	61.5	48.18	
FSA pmt.						
	Wheat	ac.	0.65	17	5.53	
	Sorghum	ac.	0.42	28	5.88	
				Annual Receipts:		$90.21
Cash Expenses:						
Spray		ac.	$3.50	6	$21.00	
Atrazine		lb.	3.48	3	10.44	
2,4-D		lb.	3.73	1.08	4.03	
Crop oil		qt.	1.20	1	1.20	
Roundup Ultra		oz.	0.44	36	15.84	
Landmaster		oz.	0.18	54	9.45	
Ally		ac.	14.42	0.1	1.44	
Planting, sorghum		ac.	6.00	1	6.00	
Planting, wheat		ac.	6.00	1	6.00	
Sorghum seed		lb.	1.00	2.5	2.50	
Wheat seed		lb.	0.13	35	4.55	
Insecticide		ac.	4.96	1	4.96	
Sorghum Harvest		ac.	22.23	1	22.23	
Wheat Harvest		ac.	16.19	1	16.19	
			Total Cash Expense for 3 year period:			125.83
			Annual Total Cash Expense			41.94
Other expenses:						
			Interest on operating capital:			$4.19
			(10% * $41.94)			
			1 Year Total specified expenses:			$46.14
			Annual Return above specified expenses:			$44.07

ESTIMATED COSTS, RETURNS

1 acre of wheat-sorghum-fallow rotation, stubble-mulch, level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested			1/3 of		
Wheat	bu.	$4.12	23	$31.59	
Sorghum	bu.	2.35	56.4	$44.18	
FSA pmt.					
Wheat	ac.	0.65	17	5.53	
Sorghum	ac.	0.42	28	5.88	
			Annual Receipts:		$87.17
Cash Expenses:					
Fallow after Sorghum					
SM sweep	ac.	$5.00	5	$25.00	
Wheat					
Planting	ac.	6.00	1	6.00	
Seed	lb.	0.13	35	4.55	
Spray	ac.	3.50	1	3.50	
2,4-D	lb.	3.73	0.33	1.23	
Harvest & Haul	ac.	16.40	1	16.40	
Fallow after Wheat					
SM Sweep	ac.	5.00	5	25.00	
Sorghum					
Planting	ac.	6.00	1	6.00	
Seed	lb.	1.00	2.5	2.50	
Spray	ac.	3.50	1	3.50	
Atrazine	lb.	3.48	1	3.48	
Crop oil	qt.	1.20	1	1.20	
Cultivation	ac.	5.00	1	5.00	
Insecticide	ac.	4.96	1	4.96	
Harvest & Haul	ac.	20.52	1	20.52	
		Total Cash Expense for 3 year period:			128.84
		Annual Total Cash Expense			42.95
Other expenses:					
		Interest on operating capital:			$4.29
		(10% * $42.95)			
		1 Year Total specified expenses:			$47.24
		Annual Return above specified expenses:			$39.93

ESTIMATED COSTS, RETURNS

1 acre of wheat-sorghum-fallow rotation, stubble-mulch, non-level plots

Operation	Unit	Price or Cost/Unit	# of Units	Value or Cost	Total Value or Cost
Gross Receipts:					
Grain Harvested			1/3 of		
Wheat	bu.	$4.12	22.9	$31.45	
Sorghum	bu.	2.35	56.1	$43.95	
FSA pmt.					
Wheat	ac.	0.65	17	5.53	
Sorghum	ac.	0.42	28	5.88	
			Annual Receipts:		$86.80
Cash Expenses:					
Fallow after Sorghum					
SM sweep	ac.	$5.00	5	$25.00	
Wheat					
Planting	ac.	6.00	1	6.00	
Seed	lb.	0.13	35	4.55	
Spray	ac.	3.50	1	3.50	
2,4-D	lb.	3.73	0.33	1.23	
Harvest & Haul	ac.	16.35	1	16.35	
Fallow after Wheat					
SM Sweep	ac.	5.00	5	25.00	
Sorghum					
Planting	ac.	6.00	1	6.00	
Seed	lb.	1.00	2.5	2.50	
Spray	ac.	3.50	1	3.50	
Atrazine	lb.	3.48	1	3.48	
Crop oil	qt.	1.20	1	1.20	
Cultivation	ac.	5.00	1	5.00	
Insecticide	ac.	4.96	1	4.96	
Harvest & Haul	ac.	20.42	1	20.42	
		Total Cash Expense for 3 year period:			128.69
		Annual Total Cash Expense			42.90
Other expenses:					
		Interest on operating capital:			$4.29
		(10% * $42.90)			
		1 Year Total specified expenses:			$47.19
		Annual Return above specified expenses:			$39.61