Kansas State University
Agricultural Experiment Station and Cooperative Extension Service

Managing Intensive Nonirrigated Cropping Systems in Western Kansas

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Contents –

The management of intensive nonirrigated cropping systems must be an ongoing, flexible process in western Kansas. Conservation of moisture for use in crop enterprises is the key determinant of success in intensive nonirrigated cropping systems in this region. Moisture preservation is accomplished mainly by limiting weed growth while at the same time reducing tillage operations. The necessary reliance on no-till or reduced-till methods forces producers to continually monitor weed development and be prepared to apply herbicides in a timely manner, especially during the wheat and summer crop stubble periods. Another key to the success of these cropping systems is the effective use of no-till or reduced-till planting and seeding equipment in fields with higher amounts of crop residue.

A summary of a 1997 survey of wheat-fallow and wheat-summer crop-fallow (W-S-F) rotation practices in western Kansas reinforces the importance of reduced-till weed control and moisture conservation practices in this region. Of the 112 crop producers who responded, 69 percent reported using wheat-summer crop-fallow or more intensive rotations, while 31 percent used less-intensive wheat-fallow rotations. Producers using more-intensive cropping systems reported they make extensive use of multiple-application herbicide treatments throughout the wheat and summer crop stubble periods. Overall, 52 percent of respondents used no-till practices, while minimum-till practices were used by 75 percent of respondents. These results are consistent with the number of producers who report they are using more-intensive nonirrigated cropping systems.

After defining the four phases of the wheat-summer crop-fallow rotation in western Kansas, this publication has a three-fold goal. First, a description of nonirrigated cropping practices in western Kansas will be given. Both state agricultural statistics and the results of a survey of western Kansas nonirrigated crop producers will be discussed. Second, an analysis will be made of the economic profitability of intensive nonirrigated cropping systems and of individual crops within these systems. Third, the key management factors during each of the four phases of an intensive 36-month wheat-summer crop-fallow system for this region will be discussed. This publication is part of a series focusing on management of intensive nonirrigated cropping systems. Other publications in this series focus on recommended weed control, crop fertility management practices, and other management-related topics. References will be made to these and other K-State Research and Extension publications to provide crop producers with a comprehensive, coordinated, decision-making guide for intensive, nonirrigated cropping systems.

The Wheat–Summer Crop–Fallow Cropping System

The separate phases of the wheat-summer crop-fallow (W-S-F) cropping system in western Kansas area are presented in Figure 1. This cropping system is 36 months in duration and has four distinct subsections. Phase I is the winter wheat production phase. This is the time period lasting from winter wheat seeding in the fall until harvest the following year — a period of approximately 9 months. Phase II is the winter wheat stubble phase. Beginning after summer wheat harvest, this phase lasts until the following spring when a summer crop is planted, a period of approximately 11 months. Phase III is the summer crop production phase, which begins with planting the summer crop and lasts through the spring and summer growing season until fall harvest. The duration can be from 4 to 6 months, depending on the summer crop selected and its planting and harvesting dates. Phase IV is the summer crop stubble phase. Beginning at fall harvest of the summer crop, this phase lasts about 11 months until seeding of the wheat crop the following fall.

The keys to successfully managing each of the four phases of this crop rotation will be discussed in the last section of this publication.

Nonirrigated Cropping Practices in Western Kansas

Two sources of information are available to describe the nonirrigated cropping system management practices of western Kansas farmers. General information including acreage, rotations, and yields is available through the USDA-Kansas Department of Agriculture Statistics Division. More specific information about cropping practices and management decisions has been obtained using a 1997 survey of western Kansas nonirrigated crop producers.

USDA-Kansas Agricultural Statistics Information [1]

Crop acreage statistics indicate, at most, 32 percent of nonirrigated crop acreage could have been in a wheat-summer crop-fallow rotation during the 1994 and 1995 crop years in the western one-third of Kansas. In those years, an average of 3,482,500 acres of wheat were seeded on summer-fallowed land in the northwest, west central, and southwest parts of the state, with an average of 3,301,500 of those acres actually harvested. This compares to a 1994-95 average of 839,150 harvested acres of nonirrigated grain sorghum, corn, soybeans, and oil-type and confectionary sunflowers.

Figure 1. *The Four Phases of the Wheat-Summer Crop-Fallow Rotation in Western Kansas*

Phase I. Winter wheat production — approximately 9 months
(Sept. 15, Year 1, to July 1, Year 2)

Phase II. Winter wheat stubble — approximately 11 months
(July 1, Year 2, to June 1, Year 3)

Phase III. Summer crop production — approximately 4 months
(June 1, Year 3, to Oct. 1, Year 3)

Phase IV. Summer crop stubble — approximately 11 months
(Oct. 1, Year 3, to Sept. 15, Year 4)

[1] Source: Kansas 1996 and 1997 Farm Facts and 1997 Crop Production and Planting Intention Reports, USDA-Kansas Department of Agriculture

If every acre of summer crop produced in western Kansas in 1994-95 were in a 3-year W-S-F rotation, that would account for 2,517,450 acres of cropland (3 × 839,150 acres). The remaining 2,462,350 acres of wheat harvested after summer fallow (3,301,500 acres – 839,150 acres) would be in a wheat-fallow rotation, accounting for 4,924,700 acres of cropland. After adjusting for the wheat harvested on continuously cropped land (436,500 acres), a maximum of 2,517,450 acres could be in a W-S-F rotation out of a total of 7,878,650 nonirrigated cropping-system acres in the western one-third of the state (32 percent).

In 1996, spring-planted crop acreage in western Kansas increased to 1,752,100 acres due to record grain sorghum plantings following severe spring freeze damage to that year's wheat crop. Much of the increased acreage of summer crops that year was planted into what remained of the freeze-damaged wheat, giving many western Kansas wheat producers their first experience in using more-intensive nonirrigated cropping practices.

In 1997, the acreage of spring-planted crops again declined statewide, but it still remained 15 percent to 18 percent greater than 1994-95 levels. More information about western Kansas nonirrigated crop acreage trends for 1994 to 1997 is presented in Appendix A.

These acreage figures indicate a sizable proportion of western Kansas cropland is currently in intensive wheat-summer crop-fallow rotations. Because the relatively small acreage of continuous summer crop and irrigated confectionary sunflowers in western Kansas is not accounted for in these figures, these percentages are approximations of actual intensive crop rotation prevalence. With the freeze-induced increase in summer crop acreage in 1996 and higher-than-normal summer crop acreage in 1997, there likely will be a continued trend toward increased wheat-summer crop-fallow and even more-intensive crop rotations in this region.

Survey of Nonirrigated Crop Production Practices in Western Kansas [2]

A survey of the nonirrigated cropping system production practices used by farmers in western Kansas was conducted by K-State Research and Extension personnel in early 1997. The survey focused on individual farmer's choices of tillage systems, herbicide programs, fertility practices, and selection of spring-planted row crops in more-intensive cropping systems. The emphasis of these survey findings was on overall summary measures for western Kansas. More detailed analysis is provided in Appendix A regarding differences between northwest and southwest Kansas and between wheat-fallow and more-intensive nonirrigated cropping systems.

The survey was conducted during January through March of 1997. Approximately 500 surveys were mailed to western Kansas producers, and 112 were returned. The producers to which this survey was mailed were selected differently in northwest and southwest Kansas. In northwest Kansas, K-State Extension agricultural agents provided area Extension staff with the names of 15 to 25 nonirrigated crop producers per county for the survey. In southwest Kansas, a random sample of crop producers was taken from county-by-county listings of farmers. Names also were drawn from a listing of farmers with an identified interest in water-conserving nonirrigated cropping systems.

Dominant crop rotation. The wheat-summer crop-fallow rotation was the dominant rotation for 66 percent of the survey respondents (Appendix B, Table A). A traditional wheat-fallow rotation was the primary cropping system of 31 percent of respondents. Three percent of those responding indicated they use cropping systems more intensive than wheat-summer crop-fallow, with consecutive years of wheat, skipped fallow periods, or other intensive cropping practices.

Dominant summer crop in W-S-F rotations. As expected in western Kansas, 98 percent of respondents indicated wheat was one of the main crops produced on their farms (Appendix B, Table B). Beyond wheat, the next most-common summer crop was grain sorghum (63 percent) followed by corn (37 percent), forages such as cane hay (27 percent), oil-type sunflowers (12 percent), confectionary sunflowers (7 percent), and other crops (1 percent).

Prevalence of no-till and reduced-till practices. Most producers did not regularly use tillage operations to incorporate wheat straw after harvest prior to fall (77 percent) (Appendix B, Table C). No respondents indicated they remove straw after wheat harvest. No-till practices were used by 52 percent of respondents, with 62 percent of those using no-till indicating they had done so for more than 5 years. Minimum-till practices were used by 75 percent of respondents, with 70 percent of them indicating they have been using minimum-tillage practices for more than 5 years.

Fertilizer applications for wheat. Of the 112 respondents, 102 reported they applied nitrogen fertilizer to their wheat (Appendix B, Table D). The most common wheat fertility program among survey respondents included 51 pounds of nitrogen (average amount) applied per acre during July and August (76 percent) by either chiseling, injecting, or knifing it into the soil (66 percent). In addition, 78 percent of those applying nitrogen also applied phosphorous, averaging 27 pounds per acre of phosphate (P_2O_5) applied during August and September (86 percent) either in the seed furrow at seeding (44 percent); chiseled, injected, or knifed into the soil (25 percent); or broadcast and incorporated (20 percent). Only 6 percent of producers applied any potash to wheat.

Fertilizer applications for grain sorghum. Seventy-three of 112 survey respondents reported they applied nitrogen fertilizer to their grain sorghum (Appendix B, Table E). The most common grain sorghum fertility program included 62 pounds of nitrogen (average amount) applied per acre during April and May (65 percent) by either chiseling, injecting, or knifing it into the soil (37 percent) or by broadcasting without incorporating (33 percent). In addition, 60 percent of those applying nitrogen also applied phosphorous, with an average of 26 pounds per acre of

[2] Daniel O'Brien and James Sartwelle, area Extension agricultural economists in northwest and southwest Kansas, respectively; Randall Brown and Curtis Thompson, area Extension crops and soils specialists in northwest and southwest Kansas, respectively.

phosphate applied during May and June (84 percent), either in a 2-inch-by-2-inch placement at seeding (43 percent), in the seed furrow at seeding (19 percent), or banded in or applied over the row (17 percent). Only a small percentage of producers reported applying any potash to grain sorghum.

Fertilizer applications for corn. Forty of 112 survey respondents reported they applied nitrogen fertilizer to their nonirrigated corn (Appendix B, Table F). The most common corn fertility program included 77 pounds of nitrogen (average amount) applied per acre during March, April, and May (82 percent) by broadcasting without incorporating (40 percent); chiseling, injecting, or knifing it into the soil (18 percent); or in a 2-inch-by-2-inch placement at seeding (20 percent). In addition, three-fourths of those who applied nitrogen also applied phosphate, with an average of 27 pounds per acre of phosphate applied during May and June (90 percent) in a 2-inch-by-2-inch placement at seeding (45 percent) or in the seed furrow at seeding (31 percent). Only a small percentage of producers reported applying potash to corn.

Fertilizer applications for cane hay. Thirty of 112 survey respondents reported they applied nitrogen fertilizer to their nonirrigated cane hay. The most common cane hay fertility program included 47 pounds of nitrogen (average amount) applied per acre during May (70 percent) by chiseling, injecting, or knifing it into the soil (66 percent) or by broadcasting and then incorporating (24 percent). In addition, half of those who applied nitrogen also applied phosphate, with an average of 25 pounds per acre of phosphate applied during May and June (93 percent) either in the seed furrow at seeding (29 percent); by broadcasting and then incorporating (29 percent); or by chiseling, injecting, or knifing it into the soil (21 percent). Only a small percentage of producers reported applying any potash to cane hay.

Use of soil tests. Soil tests were regularly performed for wheat on 50 percent of the farms in this survey. The average depth for soil tests performed was 11 inches. When nitrogen tests were regularly taken, the amount of nitrogen applied to the crop was the amount recommended by the soil test 73 percent of the time. Twenty-seven percent indicated a set amount of nitrogen was applied each year to crops.

Wheat herbicide applications. Of the 112 surveys returned, 86 reported herbicides were applied to their wheat (Appendix B, Table G). The most frequently applied herbicides were from the sulfonylurea family (49 percent) followed by 2-4,D (17 percent) and dicamba (8 percent). The survey also reported glyphosate (16 percent) and atrazine (9 percent) were applied, presumably during the fallow period prior to wheat seeding. Although application timing varied greatly, the majority of post-emergence applications on growing wheat occurred during March with some applications in February and April. Some July and August herbicide applications also were reported. Post-emergence applications to growing wheat and weeds were done more frequently (approximately 75 percent) than pre-emergence applications (25 percent). Producers reporting a herbicide program indicated approximately 78 percent of their wheat acres were treated with herbicides. On these acres, herbicides were custom-applied approximately 60 percent of the time, with operators applying wheat herbicides on their own for the remainder.

Primary summer crop herbicide applications. Grain sorghum was the most frequently identified primary summer crop (42 percent) followed by corn (23 percent), sunflowers (1 percent), cane hay (1 percent), and “none” (32 percent) (Appendix B, Table H). Grain sorghum was especially prevalent as a summer crop in southwest Kansas. Few surveys indicated insecticide or fungicide treatments were applied, so the emphasis of this section will be on summer crop herbicide treatments. Of the 112 surveys returned, 72 producers reported herbicides were applied to their primary summer crops (Appendix B, Table H). The most frequently applied herbicides were atrazine (33 percent), glyphosate (23 percent), alachlor (22 percent), metolachlor with atrazine (7 percent), 2-4,D (4 percent), dicamba (4 percent), and those from the sulfonylurea family (3 percent). Application timing was concentrated in April through June, with approximately 78 percent of treatments being for pre-emergence weed control. Producers reporting a herbicide program indicated, on average, 88 percent of their summer crop acres were treated with herbicides. On these acres, herbicides were custom-applied 51 percent of the time, with operators applying summer crop herbicides on their own for the remainder (49 percent).

Fieldwork operations and production systems. Analysis of the survey results indicate 35 percent of producers had herbicide-oriented production systems, 15 percent had tillage-oriented systems, and 26 percent utilized a mixture of herbicides and tillage (Appendix B, Table I). Twenty-four percent of the respondents gave no indication of the tillage system they used. When separated by cropping system, farmers using wheat-summer crop-fallow or more-intensive systems tended to be herbicide-oriented or to rely on a mixture of herbicides and tillage. Wheat-fallow cropping systems tended to be tillage-oriented, relying heavily on tillage with V-blade undercutting operations to control weeds. Producers using more-intensive rotations indicated they follow an ongoing process of field observation leading to herbicide treatments when needed.

Post-harvest weed control programs in wheat stubble often involved multiple herbicide treatments and contingency-plan-oriented decision making to control weeds and conserve soil moisture. The use of no-till or reduced-till and planting practices was dominant in these more-intensive nonirrigated cropping rotations. Custom application of herbicides also was common in no-till or reduced-till rotations.

Comments on the Statistical and Survey Results

The results of the Kansas Agricultural Statistics surveys and the 1997 K-State survey differed widely in regard to the prevalence of wheat-summer crop-fallow or more-intensive rotations in the western third of Kansas. Kansas Agricultural Statistics indicated as much as 25 percent of nonirrigated acreage may be in such rotations, compared to 69 percent of the respondents to the 1997 K-State survey. This difference may be due to “self-selection” on the part of those responding to the latter. Those crop producers with an interest in intensive nonirrigated cropping systems may have been more motivated to complete and return the survey. However, the survey results still have value in that they increase the understanding of producers and industry representatives regarding the management practices used in intensive nonirrigated cropping systems in this region.

The survey showed clear distinctions between the management practices used in wheat-fallow rotations and wheat-summer crop-fallow rotations and between tillage-oriented and herbicide-oriented production systems. The key issue in the long-term viability of these alternative cropping systems and of the individual crops within them is profitability. That will be the focus of the next section.

The Profitability of Nonirrigated Cropping Systems in Western Kansas

The potential for higher net returns is the main factor behind the increase in nonirrigated wheat-summer crop-fallow system acreage at the expense of long-standing wheat-fallow rotations. K-State Research and Extension budget projections for representative yield scenarios indicate markedly higher net returns for these more-intensive rotations (Table 1). Projected net returns to land and management for wheat-fallow rotations range from $16.95 to $31.70 per acre, depending on whether the average wheat yield is 35 or 45 bushels per acre. In comparison, projected net returns to land and management for wheat-grain sorghum-fallow rotations range from $22.09 to $41.71 per acre, depending on whether the average wheat and sorghum yields are 35 and 60 bushels per acre, respectively, or 45 and 75 bushels per acre. Wheat-corn-fallow rotation projected returns are slightly higher than for the wheat-grain sorghum-fallow rotation. They range from $24.65 to $41.99 per acre, depending on whether the average wheat and corn yields are 35 and 65 bushels per acre, respectively, or 45 and 75 bushels per acre.

These budget projections indicate, at lower average yields, net returns to land and management for the more-intensive crop rotations are less than net returns in moderate to higher yielding wheat-fallow rotations. If moderate to higher yields can be achieved with the more-intensive rotations, their projected net returns are approximately $10 per acre greater than for corresponding moderate- to high-yielding wheat-fallow rotations.

These comparisons of projected net returns indicate intensive wheat-summer crop-fallow rotations have the potential to improve the profitability of nonirrigated rotations in the western third of Kansas. If moderate to higher yield levels can be attained in these intensive nonirrigated rotations, this analysis indicates their profit potential is markedly greater than for even moderate- to high-yielding wheat-fallow systems.

Comparing the Profitability of Summer Crop Alternatives in W-S-F Rotations

The summer crop possibilities in the nonirrigated wheat-summer crop-fallow rotation in western Kansas extend beyond grain sorghum and corn. Oil-type and confectionary sunflowers, cane hay, soybeans, barley, and millet also can be considered. The projected profitability of these crop alternatives using new crop price projections available in early 1998 is illustrated in Table 2.

These projections of net returns over variable costs are calculated in the same manner as producers would likely consider them when making their summer crop planting decisions. Fixed costs are not considered here as a factor in year-to-year summer crop selection. Any differences in fixed costs for the current marketing year among these crops would be negligible. If long-run budget projections were being made, fixed costs are included. In the long run, machinery costs (the primary fixed cost other than land expense) may differ as alternative crops and cropping systems are chosen.

Forward contract prices in western Kansas on January 23, 1998, were used in the revenue calculations. That date occurred during the time period when producers typically were making their final crop selections for the coming year. Yield and cost estimates were selected from K-State Farm Management Guide budgets for western Kansas to match with common yield potentials of these crops over the region.

Table 2 results indicate, among potential nonirrigated summer crop choices, corn, grain sorghum, and oil-type sunflower had the highest projected 1998 returns — $60 to $63 per acre — over variable costs. Projected 1998 returns for soybeans and confectionary sunflowers were in the $51 to $56 range, followed by cane hay returns of $41 and barley returns of $29 per acre more than variable costs. Millet returns were projected at $4.58 per acre. Note that changes in projected yields and prices for these crop enterprises could dramatically affect the comparative return-over-variable-cost estimates. This is particularly true for the yields of corn (75 bushels per acre) vs. grain sorghum (75 bushels per acre), and of confectionary sunflower (1,150 pounds per acre) vs. oil-type sunflower (1,500 pounds per acre).

When making projections of summer crop enterprise returns, western Kansas farmers should use yield levels that are representative for each crop given their land quality and management expertise in growing that crop. Producers should be cautious about considering crops they have no experience or management expertise in growing or for which they have no accessible market outlet.

Key Management Factors in Intensive Nonirrigated Cropping Systems in Western Kansas

The purpose of this section is to identify key factors for crop producers to consider or monitor in each of the four phases of an intensive 36-month wheat-summer crop-fallow system in western Kansas. The four phases were previously defined in Figure 1 as the winter wheat production phase, the winter wheat stubble phase, the summer crop production phase, and the summer crop stubble phase. A graphic illustration of these phases is presented in Figure 2. References in the following section are listed in Appendix C to assist crop producers in finding more specific, technical decision-making information related to intensive nonirrigated cropping systems in western Kansas.

Phase I: Winter Wheat Production

The winter wheat production phase lasts approximately 9 months, from wheat seeding in September or October of Year 1 to wheat harvest in June or July of Year 2. The key decisions for crop producers in this phase generally relate to wheat establishment and overall wheat production practices. Specifically during this phase, producers must make decisions regarding wheat seeding date and rate, weed control and moisture management, wheat fertility management, and wheat residue management at harvest.

Wheat planting decisions relate to variety selection, planting rate, planting date, and other factors. In conventionally prepared seedbeds, the wheat seeding equipment used in a traditional wheat-fallow rotation is adequate. However, if no-till or minimum-till practices are utilized during the preceding summer crop stubble period, a wheat drill adapted to reduced tillage conditions may be needed (Appendix C, References 1 and 2).

Table 1. *Projected Profitability of Alternative Nonirrigated Cropping Systems in Western Kansas*

	Wheat-fallow		**Wheat-grain sorghum-fallow** [2]		**Wheat-corn-fallow** [3]	
Yield scenarios	**A**	**B**	**C**	**D**	**E**	**F**
% wheat of total acreage	50%	50%	33.33%	33.33%	33.33%	33.33%
% row crop of total acreage	NA	NA	33.33%	33.33%	33.33%	33.33%
% fallow of total acreage	50%	50%	33.33%	33.33%	33.33%	33.33%
Wheat yield (bu/acre)	35 bu	40 bu	35 bu	45 bu	35 bu	45 bu
Wheat price[4] ($/bu)	$3.65	$3.65	$3.65	$3.65	$3.65	$3.65
Row crop yield (bu/acre)	NA	NA	60 bu	75 bu	65 bu	75 bu
Row crop price[4] ($/bu)	NA	NA	$2.45	$2.45	$2.78	$2.78
Revenue						
Production returns per acre	$63.88	$82.13	$91.59	$116.00	$102.82	$124.25
Government payments[5] per acre	$6.67	$6.67	$6.67	$6.67	$6.67	$6.67
Total revenue per acre	$70.55	$88.80	$98.25	$122.67	$109.49	$130.92
Variable costs						
Wheat VC per acre (including labor)	$82.19	$88.54	$82.62	$89.19	$82.62	$89.19
Row Crop VC per acre (including labor)	$0.00	$0.00	$94.41	$102.22	$120.83	$126.55
Total VC per acre (crop + fallow)	$41.10	$44.27	$59.01	$63.81	$67.82	$71.92
Machinery costs						
Machinery depreciation, interest and insurance per acre (cropped acres)	$25.66	$25.66	$25.73	$25.73	$25.52	$25.52
Machinery costs (depreciation, interest & insurance per acre) (all acres)	$12.83	$12.83	$17.15	$17.15	$17.01	$17.01
Variable + machinery costs						
Total variable and machinery cost per acre (all acres)	$53.93	$57.10	$76.16	$80.96	$84.83	$88.93
Net returns to land & management	$16.62	$31.70	$22.09	$41.71	$24.65	$41.99

[1] *Wheat Cost-return Budget (W-F Rotation) in Western Kansas*, 1997 K-State Farm Management Guide MF-257, Daniel M. O'Brien and James Sartwelle III.
[2] *Wheat Cost-return Budget (W-S-F Rotation) in Western Kansas*, 1997 K-State Farm Management Guide MF-903, Daniel M. O'Brien and James Sartwelle III; *Grain Sorghum Cost-return Budget (W-S-F Rotation) in Western Kansas*, 1997 K-State Farm Management Guide MF-904, James Sartwelle III and Daniel M. O'Brien.
[3] *Wheat Cost-return Budget (W-S-F Rotation) in Western Kansas*, 1997 K-State Farm Management Guide MF-903, Daniel M. O'Brien and James Sartwelle III; *No-till Corn Cost-return Budget (W-C-F Rotation) in Western Kansas*, 1997 K-State Farm Management Guide MF-2150, James Sartwelle III, Curtis R. Thompson, and Daniel M. O'Brien.
[4] Planning prices are 5-year averages (1990 to 1994) for Kansas.
[5] Production flexibility contract payments are assumed to average $10 per base acre or $6.67 over all base and non-base acres.

Table 2. *Return over Variable Cost Projections for Nonirrigated Spring Crops in W-S-F Rotations in Western Kansas in 1998*

	Corn	Grain sorghum	Soybean	Confection sunflower	Oil-type sunflower	Cane hay	Barley	Millet
Sale-harvest units	bu	bu	bu	cwt	cwt	ton	lb	lb
Projected harvest price (2/10/97) [1]	$2.50	$2.20	$6.00	$14.00	$10.00	$45	$2.60	$0.04
Yield per acre	75 [3]	75 [3]	25 [4]	1,150 [4]	1500 [3]	2.75 [3]	40 [3]	1,150
Crop revenue per acre	$187.50	$165.00	$150.00	$161.00	$150.00	$123.75	$104.00	$46.00
Fertilizer, herbicide, insecticide cost per acre [2]	70.17	47.32	55.66	58.10	44.67	24.00	36.32	12.59
Other variable costs per acre [2]	56.38	54.90	34.31	51.07	43.67	59.05	39.07	28.84
Returns over variable costs per acre	**$60.95**	**$62.78**	**$55.91**	**$51.83**	**$61.66**	**$40.70**	**$28.61**	**$4.58**

[1] Forward contract and expected prices for western Kansas locations as of January 23, 1998.
[2] Variable cost estimates from 1997 K-State Farm Management Guide nonirrigated crop budgets for western and south central Kansas.
[3] Yield levels represent the middle of the range of likely production levels in K-State Farm Management Guides.
[4] Yield levels represent the low end of the range of likely production levels in K-State Farm Management Guides.

Figure 2. *Four Phases of the 36-month Wheat-summer crop-fallow Rotation in Western Kansas*

Phase I Winter wheat	**Phase II** Winter wheat stubble	**Phase III** Summer crop	**Phase IV** Summer crop stubble
9 months	11 months	4 to 6 months	11 months
Sept. 15, Year 1, to July 1, Year 2	July 1, Year 2, to May 15-June 1, Year 3	May 15-June 1, Year 3, to Oct. 1, Year 3	Oct. 1, Year 3, to Sept. 15, Year 4

Weed control and moisture management are closely linked in the wheat-summer crop-fallow system. Residual herbicides can be used to reduce tillage or subsequent herbicide applications. However, herbicide selection must take into account possible carry-over effects on anticipated summer crops in Phase III (Appendix C, References 3, 4, and 5).

Wheat fertility program decisions relate to the timing, amounts, and methods used to apply fertilizer to wheat. Of particular importance is the decision to apply nitrogen fertilizer either before planting in the summer or fall or as a top-dress application the following spring on growing wheat. The decision of whether or not to use phosphorus fertilizer is critical. If the choice is made to apply phosphorous, growers decide between preplant applications or the use of a starter application at planting (Appendix C, References 12 and 13).

Wheat residue management at harvest involves the use of straw- or chaff-spreader attachments on combines to avoid concentrated bands of wheat straw and chaff that can lead to volunteer wheat problems during the following wheat stubble period (Appendix C, References 1, 2, 6, and 10).

Phase II: Winter Wheat Stubble

The wheat stubble phase lasts approximately 11 months, from wheat harvest in June or July of Year 2 to summer crop planting in May or June of Year 3. The key decisions for crop producers in this phase generally relate to weed control and moisture management in stubble. Specifically during this phase, producers must make decisions regarding whether they will use tillage-based or herbicide-based weed-control and moisture-management programs.

Tillage-based weed-control programs typically rely on such implements as V-blades to undercut weeds and wheat stubble. There is a tendency for these types of field operations to cause tillage or hard pans at the common tillage depths and to preserve less soil moisture than alternative no-till or minimum-till cropping practices (Appendix C, References 1, 2, 3, and 4).

Herbicide-based weed-control and moisture-management programs are preferred in intensive wheat-summer crop-fallow rotations. Their primary advantage is the increased ability to conserve moisture for use by summer crops in Phase III. Of key importance in these programs is the timing and effectiveness of the initial and subsequent post-wheat-harvest weed-control operations occurring during July and August. Herbicide selection issues also are critical, especially with regard to their effectiveness and to their potential carry-over effects or interactions with summer crops that follow in Phase III (Appendix C, References 1, 2, 3, 4, and 5).

Phase III: Summer Crop Production

The summer crop production phase lasts from 4 to 6 months, from summer crop planting in May or June of Year 3 to summer crop harvest in October of Year 3. The key decisions for crop producers in this phase generally relate to summer crop establishment and production. Specifically, producers must make choices regarding summer crop selection; no-till, minimum-till, or conventional tillage planting practices; summer crop fertility; weed control; and harvest-time management of summer crop residues.

Summer crop selection is of primary importance in this system. Managers in western Kansas usually select among such crops as grain sorghum, corn, sunflowers, and cane hay based on projected economic returns for each crop and their expertise in growing the crop under their own field conditions. After the summer crop is selected, decisions are made about hybrids — including varieties, planting dates and rates, and planting time crop nutrient applications (Appendix C, References 1, 2, 6, 7, 8, 9, 14, 15, and 16).

No-till, minimum-till, or conventional tillage planting practice decisions are key to successful crop establishment. For no-till and minimum-till practices, decisions about planter equipment selection or modification are of major importance. Using a reduced- or no-till drill to plant summer crops is a viable option in western Kansas. However, using a no-till drill eliminates mechanical cultivation options, leaving farmers largely dependent on chemical weed control measures (Appendix C, References 2, 6, 10, 11, and 15).

Summer crop fertility programs are of key importance. Along with attention to soil tests and proper rates of applied crop nutrients, the crop nutrient application method must fit into a no-till or minimum-till system (Appendix C, References 6, 7, 8, 9, 12, 13, 14, and 15).

Weed control programs under a no-till or minimum-till system must rely on effective pre- or post-emergence herbicide treatment practices. However, some minimum-till systems may allow for the use of row crop cultivation for growing season weed control. Crop producers also make unplanned rescue weed control treatment decisions on an as-needed basis (Appendix C, References 1, 3, 4, 5, 6, 7, 8, and 9).

Summer crop residue management at harvest is an issue in this phase as it was with winter wheat residue management in Phase I. Proper combine adjustments and modifications can reduce both harvested grain loss and volunteer grain growth in following production phases (Appendix C, References 1, 2, and 10).

Phase IV: Summer Crop Stubble

The summer crop stubble phase lasts approximately 11 months, from summer crop harvest in October of Year 3 to wheat seeding in September or October of Year 4. The key decisions in this phase relate to weed control and moisture management in summer crop stubble and the maintenance of adequate residue cover for soil protection. Having sufficient residue for adequate cover to protect from soil erosion is an important factor. Crop selection and residue type will affect how the crop residue is managed (that is, grazed, disked, shredded, burned, or left untouched). During this phase, producers' decisions generally are focused on weed control and residue management and crop selection under flexible soil moisture opportunity farming regimes.

Weed-control and moisture-management decisions focus on herbicide selection, methods and timing of application, product rates, and the potential for carry-over herbicide effects on following crops. The overriding goal during this phase is to conserve moisture through effective weed control and efficient use of tillage operations (Appendix C, References 1, 3, 4, 5, 6, 7, 8, and 9).

Decisions regarding favorable soil moisture opportunity farming occur the spring after the summer crops are harvested. At that time, a producer may judge adequate subsoil moisture exists for successful summer crop production. If previously applied herbicides do not limit the choice of succeeding summer crops, a producer may wish to curtail the summer crop stubble period and plant another summer crop instead. The 1997 K-State survey (Appendix B, Table A) indicated 3 percent of those responding used cropping systems more intensive than wheat-summer crop-fallow, with consecutive years of wheat or skipped fallow periods or other intensive cropping practices. Such rotations are more-intensive than the 36-month wheat-summer crop-fallow rotation explained here but are possible under favorable moisture conditions (Appendix C, References 14 and 15).

K-State as a Resource for Intensive Nonirrigated Cropping System Information in Western Kansas

K-State conducts an ongoing program of applied research and Extension educational activities related to intensive nonirrigated cropping systems in western Kansas. Extension agronomists and agricultural economists based in Colby (northwest) and Garden City (southwest) are available as information resources for questions about intensive nonirrigated cropping systems from producers and agribusiness. Applied research on intensive nonirrigated cropping systems is carried out at several locations in western Kansas, including Hays, Garden City, Colby, and Tribune. Local or area K-State Research and Extension offices may be contacted for research-based, unbiased information about crop and livestock production and other topics.

Appendix A.
USDA-Kansas Agricultural Statistics Information [1]

Nonirrigated wheat acreage. In 1996, 4,534,000 acres of nonirrigated wheat were seeded in the western one-third of Kansas, comprising the northwest, west central, and southwest crop reporting districts. Of the total amount seeded, 2,687,000 acres were actually harvested (59 percent), a much lower proportion than in previous years. Of the 4,525,000 acres seeded to wheat in 1995, 4,230,000 acres were harvested (94 percent). In 1994, of the 4,675,000 acres seeded to wheat, 4,400,000 acres (94 percent) were harvested.

In 1996 in western Kansas, there were 3,414,000 acres of wheat seeded on summer-fallow land, with 1,959,000 (57 percent) of those acres harvested. Similarly, there were 510,000 acres seeded on continuously cropped land that year, with 268,000 of those acres harvested (53 percent). Total harvested nonirrigated wheat acreage on summer-fallow and continuously cropped land in this region in 1996 was 2,227,000 acres. In 1995 in this region, there were 3,425,000 acres of wheat seeded on summer-fallow land, with 3,238,500 (95 percent) of those acres harvested. Similarly, there were 484,000 acres seeded on continuously cropped land that year, with 438,000 of those acres harvested (90 percent). Total harvested nonirrigated wheat acreage on summer-fallow and continuously cropped land in this region in 1995 was 3,676,500 acres. In 1994 in western Kansas, there were 3,540,000 acres of wheat seeded on summer-fallow land, with 3,364,500 (95 percent) of those acres harvested. Similarly, there were 488,000 acres seeded on continuously cropped land that year, with 435,000 of those acres harvested (89 percent). Total harvested nonirrigated wheat acreage on summer-fallow and continuously cropped land in western Kansas in 1994 was 3,799,500 acres.

These statistics indicate the large majority of nonirrigated wheat cropping systems include summer-fallow periods, and during 1996, an abnormally low proportion of seeded wheat acres were harvested. However, there is no direct indication or measure of the proportion of farms using conventional wheat-fallow as opposed to more-intensive nonirrigated crop rotations.

Nonirrigated feed grain and oilseed acreage. In the western one-third of Kansas in 1996, 1,413,500 acres of nonirrigated grain sorghum were harvested. That compares with 501,300 and 557,400 acres harvested in 1994 and 1995, respectively. The large increase in 1996 grain sorghum acres in the region was due to plantings on failed wheat acres. Grain sorghum acreage declined in 1997 from the record-high levels of 1996, but on a statewide basis, it was still 450,000 to 550,000 acres greater than 1994-95 levels. Also in 1996, the harvested acreage of nonirrigated corn planted for grain in the western one-third of Kansas was 166,000 acres, up from 108,000 acres in 1995 and 127,000 acres in 1994. Harvested oil sunflower acreage in 1996 in the western one-third of Kansas was 134,100 acres, compared to 130,900 acres in 1995 and 133,200 acres in 1994. Harvested non-oil sunflower acreage in the western third of Kansas in 1996 was 38,500, down from 49,500 acres in 1994 and 65,600 acres in 1995. It is assumed that most of the confectionary sunflowers grown were not irrigated. In 1996, the total of grain sorghum, corn, and sunflower acreage in the western one-third of Kansas was 1,752,100 acres, up from 864,500 acres in 1995 and 813,800 acres in 1994.

Prevalence of intensive crop rotations. The maximum proportion of wheat acres involved in W-S-F production systems can be derived from the USDA acreage figures. If every acre of summer crop produced in western Kansas in 1994 were in a 3-year W-S-F rotation, that would account for 2,441,400 acres of cropland (3 × 813,800 acres). The remaining 2,550,700 acres of wheat harvested after summer fallow (3,364,500 acres – 813,800 acres) would then be in a wheat-fallow rotation, accounting for 5,101,400 acres of cropland. After adjusting for the wheat harvested on continuously cropped land (435,000 acres), a maximum of 2,441,400 acres could be W-S-F rotation out of a total of 7,979,300 nonirrigated cropping system acres in the western one-third of the state (31 percent).

Similarly, in 1995, if every acre of summer crop produced in western Kansas were in a 3-year W-S-F rotation, that would account for 2,593,500 acres of cropland (3 × 864,500 acres). The remaining 2,374,700 acres of wheat harvested after summer fallow (3,238,500 acres – 864,500 acres) would then be in a wheat-fallow rotation, accounting for 4,748,000 acres of cropland. After adjusting for the wheat harvested on continuously cropped land (438,000 acres), a maximum of 2,374,700 acres could be W-S-F rotation out of a total of 7,560,700 nonirrigated cropping system acres in the western one-third of the state (31 percent).

These findings about the prevalent types of cropping systems used are “deduced” or “implied” in nature, rather than the result of direct survey measurement. Harvested acreage was used instead of planted or seeded acreage in calculation of these ratios because only harvested acreage of nonirrigated summer crops was reported in Kansas Agricultural Statistics.

Finally, the slight increase in possible wheat-summer crop-fallow acres in 1997 from 1994 and 1995 levels supports the notion that such rotations are increasingly being adopted in this region.

[1] Source: Kansas 1996 Farm Facts, USDA-Kansas Department of Agriculture.

Appendix B.
Western Kansas Nonirrigated Cropping System Survey Results

Table A. *Dominant Nonirrigated Crop Rotation*

Subcategory	Number	W-F (%)	W-S-F (%)	W-W (%)
Overall survey results	112	31.0	66.0	3.0
W-S-F & W-W rotations	77	0 .0	96.1	3.9
W-F rotations	35	100 .0	0.0	0.0
Northwest Kansas surveys	67	20.9	74.6	4.5
W-S-F or W-W	53	0 .0	94.3	5.7
W-F	14	100 .0	0.0	0.0
Southwest Kansas surveys	45	46.7	53.3	0.0
W-S-F or W-W	53	0.0	94.3	5.7
W-F	14	100.0	0.0	0.0

Table B. *Dominant Summer Crop in Wheat-summer crop-fallow Rotations*

		%						
			Grain			Sunflowers		Other
Subcategory	Number	Wheat	sorghum	Corn	Forages	oil-type	confectionary	crops
Overall survey results	112	98	65	35	12	7	26	1
W-S-F & W-W rotations	77	100	64	39	13	8	23	1
W-F rotations	35	94	26	3	0	0	17	0
Northwest surveys	67	100	61	57	19	10	31	1
W-S-F or W-W	53	100	77	62	25	13	32	2
W-F	14	100	29	7	0	0	29	0
Southwest surveys	45	96	62	13	0	2	18	0
W-S-F or W-W	21	100	96	25	0	4	25	0
W-F	24	90	24	0	0	0	1	0

Table C. *Prevalence of No-till and Reduced-till Practices*

		%					
		Incorp	Remove		< 5	Reduced-	< 5
Subcategory	Number	straw	straw	No-till	years	till	years
Overall survey results	109	23	0	52	19	75	31
W-S-F & W-W	73	19	0	67	23	79	25
W-F	35	31	0	21	11	68	48
Northwest surveys	64	19	0	62	25	68	36
W-S-F or W-W	53	14	0	73	26	73	29
W-F	14	36	0	21	14	50	71
Southwest surveys	45	29	0	39	11	86	26
W-S-F or W-W	21	29	0	54	14	92	18
W-F	24	29	0	20	8	80	38

Table D. *Fertilizer Applications for Wheat*

Subcategory	Number	N lbs applied	Month applied	Application method	P lbs applied	Month applied	Application method
Overall survey results	112	51	8, 7	soil app	27	9, 8	Soil, w/ seed, broadcast
W-S-F & W-W	73	53	8	soil app	29	9, 8	Soil, w/ seed
W-F	35	45	8	soil app	23	9, 8	Soil, w/ seed, broadcast
Northwest surveys	67	54	8	soil app	29	9, 8	Soil, w/ seed, broadcast
W-S-F or W-W	53	55	8	soil app	29	9, 8	w/ seed, soil, broadcast
W-F	14	51	8	soil app, broadcast	26	9, 8	w/ seed, broadcast
Southwest surveys	42	45	8, 7	soil app	24	9, 8	Soil, w/ seed
W-S-F or W-W	24	49	8, 7	soil app	27	9, 8	w/ seed, soil, broadcast, band over row
W-F	21	42	8, 7, 2	soil app, broad-cast, topdress	21	9, 8, 7	w/ seed, soil app

Table E. *Fertilizer Applications for Grain Sorghum*

Subcategory	Number	N lbs applied	Month applied	Application method	P lbs applied	Month applied	Application method
Overall survey results	73	62	5, 4	soil app, brdcst w/o inc	26	5, 6	2×2, w/ seed, banded
W-S-F & W-W	58	66	5, 4	soil app, brdcst w/o inc	27	5, 6	2×2, w/ seed, banded
Northwest surveys	43	81	5,4,10,11	brdcst w/o inc soil, 2×2	30	4, 5	2×2, w/ seed
W-S-F or W-W	38	70	5,4,10,11	soil app brdcst w/o inc	28	5, 6	2×2, w/ seed
Southwest surveys	29	55	5,4,6,3	brdcst w/o inc, soil app	24	5, 6, 4	2×2, banded
W-S-F or W-W	20	57	5, 6, 4	soil app, brdcst w/o inc	26	5, 6, 4	2×2, banded

Table F. *Fertilizer Applications for Corn*

Subcategory	Number	N lbs applied	Month applied	Application method	P lbs applied	Month applied	Application method
Overall survey results	39	77	4, 3, 5	brdcst w/o inc, 2×2, soil	27	5, 4	2×2, w/ seed
W-S-F & W-W	35	79	4, 5, 6	brdcst w/o inc, 2×2, soil	27	4, 5	2×2, w/ seed
Northwest surveys	30	66	5, 4	soil app, brdcst w/o inc	27	5, 6	2×2, w/ seed
W-S-F or W-W	29	82	4,10,11,5	brdcst w/o inc, soil, 2×2	31	4, 5	2×2, w/ seed
Southwest surveys	9	63	4,3,5	brdcst w/o inc, 2×2	17	4,3,5	2×2
W-S-F or W-W	6	65	4, 3	2×2, w/ seed, brdcst w/ inc	15	4,3,5	banded or over row

Table G. *Wheat Herbicide Applications*

Subcategory	Number	Sulfon-yureas	2-4,D	Glyso-phate	Atrazine	DiCamba
Overall survey results	146	48	17	16	9	8
W-S-F & W-W	110	49	15	15	9	8
W-F	36	44	22	17	8	6
Northwest surveys	92	51	14	16	9	5
W-S-F or W-W	77	52	12	17	10	5
W-F	15	47	27	13	0	7
Southwest surveys	54	43	22	15	9	11
W-S-F or W-W	33	43	24	12	6	15
W-F	21	43	19	19	14	5

Table H. *Primary Summer Crop Herbicide Applications*

Subcategory	Number	Atrazine	Glyso-phate	Alachlor	Bicep	2-4,D	Dicamba
Overall survey results	151	33	21	21	7	4	3
W-S-F & W-W	128	33	22	24	7	3	3
W-F	23	30	17	4	9	9	0
Northwest surveys	106	33	20	23	7	4	2
W-S-F or W-W	94	33	21	26	6	3	2
W-F	12	33	8	0	8	8	0
Southwest surveys	45	31	24	18	9	4	4
W-S-F or W-W	34	32	24	21	9	3	6
W-F	11	27	27	9	9	9	0

Table I. *Fieldwork Operations and Production Systems*

Subcategory	Number	Herbicide-oriented	Tillage-oriented	Mixture	Nothing listed
Overall survey results	112	35	15	26	24
W-S-F & W-W	77	45	13	31	10
W-F	35	11	20	14	54
Northwest surveys	67	43	13	24	19
W-S-F or W-W	53	53	11	26	9
W-F	14	7	21	14	57
Southwest surveys	45	22	18	29	31
W-S-F or W-W	24	29	17	42	13
W-F	21	14	19	14	52

Appendix C.

References for Decision Making in Phases I, II, III, and IV

1. Schlegal, Alan. February, 1997. “Dryland Cropping Systems.” Notes and references from presentation at K-State Dryland Cropping Systems workshops at Spearville, Kan., February 7, and Colby, Kan., February 21.
2. Havlin, John et al. June, 1995. *Great Plains Dryland Conservation Technologies.* K-State Research and Extension Publication S-81.
3. Thompson, Curtis. February, 1997. “Weed Control in Dryland Cropping Systems.” Presentation overheads and background document and materials for a presentation at K-State Dryland Cropping Systems workshops at Spearville, Kan., February 7, and Colby, Kan., February 21.
4. Lyon, Drew J. and Baltensperger, D.D. 1995. “Cropping Systems Control Winter Annual Grass Weeds in Winter Wheat.” *Journal of Production Agriculture*, Vol. 8, pp. 535-539.
5. Peterson, D.E., Regehr, D.L., Ohlenbusch, P.D., Fick, W.H., Stahlman, P.W., and Kuhlman, D.K. January, 1997. *Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland*. K-State Agricultural Experiment Station Report of Progress, SRP 777.
6. Fjell, Dale. February, 1997. “No-till Milo Production Practices.” Presentation background document for a presentation at K-State Dryland Cropping Systems workshops at Spearville, Kan., February 7, and Colby, Kan., February 21.
7. *Grain Sorghum Production Handbook*. May, 1992. K-State Research and Extension Publication C-687 Revised.
8. *Corn Production Handbook*. May, 1994. K-State Research and Extension Publication C-560 Revised.
9. *Sunflower Production Handbook*. March, 1994. K-State Research and Extension Publication C-727 Revised.
10. Taylor, Randy. February, 1997. “Adjustments and Attachments for Row Crop Planters Used in Heavy Residue.” Presentation background document for a presentation at K-State Dryland Cropping Systems workshops at Spearville, Kan., February 7, and Colby, Kan., February 21.
11. Schrock, M.D., Kramer, J.A., and Clark, S.J. 1985. “Fuel Requirements for Field Operations in Kansas.” *Transactions of the American Society of Agricultural Engineers*, Vol. 28, pp. 669-674.
12. Brown, Randall. February, 1997. “Fertilizer Management in No-till.” Presentation overheads and background document and materials for a presentation at K-State Dryland Cropping Systems workshops at Spearville, Kan., February 7, and Colby, Kan., February 21.
13. Whitney, D.A., Stone, L.R., Janssen, K.A., and Long, J.H.. May, 1991. *The Effects of Nitrogen Fertilizer on Soil*. K-State Research and Extension Publication C-625.
14. Norwood, C.A. and Currie, R.S. 1997. “Nonirrigated Corn vs. Grain Sorghum in Western Kansas.” *Journal of Production Agriculture*, Vol. 10, pp. 152-157.
15. Sartwelle, J.D. III, and O’Brien, D.M. February, 1997. “Profitable Transitions to Wheat-summer crop-fallow.” Presentation overheads and background document and materials for a presentation at K-State Dryland Cropping Systems workshops at Spearville, Kan., February 7, and Colby, Kan., February 21.
16. Dhuyvetter, K.C., Thompson, C.R., Norwood, C.A., and Halvorson, A.D. 1996. “Economics of Dryland Cropping Systems in the Great Plains: A Review.” *Journal of Production Agriculture*, Vol. 9, pp. 216-222.

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