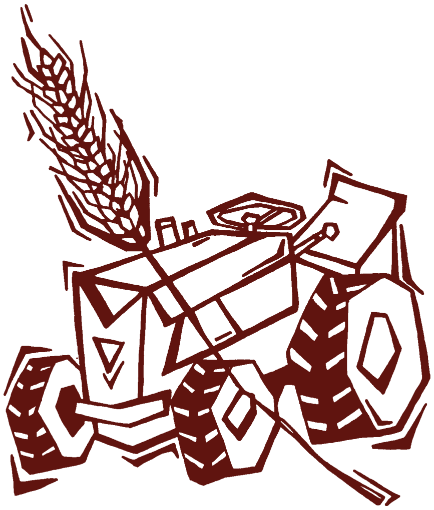

C R O P S E R I E S

PRODUCTION

Dryland Cropping Systems no. 0.516

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Quick Facts...

Soils under no-till production systems store more water than soils on conventional stubble mulch systems and allow conversion to more intense crop rotations.

Conversion to no-till systems using a three- to four-year rotation, such as wheat-corn-fallow, wheat-millet-fallow, or wheat-corn-millet-fallow, results in more profitability.

Conversion to no-till, three- to four-year rotations results in greater risk and requires greater management input.

The Wheat-Fallow (WF) system, practiced for many years in the semi-arid Western Great Plains, was a definite improvement over continuous cropping. It stabilized yields and provided farmers with a reliable income from year to year. However, wheat fallow is an inefficient user of annual precipitation in a region where water is the major limiting factor. Data collected in the Great Plains show that typically less than 25 percent of the precipitation received during the 14-month fallow period is stored in the soil. When little or no residue is left on the soil surface, water storage efficiency is less than 20 percent.

Colorado and Nebraska research indicates that precipitation storage efficiencies of 40 to 60 percent are achieved when tillage is minimized or eliminated. The key to these improvements is maintaining crop residue on the soil surface and minimizing or eliminating soil disturbance. Unfortunately, little added wheat yield results from the additional water stored under no-till compared to mulch tillage systems. In fact, it costs more to save the additional water in a no-till system than the value of the added grain yield. Weed control with herbicides is more costly than with mechanical tillage.

Water savings in no-till systems can be converted to profit only by switching to more intense cropping systems where fallow time is decreased and summer crops, like corn, grain sorghum, proso millet and annual forages are added to the rotation (Figure 1).

Maximizing water storage, which permits more intensive rotations, requires residue on the soil surface to trap snow, absorb raindrop impact, slow runoff and minimize evaporation, as well as complete weed control at critical times in the production cycle.

Producers can use the following recommendations to improve precipitation use efficiency in eastern Colorado dryland farming systems, and improve soil, water and air quality while increasing net income. These steps are built around rotations where winter wheat is the starting point in the system.

How to Intensify Dryland Crop Rotations

Step 1: Weed Control

Weed control in growing wheat is the goal of this step. If controlled in the wheat, the stubble at harvest is essentially weed free. Weeds include winter annuals such as mustard, kochia and Russian thistle.

If weeds are present at harvest, apply the appropriate herbicide for that species (Figure 2). Apply residual herbicides in late July to mid-August to control volunteer wheat, downy brome and jointed goatgrass. Various combinations of herbicides with small amounts of atrazine are effective for this purpose.

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Figure 1: No-till corn planted in wheat stubble.

Figure 2: Stubble showing poor weed control after harvest on the left, and excellent weed control on the right.

Keep the atrazine rates low and within labeled amounts for your soils and climate. Failure results in long-term damage to wheat yields.

Do not till in this phase of the rotation. Dollars spent for herbicides in this phase give maximum returns compared to any other point in the system. It should be possible to store 3 to 5 inches of water between wheat harvest to fall freeze-up if the stubble is kept weed free. By not tilling, the maximum amount of standing stubble can trap snow in the winter months and increase water storage by spring.

Step 2: Spring Crop Choices and Cultural Practices

Possible summer crops to follow wheat in the rotation are corn, sorghum, proso millet, sudex or sunflowers. Plant corn in areas north of Cheyenne Wells and grain sorghum in southern areas. Proso millet is a good option in the northern area, but not in the southern areas where yields and markets are poor. Annual forages, like sudex and hay millet, are excellent choices for livestock producers.

Whatever the summer crop, plant it into the wheat stubble or other residue base with minimal disturbance. A minimum till or slot planter is recommended. Apply an appropriate herbicide according to the label and use for weed control during the summer period. Avoid cultivation of row crops unless the herbicide fails. Choose crop varieties that adapt to your elevation, latitude and longitude.

Step 3: Rotation Choice

Specific rotation choices include: wheat-corn-fallow; wheat-sorghum-fallow; wheat-proso millet-fallow; wheat-corn-proso millet-fallow; etc. More intensive rotations (wheat-corn-proso millet-forage) are possible where no fallow is used. Consider any combination of crops that adapt to your environment and fit your equipment, budget and overall livestock feed requirements. **Do not follow** a particular crop with itself. There are too many insect, disease and volunteer problems when you repeat a species in a rotation.

Research suggests that corn follow wheat and proso millet, or an annual forage follow corn or grain sorghum. If you intend to keep winter wheat in your rotation, some fallow prior to planting winter wheat probably will be necessary. Another way to get back to winter wheat is to plant a short-season annual forage in the spring and harvest the forage prior to August 1. If regrowth occurs, kill immediately with a contact (no residual) herbicide so that all precipitation received after August 1 is stored for wheat planting. Plant wheat no-till into the forage stubble. If it was a dry summer and no stored soil moisture is present, you may have to wait until spring and go back to another summer crop.

Step 4: Fertilization

Nitrogen, phosphorus and zinc are the nutrients of concern when making fertilizer decisions. Zinc deficiency on wheat has never been observed in Colorado, but it is common for corn and sorghum. Wheat is the crop most likely to respond to phosphorus fertilization.

Base the amount of fertilizer to apply, if any, on soil test results. Ideally, collect separate samples from various soils on your farm. Sample eroded hillsides separately from summits and separately from lower-lying areas. Soil color is a good way to judge whether soils should be sampled separately.

Apply fertilizer according to each soil test, if possible. This will result in the least-cost fertilizer program.

Step 5: Overall Considerations

All of the suggestions for intensifying cropping under dryland conditions are contingent on maximum water capture and minimum losses to weeds, runoff

Table 1: Water losses from different operations 1 and 4 days after tillage.

Operation	1 day	4 days
	--- inches of water ---	
One-way	0.33	0.51
Chisel	0.29	0.48
Sweep plow	0.09	0.14
Rod weeder	0.04	0.22

Table 2: Percent residue lost after using different equipment.

Operation	% residue lost due to each operation
Spraying	0
Sweeps (24 inches)	10
Disk drills	20
Disk chisels	10
Rod weeder	15
Chisel plow	
Straight points	25
Twisted points	50
Tandem disk 3" deep	80
Tandem disk 6" deep	90
Moldboard plow	90-100
Overwinter weathering	15-25

Table 3: Water runoff when applied to no-till, disked and disked soil with straw cover.

Time (mins.)	No-till	Disked	Disked/ straw
	-- Runoff inches/hour --		
15	Started		
18	---	Started	
20	0.8	1.4	
25	2.1	3.0	Started
30	2.4	3.5	0.4
40	2.4	3.5	2.4

Table 4: Maximum daily soil temperature at 2.5 cm depth comparing 0 and 3,000 pounds wheat straw per acre.

Period	Max air temp	Straw lbs/acre 0	3,000
	Soil temp, degrees F		
Oct 7-11	77	76	67
Oct 12-16	75	78	68
Oct 26-30	67	70	62
Oct 31-Nov 4	66.8	69	61

and evaporation. No-till practices are required in certain phases of each system to be reasonably sure of conserving enough water to be successful. No-till is essential, for example, when going from wheat to corn or from corn to proso millet. It is feasible and most profitable, however, to substitute some tillage for herbicides in a summer fallow phase preceding wheat planting. An exception is a short fallow period from harvest of a summer forage crop in August to a September wheat planting. No-till is the only feasible means of weed control in that situation.

Climate, Tillage, Weeds and Water Conservation

Climate

Most of the wheat-producing areas are in the 15- to 18-inch precipitation zones of eastern Colorado. In these areas, rainfall may be extremely variable in total amount received per year and consistency throughout the growing season. Severe spring and summer storms may develop, releasing 2 to 3 inches of rain per hour. On the average, precipitation is higher in May, June, July and August (2 to 3 inches per month) and low (less than 1 inch per month) during the remaining season.

Tillage Effects on Water Conservation

Assuming soil moisture is present, expect soil water losses from different tillage operations (Table 1). Implements that stir the soil, such as the one-way disk and chisels, cause more soil moisture losses, while sweeps and rod weeders cause less mixing and moisture loss.

Consider residue retention associated with moisture loss on tillage when residue must be retained on the soil surface. Use Table 2 to estimate stubble reduction as a result of various operations.

For example, if sweeps (24 inches wide) are used one time after harvest (10 percent reduction) followed by two rod weeder operations (2 x 15 percent reduction each), a 40 percent reduction occurs. If there are 3,000 pounds of residue per acre to start, then 1,800 pounds is left after these operations.

Eliminating runoff can significantly improve water infiltration. Applying water under various field conditions shows that no-till and high levels of residue on the soil surface reduce runoff compared to standard dryland tillage systems (Table 3). During this experiment, simulated rain was applied equally on all plots. Treatments were no-till, disked and disked with 3,000 pounds wheat straw per acre. Runoff began first on the no-till; however, runoff remained low throughout the experiment, compared to the disked (standard check) treatment and the treatment with straw cover. The no-till and disked/straw cover allowed more water infiltration than the disked treatment.

Soils with stubble cover here reduce wind velocities at the surface and temperatures, reducing evaporation from the soil surface. Experiments at Akron, Colorado indicate that water losses were 1.5 times greater on bare soil compared to soils with 3,000 pounds of wheat straw (Table 4).

As wind speed and temperatures increase and humidity decreases, water evaporation increases. With a 5 mph wind at Akron, Colorado, when temperatures are 40 degrees F, a water evaporation rate of 0.1 inches per day occurs. However, if temperatures reach 80 degrees, water evaporation exceeds 0.3 inches per day. Any methods that reduce soil temperatures and wind velocity at the soil surface reduce water losses from the soil.

Plant Water Use

Under normal conditions, plants use water from the soil profile at rates depending on the species of the plant. Various crops transpire water at rates

Table 5: Summary of the transpiration ratio of various crops and weed species at Akron, Colorado.

Crop	T:R[1]
Proso millet	267
Pigweed	287
Sorghum	304
Corn	349
Sugarbeets	377
Wheat	528
Cotton	568
Sunflower	630
Oats	583
Gumweed	608
Soybeans	646
Dry beans	700
Rape	714
Lambsquarters	801
Ragweed	948

Pounds of water transpired per pound of above-ground dry matter produced. Water weighs 8.34 pounds/gallon.

between 300 and 900 pounds water per unit of dry matter (T:R) produced (Table 5). Some weeds are very inefficient and use much more water per unit of dry matter produced than agronomic crops.

Water Use by Weeds

Weeds, just like cultivated crops, extract water, usually in greater amounts per unit of dry matter than field crops. They are competitive for water and nutrients. Problem weeds may differ from one farm to another. Constant tillage by disk implements decreases grassy weed competition, while blade implements increase grassy weed competition.

The most prevalent weeds in the dryland fields of eastern Colorado include kochia, Russian thistle, pigweed, rye, downy brome and jointed goatgrass. Recently, goatgrass has invaded fields, causing nutrient and water losses and discounts at the market place because of excessive foreign material. Goatgrass is a noxious weed.

Control of winter annual grasses in winter wheat-fallow rotations is extremely difficult because they germinate in the fall during wheat germination. Most of the seed matures and falls to the ground before wheat harvest. Selective weed control by chemicals has not been very successful. Winter annual grasses compete well in no-till systems and can result in crop failure if they get out of control. Intense rotations result in increased control of winter annual grasses because summer crops are included in the system.

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