Chemical fal and water conservation in the Great Plains

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ERRATIC yields make annual cropping of wheat impractical in the Great Plains. Economic stability requires sustained crop production over the long term. In addition, soil and water conservation are needed to maintain the region's productive resource base. Summer fallow has become the accepted means for stabilizing crop production and conserving natural resources.

The first summer fallow method, called black fallow, left the soil bare. This produced intolerable soil losses because of erosion.

Stubble mulching, an improved form of summer fallow, reduced soil losses to more acceptable levels. Wheat yields were somewhat higher also than under black fallow.

Now, research with chemical fallow shows that this system of summer fallow not only minimizes soil losses by leaving all residue standing and attached to the soil but further increases crop yields.

Cropping Patterns and Methods

Research conducted at the Central Great Plains Research Station near Akron, Colorado, has direct application on about 22 million hectares (55 million acres) of farmland in southeastern Wyoming, western Nebraska, western Kansas, and eastern Colorado. This includes the heart of the Dust Bowl area in southeastern Colorado and southwestern Kansas.

A fallow-wheat rotation is the basic dryland cropping system used in this region. Some other crops are grown also, but available water limits crop yields.

Annual precipitation at the Akron station averaged 39.6 centimeters (15.6 in) for the period from 1907 to 1975. Since 1948, the average has been 34.8 centimeters (13.7 in).

Most rainfall events are short. Some are intense. About 30 percent of the precipitation occurs in storms of 0.6 centimeter (.25 in) or less; 50 percent in storms of 0.6 to 2.6 centimeters (.25-1 in); and 20 percent in storms over 2.6 centimeters. With the limited rainfall and small numbers of showers it is important to store in the soil as much precipitation as possible.

The wind blows almost constantly throughout the Central Plains. Average velocity is 10.6 kilometers per hour (6.6 mph). From January through August the average is about 10.9 kilometers per hour (6.8 mph), from September through December, about 9.7 kilometers per hour (6.0 mph).

April is the windiest month with an average of 13.5 kilometers per hour (8.4 mph). This increase over the January through August average is primarily the result of short periods of high winds—80.5 to 96.5 kilometers per hour (50 to 60 mph), gusting to 112.6 to 128.7 kilometers per hour (70 to 80 mph).

Evaporation from Bureau of Plant Industries pans placed 30.5 centimeters (1 ft) above ground at the research station averages 182.9 centimeters (72 in) of water per year. At ground level the amount declines to 132.1 centimeters (52 in) per year.

Studies using vegetative barriers show that position and orientation of the barriers reduce evaporation from the soil surface (*1*). Crop residue management is, therefore, a significant factor in any attempt to increase the water available for crop production. The amount of residue produced and conserved is also important for the maintenance of soil tilth and fertility as well as erosion control.

Need for Water Conservation

Tillage by machines other than the chisel tend to reduce the nonerodible soil aggregation (Figure 1), but weed control is limited with a tillage system that relies wholly on chiseling. Al-[illegible] it can effectively control weeds, [illegible] tends to reduce stored soil water and residue, especially standing residue (Table 1). Standing residue offsets soil water losses better than either flat residue or bare ground (Table 2).

Wheat yields increase an average of 3.4 quintals per hectare (5 bu/a) for each inch of available water above 20.3 centimeters (8 in). This response varies from 2.7 quintals (4 bu) to 4.7 quintals (7 bu) (Figure 2). Little production can be expected with less than 25.4 centimeters (10 in) of available water. It thus becomes necessary to conserve as much of the available water as possible during the fallow year to provide an adequate amount for production during the crop year.

Weeds in wheat stubble following harvest can use up to 7.6 centimeters (3 in) of storable water. Their control will help retain part of this water in storage for use by the crop the following year. Weed control can be accomplished with chemicals or tillage (*7*, *8*).

Use of Chemical Fallow

Chemical fallow, which retains all crop residue on the soil surface, usual-

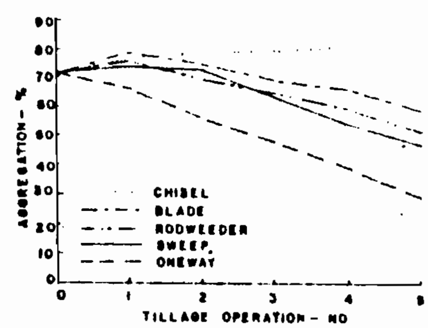

Figure 1. Change in nonerodible aggregation with tillage implement and number of operations (*6*).

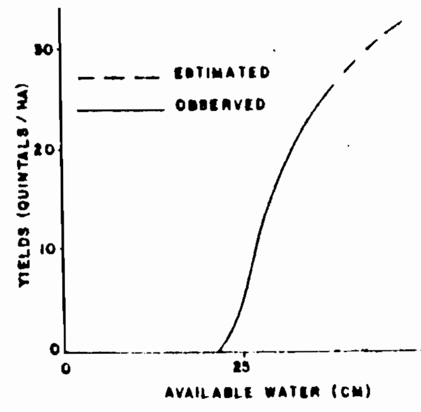

Figure 2. Yield response of wheat to available water (*7*).

L. G. Good is a district conservationist with the Soil Conservation Service, U. S. Department of Agriculture, and D. E. Smika is a soil scientist with the Science and Education Administration, USDA. Both are located in Akron, Colorado 80720 ly 2.2 metric tons per hectare (1.4 t/a) or more, appears to have a number of advantages over black fallow or stubble mulching. Black fallow usually reduces surface residue to 0.6 metric ton per hectare (500 lb/a) or less. Stubble mulching leaves 0.8 to 1.1 metric tons of residue per hectare (750-1,000 lb/a) on the soil surface.

The Environmental Protection Agency released atrazine[1] and paraquat for use on wheat stubble in 1976. Other chemicals are available or are being developed to supplement these two.

In research at Akron during the past eight years, chemical fallow conserved 23.6 centimeters (9.3 in) of water during each fallow year. Wheat yields averaged 30.5 quintals per hectare (45.3 bu/a). In comparison, stubble mulching stored 17.3 centimeters (6.8 in) of water in the soil profile, and wheat yields averaged 25.5 quintals per hectare (38.0 bu/a) (*3, 4*). Use of black fallow was discontinued in tests at the Akron station several years ago because soil losses were unacceptably high and wheat yields were consistently lower than those under stubble mulch systems.

Control of both wind and water erosion is almost complete with chemical fallow. For example, estimated soil loss on a Weld loam with an average slope of 2 percent and block-farmed on a square field of 60 hectares (160 a) is 55.7 metric tons per hectare (20.5 t/a) with black fallow. The estimated soil loss drops to 22.0 metric tons per hectare (8.1 t/a) under stubble mulching and further declines to only a trace under chemical fallow. The productivity of this particular soil cannot be maintained if the annual soil loss exceeds 13.6 metric tons per hectare (5 t/a) (*2, 9*).

Use of chemical fallow also reduces operating costs. With a combination of chemicals, such as atrazine and paraquat, costs (1977) are estimated to be about $24.70 per hectare ($10.00/a) for treatment in the late summer, following wheat harvest. A second and possibly third treatment with contact or short-term residual herbicides is usually needed the following summer. The cost of each of these treatments is about $12.35 per hectare ($5.00/a).

The total possible cost of $49.40 per hectare ($20.00/a) for chemical fallow compares favorably with the estimated cost of $59.28 per hectare ($24.00/a) for six tillage operations—$9.88 per hectare ($4.00/a) per operation—for either black fallow or stubble mulching.

[1]As of February 21, 1978, label has been issued only to Ciba-Geigy for product sold as Aatrex.

Table 1. Effects of different tillage implements on residue reduction and soil water loss 1 and 4 days after tillage (5).

Tillage Implement	*Residue Reduction per Operation (%)*	*Soil and Water Loss (cm) in the 0- to 12.7-cm Depth*	
		1 Day	*4 Days*
Tandem disc	75	—*	—*
One-way disc	50	0.84	1.30
Chisel	10	0.74	1.22
Sweep plow	10	0.23	0.36
Rod weeder	15	0.10	0.56

*Data not collected for this implement.

Table 2. Effect of position of previous year's stubble on soil temperature and soil water loss (5).

Position of Stubble	*Surface Soil Temperature (C°)*	*Water Loss Per Day (cm)*
Standing	32.2	0.043
Flat	41.7	0.056
Bare ground	47.8	0.066

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