IANR NebGuide
University of Nebraska Lincoln
Published by University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

G1009
(Revised June 2007)

Getting Started in Ecofarming: Growing the Winter Wheat Crop

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Ecofarming is a system of controlling weeds and managing crop residues throughout a crop rotation, using minimun tillage to help reduce soil erosion.

Ecofarming is a popular conservation tillage practice used in Nebraska where winter wheat is produced. It requires a high degree of management, but the rewards of higher crop yields and erosion protection are worth the effort.

In Nebraska, the winter wheat-fallow rotation is the common rotation used in areas that receive less than 17 inches of annual rainfall, while in areas that receive 17 to 22 inches, the winter wheat-corn or sorghum-fallow rotation is most common. In 1988, 41 percent of the available wheat stubble fields in west central and southwest Nebraska and 11 percent in the Panhandle were sprayed with a herbicide after wheat harvest.

In 1998, a field survey was taken one to two months after herbicides were applied following winter wheat harvest. Results indicated that many cultural practices greatly influenced weed control in the winter wheat stubble. The purpose of this NebGuide is to explain how farmers can use some of these cultural practices to improve the competitiveness of their winter wheat against weeds. Hence, when herbicides are used, their effectiveness increases.

What is Ecofarming?

Ecofarming is a system of controlling weeds and managing crop residues throughout a crop rotation, using minimum tillage to help reduce soil erosion and production costs while increasing weed control, water infiltration, moisture conservation, and crop yields.

Energy requirements are much lower with ecofallow than with fallow systems that rely more heavily on soil tillage. The ecofallow period in the two-year rotation occurs between winter wheat harvest and the planting of winter wheat 14 months later (*Figure 1*). In the three-year rotation, the ecofallow period is between winter wheat harvest and the planting of the subsequent summer crop, for example, corn, sorghum, millet, or soybean (*Figure 2*).

Ecofallow means controlling weeds during the fallow period by using herbicides or herbicides plus tillage with minimum disturbance of crop residues and soils. In the winter

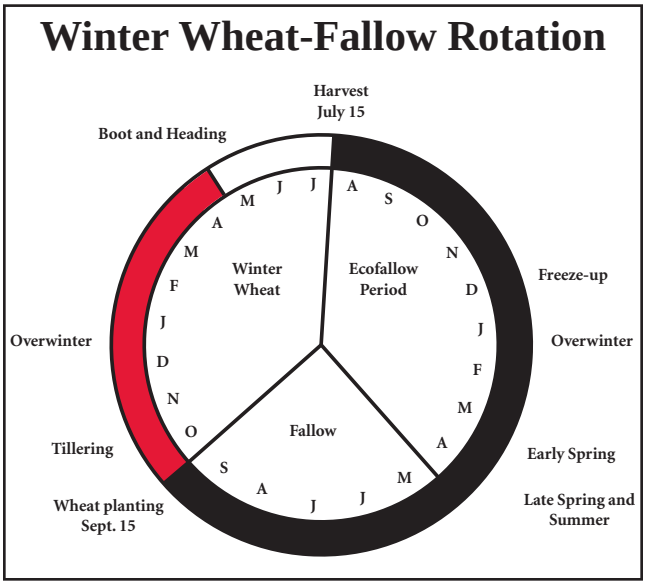

Figure 1. Sequence of events in a winter wheat-fallow rotation over a 24-month cycle.

wheat-fallow rotation this also has been referred to as chemical fallow or chem-fallow.

The ecofallow concept has been successful in winter wheat-sorghum or corn-fallow rotations because of improved weed control, soil erosion protection and the potential to store more soil water, thus increasing yields, compared to fields where only tillage was used for weed control and seedbed preparation for corn, sorghum, millet, and sunflower. The advantage of ecofallow in the winter wheat-fallow rotation is achieved largely through improved soil erosion protection from wind and water and improved weed control.

Using ecofallow in the winter wheat-fallow rotation has not always increased winter wheat yields. The grain filling period for winter wheat is usually during the period of greatest rainfall, so the extra stored soil water may not be needed by the winter wheat plant.

The cost of the herbicides and application cannot exceed the cost of tillage if profitability is to be maintained. Water stored during the fallow period will be beneficial at planting time to help establish a good stand of winter wheat. Some years, winter wheat yields may be higher on ecofallow land that has been in corn or sorghum.

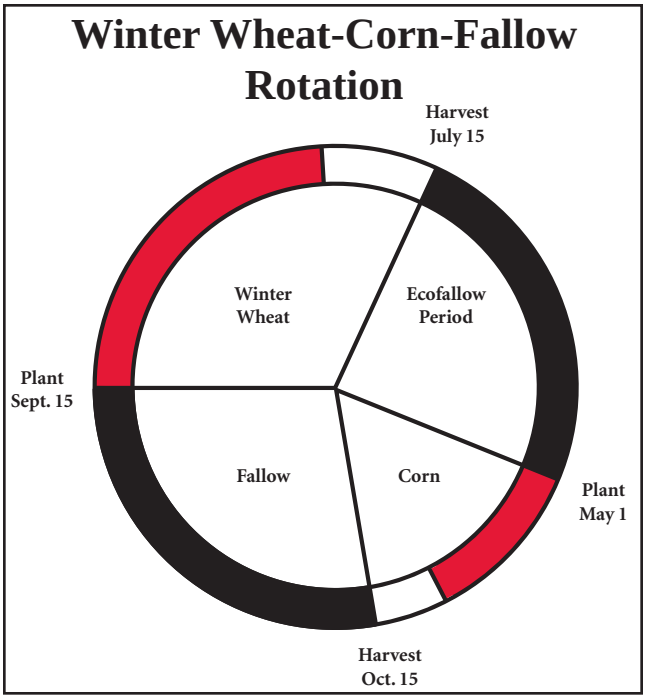

Figure 2. Sequence of events in a winter wheat-corn-fallow rotation over a 36-month cycle.

The threat of wheat streak mosaic and the Russian wheat aphid has increased emphasis on controlling volunteer winter wheat, downy brome, and jointed goatgrass prior to winter wheat seeding. These plants must be dead for at least 14 days prior to winter wheat emergence to ensure death of the wheat curl mite. The wheat curl mite is the vector for wheat streak mosaic virus. The main source of wheat curl mite and aphid infestation is volunteer winter wheat found in adjacent winter wheat stubble fields. These insects can be controlled by killing the volunteer wheat and other hosts by cultivating the fallow ground or using herbicides prior to planting winter wheat.

How to Develop an Ecofallow System

An effective fallow weed control program begins with the winter wheat crop. Planting winter wheat following an 11- or 14-month fallow period allows for the most competitive winter wheat. When winter wheat is planted after spring cereal grain, corn, grain sorghum, wheat, or soybeans without a long fallow period, expect lower winter wheat yields (*Table I*).

A good stand of vigorously growing winter wheat reduces the chance of weeds becoming a problem after harvest. Thin wheat stands have more weeds that are usually larger and harder to kill. Winter wheat planted in 7-inch rows has fewer weeds than wheat in 14-inch rows. However, 12- to 14-inch row spacings and drills equipped with furrow openers are preferred in areas that receive 17 inches or less of annual rainfall. Barnyardgrass, foxtail species, and longspine or field sandbur are especially troublesome in wider row spacings in the higher rainfall areas. Winter wheat stand and vigor can be improved by:

- Using tillage methods during the summer fallow period that maintain plant residue on the soil surface to control erosion and conserve soil water.
- Killing weeds before they remove soil water during the summer fallow period.
- Using a rodweeder to kill weeds and firm up the seedbed on the last two tillage operations before planting.
- Using a hoe drill instead of a disk drill if surface soil (top 2 to 4 inches) is dry, so that the seed can be placed into firm, moist soil and protect the wheat plant through the winter.
- Placing seed 1 inch deep into firm, moist, fine textured soils, and 1.5 to 2 inches deep in coarse textured soils. This is especially critical in the tractor tire tracks.
- Planting by seeds per acre rather than pounds per acre. The suggested rate is 18 seeds per foot of row in any row spacing.
- Planting clean and weed-free seed; trashy seed inhibits seed placement.
- Checking the winter wheat in early March through April for broadleaf weeds. Broadleaf weed problems encountered after winter wheat harvest can be partly or completely eliminated by a timely herbicide spraying in spring.

Fertilizer

Proper fertilizer application is essential for profitable winter wheat yields. Fertilizer should be applied according to soil tests and yield goals (See NebGuides on winter wheat fertilization). Phosphorus makes the winter wheat more competitive (*Table II*). Successful applications include using anhydrous ammonia, solutions, or dry fertilizers. Anhydrous ammonia can be applied in June, with or without phosphorus,

Table I. Effect of the most common rotations on winter wheat yield and weed density in 1998 stubble fields that were sprayed after wheat harvest.[a,b,c]

Fallow Rotations	*Fallow*		*Wheat yield*	*Green foxtail*	*Longspine sandbur*	*Kochia*
	Field	*Duration*				
%	mo	bu/acre		---------- no./m^2 ----------		
Wheat-corn-fallow	50	11	64	1.3b	1.0ab	0.03b
Wheat-fallow	18	14	63	0.2b	2.0ab	0.01b
Wheat-corn-soybean	13	0	47	1.8b	0.01b	0.5b
Wheat-wheat	8	2	49	2.7b	0.02b	0.09b
Wheat-corn or grain sorghum	7	0	40	1.1b	4.6a	2.9a
Wheat-corn-spring cereal grain	4	5	40	8.0a	2.0ab	0.4b

[a]Adapted from Weed Technology: 17:467-474.
[b]Numbers within columns followed by the same letter are not significantly different at the 0.05 level.
[c]Number of months of fallow before seeding winter wheat or spring small grains.

with a sweep blade. Dual injection of anhydrous ammonia and phosphorus in 12-inch bands has worked well. July and August application of anhydrous ammonia should be done with a rodweeder. If sufficient rainfall does not occur after application with a sweep plow, the seedbed will not be firm. Avoid fertilizing when the soil is too wet because heavy loads compact the soil. Wheel tracks can be a problem, particularly when driving on wet soil.

Table II. Influence of phosphorus on weed control when banded at wheat seeding time in western Nebraska.[a]

	Phosphorus	
Item	*No*	*Yes*
Winter wheat yield, bu/A	48	58
Wheat stems, m^2	600	730
Witchgrass, m^2	2.0	0
Stinkgrass, m^2	4.3	0.3
Pigweed, m^2	2.7	0
Russian thistle, m^2	0.3	0.3
Common purslane, m^2	1.0	0
Total weeds, m^2	10.3	0.6

[a]Adapted from Weed Technology. 3:244-254.

A 1986 survey of winter wheat stubble fields that had been sprayed with herbicides in west central and southwest Nebraska indicated that the timing of fertilizer application to winter wheat was related to weed control. Fertilizing prior to planting winter wheat improved weed control after winter wheat harvest when compared to top dressing winter wheat with nitrogen in the spring, but winter wheat yields were higher in south central and southeastern Nebraska with fall applied fertilizer (*Table III*). Fertilizing in the fall made the winter wheat more competitive with the weeds. Apparently, the winter wheat did not use all the spring applied nitrogen so the weeds used the remainder.

Table III. Influence of fertilizing winter wheat on weed control after herbicides were applied following winter wheat harvest in 1986 in Nebraska.[a,b]

Timing of fertilization	*Wheat yield*	*Stem density*	*Weed density*
	bu/acre	----------no./m^2----------	
Western Nebraska			
Fall	61	650a	4.2b
Spring	59	660a	7.5a
South-central Nebraska			
Fall	63	610a	0.5b
Spring	51	410b	4.4a
Southeastern Nebraska			
Fall	59	630a	8.2a
Spring	43	470b	15.9a

[a]Adapted from Weed Technology. 3:244-254.
[b]Numbers within columns and within region followed by the same letter are not significantly different at the 0.05 level.

Variety Selection

Winter wheat varieties for ecofallow should be selected on adaptability, grain yield, weed competitiveness, insect and disease resistance, and amount of stubble provided. Some winter wheat varieties do not produce enough crop residue to gain maximum effectiveness from the stubble if corn or sorghum is the following crop. Fields with more than 4,500 pounds of straw per acre store the most soil water. Using stripper headers alleviates this concern for most.

In a 1989 field survey when wheat cultivars were grouped according to height, Pennsylvania smartweed and toothed spurge densities were greater in the short-stature wheat (*Table IV*). Lambsquarters spp. density was greater in the tall-stature wheat probably because fewer tall-stature wheat fields were sprayed in the spring.

Table IV. Effect of winter wheat varieties on post-harvest weed control averaged across herbicides applied after wheat harvest in 1986 in Nebraska.[a,b]

Stature rating	*Pennsylvania smartweed*	*Toothed spurge*	*Lambsquarters* spp.
	---------- no./m^2----------		
Tall	0.0b	0.0001b	2.24a
Medium	0.0b	0.010b	0.01b
Short	1.5a	0.390a	0.01b

[a]Adapted from Weed Techology 3:244-254.
[b]Numbers within columns and within region followed by the same letter are not significantly different at the 0.05 level.

Weed Control After Winter Wheat Harvest

The effectiveness of herbicides applied after winter harvest on summer annual weeds is shown in *Table V*. Glyphosate is more effective on most grassy weeds than paraquat, and the addition of atrazine to glyphosate reduces performance on grassy weeds that are difficult to control such as barnyardgrass. On some broadleaf weeds paraquat performs much better than glyphosate.

Residue Management

Volunteer wheat can be reduced with a timely harvest and a properly adjusted combine operated so grain is put in the bin instead of out the back of the combine. Uniformly spreading the long straw and chaff will save time and frustration when planting the next crop. Use good spreaders on the combine or remove excess straw as soon as possible. Straw choppers are usually useful on conventional combines equipped with deflectors. Rotary combines do not need straw choppers, but most need improvements to spread the straw. Unload grain while moving; if you have to stop, pull out and let the combine clear before stopping. Piles of straw are difficult to plant through and require extra tillage operations to destroy or spread the crop residue. Volunteer wheat is easier to control if the chaff is distributed. If residues are extremely heavy, remove the loose straw behind the combine. Eliminate excess traffic.

Stripper platforms help maintain crop residue. They are beneficial when used with short-statured wheat varieties with

Table V. Effect of herbicides applied after winter wheat harvest on summer annual weed control in 170 fields.[a,b]

Herbicide treatment	*Green foxtail*	*Barnyard grass*	*Large crabgrass*	*Stink grass*	*Witch grass*	*Longspine sandbur*	*Yellow foxtail*	*Toothed spurge*	*Pigweed species[c]*
					% Control				
Paraquat + atrazine + 2,4-D[d]	74b	55c	5b	98a	93a	83a	74a	100a	92ab
Glyphosate + 2,4-D[e]	94a	92ab	70a	100a	89a	95a	66a	21b	76b
Glyphosate + 2,4-D + atrazine	95a	58bc	77a	99a	86a	88a	58a	10b	97a
ICIA0024[f] + 2,4-D or atrazine	100a	98a	100a	100a	100a	100a	90a	80a	100a
Sprayed twice[g]	99a	86ab	87a	100a	100a	100a	100a	27b	85ab

[a]Adapted from Weed Technology 17:467-474.
[b]Numbers in columns followed by the same letter are not significant at the 0.05 level.
[c]Pigweed species include redroot pigweed, tumble pigweed, and waterhemp spp.
[d]Includes paraquat + atrazine treatments.
[e]Includes glyphosate alone treatments.
[f]ICIA0224 is the trimethylsulfonium salt of glyphosate.
[g]Twenty-four fields were sprayed twice with glyphosate, paraquat or atrazine.

good straw strength. The standing residue of tall-statured wheat varieties with poor straw strength may lodge making planting difficult.

Most conventional winter wheat fields had residue levels of about 2 percent compared to 18 to 80 percent residue cover in ecofallow fields when measurements were taken in March 1988. It takes excellent management to maintain sufficient residue during the fallow period for erosion protection.

The producer's goal should be to obtain a suitable seedbed that winter wheat can be planted into satisfactorily for germination and emergence. If one will be using a hoe drill, some tillage will likely be necessary to destroy residue and prepare a seedbed. The economics of weed control throughout the 14-month fallow period in the two-year rotation with herbicides alone (chemical fallow) will have to be considered. If the soil is not tilled before dry hot weather and does not have sufficient residue, it may get so hard that penetration with most drills is impossible. If sweep tillage is started in June, a good seedbed can be prepared with one or more additional tillage operations.

In the three-year or longer rotations, the corn and sorghum residue needs to be disked to prevent stalks from plugging in hoe drill shanks at winter wheat seeding. Usually this operation should occur by mid-May if no herbicides are used in the spring. One may have to till sooner if downy brome or jointed goatgrass is present to prevent seed development. If using a no-till disk drill to seed the wheat, weeds may be controlled during the nine- to 10-month period with herbicides. A dry hot summer with limited residue and rainfall can cause a drill penetration problem here also. More effort needs to be made in keeping more crop residue on the soil surface. Most fields have less than 2 percent residue cover when sown back to winter wheat. Crop residues are important to the system because standing stubble traps snow. This may mean an additional 1 to 3 inches of stored soil water available for crop production, compared to fields where residue was destroyed.

Winter wheat stubble reduces soil temperature and evaporation which increases available moisture for crop growth.

Residues reduce wind and water erosion. At least 750 pounds of winter wheat residue is needed per acre to control wind erosion on medium textured soils. Sandy soils, which are more susceptible to wind erosion, require 1,250 pounds per acre. Additional residues will also improve water erosion control. Conventional hoe drills will seed through about 2,500 pounds per acre of winter wheat residues. The amount of straw left at winter wheat planting should match the clearance capacity of the drill. Straw can be redistributed by using a mulch treader or by pulling a rotary hoe backward with the teeth interlocking. *Table VI* shows how various tillage operations maintain residues.

Table VI. Wheat residue maintained with each tillage operation.

V sweeps - 3 to 6 feet in width	90%
Chisel plows	75%
Disk, one-way, tandem offset	40 to 60%
Mulch treaders	75%
Rodweeders with semichisels	85%
Rodweeder	90%

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