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Two Crops in One Year: Relay Intercropping

This publication covers crop variety selection, weed control, and other cultural practices for relay intercropping a crop like soybeans into growing winter wheat or oats.

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Multiple cropping refers to growing two crops on the same field during the same year. One method of multiple cropping is doublecropping, which is the growing of a second crop after harvest of the first crop. In Nebraska, where opportunities for doublecropping are limited, relay intercropping is a possible alternative.

In relay intercropping, two crops are in the field at the same time during part of the season. A small grain is usually relay intercropped with a summer row crop. For example, the small grain is planted at the normal time _ September for winter wheat or early spring for oats or barley. Then soybeans or another row crop is no-till planted into the first crop to minimize damage to the small grain by wheel and planter traffic. The relay intercrop will be well established when the small grain is ready for harvest (*Figure 1*). This may result in higher grain yield than with conventional doublecropping. However, relay intercropping requires more careful management than most crop production systems. Any grower trying relay intercropping for the first time should do so on a limited scale.



Figure 1. Relay intercropped soybeans in ripened winter wheat (left) and after wheat harvest (right).

Irrigation is required most years for successful relay intercropping. When the relay intercrop is planted, the small grain crop is at a moderate to heavy water use stage. Consequently, if rainfall is deficient or uneven, the underseeded row crop can undergo extreme drought stress. Irrigation may be required for survival of the summer row crop; however, excessive irrigation may increase small grain lodging, particularly of oats or barley. Irrigation after small grain harvest will likely be needed for continued development of the relay intercrop.

First Crop Small Grain

Which small grain?

Winter wheat is the best small grain to use for relay intercropping. Wheat winterkill can occur throughout Nebraska, especially in the northeast. The variety Arapahoe has good winter hardiness, medium height and maturity, and fair to good straw strength. It should be a good variety to use in a relay intercrop program. Rose and Seward have better winter hardiness but are taller and several days later than Arapahoe. Rose would be a good variety for northeast Nebraska. To avoid wheat lodging, choose a variety with good straw strength. The semi-dwarf varieties Abilene and Redland have excellent straw strength. They should not lodge even under irrigation. However, the shorter height of Abilene and Redland may make it necessary to operate the combine cutter bar lower, causing more damage to the underseeded relay intercrop. To assure adequate wheat height, it is usually better to use taller varieties like Arapahoe or Rose.

Do not over fertilize wheat to minimize lodging. Soybeans will be damaged more by top removal than will grain or forage sorghum. Soybeans which have had their tops cut off will form new stem branches and continue upward growth under favorable conditions. Under adverse conditions, new stem growth may not occur and soybean yield will be low.

Data from northeast Nebraska (*Table I*) indicate that winter wheat is better than oats for relay intercropping. Similar results have been obtained at the Agricultural Research Development Center near Mead. Winter wheat matures earlier than spring planted small grains such as oats, making relay intercrop growth possible earlier in the summer. Summer annual weeds, particularly grass species, are less troublesome in winter wheat than in spring grains. Wheat is also less likely than spring grain to lodge. Volunteer oats also have been a problem.

Table I. Small grain yields as percent of solid seeded in three relay intercrop experiments at the Northeast Research Center, Concord, NE.

Small grain relay intercropping system	Expt 1, 1982	Expt 2, 1983		Expt 3, 1984-86
	Oats	Oats	Winter wheat	Winter wheat
	--- (%) ---			
Solid seeded alone	100	100	100	100
3 planted rows to 1 skip row, no relay intercrop	88	71	104	85
3 planted rows to 1 skip row, 30 inch row relay intercrop	64	60	86	62

Are skip rows necessary?

Researchers have compared leaving skip rows when wheat is planted with relay intercropping into solid seeded wheat (*Figure 2*). Both methods work. As shown in Table I, leaving skip rows (no relay intercrop) generally results in some small grain yield reduction; additional yield loss occurs from wheel traffic during relay intercropping. Experiments at the Mead Agricultural Research and Development Center demonstrated that the relay intercrop can be planted in solid seeded wheat; yield loss is correlated with wheat growth stage when wheel and planter traffic occurs, *Table II*.



Figure 2. Skip rows left in winter wheat where the relay intercrop was planted.

Table II. Winter wheat yields as percent of solid seeded, with soybean relay intercropped into wheat on three dates, Agricultural Research Development Center, Mead, 1986.

Small grain relay intercropping system	Winter wheat	Soybean yield ¹
	(%)	(bu/acre)
Solid seeded alone	100	
No skip rows, 30 inch row relay intercrop planted:		
May 6	91	24
May 20	75	26
June 4	48	31
¹ Average yield of Williams 82, Century 84, and Hobbit.		

Progressively later planting of the relay intercrop increases wheat damage and yield reduction. The relay intercrop should be planted before wheat boot stage. If skip rows are not used, plant the relay intercrop perpendicular or at some angle to solid seeded wheat to achieve better establishment of the intercrop.

Weed control

Weed management is more difficult in a relay intercrop system than with conventional doublecropping. There is no break between crops when non-selective herbicides such as Roundup and Gramoxone Extra can be applied. It is important to minimize weed establishment in the wheat. Control broadleaf weeds in wheat with Buctril. 2,4-D should not be used on wheat within 30 days of planting soybeans, but there are no restrictions for intercropping to sorghum. Since herbicides are not available to control summer annual grass weeds in winter wheat, choose a relatively weed-free field to minimize grass weed competition with the relay intercrop after wheat is harvested.

Relay Intercrop

Choice of second crop

Soybean, grain sorghum, and forage sorghum have been used as the relay intercrop in eastern Nebraska. In two experiments in northeast Nebraska, doublecropping and relay intercropping were compared, (*Table III*). Doublecrop yields were equal or better than from relay intercropping. With doublecropping,

wheat was harvested for forage whereas with relay cropping it could be harvested for grain. Forage sorghum showed more potential as a relay intercrop than soybean or grain sorghum.

Soybean variety choice is very important. Even though a normal planting date is used with relay intercropping, soybeans will have limited growth until after wheat is harvested. Therefore, a full season soybean variety should be used to assure continued vegetative growth for maximum sunlight interception and yield. A soybean variety with moderate bushiness rather than one with slender upright growth is preferred. Relay intercrop soybean data from the research at Mead are shown in Table II. Soybeans planted later yielded better than when planted earlier. Williams 82 was the highest yielding variety tested.

An additional irrigation experiment was conducted in 1989 at the ARDC. Group III or Group IV varieties were lower yielding than Group I or Group II varieties due to an early freeze. North of the Platte River, use a late Group II or early Group III variety; use a mid to late Group III variety south of the river. With the chinch bug threat in southern Nebraska, grain or forage sorghum probably should not be used as the relay intercrop in winter wheat.

Weed control

Weed management is very complex in a relay intercrop program. Strive for minimal weed establishment in wheat by using good cultural practices and registered herbicides. There are few opportunities for herbicide applications after planting the relay intercrop and before winter wheat is harvested. With soybeans as the row crop, no herbicides are registered for use on soybeans and wheat. With intercrop sorghum, 2,4-D is registered for use on sorghum and wheat.

It is during the wheat jointing stage (when stems are lengthening) that broadleaf weeds in wheat-sorghum may be at a desirable stage for 2,4-D application. However, wheat injury can occur from 2,4-D application during wheat jointing. Buctril can be applied up to boot stage of both wheat and sorghum, but susceptible weeds must be less than 6 inches high.

If weed growth is excessive after small grain harvest, cultivation and postemergence herbicides are the only options. More herbicides are available for soybeans than for sorghum. Basagran, Blazer, Butyrac, Cobra, Classic, and Pinnacle can be used on broadleaf weeds in soybean. Poast, Fusilade, Assure, and Option can provide grass weed control. In sorghum, 2,4-D, Basagran, Buctril, Buctril/Atrazine, and Laddok may be beneficial. However, such herbicide treatments may not be effective because the weeds will likely be too large for control. It is better to strive for good weed control in the winter wheat, properly timed herbicide applications when wheat and the intercrop are growing together, and use of supplemental cultivation of the row crop if necessary. To make cultivation possible, harvest wheat with a combine equipped with a chopper-spreader. Cultivate the row crop when the straw is dry.

Summary

1. Relay intercropping is a high risk cropping system in Nebraska, with risk increasing from south to north as the growing season shortens and rainfall diminishes.
2. Supplemental irrigation is necessary for consistent success. Supplemental water may be needed before small grain harvest in deficient rainfall years to assure survival of the underseeded crop. After small grain harvest, irrigation is usually necessary for economic row crop yields.
3. Relay intercropping is more complicated than sequential doublecropping, with limited potential superiority. Complications with relay intercropping include:
 - a. choosing the best small grain and row crop varieties;

- b. minimizing wheel traffic damage during relay intercrop planting. If the relay intercrop is planted too early to minimize damage to the small grain, the relay intercrop may be too tall and injured by the combine cutter bar during harvest;
 - c. difficulty with weed control since there is no break between crops for tillage or chemical weed control.
4. Relay intercropping should first be tested on a limited acreage.

Table III. Percent of monocrop yield of three crops planted in winter wheat either by sequential doublecropping or relay intercropping, Concord, NE.

Second crop planting system	Experiment	
	1983	1984-86 ²
	--- (%) ---	
<i>Monocrop</i>	100	100
<i>Relay intercropped:</i>		
Soybean	45	17
Grain sorghum	78	10
Forage sorghum	–	30
<i>Doublecropped¹:</i>		
Soybean	62	17
Grain sorghum	–	10
Forage sorghum	–	49
¹ Wheat was removed for forage before doublecropping. ² An early freeze resulted in zero soybean and grain sorghum yield in one year.		

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