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Guidelines for Using Conservation Tillage Under Furrow Irrigation

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Introduction

Tillage is defined as those soil-stirring operations performed for the purpose of producing crops. In the past, the standard, conventional practice was to till fields until the surface was free of residue. In the past, surface residue was considered by farmers to be "trash" and an incidental, often unwanted consequence of crop production. Growers worked diligently to eliminate residue from the soil surface in preparation for growing the subsequent crop.

The use of conventional or "clean" tillage often results in overtilled soils causing the loss of organic matter and soil structure to breakdown. Clean tillage can also promote soil erosion, create soil compaction, increase soil moisture loss, and increase labor and production costs.

The best tillage system is one that accomplishes crop production along with meeting environmental and social needs while incurring the least cost. Tillage need only be sufficient to promote good soil tilth and sustained crop production. No tillage operation can be justified merely by tradition or habit.

Conservation tillage is defined as any tillage and planting system that maintains at least 30% of the soil surface covered by residue following planting, or maintains at least 1,000 pounds per acre of small grain residue on the surface during the critical erosion period. Conservation tillage is an umbrella term that includes other tillage systems such as strip tillage, mulch tillage, no-till, zero tillage, minimum tillage, slot planting, till-plant, rotary till, ridge till, zone tillage, and others.

Farmers in many furrow-irrigated areas have not adopted conservation tillage. This has been a result of concerns associated with tilling, planting, irrigating, and harvesting in fields with surface crop residue. Production practices under conservation tillage are different than conventional tillage methods farmers are accustomed to using on furrow-irrigated cropland. Furthermore, conservation tillage technologies developed for rainfed or sprinkler-irrigated conditions are not generally directly applicable to furrow-irrigated conditions.

Pinto beans produced following corn grown for grain using conservation tillage under furrow irrigation at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson.

The major concern about conservation tillage under furrow irrigation is the uncertainty of being able to furrow irrigate in fields containing surface residue because residue "dams" irrigation furrows and prevents uniform irrigation water applications. Farmers may also be reluctant to make the encompassing changes, including the necessary financial and management investments, that may be needed to adopt conservation tillage successfully on their furrow-irrigated farms.

Growers must have sufficient justification to adopt conservation tillage technology. There are numerous reasons for farmers to adopt conservation tillage for use on furrow-irrigated cropland (see page 15). Conservation tillage may reduce production costs by eliminating field operations. Conservation tillage reduces soil erosion caused by wind and water, making crop production more sustainable. Conservation tillage can maintain yields by reducing the loss of fertile soils and nutrients. Having to fill gullies and smooth fields because of erosion can be expensive and detrimental to long-term field productivity. The reasons for adopting conservation tillage may differ among farmers and locations.

The intent of this guidebook is to inform growers, agribusiness representatives, government agency personnel, and others of the potential for using conservation tillage under furrow irrigation. While the guidebook is not exhaustive, it was designed to be of sufficient detail and scope to inform the reader of the various cropping and management possibilities for successfully using conservation tillage technology on furrow-irrigated cropland.

Managing Surface Crop Residue

How crop residues are managed affects the production of subsequent crops both in terms of crop productivity and the ease and ability to perform field operations. When conducting field operations, farmers should seek to perform each operation as precisely as possible. Farmers must consider how a particular field operation influences subsequent operations. Considering how a specific operation affects subsequent operations is especially important when managing surface residue on furrow-irrigated land.

Several principles of managing surface crop residue have general application to most furrow-irrigated conditions. Crop residue should be spread and maintained as evenly as possible across the entire field. Crop production practices can be performed much more readily in fields with uniform surface crop residue. Uniform surface residue in fields is particularly important when planting and cultivating. In fields with non-uniform surface residue, equipment may not perform consistently and numerous adjustments may be required as conditions change across the field.

Crop residue should be maintained in pieces as large as practical. Large pieces of residue anchor to the soil more readily and are less subject to movement by wind and irrigation water than fine pieces of surface residue. Thus, disking and chopping residue into fine pieces is generally not desirable. The type of crop and the residue produced by various crops influences how well residue stays in place. For example, corn residue is less subject to movement by wind and irrigation water than wheat residue.

Ridging winter wheat residue using a coulter and an Acra-Plant trash tiller. Photo by Calvin Pearson.

Corn produced after winter wheat using conservation tillage under furrow irrigation at Fruita, Colorado. Photo by Calvin Pearson.

Seedbed Preparation

The soil must be prepared sufficiently across the entire field area to provide a suitable environment for seed germination and subsequent plant growth. Two important aspects should be considered during seedbed preparation when using conservation tillage under furrow irrigation. The first aspect relates to the condition of the seedbed. The field surface must allow planting to be performed without difficulty. The seedbed must be sufficiently smooth so seeds are planted at a consistent depth across the field and placed into the soil to obtain good seed-to-soil contact.

The second aspect of proper seedbed preparation when using conservation tillage under furrow irrigation concerns irrigation. Furrows needed for irrigating under conservation tillage conditions are often not the same as those used for conventional tillage. These furrows are typically formed during seedbed preparation. Consideration should be given to the size and shape of the furrows to ensure they are adequate for each irrigation.

Soil Fertility

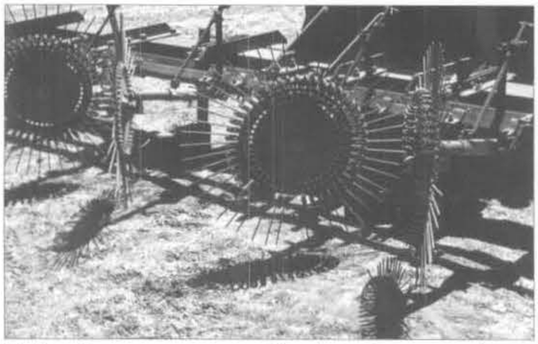
An experiment was conducted during 1996 and 1997 at the CSU Western Colorado Research Center at Fruita in which five nitrogen application rates (0, 67, 134, 201, and 268 pounds of nitrogen per acre) and three application timings were studied in a corn and wheat rotation. The three application timings were: 1) all nitrogen band-applied at planting, 2) 1/3 of the nitrogen band-applied at planting and the remaining 2/3 banded in wheat before the first node and side-dressed in corn at the five- to seven-leaf stage, and 3) all nitrogen banded post-emergence in wheat before the first node and all side-dressed in corn at the five- to seven-leaf stage of development. All treatments were applied to both crops.

Based on the results of the study, when using conservation tillage in a corn/wheat rotation under furrow irrigation, nitrogen fertilizer can be applied across a broad range of rates and application timings without adversely affecting corn yields or creating environmental problems related to leaching nitrogen down through the soil profile. Growers should use best management practices to determine appropriate nitrogen rates for their specific field situations.

When using conservation tillage and with the increased amounts of surface residue that often occur under irrigated conditions, nitrogen immobilization may occur. This is generally a short-term problem and can be readily managed by applying additional nitrogen fertilizer during the establishment phase of conservation tillage. The use of conservation tillage under furrow irrigation has prompted concerns that increased nitrogen leaching may occur. Based on research results obtained in western Colorado in two separate studies, increased nitrogen leaching is not expected to be a major problem when using conservation tillage systems under furrow irrigation, particularly, if growers use good irrigation water and fertilizer management practices.

Forming beds for planting corn using conservation tillage on ground following onions at Montrose, Colorado. Photo by John Murray.

Pinto beans planted following corn at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson.



Rolling fingers to move residue from furrows and onto the top of the bed. Photo by Wayne Cooley.

No-till grain drill developed at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson.

Equipment

Specialized and specially-adjusted equipment are often necessary when growing crops using conservation tillage technology under furrow-irrigated conditions. Crops grown with furrow irrigation often have high yields, and with many crops, not all plant material is harvested and removed from the field. This means large amounts of crop residue remain in the field following harvest.

Equipment must be capable of operating in high surface residue conditions when performing field operations, including forming and shaping beds and furrows, planting, cultivating, ripping, chiseling, and applying fertilizers.

Equipment developed and used in some cropping systems may not be suitable for use in conservation tillage under furrow irrigation. For example, most commercial grain drills will not operate properly when used for conservation tillage under furrow irrigation. A grain drill that is suitable for furrow-irrigated conditions must have adjustable drive wheels so they track in irrigation furrows. Because furrow widths

Farmers Who Know

Reduced Tillage — Growing Corn Following Dry Beans

Steve Pridy in Olathe, Colorado has been working with reduced tillage in the Uncompahgre Valley for the past three years. His conservation tillage system targets growing corn in fields that produced dry beans the previous growing season. He rips and beds either in the fall or early spring. After a year of experience under his belt, he made a deeper committment to reduced tillage by buying a John Deere ripper-bedder. Field operations consist of applying dry fertilizer, ripping and bedding, roller harrowing, and furrowing.

Steve comments, "My yields are pretty comparable to conventionally-tilled ground and reduced tillage saves a lot of time and expense because I don't have to go over the ground as much. There are usually ten to twelve field operations required with conventional tillage. With reduced tillage only about half of those operations are needed. Reduced tillage also improves soil quality by reducing soil erosion."

Reduced tillage cropping systems eliminate heavy (primary) tillage operations typically used in conventional cropping systems. Plowing, disking, and other operations are not used. Because a limited amount of surface residue is present after dry beans are harvested, only ripping and bedding are needed. These operations can be done after dry bean harvest or in early spring, as soon as the ground thaws. Dry fertilizers can be applied prior to ripping and again in the fall or spring. Beds should be left slightly rough to keep wind erosion to a minimum. Beds can be rolled or shaped before planting or left as they are. Pre-irrigation is optional. If needed, corn can be irrigated to obtain uniform germination and emergence. Reduced tillage systems save time and money in the spring by minimizing the number of operations needed. It also promotes increased soil organic levels.

change depending on the crop and grower preferences, wheels must be movable to accommodate different distances between furrows. The grain drill must also have adjustable seed openers to allow for proper seed row placement across the width of the bed.

Grain drills for conservation tillage in furrow-irrigated conditions must also have multiple tool bars for staggering seed openers so residue will flow through the planter. Planters that allow for individual adjustments to accommodate various furrow row spacings, seed row spacings, and individual seed opener planting depths are essential for conservation tillage under furrow irrigation.

Multiple tool bars can also allow for adding coulters for applying fertilizers or shovels for forming furrows. The capital equipment costs associated with the purchase of machinery that may be needed for use in high residue and under furrow-irrigated conditions may be a deterrent to farmers for adopting conservation tillage.

Planting corn following pinto beans at Delta, Colorado using reduced tillage practices. Photo by Wayne Cooley.

No-till planting pinto beans into corn residue at Fruita, Colorado 1994. Photo by Calvin Pearson.

Planting

As previously mentioned, conservation tillage systems under furrow irrigation has aspects that are different from those encountered in clean tillage conditions. Planting into large amounts of surface crop residue can be challenging, even frustrating, when using equipment that is not well suited, or when conditions are not favorable for planting.

Seed openers and planter units need adequate planter weight to penetrate through residue to place the seed at the proper depth and uniformly along the length of the row. Surface residue must flow through the machine without catching, accumulating, dragging, and causing the planter to plug. Plugged planters create residue piles in the field that must be spread, which increases labor costs and adversely affect plant stands. Residue piles also cause difficulty when performing other field practices such as furrow irrigating. Proper seed placement on the bed should also be considered during planting in conservation-tillage conditions.

Experience has shown that planting in wet soils using conservation tillage technology is much more of a challenge than planting in dry soils. Wet conditions create more difficulty for openers to penetrate through residue. Also, closing the seed row behind the planter unit to achieve good seed-to-soil contact is much more difficult in wet soils.

No-till corn planiting into wheat residue at the Western Colorado Research Center at Fruita 1996. Photo by Calvin Pearson.

Cultivation

Similar to planting, cultivating when large amounts of surface residue are in the field creates challenges that are different than when cultivating under clean-tillage conditions. Surface residue must flow through the cultivator freely, without catching, dragging, or creating clumps or piles. Rolling cultivator tools are

Cultivating corn grown after winter wheat at Fruita, Colorado 1994. Photo by Calvin Pearson.

Comparison of weed populations in pinto beans grown with conventional tillage (left) versus conservation tillage (right) at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson.

generally preferred even when only moderate amounts of surface residue are present in the field. When cultivating, operators must be careful that residue and soil do not inadvertently cover or lodge plants. A timely cultivation can move residue around plants or in other areas to create a mulch that will provide effective weed control. During the last cultivation of the season, furrows should be formed adequately to accommodate irrigation needs for the remainder of the growing season.

Weed, Insect, and Disease Management

Perennial weeds, such as field bindweed, may require special attention and management when crops are grown using conservation tillage. Problems with perennial weeds are not unique to any particular tillage system. With the use of good management strategies, conservation tillage may actually be more effective in controlling perennial weeds than clean tillage. When clean tillage is used, fields appear to be free of weeds during at least part of the year and growers can be lulled into thinking weed problems are temporary; thus, growers may not implement effective control practices to control perennial weeds when clean tillage is used.

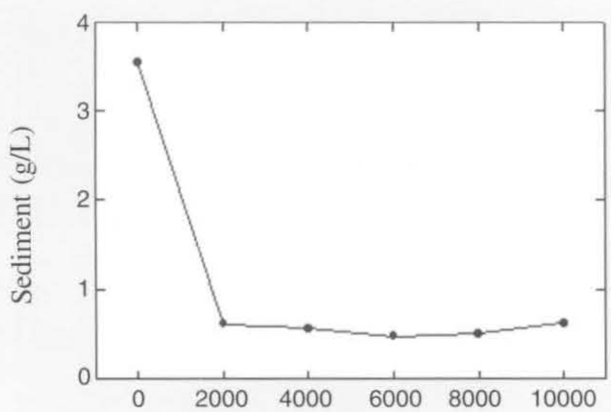
Desirable weed, insect, and disease management strategies will draw on several, if not many, practices that are effective in controlling pests, no matter what tillage system is used (see illustration right). Clean-tillage systems have been used extensively in the past for weed control; however, clean tillage for weed control is not possible with conservation tillage systems. Surface residue should be actively managed as much as possible to assist in controlling weeds, insects, and diseases. Field monitoring is essential to identify problems early so adequate time is available to select and schedule suitable responses.

Methods of Weed Control

— A dense, vigorous stand
— Proper irrigation
— Adequate soil fertility
— Crop rotation
— Adapted varieties
— Good soil drainage
— Site selection
— Cultivation/Tillage
— Flooding
— Residue management
— Planting time and methods
— Companion crops
— Weed-free seed
— Weed control before planting
— Mowing
— Mob grazing
— Burning/flaming
— Herbicides
— Biological
— Smother crops
— Herbicide-resistant cultivars

Irrigation and Water Quality

Maintaining surface crop residue and using conservation tillage technology can have a dramatic impact on reducing sediment loss and improving irrigation water quality. Sediment loss is greatest in bare, smooth (no clods) soil compared to soils containing even small amounts of surface residue (see graph below). In a study conducted in western Colorado using a furrow-residue simulator, increasing surface residue beyond 3,570 pounds per acre did not further reduce sediment loss in a loam soil. In a sandy loam soil, increasing surface residue quantities beyond 1,800 pounds per acre did not further reduce sediment loss. Farmers who learn to manage even small quantities of surface residue can significantly reduce soil erosion on furrow-irrigated cropland.



The effect of surface crop residue on the amount of sediment in irrigation water.

Based on research conducted in western Colorado, the response to conservation tillage growers are likely to encounter on their farms will depend on their soil type. These findings indicate that surface residue in furrow-irrigated, field conditions is more responsive to management in heavier soils such as loams than in light soils such as sandy loams. In other words, when a particular management is imposed, heavier soils will have a greater effect or response than lighter soils.

Conservation tillage also affects other aspects of furrow irrigation. In another Western Colorado study, infiltration rates were 24 to 50% higher with conservation than with conventional tillage. Other research in the U.S. also has shown that infiltration rates are higher with conservation tillage than with clean tillage under furrow irrigation.

Irrigation water advance times are typically longer with conservation tillage than with conventional tillage. Advance time is the time it takes irrigation water to move down the furrow. In this same Western Colorado study, irrigation water advance times were 25 to 37% longer with conservation than with conventional tillage.

Soil water content is often higher when conservation tillage is used compared to clean tillage. In western Colorado, the soil water content, averaged 17% higher for corn, 17% higher for soybean, and 27% higher for dry bean with conservation than with clean tillage. Because higher infiltration rates and hence higher soil water contents occur with conservation tillage it may be possible to irrigate less often under conservation tillage. Irrigating less often and more efficiently using conservation tillage will save water and the labor needed to irrigate crops more often that is typically used with clean tillage cropping systems.

Furrow stream size, the growing crop, field slope and length, soil type, residue quantity and type, soil clodiness, and soil compaction affect furrow irrigation. Attempting to achieve uniform infiltration along the length of the furrow in a field, while minimizing the amount of runoff, necessitates managing as many of these factors as possible. For example, when irrigating furrows containing large amounts of residue a grower may need to increase the furrow stream size to compensate for the residue effect. Furrows may also need to be larger than normal. Also, furrows may need to be smoother with fewer soil clods and more compacted to lower furrow roughness to maintain advance times at an acceptable rate.

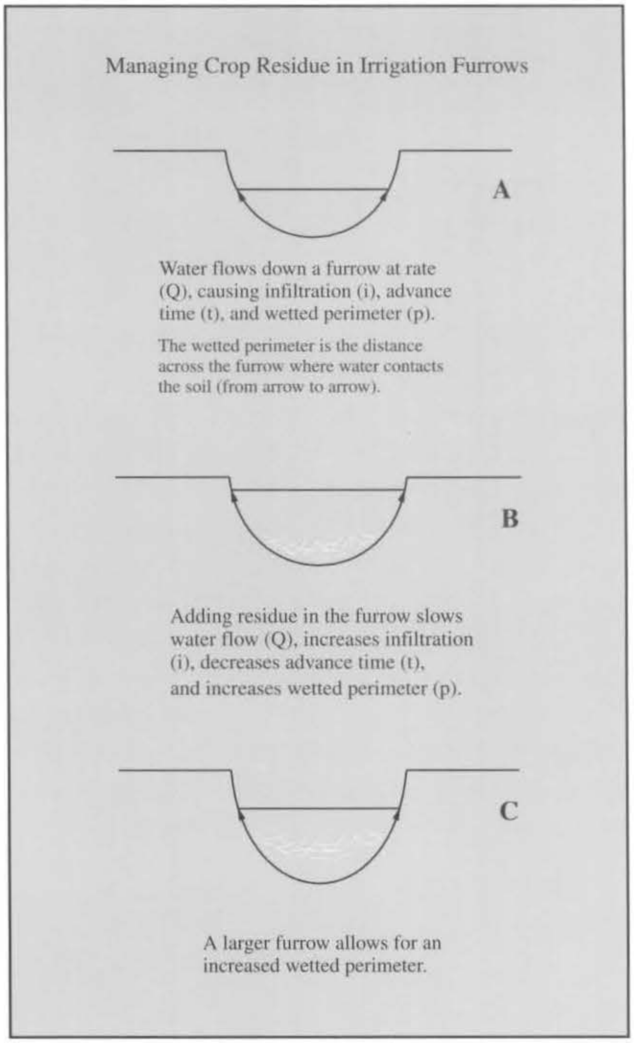
Growers need to manage the amount of residue that is in the furrow. When furrows contain too much residue some plant material may need to be moved to alternate rows or between rows using rolling cultivator tools. Moving residue will prevent it from interfering during irrigating or other crop production operations. With corn residue, a practical management technique is to move residue to alternate furrows during seedbed preparation. The irrigation after planting is done in these alternate furrows that have lesser amounts of residue. Once plants are big enough, residue in the other furrows can be mulched around the plants and all furrows can be irrigated for the rest of the season.

Furrow irrigating winter rye after corn that has been planted in the stubble at Montrose, Colorado. Photo by John Murray.

Managing the bottom of the furrow is important in controlling irrigation water infiltration. Residue in the furrow can increase lateral soil wetting. Therefore, to achieve acceptable advance times under conservation tillage conditions it may be necessary to have a slightly larger furrow with a smooth, compact, clod-free bottom (see illustration at right). Under conservation tillage, infiltration increases, and if increases in infiltration are partitioned more to lateral water movement and less to vertical movement, the potential for leaching may actually be reduced.

When furrow roughness is excessive under clean-tillage systems infiltration may be too high and advance time too slow. Farmers commonly traffic furrows to decrease high infiltration and long advance time caused by excessive furrow roughness under clean tillage systems. Reducing furrow roughness under clean tillage systems smooths the furrow by increasing soil compaction and eliminating or reducing soil clods. Furrow roughness may require similar mangement under conservation tillage.

With conservation tillage, increasing the furrow stream size too much may create an erosive energy that causes the water to transport residue. Residue moving with the irrigation water may result in "furrow damming." Maintaining the size of the residue as large as practical and using an appropriate stream size will reduce the likelihood of residue movement. Most farmers have learned to balance infiltration and advance time under clean-tillage conditions to furrow irrigate successfully. To furrow irrigate successfully under conservation tillage conditions farmers must also learn to balance



Right: Irrigation water run-off containing sediment at the end of the furrow when conventional tillage was used in pinto bean production June 17, 1993. Photo by Calvin Pearson.

Left: Sediment-free irrigation water run-off at the end of the furrow and into a tail ditch when conservation tillage was used in pinto bean production June 17, 1993. Photo by Calvin Pearson.

Tillage	First irrigation	Sixth irrigation
	Furrow width (inches)	
Conservation	12.1	8.0
Conventional	13.0	10.0

Left: Corn for silage grown after alfalfa at Olathe, Colorado using conservation tillage technology. Photo by Wayne Cooley.

infiltration and advance time, taking into account the added effects created by surface residue.

Maintaining crop residue on or near the soil surface using conservation tillage technology reduces furrow erosion during irrigating. In a study conducted in western Colorado, furrow width was found to be 8% wider in the first irrigation and 24% wider in the sixth irrigation with clean tillage compared to conservation tillage (see above). The soil is more protected from the erosive energy of irrigation water when surface residue is present. Thus, furrows are less subjected to the effects of erosion and movement of soil when conservation tillage is used compared to the wider furrows that occur when clean tillage is used.

Right: Corn residue remaining from the previous corn crop under a windrow after cutting pinto beans. Photo by Calvin Pearson.

Furrow irrigating pinto beans grown under conservation tillage at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson.

Furrow-irrigating winter wheat stubble at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson.

Harvesting

During harvest, growers are focused primarily on harvesting and little else in an attempt to ensure their efforts expended during the year are as profitable as possible. A rapid harvest greatly reduces growers' risk from weather-related losses.

While harvest is important, crop residue that occurs as a result of harvest also deserves attention. Growers should consciously consider how equipment and equipment attachments affect crop residue. Stripper headers, straw spreaders, straw choppers, and chaff spreaders are a few devices, along with their sizes, configurations, number, and adjustments that can have considerable impact on crop residue condition and distribution in the field.

Growers should consider how the type of equipment used, associated attachments, and the operation and performance of equipment can affect future field operations and situations. Proper management should be used to obtain uniform distribution of surface crop residue across the field.

Growers should also consider how wheel traffic from grain trucks, carts, and tractors affect residue and soil conditions, and how subsequent field operations may be affected by wheel traffic that occurs during harvesting.

Corn residue following flailing in the fall after harvest. Photo by Calvin Pearson.

Post-Harvest Field Management

Once harvest is completed growers may be inclined to discontinue field work until next spring; however, the way fields are managed following harvest should be thoughtfully considered during and after harvest. For example, once grain corn has been harvested, growers should determine if they should flail the residue or leave it standing through the winter. In western Colorado, we have found that more residue is retained in the field over the winter period when flailing is performed than when corn stalks are left standing during the winter. When corn stalks are left standing during the winter the wind blows more leaves and other lighter material out of the field than when the field is flailed and the corn stalks are mixed with leaves and other residue.

Soil compaction likely reduces yields more than growers realize in all types of cropping systems. Certain cropping systems and management practices are more likely to cause soil compaction than others. Concerns have been expressed about soil compaction problems developing when conservation tillage is used in furrow-irrigated conditions. Based on field research conducted in western Colorado, soil compaction was found to be similar between conservation and conventional tillage in the three crops that were studied over a two-year period, except for soybean in one year where soil compaction was 23% higher with conservation tillage than with conventional tillage. This situation represents one in six cases that soil compaction was affected by tillage and occurred after only three years of conservation tillage. This finding indicates that soil compaction under conservation tillage systems is a potential problem and should be monitored similar to recommendations currently made for other tillage systems.

Roundup applied in the fall to kill an alfalfa stand in preparation for no-till planting corn the following spring. Photo by Calvin Pearson.

Farmers Who Know

Step-by-Step Process for Growing Silage Corn after Alfalfa using Conservation Tillage

From the Grett Land Company at Olathe, Colorado —

— In early spring as soon as the ground is dry and free of frost — re-furrow and shape alfalfa beds to obtain a good square seed bed.

— Between April 25 and May 5, tank mix and apply the following: Roundup at 1 quart per acre, plus Atrazine at 2 pounds per acre of dry flowable product, plus Banvel at 1 pint per acre, plus 2 pounds per acre of ammonium sulfate, plus surfactant at 1 quart per 100 gallons of solution.

— Plant corn the following day or up to one week after herbicide application. A John Deere 7100 Max-Emerge was used for planting (pressure springs completely tight). Planting rate was 42,000 seeds per acre.

— Irrigate immediately after planting.

— Side-dress liquid nitrogen either after the first or second irrigation at 160 to180 pounds of nitrogen per acre or as based on soil test results.

— Irrigate as needed during the growing season.

"Silage yields have ranged from 20 to 30 tons per acre each year for the past 7 years. Our conservation tillage program has increased profits by $25 per acre compared to conventional tillage."

Crop Rotations

Based on research and grower experience, a number of crop rotations are possible when conservation tillage is used under furrow irrigation. Some crops and crop rotations are more conducive than others for using conservation tillage on furrow-irrigated land. Growers must determine which crops and crop rotations are acceptable for their operations when conservation tillage is used under furrow irrigation. A few crop rotation possibilities are presented in this publication. Surely, there are other possibilities. A few succinct comments have also been included about how these crop rotations work when used with conservation tillage and furrow irrigation.

Winter wheat and winter barley have been successfully grown under furrow irrigation using conservation tillage following dry beans. This crop rotation is not difficult to do when using conservation tillage under furrow irrigation. Growers should be mindful of using herbicides in dry bean that may carryover and cause damage in small grains. Dry bean residue should be spread as uniformly as possible across the field during harvest.

Corn harvested for silage followed by winter wheat can be readily accomplished using conservation tillage with furrow irrigation. Having a planter that is capable of planting or that can be adjusted to plant in uneven conditions is important. Following planting, furrows may need to be reshaped. Corn for silage or corn for grain following alfalfa is a common crop rotation that growers have accomplished successfully when using conservation tillage under furrow irrigation. Alfalfa stands can be killed in the fall or spring using suitable herbicides, often Roundup™. Grain yields of corn grown with conservation tillage following alfalfa have been comparable to yields grown using clean tillage.

Fewer field operations are needed when using conservation tillage. This allows more time for growing crops in the field instead of spending time performing field operations. Double-cropping is the production of two crops in one growing season. By using conservation tillage technology, it may be possible to develop double-cropping systems in furrow-irrigated areas where it has not been previously possible with conventional tillage systems. (see Farmers Who Know, page 14).

Winter wheat planted following corn harvested for silage using conservation tillage at the Western Colorado Reserch Center at Fruita. Photo by Calvin Pearson.

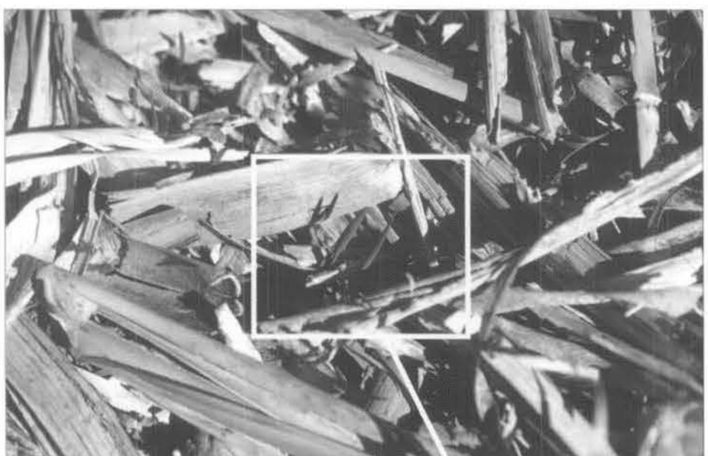
Winter wheat grown following silage corn at Fruita, Colorado. April 12, 1994. Photo by Calvin Pearson.

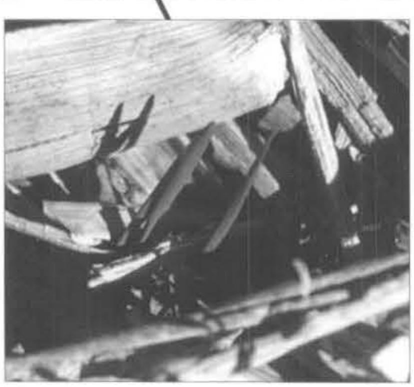
Winter wheat grown following silage corn at Fruita, Colorado. May 11, 1994. Photo by Calvin Pearson.

Winter wheat grown following silage corn at Fruita, Colorado. June 5, 1994. Photo by Calvin Pearson.

Limitations for Using Conservation Tillage Under Furrow Irrigation

Developing conservation tillage technology for various crops grown under furrow irrigation and in different crop rotations requires considerable field research and experience to identify the specific practices that perform well in a particular cropping system. With some cropping systems it may be possible to maintain conservation tillage for only a year or two. Yet, in other situations it may be possible to use conservation continuously, or at least for several years. For example, releveling fields periodically that have been under conservation tillage for a period of time may be necessary to maintain uniform furrow-irrigated conditions. Land leveling is difficult when large quantities of surface crop residue are present. Additionally, crop species, crop rotations, and cropping practices vary considerably across the various furrow-irrigated regions of the country. Regional nuances must be considered when developing and using conservation technology.





Winter wheat seedlings emerging through corn residue. Photo by Calvin Pearson.

Some crops used in desired rotations may require different row spacings. Changing row spacings from year-to-year may require field operations that limits the use of conservation tillage. Considerable tillage may also occur during harvest of various crops such as potatoes, sugarbeets, onions, and dry beans. Including some crops in the rotation can complicate or interrupt the use of conservation tillage and may not promote consistent management.

Growing no-till winter wheat following grain corn presents challenges when conservation tillage is used and high amounts of surface residue are present. Such large quantities of residue can create difficulty when planting winter wheat into these large amounts of corn residue. Large amounts of surface corn residue can cause difficulty for wheat seedlings to emerge and can lower or cause non-uniform plant stands. Also, if the soil is too wet at planting, the slot made by the seed opener may not seal properly, leaving the seed without adequate seed-to-soil contact. Planting wheat generally proceeds more smoothly when the soil and residue are dry.

Planting pinto beans following winter barley as a double-crop using no-tillage in western Colorado has not been successful. The problem encountered with this cropping system was caused by increased soil moisture. Because of the barley stubble, soil moisture increased and promoted development of root rot diseases in pinto bean, causing reduced bean yields. Furthermore, during harvest, barley roots held onto clods that were similar in size to bean seed. Large quantities of these small clods were harvested along with the pinto beans. Double-cropping pinto beans after winter barley using the no-tillage cropping system we used is not recommended.

Growers must be aware that problems can occur when using conservation tillage under furrow irrigation and they must seek to develop ways to avoid or overcome them.

Economics

A study was conducted at the Western Colorado Research Center in the early 1990s which compared conservation with conventional tillage in a cropping system of corn, soybean, winter barley, and dry beans under furrow irrigation (see table, page 13). Along with crop and soil characteristics, the economics of these two tillage systems were determined.

Direct costs averaged 4% higher under conventional tillage than conservation tillage for corn, soybean, and winter barley. Property and ownership costs under conventional tillage averaged nearly 50% higher than for conservation tillage. Net return was slightly higher (2%) for conventional than for conservation tillage when the four crops were considered together in the cropping system. The data from this study showed similar profitability for conservation and conventional tillage when all four crops in this cropping system were considered together. Growers in western Colorado have found that using conservation tillage on their farms provides them with an additional $25 to $50 per acre of income (see Farmers Who Know, page 10 and below).

Production costs and profitability are highly dependent on individual grower circumstances. By refining production practices based on grower experience and the latest research, net returns using conservation tillage are likely to increase. Reducing input costs by reducing the number of field operations needed to produce a crop while maintaining crop yields will promote increased net grower returns.

Crop	Conservation Tillage	Conventional Tillage
	Dollars per acre	
Operating Costs		
Corn	266	286
Soybean	238	253
Winter barley	162	171
Dry bean	241	236
Total	**907**	**946**
Property and ownership costs		
Corn	39	55
Soybean	35	55
Winter barley	33	47
Dry bean	35	55
Total	**142**	**212**
Net returns to the grower		
Corn	124	181
Soybean	21	-26
Winter barley	195	187
Dry bean	187	197
Total	**527**	**539**

Farmers Who Know

Step-by-Step Process for Growing Corn after Corn Using Conservation Tillage under Furrow Irrigation

From the Randy Hines Farm in Delta, Colorado —

— Used ripper/bedder and applied phosphorus at 50 pounds per acre on 60-inch beds.

— Raked corn residue to the center of 60-inch beds.

— Roller-harrowed to firm and shape beds.

— Planted corn on 30-inch centers.

— Post-emergence weed control— apply either Basis at 1/3 ounce per acre + Clarity at 4 ounces per acre or Basis Gold at 14 ounces per acre + Clarity at 4 ounces per acre or Steadfast at 0.75 ounce per acre + Clarity at 4 ounces per acre, depending on the crop rotation for the next season.

— Irrigated as recommended during the growing season.

— Side-dressed anhydrous ammonia based on soil test results.

— Grain yields in 2001 averaged 180 bushels per acre.

— Typically saves us $50 per acre in tillage costs compared to growing corn using conventional tillage practices.

Farmers Who Know

Double-cropping practices used by Randy Meaker at Montrose, Colorado

"We have experimented with double-cropping winter rye and corn for several years. In any given year, we may have from 25 to 90 acres under this cropping plan. The determining factor for the number of acres used for double-cropping is our ability to prepare the soil in the fall after silage harvest. Our soils have a high clay content and late irrigation or wet weather during the harvest promotes soil compaction."

"I feel there are distinct and significant advantages to our cropping program. Yield per acre is consistently greater than those with corn raised in a conventional manner. We experience substantially less soil erosion in furrows during irrigation due to the cover provided by the rye stubble. The root structure of the rye is very prolific and improves the soil condition by adding organic matter. This also promotes faster wetting, longer water retention, and fewer number of needed irrigations. Labor and machine time is decreased because we do not plow, land level, or cultivate. Furthermore, problem weeds such as thistle have been brought under control due to double-spraying of Roundup™ herbicide."

"In any cropping system, some obstacles are to be expected. As previously mentioned, soil compaction that may occur during harvest in the fall can be a problem. Timing of the first application of Roundup™ herbicide is important...if this application occurs too soon after irrigation, the rye stubble hasn't begun to regrow and herbicide efficacy is low. If the application of Roundup™ occurs too long after irrigation, the rye may become competitive against emerging corn. As expected in any cropping systems, weather and wind are major factors for applying herbicides."

"I am encouraged by our success with the winter rye and corn cropping system. We continue to improve fertilizer placement to increase efficiency and decrease input costs. Varieties selected for planting may also add to quality and yield. We are currently testing the use of triticale rather than winter rye."

In the Fall, after harvest of corn silage, or dry beans . . .

- — Disc only, depending on soil conditions.
- — Roller-harrow to firm the seedbed.
- — Broadcast a mixture of winter rye (or triticale) and fertilizer.
- — Form furrows.
- — Irrigate (usually only once in the fall).

In the Spring . . .

- — Broadcast nitrogen fertilizer to promote spring growth of rye.
- — Re-furrow fields as needed.
- — Irrigate as needed.
- — Harvest winter rye as ensilage. Maximum forage quality occurs when heads are still in the boot. Time harvest when heads begin to emerge. Generally harvest occurs between the 10th and the 15th of May. Yields have averaged between 8 and 12 tons of ensilage per acre.
- — Direct seed Roundup-Ready™ corn into the rye stubble. My planter is equipped to apply starter fertilizer with back-swept knives 2 inches deep and 2 inches away from the corn row. If needed, furrow shovels may be used.
- — Irrigate . . . treat the field as if it were a grain field, water every row and wet the beds.
- — Aerial apply 1 quart per acre of Roundup™ herbicide at 7 to 10 days after first irrigation to kill the regrowth of the rye. This is very important as the rye is extremely competitive and will choke out the corn if the rye is not killed.
- — Sidedress nitrogen fertilizer.
- — Apply 1 quart per acre of Roundup™ herbicide to cleanup missed rye and late germinating weeds.
- — Irrigate as needed.
- — Harvest mid to late September as ensilage. Yields have averaged between 24 and 27 tons per acre.

In the Fall...repeat the process.

Conservation Tillage — Technology That Works

Research and experience have shown that conservation tillage can be used successfully in various furrow-irrigated cropping systems. In many situations, surface crop residue on furrow-irrigated cropland can be managed readily without adversely affecting yields. Furthermore, large amounts of surface crop residue can be managed effectively under furrow irrigation without causing problems when irrigating, cultivating, or performing other field operations. Specialized and specially-adjusted field equipment and appropriate management practices are necessary for managing surface crop residue under furrow irrigation. Producing crops using conservation tillage under furrow irrigation often requires growers to develop new perspectives to overcome any psychological barriers they may have about growing and managing crops under these conditions. As additional research results and grower experience are obtained with conservation tillage under furrow irrigation, more extensive use of this technology is likely to occur.

The Benefits of Using Conservation Tillage on Furrow-Irrigated Cropland are:

— Reduces runoff and increases soil moisture.

— Reduces soil erosion and sediment transport and deposition.

— Increases soil organic matter.

— Provides shelter and habitat for wildlife.

— Traps snow during winter months.

— Reduces evaporation.

— Reduces the amount of wheel traffic across the field; thus, reducing compaction.

— Conserves fuel and labor by reducing the number of field operations.

— Saves time from fewer field operations that can be used for more precise and timely management.

— Reduces the amount of sediment that is carried from fields downstream into reservoirs, lakes, and water ways; thus, protecting water quality.

— Protects water quality by reducing surface water pollutants that may bind to soil particles, become suspended, and subsequently carried off the field in tailwater.

— May improve grower ability to assess perennial weed problems and identify effective control methods.

— May reduce weed infestations and herbicide use.

— Eliminates pollution associated with burning crop residue.

— Improves public relations with the urban community by using environmentally sound cropping methods.

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