AE-1370 (Revised)

Strip-tilled field

Strip Till for Field Crop Production

Equipment • Production • Economics

John Nowatzki
Agricultural Machine Systems Specialist, NDSU Extension Service

Greg Endres
Area Extension Specialist/Cropping Systems, NDSU Extension Service

Jodi DeJong-Hughes
Regional Extension Educator, University of Minnesota

Dwight Aakre
Farm Management Specialist, NDSU Extension Service

In dry conditions, reduced-tillage planting systems preserve moisture in the seedbed, enhancing uniform germination and plant establishment.

NDSU Extension Service
North Dakota State University

University of Minnesota | Extension
Driven to Discover

May 2011

What is Strip Till?

The trend among northern Plains farmers is toward using less tillage to produce field crops with more residue left on the soil surface. Strip till is a field tillage system that combines no tillage and full tillage to produce row crops. Narrow strips, 6 to 12 inches wide, are tilled in crop stubble, with the area between the rows left undisturbed. Often, fertilizer is injected into the tilled area during the strip-tilling operation. The tilled strips correspond to planter row widths of the next crop, and seeds are planted directly into the tilled strips. Strip tilling normally is done in the fall after harvest, but it also can be done in the spring before planting.

Advantages of Strip Till

- Reduces soil erosion because most of the soil remains covered with crop residue throughout the year
- Increases water infiltration compared with full-field tillage
- Releases less carbon into the atmosphere and maintains higher levels of soil organic matter
- Promotes seed germination and plant emergence because the tilled strips warm sooner in the spring
- Conserves soil moisture because most of the soil surface area is covered with crop residue
- Results in crop yields that are similar or higher compared with other tillage systems
- Reduces expenses, including fuel and labor, by eliminating some primary and secondary tillage

Strip Till Qualifies for NRCS Conservation Incentives

Strip tillage can be used to qualify for the Natural Resources Conservation Service (NRCS) conservation management/no-till incentive programs. To qualify for NRCS no-till incentive programs, a Soil Tillage Intensity Rating (STIR) value of 10 or less is required. STIR is a numerical value calculated using RUSLE2, a computer model that predicts long-term average annual erosion by water. This model is based on crop management decisions implemented in a field. The NRCS assigns a numerical value to each tillage operation. STIR values range from 0 to 200, with lower scores indicating reduced soil disturbance. Other benefits of low STIR values include increased organic matter content of the soil and improved water infiltration rates.

Table 1. STIR values for common tillage operations.

Operation	STIR
No tillage	0.0
Double-disk opener planter	2.4
Tandem disk, light finishing	19.5
Field cultivator, 6- to 12-inch sweeps	23.4
Tandem disk	39.0
Chisel, shovel sweeps	45.5
Moldboard plow	52.0

Strip Till Improves Carbon Sequestration

Soil organic matter plays a critical role in the global carbon cycle. Soil can act as both a major source for carbon released into the atmosphere and a sink to store carbon. When carbon is stored in the soil, it is not released to the atmosphere as greenhouse gases, particularly carbon dioxide (CO_2) and methane (CH_4). Tillage increases microbial action on organic matter stored in the soil and normally increases the rate of decomposition that changes organic carbon into CO_2. Soil organic matter is directly related to soil fertility and positively correlated with agricultural productivity potential.

Besides reducing greenhouse gases, other advantages of increasing or maintaining a high level of soil organic matter include reduced soil erosion, increased resistance to compaction, increased biological activity and enhanced soil fertility. Since **tillage results in soil carbon loss**, identifying tillage methods that reduce the amount of carbon released into the atmosphere is important.

A comparison study of soil CO_2 emissions following fall moldboard plowing, disk ripping and strip tilling conducted in 2005 in Minnesota (Faaborg et al., 2005) determined that **strip tillage maintained more soil carbon** than moldboard plowing and disk ripping. Disk ripping and strip tillage released 53.2 and 82.6 percent less CO_2, respectively, than moldboard plowing **(Figure 1)**. Moldboard plowing disturbed and exposed the greatest amount of soil, allowing carbon previously stored as organic matter or present as CO_2 in the soil atmosphere to escape into the atmosphere.

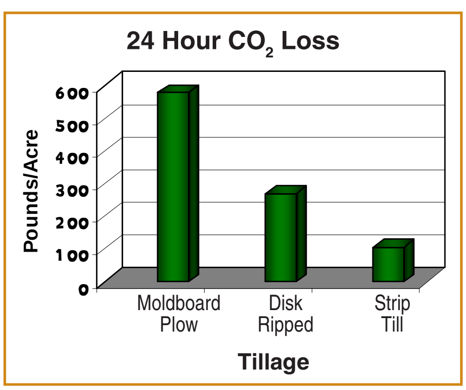

Figure 1. Carbon losses from fall tillage operations at Jeffers, Minn.

Strip till

Enhance Crop Residue Management

Residue from previous crops limits evaporation from the soil surface and maintains relatively high humidity levels in undisturbed soils at 90 to 100 percent, which are ideal for seed germination. Even with excellent seed-to-soil contact, approximately 85 percent of the water entering a germinating wheat seed is in the form of water vapor. In dry conditions, reduced-tillage planting systems preserve moisture in the seedbed, enhancing uniform germination and plant establishment. Crop residue is also a food source for beneficial fungi, bacteria and insects.

Managed properly, the beneficial aspects of maintaining high levels of crop residue with conservation tillage systems outweigh the negative aspects. Strip till leaves most of the previous year's crop residue on the soil surface, protecting new crop plants from wind damage during establishment and continuing to protect the soil if the crop fails to establish due to drought or flood. Crop residue readily decays and is incorporated into soil by earthworms and other invertebrates when the growing crop canopy covers the space between the rows.

Equipment

Equipment components and functions

Several strip-tillage equipment manufacturers offer a variety of designs and features. Most equipment manufacturers market machines with similar features, including **coulter blades, row cleaners, tillage shanks, berm-building disks** and **packing wheels** or **conditioning baskets**. Some strip-till equipment designs include paired coulters or a large disk without a tillage shank. Most strip-till equipment manufacturers in the northern Great Plains produce strip tillers with 30-inch or 22-inch row spacing. A list of Internet addresses of strip-till equipment manufacturers is included at the end of this publication.

Coulter blades cut through the soil and residue ahead of the tillage shank. The coulters require mounting that allows flexible movement over stones. Some manufacturers use fluted coulters and designs with depth-control features with the coulters. Coulter size influences

Coulter blades and row cleaners

operation in residue; larger-diameter coulters function better in heavy residue.

Parallel linkages on each row unit are desirable on strip tillers operated on soil with large stones or rolling topography because this linkage system allows row assemblies to move over stones or uneven surfaces without interrupting accurate fertilizer placement on adjacent row assemblies.

Row cleaners function to clear residue away from the front of the tillage shank and berm-building disks, leaving a clean, tilled strip. Various manufacturers use unique proprietary designs to clear the tilled area. The row cleaners usually are mounted behind the cutting coulter and a few inches ahead of the tillage shank.

Strip-till equipment needs to be designed to meter accurately and correctly place appropriate amounts of fertilizers in the tilled strips. The ability to apply one or more liquid, gaseous or dry fertilizers is an important design feature of strip-till equipment.

The **tillage shank** penetrates and loosens soil and normally is designed with a fertilizer injection tube to allow application of gaseous, liquid or dry granular fertilizers during the strip-tillage operation. Tillage depth is dependent on the soil type and conditions and the specific crop to be planted. **Berm-building disks** are mounted on each side and 6 to 8 inches behind the tillage shank. The disks can be mounted to mound the strip to promote moisture runoff and facilitate soil drying in the spring or, alternatively, mounted to create a slight depression in the soil to catch snow and rain to increase soil moisture for the next crop.

Tillage shank with berm-building disks

Conditioning basket

Conditioning baskets are mounted behind each shank to break soil clods and smooth the soil surface. Some manufacturers use rubber packing wheels instead of conditioning baskets. Large clumps likely indicate that the soil is too wet for tillage or adjustments are needed on equipment. Some system of smoothing the soil and breaking clumps is important, particularly if the strip tilling is done immediately prior to planting. Smoothing the tilled strips is less important if strip tilling is done in the fall because winter weather conditions smooth the soil naturally.

All components of strip-till machines usually are mounted on three-point tool bar attachments directly to tractors or assembled as pull-type units with wheels. Pull-type designs are more common because they can be used with wider units.

Power and Energy Requirements

The power requirement of strip-till equipment varies depending on the equipment design, number of row units, components used, soil properties, shank depth, field conditions and operator adjustments. The power requirement listed in the equipment specifications by several strip-till equipment manufacturers ranges from 12 to 30 horsepower per row unit. However, since only about one-third of the field surface is tilled with strip-till equipment, the energy requirement is less than with conventional tillage systems.

Strip Till and GPS Guidance

Accurate equipment guidance is important for strip tillage and the subsequent planting and spraying operations, particularly in irregularly shaped fields. Strip-tillage machines can be equipped with markers to facilitate accurate spacing of rows on each new round in the field, or global positioning system (GPS) guidance can be used without markers. GPS positioning accuracy of greater than 6 inches pass-to-pass is recommended. Real-time kinematic differential correction (RTK) GPS is recommended for positioning accuracy for strip tilling.

Crop Production With Strip Till

Warmer spring soil temperature

Strip-till systems move crop residue from the soil surface over the seedbed, resulting in soil temperatures similar to conventional tillage systems. No-till systems leave residue on the soil surface over the seedbed, resulting in lower soil temperatures compared with tilled soil. University of Minnesota research in southern Minnesota (Stahl, DeJong-Hughes) shows an aggressive strip-till machine can clear away sufficient residue to promote soil warming similar to moldboard plowing in a continuous corn rotation (Table 2). In a corn-soybean rotation, soil temperatures were similar for strip till and chisel plow and lower for no till (Table 3).

Table 2. Soil temperatures using several different tillage operations in continuous corn.

	Soil Temperatures at Planting, °F	
Tillage	**2006**	**2007**
Moldboard plow	65.3	55.7
Disk ripped	62.3	54.7
Strip till	65.4	54.2

Table 3. Soil temperatures at planting using different tillage operations in soybean/corn rotation.

	Soil Temperatures at Planting, °F	
Tillage	**2006**	**2007**
Chisel plow	57.7	69.1
No till	55.8	64.9
Strip till	58.9	71.5

Similarly, research in the Red River Valley (Prosper, N.D., and Moorhead, Minn.) in 2007 indicated comparable temperatures between conventional tillage and strip till (Overstreet et al., 2007). The soil temperature advantage with strip till compared with no till promotes faster plant emergence and development. This advantage is enhanced when soil temperatures are lower and approach the lower threshold for crop seed germination. For example, early planted strip-till corn or soybeans likely will emerge sooner than in a no-till system. Earlier plant establishment normally increases crop yield and quality.

Earlier emergence and stand establishment also promotes earlier crop canopy closure, reducing mid- and late-season weed seed germination, and providing a better chance for young plants to establish and withstand disease and insect pressure.

Conserves Soil Moisture

Strip tillage on the northern Great Plains in the United States conserves soil moisture by trapping winter snow and reducing evaporation and transpiration losses **(Figure 2)**, resulting in more soil moisture available for plants, particularly later in the growing season during the plant reproductive stages. Figure 2 illustrates additional soil moisture present with strip till compared with conventional till (Overstreet et al., 2007).

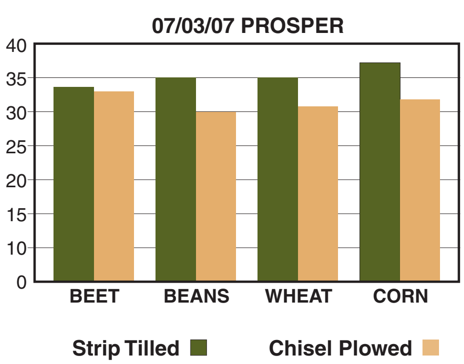

Figure 2. Volumetric soil moisture in strip-tilled and chisel-plowed fields for sugar beets, soybeans, wheat and corn.

Strip till: fall

Strip till: spring

When to Strip Till?

In the northern Great Plains, strip tillage with fertilizer application usually is performed in the fall after harvest, followed by planting in the spring. Fall tillage allows time for the soil in the berm to smooth during the winter and warm in the spring before crop planting.

Strip tillage operations can be performed in the spring, particularly in regions with coarse-textured and lower organic-matter content soils. Research conducted in 2007 on loam soil at Carrington, N.D., indicates similar crop yield between fall and spring strip tillage.

Strip-till Practices for Crop Production

Research indicates strip tillage works well with crops grown with 30-inch row spacing; however, narrower row spacings also work, but residue management is more difficult with less space for residue. Mounting strip-till units on staggered bars allows residue to flow between strip-till units in narrower row spacing. Strip tillage is used with row crops, such as corn, sugar beets, soybeans, dry beans and sunflowers.

Corn

North Dakota and Minnesota research shows **corn yields are similar or higher** when strip till is used compared with other tillage methods.

The University of Minnesota Extension compared four tillage systems for corn following soybeans on farm fields in 2004 and 2005 (DeJong-Hughes and Vetsch, 2007). The average daily temperatures were below normal in 2005, resulting in higher corn yields with strip till compared with no till and conventional till. The 2005 growing season was warmer than average, resulting in all tillage methods producing excellent corn yields while maintaining adequate residue cover to protect the soil from erosion.

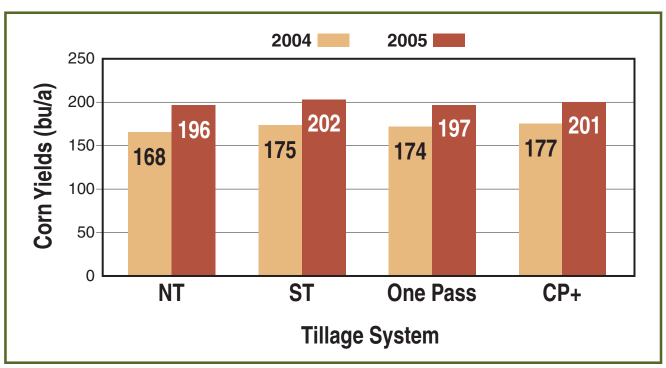

Figure 3. Corn following soybeans in Minnesota.

Another ongoing study started in 2007 in southern Minnesota with a continuous corn rotation shows corn yields grown in strip-tilled soil were similar or higher than with other tillage systems in all situations except when soil conditions are too wet to properly operate strip-till machines in the fall. This research uses moldboard plowing, disk ripping and strip till on a continuous corn field to study the effects of residue placement on seedling emergence, soil temperature and grain yield. The soil at the site is a heavy clay loam, with poor internal drainage and no tile drainage.

Four years of North Dakota corn research conducted at Carrington and Fargo in 2007-10 (Endres, Franzen and Overstreet) on fall strip till shows yields were 6 bushels per acre greater than with conventional till. At Carrington, corn was grown in 30-inch rows on a loam soil, and at the Red River Valley sites in 22-inch rows.

Table 4. Soil temperatures – continuous corn – Minnesota.

Treatment	Morris	Boyd	Halloway	Lamberton	Heron Lake
	bu/ac				
Strip Till	116.8	156.8	146.8	121.3	197.9
Disk Rip or Chisel Plow	120.8	153.2	139.3	132.1	196.6
Moldboard Plow	120.8	159.4	142.7	140.2	197.8
LSD (0.05)	NS	NS	NS	NS	NS

Table 5. Soil temperatures – soybean-corn – Minnesota.

Treatment	Morris	Lamberton	Heron Lake	Cannon City
	bu/ac			
Strip Till	122.3	152	129.7	188.9
Disk Rip or Chisel Plow	126.2	185	125.7	195.2
Moldboard Plow	134.1	194.3	154	212.7
LSD (0.05)	NS	14.2	21.2	NS

Table 6. *See page 6.*

Table 7. Dry bean seed yields with tillage systems – North Dakota.

Tillage system	2007	2009	2010	3 site-year average
Conventional	1,820	2,533	2,949	2,434
Direct-seed (no-till)	1,886	2,074	2,824	2,261
Strip till (fall)	2,129	2,286	3,069	2,495
LSD (0.05)	209	306	NS	x

Table 8. *See page 6.*

Table 9. Soybean yield with tillage systems – Minnesota.

Treatment	2006	2007	2008	Average Residue
	bu/ac			%
Chisel Plow	50.3	47.2	43.9	53
No Till	47.8	46.8	41.6	73
Strip Till	50.7	48.4	44.6	62
LSD (0.05)	NS	NS	NS	4.4

Dry edible beans

Dry edible bean production using strip till significantly reduces soil erosion potential compared with conventional tillage. Moisture conservation is an additional benefit in arid areas. The obvious disadvantage with strip-till beans is changing harvest strategies. Strip-till edible beans require direct harvest, which potentially increases harvest loss. However, reduced harvesting equipment, time and labor, and potentially improved seed quality may offset increased harvest losses. Preliminary data in 2007 and 2009-10 by NDSU researchers at Carrington with fall strip-till pinto beans indicate potential for similar seed yield compared with conventionally tilled bean, and greater than with no till.

Soybeans

Production advantages may be gained with strip till for soybeans in arid areas because of moisture conservation, or if the crop is planted early because of warmer soils compared with no till. NDSU research during 2005-10 indicated soybean yields of 2 bushels more per acre with strip till compared with conventional till or no till (Endres, Franzen and Overstreet)

The University of Minnesota Extension conducted research in southern Minnesota comparing soybean yields in a rotation following strip-tilled corn in chisel-plowed, no-till and strip-till fields (DeJong-Hughes, Stahl). The yields in 2006 and 2008 were similar, reflecting soybean versatility in various tillage systems. In 2007, the no-till fields yielded less than the chisel-plowed and strip-tilled fields.

Sugar Beets

NDSU strip-till research with sugar beets grown in 22-inch rows was conducted during 2005-07 at several Red River Valley locations (Franzen and Overstreet, 2007). **Sugar beet yields were similar among tillage systems** in two of the three years. Strip-till yields were approximately the same as conventionally tilled plots.

Table 6. Corn yields with tillage systems – North Dakota.

Tillage system	2007 Carrington	2007 Fargo	2007 Prosper	2007 Moorhead, Minn.	2008 Carrington	2008 Prosper	2008 Moorhead	2009 Carrington	2009 Fargo	2009 Prosper	2009 Moorhead	2010 Carrington	2010 Fargo	2010 Prosper	2010 Moorhead	11 site-year average	5 site-year average
	bushels/acre																
Conventional	155.8	80.6	167	157	109.5	205	163	94.7	156	184	168	163.8	200	179	154	148	121
No-till	140.1	73.4	x	x	104.0	x	x	93.4	149	x	x	171.6	190	x	x	x	117
Strip till (fall)	160.8	84.6	150	146	96.2	230	197	90.8	x	x	x	166.7	x	209	164	154	120
Strip till (spring)	166.9	x	x	x	x	x	x	x	146	203	194	x	196	x	x	x	x
LSD (0.05)	NS	9.2	9	9	NS	9	9	NS	NS	9	9	NS	NS	9	9	x	x

Table 8. Soybean yield with tillage systems – North Dakota.

Tillage system	2005 Carrington	2005 Fargo	2006 Carrington	2006 Fargo	2007 Prosper	2007 Soybean yield with	2008 Fargo	2008 Prosper	2008 Moorhead	2009 Carrington	2009 Fargo	2009 Prosper	2009 Moorhead	2010 Carrington	2010 Fargo	2010 Prosper	2010 Moorhead	12 site-year average	6 site-year aveage
	bushels/acre																		
Conventional	21.7	25.9	16.2	25.0	52.2	31.7	21.6	55.6	36.5	24.5	24.2	47.7	24.2	47.5	42.4	51.4	37.0	35.1	26.1
No-till	22.6	29.7	18.1	20.9	x	x	26.5	x	x	26.4	20.1	x	x	50.1	47.8	x	x	x	27.4
Strip till (fall)	23.4	x	18.4	23.9	49.0	29.7	27.7	53.3	44.2	26.5	x	x	x	51.7	x	51.7	45.6	37.1	28.6
Strip till (spring)	x	25.3	18.4	x	x	x	x	x	x	x	18.1	39.7	30.2	x	49.8	x	x	x	x
LSD (0.05)	NS	NS	NS	NS	NS	NS	3.0	NS	3.7	NS	NS	3.7	3.7	3.0	NS	NS	NS	x	x

Table 10. Sugar beet yields with tillage systems – Minnesota and North Dakota.

Tillage system[1]	Fargo 2005	Fargo 2006	Fargo 2007	Prosper and Moorhead, Minn. 2007	3-site average (Fargo)	5-site average
	Yield (tons/acre)					
Conventional	12.9	24	22.1	30	19.7	22.3
No-till	16.6	23.4	22.1	–	20.7	–
Strip till	15	23.9	22.7	29.6	20.5	22.8
LSD (0.05)	3.2	NS[2]	NS[2]	NS[2]	–	–

[1] Previous crop: Fargo = soybeans; Prosper and Moorhead = wheat.
[2] Not a significant yield difference.

Table 11. Oil sunflower yields with tillage systems.

Tillage system	2006	2007	2008	2009	4 site-year average
	pounds/acre				
Conventional	1,160	1,040	1,173	733	1,027
No-till	1,338	956	1,253	730	1,069
Strip till (fall)	1,134	1,086	1,501	870	1,148
Strip till (spring)	1,379	942	x	x	x
LSD (0.05)	NS	NS	NS	NS	x

Sunflowers

Sunflower production using strip till is limited in the northern regions of the United States. Strip-till research trials and commercial production in Kansas show some success for sunflowers (Olson et al., 2005). Four years of NDSU strip-till research at Carrington during 2006-09 by Endres have indicated similar sunflower performance for seed yield and quality among tillage systems, including strip till.

General Fertilizer Considerations

Phosphorus and potassium can be band-applied during strip-till operations. Banding phosphorus and potassium allows for a rate reduction of one-third compared with broadcast application on a medium or low-testing soil (University of Minnesota Fertilizer Recommendations, 2001). Phosphorus and potassium also can be applied to crops as starter fertilizer with the planter.

Nitrogen also can be applied using strip-till equipment. However, fall nitrogen application is not recommended in sandier, lighter soils. Nitrogen can be applied as a starter fertilizer and side dressed later in the growing season. Carrington, N.D., research conducted in 2010 (Endres, Hendrickson, Glatt) show similar plant emergence and stands among tillage systems and fertilizer placement methods. However, among strip-till treatments, in-furrow fertilizer had lower plant densities compared with other methods of applying fertilizer. Grain yield and quality were similar among treatments. However, among strip-till treatments, seed yield was higher with fall deep-band followed by spring in-furrow fertilizer compared with other fertilizer treatments.

The Oakes Irrigation Research Site conducts research on growing continuous corn and corn following soybeans in a strip-till system to determine efficient nitrogen fertilizer rates. Results from these studies can be used to evaluate likely corn yield and quality for various fertilizer rates (W. Albus, L. Besemann and H. Eslinger. 2010). More information is available online at *www.ag.ndsu.nodak.edu/oakes/oakes.htm.*

Economics of Strip Till

Investment costs vary depending on the type of equipment, size and accessories purchased. Total investment will run between $3,000 and $4,000 per row. Based on machine width, the investment will run from $1,600 to $2,000 per foot.

Ownership costs are heavily influenced by the amount of use per year and the number of years the equipment can be used. The annual ownership cost of a 24-row tiller is estimated to be $6,306, or $6.31 per acre, based on an estimated annual use on 1,000 acres per year. The estimated annual ownership cost of a six-row tiller would be $1,951, or $4.88 per acre, based on annual usage of 400 acres.

Operating costs include fuel, lubrication, repairs and labor. The total would be $3.16 per acre for a 24-row machine and $4.75 per acre for a six-row machine.

The total cost per acre for the 24-row equipment, including the power unit, is estimated to be $11.74 per acre. The total cost for the six-row equipment and power unit is estimated at $12.34 per acre. The smaller equipment has higher operating and tractor ownership costs but lower fixed costs.

Table 12. Corn performance in tillage systems at Carrington, N.D.

Tillage system/ fertilizer placement[1]	Crop residue	Plant: Emerge	Plant: Stand	Plant: Silk	Seed: Yield	Seed: Test weight	Seed: Moisture	Seed: Protein	Seed: Starch
	%	Jday	plt/A	Jday	lb/A	lb/bu	%	%	%
Conventional/2x2-inch band	44	144	29,881	207	163.8	55.7	17.0	8.6	70.7
No-till (direct seed)/2x2-inch band	93	144	30,213	209	171.6	55.8	16.9	8.7	70.8
Strip till/2x2-inch band	81	144	30,877	208	166.7	55.5	16.9	8.8	69.7
Strip till/in-furrow	81	144	28,885	208	162.6	55.3	17.3	8.7	70.9
Strip till/fall deep band	66	144	31,541	208	165.4	55.6	17.0	8.8	70.5
Strip till/fall deep band fb in-furrow[2]	74	144	28,221	208	174.2	55.5	17.1	8.5	71.1
Strip till	74	144	31,541	209	167.0	55.1	17.3	8.6	71.0
mean	73	144	30,166	208	167.3	55.5	17.1	8.7	70.7
CV (%)	10.4	0.2	13.2	0.4	5.5	0.8	2.0	2.4	0.6
LSD (0.05)	11	NS	NS	NS	NS	NS	NS	NS	0.7

[1] All fertilizer treatments applied during planting, except fall deep band, as 10-34-0 at 6 gal/A.
[2] Three gal/A of 10-34-0 deep-band applied in the fall followed by 3 gal/A applied in-furrow.

Converting to a strip-till method of production from conventional tillage will eliminate expenses associated with primary and secondary tillage. If the other tillage equipment is not sold, you need to include the depreciation and interest costs on that equipment when calculating the true cost of strip tilling.

Additional costs to strip tillage include machinery ownership and operation costs, chemical burn-down and a ground-spraying operation. Cost reductions include eliminating chisel plowing and field cultivation. The **estimated change in per-acre costs to convert to strip tilling using these costs indicate an increase of $10.63 per acre for a 24-row machine and $11.63 per acre for a six-row machine.**

Management Tips for Strip Tillage

- Match the strip-till row width with the planter row width.
- Leave corn stubble standing for maximum air movement and less matting of residue. Build strips between the previous crop rows.
- For the greatest soil warmup and seed-to-soil contact, strip tillage should be performed in the fall.
- In cooler, fine-textured soils, strip-till equipment should clear the berm to less than 10 percent residue for faster soil warming in the spring.
- In high-moisture conditions, build berms approximately 3 inches high in the fall so they are at least 1 inch high by planting. In arid conditions, berms can be depressed to collect winter snow.
- The economic advantages of strip till are improved if banding phosphorus and postassium fertilizer with the fall strip operation.
- Avoid slopes of more than 7 percent without contouring; otherwise, risk of soil erosion can occur in tilled strips.

References

1. DeJong-Hughes, J., J. Vetsch. (2007) On-Farm Comparison of Conservation Tillage Systems for Corn Following Soybeans. University of Minnesota Extension Publication #BU-08483.
2. Faaborg, R., C. Wente, J.M. De Jong-Hughes and D.C. Reicosky. 2005. A comparison of soil CO_2 emissions following moldboard plowing, disk ripping and strip tilling. USDA-ARS research update.
3. Overstreet, L.F., D. Franzen, N.R. Cattanach and S. Gegner. 2007. Strip-tillage in sugarbeet rotations. In 2007 Sugarbeet Research and Extension Reports. Vol. 38. Sugarbeet Res. And Ed. BD. of MN and ND.
4. Olson, B., J. Falk and R. Aiken. 2007. Sunflower yield as affected by strip-till. National Sunflower Association 2007 Research Forum.
5. University of Minnesota Extension "Machinery Cost Estimates." September 2007.
6. Endres, G., B. Schatz. 2009. Row crop performance with tillage systems and placement of fertilizer. In 2009 Carrington Research Extension Center Annual Report. Vol. 50.

Web Sites of Strip-till Equipment Manufacturers

This is not intended to be a complete list of strip-till manufactures

www.agsystemsonline.com
(Ag Systems) – NitroTill

www.thurstonmfgco.com
(Blu-Jet)

www.dawnequipment.com/
(Dawn Equipment)

www.hiniker.com/
(Hiniker Equipment)

www.orthman.com/
(Orthman Manufacturing)

www.schlagel.net/
(Schlagel Manufacturing)

www.twindiamondind.com/
(Twin Diamond Industries)

www.unverferth.com
(Unverferth Manufacturing)

www.brillionfarmeq.com
(Brillion Farm Equipment)

www.progressivefarm.com/
(Progessive)

www.deere.com/servlet/ProdCatProduct?pNbr=2510SN&tM=FR
(John Deere)

www.yetterco.com/
(Yetter)

www1.caseih.com/northamerica/Products/Tillage/Nutri-Tiller5310/Pages/Intro.aspx
(Case IH)

www.remlingermfg.com/Strip_Till.htm
(Remlinger)

www.soilwarrior.com/
(Soil Warrior)

www.elmersmfg.mb.ca/
(Elmer's Manufacturing)

www.sunflowermfg.com/
(Sunflower Manufacturing)

www.krauseco.com/
(Krause Corp.)

Strip-till demonstration videos and Internet links to strip-till equipment manufacturers are available at this Web site:

www.ag.ndsu.edu/agmachinery/conservationtillage.

For more information on this and other topics, see: www.ag.ndsu.edu

2M-7-08; 1.5M-5-11