CONSERVATION TILLAGE CORN AND FORAGE CROPS

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ABSTRACT

Several reduced, or conservation tillage (CT) approaches are currently being evaluated in Central Valley forage production systems. In theory, these practices reduce costs and minimize the time needed to go from one crop to the next. Recent single-year trials with dairy forage producers in Stanislaus and Tulare Counties have evaluated the potential of several CT systems and have identified a number of production issues that must be addressed in order for them to be more widely adopted. In both of these trials, slightly lower yields were produced with the CT systems relative to standard till practices and surface irrigation water movement problems occurred. In one study, stand establishment, early season crop vigor and surface irrigation water movement and application efficiency were seen as problems needing additional work. Ongoing trials are trying to address these difficulties and improve CT forage systems.

Key Words: strip-tillage, no-tillage, profitability

INTRODUCTION

During the last several years, a number of farmers in California's Central Valley have been experimenting with various types of reduced, or conservation tillage production systems in an effort to cut costs and save time, labor and energy use. An implicit goal of these alternative tillage systems is to reduce primary, intercrop tillage or soil preparation operations such as disking, plowing, chiseling and ripping to the greatest extent possible while still achieving adequate productivity. Most CT systems rely on three basic reduced soil disturbance planting systems: no-till, ridge-till, or strip-till. In no-till, or zero-till, the only tillage that is used is the soil disturbance in a narrow slot created by coulters or seed openers during planting. The soil surface is thus generally left undisturbed except at the time of planting. Ridge-till is a reduced disturbance planting system in which crops are planted and grown on ridges formed during the previous growing season and by shallow, in-season cultivation equipment. Ridge-till planters sweep away or shear off residues and soil in the seed line but do not disturb much of the inter-row soil surface. In strip-till, coulters cut residues ahead of subsoiling shanks that loosen the soil from a few to as many as 14 inches ahead of a planter. In each of these CT systems, only a small percentage of the soil surface is disturbed unlike the "broadcast" tillage, or land preparation operations that are typically used in today's conventional tillage systems.

California dairies require year-round availability of inexpensive, locally-produced forage materials. Common dairy forage production systems consist of winter small grains seeded either individually or in mixes in November and December. These winter forages are then harvested as

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“green chop” the following March. In conventional production systems, fields may be disked a number of times following the harvest of these winter forages, relisted or bedded and then preirrigated for spring corn planting. Turnaround time between winter small grain forage harvest and spring corn planting routinely takes about two weeks. Spring silage corn is then produced for late-summer harvest. Occasionally, corn may be double-cropped after an early planted corn crop with the second crop coming off sometime in early fall. In most current production systems, intercrop tillage and seedbed preparation is done ahead of each successive crop. Such production systems, however, lend themselves quite well to a variety of conservation tillage approaches that have been developed in other production regions, and in recent years, a number of California dairy forage producers have begun experimenting with these reduced till forage production alternatives.

CT CASE STUDY: STANISLAUS COUNTY

In the spring of 2002, a dairy farmer and forage producer in western Stanislaus County became interested in reduced till practices through his reading of work done by farmers and researchers in Oregon and by his participation in one of University of California’s Conservation Tillage Workgroup’s seminars. He then decided to experiment in the spring of 2002 with strip-tilling corn following his winter forage harvest.

Immediately after harvesting his winter forage on April 7, he used a 6-row 30” Unverferth Ripper Stripper (Photo insert 1) to till 6 – 8” strips in the flat soil in which he had grown his winter forage. A strip tiller is an implement consisting of residue-cutting coulters ahead of subsoiling shanks that loosen the soil profile from a few to as many as 14 inches. Following the subsoiler, strip tillers are often fitted with “clod busting” roller-type implements that work to smooth surface soil and prepare seedbed conditions prior to planting. He strip-tilled 17 acres on April 8, and then had a 6-row John Deere corn planter follow immediately behind. He used a RoundUp Ready silage corn variety.

Photo Insert 1. Unverferth Ripper Stripper strip-till implement performing preplant tillage following winter forage harvest, Stanislaus County, 2002

By using this CT approach, this farmer figures he saved about two weeks of time that would have normally been used in a conventional tillage sequence of land preparation operations following winter forage harvest, as well as a preirrigation that may have been required in conjunction with his standard spring tillage approach.

He was able to establish and eventually harvest an adequate crop with this approach. In-season, he relied on over-the-top applications of glyphosate for weed control. He harvested the silage on August 19.

On the whole, this first experience with strip-tilled corn was quite successful for this dairy farmer. His overall assessment of the effort is best summed up by his own statements:

> "I think that our first try at strip-tilling turned out pretty well. We averaged 29.5 tons per acre of corn silage on the strip-till field, while the ranch average was 31.5 tons per acre. I think there are 2 main things that we could have improved on and those are to have had better plant populations (by keeping the corn planter better in line with the strip-tiller and/or having more down pressure on the planter) and to have had more fertilizer available at planting."

A summary of the costs and benefits of the strip-till system is given in Table 1.

Table 1. Comparison of land preparation costs for strip-till and conventional till corn, Stanislaus County, 2002

Strip tillage			
	A)	strip till pass	$15.00 per acre
	B)	planting pass	$15.00 per acre
Conventional tillage			
	A)	discing pass	$10.00 per acre
	B)	ripping pass	$18.00 per acre
	C)	discing pass	$10.00 per acre
	D)	pre-irrigation	$8.00 - $15.00 per acre
	E)	finish tool pass	$12.00 per acre
	F)	planting pass	$15.00 per acre

Because he gained two weeks on his growing season, with a triple crop of sudan for silage, this farmer was able to gain 5 tons of silage more per acre than with his conventional tillage fields. This resulted in an increase of $60.00 per acre (5 tons @ $12.00 per ton).

There were, however, problems associated with this first attempt at strip-tilled corn. Better alignment between the strip-tiller and the corn planter is needed in order to assure adequate crop stands. In flood irrigated contexts like the one used in this trial, the strip tillage operation into previously flat winter forage tended to create uneven conditions on the surface of the soil and these required the farmer to install cross levies to create more uniform irrigation water applications. Finally, manure that was spread in the strip-tilled system was not well mixed with the soil as this farmer would have desired.

To overcome these problems with the strip-till system into previously flat, border check irrigated fields, the farmer has since developed a modified light disk-ripper implement that essentially performs the same soil loosening function as the strip tiller, but also works to provide more evening, or leveling of the soil surface. In 2003, he performed just two passes with this implement ahead of planting corn.

CT CASE STUDY: TULARE COUNTY

In Tulare County, interest in reduced and no-till corn has also increased during recent years. In 2002 a grower planted 300 acres with his new no-till planter. In 2003, he planted over 3,000 acres for himself and others in the area. Additionally in 2003, another grower in Tulare who had questions about reduced and no-till corn volunteered for two trials, one on a sandy loam soil and one on a clay loam soil.

Information presented at this meeting will emphasize the tillage trials that directly compared conventional beds to reduced-till and no-till corn production but some comments will include observations made in the variety trial and by the grower who has planted numerous no-till fields.

In the tillage trials there were 5 treatments, replicated three times in each of two fields. Treatments were:

A. Standard practice (Conventional)
B. Spread manure, strip-till, pre-irrigate, plant (Strip-till prior)
C. Spread manure, pre-irrigate, strip till, plant (Strip-till post)
D. Spread manure, light disk, pre-irrigate, strip till, plant (Light disk)
E. Spread manure, pre-irrigate, plant, no-till (No-till)

These fields are part of a dairy production system so solid manure was spread on both fields immediately after harvesting the winter forage with the exception that half of each of the no-till plots, which received no manure. This was to see if manure had any impact on germination and emergence. Commercial fertilizer was applied in all fields in sufficient quantity to insure that differences in yield were not due to differences in fertility.

The standard or conventional practice of this grower after spreading manure includes two passes with a disk, then another with a spring harrow, furrowing out, pre-irrigation, breaking the beds, rolling the beds with a ring roller, and finally planting.

Strip tillage (Photo insert 2) before pre-irrigating should break up compacted layers better in dry soil than in wet soil. Treatments B and C were meant to see if timing of strip-tilling relative to pre-irrigation would have an impact on growth and yield.

Photo Insert 2. Close up side view of a CASE DMI Ecolo-Till Strip Tiller

The light disk treatment was included in case restrictions in the future were placed on the spreading of solid manure on the soil surface.

Each plot consisted of a border check 100 feet wide by the length of the fields. With 30-inch row spacing, there were 36 rows of corn between borders. The borders in these fields were large, winter forage type borders that were about 10 feet across.

Field operations were timed as well as possible to keep everything on the same schedule and to keep planting dates as close as possible for the different treatments. Commercial fertilizer was applied in sufficient quantity so that the method of manure incorporation would not be a factor.

Weeds were controlled entirely with post-emergence materials. Roundup by itself was applied in one field and Round-up plus Banvel in the other field.

All treatments were planted with the no-till planter. The planter had a coulter, fertilizer hose, trash managers, disk openers, a tube to press down the seed, disk closers, and a wide press wheel. When planting the no-till plots the springs on the planter were all the way down.

The sandy loam field was planted between June 11 and June 16, 2003. The clay loam field was planted on June 16 and 17, 2003. The variety planted in both fields was RX897 RR. On the clay loam field all the plots were rolled on June 19, 2003, to break up clods and seal the soil to avoid losing too much moisture.

Irrigation was by ditch and siphon pipe and proved to be problematic given the flow rate, length of the field, and resistance to flow. In fact, the first irrigation proved to be very difficult. Water did not flow evenly across the field and irrigators worked to cut areas so that water would flow in a more even front to the end of the field. There was no return system and the grower was concerned that standing water at the end of the field in hot July weather would hurt the corn. To reduce the labor needed for irrigation, both strip-till and the light disk plots were furrowed out before the second irrigation for management of water. The no-till plots were not furrowed out and remained “no-till” for the entire crop.

The grower involved in these trials, and others, have noted that with no-till the window for planting after pre-irrigation is smaller than for convention plantings (on beds or flat). In these trials, the sandy loam soil was more forgiving in the timing of planting than the clay loam soil, which tended to crust on top while remaining sticky under the surface.

The checks that were strip-tilled prior to the pre-irrigation planted equally well as the checks that received the strip-till treatment after the pre-irrigation. Both made a better seedbed than the no-till plots. One of the differences between the two strip-till treatments, which occurred in both soil types, was that the strip-tilled prior to the pre-irrigation held moisture longer and could not be planted as soon as the other plots after the pre-irrigation.

Also noted in both fields was that the half of the no-till check where no manure was spread dried quicker and in an uneven fashion compared to other treatments, and was the most difficult to plant because of a wide range of moisture levels. The planter had to be adjusted several times across the check in order to place seed into moist soil for good germination. The moisture levels in the area of the no-till treatment where manure had been spread were much more consistent and this side was easier to plant. The moisture was so well maintained by the manure that this side could probably have been planted safely a day or two later.

In checks with the single, light disking, there were a lot of clods at planting, but they did not pose a problem because the trash managers kicked the clods out of the way.

Stand counts were taken in late June, when plants were 4-6 inches in height (Table 2). In 21 areas of each check, a thousandth of an acre was counted. In both fields, the conventional planting had significantly more plants per acre than the other treatments. In the clay loam soil, the no-till plots had significantly fewer plants than the other treatments. Besides being a different soil type, the clay loam field had some lodging in the winter forage. In some areas a lot of residue was left behind at harvest, which made planting more difficult. . These patches of plant No differences were noted in the no-till checks between the areas that received manure compared to those areas that did not. If anything, emergence was slightly better where manure had been applied, perhaps due to better moisture conservation and/or a shot of nitrogen from the manure.

The sandy loam field was harvested on September 29 (replication I) and October 9 (replications II and III). The clay loam field was harvested on October 9 and 10. Yield results are shown in Tables 3 and 4, respectively.

Table 2. Seedling emergence 2 weeks after planting. Plants per acre two weeks post emergence.

Treatments	Fine sandy loam field	Clay loam field
Conventional	34726 a	33886 a
Strip-till prior	33126 b	32446 b
Strip-till post	33540 b	31886 b
Light disk	33520 b	32556 b
No-till	32734 b	30286 c
CV%	1.7	1.8

Within a column, values followed by a common letter do not differ at the 5% level of probability using LSD

Table 3. Yield results from sandy loam field, Tulare County, 2003.

Treatments	**Moisture at harvest %**	**Tons/planted acre as harvested**	**Tons/planted acre adjusted to 70% moisture**	**Tons per field acre**
Conventional	56.8	25.1	35.9	35.9 a
Strip-till prior	61.6	28.8	36.7	33.0 b
Strip-till post	62.6	28.8	35.6	32.1 b
Light disk	58.6	26.4	35.9	31.8 b
No-till	60.2	25.5	33.8	30.4 b
Coefficient of variability%	3.87	7.15	4.3	4.25
Probability	0.08	0.13	0.31	0.01
LSD .05	NS	NS	NS	2.6
Trial Average	60.0	26.9	35.6	32.6

Table 4. Yield results from clay loam soil, Tulare County, 2003.

Treatments	**Moisture at Harvest %**	**Tons/Planted Acre as harvested**	**Tons/planted acre adjusted to 70% Moisture**	**Tons per field acre**
Conventional	62.2	27.5	34.6	34.6 a
Strip-till prior	64.3	27.9	33.2	29.9 b
Strip-till post	63.1	26.5	32.6	29.3 b
Light disk	63.1	27.2	33.5	30.2 b
No-till	63.3	27.0	33.0	29.7 b
Coefficient of variability%	1.28	3.23	3.32	3.34
Probability	0.11	0.41	0.29	0.00
LSD .05	NS	NS	NS	1.94
Trial Average	63.2	27.24	33.4	30.7

In both fields, there was no difference in yield among treatments when looking at the tonnage per acre planted. However, with reduced and no-till practices borders are necessary and in these fields the borders were about 10 ft wide. Calculating the reduced and no-till yields including the area of the borders not planted and comparing those yields to the yields of the conventional planting in which borders are not needed, there is a significant yield advantage for the conventional planting. Strip-tillage did not produce significantly higher yields in these fields.

It is important to note that not all the growers using reduced and no-till corn are using such wide borders as were used in these fields. Some are using alfalfa style borders and believe they are losing just one row of corn for each border.

SUMMARY

The reduced and no-till treatments reduced the number of field operations from 5-7 operations (Table 5). This would relate to savings in equipment use, labor, and fuel, which would contribute to making up for the lost production due to borders. The border width, which takes land out of production, may not have to be as large as what was used in this trial.

Table 5. Tillage Operations

	Conventional	Strip-till prior	Strip-till post	Light disk	No-till
Spread manure	X	X	X	X	X
Disk	2X's			1X	
Spring harrow	X				
Furrow out	X				
Break the beds	X				
Roll beds	X				
Strip-till		X	X	X	
Plant	X	X	X		X
Furrow out after 1st irrigation	X	X	X	X	

Some other factors need to be considered when thinking about switching to reduced and no-till corn. Irrigation is a key component and how it will be managed will be important. The width between borders and the size of borders will be dependent on soil type, the volume of water applied, slope (both down the field and across the field), and whether or not there is a return system. Growers may have to experiment on their own to determine the best set up for their fields. In addition, one needs to consider the number of rows on the planter and the choppers harvest for maximum efficiency.

GPS guided systems are extremely helpful in reduced and no-till systems. It allows for the strip-tillage to be in the correct spot so that the planter will be planting in the strip-tilled area. It allows for the accurate positioning of borders so that the minimum loss of planted areas occurs.

These trials are just one year's results. Repeated no-till and strip-till within a field could bring other issues to the forefront. Certainly the amount of residue from the previous crop can be an issue as well as compaction from one year or from one field to the next. Winter forage harvests occur in the spring when weather can be unpredictable. In 2003, due to late rains, some fields were harvested under fairly wet soil conditions. Several no-till fields in Tulare County this spring looked pretty uneven when the corn first emerged and continued to do so through several weeks of growth. However, when harvested, the fields were of uniform height. Other fields looked quite good from the start.

SUMMARY

The two case studies presented here represent single-season evaluations of strip-till and no-till corn within year-round forage production systems. Both trials point to the need for additional work that is needed to refine and improve upon the systems that were tried during these first evaluations. Major issues that need improvement are assuring uniform crop stands, being able to efficiently apply irrigation water and assuring adequate fertilizer applications. Other variants of the approaches presented are now underway.

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