Adapting Conservation Tillage Approaches for California's Central Valley: Recent Progress of the Conservation Tillage Workgroup

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Introduction

Since the development and expansion of irrigation in California's Central Valley from the 1930's through 1963 when the California Aqueduct was constructed as part of the Central Valley Improvement Project, tillage practices in this region have changed very little. Unlike other regions of the world such as the Southeast and Midwest US, Canada, Brazil and Argentina, where various conservation tillage (CT) practices have been developed primarily as a means to prevent soil erosion losses, CT in California, until very recently, has been virtually nonexistent. Acreage under no-till, strip-till and mulch till has been under 2% in the annual crop production regions of the Central Valley during this time (Mitchell et al., 2007). During the past ten years, however, a number of new factors have been converging in the Central Valley that are now making CT systems and options increasingly attractive. Reducing diesel fuel and labor costs, as well as particulate matter and greenhouse gas emissions typically associated with tillage have now become important drivers influencing interest in CT systems today.

Conservation tillage residue management was first approved in California by the Natural Resources Conservation Service as an Environmental Quality Incentives Program (EQIP) practice in 2003. In 2004, the San Joaquin Valley Air Pollution Control District mandated the adoption of conservation management practices aimed at air quality improvement throughout the Valley and for the first time, practices that "eliminate or reduce the need to disturb the soil" were identified as an eligible conservation practice in this region. In 2008, Central Valley Regional Water Quality Control Boards limited the application of nitrogen (N) from manure to dairy silage fields to 140% of crop N removal and this is now also being seen as another incentive for the adoption of "CT-enabled" triple-cropping systems that theoretically may produce more silage and remove more N in a given time.

To respond to the recent need for information on CT systems in California, the Conservation Tillage Workgroup was established in 1998. Today, the CT Workgroup has over 1500 University, farmer, private sector and NRCS members who work together and exchange information and experiences on emerging CT systems. One of the primary means for the Workgroup to learn about CT practices has been to visit experienced farmers, researchers, and equipment companies in regions where CT systems have become well developed. Connections with the Southern Conservation Agricultural Systems Conference, the Georgia Conservation Tillage Alliance, the USDA Agricultural Research Service labs in Auburn, AL and Watkinsville, GA beginning in 1999 have been a valuable and significant educational opportunity for several California CT Workgroup members and our connections with these groups have been extended via numerous Workgroup mechanisms in the Central Valley. Our Workgroup's recent involvement with the North America Conservation Agricultural Systems Alliance (CASA) continues these types of longstanding and useful partnerships to bring information to our members.

Conservation Tillage in California Forage Production Systems

California's dairy industry is a huge contributor to the State's economy. Dairy products have been California's top agricultural commodity for a number of years (CDFA, 2004). They account for over 5 billion dollars in cash receipts, which is about 17% of the State's overall agricultural output in recent times. 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 "green chop" the following March through May. In conventional production systems, fields may be disked and deep-ripped a number of times following the harvest of these winter forages, disked again, 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 or another forage crop such as milo or sorghum-sudan, may be double-cropped after an early planted corn crop with the second crop coming off 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.

The primary motivation for CT in dairy forage systems is to save time, labor and fuel. This is accomplished by reducing primary, intercrop tillage or soil preparation operations such as disking, plowing, chiseling and ripping to the greatest extent possible while still achieving adequate productivity. In general, the earlier a crop such as corn is planted, the higher the yield. Corn stunt disease is also less severe in early corn than in later-planted corn. Minimizing or eliminating intercrop tillage can reduce the time between winter forage harvest and corn seeding from 2 – 3 weeks under conventional practices, down to 7 to 10 days or even less due to reduced time for tillage operations, and less water applied as preirrigation.

Using CT to reduce the time between successive forage crops is currently being done at a number of Central Valley dairies (Photo 1). Following the harvest of a typical winter small grain forage, a strip-till pass using a GPS-guided tractor may be done ahead of a pre-irrigation and planting , or no-till corn planting either before or after a surface flood irrigation.

Photo 1. Strip-till planted silage corn in wheat residue following manure application, Petersen Dairy, Turlock, CA, 2007.

The strip-till or no-till planted corn crop will typically mature several days earlier than a crop that has had traditional intercrop tillage and this may enable more reliable triple-cropping of a crop such as a no-till drill seeded sudangrass forage following corn (Photo 2). The reliability of CT-enabled triple-cropping and the ability of these systems to remove more applied manure N relative to conventional double-cropped forage systems is now being evaluated in a series of dairy farm studies.

Photo 2. No-till seeding of sudangrass into corn and wheat residues, Petersen Dairy, Turlock, CA 2007.

Conservation Tillage in Processing Tomato Production

Since the early 1990's we have evaluated a variety of conservation tillage alternatives for processing tomato production. After demonstrating the feasibility of no-till transplanting tomatoes into a variety of crop and cover crop residues (Herrero et al., 2001), and early-season, but not season-long weed suppression by heavy cover crop mulches (Madden et al., 2004), we initiated a long-term tomato – cotton rotation study in Five Points, CA to compare CT and standard tillage practices with and without winter vetch/rye/triticale cover crops (Mitchell et al., 2007). This study has shown that no-till tomatoes can be established in high residues and that in-season cultivation is needed to suppress weeds in CT systems that reduce overall tillage passes by over 50% relative to traditional tillage systems (Photo 3).

Photo 3. No-till tomato transplanting into rye/triticale/vetch cover crop mulch, Five Points, CA 2007.

Because tillage operations, however, account for a relatively small part of the overall production budget for tomatoes (Figure 1), cost savings associated with CT tend to be relatively modest. Dust emissions from the CT tomato – cotton system have also been shown to be reduced by over 50% (Baker et al., 2005).

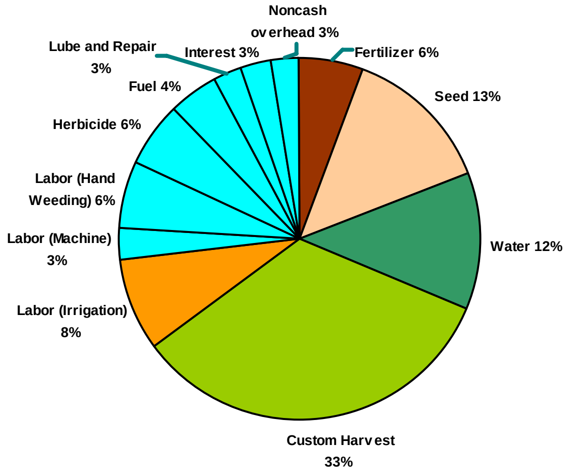

Figure 1. ST tomato production costs without a cover crop. The blue-shaded costs can be reduced by eliminating tillage operations, comprising 36 percent of total costs for the ST system without a cover crop. All other costs remain the same regardless of tillage practices.

The use of triticale cover crops and strip-till transplanted tomatoes has also been refined in subsurface drip-irrigated fields at a commercial scale in Firebaugh, CA (Photo 4).

Photo 4. Strip-tilling triticale cover crop ahead of processing tomato planting, Firebaugh, CA 2008.

Triticale is seeded on the tops of 5-ft. beds in October following two passes of a minimum till bed reconditioning tool following tomato harvest. The cover crop is then irrigated up and allowed to grown to a height of about 15 – 18 inches prior to a burn-down spray of glyphosate that is usually applied in February. A ground-driven strip-tiller shallowly mixes the triticale with the soil while applying a preplant herbicide to the centers of the beds before transplanting. This system has performed well for a number of years, however, a key to effective management is to stop cover crop growth before too much biomass is produced because excess residues can result in mechanical harvesting inefficiencies.

Future Conservation Tillage Systems in California's Central Valley

Coupling conservation tillage practices with overhead irrigation is a merging of technologies that is recently gaining attention in parts of California's Central Valley. During the past two years, a number of center pivot irrigation systems have been purchased and have been successfully used for a variety of crops including alfalfa, wheat and sugar beets. Reduced labor requirements for these systems have been documented. Work is currently under way to introduce CT production of increasingly high value crops into overhead irrigation systems and to evaluate whether such systems when coupled with conservation tillage practices can reduce irrigation requirements (Photo 5)

Photo 5. No-till corn seeding into wheat residues under overhead irrigation, Five Points, CA, 2008.

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