SUSTAINABLE AGRICULTURE FARMING SYSTEMS PROJECT
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SAFS tillage system comparisons – 2004 yield results

Progress Report: First full season

By Kent Brittan, Gene Miyao, Z. Kabir, Dennis Bryant and Will Horwath

Results from the 2004 UC Davis Sustainable Agriculture Farming Systems (SAFS) project corn and tomato conservation tillage (CT) systems are in. We are evaluating them in comparison to standard tillage (ST) in:

1) conventional winter fallow (CWF),
2) low-input winter legume cover crop (WLCC), and
3) organic (ORG) production systems.

Previous SAFS articles have described some of the challenges faced as we have adapted equipment to incorporate the cover crops and plant the tomato CT system in a timely fashion ("Cover/cash crops in tillage systems," http://safs.ucdavis.edu/newsletter/v05n1/v5n1-a.htm). Our second season at the SAFS site started out very differently with good soil planting conditions and a very good growing season compared to 2003, which had a wet spring. Stand establishment, as affected by tillage, appears to be an ongoing issue in the tomato system, but not in the corn system.

photo by Lyra Halprin

Yolo County farm advisor Kent Brittan describes SAFS conventional farming systems field corn comparison between standard and conservation tillage.

Tomatoes

Our 2004 SAFS tomato yields averaged 27 tons per acre of marketable fruit, below the 35 tons anticipated countywide yield for 2004. Yields were not significantly different among conventional, WLCC, or organic production methods (Figure 1). The conservation tillage yield was significantly lower than that in standard tillage, 25 vs. 29 tons per acre, respectively.

What modifications can be made to improve CT in processing tomatoes? For the organic system, better weed control tools are needed when in-season cultivation is reduced. In the SAFS companion research area, a buried drip irrigation system reduced weed competition by maintaining a dry surface layer, which prevented weed emergence.

We also learned that seedbed condition remains an important factor. Cloddy bed tops impaired optimal performance of our modified tomato transplanter, resulting in planter wheel slippage and jamming of the drive mechanism. The poor seedbed led to a 7 percent under-planting of the target population. With the cloddy condition, we had poorer soil-sealing, resulting in increased moisture loss from the plug and the soil surrounding the plug. The cloddiness led to an additional ~6 percent loss of stand in the CT, compared to the ST conventional with only a 1 percent mortality rate.

Lesson learned: Better seedbed preparation was necessary to reduce clod size following tillage of the legume cover crop. This cloddy condition was particularly pronounced, because rainfall was marginal in spring 2004, and soil moisture was not replenished prior to planting.[1]

For processing tomatoes, within-season cultivation to maintain bed shape as well as reduce weed competition, is critical for economic production. Until economical methods are identified to reduce weed competition and hand-weeding expenses, our research teams need to reassess our crop management approach. By evaluating the long-term benefits of maintaining semi-permanent beds, which would eliminate primary fall tillage operations such as subsoiling and disking, our SAFS research can still provide valuable information to growers while meeting substantial environmental quality goals.

Corn

Corn yields this season for the

conventional farming system averaged over the two tillage treatments were 13,990 lbs. per acre at 15% moisture compared with a regional average of 10,000 lbs. per acre. Yields were not significantly different between CT and ST for this system (Table 2). Equipment and methodology for conservation tillage corn production has been proven elsewhere for decades and, as these data show, works well here.

Yields in the winter legume cover crop and organic systems were substantially lower than those in the conventional system. Planting date, which was delayed to allow the legume cover crop to achieve full growth potential, may be a major factor in the lower yields. High surface soil moisture from the cover crop further delayed the incorporation prior to planting. The conventional systems were planted on March 22, while the WLCC and organic systems were delayed until May 2. A full-season cultivar was used for all systems. The five-week delay put this cultivar beyond its optimal yield potential. Additionally, the seeding rate for the WLCC was reduced from 32,500 to 24,500 plants/acre to compensate for the anticipated lower nutrient availability[2]. This may explain the slightly lower yield for the WLCC compared to the organic. As lab results from plant tissue nutrient levels become available, further explanation into 'what happened?' will help guide our project. Analysis of plant disease ratings may also add to our understanding. We are anxious to gather information from all the involved researchers so our group can identify ways to improve the corn yield in the WLCC and organic systems. Similar corn yield results from the 2003 season cause us to suspect the problem is complex.

What about our organic farming system? Even with organic premiums and reduced inputs (seed, tillage and compost) our yields are far too low to make the corn system economically viable. We clearly need to continue to adjust and improve these farming systems.

In summary, challenges remain in the implementation of conservation tillage in row crop systems for the Sacramento Valley. These challenges have kept many growers from adopting conservation tillage methods and cover cropping to enhance soil quality and farm income.

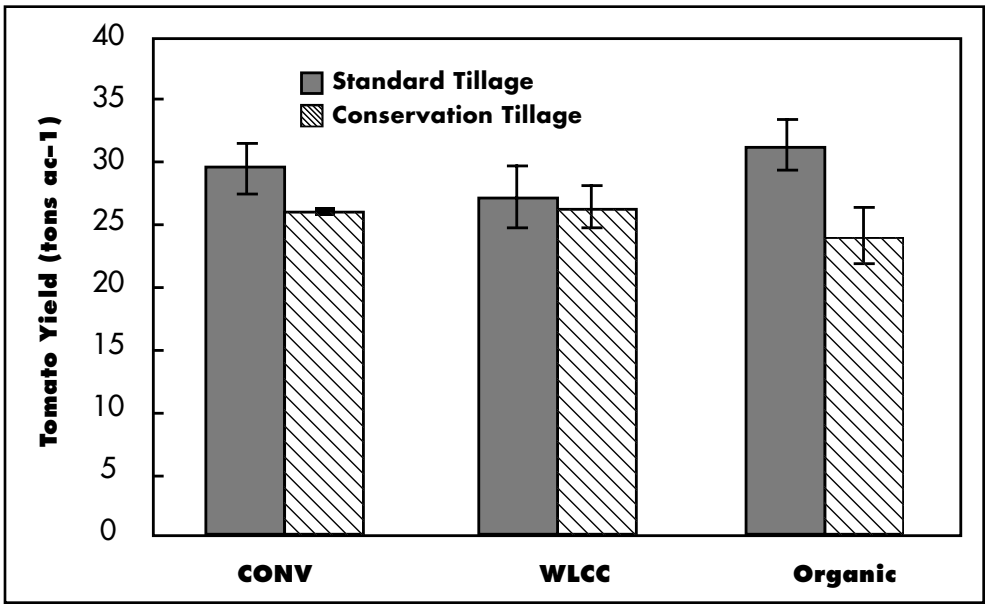

Figure 1. Tomato marketable yield, SAFS, Russell Ranch, 2004.

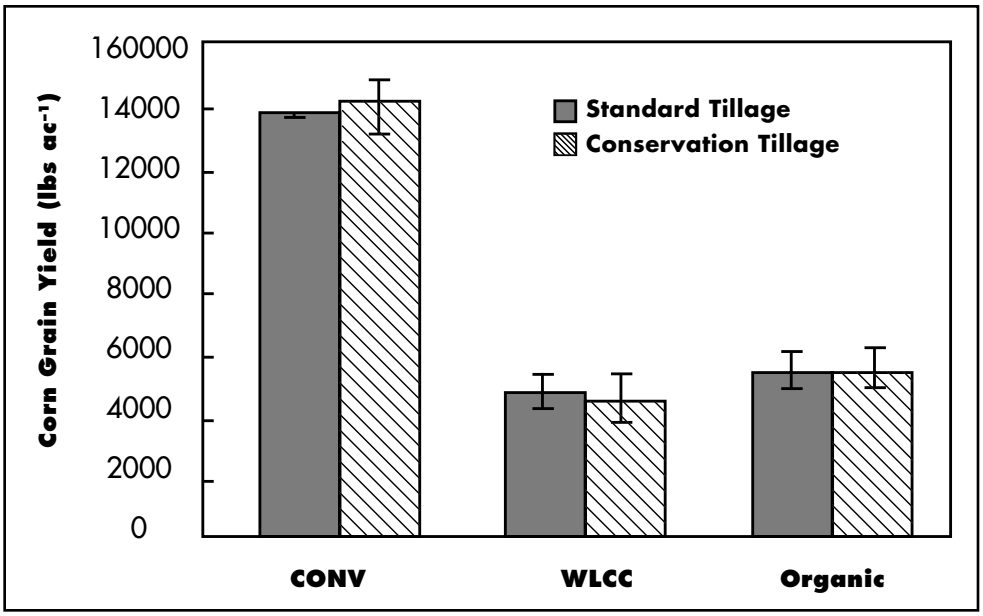

Figure 2. Corn grain yield at 15% moisture, SAFS, Russell Ranch, 2004.

These practices, however, have been shown to reduce winter rainfall runoff, an immediate concern that is confronting growers as they face loss of the federal Clean Water Act's "ag waiver" ("With loss of ag waiver looming, SAFS researchers shed light on runoff dilemmas," http://safs.ucdavis.edu/newsletter/v05n1/v5n1-b.htm). For these reasons, the adoption of CT and winter cover crops may become viable mitigating practices to reduce winter runoff. SAFS researchers will continue to examine ways to effectively implement these practices so that growers have more options to address upcoming environmental and economic issues.

[1] Other studies of CT and tomato at the University of California West Side Research and Extension Center at Five Points have shown more promising results with CT systems yielding higher than ST. Soil type may have a major influence at the SAFS site where the soil has more clay content, resulting in the clod problems described above. These results show that the successful implementation of CT is site-and crop-dependent. See *Transitioning cotton and tomato production systems to conservation tillage*, J.P. Mitchell, K.K. Klonsky, J.B. Baker, R. DeMoura, W.R. Horwath, R.J. Southard, D.S. Munk, J.F. Wroble, K.J. Hembree, J.J. Veenstra and W.W. Wallender. Submitted to *California Agriculture* January 2005.

[2] Footnote: These results for the corn are contrary to old SAFS results when the project was located on the Agronomy and Range Science facilities at UC Davis. In fact, corn yields were often highest in the cover crop system. However, the WLCC at the old site included supplemental inorganic fertilizer inputs in contrast to the present site with no added nitrogen.

Grower panel: Crop/system diversity is important

By Steve Temple and Lyra Halprin

Four growers representing diverse farm sizes and growing practices repeated a common theme at UC Davis' 2004 SAFS conservation tillage/sustainable agriculture field day: the importance of crop and system diversity. From a farmer who focuses on 20 acres to one who farms in a family operation spanning 2700 acres, they talked about blending row crops, cover and forage crops, orchard crops, livestock and the cultivation of wildlife habitat into their operations.

> ***"Cover crops have the potential to do a whole range of jobs for us."***

The panel, "Farmer perspective on conservation tillage research results: Field application of agronomic and pest considerations," was a highlight of the field day that showcased research results and the evolution of UCD's 16-year SAFS project into a conservation tillage experiment. Facilitated by Kent Brittan, UC Cooperative Extension farm advisor in Yolo County, the panel featured growers Blair Voelz, Paul Underhill, Jeff Main, and Charlie Rominger.

photo by Margaret Macsems

Growers (l-r) Blair Voelz, Paul Underhill, Charlie Rominger and Jeff Main shared information at SAFS field day. Moderator is Yolo County farm advisor Kent Brittan (far right).

Voelz talked about successes in aerial seeding of bell beans (*Vicia faba*) as cover crops for the last five years, which he said have produced a more friable soil and a better rice stand. He has seen a 5 percent to 10 percent increase in rice yields since using cover crops, which cost him $50 per acre (seed 100 lbs. per acre @ $.25 per lb., chop $10 per acre, landplane $8 per acre, disk $7 per acre). Downsides include the extra effort required to incorporate cover crop residue, and the difficulty in capitalizing on long-term benefits of his crop management from short-term land leases. Voelz has observed two-foot bell bean growth on rice ground contributing an additional 20 lbs. to 30 lbs. per acre of nitrogen (N), and five-to-six foot growth on row crop ground adding 70 to 80 lbs. per acre of N.

Main, who has farmed "100 percent organically" on 20 acres since 1984, emphasized the diversity in his operation. He plants as many as 64 different tree and annual crops, and cover crops. He said using cover crops provides "a lot more than weed suppression and nitrogen " on his land.

"Cover crops have the potential to do a whole range of jobs for us," he said.

Main noted that most cash crops seem to grow faster after cover crops, and particular cover crops or cover mixtures are more effective in some roles. He said mustards tend to improve drainage in his heavy soils; he has observed that trees planted after broccoli that has been allowed to seed grow twice as fast as those planted after other crops. Main said he uses Sudan grass as a summer or fall nematode-suppressant and lets it grow until frost-kill.

"My cover crop combinations often use two or three species that work together," he said. "That does not create a complete and rapid makeover of the soil, but over time it has made a big difference."

Like Voelz, Main said that he can "drastically change the tilth of our soil over time with cover crops."

Main uses deep-rooted cover crops instead of deep tillage. He said his soil has "not been ripped in 20 years." He buys compost to spread and follows every cash crop with a cover crop.

"We disk cover crops down early and quickly because we need to plant cash crops," he said.

Rominger discussed development of wildlife habitat, farmland preservation, and the federal Conservation Reserve Program goals. He is a partner in a 2700-acre family farming operation; his brother Bruce began organic practices on 10 percent of the land more than a decade ago. He said three-quarters of the land is rented.

Rominger noted that the first field they converted to organic had a great deal of nut grass; three years later, it was gone.

"Nut grass had been a problem when the field was farmed conventionally," he said, "But apparently it couldn't compete with the cover crops."

He has added livestock back into his CT row crop operation.

"No-till leaves time for livestock," he said, adding that goats reduced his weed problems. "They cleaned up the prickly lettuce in two days."

Like other successful CT growers, Rominger is an advocate of variable tillage operations, depending on the crop involved.

"Overall, the trend in our operation is toward more organic, more no-till and less conventionally farmed land," he said.

Rominger said he has used the Allen

Savory decision-making framework, which he considers to be "a framework of common sense."

Underhill farms 200 acres organically, including the vegetables and orchards of Terra Firma near Lake Solano in Yolo County.

He said direct marketing has helped his organic operation. He and his partners grow 50 to 60 crops using minimum tillage systems and re-bed every three to four years. The large number of diverse crops requires varying cultural practices.

He uses plastic mulch as well as no-till and pre-irrigation for weed control.

His operation uses sprinkler irrigation for the summer/fall-seeded crops.

Regarding fertility, Underhill said it is not possible to compare his operation with conventionally farmed land, and that for him, cover crop-derived N is relatively costly.

He noted that getting access to equipment that matches the size of his fields is a big problem, adding that sharing equipment is the only way small farmers with irregularly sized fields can experiment with novel CT practices. He said the high cost of appropriate-sized equipment is "putting a damper on growing cover crops in Yolo County." He noted that in Australia, contract planting is in widespread use, a practice that may be helpful for small growers here.

Underhill also asked for more UC efforts to develop crop varieties especially suited to organic production.

"'No-till' is an oxymoron for small organic growers," he said. "Weeds are the biggest problem."

He said he didn't think organic no-till had a big future, but that it would be important to focus on reduced tillage.

All the growers agreed that diversity in crops "smoothes out the highs and lows," and gives them greater stability and increased management options.

Voelz said consumers dictate what he plants.

Main said, "The bottom line is that I continue farming."

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