The Irrigated Agriculture Conservation Tillage (IACT) Project

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In the past dozen years, new environmental, economic, and social concerns related to industrial agriculture have arisen and others have begun to receive more attention. Respirable dust in the form of PM-10 has been recognized as a serious air quality concern (Pope et al., 1992; Abbey et al., 1995; USEPA 2000), with much of the PM-10 arising from agricultural operations (Grantz et al., 1998; CARB, 1999; USEPA, 2000). Water penetration problems continue to increase in severity in most irrigated farmlands in the arid and semi-arid West, and water shortages become more apparent as population levels increase. Agriculture has been shown to be a major contributor to carbon emissions (Post et al., 1990; Lal et al., 1998). The profitability of farming in the U.S. has decreased as trade globalization has proceeded and the costs of material inputs, particularly energy, have increased (Blank, 1998 and 2000). At the same time, rapid population growth in the West has put pressure on land resources such that the value of land for housing has grown at a vastly greater rate than that for agriculture (Moore, 1998). The result of these coupled problems is that even the best growers are leaving agriculture and high-quality farmland is rapidly being converted to urban uses, with consequent losses in open space, wildlife habitat, and biodiversity (Medvitz, 1999; Blank, 2000; Sanders, 2000).

Conservation tillage (CT) might be a means of addressing several of these problems at once. It has the potential for increasing water infiltration and use efficiency, increasing profits, increasing energy efficiency, increasing carbon sequestration and decreasing emissions, improving air, soil, and water quality, and providing more and higher-quality habitat for wildlife (Dimmick and Minser, 1988; Seta et al., 1993; Reeves, 1997; Reicosky, 1998). However, despite a 300 percent increase in the adoption of conservation tillage in the Midwest and other parts of the country, CT is currently being used on less than 0.3 % of California farmlands (Mitchell et al., 1999). Discussions with growers in California's Central Valley indicate that there are several reasons for this; primary among these is a lack of information on successful examples of CT in irrigated systems in California (Mitchell et al., 2000).

The site of the former Sustainable Agriculture Farming Systems (SAFS) project is an ideal location to assess the feasibility of using CT in alternative agricultural systems. The SAFS project was established in 1988 as a 12-year field experiment to study the transition from conventional to low-input and organic farming systems in California’s Sacramento Valley. It included four farming-system treatments: four-year rotations under conventional, low-input, and organic management, and a two-year rotation under conventional management. Cash crops included processing tomato, field corn, bean, safflower, wheat, and a grass/legume hay. All farming systems used “best farmer management practices” which were determined through interactions among farmers, researchers, staff, and farm advisors participating in the project. Farmers were involved in all stages of research and extension, including planning and design, execution, and interpretation and dissemination of results (Temple et al., 1994; Ferris et al., 1996). Plots of 1/3 acre in size were used to accommodate full-scale farming equipment.

Conventional management was based on current farming practices in the region. In the low-input and organic systems, use of synthetic fertilizers and pesticides was reduced or eliminated primarily through cover cropping, addition of organic amendments, mechanical cultivation and residue management, and modifications of irrigation and planting schedules. Data were collected on numerous aspects of the different farming systems, including nutrient dynamics, soil physical and biological properties, pest and weed incidence, water relations, economic viability, and others.

Some of the most important findings of the project were that cover-cropping in the organic and low-input management had positive long-term effects on soil biological, chemical, and physical properties. These systems showed greater accumulation of plant nutrients and carbon (C), greater biological activity, and reduced root disease severity. Soil physical properties were enhanced to the degree that in the low-input and organic systems, less than 15 percent of winter rainfall was lost as runoff, compared to 43 percent in the conventional systems, with the difference infiltrating and being stored in the soil profile (Joyce et al., 2000), Figures 1 and 2. Both alternative systems were found to be agronomically and economically viable. In the low-input system, pesticide use was reduced by 50 percent, without loss of yields or profits. Synthetic N inputs to corn were reduced by 30-40 % in the low-input system, which consistently produced the highest yields. Many of these results emerged slowly, over the entire duration of the SAFS project, showing the value of the long-term nature of the study (Clark et al., 1998, 1999; Poudel, 2000).

The 12-year rotation was completed in the growing season of 2000. During the course of the project, its findings were (and continue to be) successfully disseminated through a variety of means, including field days, workshops, a video, newsletters, website, extension bulletins, presentations, posters, professional meetings, peer-reviewed publications, technical and popular media articles, local, national and international radio and television interviews, visits by international scholars and officials, and others (Poudel et al., 2000).

We have now developed a new long-term research project called the Irrigated Agriculture Conservation Tillage (IACT) project. This will utilize the former SAFS research site, plus fields provided by grower-collaborators, and multidisciplinary, farmer-participatory research strategy to study the transition to conservation tillage in three farming systems: conventional, organic, and low-input. The advantages to using the SAFS site and strategy are several: the plots already have a history of organic, low-input, and conventional management, with substantial differences in soil properties corresponding to the differences in management; the research team (which includes growers) has a long history of working together productively and successfully; and a well-developed outreach structure will enable us to effectively disseminate results.

Areas to be addressed in this project include, but are not limited to, the following:

- Effects of CT on air quality, winter runoff, water quality, soil organic matter, carbon sequestration, water use and infiltration, crop yields and quality, production costs and profitability, and energy consumption.

- Optimizing soil conditions for planting in CT systems.

- Selection of cover crop varieties for use with CT in different cropping systems.
- Weed management in CT systems.
- Equipment for different production systems.
- Irrigation management: will CT work with furrow irrigation, or do crop residues create unmanageable flow barriers? Would the capital outlay needed for drip irrigation be sufficiently offset by decreased costs for weed management?
- Cover crop and residue management.
- Timing and sufficiency of N supply in cover crop-driven systems.

Figure 1: Winter runoff, Winter of 1999-2000. Low-input and organic systems were cover-cropped for ten years.

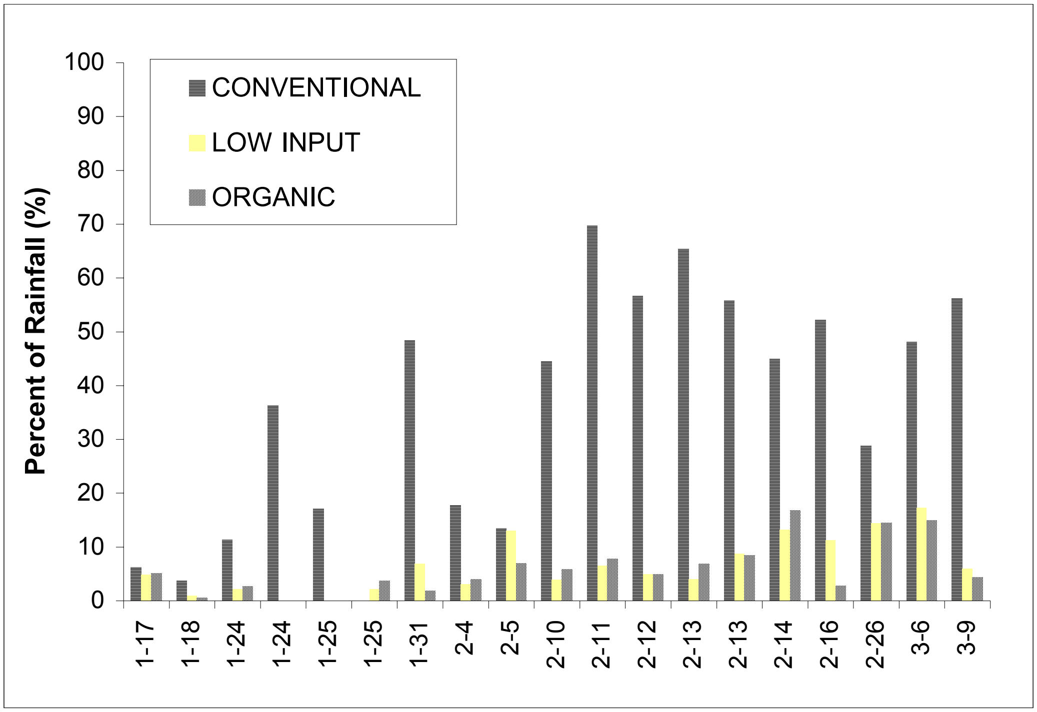

Figure 2: Visual differences between winter fallowed and cover-cropped fields

Conventional: Winter fallowed

Low-input: Winter Cover-cropped

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