EVALUATION OF OVERHEAD LOW-PRESSURE IRRIGATION AND NO-TILL PRODUCTION SYSTEMS IN CALIFORNIA'S CENTRAL VALLEY

Jeff Mitchell
Department of Plant Sciences
University of California, Davis

Southern Conservation Agricultural Systems Conference
North Florida Reseach and Education Center
Quincy, FL June 25 – 27, 2007

Collaborators

Anil Shrestha
Dan Munk
Bob Hutmacher
Steve Wright
Steve Temple
Randy Southard
Nick Madden
Kurt Hembree
Mick Canevari
Karen Klonsky
Julie Baker
Gene Miyao
Howard Ferris
Tom Lanini
Lee Jackson
Wes Wallender
Willi Horwath
Jaime Solorio
Ed Scott

Bob Prys
Jim Couto
John Diener
Andy Zylstra
Ryan Camara
Scott Schmidt
Brett Miller
Alan Sano
Jesse Sanchez
Tom Barcellos
Darrell Cordova
Emilio Cervantes
Henry Villalobos
Andy Rollin

Bill McCloskey
Steve Husman

Mike Buser
Lyle Carter

John Beyer
Rob Roy
Bob Fry
Johnnie Silizinoff
Mike McElhiney
Brooks Englehardt
Malia Hilldebrandt

Ron Harben

Alan Wilcox
Ralph Cesena, Sr.
Monte Bottens
John Bliss
Larry Beckstead

Allen DuSault
Kristen Hughes
Ladi Asgill

OVERVIEW OF PRESENTATION

- recent advances in CT systems in California

- merging no-till and overhead irrigation technologies

Possible benefits of conservation tillage

- saves fuel
- saves soil
- saves time
- saves labor
- saves machinery
- permits timely planting
- reduces run-off
- increases soil moisture
- increases soil organic matter
- sequesters carbon
- improves habitat for beneficial organisms

Dr. Sharad Phatak, University of Georgia, 1999

- *dust (PM10 and PM2.5) emissions mitigation*
- *surface water (sediment, nutrient and pesticide) runoff reduction (?)*
- *reducing GHG emission (?)*

Conservation / Standard Tillage Comparison Study (1999 – ongoing)

Standard Tillage

With cover crop

Without cover crop

Conservation Tillage

With cover crop

Without cover crop

An example of developing alternative tillage systems

EXPERIMENTAL METHODS

1) **tomato / cotton rotation with and without winter triticale/rye/common vetch cover crops**

2) **10 X 90 m plots, replicated 4 times in RCBD**

3) **"*reduce tillage to greatest extent possible*" in CT systems**

4) **monitor all inputs and operations for economic analysis**

5) **machine harvest yield determinations**

Conservation Tillage Workgroup

Standard Tillage Tomato System
(Coming Out of Cotton)

Year 1 (going into tomatoes)

- shred cotton stalks
- undercut cotton plants
- disk 2X
- chisel
- list
- cultimulch
- winter weed control
- apply preplant herbicide
- recultimulch beds
- transplant tomatoes
- irrigate
- cultivate
- fertilize
- cultivate
- harvest

Year 2 (going into cotton)

- flail chop tomato residue
- disk 2X
- chisel
- disk
- list
- winter weed control
- apply preplant herbicide
- plant cotton
- irrigate
- cultivate
- fertilize
- cultivate
- harvest

Conservation Tillage Tomato System
(Coming Out of Cotton)

Year 1 (going into tomatoes)

- shred and undercut cotton
- sweep furrows
- spring herbicide application
- transplant tomatoes
- irrigate
- cultivate
- harvest

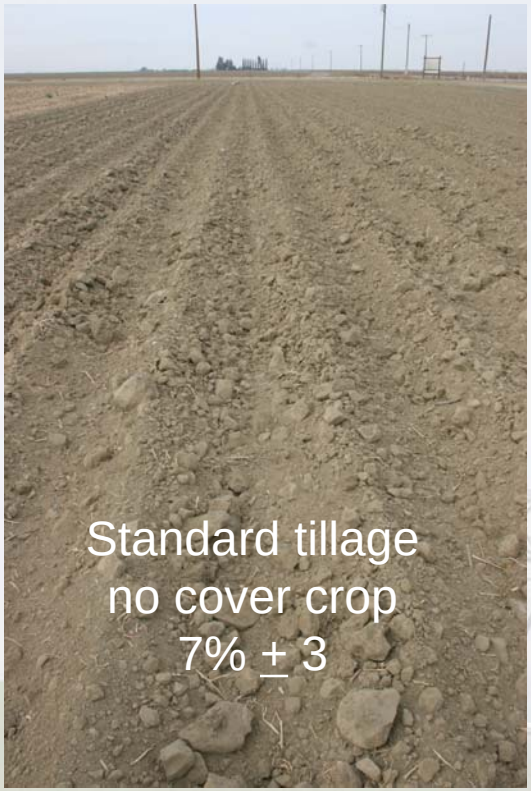
Year 2 (going into cotton)

- spring herbicide application
- plant cotton
- irrigate
- cultivate
- fertilize
- cultivate
- harvest


Conservation tillage system
following tomato harvest and
before cotton planting
Five Points, CA 2000

Rye / triticale / vetch cover crop in CTCC system
Five Points, CA 2000

Surface residue in CTCC system
Five Points, CA 2003



Following
2005 Tomatoes
November 2, 5005

No-till transplanting processing tomatoes into cotton residues
Five Points, CA
April 2007

No-till cotton planting into tomato residue
April 2007
Five Points, CA

Comparison of Standard and Conservation Tillage
Costs and Resource Use - Cotton 2001

	Standard Tillage*		Conservation Tillage**	
Operation	No cover	Cover	No cover	Cover
Disc	XX	XXX		
Chisel	X	X		
List Beds	X	XX		
Clean Furrows				X
Compact Furrows	X	XX		
Spray Treflan	X			
Lilliston	XX			
Chain Beds	X			
Plant Cover Crop		X		X
Mow Cover Crop		X		
Spray Roundup	XX	X	XX	XX
Plant Cotton	X	X	X	X
Fertilize* **				
Cultivate	XX	XX		
Spray Grnd-Insctcds/Grwth Reg	XXX	XXX	XXX	XXX
Spray Grnd-Custom: Defoliants	X	X	X	X
Spray Air-Custom:Insecticides	X	X	X	X
Harvest	X	X	X	X
Times over field	20	20	9	11

***30" rows **60" rows ***Applied with irrigation water**

Tomato yields 2000 – 2004
(tons/acre)

	2000	2001	2002	2003	2004
STNO	58 ± 1	58 ± 1	46 ± 3	42 ± 2	46 ± 4
STCC	53 ± 1	63 ± 2	45 ± 3	45 ± 3	42 ± 5
CTNO	56 ± 1	62 ± 2	56 ± 1	54 ± 4	52 ± 3
CTCC	51 ± 1	61 ± 1	43 ± 2	52 ± 3	48 ± 3

Cotton yields 2000 – 2006
(lbs lint/acre)

	2000	2001	2002	2003	2004	2005	2006
STNO	360 a	1783	1930 a	1228 ab	2217a	1528	1306
STCC	360 a	1405	1921 a	1336 a	1990 ab	1595	1213
CTNO	200 a	1579	1736 b	1058 b	1816 bc	1498	1257
CTCC	372 a	1454	1252 c	1157 ab	1486 c	1528	1170

Dust Production by Treatment and Operation (µg/L)

Treatment	STNO		STCC		CTNO		CTCC	
Size Fraction	Total	Resp.	Total	Total	Total	Total	Total	Total
Land Preparation								
Disc	98	14	81	10				
Chisel	20	1	11	1				
List Beds	12	3	11	2				
Ringroll Beds	44	7	39	24				
Power Incorporate	127	20	93	7				
Plant Cover Crop			4	trace*			21	4
Mow/Chop Cvr Crop			22	9			61	6
Compact Furrow			9	6				
Subtotal	300	44	270	58			82	9
In Season Operations								
Spray	12	3			5	2	2	1
Lilliston	92	4						
Cultivate Tomato	34	2	28	2	75	4	75	7
Cultivate Cotton	316	8	222	10				
Subtotal	455	17	250	12	80	6	77	8

*There were detectable dust measurements for these operations, but they rounded to 0 with this number of significant figures.

Dust Production by Treatment and Operation (µg/L)
(continued)

Planting / Harvest	STNO		STCC		CTNO		CTCC	
Plant Cotton	1	trace*	5	1	4	1	14	1
Transplant Tomato	2	trace*	9	1	17	2	17	2
Clean Furrow							37	5
Shred-Bed					12	4	22	8
Mow	38	6	51	6				
Undercut	29	3	27	2				
Harvest Cotton	11	2	11	2	8	2	13	3
Subtotal	81	11	103	12	40	8	103	19
Cumulative Dust Production	837	72	623	82	120	14	262	36

*There were detectable dust measurements for these operations, but they rounded to 0 with this number of significant figures.

Baker, Southard and Mitchell
JEQ, 2004


No-Till

http://ucce.ucdavis.edu/files/filelibrary/5334/37564.pdf - Windows Internet Explorer

1ST ANNUAL
No-Till Cotton
FIELD DAY

May 25, 2007 • Friday
10 am - Noon

University of California
West Side Research and Extension Center

Oakland and Lassen Avenues
Five Points, CA
(559) 884-2411

Burrito lunch available.

Although there is currently no commercial no-till cotton production in the San Joaquin Valley (SJV), over the past several years University of California researchers have been evaluating a number of no-till cotton production options in an effort to develop cheaper, yet economically profitable alternatives. This field day will present information that has resulted from these studies and will provide opportunities for SJV producers to learn about no-till management options, equipment and economics.

May 25, 2007
Friday
10 am - Noon

1ST ANNUAL
No-Till Cotton
FIELD DAY

10:00 **Welcome to the West Side Research and Extension Center**
Bob Hutmacher
Director, WSREC and UCCE Cotton Specialist

10:15 **Overview and History of No-Till Cotton Research at the West Side Research and Extension Center**
Jeff Mitchell
UCCE Cropping Systems Specialist

10:45 **No-Till, Strip-Till, Twin-Row and Ultra-Narrow Row Cotton Planting Equipment**
Jeff Mitchell
UCCE Cropping Systems Specialist

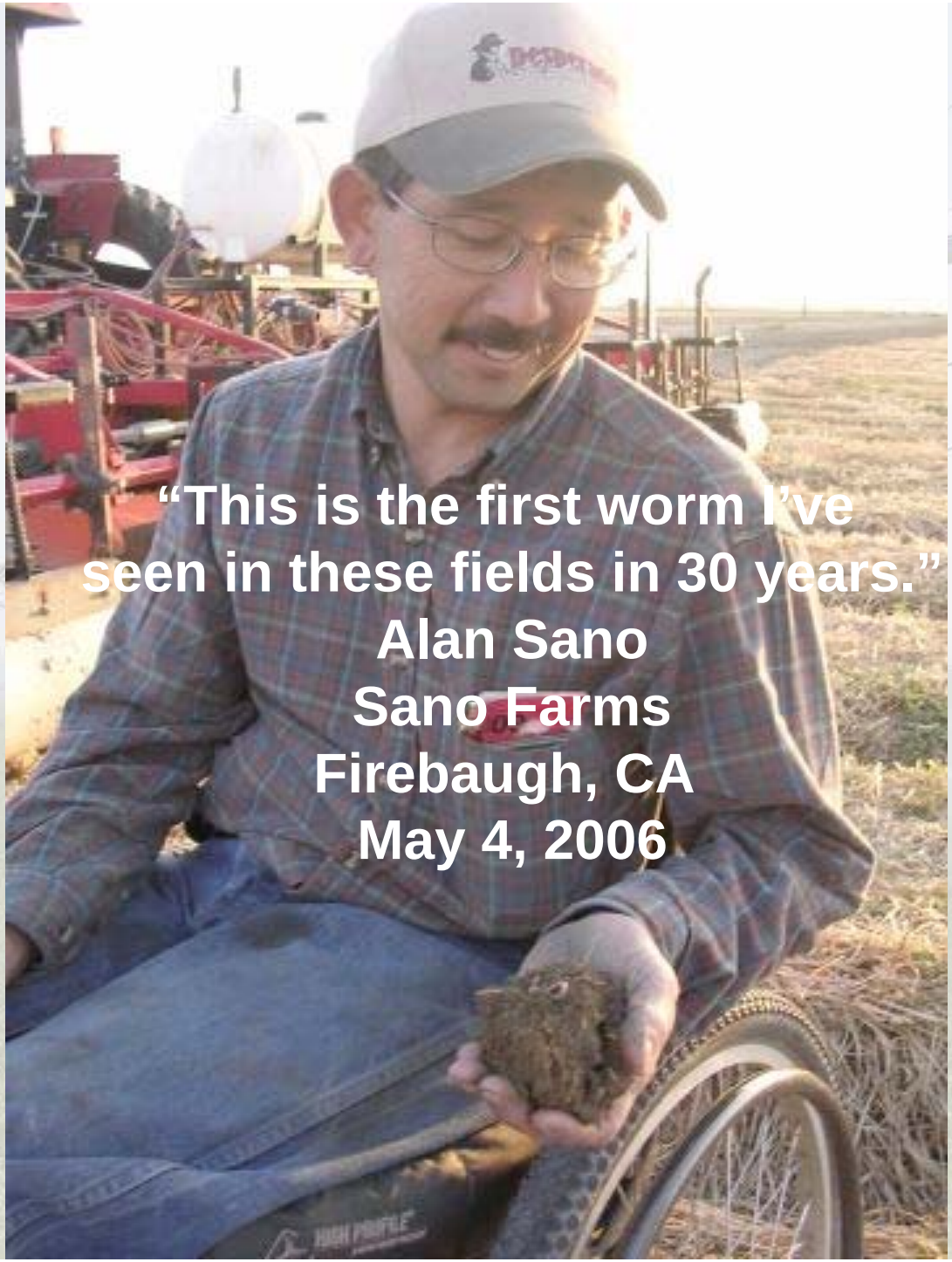
11:15 **The "Next Generation" of Tillage and Water Management Research: Coupling No-Till with Overhead Irrigation**
Dan Munk
UCCE Cotton, Soils and Water Advisor

11:30 **Discussion - Participant Feedback - Lunch**
Steve Wright
UCCE Cotton and Field Crops Advisor

Short-season triticale cover crop preceding processing tomatoes
Firebaugh, CA 2005

Strip-till planted processing tomatoes
Firebaugh, CA 2006


PROCESSING TOMATOES
STRIP-TILL PLANTED INTO
TRITICALE COVER CROP
FIREBAUGH, CA 2005


“This is the first worm I’ve seen in these fields in 30 years.”
Alan Sano
Sano Farms
Firebaugh, CA
May 4, 2006

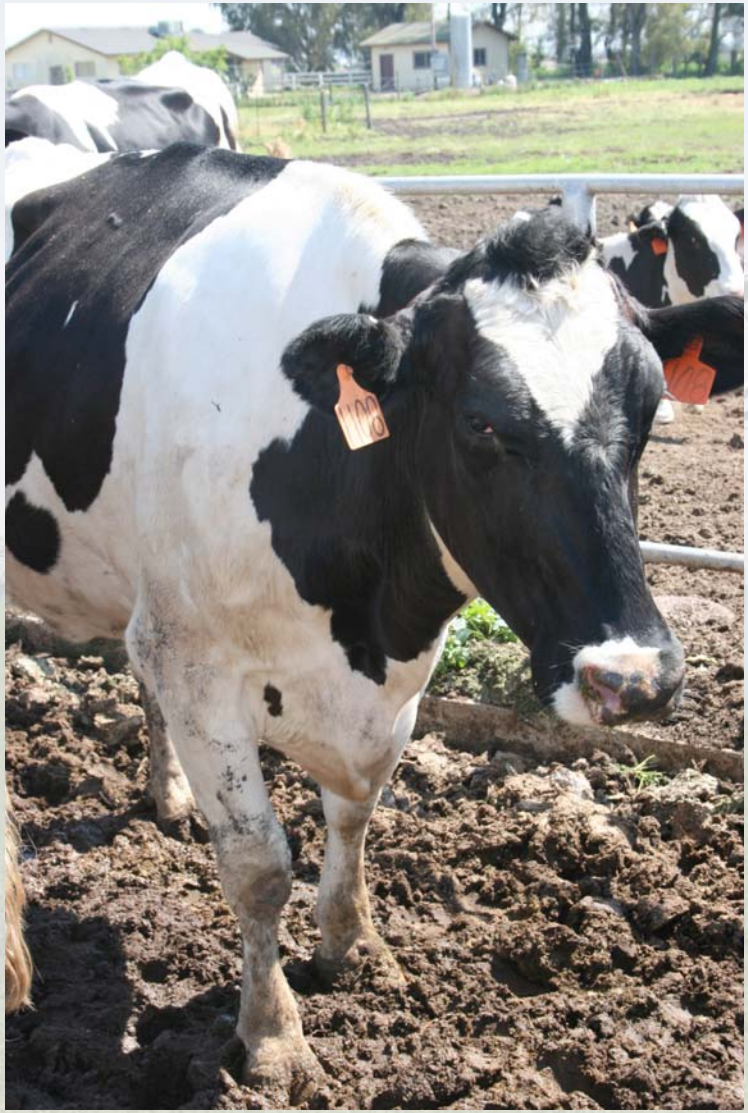
Steve Groff
Pennsylvania no-till
tomato producer visiting
Sano Farms
Firebaugh, CA
May 2006

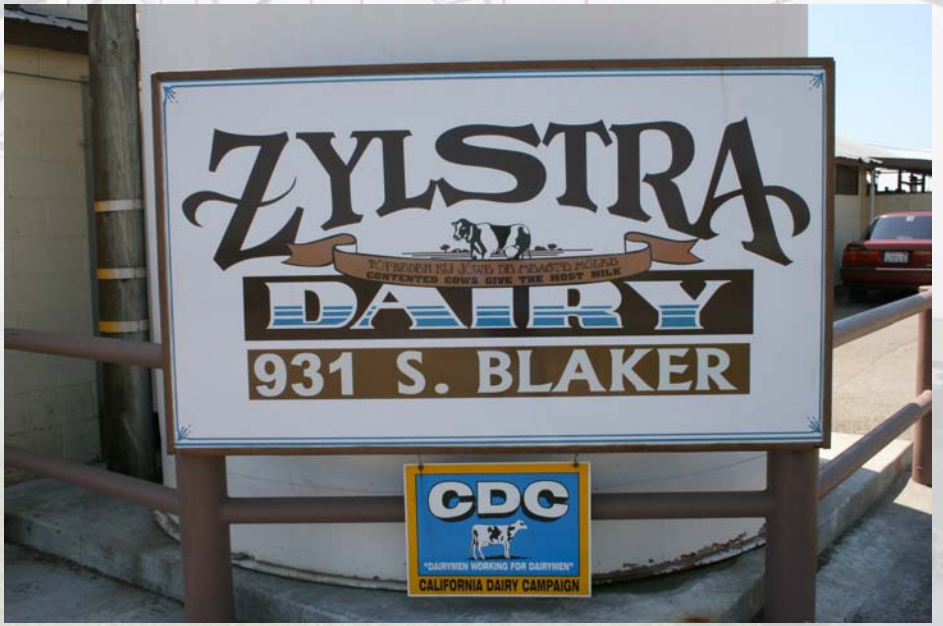
Rolling stalk chopper knocking down bell bean cover crop ahead of strip-tilling and transplanting processing tomatoes

Davis, CA

April 2006

Modified Orthman *1-tRIPr* strip-tiller preceding tomato transplanting
Davis, CA May 2006




ZYLSTRA
CONTENTED COWS GIVE THE MOST MILK
DAIRY
931 S. BLAKER
CDC
"DAIRYMEN WORKING FOR DAIRYMEN"
CALIFORNIA DAIRY CAMPAIGN

Standard tillage land preparation following alfalfa or winter forage consisting of disking cross checks prior to broadcast disking entire field

Rollin Dairy, Burrell, CA 2004

Tom Barcellos
2006 CT Farmer Innovator Award Recipient
Tipton, CA 2004

Sampling agricultural dust emi
Dairy corn production fiel
Tipton, CA 2004

Fields and Operations

Sweet Haven

Soil: Sandy Loam

Location: Burrel, CA

Crop: Oats => Corn

ST Corn	CT Corn
Disk (Off-Set)	Strip-Till
2nd Disk (0ff-Set w/ Roller) 2X	CT Drill
Corn Planter	

Barcellos Farm

Soil: ST Sandy Loam
CT Loam,

Location: Tipton, CA

Crop: Wheat => Corn

ST Corn	CT Corn
Disk (0ff-Set) 2X	CT Drill
Listing	
Disk-Bedder (Go-Devil)	
Bed Mulcher	
Ring Roller	
Planter	
Ring Roller	

Barcellos Farms, Tipton, CA

SPRING 2004

ST Corn				
Operations	AVG. EF (mg/m^2)	CARB EF (mg/m^2)	Test Grades	Avg GWC
Disk (0ff-Set)	252	135	A,C,B	0.06
2nd Disk (0ff-Set)	917	135	A,A,A	0.06
Listing	615	90	B,A,A	0.07
Disk-Bedder (Go-Devil)	25	135	B,B	0.15
Bed Mulcher	89	135	A,A	0.11
Ring Roller	566	90	A,A	0.10
Planter	96	90	A,G	0.14
Ring Roller	186	90	C,B	0.08
CT Corn				
CT Drill	198	90	B,E	0.26

- **CT emissions reduced 93%**

SPRING 2005

ST Corn				
Operations	AVG. EF (mg/m^2)	CARB EF (mg/m^2)	Test Grades	Avg GWC
Disk (0ff-Set)	51	135	A,A,A	0.21
2nd Disk (0ff-Set)	123	135	A,A,A	0.19
Circle Harrow w/ Roller	264	1403	B,C,D	0.18
Listing	466	90	B,B,B	0.19
Disk-Bedder (Go-Devil)	109	135	A,B,B	0.17
Bed Mulcher	384	135	B,A,A	0.15
Planter	481	90	B,A,A	0.17
CT Corn				
CT Drill	224	90	C,B	0.19

- **CT emissions reduced 88%**

Sweet Haven Dairy, Burrell, CA

SPRING 2004

ST Corn				
Operations	AVG. EF (mg/m^2)	CARB EF (mg/m^2)	Test Grades	Avg GWC
Disk (Off-Set)	316	135	C,B,B	0.06
2nd Disk (0ff-Set w/Roller)	1035	135	A,A,A	0.05
3rd Disk (0ff-Set w/Roller)	135	135	E,B,A	0.15
Planter	96	90	C,A,B	0.08
CT Corn				
Strip-Till	181	135	A,F,E	0.11
CT Drill	115	90	C,B,C	0.10

- **CT emissions reduced 81%**

SPRING 2005

ST Corn				
Operations	AVG. EF (mg/m^2)	CARB EF (mg/m^2)	Test Grades	Avg GWC
Disk (Off-Set)	145	135	B,C,B	0.14
2nd Disk (0ff-Set w/Roller)	375	135	B,B,B	0.10
3rd Disk (0ff-Set w/Roller)	404	135	A,A,B	0.16
Planter	263	90	A,A,A	0.16
CT Corn				
Strip-Till	180	135	A,A,A	0.17
CT Drill	385	90	A,A	0.16

- **CT emissions reduced 52%**


California Waste Discharge Permit Requirement
General Order 55-2007-0035 for Milk Cow Dairies

Dairy forage triple-cropping as a means to increase forage production and nutrient uptake

Side-by-side comparison of traditional tillage (left) and strip-till corn production (right)

Gwerder Dairy • May 31, 2007

Harvesting winter forage wheat, strip-tilling and planting corn, Tipton, CA, May 2005

Corn planting following strip-tilling wheat residue
Barcellos Farms, Tipton, CA 2005

Triple-crop no-till planting of sorghum sudan following wheat and corn
Barcellos Farms, Tipton, CA 2005

No-till vs. Conventional

Double Cropped Corn following Wheat

per acre comparison

		No-till	Conventional	
Seed		$50	$36	1
Fertilizer		$60	$60	
Pesticide		$12	$12	
Herbicide		$41	$18	2
Field Operation				
Disc 2X		$0	$28	
Landplane	$0	$14		
Rip		$0	$20	
List		$0	$12	
Disc Bedder	$0	$12		
Mulcher		$0	$15	
Roller		$0	$5	
Plant		$28	$16	3
Cultivate		$0	$10	
Fertilizer App.		$7	$10	4
Layby		$0	$10	
Herbicide App.		$20	$10	5
Irrigation	2.5 a/f	$150	$150	
Total Cost		**$368**	**$438**	

1. No-till seed is Round-up Ready
2. Round-up used for weed control, multiple applications as needed
3. No-till planter uses coulter openers and fertilizer attachment
4. No-till= coulter, conventional=knife
5. No-till is two applications vs. one application

Total savings $70 per acre!

Data compiled by Tom Barcellos, Dairyman, Tipton, CA, 2006

At this Strip-Tillage Field Day, you'll have an opportunity to learn about new information that is being developed for strip-till forage corn production at Giacomazzi Dairy. You'll see how strip-till is done, what different strip-tillers are available, and learn about ongoing field studies that are trying to answer the following questions:

- Is it better to strip-till before or after a pre-irrigation?
- Does twin-row corn planting out perform single-row planting in strip-till?
- Which corn varieties yield best in strip-till?
- How do different strip-tillers perform?
- What is the best weed management in strip-till corn?

For more information, call
Jeff Mitchell at (559) 303-9689

Strip-Tillage Field Day

Wednesday
August 30, 2006
9am - noon

Conservation Tillage Workgroup

2007 Conservation Tillage FARMER TOUR

JUNE 12 - 16, 2007

California's Conservation Tillage Workgroup is pleased to announce its 2007 Farmer tour that will take place from the afternoon of Tuesday, June 12 through Saturday morning, June 16. The objective of this tour will be to provide intense learning opportunities for California producers on a wide variety of successful conservation practices that have been developed for a number of row and field crops in the region of western Nebraska, southern South Dakota and western Colorado and Wyoming where irrigation systems are common.

This year's tour will highlight a wide range of no-till and strip-till cropping systems and will feature farmer, researcher and private sector hosts who have considerable, state-of-the-art experience with successful CT systems. Participants in the tour will view a range of no-till and strip-till farms and research sites and learn about the mechanics of systems in terms of planting, crop rotations, pest management, irrigation, labor and resource conservation.

Well-known and world-renowned researchers, including Dr. Dwayne Beck of South Dakota State University and Dr. Paul Jasa of the University of Nebraska, leading no-till and strip-till farmers, and No-Till on the Plains Director, Brian Lindley, will be featured on the tour which will depart from and return to Fresno Yosemite Airport.

Applications must be received by April 25 to guarantee a spot on the tour.

TENTATIVE ITINERARY

TUESDAY
JUNE 12, 2007

- Depart Fresno Yosemite Airport 2pm.
- Arrive Denver International Airport.
- Board bus for overnight stay near Greeley, CO.

WEDNESDAY
JUNE 13, 2007

- Visit Strip-till Farms and research sites with Mike Petersen, former USDA NRCS Conservationist and current Precision tillage Coordinator for Dothman Mfg.
- Depart for Pierre, SD in afternoon.

THURSDAY
JUNE 14, 2007

- Meet with Dwayne Beck at SDSU Dakota lakes Research Farm, Pierre, SD.
- No-till intensive, diverse crop rotations.
- No-till farm visits.
- Depart for Alliance, NE.

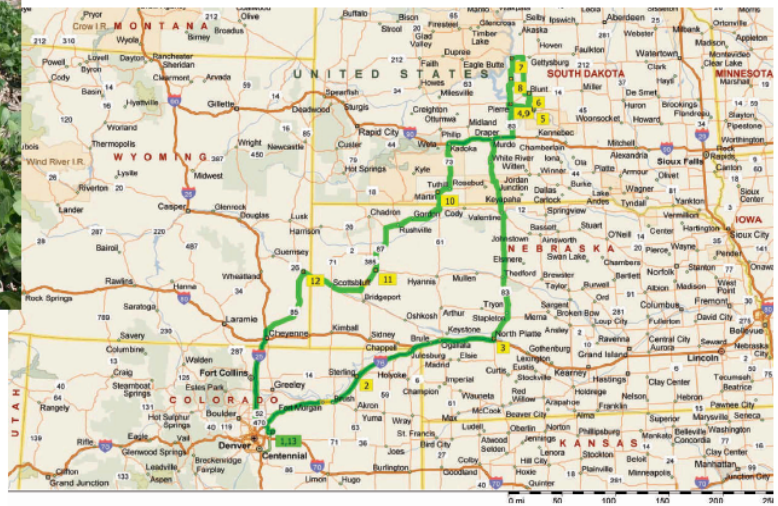
FRIDAY
JUNE 15, 2007

- Whirlwind Expo No-till Field Day, Alliance, NE hosted by "No-Till on the Plains" (Brian Lindley, Coordinator) and the University of Nebraska (Paul Jusa) at the farm of long-time no-till , Mark Watson.
- Depart for Torrington, WY.

SATURDAY
JUNE 16, 2007

- Visit strip-till production region with Dave Zimmerer, Schlagel Mfg.
- Depart to Denver.
- Return flight to Fresno.

Dwayne Beck, South Dakota State University, Dakota Lakes Research Farm • Pierre, SD

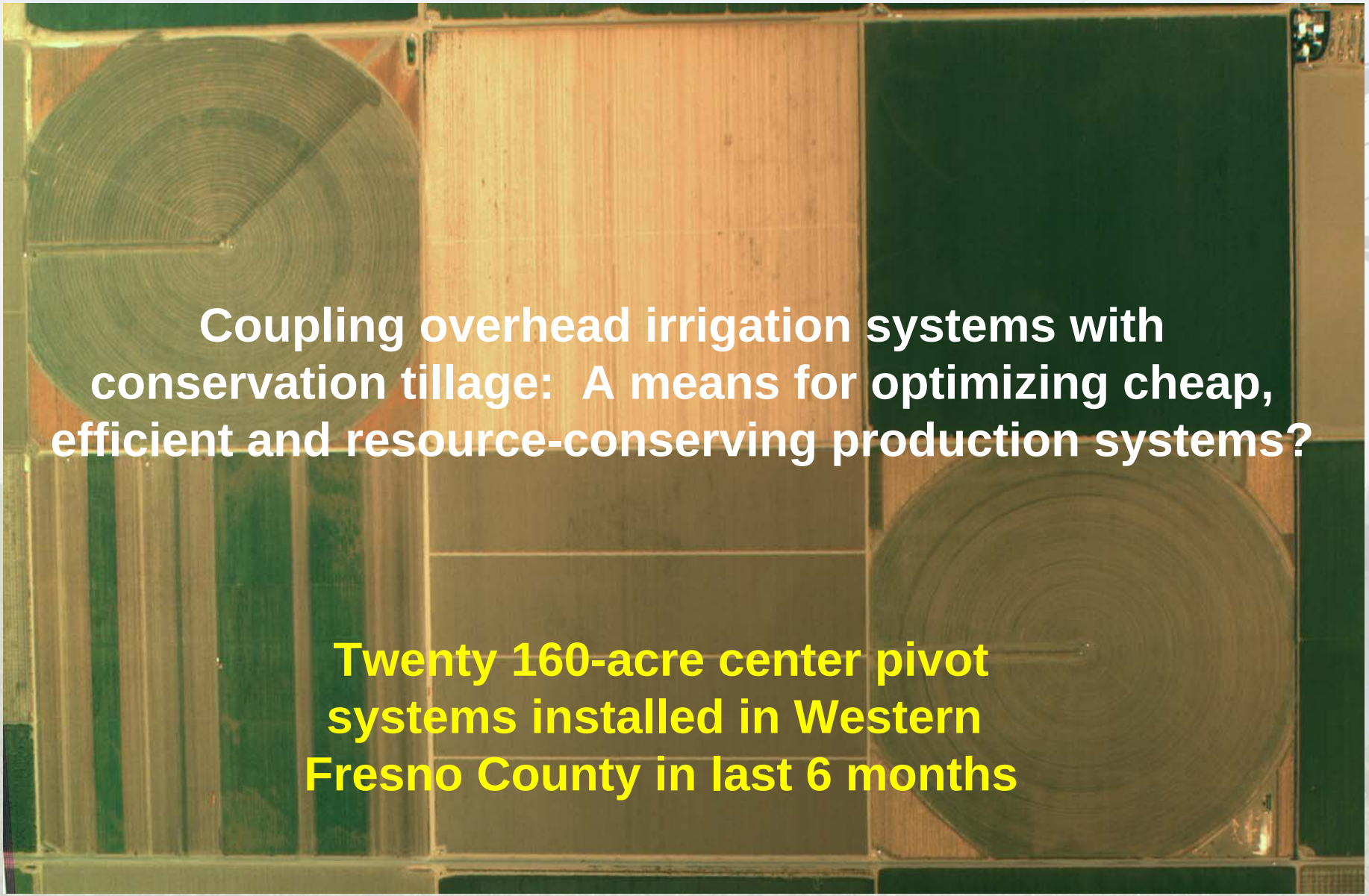


2007 Conservation Tillage FARMER TOUR JUNE 12 - 16


2007
California
CONSERVATION TILLAGE
FARMER TOUR

No-till soybeans in corn residue
Center pivot irrigated
Dakota Lakes Research Farm
Pierre, SD
July 2005

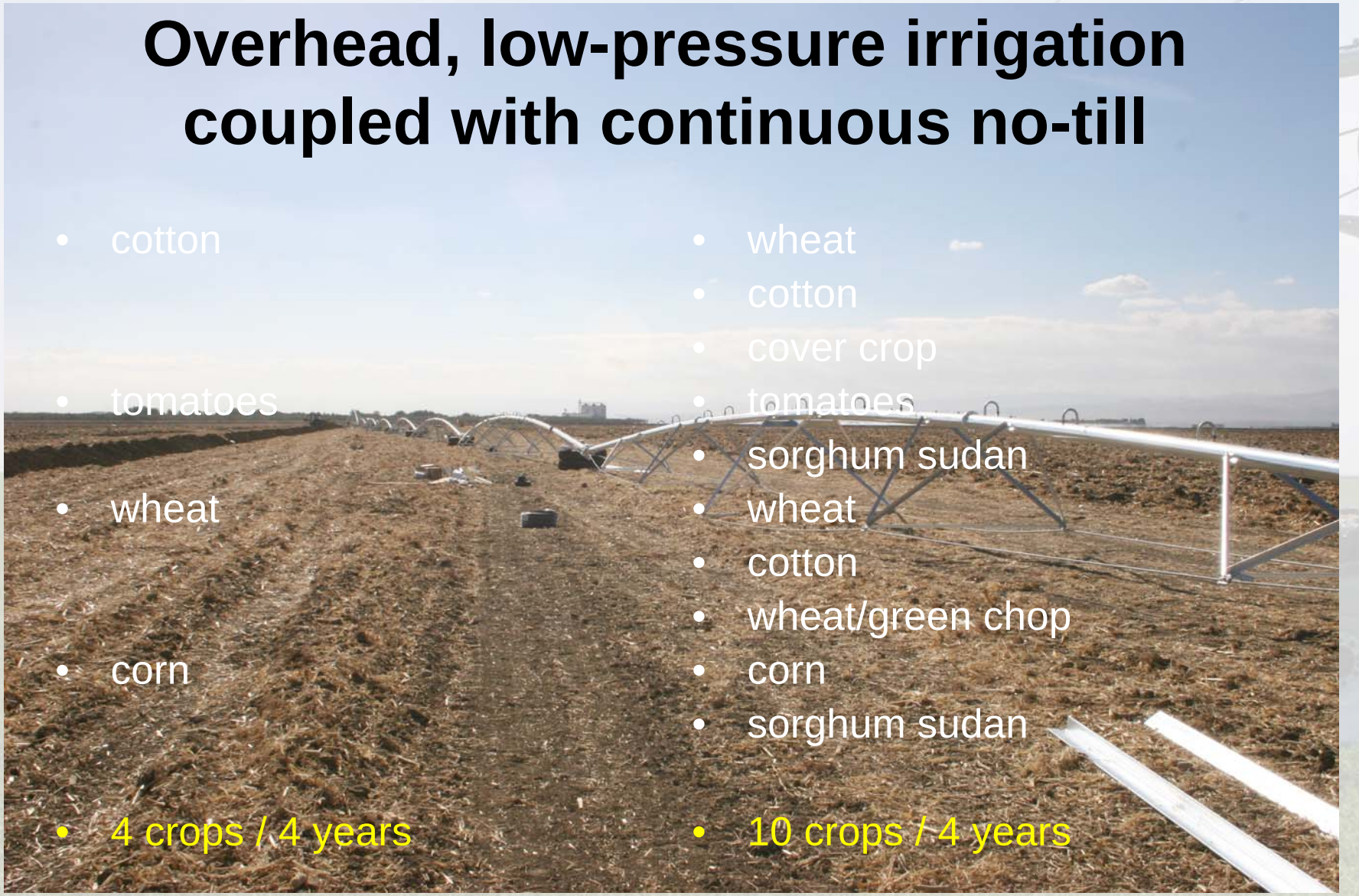

CENTER PIVOT, OVERHEAD
IRRIGATED NO-TILL COTTON
BUSHLAND, TX 2006


Coupling overhead irrigation systems with conservation tillage: A means for optimizing cheap, efficient and resource-conserving production systems?
Twenty 160-acre center pivot systems installed in Western Fresno County in last 6 months

Developing new crop production systems that couple overhead irrigation with no-till practices
Five Points, CA

Wes Wallender
Karen Klonsky
Dan Munk
Bob Hutmacher
Anil Shrestha
John Diener
Scott Schmidt
Monte Bottens
Steve Wright
Kurt Hembree
Pat Murray
Darrell Cordova
John Beyer
Rita Bickel
Anita Brown
Tom Gohlke
Ron Harben
Johnnie Siliznoff
Brook Gale

Overhead, low-pressure irrigation coupled with continuous no-till



- cotton
- tomatoes
- wheat
- corn

- 4 crops / 4 years

- wheat
- cotton
- cover crop
- tomatoes
- sorghum sudan
- wheat
- cotton
- wheat/green chop
- corn
- sorghum sudan

- 10 crops / 4 years

Conservation tillage / overhead irrigation and industrial / bioenergy crop production:

An ideal match?

No-till planting of sorghum into wheat residue

Five Points, CA 2003

Making Conservation Tillage Conventional:

Building a Future on 25 Years of Research

Proceedings of the 25th Annual Southern Conservation Tillage

Conference for Sustainable Agriculture

Auburn, AL, USA 24-26 June 2002

CONCLUSIONS

- **considerable innovation underway with CT systems for forage production and to some extent for tomato production systems**

- **rather recent and emerging interest in merging overhead irrigation with CT technologies, but cost / benefit evaluations are needed**

- there are tremendous opportunities and needs for far greater connections between CT research, extension and impact making in terms of
  - resource quality
  - economics
  - ag engineering and cropping systems design

- future goals
  - biofuel production systems design
  - integrated animal / crop systems, and
  - sustaining CT production through more diverse rotations including vegetables and root crops


Thank you very much.