TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

TN - AGRONOMY - 49 — SEPTEMBER 1990

POTENTIAL ENERGY SAVINGS USING CONSERVATION TILLAGE

USE OF CONSERVATION TILLAGE

In the United States, work started in the 1950s on stubble mulch experiments to reduce wind erosion problems in the wheat growing area of the Midwest. Land grant colleges and the U.S. Department of Agriculture's Agricultural Research Service efforts have helped Midwest growers perfect conservation tillage systems for no-till corn, soybeans, and wheat, and ridge till corn and soybeans. Even some no-till cotton is being grown in the South.

In California, conservation tillage techniques have been evolving since the 1970s beginning with dryland grain-summer fallow systems in the Paso Robles area. George Work, who farms in the southern part of Monterey County, is considered the 'father of conservation tillage in California' because he stopped plowing in the early 1960s and started using chisels with sweeps. Soil erosion problems and sediment filled roads led other growers to look for new tillage systems in Monterey and San Luis Obispo Counties.

The Upper Salinas and Las Tablas Resource Conservation Districts (RCD) (now called the Upper Salinas - Las Tablas RCD) sponsored the first Dryland Grain Conservation Tillage Workshop in 1979 at George Work's farm. They held eight more workshops: 1981, 1982, 1983, 1984, 1985, 1986, 1988, with the last one in 1989.

A Conservation Field Trial was started in 1981 with the Johansing Partnership near Paso Robles to compare no-till, reduced till, and conventional till barley. The RCDs, Soil Conservation Service, and Cooperative Extension worked jointly on this effort. Similar conservation field trials were started in Alameda County in 1983 with Norman Marciel near Livermore and in Yolo County with Henry Van Der Stoel west of Woodland. Then in 1985, a ridge-till, field corn Conservation Field Trial was started on Tyler Island with John Lewallen and Sons and the Kay-Dix Ranch to reduce wind erosion.

The Elsinore-Murrietta-Anza and the San Jacinto Basin RCDs co-sponsored Conservation Tillage Workshops at Hemet in 1985 and 1986. The Yolo County RCD sponsored Conservation Tillage Workshops at Zamora in 1986 and at Woodland in 1987. The California Conservation Tillage Association was formed in July 1988 at Paso Robles.

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During this same period, University of California Cooperative Extension Farm Advisors Mike Smith in San Luis Obispo County, Steve Wright in Tulare County, Tom Kearney in Yolo County, William Richardson in Tehama County, and Roger Benton in Siskiyou County were involved with conservation tillage work. A UC Extension Conservation Tillage Project under the leadership of G.Stuart Pettygrove, UC Davis Extension Soils Specialist, was initiated in 1985 with extensive plot work in Tehama, Yolo, San Luis Obispo, and Tulare Counties using the Haybuster no-till drill.

In 1989 the University of California at Davis's No-till Dryland Wheat and Barley Demonstration Project proposal was funded by a Farm Energy Assistance Demonstration Grant from the California Energy Commission. These monies were part of the Petroleum Violation Escrow Account allocated by the State Legislature in Senate Bill 1145 signed by the Governor in 1986. Plot work and demonstrations on farms in Yolo and San Luis Obispo Counties were conducted in 1989 and 1990 using a new Cross-slot no-till drill.

In Response to the 1985 Food Security Act (Farm Bill), persons growing commodity crops on fields determined to be highly erodible (HEL) needed conservation plans to reduce soil erosion if they will participate in one of the USDA benefit programs affected. Conservation tillage systems provide erosion control for grain growers farming sloping land. The plans were developed with Soil Conservation Service help and approved by the local Resource Conservation District before January 1, 1990 with full implementation by January 1, 1995.

The Conservation Reserve Program was authorized under the 1985 Farm Bill and the first signup was in March 1986. Many of the dryland grain fields where conservation tillage was being tried have been enrolled under 10 year contracts. Beginning in 1997, CRP contracts will begin to expire although there may be provisions for some contracts to be extended. Some growers will begin using these fields for crop production and the need to use conservation tillage will increase. The next few years offer an opportunity to improve existing conservation tillage systems and develop new techniques. Reduced costs and reduced equipment size and fuel consumption will make conservation tillage even more important in the future in California.

DEFINITIONS

Conservation tillage in Water Erosion Problem Areas:

ANY TILLAGE OR PLANTING SYSTEM THAT MAINTAINS AT LEAST 30 PERCENT OF THE SOIL SURFACE COVERED BY RESIDUE AFTER PLANTING TO REDUCE SOIL EROSION BY WATER.

Conservation tillage in Wind Erosion Problem Areas:

ANY TILLAGE OR PLANTING SYSTEM THAT MAINTAINS AT LEAST 1000 POUNDS OF FLAT, SMALL GRAIN EQUIVALENT (SGE) ON THE SOIL SURFACE DURING THE CRITICAL EROSION PERIOD.

TYPES OF CONSERVATION TILLAGE

No-Till--------

THE SOIL IS LEFT UNDISTURBED FROM HARVEST TO PLANTING EXCEPT FOR NUTRIENT INJECTION. PLANTING OR DRILLING IS ACCOMPLISHED IN A NARROW SEEDBED OR SLOT CREATED BY COULTERS, ROW CLEANERS, DISC OPENERS, IN-ROW CHISELS OR ROTOTILLERS. WEED CONTROL IS ACCOMPLISHED PRIMARILY WITH HERBICIDES. CULTIVATION MAY BE USED FOR EMERGENCY WEED CONTROL.

Ridge Till-----

THE SOIL IS LEFT UNDISTURBED FROM HARVEST TO PLANTING EXCEPT FOR NUTRIENT INJECTION. PLANTING IS COMPLETED IN A SEEDBED PREPARED ON RIDGES WITH SWEEPS, DISC OPENERS, COULTERS, OR ROW CLEANERS. RESIDUE IS LEFT ON THE SURFACE BETWEEN RIDGES. WEED CONTROL IS ACCOMPLISHED WITH HERBICIDES AND/OR CULTIVATION. RIDGES ARE REBUILT DURING CULTIVATION.

Mulch Till-----

THE SOIL IS DISTURBED BY TILLAGE PRIOR TO PLANTING. TILLAGE TOOLS SUCH AS CHISELS, FIELD CULTIVATORS, DISCS, SWEEPS, OR BLADES ARE USED. WEED CONTROL IS ACCOMPLISHED WITH HERBICIDES AND/OR CULTIVATION.

These are national definitions used for the annual Conservation Tillage Acreage Survey by the Conservation Technology Information Center (CTIC)(formerly known as the Conservation Tillage Information Center) now located at 1220 Potter Drive, Room 170, Purdue Research Park, West Lafayette, Indiana 47906-1334.

CHARACTERISTICS OF CONSERVATION TILLAGE

Less Tillage with more time for management.

Cultural operations performed on a more timely basis.

More Residue on surface providing erosion control.

Less Erosion on field from rainstorms or high winds.

Gully erosion controlled minimizing future loss of land area.

Less Fuel used due to fewer, separate cultural operations.

More Soil Moisture stored in soil from residue management.

Same Yields expected compared to conventional tillage.
Fritz Durst in Yolo County found his no-till wheat averaged 11.5 percent protein compared to conventional wheat that made 8.5-9.5 percent in 1986.

Temporary yield loss may occur until the new conservation tillage system is perfected for that farm.

John Lewallen on Tyler Island planted his ridge till corn two weeks early and then had cold weather. Tasseling was two weeks early but that coincided with a hot spell and resulted in a 3000 pound yield reduction that year.

More Herbicide may be needed at first due to different weed control management, which is critical.

More Wildlife can result from the increased amounts of residue.

POTENTIAL ENERGY SAVINGS

From Less Tillage and Less Fuel

PLANTING NONIRRIGATED WHEAT/BARLEY IN FALLOW SYSTEM

Approximately 3.3 gallons/acre of gasoline are used for conventional fallow where disk 3X and rodweeder 2X. About 2.0 gallons would be used for a reduced till system using chisel with sweeps 2X and rodweeder 1X. The no-till system uses chemical fallow with two spray operations using about 0.5 gallons.

PLANTING WHEAT/BARLEY AFTER CORN

Approximately 2.5 gallons/acre of gasoline are used for conventional till to chop cornstalks, disk 2X and harrow. Only about 0.7 gallons would be used under no-till to chop the cornstalks.

PLANTING BEANS OR GRAIN SORGHUM AFTER WHEAT/BARLEY

Approximately 2.8 gallons/acre of gasoline would be used for conventional till to disk 2X, harrow, and bedup. Only about 1.0 gallons would be used under no-till to bedup in the fall before planting the wheat or barley.

PLANTING RIDGE TILL CORN AFTER CORN

Approximately 6.2 gallons/acre of gasoline would be used to chop cornstalks, disk 2X, drag, and bedup. Only about 1.2 gallons would be needed using ridge till to chop cornstalks and rebuild beds.

LOWER HORSEPOWER TRACTORS NEEDED WITH LOWER MAINTENANCE COSTS

Ridge till corn used a 100 hp tractor instead of the 200 hp tractor normally used for plowing under conventional till on Tyler Island.

Kay-Dix Ranch in Walnut Grove no-tilled wheat into corn residue using a Duncan Multiseeder drill pulled with a 35 hp tractor compared to a 60 hp tractor needed for conventional seeding.

Kellogs's Seed Service in Chico estimated in 1984 that to farm 500 acres of rice and 100 acres of small grain would require about $555,000 invested in equipment. Only about $286,000 in equipment would have been needed if switched to no-till - about $446/acre less.

GETTING STARTED

Introduce interested growers to producers using conservation tillage for the same crops. Most growers like to talk about their experiences and they will give you shortcuts.

Interested growers need to start small by experimenting on 5 to 10 acres. Some people put this out of sight on the back 40. Be prepared to make adjustments for the first few seasons and then you can expand to more acres.

Best time to start is at harvest time. Residue management is the key and begins with harvest by chopping and uniformly distributing the straw and chaff. There are adapters for combines that will do this and will minimize most problems with next operation.

Encourage growers to work with Cooperative Extension and attend their Field Days and look at their research plots. Try to get them involved on some plots on your place.

Assist your local Resource Conservation District to sponsor a Conservation Tillage workshop or publicize where the nearest one will be held. Try to identify other growers using conservation tillage in your area. See if they will support a Conservation Field Trial to help demonstrate the new techniques and equipment.

Encourage growers to contact the local Soil Conservation Service Office and ask about conservation tillage work going on and see if they can use some of it in their conservation plan.

Become knowledgeable about the availability of cost-sharing regarding Agricultural Conservation Program practices SL-14 and SL-15 offered in many counties by the USDA Agricultural Stabilization and Conservation Service. This is normally a 3 year practice to help new growers get started with conservation tillage to control erosion.

Help growers use the **Conservation Tillage Worksheet for Residues** to plan a shift to conservation tillage and then help them use the **Conservation Tillage Worksheet for Fuel** to estimate their reduced energy requirements.

CA-CPA-WORKSHEET
9-90

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CONSERVATION TILLAGE WORKSHEET - RESIDUES FOR WATER EROSION CONTROL

FOR OWNER : _____

FIELD NUMBER: _____ CROP: _____

PREPARED BY : _____ DATE: _____

STEP 1 _____ Pounds of grain per acre x straw/grain ratio of _____ from Table 1 on back

= _____ Pounds of crop residue per acre after harvest.

= _____ Percent ground cover after harvest.

STEP 2 Residue ground cover requirement after planting for effective erosion control. = _____ Pounds/Acre or Percent Cover

Step 3 Present Tillage System

Date	Implement/Operation	Residue Remaining on Soil Surface 1/		Residue Left (lbs/Ac.) or Percent Cover
			=	
			=	
			=	
			=	
			=	
			=	
			=	
			=	
			=	

STEP 4 PROPOSED CONSERVATION TILLAGE SYSTEM

			=	
			=	
			=	
			=	
			=	
			=	
			=	
			=	
			=	

1/ Percentage figures from Table 2 on back expressed as a decimal.

RESULTS:

Answer from Step 2 (What you need) _____ Answer from Step 3 (What you have) _____ Answer from Step 4 (What you plan) _____

TABLE 1. DRY WEIGHT RATIO OF RESIDUE TO GRAIN FOR SELECTED CROPS

CROP	STRAW/GRAIN RATIO 1/
Alfalfa Hay (Full Bloom)	1.0
Barley (Irrigated)	1.5
(Nonirrigated)	1.0
(Milk Stage)	1.0
Beans, Dry	1.0
Corn, Field (Irrigated)	1.5
(Nonirrigated)	1.0
Cotton	1.0
Oats (Irrigated)	1.5
(Nonirrigated)	1.0
Peas (Irrigated)	1.0
Rice	1.5
Rye, Cereal	1.5
Safflower (Irrigated)	2.0
(Nonirrigated)	1.0
Sorghum, Grain (Irrigated)	1.5
(Nonirrigated)	1.0
Soybeans	1.5
Vetch (Full Bloom)	1.0
Wheat (Irrigated)	1.5
Winter (Nonirrigated)	1.7
Spring (Nonirrigated)	1.3

1/ Also called Residue Factor

TABLE 2. EFFECT OF TILLAGE ON CROP RESIDUES

Tillage Operation	Residue Remaining on Soil Surface (Percent)
Moldboard Plow (7" deep)	0-5
Blades (30" or wider)	90
V Sweeps (18" or wider)	80-90
V Sweeps (30" or wider)	90
Mulch Treader (spade tooth)	75-80
Rodweeder (with semi-chisels or shovels)	80-90
Rodweeder (plain rotary rod)	90-95
Heavy Duty Cultivator (16-22" sweeps)	85
Heavy Duty Cultivator (shovels and chisels 12" apart)	75
Field or Duckfoot Cultivator (shovels or sweeps 9" apart)	75-80
Heavy Tandem or Offset Disk	50
Disk (with depth control 3")	70
Disk set straight	90
Chisel (9-12")	75
Chisel Plows	65-75
Aqua Fertilizing Implement	75

CA-CPA-WORKSHEET
9-90

U.S. DEPARTMENT OF AGRICULTURE
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CONSERVATION TILLAGE WORKSHEET - FUEL

FOR OWNER : _____

FIELD NUMBER: _____ CROP: _____

PREPARED BY : _____ DATE: _____

STEP 1 - Present Tillage System

Implement	Trips	Fuel Type	Fuel/Trip Gal/Acre	Gallons/Acre Gasoline	Gallons/Acre Diesel
			Total Present Fuel Use:		

STEP 2 - PROPOSED CONSERVATION TILLAGE SYSTEM

			Total Proposed Fuel Use:		

STEP 3 - Change in Gasoline Use = _____

Change in Gasoline Costs @$_____ /Gal.= $_____

Change in Diesel Use ..... = _____

Change in Diesel Costs @$_____ /Gal.= $_____

STEP 4 - Total Change in Fuel Use = _____ Gal/Acre = _____%

Total Change in Fuel Costs ..... $_____ /Acre

FUEL REQUIRED FOR FIELD OPERATIONS

Field Operation	Gallons Per Acre	
	Gasoline	Diesel
Fertilization		
Spreading dry	0.20	0.15
Anhydrous Ammonia (30" rows)	0.80	0.60
Tillage		
Shredding Cornstalks	0.70	0.50
Moldboard Plow	2.70	1.90
Chisel Plow	1.70	1.20
Offset disc	1.35	0.95
Powered Rotary Tiller	2.30	1.60
Tandem disc, plowed field	1.00	0.70
Tandem disc, tilled field	0.85	0.60
Tandem disc, cornstalks	0.70	0.50
Field-cultivate, plowed field	1.15	0.80
Field-cultivate, tilled field	1.00	0.70
Springtooth harrow, plowed field	1.00	0.70
Springtooth harrow, tilled field	0.85	0.60
Pegtooth harrow, tilled field	0.45	0.30
Planting (30 inch row)		
Planter, seed only, tilled seedbed	0.65	0.45
Planter with fertilizer and pesticide and attachments, tilled seedbed	0.85	0.60
Till-planter (sweep)	0.85	0.60
No till planter (fluted Coulter)	0.70	0.50
Harrow-plant Combination	1.30	0.90
Rotary strip till-plant	1.50	1.05
Grain drill	0.50	0.35
Broadcast seeder	0.20	0.15
Weed Control (30 inch rows)		
Sprayer, trailer type	0.15	0.10
Rotary hoe	0.30	0.12
Sweep Cultivator	0.65	0.45
Rolling Cultivator	0.60	0.40
Cultivator with disc hillers	0.65	0.45
Powered rotary cultivator	1.00	0.70

Other Similar Operations You Want To Add:

Field Operation	Gallons Per Acre	
	Gasoline	Diesel
Harvesting		
Cutterbar mower	0.55	0.35
Mower-conditioner, pto	0.85	0.60
Self-propelled windrower	0.70	0.50
Rake	0.35	0.25
Baler	0.65	0.45
Stack-forming wagon	0.70	0.50
Forage harvester		
Green forage	1.35	0.95
Haylage	1.80	1.25
Corn silage	5.20	3.60
High moisture ground ear corn	2.75	1.90
Forage blower		
Green forage	0.30	0.35
Haylage	0.35	0.25
Corn Silage	2.00	1.40
High-moisture ground ear corn	0.65	0.45
Combine, soybeans	1.70	1.10
Combine, corn	2.35	1.60
Corn picker	1.75	1.15
Grain drying, corn	10.90	7.50
Hauling, field plus 1/2 mile on graveled road		
Green forage	0.55	0.35
Haylage	0.30	0.20
Corn Silage	2.00	1.40
Corn grain	0.30	0.20
Soybeans	0.12	0.08
Hauling, add following values to those above for each additional mile on gravel road		
Green forage	0.20	0.14
Haylage	0.30	0.20
Corn Silage	1.30	0.90
Corn grain	0.20	0.15
Soybeans	0.07	0.05

Other Harvesting Operations You Want To Add:

Iowa State University figures reported in Progressive Farmer, 11/80.

ENERGY REQUIREMENTS FOR VARIOUS TILLAGE IMPLEMENTS

Implement	Speed Mph	Type of Tillage	Energy Requirement * PTO Hp Hr/A	Consumption Gasoline ** Gallons/A	Consumption Diesel *** Gallons/A
Moldboard Plow (7" deep)	4	Primary	23.4	2.6	1.8
Chisel Plow 2" wide points (7" deep)	4	Primary	18.9	2.1	1.5
Oneway (18" to 20" disks)	4	Primary	10.0	1.1	0.8
		Secondary	13.6	1.5	1.0
Oneway (24" to 26" disks)	4	Primary	12.5	1.4	1.0
		Secondary	15.4	1.7	1.2
Heavy Tandem or Offset Disks	4	Primary	10.7	1.2	0.8
		Secondary	14.5	1.6	1.1
Field Cultivator (12" to 18") Sweeps	4	Primary	5.3	0.6	0.4
		Secondary	7.3	0.8	0.6
V Sweep (20" to 30" wide)	6	Primary	8.0	0.9	0.6
		Secondary	10.9	1.2	0.8
V Sweep (over 30" wide)	6	Primary	9.3	1.0	0.7
		Secondary	12.7	1.4	1.0
Mulcher Treader (spade tooth)	6	Secondary	4.0	0.4	0.3
Rodweeder (with semi-point chisel or shovel)	5	Secondary	8.5	0.9	0.7
Rodweeder (plain rotary rod)	5	Secondary	6.9	0.8	0.5

* Tractive Efficiency Factor included

** 9 hp hr/gallon

*** 13 hp hr/gallon

Compiled from EC-703. Cooperative Extension Service, South Dakota State University. 1975