

# ZONE TILLAGE SAVES ON TIME AND ENERGY

By W. A. LePori and H. N. Stapleton

*Cotton producers must lower production costs to remain competitive with producers of other fiber products. Energy and time inputs for machine operations are important in determining production costs.*

*Electrical energy is purchased in kilowatt-hours, which are recorded by meters, but energy required for field operations are not so easily determined. Horsepower-hours per acre is a term used to describe energy used in farming operations. It denotes the amount of work expended per acre by a machine doing a specific function.*

(Continued from Previous Page)

acre, compared to some 150 pounds on the native chaparral range.

Predominant species of chaparral is Scrub Liveoak, but also there is Mountain Mahogany, Desert Ceanothus and Skunkbush. Earliest native grasses in the spring are Squirreltail and Long-tongue Muttongrass. Later in the summer come the gramas — sideoats, black, blue and hairy — and three-awn.

The cattle used as the "consumer panel" for this research are weighed monthly. Results from one year of trials (May 1965 to May 1966) show cattle on grass gained .91 of a pound a day, those on native brushland .83, and those grazed half a year on the root-plowed and seeded pasture, May to November, and then the other half of the year on native pasture, November to May, gained the least, at an average of .70 of a pound per day.

## No Recommendations Yet

"It is too early, with just one year's results, for any final conclusions," Pond says firmly. "Certainly, we wouldn't want anyone to adapt any new practices on the basis of our brief experience.

"We are learning all the time, we are checking all the variables so our answers will be valid. But on the basis of rainfall alone, one year is very apt not to be typical of a long time average. That is why you will be getting only progress reports from us for the next few years — not any firm recommendations."

One of those progress reports was given at a field day in August, timed at the end of the month so the grass would be lush and the country green. With characteristic stubbornness, the weatherman didn't cooperate, and the field day came before the rains did. Barry Freeman, University of Arizona Extension Range Specialist, was master of ceremonies. An audience of less than 100 was highly receptive, but the sponsors of the field day were disappointed because the crowd was so small.

A few interesting findings:

1. Animals on the root-plowed pastures consumed 8 to 11 pounds of forage (oven-dry basis) per day, principally the Weeping Lovegrass, while animals on chaparral ate 4 to 6 pounds (oven-dry) per day, indicating that the rest of their diet was made up of browse from the chaparral.

Power is the time rate at which work is done and is often confused with energy. Energy can be considered independent of operating speed, but power varies with speed. For example, if an operation requires 50 tractor horsepower-hours per acre, theoretically a 50 horsepower tractor could complete an acre in one hour while a 25 horsepower tractor would take 2 hours per acre to do the same operation.

## Fuel Index to Energy

Fuel is the source of energy for tractor operations. Because of energy losses, much more fuel energy is consumed by the tractor than is used by implements. Energy is lost through exhausts, transmissions, slip, and rolling resistance. The ratio of implement drawbar energy to fuel input

(Continued on Next Page)

2. On root-plowed pastures with introduced grasses the animals gain weight for eight months of the year, from May through late November or December, while animals on chaparral gain weight for nine months, getting a month more of "gaining weather" in December or January, depending on the year.

3. The root plow kills about 75 percent of the oak chaparral. In one pasture the kill was made complete by using fenuron, a soil sterilant. In the other root-plowed pasture a very noticeable 25 percent of the shrub oak has reestablished itself.

4. While Lehman Lovegrass may be the introduced answer to southern Arizona ranges, it isn't cold-tolerant enough for the mile-high Yavapai County ranges.

5. Where degree of slope is equal, the root-plowed pastures absorb more runoff from rains. Apparently the disturbed soil, with depressions and uneven surface where the shrubs have been dislodged, allows water to stop and penetrate into the soil. As a contrast, in the native chaparral pastures, ground between shrubs is smooth and hard-surfaced, permitting runoff of surface water and poor penetration.

6. While root plowing, chaining, bulldozing, aerial spraying, burning and reseeding are all tools which man can — and does — use in trying to make native ranges more productive of nutritious forage, research is too sparse, terrain and other conditions too variable, for anyone today to come up with any quick and easy answer applicable generally.

The Forest Service people, at Tonto Springs and in all their work, have an earnest humility which invites cooperation from other federal and state agencies, with several represented at the field day in August. While the grazing animals used in this project are privately owned cattle, property of Lee Iles, permittee on the Contreras Allotment, the "laboratory" does include two fistulated steers provided by The University of Arizona and fistulated by its Animal Science Department, for rumen studies.

"We're learning," says Floyd Pond. "We hope in a few years to have information of considerable value to Arizona ranchers, answers which they can translate into dollars in their own ranching operations.

"Meanwhile we are doing this work carefully, keeping accurate records, making close observations of the animals and the forage they graze. And we are utilizing, too, the counsel and help which others contribute so graciously."

## Total Energy Inputs in Horsepower — Hours Per Acre

Machine System	Operations	Energy in HP-HR/Acre		Overall Efficiency %	Energy Input as % of Con. Sys.	
		Implement	Fuel Input		Implement	Fuel Input
<b>BROADCAST TILLAGE SYSTEM</b>						
Conventional	Disk	3.12	18.26	17.1		
	Plow	25.05	140.52	17.8		
	Disk	3.19	30.57	10.4		
	Float	6.39	44.74	14.3		
	List	6.78	51.37	13.2		
	Five Operations	44.53	285.46		100	100
<b>ZONE TILLAGE SYSTEMS</b>						
List only	One Operation	11.16	66.65	16.7	25	23
Shallow Chisel-List	One Operation	11.45	62.67	18.3	26	22
Medium Chisel-List	One Operation	13.27	82.41	16.1	30	29
Deep Chisel-List	Chisel	16.81	98.86	17.0		
	Chisel-List	15.28	102.52	14.9		
	Two Operations	32.09	201.38		72	71

(Continued from Previous Page)

energy provides an overall efficiency rating of the operation.

Present pre-plant tillage systems have been described as "broadcast" tillage systems. Entire fields of soil are worked to plowing depth and subsequently reworked in preparation for planting. "Zone" tillage is a new method of working soil zones in relation to the needs of the plant root system. Cotton plants have long tap roots. This suggests that the soil zone beneath the row requires more preparation than zones between the rows.

Zone tillage would be expected to require less energy and time than

broadcast tillage because the soil is worked less with fewer operations. If land preparation costs can be cut without reducing yield, the result will be increased profit. An experiment has been initiated to compare several tillage machine systems and the effect of these systems on yield.

### Zone Tillage Study

Fuel input energy, implement drawbar energy, and theoretical capacity were measured in a study of five tillage machine systems on The U of A Marana Experiment Farm while preparing land for the 1966 cotton crop. The five tillage machine systems were:

### Broadcast Tillage System

**Conventional**      shred stalks, disk, plow, disk, float, list.

### Zone Tillage Systems

**List only**            shred stalks, list.

**Shallow chisel-list**    shred stalks, chisel-list, (chisels run in old furrows 10-12 inches deep; new rows formed over chisel slots).

**Medium chisel-list**    shred stalks, chisel-list, (chisels run in old furrows 14-18 inches deep; new rows formed over chisel slots).

**Deep chisel-list**        shred stalks, pre-chisel 24 inches deep, chisel-list, (chisels run in old furrows, 18-20 inches deep; new rows formed over chisel slots).

## Energy Is Reduced

Fuel input energy, implement drawbar energy, and overall efficiencies of the different operations and systems are shown in our table. Plowing required more energy than any other single operation, and the conventional system required more energy than the other systems. Shallow chisel-list required only 22 percent of the fuel input energy required by the conventional system.

Overall efficiencies are also shown in the table. The overall efficiencies for disking, floating, and listing after plowing are lower than the efficiencies of other operations because the plowed soil increased rolling resistance and slip for these operations. The same was true for chisel-listing after pre-chiseling in the deep chisel-list system.

## Time Also Reduced

Capacity of a machine is the time rate at which a machine performs its function. Machine capacities are important because of labor costs and allowable time intervals for different operations. Time inputs per acre were computed from theoretical capacity measurements and included only time when the machine was operating in the row.

If lost time is assumed to be equal for all systems, time requirements can be compared. Plowing required more time than any other single operation, and the conventional system required more time than other systems. The time input in minutes per acre for the systems were: Conventional, 84; List only, 18; Shallow chisel-list, 17; Medium chisel-list, 22; and Deep chisel-list, 51. Shallow chisel-list required only 20 percent of the time required for the conventional system.

## Yields About the Same

Net profit is the final criteria for judging machine systems, and yield is important in determining net profit. To benefit financially from time and energy savings, yield level must be maintained. No significant differences in yield due to the tillage machine system have been found. Since the same yield level has been maintained, Zone Tillage provides a means of reducing land preparation costs, thereby increasing net profit.

Abstracted from Arizona Agricultural Experiment Station Technical paper No. 1113. Wayne LePori and H. N. Stapleton are, respectively, research associate and professor in the Department of Agricultural Engineering.