Role of Conservation Tillage in Production of a Wholesome Food Supply

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INTRODUCTION

Erosion of farmland continues to be a major conservation issue facing the United States today. Agricultural lands can lose many tons of valuable topsoil to wind and water erosion, as much as 20 large truckloads/yr from an average-sized farm. This much soil can change the course of a river, altering ecosystems by destroying fish spawning areas and preventing light from reaching aquatic life. In addition, eroded soil carries nutrients, pesticides, and other harmful chemicals into rivers and streams (Gallaher and Lauret, 1983).

Most of the Southern states have a high average annual rainfall and are subject to flash flooding. Erosion from rainfall is a major problem. While the flat lands of some areas such as in Florida, are less likely to erode, sandy soils and heavy rainfalls make erosion and related water quality problems a concern for farmers to deal with. A Best Management Practice, or BMP, which reduces soil erosion and protects water, while at the same time increasing land productivity and conserving fuel, is conservation tillage. The objectives of this paper are: 1) toprovide a review of conservation tillage management, 2) to present mformation on new emerging biotechnologies and equipment impacting conservation tillage, and 3) to provide information on changing trends in farmer adaptation.

DEFINITIONS

Conservation tillage - Any tillage and planting system that covers 30% or more of the soil surface with crop residue, after planting, to reduce soil erosion by water. Where soil erosion by wind is the primary concern, any system that maintains at least 1,000 lb/a of flat, small grain residue equivalent on the surface throughout the critical wind erosion period (Anonymous, 1996a). No-till, no-tillage, ridge-till, mulch-till, row-till (in-row subsoil no-tillage; drip-tillage), minimum tillage, etc. are examples (Anonymous, 1996b).

No-till - Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disk openers, in-row chisels, or roto-tillers. The soil is left undisturbed from planting to harvest except for nutrient or pesticide injection. Weed control is accomplished primarily with herbicides. Cultivation may be used for emergency weed control (Anonymous, 1996a; 1996b).

Ridge-till - Planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. The soil is left undisturbed from planting to harvest except for nutrient injection. Residue is left on the surface between ridges. Weed control is accomplished with herbicides and/or cultivation. Ridges are rebuilt during cultivation (Anonymous, 1996a; 1996b).

Mulch-till - The soil is disturbed prior to plantmg. Tillage tools such as chisels, field cultivators, disks, sweeps, or blades are used. Weed control is accomplished with herbicides and/or cultivation (Anonymous, 1996; 1996b).

Strip-till (Row-till or in-row subsoil no-till) - Planting is accomplished by use of a subsoil unit following in sequence after the no-tillage coulter. Subsoil depth is extended 2-in below the average hardpan layer. The subsoil slot is closed immediately with coulters or other appropriate devices following the subsoil units and in frontof the seed placement attachments. Approximately 3- to 6-in of bare soil seedbed is prepared over the row with minimum disturbance of crop residue between the rows. Injection of fertilizers and pesticides can be accomplished in the row area during the planting operation. The soil is usually left undisturbed from planting to harvest. Weed control is accomplished with herbicides and/or cultivation (Anonymous, 1996b; Gallaher and Lauret, 1983).

Reduced tillage/minimum tillage - Tillage types that leave 15-30% residue cover after planting or 500 to 999 lb/a small grain residue equivalent throughout the critical wind erosion period (Anonymous, 1996a; 1996b; Gallaher and Lauret, 1983; Gallaher, 1980).

Conventional tillage - Tillage types that Leave less than 15% residue cover after planting, or less than 500 lb/a of

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small grain residue equivalent throughout the critical erosion period. These types generally involves plowing or intensive tillage where seedbed preparation is by use of cultivation equipment such as harrows, moldboard plows, offset harrows, subsoilers and/or rippers (Anonymous, 1996a; 1996b; Gallaher and Lauret, 1983).

Multiple cropping - Intensive cropping *systems* where two or more crops/yr are grown on the same land area (Gallaher and Lauret, 1983).

Double cropping - A form of multiple cropping where two crops are grown on the same land area in one yr, usually in sequence, like wheat *(Triticum aestivum* L.) followed by soybean *(Glycine max* [L.]Merr) (Gallaher and Lauret, 1983).

CONSERVATION TILLAGE AND WATER QUALITY

Since conservation tillage disturbs less soil than conventional tillage, wind and water erosion is reduced (Langdale and Leonard, 1982). Conservation tillage is usually practiced in combination with multiple cropping where the second crop is planted in the residue of the first crop. This residue acts as a mulch to conserve moisture and protect soil (Gallaher, 1977).

THE BENEFITS OF CONSERVATION TILLAGE

Conservation tillage is well-suited to the South, especially in Florida's sandy and medium-textured soils. In addition to soil and water conservation, this farming method has several other benefits (Gallaher and Lauret, 1983): 1) fuel is saved because fewer trips over a field are necessary, 2) higher yields often result due to compatibility with multiple cropping, 3) land use is intensified since it is possible to plant a second or third cash crop without delay of elaborate seedbed preparation; 4) lower-cost land can be farmed because it is possible to plant row crops on sloping pasture land; 5) soil structure is improved near the soil surface due to organic material in residue, particularly if burning of residue is required under conventional tillage; 6) time and labor are saved throughout the season because of fewer field operations; 7) machinery costs are lower, since only one machine is required, and 8) stress of drought is reduced because a more vigorous root system is fostered, especially with in-row subsoil no-tillage systems (Gallaher, 1980; Gallaher and Lauret, 1983; Langdale and Moldenhaure, 1995; Anonymous, 1996a).

PROBLEMS

The risk that weed control will not be effective is a major drawback associated with conservation tillage. Herbicides often developed for use in conventional tillage have been adapted for control of grass and broadleaf weeds in conservation tillage management. Only in the last few years have new herbicides been developed specifically for conservation tillage systems. These new herbicides have lessened the weed control problem to a large extent Other disadvantages of conservation tillage are: 1) herbicides necessary to make conservation tillage a success may be costly; 2) some pests can be more troublesome because crop residues are a haven for breeding insects and diseases(A spraying program may have to accompany the practice of conservation tillage in some instrances); and 3) if farmers do not have up-to-date equipment they must plant about 10% more seed since seed may not be uniformly buried in rough seed beds. However, subsoiler attachments can alleviate this problem, as well as new planters specifically designed for conservation tillage.

HOW TO DO IT

Careful management of fertilizer is essential for the success of most conservation tillage cropping systems because, in most cases, fertilizer lies on the soil surface, not in it. However, with in-row subsoil planters it is possible to have greater precision of placement of fertilizers in the soil and at specific distances from the seed being planted. When legumes like soybean and peanut *(Arachis hypogaea* L.) are part of a multiple cropping operation, less fertilizer may be needed because the legume creates its own N, enriching the soil for the next crop as well. These legumes may also obtain recycled nutrients from the previously fertilized crop in the sequence. Data shows that many multiple cropping systems, dependmg on the soil type, can be fertilized effectively with a one-time application of lime, P and K in the fall. In extremely sandy soils, more fertilizer may need to be applied with the second crop as well.

Growers who opt for a conservation tillage/multiple cropping system sometimes need to step up their application of pesticides. The reduction of intervals between crops may not leave enough time for roots to decompose and cause root pests to flourish. On the other hand, selecting some cropping sequences may result in reductions of crop pests (Gallaher et al., 1988). Crop rotations have been used historically and continue to be used today to aid in control of pests (Gallaher et al., 1988; Gallaher et al., 1991; McSorley and Gallaher, 1994; 1995). Wise use of crop management strategy can result in reduced need of pesticides if proper selection of herbicides, insecticides, and nematicides are chosen.

CROPS FOR CONSERVATION TILLAGE

Soybean planted in small grain residue is the most widely used no-tillage double cropping system in the Southeast, and probably the world, among agronomic crops. In some areas of the United States, more than 50% of corn *(Zea mays* L.) and soybean are grown by conservation tillage (Anonymous, 1996). Generally speaking, the most common crop combinations are: 1) soybean, grain sorghum *(Sorghum bicolor* [L.] Moench), and forage crops following small grain (for grain); 2) field and pasture crops following corn; 3) corn, grain sorghum, and soybean following green manure crops, like vetch *(Vicia vilosa* L.), lupin *(Lupinus angustifoilus* L.), crimson clover *(Trifolium incurnatum* L.), and rye *(Secale cereale* L.); and 4) corn, soybean or grain sorghum following temporary winter pasture, like rye, oat *(Avena sativa* L.), and ryegrass *(Lolium* spp.) (Gallaher, 1980; Gallaher, 1981a; 1981b; Gallaher, 1989. Experimentation and some application is on-going with many other agronomic and horticultural crops such **as:** tobacco *(Nicotiana tabacum* L.), cotton *(Gossypium hirsutum* L.), squash *(Cucurbita pepo* L.), okra *(Hibiscus esculentus* L.), bushbean *(Phaseolus vulgaris* L.), sweet corn, and cowpea *(Vigna unguiculata* [L.]Walp.).

EQUIPMENT

The availability of planting equipment designed to operate underunplowed stubble or mulched conditions is another reason for the rising popularity of conservation tillage. Several makes of planters and drills are now on the market. A good planter and associated tractor can be adapted so that application of herbicides(s), insecticide, and fertilizer can be performed in a single pass over the field. Even with all the successes with conservation tillage there may be times when the moldboard plow will still have to be used. Past and present research indicate that elimination of conventional tillage may be possible, particularly with the in-row subsoil (row-till or strip-till) equipment. If tillage does become necessary, it is possible to plow part, say 25%, of the area over the row each year. Strip-tillage allows seedbed preparation over the row, while allowing crop residue to remain for conservation uses between the rows to offset the need to plow.

NEW BIOTECHNOLOGIES AND EQUIPMENT

New discoveries in biotechnology are quickly providing cultivars of crops that have been altered to be resistant to herbicides and other chemicals. New biotechnologies to be discussed in this presentation will include: 1) Roundup Ready (RR) crops (Woodruff, 1997) such as soybean and cotton, 2) Liberty Link corn, 3) *Bacillus thurgiensis* (Bt) technology, etc. Additionally, this presentation will include information on new equipment inventions, such as various versions of the hooded sprayer that allows the safe and effective use of previously unusable herbicides. These new and emerging technologies are having a significant impact on the ability to use conservation tillage management on previously difficult situations and thus providing for the conservation of our natural resources and a greater sustainable agriculture for the future.

ADOPTION OF CONSERVATION TILLAGE

It has been reported that there are 149.7 million a of highly erodible land in the U.S. Of this acreage, indications are that 127.2 million acres are currently reported as "adequately treated." Total U.S acreage in crop production was up in 1996. Total cropland planted in 1996 was 290.2 million a, compared to 278.6 million in 1995. The increased cropland acres planted in 1996 likely reflects land returned to production following the end of commodity-based, government set-aside programs.

Conventional-till gained 1.9 million a for a total of 115.5 million a in 1996. Over the last 8-yr, conservation tillage systems have experienced phenomenal growth. For example, in 1989 the U.S. had 71.7 million planted a of conservation tillage (25.7% of U.S.total). In 1996 conservation tillage had increased to 103.8 planted a (35.7% of U.S. total). The upward trend continued in 1996 over 1995. In 1996, no-till increased 2 million planted a for a total of 42.9 million a. Mulch-till gained 2.9 million a for a total of 57.5 million a. Ridge-till was unchanged at 3.4 million a. Reduced-till gained 4.7 million a for at total of 74.8 million a. Two of the Southem states are among the top five no-till states in the U.S., based on % of acres planted to no-till in 1996. These states are, number one Kentucky with 51% and number three Tennessee with 44%. The Southem states had a total of over 17.2 million conservation tillage planted a in 1996 (Anonymous, 1996a). New discoveries in biotechnology, equipment, and production research, education and communication efforts, and the continual improvement in the U.S. agricultural infrastructure, among all those involved with the production of a wholesome food supply, should keep this upward trend of conservation tillage planted acreage on the move.

Conservation tillage technology advancements are not only on the move in the U.S.A. but are also rapidly advancing in other parts of the world (Gallaher, 1981a; 1981b; 1989; Landers, 1996). One example is the Brazil, where in 1981 there were only a few thousand a of no-sage planted crops (Gallaher, 1981a) and today there are almost 14 million planted a (Landers, 1996). This same phenomenon is occurring in Canada, Australia, Europe, Africa, Asia, etc. As in the U.S.A., conservation tillage farmers all over the world are living in harmony with their environment and doing their part to not only provide a wholesome food supply for people today but also are providing for a more sustainable agriculture for future generation to come.

HOW TO GET HELP

Many types of conservation tillage require an innovative, highly skilled, and informed individuals who want to make the management work on their farm. Therefore, if you are considering conservation tillage, learn before, not after you make mistakes. Attend short courses, conferences, field days, and demonstrations. It is best to test conservation tillage, especially no-tillage, on a small scale acreage first. The USDA-Natural Resource Conservation Service (NRCS) in your district may know of conservation cost-share programs for small-scale learning. The USDA-NRCS can help with farm plans that include conservation tillage. The Farm Service Agency may be helpful as well. Major companies who manufacture conservation tillage equipment or make and sell products for conservation tillage management of weeds, insects, and diseases in cropping systems have college-trained personnel. These individuals can also provide expertise to those beginning into conservation tillage as well as those who are established conservation tillage producers.

Because planning is so important for successful conservation tillage management, you will benefit from guidance of your county Extension agent. The agent can advise you of the conservation tillage/multiple cropping system best suited to your land and crops. Several publications related to conservation tillage and multiple cropping are available through the county Extension service.

CONCLUSIONS

Conservation tillage is a BMP that guards water quality and controls erosion as well. For maximum conservation of soil and water, you may want to develop a conservation plan of BMPs that includes a conservation tillage/multiple cropping system. Your USDA-NRCS can assist in developing such a plan. Others in the farming infrastructure of research and extension can help solve and provide answers to make your operation successful. Industry is indispensable in this infrastructure as well. The seed, chemical, fertilizer, etc. industries have products and expertise to aid in your success with conservation tillage/multiple cropping systems. Utilizing knowledge from all of the partners involved with production of a wholesome food supply, while adopting conservation tillage management, will help ensure a greater sustainable agriculture for future generations.

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