TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

TN - AGRONOMY - 44 — JUNE 1987

BENEFITS OF CONSERVATION TILLAGE

On the next three pages is an article on "The Public Benefits of Conservation Tillage," fall 1986 issue of Resources. It was written by Pierre Crosson, senior fellow in the Resources for the Future, Renewable Resources Division.

There is some good background on what motivates growers to adopt conservation tillage. Emphasis is on off-farm impacts of conservation tillage.

The author does not believe loss of productivity is a major concern over the next fifty years. About a 5 percent loss in productivity would result in that time span if current erosion rates were to continue.

The question of conservation tillage systems using more pesticides than conventional till systems is also addressed.

Prepared by Walt Bunter, State Agronomist, Ecological Sciences Staff, Soil Conservation Service, Davis, California.

The public benefits of conservation tillage

Pierre Crosson

CONVENTIONAL TILLAGE, in which a moldboard plow lifts and turns the soil to prepare it for planting, buries most of the residue from the previous crop. Conservation tillage disturbs the soil less and leaves much of the residue on the soil surface. Because of this difference, erosion on sloping land generally occurs much less with conservation tillage than with conventional tillage.

Conservation tillage has been expanding rapidly in the United States since the early 1970s, although recently the rate of expansion has slowed. According to the Conservation Tillage Information Center, nearly one-third of planted cropland acres now benefit from some kind of conservation tillage, compared to almost none in 1970.

Although people argue at length about how best to define the set of farming practices generally known as conservation tillage, the Information Center's definition, used here, is widely accepted: conservation tillage is any tillage system that leaves not less than 30 percent surface residue cover after planting. The cover may be meadow, a winter cover crop, or a small grain or row crop. The Information Center distinguishes five types of conservation tillage, varying from no-till, in which crops are planted in slots in the otherwise unbroken soil, to reduced-till, a catchall that includes any system not among the other four and that meets the 30 percent residue requirement. Only about 3.5 percent of total planted acreage is in no-till, with some 27 percent in other forms of conservation tillage.

American farmers have adopted conservation tillage primarily because of its economic advantages. Compared to conventional tillage, it uses less labor and fuel and less expensive machinery. It may use more herbicides—no-till almost always does—but savings in other inputs more than offset higher herbicide costs. Where soils are not too wet, where weeds can be controlled by herbicides, and where the growing season is not too short, yields of conservation tillage compare favorably with those of conventional tillage. These conditions are widely met in the Cornbelt, and the five states in that region have about 30 percent of the nation's conservation-tilled land. Because conservation tillage conserves soil moisture it has a relative yield advantage in much of the semiarid Northern Plains, particularly in Kansas and Nebraska, where it has proved very popular. It also has caught on in the Southeast, especially in Georgia, because it permits double-cropping, thus increasing the economic return to the land.

Private and public interest

That many American farmers have discovered and adopted a new, more profitable technology must hearten anyone interested in the welfare of the nation's agriculture. But conservation tillage is of interest not only because it bestows private benefits on farmers, desirable though that is. If that were all there were to it, the play of private markets and private incentives could be depended on to spread the idea to those farmers who could profit from it. The resulting rate of adoption would be optimal both for farmers and for society. But there is a social interest in conservation tillage that transcends the farmers' interest. Consequently, the rate of adoption may be less than in the social interest it should be.

Reduced erosion is the main social benefit conferred by conservation tillage. The equation seems simple: compared to plow tillage the surface cover characteristic of conservation tillage reduces erosion by as much as 50 to 90 percent, with the heavier surface covers of no-till systems generally producing the largest reductions. But in what sense does reducing erosion convey social benefits beyond those the farmers receive? Do not farmers also gain from less erosion? How do these gains differ from the benefits both farmers and society receive from reduced labor, fuel, and machinery costs?

Reducing erosion gives two kinds of benefits, with important distinctions between them. One is the productivity of the soil saved. The other is the reduction in damages from eroded sediment after it leaves the farm—primarily less siltation and therefore longer life for reservoirs,

reduced risk of flooding, lower costs of removing sediment from municipal water supplies, undiminished recreational values, and damage avoided to biological systems.

Society has an interest in protecting the productivity of the land. But so does the farmer. For most farmers land is by far their most valuable single asset. If erosion reduces its productivity, the farmer loses capital value. Farmers are good business people, and if the erosion-induced loss of capital value exceeds the costs of controlling erosion, farmers will opt for control. Nevertheless, the amount of erosion control farmers undertake in their own interest may be inadequate to protect the long-term public interest in the productivity of the land.

It often is argued that farmers underinvest in soil conservation because they are unaware of erosion's effects on soil productivity, or because they are hard-pressed by high interest and other current costs and so cannot wait for the long-term benefits of erosion control, or because they just do not look beyond the next few years in making investment decisions. There are kernels of truth here, particularly concerning inadequate information about erosion's effects. But if one believes, as I do, that U.S. credit and land markets work reasonably well, then most of the time these sources of underinvestment probably are not very important.

The more compelling argument is that farmers react primarily to market signals and that these signals may not adequately represent the interests of future generations in protecting the productivity of the land. This is not to denigrate the role of markets in guiding farmers' investment decisions, but only to point out that markets have no responsibility for the welfare of future generations. Society does. To meet this responsibility, we as a society may decide that we need more erosion control to protect productivity than farmers will provide in their own interest. And conservation tillage, in many places, offers a cost-effective alternative for serving the public interest in erosion control.

Despite the emphasis in the news media on erosion's threat to the productivity of the soil, I do not believe that protecting productivity alone would justify the substantial public interest in conservation tillage. The reason is that current rates of erosion do not appear to present a major threat to soil productivity over the next century. Studies conducted by the U.S. Department of Agriculture (USDA) in connection with the 1985 Resource Conservation Appraisal, by soil scientists at the University of Minnesota, and by me show that if current rates of erosion continue over the next fifty to one hundred years, crop yields would be reduced only 5 percent or less. Unless the agricultural research establishment falls flat on its face in developing new technology, it easily should be possible to compensate for these erosion-induced yield losses. Not that we can forget about these losses: for some farmers and some regions they are and will be important. But in a national perspective they do not appear to present a major threat.

As it happens, however, the public interest in controlling erosion extends well beyond protecting soil productivity. According to a recent Conservation Foundation study, sediment damage now costs the nation somewhere between $3.4 billion and $12.9 billion annually; the most likely single estimate is $6.2 billion (1980 dollars). And these estimates do not even include sediment damage to biological systems, like fish-spawning areas.

Missing incentives

These sediment damages almost surely are substantially greater than are erosion-induced losses of soil productivity, and a strong case exists for public action to reduce them. Farmers have an incentive to protect the productivity of their land when they know it is threatened, but they lack an incentive to reduce sediment damages because they do not bear them. This is not to point an accusing finger at farmers. It simply is to state that they behave like the rest of us: in managing our economic affairs we are more sensitive to those things that affect us directly and less sensitive to those that do not. Indeed, it can be put more strongly than that. For the farmer, controlling erosion to reduce sediment damage off the farm is a matter of all cost and no benefit. Under these circumstances, how many among us would opt for control?

That sediment causes damage off the farm is a clear case of divergence between the private (farmer) interest and the public interest in controlling erosion. The great appeal of conservation tillage is that it offers a promising alternative for narrowing, if not eliminating, this divergence. The key is the economic advantages of conservation tillage under a wide variety of soil and climatic conditions. Responding to these advantages, farmers act in their own economic interest while at the same time serving the public interest in controlling erosion.

Several challenges must be met, however, if the nation is to achieve this happy convergence of private and public interest. One is to find ways to increase the economic attractiveness of conservation tillage on the nation's more erosive soils. Both the 1977 and the 1982 National Resource Inventories taken by the USDA's Soil Conservation Service revealed a large amount of conservation tillage on land with low inherent capacity to erode. This should not be surprising; farmers adopt conservation tillage because of its economic advantages, not its erosion-control benefits. But if conservation tillage is to serve the larger public interest, it must be widely adopted on land where erosion is a problem. On a small scale, the government now shares with farmers some of the costs of controlling erosion. But to achieve adequate control through cost-sharing would require more in public funds than the public is willing to accept. Undertaking research to make conservation tillage economical on more erosive soils almost certainly would be cheaper.

But not too much should be expected from this. The worst erosion occurs on only a small percentage—probably not more than 10 percent—of U.S. cropland, most of it steeply sloping and of low quality. Conservation tillage is not likely ever to be economical on this land. Indeed, from an erosion standpoint, it probably should not be in crops at all, and if the Conservation Reserve provisions of the 1985 farm bill work as planned, many of these acres will be taken out of crops. Apart from this worst 10 percent, however, there still is much good, but erosive, cropland where conservation tillage could make a difference.

More research also is needed to find ways to make conservation tillage profitable to farmers on poorly drained soils, in areas where perennial weeds are a problem and where the growing season is relatively short. (In the northern tier of states from the Dakotas east to Michigan, only 20 percent of cropland was in conservation tillage in 1983. With 20 percent of the nation's cropland, these states had only 13 percent of the total in conservation tillage.)

More chemicals?

Research aimed at broadening the present economic limits of conservation til-

lage, along with extension work to ensure that farmers get the results, will go a long way toward eliminating the divergence between the private and public interests in erosion control. But first an environmental challenge must be faced—the presumption that conservation tillage relies more on herbicides to control weeds than does conventional tillage. Some evidence suggests that conservation tillage also may require more insecticides, because the surface residue improves insect habitat. And it is sometimes argued that conservation tillage requires more fertilizer per acre.

Does conservation tillage in fact require more herbicides and other agricultural chemicals? And if so, does greater use of chemicals translate into higher environmental costs?

The USDA surveyed more than 2,600 fields planted to corn and soybeans that in the 1980 crop year were divided among no-till, reduced-till, and conventional-till. The survey found that no-till and reduced-till farmers did apply somewhat more herbicides per acre to corn and soybeans, but only in the Midwest, and only for no-till was the difference large enough to be statistically significant. No-till and reduced-till farmers also applied more insecticides and more fertilizer per acre than did conventional-till farmers, but only in the case of insecticides applied to no-till corn in the Midwest was the difference statistically significant.

The U.S. Environmental Protection Agency and the National Association of Conservation Districts jointly sponsored a study of counties located in the western basin of Lake Erie; the results showed that conservation-till farmers applied more fertilizer and herbicides to corn and soybeans. As in the USDA survey, however, the differences were small.

These studies support the presumption that, given the state of the art in the early 1980s, conservation tillage, particularly no-till, requires somewhat greater use of chemicals than does conventional tillage. Does this mean that the erosion-control benefits of conservation tillage are obtained only at high chemical costs to the quality of the environment? Not necessarily. Note first that, according to the USDA survey, all the differences in chemical use are too small to be statistically significant, except for no-till. Less than 4 percent of U.S. cropland is no-tilled, and no-till is expanding less rapidly than other forms of conservation tillage. Moreover, even with increased research it is unlikely that no-till will ever be used on more than a small percentage of cropland.

Second, because most phosphorus fertilizer bonds to the soil, reducing erosion tends to reduce phosphorus delivered off the farm. The Lake Erie region study confirmed this. Phosphorus is the principal culprit in stimulating eutrophication of lakes and reservoirs, and reducing its flow to watercourses is an important accomplishment.

Conservation tillage usually reduces run-off, but the environmental consequences of this are not certain. Although total run-off may be less, the concentration of nutrients in what does run off is higher because of the surface application of fertilizers. Thus, nitrate-nitrogen and soluble phosphorus leaving the field may be greater with conservation tillage even if the volume of run-off is less. Reduced run-off also generally means greater infiltration of water, which may carry nitrate-nitrogen and soluble pesticides to groundwater.

On balance, it appears to me that the risk of increased chemical damage from conservation tillage is acceptably small compared to the benefits from reduced erosion. But final judgment must be reserved. The evidence about chemical damage is incomplete and not entirely clear, and not all the ways that herbicides may affect the environment have been studied adequately.

In any event, today's course is clear. The research community should do the work needed to make conservation tillage economical on the more erosive land and at the same time step up research on the more subtle environmental impacts of herbicides. Conservation tillage is no panacea, but given research progress it can be a valuable instrument for serving the public interest both in erosion control and in a chemically less-risky environment. ■

Pierre Crosson is senior fellow in the RFF Renewable Resources Division. With Anthony T. Stout, he is the author of Productivity Effects of Cropland Erosion in the United States, *published by RFF in 1983.*