NO-TILL OF THE FUTURE

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Naisbitt (6) stated, "The most reliable way to anticipate the future is by understanding the present.'' To understand the present status of no-till, we must know where it is in relation to the past and know whether the trend is up or down. According to estimates from a survey conducted by No-Till Fanner, no-till in row crops increased from about 3.3 to 9.2 million acres, an increase of 179 percent, during the period from 1972 to 1982. The rate of adoption has accelerated in recent years. No-till of row crops increased by about 30 percent in 1981 and 16 percent during 1982.

It seems safe to predict that the upward trend in no-till will continue into the foreseeable future. The U.S.D.A., Office of Planning and Evaluation (9) estimated that 45 percent or 153 million acres of the total U.S. cropland will be under no-till by 2000. An estimated 65 percent of the seven major annual crops (corn, soybeans, sorghum, wheat, oats, barley, and rye) will be grown using no-till by 2000 and 78 percent by 2010. The level to which the use of no-till will rise depends on the future of the many factors affecting it.

This paper examines the major factors that are likely to shape the future of no-till. Factors discussed are (a) use of no-till for erosion control, (b) need for marginal land for production of row crops, (c) supply of fossil fuel energy and the need for its conservation, (d) developments in technology applicable to no-till, (e) governmental programs, and (f) possible environmental restrictions.

No-till for Erosion Control

Concern for soil erosion is not new, but public and farmer interest in the effects of soil erosion may be greater now than ever before. In a survey conducted in Iowa in 1981 by Wallaces Fanner, 91% of the farmers responding listed soil erosion control as a reason for changing to no-till. A survey conducted by the Chevron Company in the Southeast showed that fanners considered erosion control as the primary reason for using no-till.

Farmers are seeking soil erosion control practices that are economical, agronomically sound, and compatible with modern farming methods. No-till fits those requirements in many areas of the U.S. Not since the soil conservation movement of the 1930's has an agricultural practice been so widely acclaimed for its soil erosion control value as has no-till. It appears likely that emphasis on erosion control will continue well into the future. In fact, soil erosion control must be an integral part of soil management on every farm if the quality of our soil resource is to be protected and its productivity maintained.

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Need for Crop Production on Marginal Lands

Faced with surpluses of food and government efforts to decrease production, it may seem absurd to suggest the need to bring additional land into production. But, food surpluses have come and gone in the past, and so will these. World population and people's expectations will continue to increase, especially in developing countries. As we move toward a global economy, demand for food in any part of the world will expand production in our part of the world. As production is expanded, more of the land brought into production will be marginally suited or perhaps unsuited for row crop production under conventional tillage because of erosion hazard. Much of this land can be safely no-tilled in row crops.

Supply and Cost of Fossil Fuel Energy

Our present form of agriculture is highly dependent upon petroleum fuels. As petroleum decreases in abundance, its cost will increase. Farmers can moderate the effects of increasing energy costs by adopting practices that use energy more efficiently. No-till is such a practice. The fossil energy required to bring a crop of corn to the harvest stage (excluding fertilizers) was estimated at 7.7 gallons diesel fuel equivalent (DFE) per acre for conventional tillage and 4.1 for no-till. Offsetting some of the savings in fuel is the energy required for manufacturing the herbicides used, which is estimated at 2.9 gallons per acre DFE for no-till compared to 1.8 for conventional tillage (4).

Technological Developments in No-till

For no-till to continue its upward trend, technological developments must keep pace. Worsham (11) conducted a survey in which he asked Extension personnel in 25 states with the greatest corn acreages to identify areas that need more research to help make no-till corn successful. Areas listed six or more times were weed control (15), nutrient and low-temperature problems (12), insects (ll), adapted hybrids (8), cropping systems (7), and equipment (6).

Weed Control. Crosson (2) concluded that problems of weed control may limit the continued spread of conservation tillage more than any other factor. From a technological standpoint, probably the greatest need in this area is herbicides that can be surface applied and control troublesome weeds. Expansion of no-till and other forms of conservation tillage will create the market incentive to develop new herbicides that are more effective under the specific conditions of no-till. Therefore, progress will continue in new herbicides.

By understanding the life cycle of problem weeds and knowing when they are most vulnerable to herbicides, one can increase the effectiveness of weed control. This points out the need for continued involvement of weed scientists in developing no-till technology.

Soil Temperature. Low soil temperature caused by a mulch with no-till may delay planting in the central and northern U.S. Some delay in planting no-till compared to conventional tillage corn seems not to decrease yields, however, long delays will decrease yields, which will quickly negate any economic advantages of no-till. An optimum balance between the amount of mulch and the soil temperature may be impossible to attain in some areas. Thus, no-till with heavy mulch may not be practical in those areas or on wet soils in areas where no-till is more adaptable.

Soil water contributes to lower soil temperature, so a winter cover crop that is not killed until corn planting time may help warm-up soils that tend to be wet in the spring. Albedo of the mulch can also have a significant affect on soil temperature. Soil is warmer under dark-colored mulch.

Nutrient Problems. Most of the nutrient problems unique to no-till can be traced to four inherent characteristics--presence of mulch, low soil temperature, surface applied soil amendments, and lack of soil mixing. These characteristics are likely to contribute to immobilization of N fertilizer in the mulch layer, ammonia volatilization loss from surface-applied urea, slow mineralization of N and other nutrients, lower efficiency of lime and fertilizer when surface-applied, and accumulation of plant nutrients, organic matter and soil acidity in the surface 2 inches of soil (5). The high acidity may interfere with the activity of herbicides, resulting in poor weed control (8).

To obtain fertilizer efficiency to the extent that will probably be needed in the future, practical techniques for subsurface banding of fertilizers in no-till may be necessary. To avoid problems associated with lack of mixing of the soil, future no-till management may routinely include moldboard plowing every 4 to 6 years. Plowing periodically would also allow the farmer to capitalize on the nitrogen immobilized in organic matter, since plowing increases mineralization of nitrogen (3).

Insect and Disease Problems. Some insect and disease problems are intensified by no-till while others are reduced. Genetic resistance to diseases and insects will remain the most effective and economical control regardless of tillage. Where biological control is not effective, pesticides commonly used in conventional tillage are usually as effective under no-till (7).

Adapted Hybrids. Many crop varieties have been tested under the conditions of no-till, but little has been done to develop varieties with characteristics specifically suited to no-till. To accomplish this would require that plant breeders become involved in no-till research and would require better cooperation between plant breeders and soil management researchers. I believe that plant breeders will become more involved in no-till research programs, similar to the way in which weed scientists, entomologists, and plant pathologists have been involved for several years. Interdisciplinary research has the potential to solve more problems limiting no-till than anything else.

Cropping Systems. No-till has contributed to increased use of several higher intensity cropping systems. Perhaps the best known example of this is the double cropping of wheat and soybeans, which has increased phenomenally in acreage during the past few years and is expected to continue to increase. No-till is required in interseeding soybeans into winter wheat, a practice presently in the developmental stage. The use of legumes in various ways to provide nitrogen for no-till row crops will be an important part of future cropping systems if nitrogen fertilizer prices continue to increase relative to crop prices.

Phillips et al. (7) listed several ways in which no-till enhances high-intensity cropping systems, but the saving of time is probably the most important one. Not to be overlooked, however, is the fact that, under no-till, intensive cropping can be practiced over periods of several years with no apparent deterioration in soil quality (10).

Equipment. Equipment manufacturers have kept pace very well with technological growth in no-till. Developments in no-till planting equipment for corn, soybeans, small grains, and forage crops have been particularly encouraging. In the future, development of no-till planting equipment for other crops can be expected as the demand increases.

With recent and expected future developments in directed-spray equipment and post-herbicides, farmers may use less herbicides or use herbicides with lower residual activity knowing that they have the capability of using a post-directed application in case weed control is being lost. This will diminish two important disadvantages of no-tillage--the need for greater amounts of herbicides and the lack of the option to cultivate.

Other possible future needs include fertilizer placement equipment that will take advantage of the principles of improved fertilizer efficiency now being studied in no-till field experiments. These include improved placement of anhydrous ammonia and subsurface banding of all fertilizers.

Government Programs

Major influences from government on no-till will likely take three forms--incentive programs, research programs, and educational and technical assistance programs. The major incentive program will probably be cost-share payments for the use of conservation tillage to control soil erosion. This is being done to a limited extent in some cases already. Incentive payments to adopt no-till, which is likely to be more profitable than conventional tillage where adaptable, may seem to be a misuse of funds. However, in many cases no-till is far superior to some conservation practices now being supported. Furthermore, risks and uncertainty are likely to be higher for beginners in no-till farming; and, where the need exists but the practice is not as well adapted, incentive payments may be needed to prevent a decrease in income.

The Payment-In-Kind (PIK) program will have some "spin-off" effects on no-till when set-aside land that was planted to a cover crop is returned to row crop production. That will be the most opportune time for PIK participants who are not using no-till to adopt it. Since much set-aside land is erodible, no-till is the most sensible way to return it to crop production.

Possible Environmental Restrictions

The dependence of no-till upon herbicides is the single characteristic that makes it vulnerable to restrictions. Crosson (2) views the potential problems of increased use of herbicides as the greatest threat to the expansion of no-till. He raises the possibility that society through government regulations will limit the use of herbicides, thus restricting the spread of no-till. Society, he claims, will have to weigh the potential problems of increased use of herbicides associated with the spread of conservation tillage against the high social cost of soil erosion that would occur if conservation tillage is restricted.

Phillips et al. (7) stated that most pesticides used in no-till production of corn and soybeans move in the environment mainly by soil erosion. Thus, one would expect less movement of pesticides from no-till fields than from conventionally tilled fields. Furthermore, some herbicides are degraded to harmless products faster under no-till than under conventional tillage (8). Nevertheless, as pointed out by Crosson, there is no ground for complacency about either the excessive use of herbicides or increased soil erosion. Therefore, environmental safety must continue to be a prime consideration in tecnhological developments in the area of herbicides.

Conclusions

No-till is a system of conservation farming that offers many advantages over conventional tillage. It is a system of soil conservation that offers many advantages over several of the conventional soil conservation methods, particularly the earth-moving practices. It is compatible with modern farming practices and trends. It requires less labor, less fuel, and less and smaller machinery, all important considerations for a system of fanning with a future. I believe that history will say that the no-till system of crop production was one of the greatest agricultural developments of the last half of the twentith century.

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