The Future of No-Tillage

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It is sometimes assumed that the development of wonder chemicals will solve the problems that arise in no-tillage such as persistent or resistant weeds or the changes in weed ecology that come with the practice. It is difficult to be a prophet when one can hardly keep up with what is going on at the present time, but leaving the future of no-tillage to the mercy of expensive chemicals of the present or future does not seem reasonable to me. It does not seem reasonable for two reasons: First, the price of crops most adaptable to no-tillage is almost certain to remain low for the near future, barring a world-wide disaster. Even if we should control production in the United States, nobody else will, and we have real competition in many parts of the world. Second, the use of chemicals to control weeds has limits. These limits are exceeded when it is much cheaper to mechanically till than to spray herbicide, or when changing to another crop can give better weed control than that obtained with the present crop.

Therefore, my view of the future does not envision the salvation of no-tillage as resting on a research base of wonder chemicals. Instead, some old-fashioned principles will probably be more important. These principles are heavy ground mulch to suppress weeds (and for other benefits), crop competition with weeds and the use of rotations.

To study the future, let us go back and study the past. The first no-tillage I ever saw was in 1960 in southwest Virginia. It was corn, planted in a bluegrass sod, killed with the use of black plastic. The corn was planted using a soil sampling tube to cut little disks of sod out of the soil. And, It worked. With the dead sod, there was a good ground cover to suppress weeds and the corn itself was a good competitor against the weeds that did come.

As time went on, there were less and less pastures to plant corn into and a substitute was devised. This practice was to plant rye or wheat as a winter cover crop and kill it with paraquat in the spring. Corn was then planted in the residue. If there was often encroachment by trees or bushes, the bushhog was employed, and often became the best friend no-tillage would have. Later developments the corn-wheat-soybean rotation which has been successful, partly because it provides good natural ground cover (cornstalks and wheat stubble), and because it includes a crop where grasses can be fought, if not controlled (soybeans). Still later came the use of legume cover crops during the winter to suppress weeds and to provide at least some of the nitrogen needed by corn. In all these systems, control of weeds by competition is an important part. The competition is offered by the shade

of a tall plant such as corn, or by a thick-growing ground cover such as rye, wheat or vetch. In addition, the rotation of a broadleaf plant with members of the grass family allows some alternatives for chemical weed control. The rotation itself almost always gives a yield improvement to both crops. The reason for the effect is not truly understood, but as shown in table 1, it does exist. Table 1 shows average yields of corn with three covers under no-tillage. Where hairy vetch was used, yields were higher and the response to nitrogen was better as well.

So, it appears that in the past there has been success with good ground cover, crop shading and rotations. Earlier, it was suggested that most progress in the future would depend on these same principles. There is another factor involved also, which is why farmers accept no-tillage in the first place.

I have no formal study at hand, but in talking to hundreds of farmers, I would say that making money and/or saving money, time or work is, without doubt, the first consideration. Because time and work can be equated in some way with money, one would have to conclude that making or saving money is the primary consideration. A second reason, reducing erosion, is very secondary and is mentioned mostly because the Soil Conservation Service has done such a good job of brainwashing farmers for the past 50 years. A third reason, the effect of no-tillage on soil water, fertilizer efficiency, etc., exists mostly in the minds of technical workers. Most farmers never even consider these points and, in fact, do not know much about them even though working on them keeps us busy and paid.

Then, why do farmers abandon no-tillage? I suspect it is for the same primary reason; because it is not economically good for them. Hence, it seems to me, that we must concentrate, in the future, on no-tillage as seen from the farmer's point of view. If the other advantages of less erosion and incremental savings in soil water and fertility are obtained, so much the better. But, I rather doubt that no-tillage will survive on them alone.

Table 2 shows the returns to labor, management and land with a wheat-dry pea rotation with conventional and with no-tillage. Differences like these might conceivably lead to a certain stubbornness among farmers being courted with the no-tillage gospel. Looking at no-tillage strictly from the farmers' standpoint, what can we see?

First, we should see that if no-tillage costs more (or makes less) than conventional tillage, we can kiss it goodbye. I have just finished two-and-a-half years of work in the Dominican Republic where I worked on no-tillage, among other things. Table 3 shows some results with red beans in 1983. The results looked almost promising and farmers were interested. Decent weed control in beans required three herbicides, Roundup, Lorox and Prowl and they were slightly more costly than oxen and hoe-hands in the year 1983. By 1984, the Dominican peso had collapsed against the dollar and the price of herbicides changed rapidly, whereas the price of beans and the cost of labor moved up only slightly (they really moved down in dollar terms).

Thinking that the only way to keep a research program in no-tillage alive was to try something simple and cheap, I used paraquat on pigeon peas. Pigeon pea is a crop that grows tall and offers good competition to

weeds once it develops. The results (table 4) were very favorable when the price of Paraquat was low (1983). Because of the large yield increase, even when herbicide prices climbed, the chemical weed control was more profitable than that with machete.

There will be those who say that this is a small sample from an economically-stressed, postage stamp of a country and that it hardly applies in the United States. That is possible but doubtful. The attitude of Dominican farmers is no different from that of American farmers. Both groups want to make money or at least to survive. Both are generally in trouble with the banks. Both hate unnecessary work and try to produce crops as cheaply as they can. Both are afflicted with the disease known as "love of the land" and both think that next year, somehow, will be better than this year. Their motivations are about the same and their response to economic factors does not seem to be different than that of their North American neighbors.

If we can accept that a major reason for the growth of no-tillage has been economic and that there are basic physical requirements for no-tillage, then what does the future hold?

1. Climatic Restrictions: No-tillage will never dominate where water is so scarce that a natural cover (mulch) cannot be established pretty much for free. The crop produced for the cover will have to pay for itself and this will be difficult if the cost of water is charged mostly or completely to the crop used as cover. A perfect example would be wheat produced under irrigation so that a crop of corn or sorghum can be produced using the stubble as mulch. Unless the wheat yields are very high or unless the price of wheat rises magically, which it will not, the practice is not feasible.

Another climatic restriction is cold spring weather. The bad effect under no-tillage is related directly to the mulch which inhibits soil warming through color, insulation and higher soil water content. The very advantage of the mulch in summer is its principal disadvantage in the springtime. At what latitude will no-tillage stop and some form of limited tillage begin? No one really knows but there will be a consistent restraint on no-tillage where soil temperatures are low at planting time.

2. Weed Control Restrictions: As in the case of any other problem in farming, there are ways to control the problem of weeds. In this case, one is confronted with the need to control weeds and the means to control them chemically. The constraint is the cost of controlling them. There is a certain romance in dreaming of the wonder chemicals that will come to our aid and destroy our enemies, the weeds. It is just dreaming unless these chemicals cost about the same as say, 2,4-D, and they won't. They will cost a lot more.

How can the future be seen, then? We probably will rely more on crop competition, good ground cover and cheap, or relatively cheap chemicals for weed control. Added to this, rotation of crops will play a big part and the rotations will be much more varied than those that we have now. They will be designed to make money but they will have a secondary purpose of controlling problem weeds.

Take, for example, our old friend, Johnsongrass. It is always happy when corn is around because they both have about the same growth habit and because chemical weed control at an affordable price does not exist in a really infested field. One approach is to switch to soybeans and wipe the Johnsongrass with Roundup. Alternately, one could spray with one of the newer herbicides to kill the Johnsongrass. The truth is, however, that when corn comes again, there will appear much more Johnsongrass than anyone thought possible.

A different and perhaps cheaper approach is to plant the field to a hay crop for two years. Cutting the field regularly will cause the Johnsongrass great pain and sap it of much of its vitality. Cash money will have been saved, but will money have been made? That will depend on the yield and use of the hay crop. But at least it is an alternative and it provides a good mulch for no-tillage corn.

In the future, I believe we will see a lot more of this approach to weed problems. It is especially feasible when there is less incentive to plant every acre to basic grain crops, and other production alternatives become more attractive.

In the future, I believe that the use of post-planting sprayings will be even more important than it is at present. The products used will certainly include such time-tested products as 2,4-D and Paraquat, because they are cheap. For example, in place of trying to concoct a recipe at planting to control all possible weed disasters, it may make more sense to use post-planting sprays, directed or non-directed to control some weed problems. Using this system, the farmer has the possibility of saving a lot of money. The system takes observation, planning and timeliness but offers real advantages. For one thing, the farmer does his own planning instead of leaving it to the chemical companies or the experiment stations. For another thing, we might learn a lot from his successes and failures.

As with any other farm problem, our concern should be to resolve it as simply and cheaply as possible. Somehow, four herbicide-tank mixes do not seem simple to me and they certainly do not come cheap. Is it not likely that post-planting sprays are a viable alternative, especially if they can be used with relatively cheap chemicals?

3. Taking Advantage of Some Consequences of No-Tillage: No-tillage sometimes leads to the reappearance of woods. I remember well bushhogging a marginal field which had been in no-tillage corn and noting that the field had a nearly perfect stand of young ash. I have wished several times that I had just left it so that my grandchildren could have sold the trees in the year 20 something. It is probably an extreme notion, but for some fields or corners of fields it may make better sense than fighting nature. And, suppose it had been walnut.

Another idea, less romantic, is to take advantage of the increased organic matter and organic nitrogen content of the soil under no-tillage by plowing it and planting it to a high-value crop. This approach takes advantage of some free nitrogen, good soil structure and at the same time, allows one to give the weeds a good mechanical workout if they happen to be a problem. There generally will be very little erosion because the physical

characteristics of the soil will be excellent. It is much like using an old pasture soil and with similar advantages.

4. Not Being No-Tillage Fanatics: In the manner of most religious fanatics, we have sometimes been too severe with our critics when they question the use of more and more chemical control schemes simply so we can stick with our puristic notions of no-tillage. They may have a good point. There are other ways of controlling weeds besides the use of chemicals and they have a very long history of working. It may be time to consider a mixture of chemical, mechanical and competitive weed control in no-tillage. Perhaps that is what the future holds. If it does, it should not be a bad future, keeping in mind that using chemicals alone just to keep the faith pure is pretty foolish.

I hope the future will include more about how to mechanically control weeds without turning the soil. All these methods are basically variations on the theme of stubble mulching. One of the cleverest I have seen is an Argentine corn planter with duckfoot points which cuts the weeds just below the mulch cover. It seems to work well where there are no rocks or stumps. I also hope we can learn more about using competition to limit weed growth, whether it be by changing planting patterns or by turning to more impermeable ground mulches. There is a lot to be learned about this subject.

Summary

The principles which were important in the development of no-tillage in the first place are still important. They include crop competition, a good ground cover and rotations. The basic desire of the farmer to make money is also important. Because of these principles and the necessity for farmer survival, I have suggested that the future will have to look to the past. The no-tillage movement will have to pay more attention to these fundamentals and perhaps less attention to the siren songs of the new and expensive chemicals. Some have their place, but I doubt that they offer salvation to no-tillage. In the end, the basic principles are far more important.

References

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Table 1. Yields of corn under no-tillage with various cover crops (Ebelhar et al. 1982).

Cover	N Fertilizer, kg/ha 0	50	100
	grain yield, kg/ha		
Hairy Vetch	6410	6840	9040
Rye	4030	5720	7580
Corn Stalks	3790	5230	6820

Table 2. Returns to labor and management and land for a winter wheat-dry peas rotation of 445 ha, Palouse, Idaho-Washington (Hinman et al. 1983).

Conditions	Conventional Tillage Returns Labor&Mgt	Land	Total	No-Tillage Returns Labor&Mgt	Land	Total
Same Yield	$11,952	$37,301	$49,253	$2,074	$32,258	$34,332
Expected Yield Reduction	(same)	(same)	(same)	$20,185	$22,561	$ 3,454

Table 3. Yields, values, and production costs of conventional and no-tillage red beans in the Dominican Republic with 1983 and 1984 prices (average of three experiments).

	Conventional Tillage 1983	1984	No-Tillage 1983	1984
Yield, kg/ha	347	---	354	
Value RD$	473.20	788.00	482.70	804.50
costs				
Seed RD$	95.40	159.00	95.40	159.00
Land Prep & Weed Control RD$	151.00	199.00	165.60	522.60
Fertilizer RD$	33.30	89.70	33.30	89.70
Gross Net	193.60	340.30	186.40	33.20

Table 4. Yields, value, and production costs of pigeon peas in the Dominican Republic with 1983 and 1984 prices. Weeds controlled with paraquat or by machete (average of seven experiments).

	"Chapeo" with Machete 1983	1984	Paraquat 1983	1984
Yield,	1257	--	1899	--
Value RD$	553	636	835	961
Weed Control RD$	32	48	56	131
Picking RD$	56	84	84	126
Gross Net RD$	465	504	695	704