Reduced and Zero-Tillage Options

Reduced or zero-tillage systems are often found to generate higher yields, reduce production costs, and reduce erosion and other forms of land degradation, with corresponding benefits for the natural resource base. They improve environmental quality owing to less green house gas emissions and air pollution made possible by the reduced use of diesel fuel and stoppage of burning of residues (when planting could be done into surface mulch). It also ensures 25% saving in water. Many developed countries use these systems along with a whole system of mechanization to ensure good crop establishment, proper placement of fertilizer, and handling of crop residues. This is accompanied by a set of crop protection practices for handling weed, disease and pest problems.

In South Asia, reduced and zero-tillage practices for wheat after rice have been developed, though progress in the elaboration of complementary crop management practices is not as advanced as in developed countries. Nevertheless, farmers have already started to use some of these technologies. Zero-tillage for wheat after rice generally results in yields that are better than or equal to yields obtained using conventional practices.

Reduced and Zero-Tillage Options

- Surface seeding
- Reduced tillage with two- and four-wheel tractors
- Zero-tillage with four-wheel tractor
- Bed planting systems, particularly permanent beds

Surface Seeding

Surface seeding is the simplest method of zero-tillage system involving the placement of seed onto the soil surface without any land preparation. Farmers in parts of eastern India, Bangladesh and Nepal commonly use this practice to establish legumes and oilseeds and occasionally for wheat. Wheat seed is either broadcast before the rice crop is harvested (relay planted) or afterward.

The key to success with this system is having the correct level of soil moisture. Too little moisture will result in poor germination, and too much moisture will cause seed to rot. A saturated soil is best. The seed germinates into the moist soil and the roots follow the saturation fringe as it drains down the soil profile. High soil moisture reduces soil strength and thus eliminates the need for tillage, but at the same time the moisture level must not be too high, as oxygen is needed for healthy root growth.

Zero and reduced tillage can increase fertilizer efficiency because they enable wheat to be planted on time, but they can also be the cause of inefficiency when nitrogen has to be applied on the soil surface, and where nitrogen losses are high.

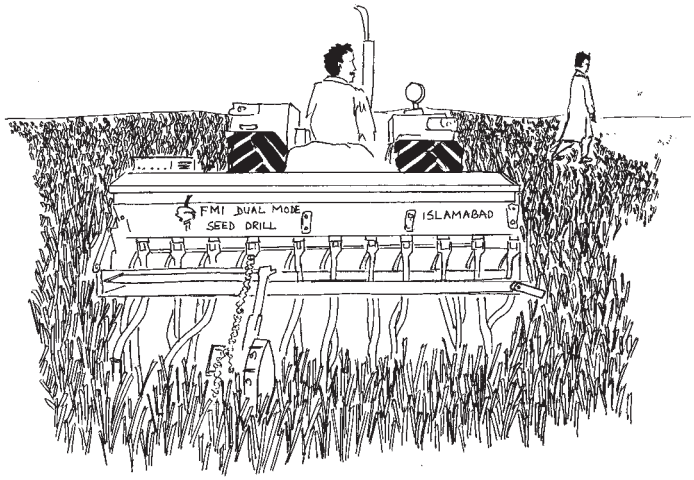
An early, light irrigation may be required. Some farmers who relay wheat into the standing rice crop place the cut rice bundles on the ground after harvest. This practice allows the rice to dry and also act as a mulch, keeping the soil surface moist and ensuring good wheat rooting. Young seedlings are also protected from birds. However, relay planting can be done only if the soil moisture is enough for planting at this stage.

Surface seeding gives significantly higher yield than that in the farmers' practice, and because the cost of land preparation is zero, surface seeding also generates higher net benefits.

There are benefits associated with delayed application of nitrogen in surface seeding which include higher efficiency of applied nitrogen, higher yield and better grain protein content.

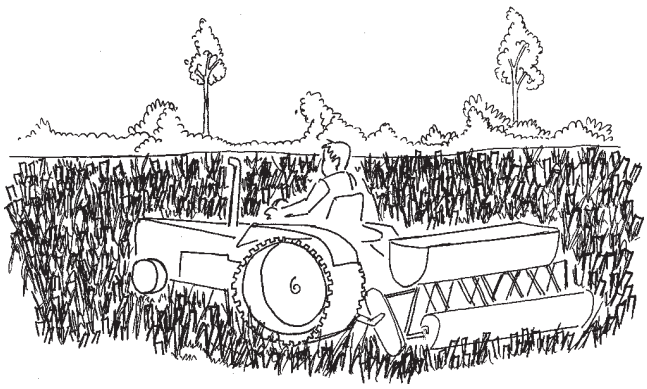
Reduced Tillage with Two-and Four-Wheel Tractors

Chinese scientists have developed a seeder for use with a 12 horse power, two-wheel diesel tractor that prepares the soil and plants the seed in one operation – even planting into standing rice stubble on heavy soils. This system consists of a shallow rotovator followed by a six-row seeding system and a roller for compaction of the soil.



As with surface-seeding practices, soil moisture was found to be critical in this reduced tillage system. The rotovator fluffs up the soil, which then dries out faster than when conventional land preparation technologies are used. The seeding coulter does not place the seed very deeply, so soil moisture must be high during seeding to ensure germination and root extension before the soil dries appreciably. This problem could be overcome by modifying the seed coulter to place the seed a little deeper.

One benefit of the two-wheel tractor is that it comes with many options for other farm operations; it includes a reaper, a rotary tiller, and a moldboard plow and it can also drive a mechanical thresher, winnowing fan, or pump. However, most farmers are attracted to the tractor because it can be hitched up to a trailer and used for transportation.

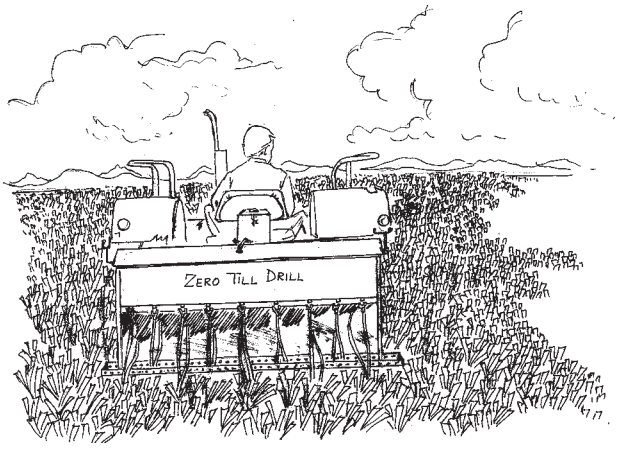


The main drawback of this technology at the moment is that the tractor and the various implements are not available in sufficient numbers.

In India, a four-wheel version of the two-wheel tractor is available. Engineers at Punjab Agricultural University, Ludhiana, India, have developed a "strip-till drill," which uses the same rotary land preparation and seeder combination described earlier but differs by tilling the soil in a strip into which the seed is planted, rather than tilling the whole area. The results have been encouraging.

Zero-Tillage with Four-Wheel Tractors

Zero-tillage may be defined as the placement of seed into the soil by a seed drill without prior land preparation. This technology was first tested in the higher yielding, more mechanized areas of northwestern India and Pakistan, where most land is now prepared with four-wheel tractors but recent work in eastern areas of India, Nepal and Bangladesh shows that it also has great potential in those areas especially if a two-wheel tractor or animal drawn implement can be developed. It can also be used for planting other crops like lentil, chickpea and even rice.



In the late 1980s, 34 zero-tillage trials were conducted on farmers' fields over three years in the rice-growing belt of the Pakistan Punjab. The implement used in these trials was a tractor-pulled seed and fertilizer drill with inverted-T openers. With this equipment, farmers could place the seed directly into the standing rice stubble without any land preparation.

As with the reduced tillage systems discussed previously, earlier planting is the main reason for the additional yields obtained under zero-tillage. In trials in Pakistan, zero-tilled plots were planted as close as possible to 20 November, the optimum date for planting wheat; the longer the farmer delays planting, the lower the yield.

Data from a Trial on Establishment of Wheat Following Rice
Bhairahawa Agricultural Farm, Nepal 1993-94

Method	Wheat yield (kg/ha)	1000-grain weight	Cost to plow (Rs/ha)	Net benefit (Rs/ha)	Extra days needed to plant[a]
Surface seeding	2,775a	46.11a	0	11,485a	0
Chinese seed drill	2,831a	45.43 b	600	12,090a	8
Farmers' practice	2,314b	40.87c	2300	8,065b	15

Note : Figures followed by the same letter are not significantly different at 5%probability using DMRT.
[a] Number of extra days needed for land preparation before seeding compared to the surface seeding

At Pantnagar University, India, engineers have modified the seed drill used to plant *rabi* (winter) wheat by replacing the old seed coulters with the new inverted-T openers that had been tested in Pakistan. This seeder is now being produced locally in India at a fraction of the cost of a similar, imported New Zealand drill.

Combine harvesting of wheat is becoming popular among farmers in northwestern India and Pakistan. A potential difficulty with this technology is that the inverted-T opener may not work well where combines are used, as the opener acts as a rake for the loose straw. In this case, various options need to be considered:

- Stubble can be burnt, as is presently done in most conventional systems. However, this creates environmental problems of air pollution and also results in a loss of organic matter.

Weed problems typically are more severe under conventional tillage than under zero-tillage. Longer-term research is needed to anticipate how changes in tillage practices may affect weed populations.

- A suitable trash drill, using some form of disk opener, can be developed. It could either take the form of disk cutters running ahead of the inverted-T openers or a new system of disk planters could be developed and tested. This implement would raise the weight and cost of the seeder, but it might still be within reach of some farmers, particularly those using combination for harvesting. Through the use of custom hiring, a common practice for resource-poor farmers without tractors for plowing, even these farmers can benefit from the new technology.

- The combination should be modified to chop the straw into small pieces before it leaves the machine and also distribute it evenly on the soil. These small pieces of straw would not interfere with the inverted-T openers and would leave a stubble mulch on the soil surface.

Adapted from:

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