

Possibilities of Zero Tillage for small-scale farmers in the tropics

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Zero tillage (or no-till, no-tillage, slot planting, ecofallow, sod planting, chemical fallow, or direct drilling) is a system of farming that uses herbicides or manual methods to control weeds and maintains crop residues on the soil surface. No seedbed is prepared; and planting is done with minimum soil disturbance, using coulters (iron blade fixed vertically in front of a plough share) or disk openers to cut residues and open a small slit for seed placement. Alternatively, seed can be placed in holes punched in the soil. The crop is not cultivated, and weeds are controlled chemically or manually.

The benefits ascribed to zero tillage systems include improved soil and water conservation, increased use of land, equal or higher crop yields, reduced labour and energy requirements, reduced equipment inventories, reduced wear and tear on tractors and equipment, and greater net returns. These benefits have been realized for various crops at numerous locations. However, adoption of zero tillage is limited by many constraints including those related to soil, climate, crop grown, equipment availability, managerial ability of the farmer, etc. Adoption of zero tillage undoubtedly is easier in developed countries where suitable equipment and herbicides are readily available, but the principles of zero tillage are just as applicable in developing countries.

Zero Tillage in the U.S.A. and other developed countries

Zero tillage in developed countries usually involves management of crop residues on the soil surface for controlling erosion and conserving water, the use of herbicides to control weeds, and the use of suitable equipment for spraying and planting. A common definition of zero tillage (no-tillage) specifies that 30 percent of the soil surface should be covered with residues at planting time. This implies that a greater amount would be left on the surface during the interval between crops. Where residues are limited (under dryland conditions and with some crops) and the potential for erosion is high, a limited tillage system may be necessary because both residue conservation and tillage to ridge or roughen the soil surface may be required to control erosion effectively.

Herbicides are used widely for weed control in developed countries, not only in zero tillage systems, but also in clean or conventional tillage systems. Consequently, herbicide usage often is not increased greatly when zero tillage is adopted. The substitution of herbicides for labour, fuel and machinery



Planting by hand in an alley cropping system. (From: Wyewardene, R.)

frequently increases economic returns to the farmer. Even greater economic returns result when zero tillage increases crop yields.

Zero tillage is most adaptable to soils having 1) a coarse-textured surface or a surface of self-mulching clay with high initial infiltration; 2) low susceptibility to compaction and crusting; 3) good internal drainage; 4) high biological activity; and 5) friable consistency over a wide range of water contents. Zero tillage is not adaptable to severely degraded soils or to soils that undergo severe hardening during dry seasons. On such soils, tillage is required to create a favourable zone for water infiltration, crop establishment, and root penetration. After several well-managed crops, it may be possible to grow subsequent crops on these soils with zero tillage.

Zero Tillage for small-scale farmers in the tropics

The principles of zero tillage are equally applicable to large- and small-scale operations; but in practice, small-scale farmers may not have the financial resources to acquire suitable equipment (sprayers and planters) and herbicides. Herbicides and specific types and sizes of equipment, however, are not prerequisites for successful zero tillage crop production by small-scale farmers. Zero tillage methods involving applied mulch, killed sod as mulch, live sod and alley cropping have been successfully used under small-scale farming conditions in the tropics. Each provides a residue cover for the soil surface, which is an essential component of successful zero tillage.

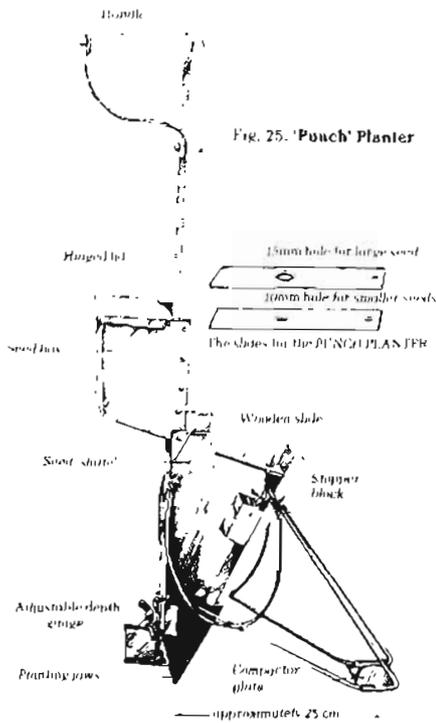


Fig. 25. 'Punch' Planter

*** Mulch farming**

Applied mulches may be residues from a previous crop or slashed and hoed weeds. The mulch helps erosion control, enhances water infiltration, suppresses evaporation, moderates soil temperatures and suppresses weed growth, all of which have potential for increasing crop yield. In mulch farming systems, weeds may be controlled by herbicides, but slashing or hoeing is generally satisfactory. In fact, weed control by slashing or hoeing probably would not be more difficult than in traditional farming systems. The drudgery of manual weed control can be reduced by using improved tools when weed growth is not excessive. If herbicides are used, the amount required can be reduced if rope-wick or controlled droplet applicators (CDA) are used. The use of a CDA also reduces the water requirement for spraying herbicides, with applications of less than 10 liters per hectare possible. Small battery-powered or hand-pulled CDAs are available.

*** Killed sod**

Zero tillage in a killed grass or legume sod involves herbicides to kill the sod. However, herbicides are not needed when susceptible sod plants die during



Use of the 'Punch' Planter. (From: Wyewardene, R.)

the dry season or are killed by frost. Crops can then be planted in the resultant surface mulch with a punch planter. Several hand-operated types are available. Subsequent weed control could be achieved by herbicides or manually, as for applied mulches.

*** Live mulch**

The use of zero tillage in a live mulch is possible if the mulch crop is not highly competitive with the planted crop for light, water, and nutrients. Favourable results were obtained when maize (*Zea mays*) was established in a low-growing legume (*Stylosanthes* sp.) that was either sprayed or mowed to suppress its growth. In some cases grasses or climbing legumes greatly reduced maize yields. The advantage of a live mulch is that it provides continuous ground cover and maintains favourable soil structure.

*** Alley cropping**

The foregoing examples involved residues from previous crops or those of in-place killed or live cover crops. Unfortunately, crop residues often are harvested for fuel or livestock feed in less developed countries. The remaining residues may be eaten by grazing animals or destroyed by termites or fire. Under such conditions, an alternative approach to zero tillage by providing mulch, maintaining ground cover, and providing soil fertility is alley cropping, also called alley farming or avenue cropping. With alley cropping, deep-rooted perennial shrubs or legume trees are grown in rows or strips far enough apart to permit crops to be grown between them. The shrubs or trees are pruned at the start of, and periodically during, the cropping season to minimize competition for light and water. The pruned leafy materials and twigs are used as mulch. Woody branches are used as fuel. The crop can be grown by zero tillage using either manual or herbicidal weed control. Weed problems often are not severe because the shrubs or trees shade the soil during the interval between crops and the surface mulch suppresses weed growth during the cropping season. The choice of an appropriate tree or shrub species depends on the soil, the climate, and the crop to be grown. Selected species should grow rapidly, be able to fix nitrogen, have a multipurpose nature (mulch, wood), and be deep-rooting to minimize competition with crop plants. Leguminous species that have performed favourably in an alley

cropping systems are *Leucaena leucocephala* and *Gliricidia* sp.

Summary and Conclusions

Zero tillage has received much attention throughout the world in recent years because of its various benefits. In developed countries, zero tillage depends on a surface residue mulch and herbicides for controlling weeds. Although used primarily in developed countries for relatively large-scale farming conditions, the principles of zero tillage apply equally well to small-scale farming operations in the tropics. In practice, zero tillage, especially on small farms in less developed countries, may be different because farmers may not have the resources to acquire suitable zero tillage planters or herbicides. However, these are not prerequisites for zero tillage because seeds can be planted in holes punched in soil and weeds can be controlled by slashing or hoeing. Surface residues can be provided by residues from previous crops, slashed or hoed weeds, killed or live sod, or from trees or shrubs in alley cropping systems. Although successful under many conditions, zero tillage has not proved successful under all conditions. While it may not be necessary or desirable to use zero tillage under some conditions, research should be continued to develop satisfactory zero tillage systems for situations where conservation of soil and water is important for maintaining the crop production capability of the land.

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