Shedding light on Conservation Agriculture

Everyone who works in tropical agriculture sooner or later starts to wonder whether the way we treat agricultural soils is the right one. Soil conservation has been taught and practised for a long time, yet agricultural soils continue to degrade and erode in the tropics and elsewhere. Conventional tillage, which depletes soil organic matter and creates the conditions for erosion is a major cause. By contrast, 'conservation agriculture', which dispenses with pre-plant soil preparation altogether, is gaining ground - literally.

What is the major difference between the two concepts of agriculture?

Conventional agriculture is the foundation of agricultural sciences. Within this concept, modern technologies like reduced tillage, zero tillage and direct planting are considered as practices that might prove to work under certain conditions. Usually, this understanding is reflected in expressions such as, "conservation tillage does not work everywhere and you need to use the plough every few years". Conservation agriculture questions the necessity for tillage in the first place. The scientific basis for this is as valid as for conventional agriculture but the conclusions drawn lead to different actions in practice. Soil under conservation agriculture may, for example, have higher bulk densities than a tilled conventional soil. This would normally be taken as a sign of compaction and yet the type and distribution of pores in the soil, and the higher average moisture content, allow better root penetration and water infiltration than on conventionally tilled soil.

For the outsider it might be confusing to draw the line between *conventional* agriculture (usually employing physical soil conservation works) and *conservation* agriculture. In fact a number of practices such as conservation tillage, minimum tillage and even zero tillage can be found in both systems. The main difference might be in the mind of the farmer: conventional farmers believe that they do something good and necessary by tilling and would eventually increase tillage if economically possible whereas conservation agriculturists feel uncomfortable whenever they have to force some steel into the soil and would try to avoid it the next time.

But is tillage really necessary?

There are some very obvious reasons to doubt this:

1. Nature shows that plant growth is possible without any soil tillage; otherwise all virgin lands would be deserts;
2. There is scientific evidence that water infiltration is highest on undisturbed soils provided the microclimatic soil conditions allow soil life to develop under permanent soil cover;
3. Under many conditions, experiments have shown that soil tillage causes physical degradation of soil structure.

There is a simple explanation to this: in a long term scenario of an undisturbed soil, comparable to a forest or a virgin savannah, the accumulation of a ground mulch cover protects and feeds intensive soil life, which then provides a stable and favourable soil structure and sufficient continuous deep-reaching macro-pores for improved water infiltration. This process can be called biological tillage. It builds up as mechanical tillage is reduced and it decreases with increasing mechanical tillage. Biological tillage increases significantly under zero tillage conditions and achieves a durable and sustainable soil structure. The structure-building effects of mechanical tillage often disappear after the first heavy rain, and biomass incorporated into soil disappears in a much shorter time than when it is left on the surface.

So if tillage is not necessary in the first place, why did people till at all?

The first agricultural intervention was a kind of no-till within a slash and burn agriculture, using a planting stick to make a hole for the seed. As agriculture became more intensive the seeding machines available allowed only a clean tillage approach to larger scale farming, as typified in Jethro Tull's eighteenth century classic "Horse Hoeing Husbandry". There was no other way to properly place the seeds into the soil and to control weeds on a larger scale.

In temperate climatic zones the detrimental effects of tillage were not as pronounced as in the tropics. Tillage produced warming of the soil in Spring and aeration; the latter caused mineralization and release of nutrients from soil organic matter which is high in most virgin soils. The yield was proportional to the intensity of tillage and from that time gave rise to the misbelief that tillage increases soil fertility. However, today there is sufficient scientific and practical evidence that conservation agriculture also works. Those farmers using the system for more than a decade report ongoing improvements in their yields. Where farmers have adopted the concept covering entire geographic areas, such as water catchments, general environmental improvements, including improved water quality and quantity and less air pollution, are visible to the naked eye. Scientists claim global advantages, for example through carbon sequestration and improved food security. This means in general terms that conservation agriculture can be considered as a win-win-win approach. It is now being applied on about 45 million ha around the world on all kinds of farm, from small peasant holdings to large commercial farms.

But if there are so many advantages to the system, why do not all farmers adopt it right away?

There are a number of reasons for this: first of all, the immediate benefits to the farmer are different according to his/her environmental and economic situation. In any case, changing the way of doing agriculture requires a lot of knowledge and a basic cultural change. How many people are willing and capable of taking this step? Changing the mind - what a farmer in Brazil called *mental compaction* - is usually a much bigger problem in the promotion and adoption of conservation agriculture than soil compaction.

What happens to disease, weed and other problems in conservation agriculture?

In addition to the general problems of adopting new techniques, there are still many situations with open questions in conservation agriculture. Conservation agriculture is fairly new and the practice is in the process of continuous development. So far, wherever serious attempts have been made to make it work, all problems (for example regarding weeds, pests and diseases, or the provision of forage for animals which would usually compete with the soil for residues) can be solved in relatively short order. Where conservation agriculture has been adopted on a massive scale, with good rotations and for a long time, it can be proven that weed and disease problems, and thus the use of agrochemicals, tend to decline and eventually reach levels below that of conventional agriculture. There are still open questions and problems to solve, and there will be more problems in future. Nevertheless, conservation agriculture has so far provided sustainable answers wherever it is applied, whereas conventional agriculture has, in much of the world, irreversibly destroyed agricultural land.

If we know that conventional agriculture invariably degrades cultivated soils then we have to have a different attitude to no-tillage and conservation agriculture. That attitude should be: I am going to face some problems when changing the system but, for the sake of sustainable land use, I have to find a way of solving the problems that will arise.

FAO conservation agriculture site: http://www.fao.org/ag/ags/agse/Main.htm