

DOES NO-TILL FARMING REQUIRE MORE HERBICIDES?*

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Keywords

herbicides, weed control, no-tillage, direct seeding, conservation agriculture

Introduction

In an increasingly competitive agricultural scenario, no-tillage farming systems are gaining growing attention worldwide. These are farming systems where no soil tillage is used, not even superficially. There are many benefits associated with these no-tillage systems, particularly economic advantages. In addition, environmental benefits are also attributed to no-tillage farming regarding soil structure, aquatic resources and positive effects through the storage of organic carbon, which, as carbon dioxide, acts in the atmosphere as a greenhouse gas. However, there is a general perception, that no-till farming systems require an increased amount of herbicides, as mechanical weed control and tillage is not a valid option for these systems. This increased use of herbicides is considered a major problem of no-till farming, particularly in a time when the use of agrochemicals is considered by the general public as threat for human health and the environment.



Photo 1. Sprayer with drift

“More” compared with...?

There is obviously a wide variety of no-till farming systems and so there is an equally wide variety of conventional tillage based agricultural systems. The use of herbicides is a common feature and widespread practice in many intensive farming systems. This applies equally to tillage based conventional farming as to no-till farming. Herbicides are a useful tool for weed management, particularly in the first years after shifting from conventional farming to no-till farming. It is much easier, to do no-till farming with herbicides than without.

If now no-till farming is introduced in an environment of traditional peasant farming, where no herbicides are used at all, these no-till farming systems will obviously use “more” herbicides than the traditional conventional systems. However, in many conventional systems herbicides are already frequently used and mechanical weed control has nearly disappeared in intensive farming. In such a system, the shift to no-till farming might not necessarily increase the use of herbicides dramatically. Even where it does increase the amount of active ingredient applied per area and year, the environmental impact is not necessarily worse, as often there is a shift from herbicides with relatively high environmental impact to other herbicides with less impact. Therefore, it is difficult to generalize and no-till farming systems might not always require more herbicides than conventional farming systems.

What are the conditions for increased herbicide use under no-till?

Nevertheless, most of the scientific literature shows that no-till farming does in fact require more herbicides than conventional systems comparing similar cropping systems. There is no doubt that there are significant areas under no-tillage systems, where herbicide overuse is creating environmental problems. These systems are characterized by monocultures and, in absence of soil tillage, by herbicide use being the only weed management strategy applied. These areas are the ultimate proof for the statement, that no-till farming uses more herbicides. Many of these areas are also cropped with genetically modified crops, which are resistant to a specific herbicide. Therefore, the herbicide use in these cases is restricted to a single product. However, under such a condition, even soil tillage would not really improve the herbicide use. Such cropping systems, with or without tillage, can be considered as not conforming to good agricultural practice.

* The views expressed in this paper are the personal opinion of the author and do not necessarily quote the official policy of FAO

What is the weed control effect of tillage?

Soil tillage has been developed for a number of reasons, such as to facilitate the preparation of a seedbed for a more efficient seeding. However, weed control has always been attributed to soil tillage and, particularly, the development of the mouldboard plough was very effective for weed management. But, in the long term, the weed control effect of tillage has proven to be insufficient and herbicides have become the tool of choice in intensive farming. The problem of tillage is that by creating a good seedbed for the seeds, it creates the same conditions for the weeds. While weed seeds are buried deeply with the mouldboard plough, the same plough brings to the surface the weed seeds that had been buried the season before. The seed bank in most agricultural soils is probably large enough that the plough does not have a long lasting control effect on weeds which multiply by seeds. On the other side, weeds propagating through sprouts or roots can even be multiplied by tillage implements, which only cut and mix them with the soil, so that the number of potential weed plants is increased. Through soil carried with tillage implements from one field to another, the weed population is also spread throughout the entire farmland. Therefore, the use of tillage for weed control is not the ultimate answer, nor is the move to no-till the ultimate doom in terms of weed control.

How can herbicide use be reduced?

This brings us back to herbicides. In all farming situations, not only in no-till farming, the use of herbicides can be reduced by applying the products correctly, using the right equipment with the appropriate settings under optimal conditions. Often the application of herbicide is done with even less care than the application of other pesticides, as herbicides are usually considered less toxic than, for example, insecticides. It leads then to increased application rates as the product is not reaching the target, but is wasted in the environment. This can become a problem, where herbicides have not been used traditionally and where, therefore, there is no appropriate equipment available for the application of herbicides once more intensive farming systems are introduced. For example, in the case of Uzbekistan, farmers start using the existing air blast sprayers, which are traditionally used for application of defoliant in cotton, for herbicide application (photo 2: Uzbek sprayer). Similar cases can be found in other Central Asian countries, such as Mongolia or Kazakhstan, where frequent cultivation of black fallow has been the only weed management strategy for the past few years and where the spray rigs are sometimes in very bad conditions (photo 3: badly maintained sprayer). In FAO projects carried out in these countries, the simple upgrade of existing sprayers with upgrade kits, comprising pumps, controls, hoses and nozzles, reduced the herbicide use compared to farmers practice before the upgrade by 10 to 15 % while the weed control efficiency was at the same time improved by 20 % to values above 90 % control (photo 4: upgraded sprayer).



Photo 2 Uzbek sprayer



Photo 3. Badly maintained sprayer



Photo 4. Upgraded sprayer

What are alternatives for weed management under no-till?

However, the main question remains, whether there are any alternative strategies for weed control that are applicable in

HERBICIDES AND NO-TILL FARMING

no-till farming systems and which would allow reducing the dependency on herbicides. There is actually a wide range of options and principles within a weed management strategy that allow managing weeds without tillage and herbicides.

This starts with a forward looking strategy of weed control, to avoid the maturation and seeding of weeds in the first place by not allowing weed growth even in the off season. Applying this strategy, the farmers in an FAO project in Kazakhstan noticed after only two years of no-till cropping without even using a diversified crop rotation that the weed pressure and, hence, the need for herbicide use was being reduced compared to the conventional tillage based systems.

Another general point is to determine, at which point weeds are actually damaging the crop. It is often not necessary to eradicate the weeds completely, but only to avoid the setting of seeds and competition with the crop. Leaving weeds in a crop at a stage where the crop can suppress them and where there is no damage or problem for the harvest can actually help with managing other pests, such as termites or ants, which in absence of weeds would damage the crop.

A second aspect comes from the soil tillage itself. Farmers who do no-till for several years will notice that weed germination is reduced where the soil is not touched. Once the superficial weed-seed bank is depleted and no new seeds are added, the other seeds still remaining in the soil will not germinate as they will not receive the light stimulus for germination. For this reason, the no-till planters from Brazil, for example, where no-till farming is reaching nearly 50 % of the total agricultural area, are designed to avoid any soil movement and to cover the seed slot immediately with mulch to create an “invisible” no-till seeding. This is done to reduce the emergence of weed seeds.



Photo 5. Invisible seeding

The most powerful no-tillage and non-chemical weed control in no-till systems, however, is soil cover and crop rotation. Maintaining the soil covered with an organic mulch or a live crop can allow, under certain conditions, no-till farming without using any herbicide. For this purpose, it

is important to know the allelopathic effects of cover crops. These effects result from substances in the plants which can suppress other plant growth. Cover crops are crops which can be grown between commercial crops to maintain permanent soil cover. Crop rotations have to be designed in such a way, that the soil is always covered and that the variety of crops in the rotation facilitates the management of weeds. For managing the cover crops, a knife roller is used, which breaks the plants and rolls them down (photo 6: knife



Photo 6. Knife roller

roller). Applied at the right time, this tool can actually kill some of the cover crops without need of herbicide and achieve complete weed control throughout the next cropping season, provided the planting is done with minimum soil movement. Applying a knife roller, for example, in a well developed cover crop of black oat (*Avena strigosa*) at milk stage, will completely kill the cover crop, which on the other side will provide good weed control. In Brazil after a cover crop of black oat, there is usually no additional herbicide applied for the following crop (photo 7: seeding into black oat). There is a lot of scientific and practical evidence that weed infestation under no-till farming using certain cover crops and diversified crop



Photo 7. Seeding into black oat



Photo 8. Maize and cowpea mixed cropping with excellent biomass production and good weed control in Swaziland without tillage and herbicides (photo Telmo Jorge Carneiro Amado)

rotations is declining in the long term, allowing a similar decline in herbicide use. Farmers using these principles of good agricultural practice in no-tillage systems report declining pesticide use in general, which also includes declining herbicide use at a level lower than comparable conventional systems.

Starting no-till farming with the establishment of good cover crops and a forward looking weed management allows the introduction of no-till farming in small holder farms in Africa without any herbicide use at all and with a reduction of manual weeding requirements. Spectacular effects were achieved in an FAO project in Swaziland using no chemical inputs and increasing both yields and reducing the drudgery of farm work by introducing a no-till farming system combined with permanent soil cover and crop rotation better known as Conservation Agriculture (photo 8: No-till crop without herbicides in Swaziland).

Conclusions

There is no question that herbicide use in agriculture and particularly in no-till farming systems can be a problem. There is plenty of scientific and practical evidence of excessive herbicide use in no-till farming. However, this is not an inherent characteristic of no-tillage farming, as there are alternative ways for weed management even without returning to soil tillage and cultivation. If correctly applied, these practices allow a sustainable use of herbicides in an integrated weed management programme and even completely non-chemical weed control is possible. These practices are already successfully applied in commercial farming, but globally they are not yet sufficiently known or appreciated. Therefore, the general perception remains that no-tillage farming requires increased herbicide rates, which in reality not true as a general statement.

Theodor Friedrich was educated at Göttingen University in Agricultural Sciences and Agricultural Engineering. His first overseas assignment was in Ecuador, where he supervised a project for Deutscher Entwicklungsdienst (DED). He later lectured in agricultural engineering in the tropics and subtropics at Göttingen University before becoming a GTZ-expert consultant in a number of different engineering and training programmes that took him to Pakistan, Nicaragua and Syria. In 1994, Theo took the position of Senior Agricultural Engineer in the Agricultural and Food Engineering Technologies Service (AGST) of FAO, in Rome; where he is particularly involved in mechanization for conservation agriculture and in standards and guidelines for agricultural pesticide application technologies, with experience in more than 50 countries in Africa, America, Asia, Australia and Europe.

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