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No-till: opportunities and challenges for cereal and oilseed growers

What is ‘no-till’?

No-till, also known as direct drilling or zero tillage (conservation tillage in the USA and Australia), means sowing directly into the residues of the previous crop without any prior topsoil loosening.

The objective of no-till is to reduce production costs, while maintaining or increasing yields (with possible added environmental benefits).

Figure 1. Direct-drilled winter wheat

Key points

- Climatic, soil and cropping differences markedly influence farm suitability for no-till
- Drier and more stable soils are most suited to no-till
- Look to operate one main establishment system but be flexible (it may be necessary to change system or cropping at short notice)
- Contract labour/machinery or share with neighbours to reduce costs
- Take care to minimise compaction, especially at harvest
- Maintain good soil conditions and control grass weeds
- No-till is not an easy option, as it demands commitment, time and patience
- Visit other farms or tillage demonstrations and learn from them

Advantages of no-till

– Opportunity to increase autumn-sown crop area
– High work rates and area capability
– Increased opportunities to carry traffic without soil damage (bearing capacity and trafficability)
– Drilling phased to take advantage of favourable weather conditions
– Stones not brought to the surface
– No compaction below plough furrow
– Reduced erosion, run-off and particulate P loss
– Reduced overall costs (fuel and machinery)
– Better retention of soil moisture in dry areas
– Increased biological activity, especially of earthworms

Disadvantages of no-till

– Unsuited to poorly drained or poorly structured soils, especially sandy soils
– Increased variability of crop yields, especially in wet seasons
– Crop establishment problems during very wet or very dry spells
– Increased grass weed control challenges (heavy reliance on glyphosate)
– Increased slug damage
– Risk of topsoil compaction
– Problems with eradicating residual plough pans
– Risks of increased N_2O (nitrous oxide) emissions and leaching of dissolved reactive P
– Unsuited to incorporation of solid manures
– Increased risk of fusarium mycotoxins (DON)

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Crop yields

No-till can give annual yields of combinable crops within five per cent (above and below) of those after ploughing but there is greater seasonal variability in yield. Potential yield-reducing factors include: Poor incorporation of crop residues; increased grass weeds and volunteers; and topsoil compaction (especially when associated with poor drainage).

Yields are most variable in the first or second year of no-till. Crop yields immediately after adopting no-till may be appreciably lower than after ploughing but tend to improve as soil structural conditions improve. Possible reasons for this initial decline in yield include:

– Compaction from previous harvest traffic, before soil strength and bearing capacity has increased
– Limited time for the build-up of soil structure-improving factors (eg accumulation of organic matter)
– Reduced nitrogen availability
– Lack of practical experience of no-till (equipment may need to be adjusted to suit land)

Winter-sown crops yield better than spring-sown crops. Soil conditions for spring-sown crops, particularly in wet areas, may be sub-optimal under no-till such that early growth can be delayed or reduced. No-till allows a greater area of winter crops to be established under good soil conditions than conventional ploughing.

Crop residues

A key feature of no-till is the presence of crop residues after drilling, usually 30-100 per cent of the surface being covered. **The quantity of crop residues left on the surface after harvest varies with different crops.** Crops such as legumes, sugar beet, oilseed rape and silage maize usually leave few residues on the surface after harvest. Cereals produce high levels of residues, with straw biomass approximately equal to grain yield. Winter cereals produce more biomass than their spring counterparts. Drills should be set to ensure that crop residues and the planted seed are not in close proximity. Otherwise, this can increase fungal contamination in wet conditions and delay germination as a result of poor soil-seed contact in dry conditions.

The lack of soil disturbance and presence of crop residues reduces the likelihood of soil erosion and run-off. The presence of crop residues keeps the soil cooler and wetter than bare ploughed soil, which can delay drilling of spring crops. Crop residues can affect the drilling operation and reduce the evaporation of water from the surface.

Cover crops

Cover crops play an important role in some no-till systems, particularly where spring cropping is practised. As well as immobilising residual soil nitrates present at harvest, they contribute organic matter to the soil, improving soil structure, and can enhance the biological activity of the soil. They also have a role in suppressing weeds and, where legumes are used, they also add nitrogen to the soil.

Figure 2. A cover crop

Soil suitability for no-till

No-till success varies with soil type. Soils with poor drainage and weak structure generally lead to lower yields with no-till than after ploughing, especially for spring-sown barley after wet winters. Stable-structured (compaction resistant) soils, such as self-mulching calcareous clays, in lower rainfall areas are more likely to be suitable for no-till than weakly structured or slower-draining soils in wetter areas.

Good internal drainage is required for reliable success with no-till but sandy and sandy loam soils, especially if low in organic matter, may lack the ability to acquire a stabilised structure.

Soil response to no-till

No-till dramatically changes the soil environment. Organic matter accumulates near the soil surface so that structural stability (resistance to erosion) and biological activity increase; this may lead to a reduced N requirement after several seasons. Soils may show self-mulching at the surface, especially when calcareous. A stable system of vertically oriented pores and cracks may develop due to increased earthworm activity and the presence of stable root channels. This can develop greater water permeability.

The lack of disturbance causes bulk density to increase in the top 25cm of soil. This can permit faster field work but can also lead to poor aeration and cooler, wetter conditions at the surface which delay drilling in spring. Acidity and the content of phosphate may increase near the surface leading to risks of nutrient loss, if run-off occurs.

Figure 3. Direct drill discs and drill

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Changes in some properties after the introduction of no-till may be within a few months (bulk density, soil strength) or take several years (organic matter).

Environmental effects of no-till

The widespread use of glyphosate in no-till practice does not appear to be an environmental problem but other herbicides are less strongly adsorbed on the soil and the presence of large macropores in no-till soil profiles may increase the risk of herbicide leaching.

The lack of soil disturbance and presence of crop residues reduces the likelihood of soil erosion and run-off with loss of particulate P. No-till is, therefore, a good means of reducing the risk of nutrient losses by run-off from slopes adjacent to freshwater bodies prone to eutrophication. There is no clear evidence that no-till influences nitrate leaching.

Earthworm populations are higher under no-till than under ploughing and increase with the duration of no-till. The casting activity of earthworms below the soil surface contributes to greater aggregate stability, especially at about 12cm depth in no-till soils.

Greenhouse gas emissions and fuel usage

Emission of the greenhouse gases N_2O (nitrous oxide) and CO_2 (carbon dioxide) from no-till soils is highly variable, but the emissions from fuel usage are substantially reduced. Carbon sequestration tends not to increase to depth with no-till but it does increase near the surface (0-30cm), improving soil structure and nutrient cycling. Higher greenhouse gas emissions, particularly N_2O, on poorly drained soils may counterbalance greater carbon sequestration so that no-till may have a negative effect on carbon footprinting.

Fuel consumption under no-till is invariably less than under conventional ploughing, though the difference will depend strongly on the soil type, the depth of ploughing and secondary cultivations. Potential fuel savings, on an average fuel consumption of 43l/ha under a ploughing system, range from 50 to 80 per cent.

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Pests

There is evidence that pests can be fewer under no-till conditions because of increased numbers of predators. However, the presence of crop residues on the soil surface, particularly in wet conditions, tends to increase slug populations, causing damage to young seedlings.

Diseases

No-till can lead to more crop debris on the surface, compared with more disruptive cultivations, and this can alter disease pressures. The risk of fusarium, ergot and sclerotinia will be higher under no-till; in contrast, the risk from eyespot will be reduced. Where the survivability of volunteer cereals is increased under no-till, these volunteers can act as a ‘green bridge’ from one season to the next for rusts and mildew.

Weeds

Weed populations under no-till show marked differences from those after ploughing, with previously unimportant weeds often becoming dominant. No-till tends to increase grass weeds and volunteer cereals because their seeds are retained near the soil surface where they can readily germinate. Black-grass and sterile brome can be particularly hard to control. Perennial grass weeds, such as couch grass, are also likely to increase under no-till. Populations of broad-leaved weeds tend to be similar under no-till to those under ploughing. Their control will depend on the dormancy levels and good weed management in the crop.

Rotations and cover crops are considered to be essential components of reducing weed problems and the dependence on herbicide use in no-till systems. Widespread adoption of no-till has led to glyphosate resistance in weeds in Australia and the USA. The shading provided by a heavy layer of crop residues with no-till can inhibit germination and early growth of weeds on the soil surface.

Note: After the use of some persistent herbicides there is a need to plough or deep-cultivate to avoid damaging the following crop.

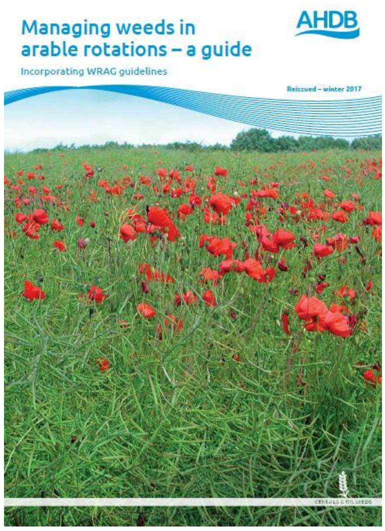

*Figure 4. The AHDB **Managing weeds in arable rotations** publication includes information on cultivation options and the effect on the weed seedbank*

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