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# TILLAGE, MICROBIAL BIOMASS AND SOIL BIOLOGICAL FERTILITY

Biology

## Key points

- An experiment tested the observation by farmers that low disturbance tillage increases total organic carbon in soil.
- Rotary tillage decreased total organic carbon and labile organic carbon. Such losses could lead to degradation of soil structure and ultimately to a decline in productivity.
- No-tillage and conservation tillage increased microbial biomass carbon and microbial activity. This indicates that less intensive cultivation may favour sustained microbial function in soil.
- Although no-tillage and conservation tillage were similar they may become different in the longer term.

## The experiment

In the mid 1990s, no-till farmers called for an experiment to test anecdotal evidence that low disturbance tillage increased total organic carbon in soil.

The seven-year experiment was conducted on a deep sand near Wongan Hills in Western Australia under a lupin/wheat rotation. The experiment compared the effect of three tillage types on total organic carbon, soil microorganisms and crop yields:

- **no-tillage**—no soil disturbance other than seeding
- **conservation tillage**—a single pass before seeding with 13 cm wide tines to a depth of approximately 7.5 cm
- **rotary tillage**—a single intense cultivation, before seeding, to a depth of 8 cm using a rotary hoe.

## Total organic carbon

Total organic carbon is a measure of the carbon contained within soil organic matter. Low levels can indicate that there might be problems with unstable soil structure, low cation exchange capacity and nutrient turnover (see Total Organic Carbon fact sheet).

After seven years, total organic carbon had increased by 4.4 t/ha under no-tillage and by 2.6 t/ha under conservation tillage (figure 1), but had decreased by 0.5 t/ha under rotary tillage.

## Light fraction organic carbon

Light fraction organic carbon decreased as tillage became more intensive. Light fraction organic carbon consists of more recent inputs of organic matter. It responds more quickly to management than total organic carbon and better reflects changes in soil microbiology.

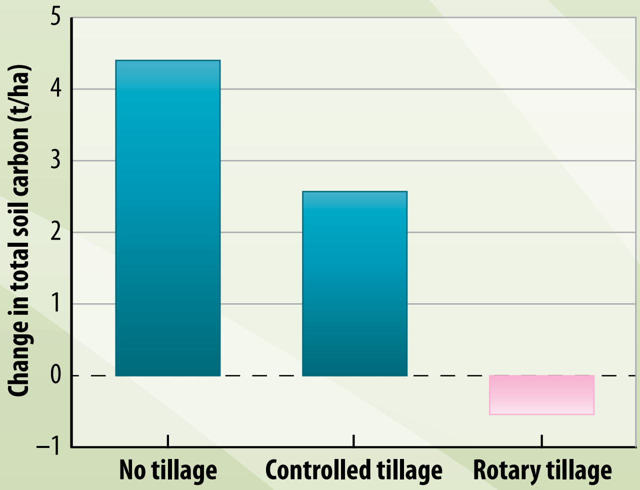


***Figure 1:*** *Change in total soil carbon content in 0–10 cm of soil 1998–2004 in crops under three tillage regimes. Treatments with different coloured shading are significantly different (P=0.05).*

By the end of the experiment, light fraction organic carbon in the top 10 cm was 0.83 t/ha under no-tillage, 0.73 t/ha under conservation tillage and 0.46 t/ha under rotary tillage.

This may indicate that less intensively tilled soils are more biologically active, have higher potential for nutrient turnover and that total organic carbon will increase further in the future.

## Soil microorganisms

Microbial biomass carbon is a measure of the mass of carbon in the microorganisms in soil (see Microbial Biomass fact sheet). Microbial biomass carbon in 0–5 cm soil decreased under rotary tillage compared to no-tillage and conservation tillage (figure 2).

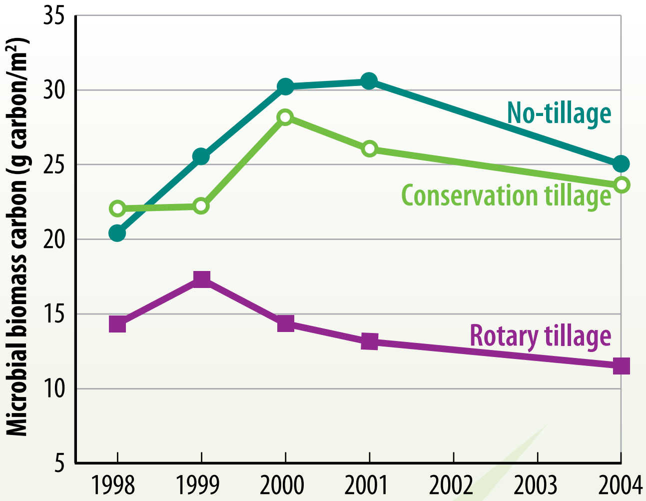


***Figure 2:*** *Microbial biomass carbon in 0–5 cm of cropped soil under three tillage regimes. .*

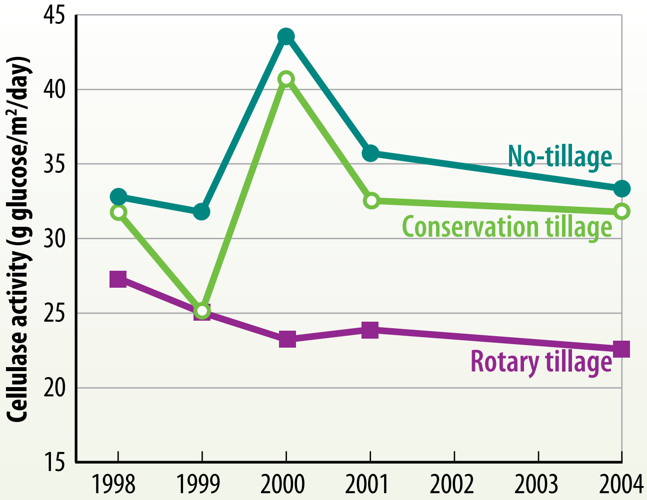


***Figure 3:*** *Activity of the microbial enzyme cellulase in 0–5 cm of cropped soil under three tillage regimes.*

Microbial biomass nitrogen was also higher under no-tillage and conservation tillage than under rotary tillage. By the end of the experiment, microbial biomass nitrogen under no-tillage and conservation tillage was 31% higher than under rotary tillage.

Tillage also decreased microbial activity in soil. The activity of the microbial enzyme cellulase in 0–5 cm soil was higher under no-tillage and conservation tillage than rotary tillage (figure 3).

## Crop yields

Tillage practice did not affect crop yields except in a single year of the trial. In 2003, lupin grain yields were higher under no-tillage (2 t/ha) and conservation tillage (1.9 t/ha) than under rotary tillage (1.6 t/ha).

Although tillage did not affect wheat grain yield, it did affect the incidence of Rhizoctonia bare patch caused by *Rhizoctonia solani* (see Rhizoctonia fact sheet). Wheat plants grown under both no-tillage and conventional tillage were more visibly affected by Rhizoctonia bare patch than wheat plants grown under rotary tillage (figure 4).

***Figure 4:*** *Rhizoctonia bare patches are more visible in wheat seedlings under no-tillage (right) and conservation tillage (centre) than under rotary tillage (left) (image: M Roper).*

## Further reading and references


Roper MM, Gupta VVSR and Murphy DV (2010) 'Tillage practices altered labile soil organic carbon and microbial function without affecting crop yields', *Australian Journal of Soil Research*, **48:** 274–285.

Cookson WR, Murphy DV and Roper MM (2008) 'Characterizing the relationships between soil organic matter components and microbial function and composition along a tillage disturbance gradient', *Soil Biology & Biochemistry* **40:** 763–777.



*Authors:* **Margaret Roper** (CSIRO), **Jennifer Carson** (Ghost Media) and **Daniel Murphy** (University of Western Australia)



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