times and biologically-friendly fertilisers are used rather than products with anti-microbial effects.

A change from annual to perennial groundcover can double levels of soil carbon in a relatively short time. This is not surprising, given photosynthesis and the 'mycorrhizal carbon highway' are the most important drivers for soil building.

Pasture cropping

Photosynthesis occurs for a much greater portion of the year in perennial pastures. Further, the permanent presence of a living host provides a reliable supply of soluble carbon and suitable habitat for colonisation by mycorrhizal fungi.

The practice of pasture cropping, where an annual crop (preferably sown without herbicide) is grown out-of-phase with perennial pasture, can result in higher rates of soil building than under perennial pasture alone.

This may be due to year-round transfer of soluble carbon to the root-zone and maintenance of the humification process in the non-growth period of the perennial.

Interestingly, the growth of an annual crop planted out of phase with a perennial pasture can also be equal to, or better than, the growth of an annual crop planted alone.

This may reflect higher levels of biological activity, improved soil structure, enhanced nutrition, water balance advantages (such as hydraulic lift and hydraulic redistribution) and microclimate benefits attendant upon co-existence with perennials.

Such benefits are not available to annual crops or pastures grown in the absence of perennials. Indeed, where perennial groundcover is inadequate, soils frequently deteriorate, leading to problems with structure, sodicity, waterlogging, mineral imbalance, salinity, erosion and colonisation by weeds.

Although there is clear evidence that both annual crops and perennial pastures can benefit from being appropriately combined in a mutualistic fashion, it will take time to ascertain the best species combinations for varying soils encountered across the cropping zones of eastern, southern and western Australia.

To date, the stand-out perennial grass for pasture cropping has been Gatton Panic, which grows in a surprisingly wide range of environments ranging from central Queensland through northern, eastern and central NSW, Victoria, and the southern, central and northern agricultural regions of Western Australia.

The leaves and stems of Gatton Panic contain several naturally occurring nitrogen-fixing endophytes, which appear to help with crop nutrition.

Soil C lifts markedly

Under appropriate conditions, 40%-60% of carbon fixed in green leaves can be transferred to soil and rapidly humified, resulting in rates of soil carbon sequestration in the order of five to 20 tonnes of CO_2 per hectare per year.

In some instances, soil carbon sequestration rates above 20 tonnes of CO_2 per hectare per year have been recorded where there were virtually no 'biomass inputs', suggesting the mycorrhizal carbon highway was the primary mechanism for soil building.

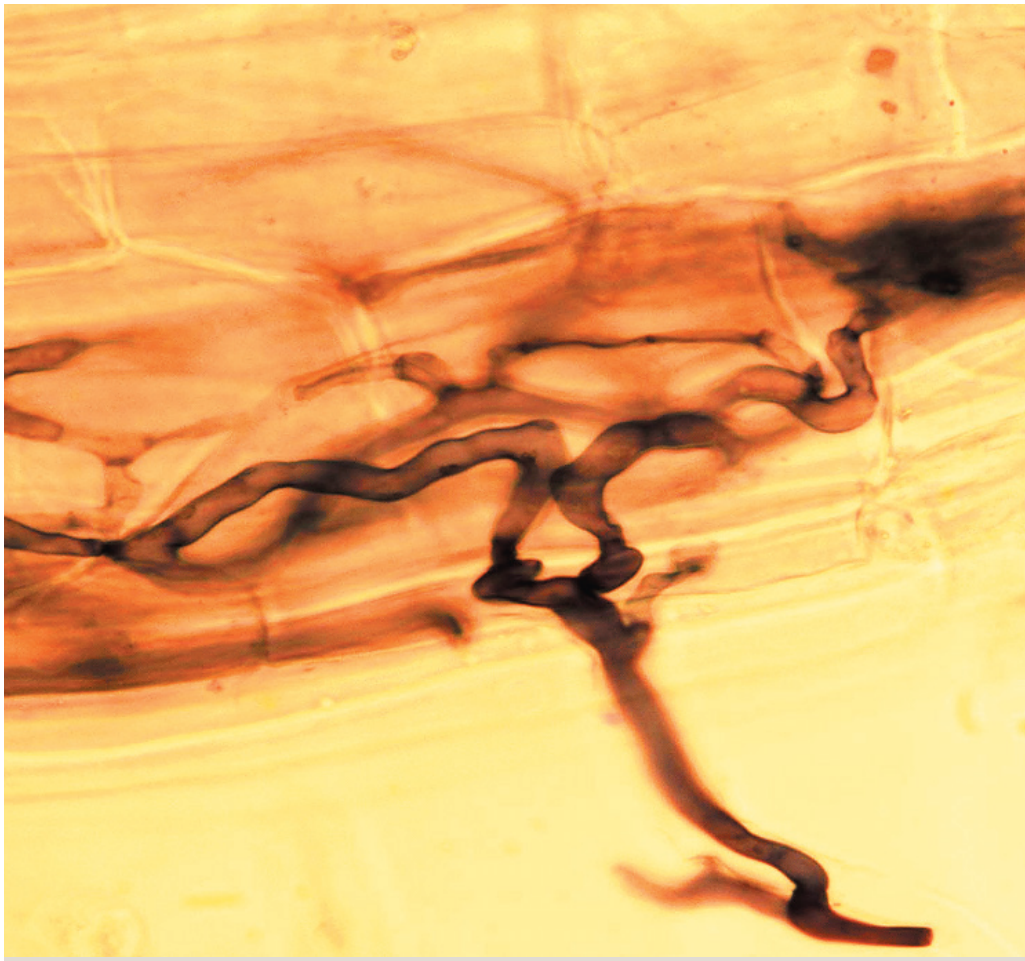
A change from annual to perennially based agriculture can double soil carbon levels in the topsoil within three to five years, particularly when the starting point is below 2%.

Soil carbon increases of 0.5%-1% could thus be achieved relatively easily with simple changes to land management across the agricultural zones of eastern, southern and western Australia.

Almost 60% of the Australian continent is currently used for food production. The resilience of the resource base to climatic extremes will increasingly be of national and international significance in coming decades. Every 27 tonnes of carbon sequestered biologically in soil represents 100 tonnes of CO_2 removed from the atmosphere. As a bonus, it also enables more reliable and profitable production of nutritious food.

In conventionally managed agricultural soils, the 'biomass in, CO_2 out' process predominates. It will become increasingly difficult to farm productively if we fail to progress from this 'soil depletion' type of management, particularly in a warming, drying environment.

Next issue: Carbon sequestration options



Although mycorrhizae don't make humus, it is difficult to start the humification process without them. They bring large quanitites of soluble C into the soil from plant roots, which feeds the microbes involved in the complex process. Photo: Jill Clapperton.

Find out more:

Dr Christine Jones, is principal of the Australian Soil Carbon Accreditation Scheme (ASCAS), www.amazingcarbon.com

Reference: Allen, M.F (2007) 'Mycorrhizal fungi: highways for water and nutrients in arid soils'. Soil Science Society of America, Vadose Zone Journal Vol 6 (2) pp. 291-297. <www.vadosezonejournal.org>.