RTDS
Directorate: Plant Science

Can soil microbial diversity increase wheat yields?

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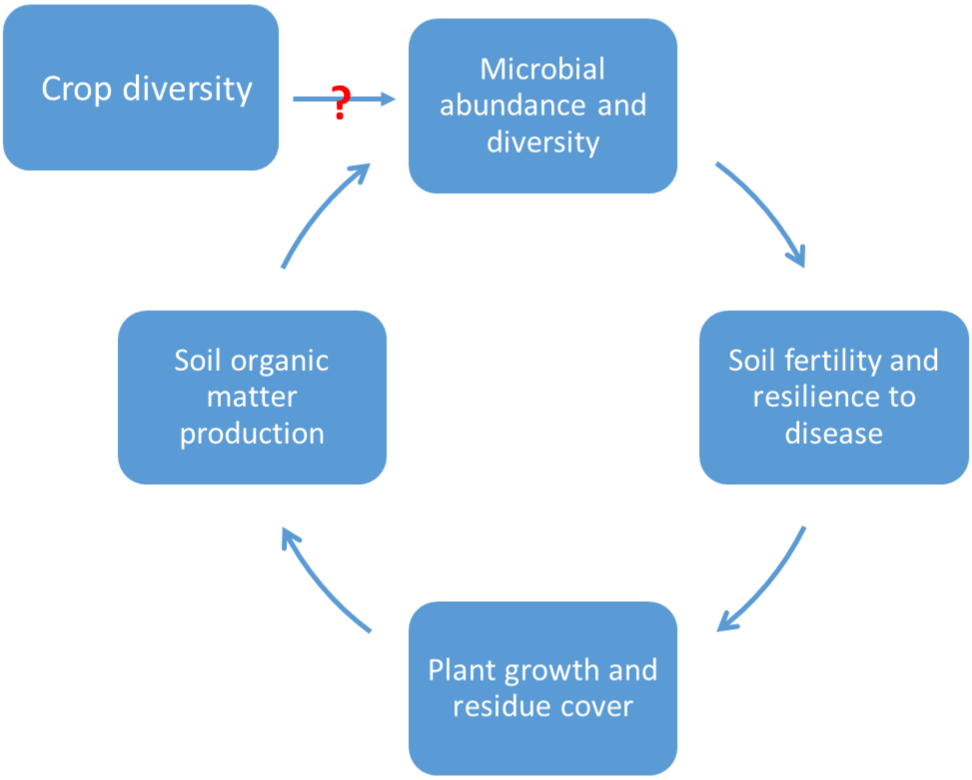
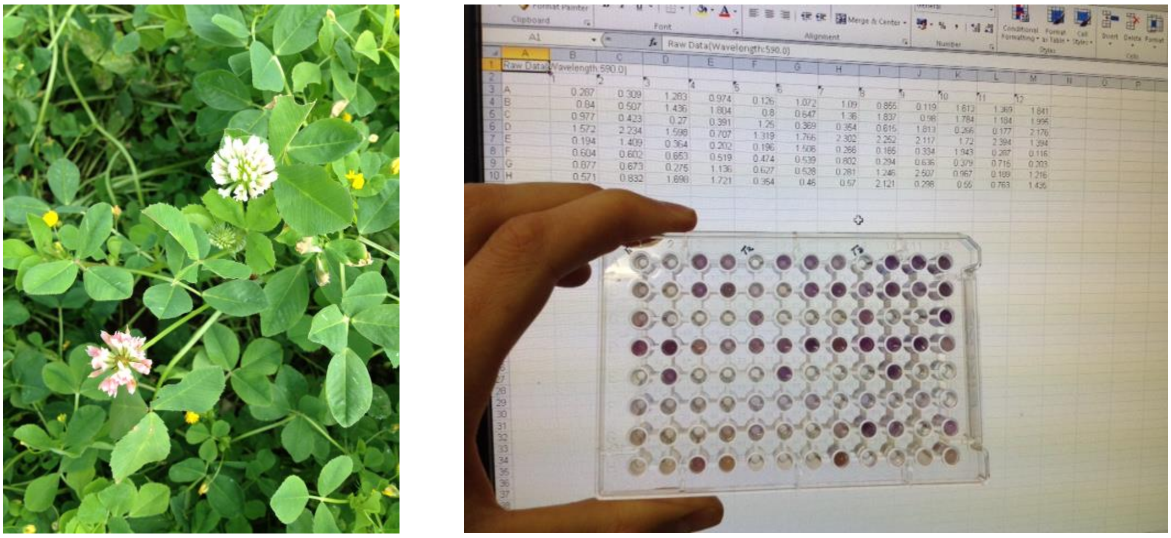
Over the past 15 years, the adoption of conservation agriculture within the Western Cape has dramatically increased, ultimately resulting in higher average incomes generated per hectare. Crop rotation with legumes (e.g. medic and clover), is one of the components of conservation agriculture and it contributes to larger wheat yields predominantly through enhancing soil fertility, pest management and plant protection. With recent advancements in soil biological science, the question on everyone's mind is what role soil microorganisms play in this relationship between crop rotation and yield.

Wheat (left) in rotation with medic and clover (right) is a common crop rotation within the Western Cape.

Within the broader literature there are two schools of thought on the matter (Hooper et al. 2000). One is that the diversity of soil microorganisms contributes to the resilience and functional redundancy of the agroecosystem. In this case, redundancy is thought to be positive: it means that different species perform the same function, and if one is removed the function is still carried out by other species. For example, if a soil pathogen invades, the diversity of the microbial fauna and flora should provide an adequate arsenal of defence mechanisms to subdue the pathogen and maintain soil functionality. Another school of thought holds that specific keystone microbial species are responsible for the functioning of the system, an example being the nitrogen-fixing symbiotic bacteria called *Rhizobia*, which are associated with legumes.



Recent research at Langgewens Research Farm in the Swartland has found evidence to support both these schools of thought. Results show that wheat in rotation with legumes does not significantly change the soil microbial diversity, and that this diversity is not necessarily linked to the soil fertility or wheat yield. Rather, soil with high or low microbial diversity may support a range of soil fertility levels and yields. Further research into the functional composition of microbial communities under rotations may help us understand why rotations produce higher yields.



Research examining the soil microbial diversity using Community Level Physiological Profiling where carbon substrate utilization by different microbial functional groups (indicated by a colour change to purple) gives an indication of diversity.

Yet, within broader ecological theories it is a general rule of thumb that biodiversity is good for ecosystem functionality. In other words, a diversity of microorganisms is good for the health of your soil and consequently your pocket. Understanding the drivers of this diversity may allow us to manipulate it for our benefit through crop management practices.

The research at Langgewens found that phosphorous (P) availability and sodium (Na) and potassium (K) excess are drivers of microbial diversity. Consequently farmers who want to promote soil microbial diversity should regularly check that soil P, Na and K are within recommended limits.

Fields of wheat ready for harvest at Langgewens Experimental Farm.

To answer the question set out in the title; microbial diversity does not necessarily increase wheat yields. However, it is perhaps too simplistic to imagine that we would find a direct relationship between microbial diversity and wheat yield, which is a composite measure of many factors over the lifecycle of the plant. As molecular biology of microbes advances it will become more useful to tease apart which functional groups (e.g. nitrogen fixers, predators of pests, etc.) are encouraged by which conditions in the soil and by choice of crop/s.

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Reference:

Hooper, D.U., Bignell, D.E., Brown, V.K., Brussaard, L., Mark Dangerfield, J., Wall, D.H., Wardle, D.A., Coleman, D.C., Giller, K.E., Lavelle, P., 2000. Interactions between Aboveground and Belowground Biodiversity in Terrestrial Ecosystems: Patterns, Mechanisms, and Feedbacks. Bioscience 50, 1049-1061.