EquiBiome.org
Soil Analysis

SOIL SAMPLE REPORT

3/6/23

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ABOUT HEALTHY SOIL

Healthy soils are crucial to the health of the ecosystems your horse is part of. The contribution of microbes to soil health is well known. Microbes and microbial processes are often used as metrics of soil health. Your soil sample has been analysed using 16s rRNA gene technology to identify the entire microbial population.

organic matter

Vitamins and Minerals for Horses

Healthy soils containing a large population of micro-organisms that enhance both plant and animal health.

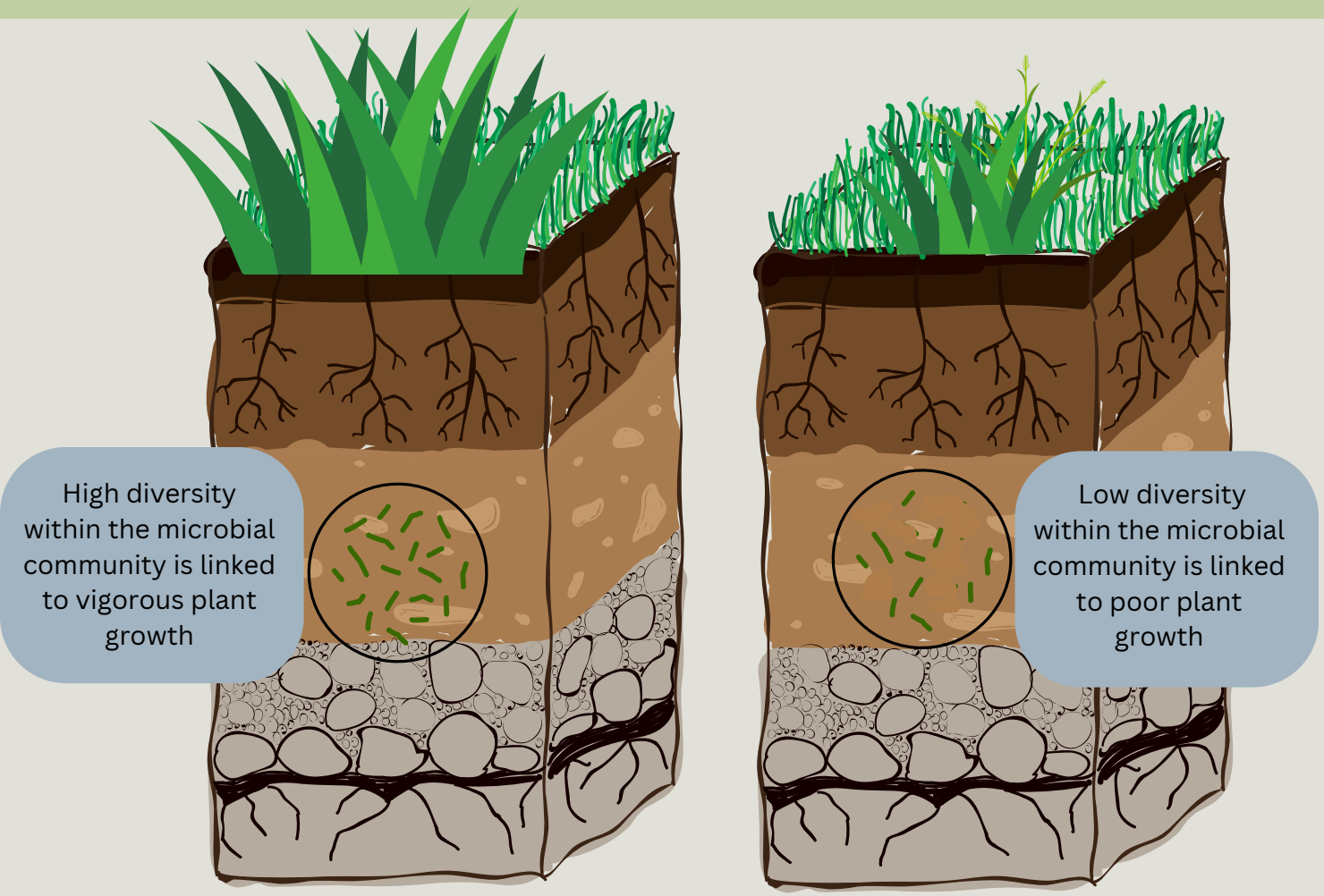
A healthy microbial population promotes healthy plant growth to provide sufficient levels of essential nutrients to NRC levels, reducing the need to add a vitamin and mineral supplement.

Organic matter and plant diversity are key to good soil health, Organic matter consists of plant and animal residues in several stages of decomposition. It contains carbon a source of energy and nitrogen as a source of protein to feed the micro-organisms in the soil. Organic matter helps to increase the numbers of good soil bacteria and keeps the pathogenic (bad bacteria) in check. Plant diversity encourages a more diverse microbial community

DIVERSITY SCORE

Biodiversity is measured by the Shannon Index. Having a good score is key to identifying a healthy soil microbiome. Having a diverse and varied populationhelps support soil/plant interaction and health. An example of a good diversity score is 4.5 whilst a poor score is below 3.

Soil microbial communities play a central role in driving multiple ecosystem functions and ecological processes that are key to maintaining plant productivity.



Chen, Q. L., Ding, J., Zhu, Y. G., He, J. Z., & Hu, H. W. (2020). Soil bacterial taxonomic diversity is critical to maintaining the plant productivity. Environment International, 140, 105766.

DIVERSITY SCORE OF YOUR SAMPLE

3.6

High Diversity is calculated to be 4.5 and above

Medium Diversity 3-4.5

Low Diversity below 3

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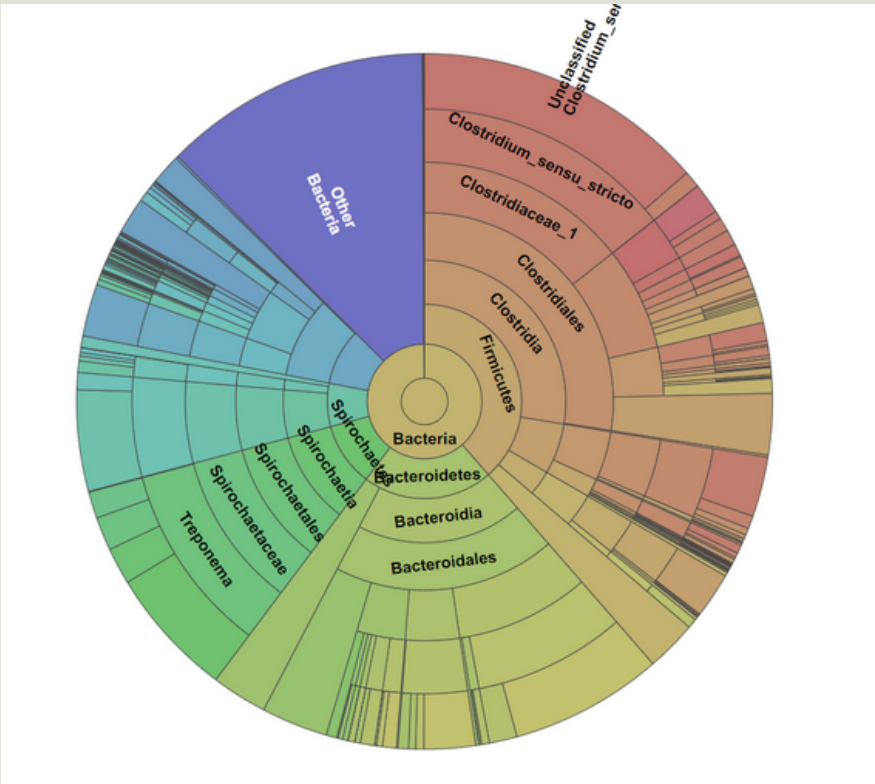
SUNBURST & BARCHART

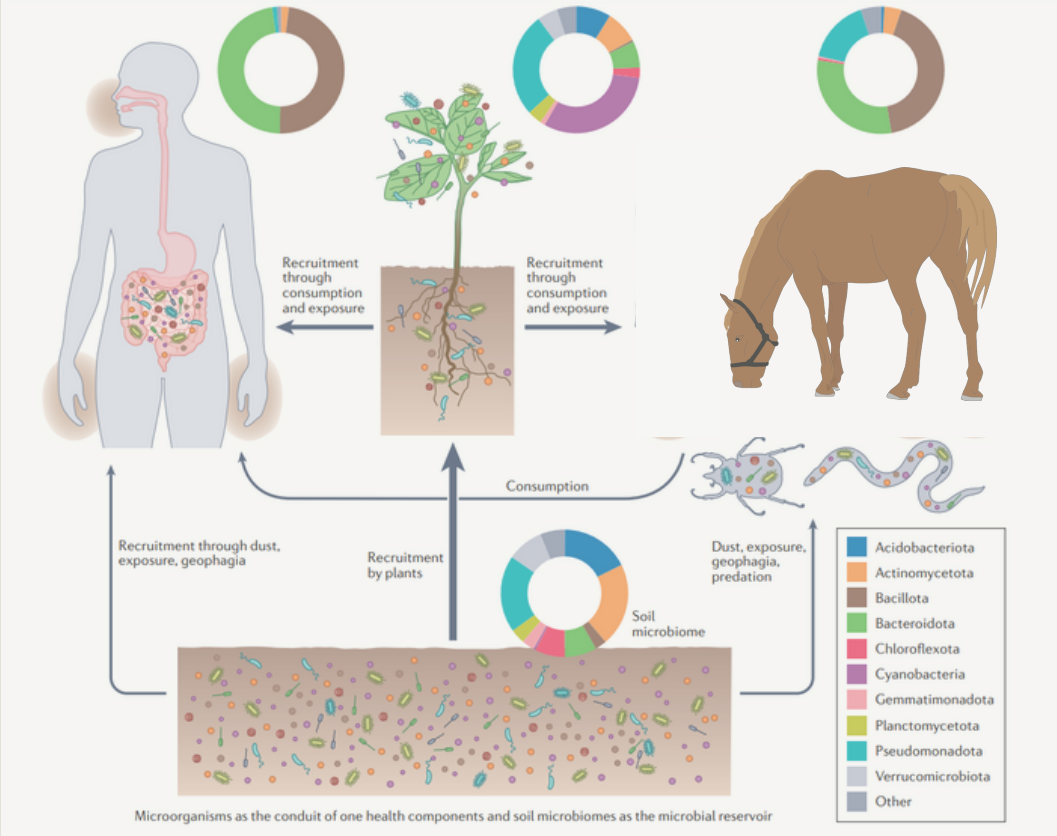


TOP 20 CLASSIFICATION RESULTS BY TAXONOMIC LEVEL

This column chart shows the relative abundance of the top 20 classification results within each taxonomic level

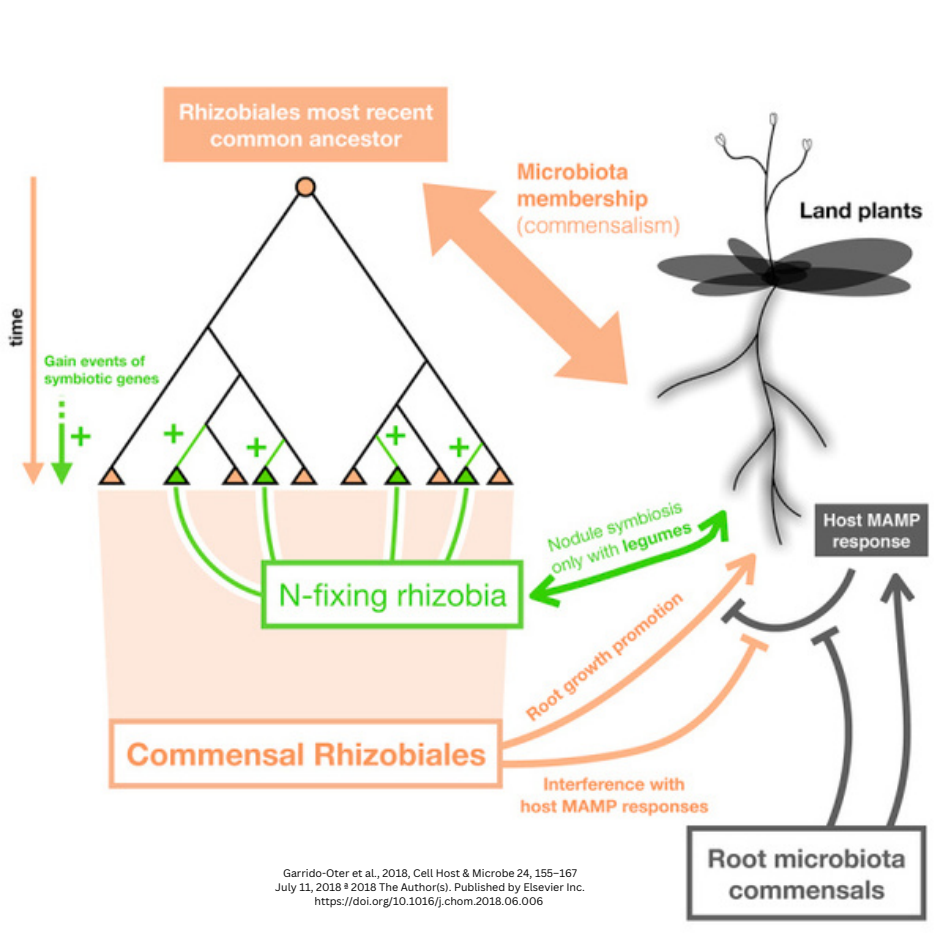
THE MICROBIAL RESERVOIR

Microbes link ecosystems together and influence the health of the soil, human, animal, and plants. Soil has the most diverse community and is the reservoir of many different species. It contributes 2/3rds of the microbes to plant microbiomes which are then passed onto the horse.
Horses often eat soil and all will inhale or swallow soil during the normal daily routine of grazing and rolling.
The width of the arrows indicates the strength of the association with the plant/soil being the strongest association, the pie charts show the average top ten dominant species.



Microorganisms as the conduit of one health components and soil microbiomes as the microbial reservoir

Banerjee, S. and van der Heijden, M.G., 2023. Soil microbiomes and one health. Nature Reviews Microbiology, 21(1), pp.6-20.



Garrido-Oter et al., 2018, Cell Host & Microbe 24, 155–167
July 11, 2018 ª 2018 The Author(s). Published by Elsevier Inc.
https://doi.org/10.1016/j.chom.2018.06.006

NITROGEN FIXING BACTERIA

There are 29 different nitrogen-fixing bacteria species, these play a vital role in plant health by transforming atmospheric nitrogen into fixed nitrogen an inorganic compound used by plants. The major chemical components of plants are carbon, hydrogen, oxygen and nitrogen.

Nitrogen is found in the leaves, seed, plant tissue and roots of plants it functions as a part of plant structure and forms a major constituent of chlorophyl used by the plant to make sugars.

Nitrogen is a component of amino acids the building blocks of life, it helps the plant grow and reproduce.

The best-known group of symbiotic nitrogen-fixing bacteria are the rhizobia, with two others Frankia and Cyanobacteria that can also fix nitrogen in symbiosis with plants.

percentage of nitrogen fixing bacteria

Average percent of NFB in productive soil

Average percent of NFB in your soil

NITROGEN FIXING BACTERIA

There are two types of nitrogen-fixing bacteria.

1. Free-living (nonsymbiotic) bacteria, includes Cyanobacteria, Anabaena, Nostoc, Azotobacter, Beijerinckia, Bacillus, Klebsiella and Clostridium.Free-living bacteria find their own source of energy by oxidising organic molecules released through the process of decomposition or by using inorganic compounds such as sulphur. Previously thought to have a minor role in nitrogen fixing but recently thought to contribute 30-50% of the total needs of the field.
2. Mutualistic (symbiotic) bacteria, includes Rhizobium, Frankia, and Azospirillum.

Biological nitrogen fixation is a natural means of providing nitrogen for plants and a better more sustainable method of fertilisation.

RHIZOBIALES

Healthy soil has higher levels of the bacteria that support the production of interactive plant hormones, and has lower levels of bacteria that increase plant carbs and sugars. Rhizobiales is the main microbial promotor of healthy plants, the range is 3-18% across different fertilised/glyphosate sprayed soils. Organic untilled soils having the highest percentage.

Rhizobiales inhibit the growth of plant pathogens, promote healthy plant growth, clean up the soil of pollutants (cyanobacteria is high in the gut of horses with laminitis) and are present in the microbiome of dogs and horses, presumably having a positive effect?

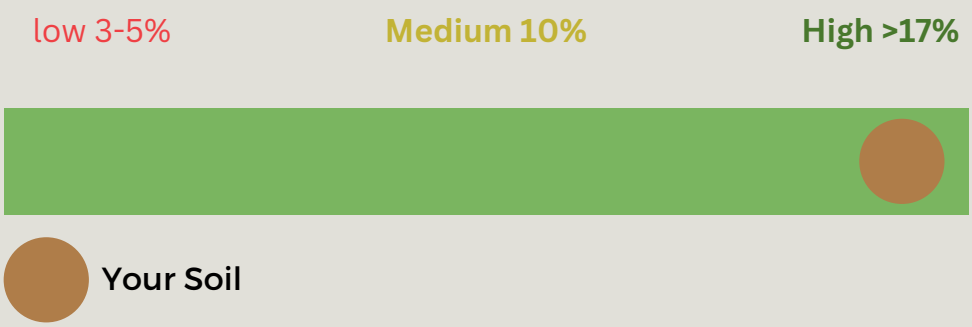
Fertilisers and agrichemicals reduce rhizobiales by lowering the pH of the soil. Speed of recovery is dependent on the field having some legume content, recovery is possible without legume content if the field is left untilled and unploughed.

The main horse health promoting functions of these bacteria is to supply nutrients, supply plant hormones and reduce toxic plant pathogens. Rhizobiales come with a vast community of phages that kill susceptible bacteria, contributing to population turnover and driving selection for resistance, plus providing competitive advantages (make the soil strong).

There are 4 main plant hormones with benefits to the animal that are supported by healthy levels of rhizobiales - indole-3-acetic acid (IAA) is an antitumor and anti-cancer agent, gibberellin- helps in apoptosis (death of abnormal cells), abscisic acid (ABA) regulation of glucose homeostasis, ecdysterone stimulates energy pathways and reduces adipose tissue and cytokinin which works as an anti-ageing compound.

Rhizobiales are reduced by drought and flooding. In the case of poor drainage and/or flooding the microbial community becomes predominantly clostridium, and following drought is dominanted by nostoc,

RHIZOBIALES PERCENT IN YOUR SOIL

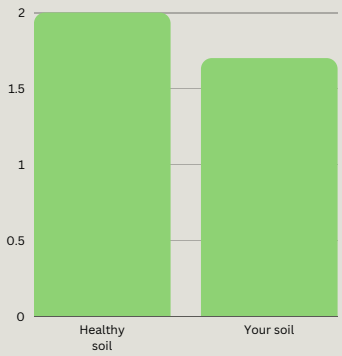


For soil with a low to medium score pasture soil can be improved by the addition of legumes such as birdsfoot trefoil, sainfoin and lucerne. To improve rhizobiales content increase the legumes content of the pasture to 26%. The soil pH needs to be around 6.7 for establishment to be successful.
Increasing levels of rhizobiales has huge benefits for grazing horses, including– an increase in minerals especially magnesium, chromium and zinc.
Good ratios of calcium:magnesium:phosphorus: 2:1:1
Copper:Zinc:Manganese: 1:3:3
Mineral levels increase as the pasture plants mature and are grazed, easily meeting the NRC levels required for an exercising horse.
Significant increase in antioxidants especially Vitamin E and beta-carotene, known to reduce plasma triglyceride levels (EMS horses).

PATHOGENIC BACTERIA

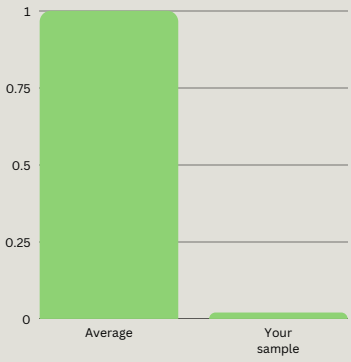
Clostridium

Clostridium contribute to nitrogen fixing and are predominant in compacted soil with poor drainage where they can be as high as 20%, associated with grass sickness in horses and reduced productivity of pasture (low sugar content).



The average clostridium from 20 healthy samples is 2% and your sample is 1.7% the sample contained no pathogens associated with grass sickness.

Brucellaceae



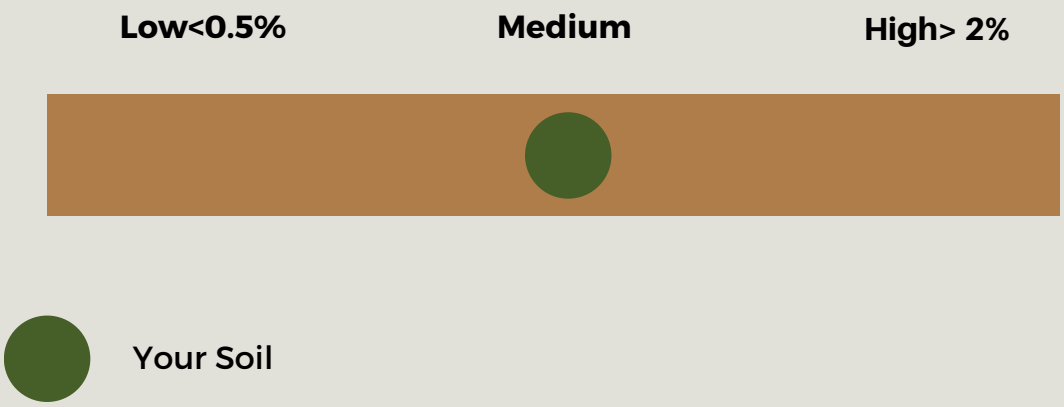
Though the UK was declared brucellosis free in 1979 some poorly drained compacted soils have significant levels of brucellaceae. There is some concern relating to a come back of the disease in animals and the soil is considered to be a resevoir, .

Garrett, L.A., Brown, R. and Poxton, I.R., 2002. A comparative study of the intestinal microbiota of healthy horses and those suffering from equine grass sickness. Veterinary microbiology, 87(1), pp.81-88.

SOIL RESILIENCE TO HERBICIDES

Glyphosate degrading bacteria

Widespread use of glyphosate disrupts the soil microbial ecology, and negatively affects plant growth-promoting microorganisms including Burkholderia spp., Pseudomonas spp., and Rhizobium spp.
There are bacteria able to degrade glyphosate and its main metabolite aminomethylphosphonic acid (AMPA). Chryseobacterium sp. Degrades glyphosate directly and indirectly by altering the microbial community of the soil and increasing biodiversity.



Zhang, W., Li, J., Zhang, Y., Wu, X., Zhou, Z., Huang, Y., ... & Chen, S. (2022). Characterization of a novel glyphosate-degrading bacterial species, Chryseobacterium sp. Y16C, and evaluation of its effects on microbial communities in glyphosate-contaminated soil. Journal of Hazardous Materials, 432, 128689.

VERRUCOMICROBIA

+17%

Members of the phylum Verrucomicrobia can make up 1-10% of the total soil microbiome and they play an active part in the metabolic processes of soil, supporting plant growth, development, and yield.
In your soil sample, verrucomicrobia are present at 17.67%, which is above average.

The pH of the soil is the most important influence on the density, diversity, and number of verrucomicrobia members. There are abundant increases in verrucomicrobia in a pH of 6-7.5, and/or temperatures of 25-35 degrees Centigrade. Verrucomicrobia use carbon as a source of energy, they live in profusion in the roots of mature plants.

Spartobacteria is the highest-represented species of verrucomicrobia (genus level) in your soil sample, followed by Verrucomicrobia sub-division 3 (good at protecting plants against disease) together making up 16% of the total biome. When rhizobiales and verrucomicrobia are present in sufficient quantities then a phenomenon called quorum sensing is triggered.

This is a type of gene regulation soil nutrient balancing system, boosting the health of the soil and plants by releasing siderophores and chelate-like molecules, which scavenge iron and make minerals (Mo, Mn, Co and Ni) more available for other microbes and plants.

Thank you!

For using our service, the dataset from the analysis of your soil sample is extensive and there is a plethora of information on the health, biodiversity, productivity etc. that could be of further use. Please contact me direct on carol@equibiome.org to arrange further consultation.

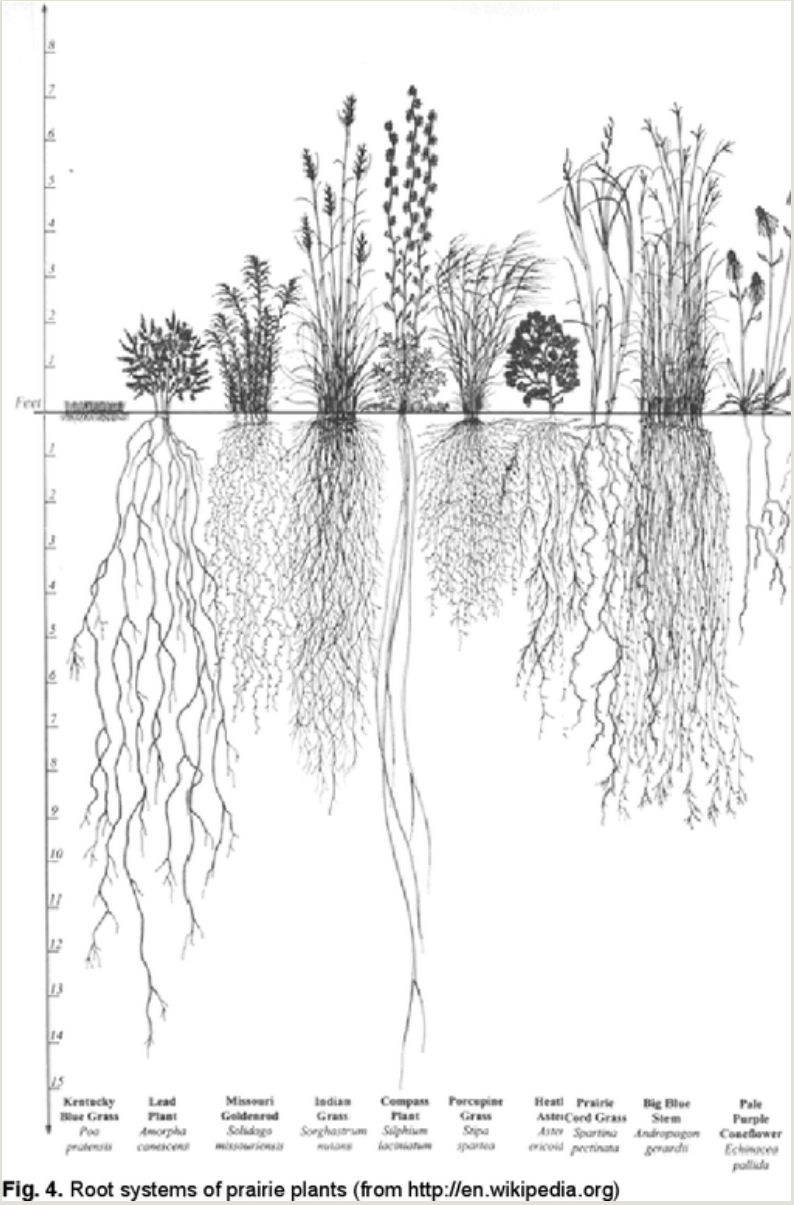


Fig. 4. Root systems of prairie plants (from http://en.wikipedia.org)