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Studying deep rooting and its value for crops

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Water and nutrients are distributed throughout the soil volume, and their ability to move towards the plant roots is highly restricted, in most cases to a few mm or less. This mean, that unlike the aboveground resources of light and CO_2 moving to the plants, roots need to grow towards the resources. Thus, for efficient resource uptake, roots need to be well distributed in the soil, both locally within the root zone and to grow deep to increase the overall volume of soil exploited. In crop production, deep rooting has been shown to be highly important for water and nitrogen use, and deep rooting is expected to contribute specifically to soil C sequestration.

Research into deep rooting and its functions is strongly restricted by the difficulties of studying roots hidden deeply in the soil. It is very laborious to access them, and even more difficult to set up experiments giving frequent and non-destructive measurements of the relevant parameters.

In previous experiments, we have studied deep rooting of crops and cover crops and its effect on deep nitrogen uptake. By measuring roots and soil nitrogen to 2.5 m depth, we found that deep rooting was a main factor in nitrogen uptake and the reduction of nitrogen leaching loss. This showed how deep rooted species can be used to develop nitrogen efficient cropping systems. Further, it was shown that inclusion of deeper soil layers in the studies were critical for the conclusions to be drawn. Increasing the depth of study from e.g. 1 m to 2.5 m did not just moderate the conclusions and quantitative estimates, in several studies it basically changed conclusions that could be drawn.

Since 2015, we have built three new research platforms dedicated to detailed study of deep root growth and function. We have built a rhizobox facility consisting of 24 rhizoboxes each 4 m deep. The rhizoboxes are equipped with soil water sensors, and give access to observe the roots, take soil and root samples and inject tracers along the whole soil profile. In the field, we have built a platform, aimed at giving similar research possibilities, using long minirhizotrons, soil water sensors and metal access tubes for inserting ingrowth cores, all together giving valuable opportunities, though we cannot achieve the same easy access to the root zone as in the rhizoboxes. Finally, we have built a deep root phenotyping facility, using minirhizotrons to allow screening of 600 plant lines for root growth down to 3 meters depth, and allowing us to measure root activity of the lines by deep placement of isotope tracers.

These new facilities, and the research opportunities they give will be discussed, together with some of the first research results on deep roots we have obtained there.