SOIL FERTILITY

OPT FOR
“tailor-made” solutions

In order to choose appropriate action levers that will improve fertility, it is important to first understand the effect of cropping techniques on the way a particular soil works.

Achieving a fertile soil is a long term task. The farmer must understand how his soil works, and observe it in order to implement appropriate techniques at the right time. Two farmers in the Alsace region, looking to achieve a “living, porous and high organic matter” soil, experimented with those principles.

With dropping milk prices, one strategy for remaining competitive is to become more self-sufficient. Thierry Willem and Jacques Adloff, two farmers from Kleingoeft (Alsace), are looking to achieve this self-sufficiency through the way they manage their crops and herd of 120 Prim’Holstein dairy cows. One of their objectives is to save on fertiliser, plant protection products and fuel, while maintaining satisfactory yields. They also want to feed rations that are weakly dependent on purchases, while producing 10,000 litres of milk per cow per year.

A fertile soil is key for self-sufficiency

According to them, soil fertility is key for the success of this triple plan: the soil must be rich in organic matter and allow roots to explore, water must circulate freely through it, and it must provide crops with sufficient amounts of nutrients. Such a soil, defined as “living, porous and organic” requires few inputs to achieve “good yields”.

They came to this conclusion progressively. Fifteen years before, Thierry Willem direct drilled wheat for the first time, to save time. This made him a pioneer in Alsace, where 90% of the land cropped as part of a yearly rotation is ploughed every year. “Then, I felt I was taking a risk. Now, we haven’t ploughed for ten years.” Since the end of 2011, the Association pour la Relance Agronomique en Alsace (ARAA) and the Chambre d’Agriculture d’Alsace have been testing an innovative cropping system on two of the farm’s fields, as part of a system experiment.

With 38% clay, 51% silt and 11% sand, both fields have a deep, stoneless clayey-silty soil. Thanks to its texture and depth, it has significant water soil capacity (140mm), and

interesting fracture porosity properties due to alternating frost/thaw patterns and drying/wetting conditions. However, the soil is slow to warm up in the spring and prone to compaction. Drainage takes around 5 days, and can trigger a capping effect in wet conditions.

At the beginning of the experiment, the farmers were only partially happy with the physical condition of their soil. They were therefore looking to improve its vertical porosity, including facing drainage issue.
The techniques being experimented to improve the porosity of the soil are primarily preventative actions. The aim is to "feed life into the soil", and indirectly into the crops, by supplying it with organic matter, and to respect its structure. The farmers only undertake remedial mechanical cultivation as a last resort, and as unobtrusively as possible. "When the condition of the soil requires it, we till it. For example, in September, the soil was too dry to direct drill oilseed rape, so we rotovated to a depth of 2-3cm so that the earth was fine, and now that oilseed rape is the best there is in the region." Similarly, fertiliser inputs and mineral nutrients are used sparingly and in the most efficient way possible (split applications, nitrogen fertilisation before rain, etc.).
The crop rotation is more diverse than those of most other mixed dairy farms in the area (grain maize, maize silage, wheat). Alfalfa was introduced for its nitrogen and organic input into the soil, as well as for its forage quality and weed control effect. Maize and oilseed rape, which are real "nitrogen sponges", follow alfalfa, which supplies nitrogen for two years after it has been destroyed.
Legume covers limit nitrogen loss through leaching, even if the intercropping season is short. They also bring nitrogen and organic matter. Fasciculate roots (cereals) that bind the topsoil alternate with tap-roots (alfalfa, oilseed rape) that deepen fissures. Very few fields are harvested late.

Inspecting the soil with a fork or a knife is one of the key steps to achieving good soil structure. Another one is to undertake crop operations at the right time. "Establishing maize is what I find most stressful. We always strip-till in the autumn, and in the spring, without the big tine, at less than 15cm", volunteers Thierry Willem.

"A soil which works well"

After six years, even though the experiment is only half way through, preliminary results are encouraging. The soil structure was never identified as being a limiting factor. Porosity has evolved positively. When experimental researchers from the "Systèmes de culture innovants" mixed technology network (RMT) (1) visited the field as part of a workshop held in Strasbourg in March 2017, Olivier Rapp took the opportunity to point out that "the oilseed rape plants' tap-roots are straight, and remains of alfalfa roots from two years ago are really vertical, which shows that the structure of the soil encourages good root establishment".
Around 50 earthworms per square meter were counted in March 2017, whereas the average number found in crops using the same method (from the participative observation platform set up by the University of Rennes) is 20/m².
The worm castings and worm "huts" found by the farmers corroborate those numbers. The absence of ploughing and the plant biomass supplied by cover crops therefore do encourage the presence of earthworms. The farmers expect the vertical tunnels created by the worms as they move around between the surface and deeper layers of the soil to drain away excess water, and help fields drain away as quickly as possible. "Earthworms do our work for us, it saves fuel. It is also a sign that the soil is living and in proper working order".
Soil analysis does not show any changes between 2012 and 2016 for the parameters measured, except for the level of exchangeable potassium, which dropped, as it was absorbed by alfalfa, but remains nonetheless high (0.75 to 0.54g K2O/kg through the 0-10cm layer).
The phosphorus level is low but stable (0.051g P2O5 Olsen/kg through the 0-10cm layer), which led to spreading slurry and mineral fertiliser on the oilseed rape.

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Improving the cropping system

The establishment of cover crops and alfalfa helped to save on average 23kg of nitrogen per hectare per year over the six years of crop fertilisation, and, of course saved spreading any mineral nitrogen in the three years when alfalfa was grown. However, the two farmers are still not satisfied with this. Thierry Willem expected to save on nitrogen fertilisation thanks to "the cover crops and legumes, but with min-till, crops struggle at the start, despite, for example, systematically adding a starter fertiliser to maize. The soil seems to mineralise the nutrients less and later than expected. Mineral nitrogen fertiliser then needs to be used when sowing maize. Another constraint is the need to choose a variety better suited to direct drilling, i.e. vigorous at the start. We lack local reference data in this respect."

« Straight oilseed rape tap-roots and vertical remains of alfalfa roots from two years ago show that the structure of the soil encourages good root establishment. »

It is also difficult to take the risk of drastically reducing nitrogen rates. In theory, it would have been possible to reduce the rate by 80kg N/ha in maize after alfalfa, but in reality, it was reduced by 40kg N/ha.

Yields are reasonable, except for alfalfa, which is disappointing at 11.3 tonnes DM/ha/year on average. This raises questions regarding its suitability, given the soil and weather conditions. Dry summers and sometimes very wet springs impacted negatively on yields. In addition, "the number of machinery passes is very high with alfalfa, which compacts the soil as soon as the weather is wet", complains Jacques Adloff. Results will have to be consolidated through monitoring for another three years at least. The effects of combined action levers on an environment are slow to materialise, especially in respect of soil fertility. The farmer needs to be patient before he can see the "system effect" on it.

(1) The experiment is supported by technical exchanges within two national networks: the "Systèmes de culture innovants" mixed technology network (RMT), and the Ecophyto DéphyEXPE network. It is funded by the Agence de l'Eau Rhin-Meuse, the Grand Est Region and FEADER.

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June 2017

Knowledge and experience sharing, including on the agronomic indicators involved in good root establishment, proved invaluable.