Towards sustainable plant production – carbon sequestration and soil life in arable farming:

Farm level comparison between England and Finland in No-till production

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Conservation Agriculture, No-till in this farm level case study, is largely adopted in dry or erosion prone conditions. The need to utilize sustainable production methods has also become a very important topic in conditions where conventional tillage and practices have been used.

There are several reasons for this like: Economical pressures, environmental causes and EU regulations.

To be able to learn and compare how the same common problems are solved, we have started a two dimension Farm level Case study between England and Finland.

We have chosen as similar as possible conditions and farm types. Both farms are located on heavy clay soil, with relatively low annual rainfall. In both areas plow culture is still dominant and no-till considered difficult due to very heavy clay soil with low organic matter.

Farm selection

Farms selected to study were:

1. Simon Cowell, Motts Farm, St. LarwenceSouthminster, Essex, England
2. Eero Kovero, Kovero Farm, Mustilanmäentie 34 A, 13900 Pekola, Finland

Both farms are same size class, 160 to 200 hectar. Both are fully arable farms with conventional, but sustainable methods.

Motts farm has autumn cereals dominated rotation, whereas Kovero farm has spring dominated rotation.

Motts farm grows autumn and spring cereals, flax, lupines, beans, peas, alfalfa etc. Kovero farm grows mainly spring cereals and oilseed rape.

Both farms have adopted full No-till for 6 years. Motts Farm can use a lot of compost and cover crops. Kovero Farm is relying more to conventional agro-chemical methods.

Methods of study and comparison

Working group has visited both farms and done a comprehensive Case study, where conditions, soil quality, working technics, inputs, crop walking and measurement and yield result were analyzed. A technical analysis is also under preparation.

We have already registered several interesting points, such as:

a. Soil microbial condition can be enchanged. At Motts Farm fertilizing levels have been dropped considerably as a result of compost and use of bioenchancers. This has not dropped yields though.
b. Soil workability has become easier and it has been possible to take spring peas etc. back to rotation.

c. Level of soil life has increased on both farms and production has become more sustainable. Abiotic stresses have become easier to tolerate.

Beginning year 2013 and from there on, the working group will compare and analyse several factors related soil quality, it's microbial activity, carbon sequestration and general sustainability. First soil samples are already under full analysis including bacteria/fungi assessment.

Results will be available in the media as work proceeds.

Working group:

JussiKnaapi, agronomist

Simon Cowell, no-till farmer, named as "Motts farm"

Eero Kovero, no-till farmer, farm co-operation with TuomoYlitalo, named as "Kovero farm"

MattiLaurila, sustainable mechanic specialist

Keywords

Carbon Sequestration, No-till, Sustainability, Soil Life, Albrecht Soil Analysis

Foreword

As said in the abstract, the working group has been set up to study and compare how different modifications of no-till could function as part of sustainable arable production. Key target is to study the impact of no-till on soils carbon content and possible environmental effects.

To accomplish this, we have started continuous comparison of these two farming operations in England and Finland, see details in previous page.

Our toolset for this study consist of description and analyses of both farming operations. The main instruments have been: Interviews and working group interaction over the web, soil analyses from both farms – time span has been the last 10-12 years. We have also had a possibility to accomplish a microbial soil life assessment of both farms.

Results and comments

Soil organic matter and carbon sequestration

Both farms have very heavy clay soils with low organic content. At Motts Farm the start level (12 years ago - 2001) of soil organic matter was 4,5 %. During 12 years the value has risen up to 5,6 %. The value is an average of 50 individual samples. Increase has been 24 per cent. We need to remember that Motts Farm has been in full no-till only half of this period. The value is based on burning of OM.

To measure how sustainable this rise has been, we can't rely on OM figure only, because it includes all levels of organic matter. At Motts Farm a well-known Leubke method is used. It was developed by Austrian microbiologic Siegfried Leubke and his system is adopted in advanced organic and sustainable systems in Central Europe, USA and UK.

In the Leubke system organic matter is divided also into humus portion, which is a very durable form of OM. It has a scale of 1 to 140, the highest value being the best. At Motts Farm the value has risen from 9,8 to 15,5 during the last 6 years only. In other words the level of durable humus has risen 60 %.

At Kovero farm soil sampling is based on Finnish methodology, which does not include precise measuring of OM, and does not to even mention humus content. However there is a subjective assessment of organic matter – vm (<3 %), m (3-5,9 %), rm (6-11,9 %) and erm (12-19,9 %) plus organic (20 -39,9) and turf (> 40 %) soils, which is related to low, medium, high, very high and fully organic plus less composted turf soil type. Because of this, direct comparison of UK/Finnish result is difficult.

At Kovero Farm the OM has risen approximately one class, from m torm andrm to erm level. This is not very precise, but we can assume that the direction has been upward.

Reasons for OM rises are numerous. The single biggest difference has been the change from inversion to non-inversion tillage. On top of this there are many remarks and hints that could be behind this change. They are like: Adding of organic matter (compost on Motts Farm), exchanging soils microbial status (on both farms) by feeding soil micro fauna. This has been done with microbial inoculation and adding their foodstuff by numerous ways.

Based on the data from both farms, soil OM had increased by approximately 24 per cent. We modestly assume that this rise took place in top 15 centimetres at least, if not even deeper. A simple calculation shows a carbon increase of 1-2 tons /year, (Motts farm).

OM from 4,5 % to 5,6 % approximately in 7 years = total 14 m^3 in top 15 centimetres

Total OM rise in 1 ha is approximately 18 tons/ha (specific weight 1,3)

Carbon content in organic matter in approximately 580 kg/ton

Result: Increase of Carbon per hectare is 10 tons in 7 years.

Amount of Carbon accumulation per year is 1,4 tons.

Carbon sequestration has been possible in our Case study farms. Depending of the value of carbon this alone could be a substantial amount, not to mention all the other benefits associated with soil organic matter.

Soil condition

Due to OM increase, lighter footprint, and lesser compaction, soil conditions on both farms have risen substantially.

Main benefits have been: Sustainability has risen. Soil can tolerate extreme drought or moisture better compared to inversion or plow culture. Soil microbial activity has risen. No-till has moved the bacterial/fungal balance toward fungal direction. Microbial assessment done by Soil Food Web laboratory (UK) show this clearly. The whole soil food web is working better, which is seen in lab tests and also in practice by visual counting of lumbristerrestis activity, (Motts and Kovero Farms).

The need for pH control (liming) is practically absent, indicating that soil microbes might have a positive effect there, (Motts and Kovero Farms).

Depending of the rotational system, the need for fertilizing has fallen drastically. This has not however influenced the soil nutritional reserves at all, which have been monitored regularly (Motts farm). Even soluble nutrients have stayed at constant level indicating that good clay type soil has huge nutritional reserves. By having active micro fauna, soil can buffer nutrients to soluble form steadily. At Motts Farm P and K fertilization has been close to zero in past 10 years. One more reason making this possible is the rotational balance where autumn seeded crops and N-fixing spring crops are part of the system. When needed (mainly winter wheat), N fertilizing is used however. At Motts Farm the role of compost and soil microbial inoculation is important, even though the amounts are not very high. The main reason for this is the supporting and activation soil life.

At Kovero Farm, rotation is limited by natural reasons. Spring crops dominate and the role of starter fertilizing is emphasized. Here the amounts of fertilizing are closer to normal level. Temperature in soil at seeding time is the main factor increasing the need for soluble starter fertilizer, (N + P).

Straw management has fundamental role at Motts Farm, where it's done in integration with feeding soil life in numerous ways, (mechanical, biological and chemical). Decomposition of straw is accelerated with good results. At Kovero Farm straw management is based on a highly effective chopper at harvest and combined use of autumn glyphosate, AMS and molasses to encourage straw decomposition.

When it comes to soil fertility and nutrient retention, the data from Motts Farm reveals that Cation Exchange Capacity has increased during past 10 years by 22 per cent, which is remarkable when we think the

environmental impact soils have. Soil can hold that much more cations and in this way possible leaching will decrease. Together with increased organic matter, soils crack less thus minimizing evaporation and internal erosion. At the same time water infiltration improves, and together with cover crops, water erosion is practically absent. This can be observed visually by checking water quality (colour) coming out of drainage pipes or into open drains.

Anion holding capacity was not tested 2013, but will be in program 2014.

Both farms use conventional agro-chemical IPM crop protection.

Conclusions

These remarks are based on historical data from both farms with supporting analyses done 2013. The Case study has already revealed the potential of enchanged sustainable no-till. Here we do not count light straw harrowing as cultivation, but more or less bio-mulching or simply straw management.

Our Case study has also proved that no-till can easily be adapted also to heavy clay soils.

The Single most important measure, which has increased, is soil organic matter and eventually carbon. The environmental effects this can have together with other management activities, are substantial and give many possibilities to mitigate nutrition leaching and at the same time preserve or raise farm profitability.

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