

Improving soil biodiversity and humus content for better soil fertility and climate change resilience of farms; Biodynamic farm Černelič

Our whole farming approach (actions and means) involved to reach the project objectives is described in the summary.

We want to present how effective in relatively short period is our approach for regeneration of soil, which was impermeable because of construction works and with very bad structure.

We prepared a short photo and video report, to show and demonstrate very evident extraordinary good results. Please, look to the attachment and you will be surprised.

In 2018 we accepted a challenge to restore degraded soil in Krška vas (1,4 hectares). Brežice Hydro Power Plant asked for our help to restore the plot 4338/1, which was a part of a 4 hectare dumping area for construction works on a new river bed for the river Sava in 2014.

Because of heavy construction machinery and huge amount of soil and material from the river, deposited on this area for three years, the soil structure was totally ruined, compacted. This caused water stagnation in micro and macro depressions (photos in the attachment).

According to the expertise about restoration of arable land on the territory of a temporary dumping area in Krška vas (made by Ljubljana University, Biotechnical Faculty), the soil on this plot in June 2017 was practically impermeable for water (hydraulic permeability 0- 20 cm deep: $5,20 - 5,89 \cdot 10^{-05}$). The soil analyses show also very poor content of P and K in June 2017: $0,7P_2O_5$ and $7,9K_2O$ (mg/100g). Construction Company ripped the soil with a bulldozer (50-80 cm deep), used mineral fertilizer (NPK 15-15-15) in amount of 250 kg/ha and sowed grass-clover mixture in July 2017.

We took over this plot in April 2018. At the end of April, we started with ripping the plot (40 cm deep) and spraying it with biodynamic preparation 500. We repeated the spraying after some days and sowed a biodiversity mixture bought in Germany (23 plant varieties, by the Camena Company) with a seeding and ripping machine.

At germination the plants had showed promising results, because the mixture germinated evenly and very good, there were no empty places. Also the growth of the plants during the summer 2018 was incredibly good, vigorous all over the plot. When we visited the plot in the time of flowering of most plants, we were very surprised, because there were many pollinators and bees, it was like being near a beehive.

In early September 2018 the mixture on the plot was mulched (2 m high, look at a video on the link in the attachment), worked in the soil with the ripper (30 cm deep) and soil was sprayed with a biodynamic preparation made of manure according to the Maria Thun method. After some days, we sprayed the soil with preparation 500 and sowed a frost resistant mixture (Wintergrün of Camena Company, 6 varieties of plants).

The plants of this mixture again germinated evenly and very good, which is well seen on photos from April 2019. This winter mixture was also surprisingly vigorous and 2 m high.

After mulching it in May 2019, we repeated the procedure by ripping, spraying the biodynamic preparation 500 and sowing a summer biodiversity mixture in May (the same as the previous spring). In September 2019, the mixture was mulched, soil was sprayed with preparation 500 and after ripping grass leguminous mixture was sown.

As you can see on the photos, procedures extremely improved fertility of the soil, even in the first month after taking over this plot: after ripping and spraying biodynamic preparations in April 2018. The proof for this is excellent germination of the mixture in May 2018.

We are sure that we had activated the soil life with aeration by ripping 35-40 cm deep and spraying biodynamic preparations. Afterwards we considerably activated soil life and improved soil biodiversity with the help of summer mixture with 23 plants. With the help of very diverse plants in the green manure mixture (diverse exudates of plant roots, and organic mass of plants themselves) we invigorated the soil life. The soil organisms released minerals, and made them accessible- available for plants (as scientists in [EU SOILSERVICE project](#) say). The fact is that plants of the summer mixture in 2018 were vigorous and gave high yield of organic substance, although the soil analysis in 2017 showed very poor content of P and K.

After 16 months of regeneration of this plot (1,4 hectare) in Krška vas, we decided to lease it in Autumn 2019, because we want to preserve the soil in this good state. The plot was mowed for the first time in 2020, the yield per 1,4 hectare: first Cut 6.460 kg of hay (19 bales), second Cut 3.400 kg of hay (10 bales) and estimation for third Cut which was mulched - the same as the second Cut. This means 9.471 kg of hay/hectare; hay was picked up in round bales.

Today soil is healthy, very good aerated, with excellent structure (photo from January 2021), no water stagnation on the surface after heavy rainfalls any more. Vigorous crops in 2018, 2019 and 2020 are showing us excellent fertility of the soil, which proves that we have activated and improved soil life (biodiversity and biomass of soil microorganisms), which helps us now to reach amazingly good and quality yields.

The soil analyze from January 2021 shows: 5.18 % organic matter (W&B), 2.8 P₂O₅ and 15.9 K₂O (mg/100g). In 2017, it was 2.6% organic m., 0,7P₂O₅ and 7.9 K₂O (mg/100g).

We have to underline that in the period from April 2018 until now, we have worked with the soil very carefully. That is why we ripped it only when it was not too wet. We used a tractor with an 86-horsepower, with a total weight of 3.5 tons. The speed did not exceed 5 km/h, which is most important. In addition, the soil was sprayed with the backpack sprayer, by hand, because we are aware of the fact that heavy mechanization ruins the structure the most.

Our farm's objectives

Long-term objectives

Main ambition of our farm over the years has been to produce good food of the best quality, with the best attitude towards nature, which ensures that our biodynamic farming is

environmentally friendly and sustainable and that our farm has good resilience towards climate change.

We give special attention to the soil, as we want to enliven and develop it as much as possible and preserve it in the best possible condition for the generations in the future.

We want to prove that it is possible to farm in this way and live from the incomes, using the knowledge learnt on farm, from other similar farmers in Slovenia and from biodynamic farmers abroad.

For us it is very important, that we are able to transfer this knowledge to other interested farmers through conferences, farm visits and workshops that we hold at our farm and in other venues.

Nevertheless, our long-term objective is also to inform the consumers about the great value of the farmer's work in preserving the nature and producing vital and healthy food and to inform them about the importance of farmer's activities to improve soil functions.

Short-term objectives

- Specialization and modernization of agricultural production (greenhouses for production of vegetables and strawberries, irrigation system with water accumulation lake, own solar plant power, modern implements for appropriate soil cultivation, sowing, harvesting of vegetables and hay, machines for stirring and spraying the biodynamic preparations, ...)
- Improved working conditions on the farm.
- Improved production capacities of the farmland (optimizing the soil functions by encouraging soil biodiversity organisms, improving soil structure and % of humus...)
- Regeneration of the plot in Krška vas, ruined by construction works.

Summary

We began 26 years ago, with the purchase of a small 2,5 hectare farm. Today we care for 40 ha, of which 6 hectares are owned and 34 hectares are rented, half of them in 10 hilly villages in the surrounding, where cattle is grazing to prevent overgrowth. 24 years ago we stopped using chemicals for production of strawberries, and this was the turning point towards organic agriculture. The farm has been organic for 17 years. We are officially in biodynamic agriculture since 2012 and from 2014 we have got a Demeter Certificate.

More than 30 varieties of vegetables are grown on 0,7 ha and strawberries on 0,3 ha. Vegetables and strawberries are grown mostly in greenhouses. We sell our vegetables and strawberries directly in short supply chains: on the marketplace in Ljubljana, to some schools and other public institutions and to consumers who come in our small shop on the farm.

39 hectares of grassland are for our 40 heads of cattle, they are outside for 8 months, grazing on pastures in 8 villages in the surrounding. During the winter months they are fed only with dry hay, without any cereals or soya beans. This results in healthy livestock and good fertility. The biggest contribution for the nature is: no plastic for silage production, no transport for cereals, therefore less energy – fuel consumption. In winter, the cattle is also free in the stable (on deep litter), which is very important from the animal welfare aspect.

Our main ambition is to produce healthy food with the best flavor and taste, with the right attitude towards nature and consumers and with the lowest carbon footprint possible. We chose the biodynamic approach, because it is the best for members of our family, the best

for our consumers, the best for our neighbors, the best for our soil and the best for the planet.

Main concern in biodynamic approach is formation of living soil, humus

In greenhouses we are not plugging already 25 years and on fields more than 10 years. We use special rippers-subsoilers (the shape of tines are very important, working from 20-30 cm deep), two times a year, which provide aeration of the soil with fewer disturbances than plugging, increase the soil's microbial mass and the soil's carbon sink capacity. Soil aerated in this way retains more water and prevents crop losses during droughts. During heavy rain, such soil with good structure and humus also absorb more water and prevent floods.

We work with the soil when it is not too wet, with appropriate tools, some of which are for the ridges, gently as possible, with tractors as light as possible...

We sow green manure crops, with a wide range of plant species, which contribute important to humus production. We use mixtures from Camena Samen Company from Germany, which offers many mixtures stimulating humus production. It is of great importance that the mixtures have many, more than 20 varieties of plants and provide huge row material for soil organisms. The green manure crops are mulched and then worked in the soil with the ripper. We also use diversified crop rotation.

The most important by all means is the use of the preparation 500, or 500 prepared, or Maria Thun preparation, not only after ripping but on all our land, including grassland. All preparations are prepared within the biodynamic association.

500 and 500 prepared = horn manure, works primarily on the soil and roots of plants:

- strongly help build soil structure,
- stimulates microbial activity and the formation of humus and
- stimulates growth of root system.

Horn silica, preparation 501 is complementary to horn manure. It works on the growing plant, brings light that helps to improve vitality of the plant and quality (taste and flavor) of the crop.

We control disease and pests not only with two main preparations 500 and 501 but also with other biodynamic preparations. Because of rich soil biodiversity, we do not have any problems with weeds, plant diseases nor pests.

For fertilization of the arable land, we use green manure crops and compost made from cattle manure prepared with six biodynamic compost preparations (made from oak bar, yarrow, dandelion, nettle, chamomile and valerian). These preparations act not only on the compost and regulate the process of composting, but work especially on the soil. They mobilize elements in the soil and soil life, provide the vitality of the plants and balanced growth.

These methods increase the proportion of organic matter in the soil, contribute to its ability to provide a sink for carbon, provide very good structure of the soil – in short they enable excellent and sustainable fertility of soil, good yields and the best quality of crops. In this way such soil management approach prevents soil erosion, soil compaction, water stagnation, decline of soil biodiversity, decline of soil organic matter on arable land and floods.

Conclusion

With regeneration of the plot in Krška vas, which was ruined and impermeable due to a huge dumping area for construction works, we have proved that presented soil management is

very efficient, even in short period of time. The procedures and means that we used are described in the beginning of this text. A very impressive and telling Photo and video report about our soil management approach regarding regeneration of this plot is in attachment.

Today soil on this plot is healthy, very good aerated and with excellent structure (take a look at the photo from January 2021); no water is staying on the surface after heavy rainfalls any more. Vigorous crops in 2018, 2019 and 2020 are showing us excellent fertility of the soil, which proves that we have activated and improved soil life, which helps us now to reach amazingly good and quality yields.

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Presented soil management approach for regeneration of soils with low humus content (in the early stages of desertification): ripping 20-30 cm deep + incorporation of biodiversity rich green manure mixtures + biodynamic preparations, guarantees improvement of soil structure and humus content even in short period of time.

We have to underline that for radical improvement of soil fertility (soil structure and soil biodiversity) it is vital, that neither herbicides nor other chemical pesticides are used, nor mineral fertilizers, because they all have extremely negative effect on biodiversity of soil organisms and their biomass.

Presented soil management approach and biodynamic farming approach are in accordance with EU Biodiversity Strategy to 2020 and EU Farm to Fork strategy, as they follow the main goal: reduction of the environmental and climate footprint.

This soil management approach is very efficient and can be used not only on small farms, but even on very large farms with 100 or 1000 of hectares – biodynamic farms in Australia, where climate conditions are much harder than in Europe, prove that (one of those farms with 1.200 hectares <http://www.powletthill.com.au/about-us.html>). For such large farms of course mechanization and appropriate implements with big working width are used, and appropriate bigger stirring and spraying machines for biodynamic preparations too (for instance spraying implement with 16 meters working width). We are grateful that Alex Podolinsky from Australia and Pasquale Falzarano from Demeter farm Agrilatina in Italy presented us these facts, which show a great potential for future truly sustainable and economically efficient farming in Europe in spite of climate changes.

If many more farms would use soil management approach as presented here, a radical change in Carbon dioxide sequestration into soil would be reached and the soil fertility would be improved. Higher uptake of atmospheric carbon dioxide into soil would mitigate global warming and reduce consequences of the climate change.

[1. Video](#) (English language, 10 minutes),

[2. Video](#) Ripping instead of plugging (1 minute)