Tulevaisuuden maanviljelijät
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Closing the loop: regenerating pasture´s productivity by utilizing microbiota from aerobically decomposed manure

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Abstract

Community of soil microorganisms play a fundamental role in nutrient cycling, building soil structure and support plants´ growth and resilience to pests and diseases. In conventionally managed pastures (tilling, mineral fertilizers, and herbicides usage), the naturally occurring microorganisms cannot survive, therefore, cannot sustain above mentioned functions. The experiment was aimed to show the effects of inoculating compacted, conventionally managed pastureland with soil microorganisms by utilizing aerobic thermophilic compost. The compost produced and the soil treatments applied were done according to the Soil Food Web method. The experimental plot of pasture was treated with bioactive compost extract every few weeks throughout the seasons and soil samples were assessed regularly.

The results of microbiological assessment at the end of both seasons show that the compost extract changed the microbiological profile of the treated plot in comparison to the control plot. Bioactive compost extract inoculated the soil with the microorganisms that were missing from the system. Bacterial biomass decreased, which indicates that the inoculation of their predators, protozoa and nematodes managed to control their numbers adding to the nutrient cycling effectiveness. Fungal biomass was rising steady with every application. Even though it changed, the numbers of most of the functional groups of microorganisms haven´t reached the desired range of values for the ecological succession stage of productive pastures. More applications and monitoring of the progress in the coming years is needed.

1. Introduction

1.1. Soil ecology and its importance in agricultural systems

The soil food web makes soil ecosystem community of soil microscopic organisms living in the soil that perform all the complex biochemical soil functions like cycle nutrients, build soil structure and support plants´ growth and health. [8,9] The interaction of different trophic levels of soil organisms generates nutrient cycling: saprophytes decompose organic matter thus releasing nutrients in soluble, plant available form. Additionally, specialized bacterial and fungal species “mine” different minerals from the crystalline structures of stable mineral components in the soil (slay, silt, sand…), making those minerals available to plants. Higher trophic levels (protozoa, nematodes, arthropods) consume bacteria and fungi and excrete the excess nutrients which are then available for plant to use. Plants release exudates in form of sugar compounds that microorganisms feed on. Therefore, microorganisms´ activity is most dense in the rhizosphere, where the most effective nutrient cycling and building of the soil structure occur [7].

Different stages of ecological succession are followed by a belowground succession that reflects primarily in the fungal to bacterial biomass ratio.[6] Quantities and diversity of functional groups of soil microorganisms also differs in different in different stages of succession. This point of reference is used in the experiment in question, as successional stage of productive pasture has determined desired ranges of bacterial (135 - 1350 µg/g), fungal (135 - 1350 µg/g) biomass, their ratio (F:B ≈ 0.75 - 1.0) as well as numbers of protozoa (>50,000 /g) and functional groups and numbers of nematodes (bacterial, fungal and predatory nematodes, ≈ 100/g) per gram of soil [8].

In undisturbed soil systems biodiversity and quantity of soil microorganisms is higher, F:B ratio balanced, and the soil food web can efficiently perform and maintain all the ecosystem processes. Therefore, agricultural land also benefits from the balanced and healthy soil food web which, as an inseparable part of the soil, plays fundamental role in regulating all the soil functions.

Soil disturbances in agricultural soils, as heavy tilling, synthetic fertilizer usage, and different chemical applications for managing pests and diseases, all negatively influence the soil food web. Fungi are the most sensitive to those disturbances and therefore agricultural soils usually lack in fungal biomass; they are bacterially dominated soil systems which reflect the state of early successional stage, that best supports growth of early successional plants (weeds). Moreover, fungi are also responsible for creating soil aggregates, basic elements for building and maintaining soil structure. Lack of fungal communities, among other effects, results in poor soil structure from which many of the agricultural soils suffer [8].

Furthermore, communities of protozoa and beneficial nematodes soon disappear or decrease in numbers in soils with compaction problems, which additionally contributes to poor nutrient cycling and the negative feedback loop of deteriorating soil health.

1.2. Objective

The objective of the experiment therefore is to document the effect of aerobically decomposed bioactive compost and compost extracts on conventionally managed pastureland by utilizing the method developed by the Soil Food Web institute.

Biological soil management utilized in the experiment aims to fix microbiological imbalances by inoculating the soil with the microbial communities missing from the system, specifically balance out the numbers of fungal to bacterial ratio which means decrease bacterial biomass by inoculating the soil with their predators (protozoa and nematodes) and increase fungal biomass. Furthermore, the increase in the numbers of protozoa (amoebae and flagellates) and functional groups of beneficial nematodes (bacterial and fungal-feeding nematodes) is desired to make the nutrient cycling more effective.

1.3. Biological soil management - the Soil Food Web method

The Soil Food Web method developed by dr. Elaine Ingham´s Soil Food Web institute utilizes aerobic thermophilic compost called BioComplete Compost ™ and its liquids to balance the microbiological state of the soil and thus enable the soil to perform all its functions. This method has proved to be effective in improving the soil condition and plants´ growth and nutrient density sometimes within one season [13].

Compost that is being used as a soil amendment is aerobically decomposed which has all the possible weeds and pathogens sterilized in the thermophilic phase of composting. Aerobic decomposing process itself and the diversity and balance of different types of feedstocks being used ensure that the result is a highly diverse soil amendment rich in beneficial aerobic soil microorganisms. Most of the nutrients from the feedstocks consumed by bacteria and fungi, are stored in their bodies, which means that the compost is fully decomposed, nutrient rich balanced organic matter without dangerous amounts of soluble nutrients and at the same time it is a rich in all the functional groups of organisms. The compost and compost derived liquids must meet the minimum standard of different functional groups of organisms. More about the compost quality is discussed in the Methodology section.

1.4. Experimental plot – *Pieni hevoslaidun* initial state

The plot of pasture named *Pieni hevoslaidun* of approximately 3000m2 plot of a bigger pasture system (8 Ha) that is regularly grazed during the season, from mid-May till mid-September.

This plot however occasionally serves as a summer pasture for heifers. The cows were grazing on the plot three times during the summer days for several days at a time (3-7). This kind of pasture management can put additional stress to the plants and soil.

The pasture is conventionally managed for decades; the pasture plot in question has been fertilized regularly with mineral fertilizer in quantities suggested by the local soil analyses authority. The plot however hasn´t been fertilized from the year 2021 Experiment is therefore being conducted on the newly abstinent pasture.

Structurally, it is a heavy clay loam soil.

Initial compaction assessment showed that there is a compaction rate of 20 Bars on the depth of about 15 cm which is generally considered to be the rate unbreakable by any root. Reduced porosity and permeability due to the compaction results in poor pasture growth.

The plot has been renewed in 2014, tilled and resowed with a conventional grass mix. Dominating plants on the pasture are Timothy grass and English ryegrass.

Although the pasture on the first glance looks green and lush, with a closer inspection it is visible that it has small bare patches of soil where could easily be plants growing.

Initial microbiological assessment (Table 1) showed symptoms of conventionally managed pasture: the soil showed to be bacterially dominated, with very little fungi and protozoa, with no beneficial nematode and significant numbers of root feeding nematodes.

The successional stage of productive pasture requires a balanced fungal to bacterial biomass ratio of 1:0,75 - 1. By analyzing this sample, we estimate the F:B ratio to be 1:0.03, which is too low for the plants growing there.

We can see that the fungi count is in the desirable range, slightly on the lower side, but the bacteria count is way too high, lowering the ratio. The high bacterial count suggests several things, one of which is a lack of beneficial protozoa and nematodes to keep the large population in check by eating them.

And it's true, the number of protozoa is too low and there are no beneficial nematodes detectable in the sample.

Beneficial Organisms	**Experimental plot initial state**	**Desired range for the productive pasture**
Bacterial biomass (μg/g)	5825	135 - 1350 μg/g
Fungal biomass (μg/g)	156	135 - 1350 μg/g
Fungal Standard Deviation (%)	60 %	
S:B Ratio	**0,03**	**F:B ≈ 0.75 - 1.0**
Beneficial protozoa (nr/g)	44577	Constant stable numbers of flagellates and amoebae throughout the growing season > 50,000 /g
Protozoa standard deviation (%)	136 %	
Bacterial-feeding nematodes (nr/g)	0	Bacterial feeders, fungal feeders and predatory nematodes necessary (>100/g)
Fungal-feeding Nematodes (nr/g)	0	
Predatory Nematodes (nr/g)	0	
Detrimental Microorganisms		
Oomycetes (μg/g)	0	/
Ciliates (nro/g)	0	/
Root-feeding nematodes (nr/g)	270	/

Table 1 Microbiological profle of the plot, May 2021

2. Methodology

2.1. Design of the experiment

The experiment was conducted during two seasons, 2021 and 2022. A plot of about 200 m2 of pasture land was chosen (Figure 1) It was divided into two sections, experimental plot, and control plot (50m2)

FIGURE 1. EXPERIMENTAL PLOT, MAY 2021

2.1.1. Season 2021

The initial microbiological assessment was made, as well as initial compaction measurements with penetrometer. During the first season, compost extract was applied to the experimental plot three times, after which the final assessment was performed from both experimental and control plot by utilizing the shadowing microscopy assessment method developed by the Soil Food Web School. About 250l of bioactive compost was spread onto the experimental plot before the first snow (October 2021)

Date	Activity	Details
27.4.2021	marking of the experimental plot	150m2 + 50m2
29.4.2021	sampling, assessment	
4.5.2021	application of compost extract	40l
17.5.2021	application of compost extract	40l
31.05.2021	application of compost extract	40l
12.08. 2021	sampling, assessment	
14.10. 2021	applying bioactive compost	250l

TABLE 2 BIOLOGICAL PLAN, SEASON 2021

2.1.2. Season 2022

The initial microbiological analyses were performed of both experimental and control plot at the start of the season to assess the quantities of different functional groups of microorganisms existing in the soil. (Table 4) Compaction levels were also measured (20 Bar still but deeper this year, on 40cm)

Greatest plant species´ diversity was found on the treated plot as opposed to control plot. (*Urtica dioica*, Achilleamillefolium, Taraxacum officinale, Aegopodium podagraria*, Pilosella piloselloides, Antrhriscus sylvestris, Veronica polita, Glechoma hederacea, Plantago media, Trifolium repens*)

Compost extract was applied four times (Table 2) during the season every two weeks, a week after which a microbiological assessment was conducted to follow on the changes.

Additionally, Brix tests were performed three times throughout the season.

To add to the plant biodiversity of the pasture [14], two seedings were performed, one with conventional nine species´ pasture seed mix of grasses and legumes (*Phleum pratense, Festuca pratensis, Festuca arundinacea, Festuca rubra, Poa pratensis, Lolium perenne, Trifolium repens, Trifolium pratense, Trifolium ribidum)* and 100g of indigenous perennial meadow flower species (*Centaurea jacea*, *Stellaria graminea, Calluna vulgaris, Lotus corniculatus, Carum Carvi, Rumex acetosa, Silene vulgaris, Campanula glomerata, Tanacetum vulgare, Succisa pratensis, Leucanthemum vulgare, Knautia arvensis).*

Date	Activity	Details
04/05/2022	application of compost extract, compaction rate measurement	40l
18/05/2022	sampling, assessment	
24/05/2022	application of compost extract, Brix measurement, seeding	40l, 200ml seeds (9 species, grasses and legumes
08/06/2022	sampling, assessment	
09/06/2022	application of compost extract, seeding	perennial meadow flowers (100g)
13/06/2022	sampling, assessment, Brix measurement	
15/06/2022	application of compost extract	40l
16/06/2022	sampling, assessment	
28/06/2022	application of compost extract	40l
01/07/2022	sampling, assessment	
27/07/2022	application of compost extract, compaction rate measurement	40l
03/08/2022	sampling, assessment, Brix measurement	

Table 3 Biological plan, Season 2022

2.2. Shadowing microscopy – microbiological assessments

Microbiological assessment performed in this experiment estimates number of relevant functional groups of microorganisms or their biomass in the soil sample by using compound microscope and shadowing technique. It is used to assess soil, compost, and compost liquids samples for microbiological composition. The values are expressed in micrograms per gram of sample or in numbers of individuals per gram of sample. Samples are taken from the first 7-10 cm of the soil. The results are compared to the desired range of soil microorganisms for the given successional stage of productive pasture.

2.3. Bioactive compost

The "tool" used to inoculate the experimental plot with the soil microorganisms was bioactive compost and extract from that compost produced on the farm by using thermophilic, aerobic process. The idea was to develop a compost recipe and process according to the Soil Food Web method that can be repeatable and scalable on farms. The recipe for the compost can be found in the appendices. The quality of the compost is assessed by microscope. Quantities of the microbiota in the compost as well as minimum values determined by the Soil food Web method are expressed in the Table 4.

Functional group	Minimal values	Compost 2021	Compost 2022
Bacteria	135 µg/g	1939 µg/g	1400 µg/g
Fungi	135 µg/g	363 µg/g	495 µg/g
Protozoa (amoebae and flagellates)	10000/g	226000/g	1300000/g
F:B ratio	0.03	0.25	0.03
Nematodes	100/g	1000/g	1400/g

TABLE 4 BIOLOGICAL ASSESSMENT OF BIOACTIVE COMPOST, FUNCTIONAL GROUPS/GRAM, F:B BIOMASS RATIO

2.4. Brix measurements

The Brix values show percentage of sugar in the plant sap, it is measured by a simple tool called refractometer. The sugar levels indicate the efficiency of the plants to photosynthesize. Generally, value of around 12% sugar content is optimal value for pasture plants. Lower value indicate that the plant is stressed and cannot function properly.

The refractometer (brand listed below) was used to measure the efficiency of the photosynthesis of plants in experimental plot and to compare it to the efficiency of the plants to photosynthesize from the control plot.

2.5. Materials and supplies used:

- 400 µm holes mesh bag for the compost extraction
- iScope trinocular compound microscope IS.1153-PLi
- Microscope slides 25x76x1 mm
- coverslips 18 mm x 18 mm, thickness 0,17 mm
- Test tubes 10 ml, conical base, plastic, screw cap
- Pipettes 3 ml graduated transfer pipettes, volume 7 ml, 1/2 ml scales, 155 mm
- ATC refractometer
- Wile penetrometer
- Naturcom Pihvilaidunseos pasture seed mix
- Suomen niitysiemen – monivuotinen mesiniitty – indigenous perennial meadow plants

3. Results and discussion

3.1. Season 2021

After three compost extract applications, the state of the experimental and control plot was significantly different (Table 5). In just three months microbiological profile has significantly changed, and even though the numbers did not reach the desired range for all the functional groups of organisms (except for the fungal biomass), the change observed was still promising and showed a positive trend. Control plot also showed an increase in fungal biomass, but the bacterial biomass also increased dramatically leaving the soil s F:B biomass ratio to a very low value (0,003:1). The fact that the root -feeding nematodes were observed at the end of the season on the control plot, and hadn´t been observed in the experimental plot, indicates that the inoculation of the beneficial organisms made the condition unfavorable for root feeders to be present (anaerobic conditions, lack of their predators).

Season 2021				
Beneficial Organisms	**Experimental plot initial state**	**Experimental plot end state**	**Control plot end state**	**Desired range for the productive pasture**
Bacterial biomass (µg/g)	5825	7888	9771	135 - 1350 µg/g
Fungal biomass (µg/g)	156	506	227	135 - 1350 µg/g
Fungal Standard Deviation (%)	60 %	96 %	131 %	
S:B Suhde	**0,03**	**0,07**	**0,003**	**F:B ≈ 0.75 - 1.0**
Beneficial protozoa (nr/g)	44577	49104	31177	Constant stable numbers of flagellates and amoebae throughout the growing season > 50,000 /g
Protozoa standard deviation (%)	136 %	122 %	136 %	
Bacterial-feeding nematodes (nr/g)	0	360	0	Bacterial feeders, fungal feeders and predatory nematodes necessary
Fungal-feeding Nematodes (nr/g)	0	0	0	
Predatory Nematodes (nr/g)	0	0	0	
Detrimental Microorganisms				
Oomycetes (µg/g)	0	0	0	/
Ciliates (nro/g)	0	0	0	/
Root-feeding nematodes (nr/g)	270	0	200	/

TABLE 5 RESULTS OF THE MICROBIOLOGICAL ASSESSMENTS INITIAL AND END STATES, SEASON 2021

3.2. Season 2022

The season of 2022 had some dry periods that can affect poorly structured pasture soil that hasn't got a good water permeability. The soil would easily get very dry and hard, and in those moments the compaction rates would come to the initial 20 Bar close to the surface (10-15cm), even though initial measurement of the soil compaction were promising (20bar about 40 cm deep).

Compost was applied in the autumn of 2021 and was mostly decomposed at the beginning of the season. Some earthworm castings were observed. However, as soon as the snow melted and soil dried, there was a sunny and dry period that soon showed the effects on the soil structure and soil microorganisms

Season 2022					
Beneficial Organisms	**Experimental plot initial state**	**Experimental plot end state**	**Control plot Initial state**	**Control plot end state**	**Desired range, productive pasture**
Bacterial biomass (µg/g)	8013	5550	16420	13160	135 - 1350 µg/g
Fungal biomass (µg/g)	184	364	48	40	135 - 1350 µg/g
Fungal Standard Deviation (%)	63 %	46 %	76 %	131 %	
F:B biomass ratio	**0,02**	**0,07**	**0,002**	**0,003**	**F:B ≈ 0.75 - 1.0**
Beneficial protozoa (nr/g)	98 208	49104	undetectable	19642	Constant stable numbers of flagellates and amoebae throughout the growing season > 50,000 /g
Protozoa standard deviation (%)	136 %	122 %	x	136 %	
Bacterial-feeding nematodes (nr/g)	400	360	0	0	Bacterial feeders, fungal feeders and predatory nematodes necessary
Fungal-feeding Nematodes (nr/g)	400	0	0	0	
Predatory Nematodes (nr/g)	0	0	0	0	
Detrimental Microorganisms					
Oomycetes (µg/g)	0	0	0	0	/
Ciliates (nro/g)	0	0	0	0	/
Root-feeding nematodes (nro/g)	0	0	400	200	/

TABLE 6 RESULTS OF THE MICROBIOLOGICAL ASSESSMENTS INITIAL AND END STATES, SEASON 2022

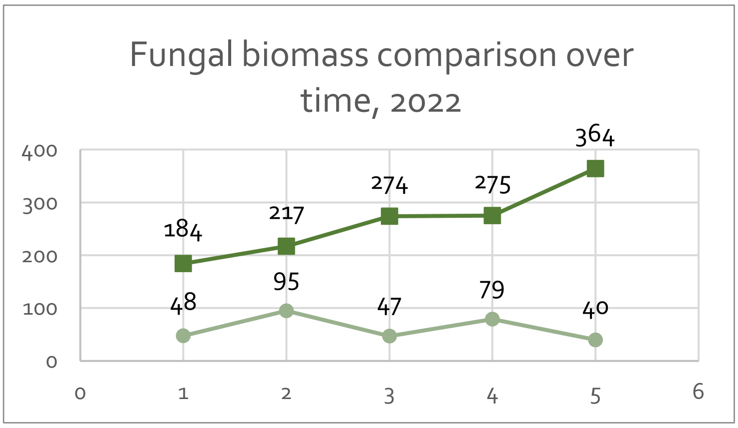
3.2.1. Experimental vs. Control plot – Season 2022

Table 6 shows initial and end microbiological assessments of both experimental and control plot (2022). It is clear from the table that the microbiological profile of the experimental plot has changed in positive direction for most of the functional groups of organisms. Control plot is in much worse microbiological state; bacterial biomass numbers are extremely high, almost no detectable fungal biomass as well as protozoa and nematodes, except for the undesirable, root feeding nematodes that are detectable in significant quantities throughout the season.

3.2.2. Fungi:

Initial assessment of the soil samples taken in the beginning of May 2022 showed decreased numbers in fungal biomass (184(μg/g), 63% standard deviation) in comparison to the end state of the previous season (506(μg/g), 96%STD), which can be attributed to a natural ebbs and flows of fungal biomass numbers that increase towards the end of the season and their numbers are lower at the beginning of the active period. If compared to the results of the assessment form the last season at the same time, things look more promising: fungal biomass is initially greater (with lower STD%) than biomass estimated for the same period of last year.

Additionally, fungal biomass (Graph1) throughout the season shows a steady increase (dark green) and much higher numbers in comparison to control plot (light green line). It was in the desired range or the successional stage (135 - 1350 μg/g).



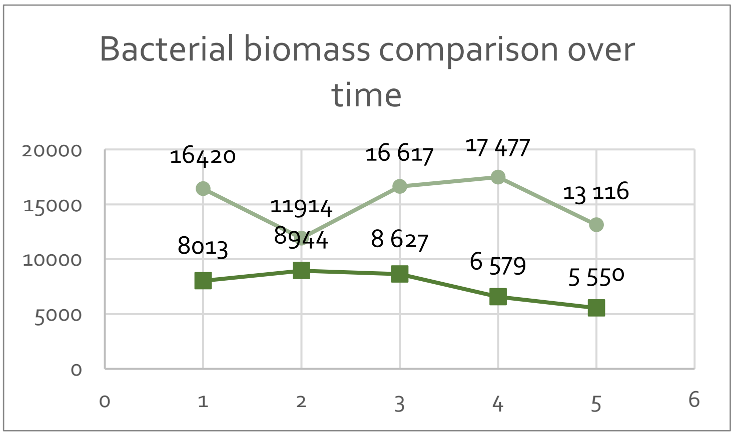
GRAPH 1 FUNGAL BIOMASS COMPARISON OVER TIME, SEASON 2022

3.2.3. Bacteria

Bacterial biomass, even being too high for a desired range for this successional stage (135 - 1350 µg/g), it was still lower throughout the season on the experimental plot (Graph 2, dark green line), and lowered throughout the season steadily.

This shows the efficiency of the inoculated bacterial predators to control their numbers, as expected.

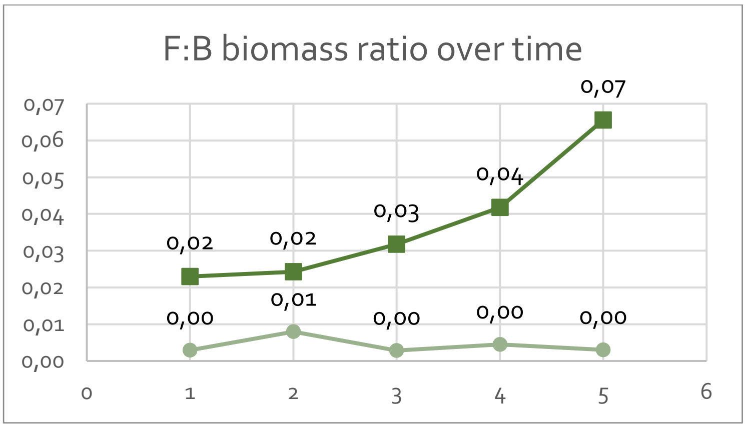
Control plot shows extreme high numbers of the bacterial biomass throughout the season.



GRAPH 2 BACTERIAL BIOMASS COMPARISON OVER TIME, SEASON 2022

3.2.4. F:B biomass ratio

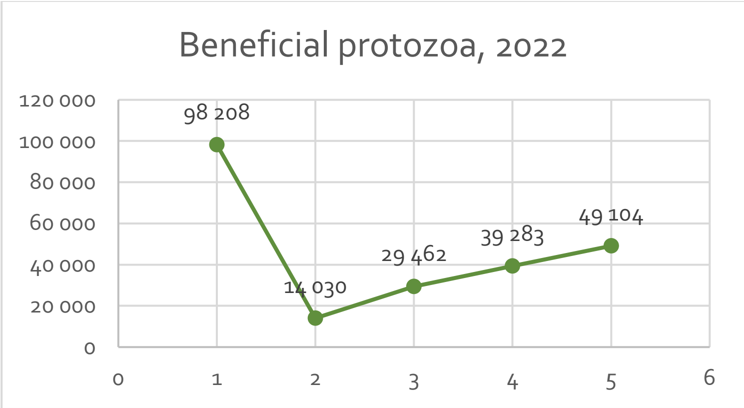
Similarly, F:B biomass ratio values increased throughout the season (Graph 3), but even though the fungal biomass was in the desired range, bacterial biomass was still too high for the F:B biomass ratio to reach the desired range of 0.75 - 1.0 Control plot shows bacterial domination.



GRAPH 3 FUNGAL TO BACTERIAL BIOMASS RATIO COMPARISON OVER TIME, SEASON 2022

3.2.5. Protozoa

Desired range for the successional stage of productive pasture is constant stable quantities of beneficial protozoa (amoebae and flagellates) throughout the season. This has not been the case on this plot. Even though protozoan numbers were always higher compared to the control plot (where protozoa were in some assessments undetectable), their numbers for some reason plummeted after the initial assessment. Many dormant protozoa were observed in the sample, which indicates that the conditions in the soil weren´t favorable for the protozoa to thrive. Their numbers were probably influenced by the dry period (Graph 4) Their numbers were slowly recovering after that.



GRAPH 4 BENEFICIAL PROTOZOA EXPERIMENTAL PLOT, 2022

3.2.6. Nematodes

Similarly to the protozoa, beneficial nematodes are sensitive to water fluctuations in the soil. Still constant number of bacterial feeding nematodes was detected throughout the season on the experimental plot, while the fungal feeding nematodes were observed at the beginning of the season, and no more after that. No predatory nematodes were observed. Control plot was completely devoid of beneficial nematodes, but detrimental, root feeding nematodes were present.

3.2.7. Brix values

The comparison of brix levels on two occasions showed the difference in sugar content, which means that efficiency of the plants to photosynthesize was higher in the experimental plot which is attributed to the to the higher nutrient cycling potential of the soil food web present.

Date	Experimental plot	Control plot	average Brix value between three measurements
24/05/2022	10	6	
13/06/2022	12	7	
03/08/2022	8	8	

TABLE 7 AVERAGE BRIX VALUES ON BOTH PLOTS MEASURED ON 3 OCCASIONS, 2022

4. Conclusion

The highest numbers of microorganisms were found at the beginning of the second season when the soil had enough moisture and organics matter from the applied compost before the end of the first season.

The microbiological soil profile changed with the applications of bio complete compost extract and some positive indications were observed (brix values, lowering numbers of bacteria, successful inoculation of bacterial feeding nematodes…) However, the results still show insufficient quantities of beneficial protozoa, too high numbers of bacterial biomass as well as unbalanced bacterial to fungal biomass ratio determined for the productive pasture. For nutrient cycling to work effectively, we need to do more applications to increase the missing organisms´ numbers and balance the fungal-bacterial biomass ratio. Progress will be monitored in the coming years.

The comparison of brix levels on two occasions showed the difference in sugar content, which means that efficiency of the plants to photosynthesize was higher in the experimental plot which is attributed to the to the higher nutrient cycling potential of the soil food web present.

While compaction levels showed a change in the beginning of season two, the compaction rates were still too high, and the application of bioactive compost extract and bioactive compost was unable to break the compaction.

While the bioactive thermophilic compost is an effective way of inoculating the pasture soil with the soil microorganisms, the compaction issue on this heavy compacted soil requires mechanical breaking of the compacted layers and applying biology directly to the furrows. Another issue that hinders the pasture regeneration is the fact that it is overused during prologued periods of time (heifers graze for several days at a time).

Bioactive compost showed as a good, safe and cost-effective substitute for mineral fertilizers that have unattended consequences

Appendix 1:

A bare patch circled on the figure (May 2021) has been bare and compacted for years. This is the place where a water tank is brought every season for the cows to have a source of fresh water. It was so heavy compacted (20Bar at 1cm depth!) that nothing grew there.

FIGURE 2 BARE PATCH ON THE PLOT, MAY 2021

Every time a compost extract was applied to the experimental plot, this bare patch would also be sprayed. Some compost was also spread there in October of 2021. The microbiological progress hasn't been followed and even though this patch of bare land is formally excluded from the experiment, the effects of the compost and compost extract applications are so dramatic and visible that it is decided to be put in this report.

The following figures (Figure 3 a, b, c) show the visible progress of the bare patch throughout the season 2022.

It clearly shows that it has started to progress on a scale of the successional stages, as it became covered with early successional plants.

Figure 3a. shows that early in the season the bare patch started to get covered, and by the end of the June (Figure 3c.) the whole patch was almost whole covered with various self-propagating plants. The soil started to regenerate!

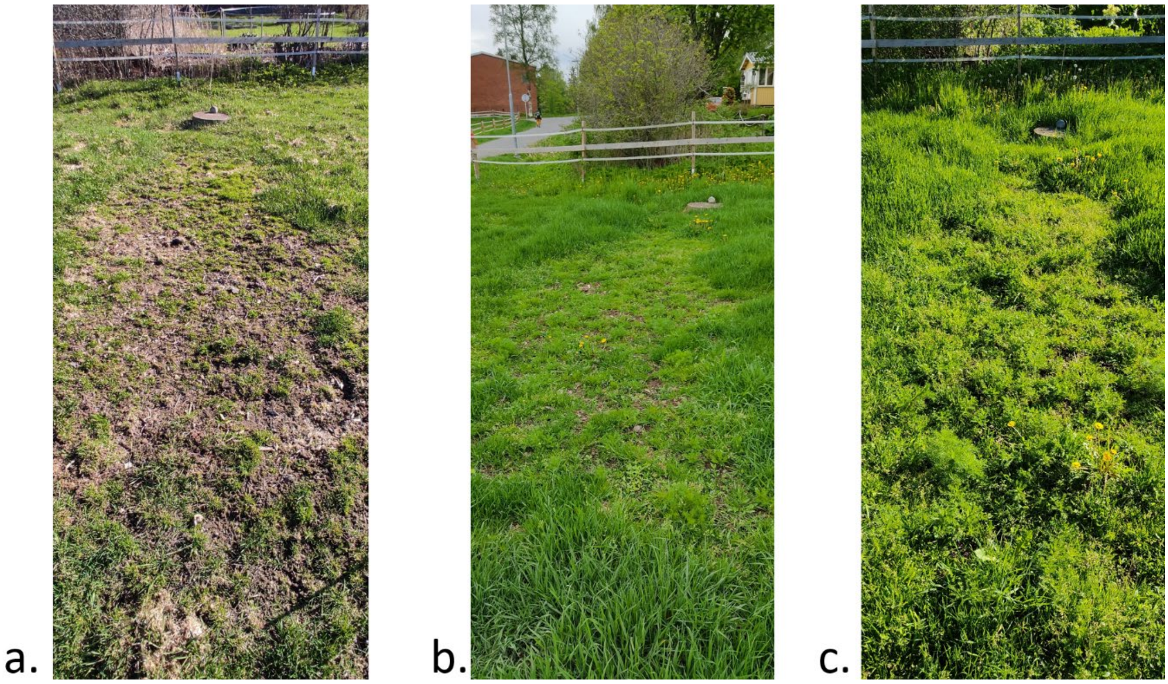


Figure 3 Progress of bare patch of the pasture, a. beginning of May, b. mid-May, c. June 2022

Appendix 2: Compost recipes

Pile 2021			
High-N Materials		**20l bucket**	**%**
Type	**Details**		
cow manure	50% of the cowbedding)	10	16.7%
Total High-N Materials		10	16.7%
Green Materials		**20l bucket**	**%**
Type	**Details**		
hay		15	25.0%
coffee grounds		5	8.3%
Total Green Materials		20	33.3%
Woody Materials		**20l bucket**	**%**
Type	**Details**		
peatmoss	50% of the cowbedding	10	16.7%
straw		10	20.0%
woodchips		10	8.3%
Total Woody Materials		30	50.0%
Total Materials		60	100.0%

Pile 2022			
High-N Materials		**20l bucket**	**%**
Type	**Details**		
cow manure	50% of the cowbedding)	4	10 %
Total High-N Materials		4	10 %
Green Materials		**20l bucket**	**%**
Type	**Details**		
green plants	various cultivated and self propagated plants and tree branches and leaves. 20+varieties	12	30 %
Total Green Materials		12	30 %
Woody Materials		**20l bucket**	**%**
Type	**Details**		
woodchips	Last year´s woodchips of several different tree species, both deciduous and evergreen	12	30.0%
straw	fungal spawn in shredded straw	6	15.0%
dry leaves		2	2.5%
peat moss	cow bedding	4	10.0%
Total Woody Materials		24	60 %
Total Materials		40	100.0%

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