Soil Biology Examples for Row Crops, Grasses and Pastures

Compiled by Soil Foodweb Inc
Case Studies for Soil Biology Restoration
Restoring Soil Biology on Row Crops
Row Crops

5,000 hectares, South Africa

Row Crops without Biology severely damaged by pests, diseases, weeds, and low quality yields.

Row Crops treated with Biology outcompeted weeds and pests and created high quality, high brix, high value produce at record numbers. No fertilizers, pesticides, or herbicides were needed after.
In some fields, they needed to stop for 10-14 years to let the land recover.

The farm was depleting at a rapid rate.

With Soil Biology, tomatoes could be rapidly grown with no rotation.

No chemicals, fertilizers, pesticides.

Over $200,000 a year saved on a 300 acre farm section.

Work on the farm became easier.
Christmas Tree Farm

By applying Fungal-Rich Compost Tea on Their Christmas Trees at Different Stages of Growth, they decreased Mortality, and decreased the time to saleable trees from 8 years…to 4 years.

Needle cast (fungal disease) was a major problem for these growers; good biology applied to the needles alleviated that problem.
Shane’s farm (organic) and others in the area were suffering from crop losses. Extreme heat, pests, water logging, and diseases were reducing yields every year. He was considering changing to chemical agriculture because his system was failing.

Input Costs were extremely high, leading very tight margins. The farm’s future as well as the future of the farm workers was in serious jeopardy.

Taking Elaine’s Courses and creating Biologically Active Compost and Compost Tea radically improved production and reduced costs on their organic farm.

1500 hectare farm, South Africa

Main Crop: Bananas

Secondary Crops: Spinach, Green Beans, Ginger

Struggling Plants, December 2015

Thriving Crops, June 2017
The 1500 hectare banana farm had been organic for years, but yields were decreasing.

-Shane was already making 50,000 tons of compost on his farm a year, but it smelled bad, was infested with flies, and it wasn’t helping the plants. He later learned, it was anaerobic, disease causing compost.

-Every year he had to spend more on Potassium sulfate (1.5 tons/ha) blood meal, lime and gypsum (1.5-4.5 tons/ha), manure (40 ton/ha), and cedar wood chips. All these efforts were futile.

-In desperation, he found Elaine Ingham’s work online, signed up for her classes, and immediately started to implement a biological growing approach with his compost and compost tea.
Compost/Compost Teas decreased the pests, diseases, and plant mortality, fertilizer inputs and increased yields and plant growth.

December 2015

June 2017
By monitoring compost biology using a microscope and adjusting that biology when necessary, Shane’s team reduced their compost needs from over 45000 tons to only 12000-14000 tons per year.

The quality of the compost improved exponentially. More fungi, better smells, no flies, no more anaerobic bacteria.

Compost was applied on land at a rate of 2-10 tons per hectare, depending on the condition of the soil.
Shane trained 25 workers to manage making and applying compost tea.

Each brewer was 5000 liters; 36 brewers total.

For areas in production, they applied 150,000 liters of compost tea every two days to rapidly get the leaf coverage they needed.

Cleaning the tea brewers was the most challenging part of the compost tea process, luckily labor was affordable in Shane’s area of South Africa.
As the biology in the compost improved, in other words, the beneficial fungi started growing in the compost, the quality of the plant roots improved markedly.

The thickness and density of the root hairs in the plants increased and this was observed in both young and mature plants.
Compost and Compost Tea increased plant quality, yields, and survival rates in every stage of production.

Crop loss from pests (looper worm, grasshoppers cut worm) decreased almost entirely.

Biological improvements were measured using a microscope. Fungal : Bacterial ratios improved from 0 to 0.35 and are continuing to rise, with Protozoa and Bacteria present throughout.

All the expensive organic amendments were cut, while improving yields, and without having to rely on chemicals at all.
Shane was able to successfully grow other crops on his farm as well. 15 hectares of spinach, 20 hectares of green beans, 10 hectares of ginger.

Biologically active compost improved yields across the board and made organic production of these other crops feasible.
What Looks Better to You?

Without Biology, 2015

With Biology, June 2017
Final Words from a Farmer…

• “I would like to give God all the glory for what’s been achieved on the family farm, which could have not been possible without the help of Dr. Elaine Ingham and the Environment Celebration Team.”

- Shane Plath
Charlie’s Peanut Farm

Texas Organic Peanut Farm -- 90 Acre Circles

20% Increase -- 2015 to 2016 -- Two Compost Tea Applications
Problems on Surrounding Farms

• Recurring drought was a problem for farmers in the area.
• Conventional Farmers were losing money and yields from extreme weather events and input costs.
• 2016 Third Warmest Year on Record in Texas.
• Instead of increasing his fertilizer use, Charlie opted for restoring his Soil Biology....
Planting Peanuts -- May 2016

- 5 Gallons of Compost Tea Applied
  - Compost Tea & Mycorrhizae Applied
    - Seeds soaked with tea & mycorrhizae when planting
    - Brady’s Rhizobium (*Primo Power GX2 liquid*) also used
  - Soil Tested 8 Days After Planting
    - Checked Soil around baby roots
    - Good Organisms
      - bacteria, fungi, protozoa (okay)
      - testate amoebae
      - some nematodes (mainly bacterial feeders)
      - not many predatory nematodes.

Without Biology 2015  With Biology 2016
2016 - 20% Increase in Yield
$54,000 Increase in Profit

2015 (225 Tons) versus 2016 (270 Tons)
Ian Smith, Mooreville, Tasmania

Onion Grower

Conventional for many years
Wanted to see if all the fuss about biology was real
Ian Smith, Mooreville, Tasmania

Background issues

• Weeds

• Some insect problems
• Fertility
• Compaction
Ecologically, what is a weed?

• Only occur early in succession
• Disturbed soil, i.e., food web lacks one or more groups
• Pulses of nitrates: high concentrations for short times, no nitrate for short times
• Lack of soluble nutrients at certain times
• High acid or base; extremes of pH
• Habitat that helps “r” selected plants; plant is geared to seed production, not roots
Paddock 7 Onions with Conventional fertiliser and herbicide applications, planted same date as paddock
Close-up showing clean seedbed. Paddock 12
Overall view of paddock 12 low weed pressure
Overall view of paddock 12 low weed pressure
Paddock 12 one spray run not treated with compost tea. Can you spot where?
Paddock 7 Onion root system on conventional program. Poorer than Paddock 12.
Well established root system on onion plant. Paddock 12.
• Three compost teas have been applied to date. 2 x prior to seeding and 1 x post seeding.
• Reduced herbicide rate used prior to germination greatly reduced weed pressure on paddock 12, when compared with conventional paddock 7
• I am very excited about the progress to date and very impressed with the dedication that the SFI crew show towards their client.
Work by Renald Flores- Flores Sens Systems
Trials conducted with Normal Soil, Commercial Compost and Biologically Active Compost
Table 35: Potatoes Visual yield results

<table>
<thead>
<tr>
<th>Scenario 3: MICROBIOLOGICAL INOCULATION + COMPOST</th>
<th>Scenario 1: CONTROL (NO INPUT)</th>
<th>Scenario 2: COMMERCIAL COMPOST</th>
</tr>
</thead>
</table>

Our microbiological inoculant has a positive effect, cycling up the commercial compost carbon & nitrogen content, on our crops.
# Potatoe yield results

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>Field pre-growing season</th>
<th>Scenario 1 Control (No input)</th>
<th>Scenario 2 Compost Only</th>
<th>Scenario 3 Microbiological Inoc + Compost</th>
<th>Scenario 3 vs Scenario 1</th>
<th>Scenario 2 vs Scenario 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL CROP YIELD</strong></td>
<td>g/m²</td>
<td>N/A</td>
<td>1049</td>
<td>596</td>
<td>1492</td>
<td>42%</td>
</tr>
<tr>
<td><strong>1st Trophic Level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUNGI (µg)</td>
<td>24</td>
<td>170</td>
<td>491</td>
<td>523</td>
<td>208%</td>
<td>189%</td>
</tr>
<tr>
<td>BACTERIA (µg)</td>
<td>12829</td>
<td>5667</td>
<td>6653</td>
<td>3992</td>
<td>-30%</td>
<td>17%</td>
</tr>
<tr>
<td>FUNGI:BACTERIA</td>
<td>0.0019</td>
<td>0.03</td>
<td>0.074</td>
<td>0.131</td>
<td>337%</td>
<td>not relevant</td>
</tr>
<tr>
<td><strong>Protozoan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLAGELATES</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.08</td>
<td>Not relevant</td>
<td>not relevant</td>
</tr>
<tr>
<td>AMOEBAE</td>
<td>0</td>
<td>0.6</td>
<td>0.55</td>
<td>1.45</td>
<td>142%</td>
<td>Too low</td>
</tr>
<tr>
<td>CILIATES</td>
<td>0</td>
<td>0.56</td>
<td>0</td>
<td>0.08</td>
<td>In target</td>
<td>In target</td>
</tr>
<tr>
<td><strong>2nd &amp; 3rd Trophic level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root feeding</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>In target</td>
<td>In target</td>
</tr>
<tr>
<td>Bacterial Feeding</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Too low</td>
<td>Too low</td>
</tr>
<tr>
<td>Fungal feeding</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Too low</td>
<td>Too low</td>
</tr>
<tr>
<td>Omnivore</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>In target</td>
<td>In target</td>
</tr>
<tr>
<td><strong>Fungal density At 100X Total Mag</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Strands</td>
<td>N/A</td>
<td>45</td>
<td>42</td>
<td>77</td>
<td>71%</td>
<td>-7%</td>
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<tr>
<td>Occurrences</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av. Strand per field of view</td>
<td>N/A</td>
<td>0.58</td>
<td>0.55</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOIL PHYSICAL PROPERTIES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth in cm</td>
<td>N/A</td>
<td>21.89</td>
<td>20.11</td>
<td>19.67</td>
<td>-10%</td>
<td>-8%</td>
</tr>
</tbody>
</table>

(Source: Flor. és. Sens Systems, 2017)
Table 33: Onion Visual yield results

<table>
<thead>
<tr>
<th>Scenario 3: MICROBIOLOGICAL INOCULATION + COMPOST</th>
<th>Scenario 1: CONTROL (NO INPUT)</th>
<th>Scenario 2: COMMERCIAL COMPOST</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Our microbiological inoculant has a positive effect on 1st trophic level biomass, still was insufficient initial bacterial biomass to level enabling decent nutrient cycling.
# Onion yield results

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>Field pre-growing season</th>
<th>Scenario 1 Control (No input)</th>
<th>Scenario 2 Compost Only</th>
<th>Scenario 3 Microbiological inoc + Compost</th>
<th>Scenario 3 vs Scenario 1</th>
<th>Scenario 2 vs Scenario 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL CROP YIELD g/m²</td>
<td>N/A</td>
<td>1835</td>
<td>1784</td>
<td>2059</td>
<td>12%</td>
<td>-3%</td>
</tr>
<tr>
<td>1st Trophic Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUNGI (μg)</td>
<td>24</td>
<td>71</td>
<td>918</td>
<td>314</td>
<td>342%</td>
<td>1193%</td>
</tr>
<tr>
<td>BACTERIA (μg)</td>
<td>12829</td>
<td>18365</td>
<td>14587</td>
<td>7908</td>
<td>-57%</td>
<td>-21%</td>
</tr>
<tr>
<td>FUNGI:BACTERIA</td>
<td>0,0019</td>
<td>0,004</td>
<td>0,063</td>
<td>0,04</td>
<td>900%</td>
<td>not relevant</td>
</tr>
<tr>
<td>Protozoan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLAGELATES</td>
<td>0</td>
<td>0,001</td>
<td>0,05</td>
<td>0,24</td>
<td>not relevant</td>
<td>not relevant</td>
</tr>
<tr>
<td>AMOEBAE</td>
<td>0</td>
<td>0,47</td>
<td>0,45</td>
<td>1,19</td>
<td>153%</td>
<td>-4%</td>
</tr>
<tr>
<td>CILIATES</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0,06</td>
<td>No relevant</td>
<td>In target</td>
</tr>
<tr>
<td>2nd &amp; 3rd Trophic level</td>
<td>Root feeding</td>
<td></td>
<td></td>
<td></td>
<td>In target</td>
<td>In target</td>
</tr>
<tr>
<td>Nematodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterial Feeding</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Too low</td>
<td>Too low</td>
</tr>
<tr>
<td>Fungal feeding</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Too low</td>
<td>Too low</td>
</tr>
<tr>
<td>Predatory - Omni</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>In target</td>
<td>In target</td>
</tr>
<tr>
<td>Fungal density At 100X Total Mag</td>
<td>Total Strands Occurrences</td>
<td>N/A</td>
<td>50</td>
<td>80</td>
<td>125</td>
<td>150%</td>
</tr>
<tr>
<td></td>
<td>Av. Strand per field of view</td>
<td>N/A</td>
<td>0,65</td>
<td>1,04</td>
<td>1,62</td>
<td></td>
</tr>
<tr>
<td>SOIL PHYSICAL PROPERTIES</td>
<td>Depth in cm reached under 100psi</td>
<td>N/A</td>
<td>21,22</td>
<td>21,22</td>
<td>19,89</td>
<td>-6%</td>
</tr>
</tbody>
</table>

Celeriac Visual yield results

**Scenario 3:**
MICROBIOLOGICAL INOCULATION + COMPOST

**Scenario 1:**
CONTROL (NO INPUT)

**Scenario 2:**
COMMERCIAL COMPOST

## Table 31: Fennel Visual yield results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1:</td>
<td>Control (No Input)</td>
<td>Base – tip 46 CM, Total sellable weight 52g, Total edible weight 61g</td>
</tr>
<tr>
<td>Scenario 2:</td>
<td>Commercial Compost</td>
<td>Base – tip 46 CM, Total sellable weight 52g, Total edible weight 61g</td>
</tr>
<tr>
<td>Scenario 3:</td>
<td>Microbiological Inoculation + Compost</td>
<td>Base – tip 56 CM, Total sellable weight 140g</td>
</tr>
</tbody>
</table>

(Source: Flor.Ès.Sens Systems, 2017)
Restoring Soil Biology on Ranches
Tony Evans and Nick Routson
Andrew and Linda Whiting’s Farm
Reggie and Geoff Davis
Featured on Landline  3/7/2011
Tim and Sally McGlade
Background Issues

• Fertiliser costs out of control but fertility not good enough
• Insect pressure on lucerne; Insecticides used regularly
• Grass being pulled out by the roots, had to re-sow many paddocks each Autumn ($20,000/field)
• Clover long gone: no nitrogen fixation, dependence on chemical fertilizers
• Profit margins not good, animals sick, disillusioned with results of farming
• No waste management plan
Why is composting needed?

• Kill human pathogens, plant pathogens, parasites
• Kill seeds
• Kill root-feeding nematodes
• Concentrate and retain nutrients
Program

• Make compost ON-FARM;
• Applied at 3 tonne hectare (1.5 tons to the acre) after a grazing rotation in the autumn; again in spring if needed, based on biology assessment, then three extracts or teas with fish hydrolysates, a month apart.
• In the first year, shared equipment over 5 farms, in the second year, 74 farms, in the third year 175 farms
• Initially if fertility was inadequate, the grower could add liquid calcium nitrate, pond water.
• This was never required.
Nodules on N-fixing plants
May 2011

No N has been applied since compost addition. Pasture is ready to be grazed ten days after last grazing.
December (spring) 2010

The left side is the neighbors’ farm; the right side of fence is the Whiting’s farm.
Same paddock in April, 2011
Whiting’s on left
Grazed 5 times
Neighbours on right
Grazed once
since the season started
Whiting’s: Grazed 7 times times since season started  Neighbours grass still not grazed
Results

• Deeper and larger root system; Cows not pulling grass out by roots
• Re-sowing costs decreased by 90% ($20,000 reduced cost per field per year)
• Nitrogen use reduced by over half each year (dropped costs by $100,000 in first year, $50,000 more in second year, no N applications in this year). Saved growers over $200,000/yr
• Converted wastes into benefit
• No disease or insect pressure
• Cow fertility improved significantly (need to validate).
• Stocking rate increased over last two years by 15%
• Mycorrhizal fungi increase from 4% to 87% in three years
Results

• Tissue tests balanced
• Farm different colour
• No response to gibberellic acid or N fertiliser
• Much higher brix from 1-2 up now to 11-13
• No cockchafer damage, neighbours still do
• No red legs or lucerne flea damage
• Clovers coming back
• Deeper roots
• Good growth in wet conditions
• Lots of worm activity and good numbers
• Bringing Soil Biology into Compaction Layers with hole punching and Compost/Compost Tea Injection.

• Deep tilling and injecting with Soil Biology.

• Tilling and spreading with Compost. (Your last tillage ever!)

If you cut the top, do the roots fall off?

Hendrikus Schraven holding ryegrass planted July 15, 2002

Harvested Nov 6, 2002
Mowed twice to ½ inch

70% Essential Soil, 30% Compost/organic fertilizer
Compost tea once

No weeds, no disease
www.soildynamics.com
Other Grassland Trials

Biological V’s Conventional Approach to Soil Management

Compost Tea Test Trial
Summer 2003

by Abron New Zealand
Russell Snodgrass, SFI Advisor
Background

- Trial area consists of two plots fenced off from stock and the pasture harvested every 20-30 days using a mower
- Trial was carried out on a conventional dairy farm in the Bay of Plenty, New Zealand
- All testing is done by Hill Laboratories and the Soil Foodweb Institute NZ
- Trial overseen by Mark Macintosh of Agfirst Consultants
- Trial started 1 October 2003
  Trial finished 24 February 2004
Treatment

• Compost Tea Plot
  – Three applications of compost tea and foods at 150L/ha applied every 4 weeks starting in October 2003
  – No fertiliser had been applied to the compost tea trial plot for the 12 months prior or throughout the trial

• Control Plot
  – Conventionally fertilised with urea at an application rate of 75kg/ha every 6-8 weeks (450kg/ha per year)
  – Phosphate Sulphur Magnesium applied at industry maintenance levels
Total Dry Matter Grown

- Control: 7276 Kg per ha
- Compost Tea: 8133 Kg per ha
Average Clover % in Pasture Sward

- Control: 6.25%
- Compost Tea: 42.5%

Trial
Biologically Active Compost created from waste materials from the dairy farms had incredible results in just one growing season.

Grass on pasture could be grazed every 10 days, as much as 7 times a season, while the neighbors land could only be grazed once.

Compost application saved the farm 200K a year in the first year by reduced costs on fertilizers, reseeding, and veterinary bills.
Results

• Deeper and larger root system; Cows not pulling grass out by roots
• Re-sowing costs decreased by 90% ($20,000 reduced cost per field per year)
• Nitrogen use reduced by over half each year (dropped costs by $100,000 in first year, $50,000 more in second year, no N applications in this year). Saved growers over $200,000/yr
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• No disease or insect pressure
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Restoring Soil Biology on Parks, Turf and Landscapes
Todd Harrington Case Study- Governors Island, New York Harbor

- [https://govisland.com/](https://govisland.com/)
- Land Restoration Lead By Todd Harrington, former student of Elaine Ingham and Life in the Soils Certified Consultant
- [http://harringtonsorganic.com](http://harringtonsorganic.com)
Project Background

• 172 Acre Park Project
• Started in 2015
• Idea was to former concrete, bare ground areas into mixed biome parkland in a short amount of time.
Area was dirt before start of project, 2015
Topsoil and Organic Material were brought in from off-site, 2015
Before planting and biology added, late 2015
Planting trees, late 2015/early 2016
Different Compost made for each unique biome (Turf, Native Grasses, Forest, etc.)
Scalable Compost Tea/Extract systems made alongside a Mobile Compost Tea Brewer.
Compost/Compost Tea applied to new plants
2016

- Green section had a compost tea application before the season ended.

- Right section didn’t get a compost tea treatment before the season closed.
2017
2017
Battery Park understory planted April 2010
Picture taken by Tom Pew (U of Arizona) Aug 17, 2010 during drought period
Work by James Sottilo, elmsave.com
Battery Park Ball Field maintained with biological approach only (T. Fleischer, Park Conservancy)

Picture taken by Tom Pew (U of Arizona) Aug 17, 2010 during drought period

Work by James Sottilo

www.elmsave.com
Brooklyn Bridge Park, NYC Compost tea user
Client of James Sottilo  ElmWise.com

After weeks of hot weather and after 8,000 people watched a movie on the lawn the previous night!
Brooklyn Bridge Park, planted April 2010

Picture taken by Tom Pew (U of Az) Aug 17, 2010 during drought

Work by James Sottilo, elmsave.com
Brooklyn Bridge Park
Planted April 2010
Picture taken by Tom Pew (U of Arizona)
Aug 17, 2010 during drought period

Work by James Sottilo
www.elmsave.com
August 3, 2005

Black layer in turf strongly evident

No roots growing through the black layer

100% pure sand green
September 26, 2005

Following third application of compost tea to turf

Note significant decrease in black layer
Left side treated with compost tea with soil biology, right side not treated.

Side with biologically active compost tea was able to retain green growth during the summer, even when water was cut.
Tea sprayed (green area) versus no tea area (brown)
Diverse Landscape Management

Harrington’s Organics; Boston Tree Preservation; SafeLawns
Sod installed around new pond just after installation and one compost tea spray
6 weeks after sod was laid with compost tea below and on the sod. Roots were less than \( \frac{1}{2} \) inch, now 6 inches deep into the soil. No erosion, no weeds, no disease