everflux TECHNOLOGIES

High Yield Natural Farming for the Modern Era

Using microbes to eliminate chemical fertilizers and pesticides

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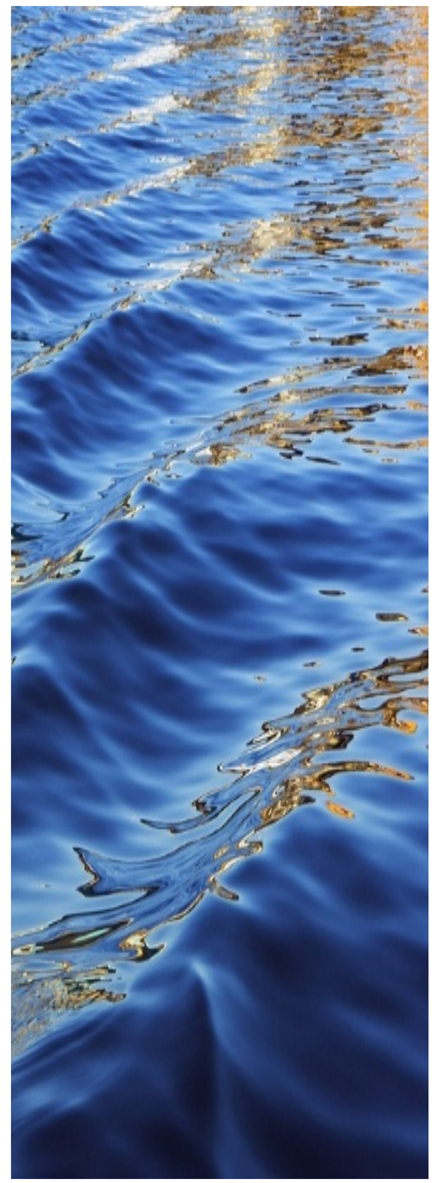

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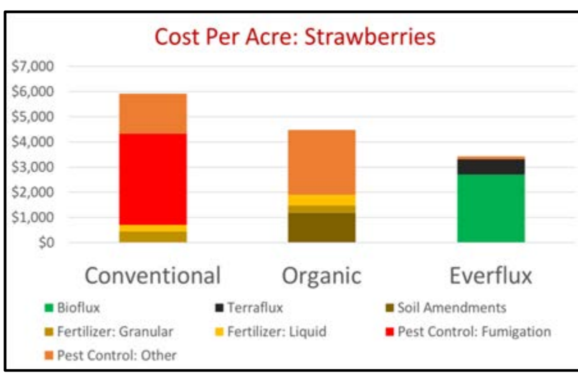
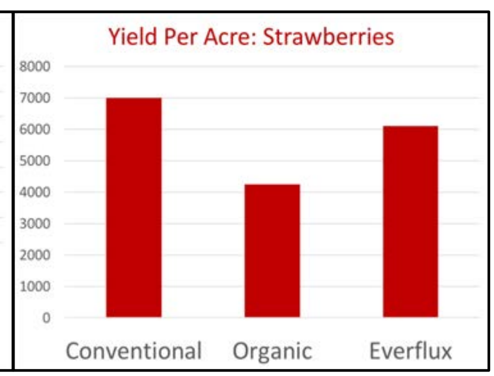
Executive Summary

Modern agriculture is in need of a transformation. Ever since the discovery that Nitrogen, Phosphorus and Potassium were the key macronutrients needed for plant growth, agriculture has been dominated by chemicals. But this is 150-year-old science. New research is finally validating what western organic farmers have known for decades, and what Eastern farmers have known for thousands of years: cultivating **soil organic matter** is the key to healthy plants, healthy people, a healthy planet *and* healthy yields. Modern science is just now uncovering the reason why soil organic matter is so key: it is what supports soil microbes, which provide plants with all manner of benefits.

In this paper, you will learn about how regenerative organic farming pioneer Michael Collins stumbled across a scientific insight that allowed him to grow crops with yields similar to conventional agriculture, while using only natural and organic inputs, at about half of the average cost. The system he developed was not only natural and in-expensive, it was also less work, and completely compatible with the implements of modern agriculture. What's more, this system is backed up by decades of research into soil and plant science, as well as thousands of years of Eastern agricultural practices.

Michael took this insight and turned it into two products, which today we call Bioflux and Terraflux. Bioflux is a liquid microbial inoculant made from recycled organic materials, and Terraflux – the name of which was inspired by Tera Preta, one of the most fertile soils on Earth – consists of biochar, inoculated with Bioflux. Using only these two inputs and regular cover cropping, Michael was able to achieve the amazing results described above: high yields, lower input costs, minimal effort, and no chemical fertilizers or pesticides. The chart below shows Michael's results for strawberries grown at Bloomfield Organics (labeled as "Everflux").





The goal of this paper is to explain the benefits of using Bioflux and Terraflux, the ancient farming wisdom from which it originated, as well as the modern science that is now explaining how it works. It will also describe how this system can be used across the world to make farming more sustainable and productive.

A Farmer-Scientist is Born

Michael Collins grew up in Silicon Valley, when there were still more apricot trees than tech companies. His father was an engineer and did business with technology pioneers like David Packard, while running an orchard at the same time. They later opened one of the first wineries in the Napa Valley: Con Creek. From a young age, Michael was exposed to both farming and high technology.

After receiving an advanced degree in Olericulture – the science of vegetable growing – from UC Davis, Michael traveled the world for nearly 10 years, working on various organic farms from the Philippines to Costa Rica. Then in the early 1990s, he moved back to California to start one of the first certified organic farms in the state: Bloomfield Farms, based in Valley Ford, Sonoma County, California (the name was later changed to Bloomfield Organics). Before long, he became the first farmer to supply vegetables to the newly opened vegan organic food manufacturer, Amy's Kitchen. He would also become one of an elite few farmers to grow vegetables for world famous chef Alice Waters, of Chez Panisse.

Michael is a constant innovator, often far ahead of the curve in both methods and science. He saw the importance of promoting soil biology and building organic matter for long term soil health before terms like "regenerative" and "biodynamic" became popular. Whereas many farmers specialize in growing just a few crops, Michael learned to cultivate over 200 species of vegetables, fruits and grains on his 50-acre farm. This intensive polyculture, the small scale of his farm and the rapidly rising cost of land in Sonoma county forced him to explore new, cutting edge methods of farming.

Michael began to study the school of thought known as Korean Natural Farming, as well as the work of Japanese scientist Dr. Teruo Higa, the inventor of one of the world's first microbial fertilizer, Effective Microorganism (EM1). As a result, he began experimenting with anaerobic fermentation of organic material to make a biological fertilizer and pest control. He would study various organic materials under a microscope to identify the bacteria and fungi present in those materials, research which species might be useful to his plants, and which ones could survive under similar pH and temperature conditions. Then, if they seemed suitable, he would add them to his mixture. He largely targeted microbes that were known *endophytes* – microbes that live in symbiosis with plants and provide them with benefits in exchange for food – as he believed these had the greatest potential for aiding in plant growth and overall health.

After 15 years of experimentation, Michael noticed one day that his strawberries had grown bigger and shinier than ever before. After harvest, he found they had yielded 6,100 trays per acre – higher than even the highest organic strawberry yield on the California Central Coast: 5,000 trays per acre.[1] Yet unlike most conventional strawberries, they still had a rich, sweet flavor. He began trying this new formulation on the 215 other crops he grew on his farm, and achieved similar results with all of them.

After using this system for a number of years, Michael realized that other farmers would likely be willing to pay for access to a system that would decreased their input cost, while maintaining or increasing their yields. Now Everflux Technologies is offering this system to farmers across the world, through the products Bioflux and Terraflux.

Mexican Quinoa grown with Bioflux and Terraflux

Bioflux: A fermented juice for plants and soil

Like fermented beverages for humans, Bioflux is a diverse nutrient source and a probiotic. Fertilizers based strictly on chemistry alone fail to provide all the micronutrients, organic compounds and other functions that plants evolved to receive from soil microorganisms. Most agricultural soils no longer contain all these microbes either, because they have been disturbed by everything from tillage to plant roots being removed when annual crops are harvested, to a lack of plant cover during fallow periods. Bioflux restores all this great and necessary biology. Its primary benefits are as follows:

1. It contains hundreds of species of mostly facultative anaerobic microbes. Many gardeners and farmers have been taught mistakenly that anything anaerobic is bad. If your goal is aerobic composting, then you don't want it to become anaerobic. But anaerobic decomposition is not inherently bad, and it mimics nature more accurately. When leaves fall on the ground, they often get saturated in water and don't move for months, undergoing anaerobic decomposition. The microbes that develop in this process are flexible – *facultative* – meaning they can use either aerobic or anaerobic respiration, and can therefore adapt to changes in soil oxygen. The microbes that proliferate through this process include both bacteria and fungi that have evolved to help plants take in the nutrients and fight off diseases from decomposing organic matter. Many of them are endophytes.

2. It's full of organic acids that plants love. Because Bioflux undergoes a fermentation, it eventually reaches a pH below four, where acid-loving microbes thrive and produce more organic acids, such as lactic acid, acetic acid, humic and fluvic acid. While the benefits of humic and fluvic acid are well known as components of soil humus, the benefits of lactic and acedic acid are also significant, and will be discussed in more detail in a later section. When mixed with the right ratio of water, Bioflux can be delivered to plants with an overall pH that's near neutral, so it doesn't over acidify the soil. The availability of nutrients in these organic acids also makes it ideal for hydroponic growing.

A strawberry and an heirloom tomato grown with Bioflux and Terraflux

3. It's guaranteed to be 100% safe and pathogen free. Because the pH of Bioflux dips below four and is kept there, human pathogens cannot survive in that environment. The fact that Bioflux is kept in static, closed containers rather than being aerated like compost tea means that pathogens which may be floating around in the air won't be reintroduced – and even if they were, the acidity would quickly kill them.

4. It will never clog, and in fact will *clean*, your irrigation equipment or sprayers. This is largely due to the relatively high concentration of microbial-produced acetic acid in Bioflux. Acedic acid is the main acid present in vinegar, a common solution used to clean irrigation lines.

5. It builds soil organic matter. Bioflux is made up of decomposed or decomposing organic matter and microbes. The lives of individual microbes are short, and once they die, they also become organic matter themselves. Organic matter also provides a lot of other benefits to the soil. It is crucial in the formation of soil aggregates, which give soil its structure, and leaves space for water and oxygen to get in. Water can be absorbed into and stored by the soil, making plants more resistant to droughts. It also allows water to drain into aquifers during a heavy rain – as opposed to running off into nearby waterways. Soil organic matter can also help retain mineral nutrients for later use by plants.[2] Bioflux can quickly saturate depleted soils with organic matter, jumpstarting the process of remediation, and building up the reservoir of organic matter in already healthy soils.

6. It reduces salinity. Michael measured a significant drop in electrical conductivity (EC) – an indicator of salinity – in soils where he applied Bioflux. This is likely due to the fact that either mycorrhizal fungi help roots to reduce salinity,[3] or that the mycorrhiza themselves tie up the salts and protect the plants.[4]

Terraflux: Simulating the fertility of Terra Preta

The one disadvantage of Bioflux is that its effects usually do not last much past one crop cycle. Soils become disturbed again through plowing and harvesting, and nutrients get used up. Both of these phenomenon lead to a re-decline in soil life and a departure of endophytes from the field. This is why we created Terraflux: to **prolong and enhance the effects of Bioflux**. Terraflux is made by fermenting biochar in bioflux, essentially inoculating the biochar with the microbes and nutrients from Bioflux.

This simulates how one of the most fertile soils in the world, Terra Preta, was created over thousands of years near villages in the Amazon Rainforest. Many millennia ago, people living in the Amazon realized that the charcoal left from their fires was somehow enhancing the fertility of their soil. It appears that they began mixing this into the soil, and over time the soil microbes transformed this into "dark earth" (terra preta), the fertility of which has been preserved to this day, despite the otherwise infertile soil throughout the rest of the Amazon.[5]

Biochar has been recognized for at least a decade as a great material for promoting soil fertility. Biochar consists of woody biomass that has been "thermally modified" by burning it in the absence of oxygen, a process sometimes known as pyrolysis. Biochar has been shown to have a number of improvements on the soil, including improving moisture retention, improving air permeability, but most importantly, it enhances cation exchange capacity (the ability to move nutrients around), and catalyzes the growth of soil microbial life. It also is very stable in the long-term, because the carbon structures created in the process of making biochar are very hard for microbes to consume.[6] Because biochar is very dry and has a high surface area, it essentially acts like a sponge for nutrients and microbes. This, along with its longevity, makes it a perfect home for microbes to move into.

But putting "raw" biochar into the soil has some disadvantages, and can even create some problems. Despite its ability to absorb and hold water, biochar is initially somewhat hydrophobic, and its cation exchange capacity is relatively low, until it comes in contact with soil microbes.[7] Therefore, inoculating biochar before it's put into the soil can make the biochar immediately ready to enhance these soil properties. Biochar can be detrimental to the soil primarily in two ways. First, biochar typically has a very alkaline pH – around 10 or 11. If a soil's pH is not acidic, the addition of biochar can make the pH undesirably high. Second, because of its sponge-like capabilities, biochar may absorb too much water and nutrients from the soil around it, "stealing" these from the plants, at least in the short term. Being that it is both a liquid and runs acidic, Bioflux is an ideal pre-inoculant for biochar, mitigating both of these pH and absorption effects.

Above all, the physical and chemical effects of biochar have been shown to increase microbial abundance and reproductive activity in a number of environments.[8] Biochar is therefore a natural carrier for the hundreds of microbe species in Bioflux, and Bioflux can ensure that soil gets the maximum benefits from biochar. Michael Collins demonstrated this when he grew giant strawberries that were both rich in flavor and practically devoid of fungal diseases over a number of seasons.

Strawberries grown in a controlled trial without Bioflux or Terraflux (6 in height) and with them (9 in height)

It isn't just Michael Collins who saw results using Terraflux and Bioflux. Over a dozen other farmers have used the product as well in a variety of soil types and climatic conditions and also observed many of the same benefits. And it turns out, Eastern Asian farmers have been using these principles to achieve high yields and maintain fertility for thousands of years.

Ancient Wisdom

Agriculture is one of the few modern disciplines that has been practiced for thousands of years – long before the advent of science. As a result, there are some practice which have been developed by tradition cultures that are known to work, even though we may not have a complete, scientific explanation as to why they work. Explaining these practices with science is useful, but a lack of a complete scientific explanation for why they work should not necessarily preclude us from learning from this ancient wisdom, as Michael Collins did.

In his book *Farmers for Forty Centuries*, written in 1911, F.H. King first documented the stunning success of Eastern organic agriculture and introduced it to the West. One of the key facets of Eastern agriculture that he observed is their practice of returning organic material to the soil. He describes how crop residues, animal and human excrement are treated, not by turning aerated compost piles, but by sealing them in air-tight structures made of clay, where they are saturated with water and allowed to ferment for several weeks.[9] This, along with cover cropping, appeared to him to be what had allowed East Asians to sustain dense populations on the same farm land for thousands of years. The fact that this region of the world could support as many people as it did is quite telling of how effective these practices were. In the United States today, there are about 228 people per square mile of farmland. According to King's calculations at the time – around the year 1900 – there were 1,783 people per square mile of farmland in China.[10] This means that China was able to support a population to farm land ratio almost eight times higher than that ratio in the US today, with small scale, organic agriculture alone.

A few decades later, Sir Albert Howard picked up this line of thinking. In his most famous work, *An Agricultural Testament*, he described the importance of building soil organic matter for feeding plants and maintaining soil fertility, and that mycorrhizal fungi somehow played an important role in this. This idea was followed religiously by the nascent organic farming movement, but it was rejected by mainstream agriculture because Howard was not able to fully explain why soil organic matter and mycorrhiza were important.[11] Several decades later, scientists have come to understand that Howard had been right the whole time. We now know that organic matter provides the habitat and food for a diverse array of microbes, including mycorrhizal fungi and bacteria, which in turn make nutrients bioavailable to plants. Just like microbes are the key to human digestion, they are also key for plants to "digest" and use mineral nutrients. Practices like adding compost or manure to a field are understood to contribute to building this soil organic matter.

A less well researched practice for adding organic matter and nutrients to the soil is the practice of anaerobic fermentation that King observed in China, Japan and Korea. As the originator of the Cradle to Cradle concept, William McDonough, observes in his TED talk, it seems that East Asian farmers understand a lot about soil fertility that western civilization does not, since they were able to farm the same ground for over 4,000 years.[12] Could they have been right about this too?

Today, the technique of fermenting organic material to make biofertilizer is practiced by a small but growing group of farmers in North America who follow the practices of "Korean Natural Farming." In his book *JADAM Organic Farming*, Youngsang Cho describes the practice of making fermented plant juice from organic waste, and claims that himself and many other farmers are able to produce liquid biofertilizers with more nutrients in them than compost, through the process of anaerobic fermentation.[13] Scientific research on Korean Natural Farming practices in the US is largely centered at the University of Hawaii, where researchers have been studying these practices since the late 1990s. In some of these studies, farmers have been able to achieve similar to better yields than conventional methods, using natural farming methods, including fermented plant juice. In the experiment depicted below, the soybean plants that received natural farming treatments actually product 28% higher yields than the conventionally treated plants.[14]

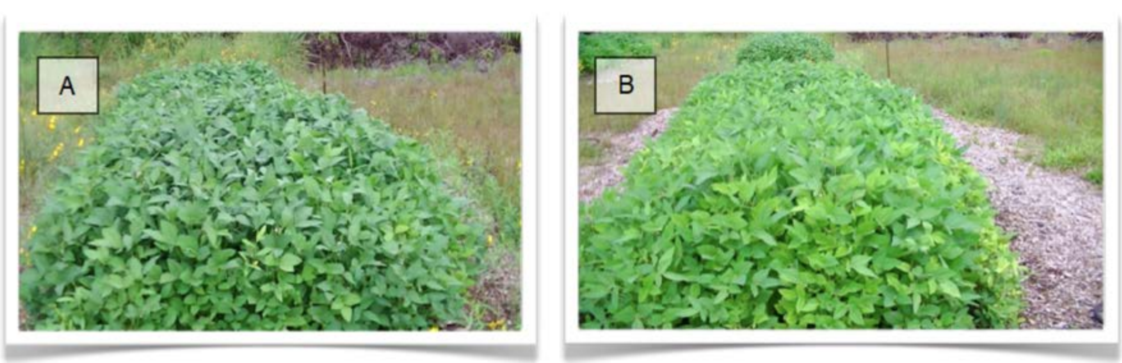


Fig. 1. Experiment at Farm 1: soybean growth in A) Korean Natural Farming (KNF) practice, and B) conventional (CONV) farming practice.

Farmers around the world have been using Effective Microorganism (EM1) for decades as an agricultural additive and a starter culture for making fermented plant juice. EM1 combines several species of microbes from five primary groups: lactic acid bacteria, phototropic bacteria, actinomycetes, yeasts and mold. Together, these groups bio-dominate their environment and proliferate faster than other species, and they are able to decompose organic matter in a way that makes all the energy and nutrients stored in the organic material bioavailable to the new plants. This happens also through an anaerobic fermentation process. EM1 has been used by farmers around the world for decades. In one of the most comprehensive studies ever conducted on the effects of EM1, 45 out of 62 farmers participating in the trials considered the EM1 treatment they received to be effective in qualitative ways. Out of 30 trials which were analyzed quantitatively, 19 showed statistically significant benefits of EM1, either directly applied, or used to ferment organic material before applying it to the field.[15]

Since the introduction of EM1 to the farming world in the early 1990s, soil science has undergone a renaissance. Scientists understand orders of magnitude more today about the microbes inhabiting the soil and plants, and the many ways in which they benefit plants, than they did 30 years ago. And this new science is beginning to shed light on why the techniques of Natural Farming, Dr. Higa and Michael Collins, work so well.

Emerging Science

A nutrient analysis of Bioflux using standard laboratory techniques yields results that would be dismaying to the average fertilizer manufacturer: it shows less than 0.5% Nitrogen and Phosphorus, and just 0.68% Potassium. Other nutrients come up with similarly low results, as you can see in the image below. Yet Bioflux has produced amazing results not only for Michael Collins, but for dozens of other farmers that have used it.

CERTIFICATE OF ANALYSIS

Method	Parameter	Result	Units
AOAC 978.02	Nitrogen, Total (N)	0.21	%
AOAC 993.31 D.3	Phosphate, Available (P2O5)	0.22	%
AOAC mod	Potassium, Water Soluble (K2O)	0.68	%
AOAC 982.01	Boron (B), Total	< 0.01	%
AOAC 928.02	Chloride (Cl)	0.18	%
AFPC IX.14.B	Fluoride (F)	< 5	ppm
AOAC 980.02(b)	Sulfur, Total (S)	0.20	%
AOAC 2006.03(mod)	Aluminum (Al)	0.003	%
	Calcium (Ca)	0.34	%
	Copper (Cu)	< 0.001	%
	Iron (Fe)	0.006	%
	Magnesium (Mg)	0.13	%
	Manganese (Mn)	< 0.001	%
	Zinc (Zn)	< 0.001	%
J AOAC, 97 (3): 721-730	Humic Acid	< 0.1	%

This would not be entirely surprising to David Montomery, Professor of geomorphology at the University of Washington, and author of *Growing A Revolution*. Nutrients that are not readily available to plants will not show up in these types of tests. They are missing the potential for microorganisms to convert those nutrients into something the plants can use.[16] The same effect was observed by David C. Johnson, a researcher at New Mexico State University, who was able to grow chilis twice as fast in anaerobically fermented cow manure. His conclusion was that the balance of bacteria and fungi were the main contributor to this, because a conventional soil test did not show any surplus nutrients.[17] These tests also do not consider the effects of microbe species which may help plants obtain nutrients from the soil or the air (i.e. nitrogen fixation) that were not available to them otherwise.

This fact highlights exactly what agricultural science has been missing for the last 150 years, ever since Justus von Liebig first popularized the idea of N-P-K chemistry's importance to plant growth. Microbes are the missing link between soil nutrients and plant nutrition. According to soil scientist Jon Stika, author of *A Soil Owner's Manual*, most soils in the United States, whether agricultural or otherwise, are to some degree dysfunctional. These soils suffer from too much disturbance, too little plant diversity, not enough time hosting living roots, and a lack of soil cover.[18] All of these factors contribute to a loss of the microbial communities that would normally help plants absorb nutrients and fight pests and diseases.

We know that Bioflux can reintroduce these microbial communities. But what exactly are these microbes doing? What species are present, how do they help plants, and how do they interact? Unfortunately, modern science so far can only answer some of these questions. As Australian soil scientist Christine Jones points out, "When living things behave symbiotically they have emergent properties that reductionist science cannot predict."

The best effort we've seen so far to interpret the impacts of these microbes as a consortium is by a company called Biome Makers. They use a combination of next generation DNA sequencing technology and Artificial Intelligence to come up with what they call a "BECROP" analysis, where they first identify, and then assign functions to, all the microbes in a given biome. The cover page of this report is pictured above.

According to one analysis they performed on Bioflux, there were **238 species of bacteria and fungi present**, performing functions ranging from pest biocontrol and stress adaptation, to plant hormone production and nutrient uptake. For more details, please request a full copy of the report by emailing info@everflux.tech.

Besides this, scientists have begun to study and catalogue the functions of individual microbe species and genera in relation to plants. In additional to their meta-analysis, Biome Makers came up with a list of all the individual species of bacteria and fungi present in Bioflux. Described below are a handful of the species identified in Bioflux, which have individual functions that are recognized as being plant beneficial.

BACTERIA	BENEFITS
Acetobacter sp.	Acetobacter species produce acetic acid, which gives Bioflux its ability to clean irrigation equipment. One study showed that the presence of acetic acid along with lactobacillus increased its effectiveness as a fungicide.[19] Another found that acetic acid combined with humic acid could be used to increase grape yield when used as a foliar spray.[20] Indol-3-acetic acid is also the primary chemical in the plant hormone auxin, which is responsible for stimulating all aspects of plant growth, from stems and roots to fruits and flowers. Auxin production was one of the functions of Bioflux identified by Biome Makers in the BECROP analysis.
Clostridium pasteurianum	This species was the first free living (non-symbiotic) micro-organism discovered that could fix free nitrogen from the air. It is a known acid producer, and has the ability to convert carbohydrates to butyrate, acetate, carbon dioxide, and molecular hydrogen through fermentation.

Lactobacillus and other lactic acid producing sp.	Lactic acid producing microbes are one of the most heavily concentrated groups found in Bioflux, and are largely responsible for the fermentation process that produces Bioflux. Scientific research has shown that they perform a number of functions for plants, including producing enzymes that attack pathogenic organisms, especially fungi, and making trace minerals more bioavailable. Soaking in lactic acid is also an especially effective seed treatment.[21] Some cannabis growers have found lactobacillus effective at fertilizing, pest control, and producing a superior high.[22]
Nitrosococcus sp.	These species are both nitrifying bacteria – specifically, ammonia oxidizing. They can help convert ammonia, which forms through the decomposition of proteins, into plant available nitrogen.[23]
Paenibacillus sp.	One of these species, Paenibacillus polymyxa (previously Bacillus polymyxa) is one of many Plant Growth-Promoting Rhizobacteria (PGPR) and is known to have a broad host plant range. Due to its broad host range, its ability to form endospores, and its ability to produce different kinds of antibiotics, P. polymyxa is a potential biocontrol agent. It is also capable of nitrogen fixing.[24]
Pseudomonas fluorescens	While there are several species of Pseudomonas in Bioflux, fluorescens seems to be the most important because of the key role it plays as a PGPR. One way it does this is by improving plant iron nutrition through siderophore secretion. Much iron in the soil is non-soluble and so not available to plants, but P. fluorescens can make it bioavailable (this was another major function of Bioflux identified by the BECROP report). It also secretes Indo-acetic acid, which, as described earlier, is a key plant growth hormone. Finally, different strains of P. fluorescens produce various antibiotics that help fight off common plant pathogens, such as black root rot.[25]
Shewanella putrefaciens	This is a facultative anaerobe with the ability to reduce iron and manganese metabolically, with implications for bioremediation, possibly reducing the harmful effect of heavy metals in soil.[26]

FUNGI	BENEFITS
Aspergillus sp.	One of these, Aspergillus piperis A/5 exhibits strong antifungal activity against the phytopathogen Pythium aphanidermatum. It secretes a complex mixture of metabolites consisting of small molecules, including gluconic acid, citric acid and itaconic acid derivatives, but the most potent antifungal activity was associated with proteins resistant to heat and organic solvents.[27]
Endomycorrhiza sp.	Endomycorrhiza facilitate the exchange of nutrients between the host plant and the soil. Mycorrhizae aid in the uptake of water, inorganic phosphorus, mineral or organic nitrogen, and amino acids. In exchange for the mycorrhizae providing all of these nutrients, the plant in turn provides the mycorrhizae with carbon. The mycorrhizae greatly increase the surface area of the plant's root system which is hugely beneficial in areas where drought is common.[28]
Epicoccum nigrum	This species has antimicrobial compounds that are effective against other fungi and bacteria present in soil. It is a biocontrol antifungal agent active against brown rot in stone fruit.[29]
Saccharomyces cerevisiae	This yeast species has been shown to be one of the most effective biofertilizers, because it increases nitrogen and phosphorous uptake by plant roots. It also increases the root to shoot ratio of plant seedlings.[30]
Trichoderma sp.	This fungal species is favored by the presence of high levels of plant roots, which it colonizes readily. Some strains are highly rhizosphere competent, i.e., able to colonize and grow on roots as they develop. Trichoderma spp. attack, parasitize and otherwise gain nutrition from other fungi. Since Trichoderma spp. grow and proliferate best when there are abundant healthy roots, they have evolved numerous mechanisms for both attack of other fungi and for enhancing plant and root growth. Several new general methods for both biocontrol and for causing enhancement of plant growth have recently been demonstrated.[31]

Again, these are only the effects of a handful of known species in Bioflux. What about the scores of other species that are less well studied? Many of the species identified in Bioflux have received little to no attention in the scientific literature. A Google scholar search for Rhizobium sp. 10II, for example, comes up with just ONE scientific paper published that even mentioned it. The genera Rhizobia is well known for containing many plant symbiotic, nitrogen-fixing species of bacteria. Could this one be nitrogen fixing as well? How does it perform in the presence of other microbes? These are still unanswered questions.

Given the scale of environmental and health problems posed by our modern agricultural system, we do not have time to wait a few more decades to fully understand what these microbes are capable of. We need new agricultural solutions today that have been proven to work through practice over decades, centuries and millennia – by farmers. Such methods, many would argue, have a better chance of being effective than those developed over the course of just a few years in a laboratory, by people who were far removed from the field.

Beyond "Bugs in a Jug"

With all this new information we have about the functions microbes perform for plants, it's easy to see why microbial fertilizers, sometimes deridingly called "bugs in a jug," have proliferated. Everyone is excited about harnessing the next great tool in agricultural science. All great, new advancements are looked upon skeptically when they are first introduced. And often justifiably so, because the first iterations sometimes don't work very well. In this case, the performance of many microbial fertilizers on the market today perform questionably.[32] We propose one overarching reason why this might be the case, using the analogy of the cane toad.

Humans have a history of introducing new species to an environment in the hope of fixing a problem that they created in the first place, rather than looking for the root cause of the problem. In 1930s Austrialia, the grey-backed cane beetle was becoming a major pest problem for sugar cane farmers. So in 1935, the Bureau of Sugar Experiment Stations introduced the cane toad from Hawaii to control the cane beetles. Rather than feeding on the cane beetles however, the toads found lots of other food, and quickly multiplied, eventually becoming a pest themselves. This is a classic example of how humans' lack of understanding of the interactions between different species in an ecosystem can lead to unintended consequences of introducing a new species. As Christine Jones points out, it's the result of reductionist, rather than holistic, thinking.

Most microbial fertilizers contain just a few species of microbes. Could the introduction of these species to the microbial community in the soil be having a similar impact as the cane toad? Given how little we still know about microbial ecosystems, this seems possible. Even proponents of microbial genetic engineering have admitted that microbial consortia are more effective at performing various functions than are individual species.[33]

On the other hand, introducing an entire ecosystem to your soil – an ecosystem of organisms that have grown and evolved together in a single environment – would be very different. And if that ecosystem is something the plant is familiar with – say, an ecosystem of decomposers of organic matter – then the soil and plants are likely to be prepared to benefit from that ecosystem. Bioflux is exactly this: an "ecosystem in a jug." It was developed literally in the field, by a farmer who could observe the impacts it had on nutrient cycles and pest outbreaks first hand. And it follows the principle of biomimicry, which is the best tool we have to correct the various ills humans are inflicting on our planet.

Closing the Loop; Correcting the Climate

There is perhaps no greater solution to the world's environmental and human health challenges than returning organic "waste" to the soil. The transformation of dead organic matter back into soil life has been the ultimate recycling machine used by nature for billions of years, and it is the key meta factor – besides the removal of fossil fuels from the ground – in determining whether the earth will have a stable, or changing climate. Humans have significantly disrupted that cycle. Now we have an opportunity to harness that cycle to ensure the long-term sustainability of human civilization.

A 2011 study conducted by the UN Food and Agriculture Organization (FAO) found that if the greenhouse gas emissions from food waste were a country, it would be the third largest emitter in the world, behind China and the US.[34] This is largely because 24% of all food produced globally is wasted, and in the US that's closer to 40%.[35] While some of this food waste can and is being diverted to composting, the high water content of much food waste makes composting difficult, and makes it more ideal for anaerobic treatment. One alternative is anaerobic digestion to produce methane, or biogas, for energy. In North America, the cost of the equipment needed to generate biogas is high, while the price of natural gas is quite low, and the effluent produced at the end of the process is not ideally primed for use in agriculture, nor does it have the guarantee of pathogen kill. So this solution has been slow to catch on. Anaerobic *fermentation*, on the other hand, is a lower cost solution that produces an end product which is guaranteed pathogen free. From this fermented organic material, Bioflux is made by introducing additional ingredients which generate a consortium of microbes that are ideal for growing crops. The widespread adoption of this practice could speed up the diversion of wetter food wastes from landfills and sewers.

Perhaps even more important than reducing food waste is making sure that organic matter gets returned to the soil. Building soil organic matter is the single greatest solution we have to not only reduce emissions, but to remove carbon from the atmosphere that is already there. After an experiment in building soil organic matter was conducted by New Mexico State University, researcher David C. Johnson sent a report to Sandia National Laboratory, concluding that if practices were changed to rapidly build soil organic matter on just 11 percent of the world's agricultural lands, they could capture enough CO_2 to offset all the world's greenhouse gas emissions combined.[36] While other studies have found lower estimates, the scale of this potential solution is staggering. And to most farmers, sequester carbon in the soil is just icing on the cake. Building soil organic matter will have so many other benefits to farmers and their soil, both in the short and long term.

Finally, returning organic nutrients and microbes to the soil will significantly reduce, or eliminate, the need for chemical fertilizers and pesticides. It is very easy for excess nitrogen and phosphorus fertilizers from agricultural lands, lawns and golf courses to run off into waterways, causing blue-green algae blooms that result in dead zones. This runoff is exacerbated by declining soil organic matter in agricultural lands, which leads to soil compaction that causes more water to run off the land during storms, washing fertilizers with it. This runoff is indirectly responsible for red tide-causing algae, because these algae can feed on dead blue-green algae. Even organic nitrogen fertilizers and manure can contribute to this excess nitrogen runoff. Because the fertility in Bioflux is tied up in its biology, it does not lead to any chemical nutrient runoff. The biological control agents in Bioflux also significantly reduce the need for pesticides.

So, to summarize the many environmental and climate benefits of Bioflux:

1. **Diverting organic waste from sewers, or landfills decreases carbon dioxide and methane emissions**. When organic matter rots in landfills it releases methane. When highly concentrated organic waste it goes into sewage systems, it also generates methane, which seeps out of pipes or sewage treatment plants. Even plants that have anaerobic digesters often flare this methane, rather than using it for energy.

2. **Anaerobically fermenting organic waste releases less greenhouse gases than composting**. Fermentation with a low pH kills off methanogenic bacteria and archaea, and releases much less carbon dioxide and nitrous oxide than open air composting.

3. **Adding organic material to the soil builds soil organic matter**. This has been observed with various types of organic material, from manure, to compost, to biochar. It stands to reason, and there is already some evident to show, that fermented plant juice can do the same.

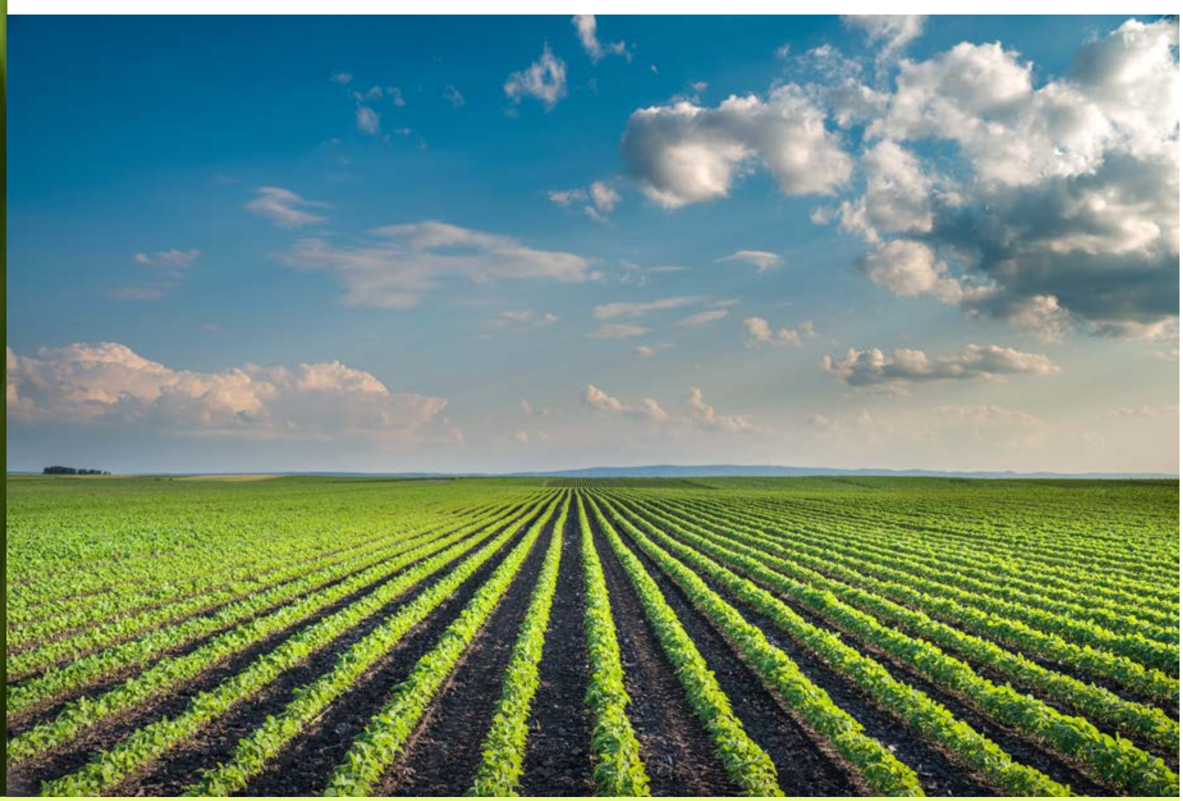
4. **Promoting mycorrhizal fungi stimulates root growth, which also increases organic matter**. Roots secrete many organic compounds into the soil that become food for microbes, which die and leave some of their carbon in the soil as humus.

5. **Reducing the need for chemical fertilizers reduces runoff into waterways.** It is possible to achieve high crop yields with little or no nitrogen, phosphorus or potassium fertilizers, by using products like Bioflux.

6. **Reducing the need for pesticides promotes ecological diversity and human health**. Pesticides have been shown over and over again to be harmful to human health, and to kill off beneficial insects and animals, like honey bees, that are crucial to maintaining ecosystem balances.

Conclusion

Michael Collins likes to refer to Bioflux as his “all-in-one” solution. His dream was to maintain high yields and a health ecosystem on his farm, while significantly reducing the amount of work he would have to do to keep everything going. After many years of hard work, he was able to sit back and watch as Bioflux was disbursed into his fields through irrigation, where it provided fertility and maintained ecological balances so that pest activity was significantly reduced. By adding Terraflux to the fields at the beginning of the season, he was able to amplify and prolong these benefits, while growing soil that was rich in carbon and microbial life. These are regenerative agricultural methods that were proven to work for ancient farmers for thousands of years, and are now being backed up by modern science. Everflux is on a mission to bring these highly productive, highly ecological solutions to farmers across the world. Let’s work together to sustain farming for the next forty centuries.



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