The Use of Effective Microorganisms (EM) in Organic Waste Management

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For centuries, one of the most eternal problems facing mankind has been the dilemma of how to dispose of our garbage. Today, with global populations expected to climb into the tens of billions within the next century, never before in history has the issue of garbage disposal been more pressing. Our society must find new ways not only to reduce, reuse, and recycle our materials, but to detoxify our wastewater, soils, and environment as well. The answer may lie in the adopted widespread use of Effective Microorganisms (EM) to detoxify our landfills, decontaminate our environment, and promote highly sustainable, closed-cycle agricultural and organic waste treatment methods worldwide. This paper examines a case study of the use of EM in all aspects of organic farming and processing of organic waste at Lucasfilm's Skywalker Ranch in Marin County, California. Further applications of EM for home composting systems, wastewater and incinerator treatment, and bioremediation projects will also be discussed.

EM owes its discovery to the work of Dr. Teruo Higa, a microbiologist and organic farmer from the University of the Ryukyus in Okinawa, Japan, who made an accidental discovery while researching the various beneficial aspects of isolated strains of microorganisms on soil composition and plant growth. In 1982, Dr. Higa learned that when blended in a state of balance, certain mixtures of beneficial microorganisms promoted "healthy plant growth resulting in more abundant harvests of better tasting crops (Higa, p. 55)." After months of testing these mixtures on seasonal crops of mandarin oranges with entirely positive results, Dr. Higa was sure that he had made an astonishing discovery.

EM consists of a symbiotic mixture of various strains of naturally occurring microorganisms found in healthy soils. The primary active agents are a group of photosynthetic bacteria, which when fed a simple diet of molasses and moisture produce a primordial soup of great life-giving power. The basic principle is this: When introduced into an environment of anaerobic biodegradation, the EM rapidly devours the methanogens and toxic pollutants which are formed as a result of the chemical breakdown process. As a result, anaerobic compost piles mixed with EM produce no harmful or offensive odors, and decompose very rapidly into pure, nutrient-rich composts, which can be directly infused back into the process of organic farming with astonishing results. Unlike conventional aerobic decomposition piles, which require continuous aeration and months of careful attendance, anaerobic piles treated with EM have the ability to break down organic waste into useable nitrogen-rich fodder in less than four weeks. Due to the microorganisms' ability to antioxidize root systems and purify toxic soils, plants grown in EM-rich soil can focus their energy on healthy development, rather than defense, producing fruits and vegetables of the finest taste and quality. Years of tests in soils of all structures around the world have produced indisputable results that confirm EM's benefit to the healthy growth of all plant species (Higa, p. 104).

The Use of EM at Skywalker Ranch: A Case Study of Sustainable Farming and Composting

The main focus of my research consisted of a trip to Lucasfilm's Skywalker Ranch in Marin County, where head agriculturist Brian Flannery demonstrated the awesome capabilities of EM to promote complete closed-cycle sustainability within a vibrant organic agricultural system. Flannery is in charge of three acres of ranch land which produce fruits, vegetables, and garnishes for Skywalker's employee restaurant. EM is used in every step of the process from soil formation to composting, and has provided Flannery with amazing results.

The farm is located in a depression at the narrowest and coldest part of a shady valley, which bisects the ranch (see attached map). The soil itself was generated and laid three feet deep on top of an old asphalt parking lot, squeezed between a bank of redwoods, a creek, and the access road. In the winter, there is a limited amount of sunlight, making the growing conditions of this particular location far from ideal. Even so, with the help of EM, Flannery is able to produce healthy crops, including arugula, parsley, basil, lettuces, carrots, tomatoes, potatoes, winter squash, beans, and lemongrass. He even produces excellent lemons and tangerines, which generally prefer warmer climates. Due to his success with EM in the garden, George Lucas has allowed Flannery to expand the operation to cultivate a one-acre sunny hillside of grapes for wine production this year.

In the barn, Flannery begins the process of making his own "EM-bokashi" out of waste grains donated from a local brewery in Novato. These grains consist of dried out rice, barley, and wheat bran that would otherwise have been sent to landfill. First, Flannery has concocted a 50-gallon mixture of "extended EM" which is combined with the brewery waste to make the bokashi. This liquid "EM-EX" mixture is formed by mixing 1 gallon of EM-1 concentrate, 1 gallon of molasses (to activate the life forms), 2 tablespoons of EM-X (a highly concentrated form of EM), and two tablespoons of EM ceramic powder. The rest of the 50-gallon drum is filled with water, sealed, and left to ferment anaerobically for fourteen days. After two weeks have passed, the next step is to ferment the bokashi in another 50-gallon drum by adding two parts wheat bran to one part rice bran, 1 tablespoon of molasses, one tablespoon of EM-1, and four gallons of the activated EM-EX solution. The solution is combined with the dried bran and fermented for eight days. At this point, Flannery's "beautiful blonde bokashi" is ready to use on the farm, but can be stored in the airtight containers for up to a year's time. "It's truly a blessing," Says Flannery of his ability to produce organic fertilizer so quickly and inexpensively. "It's like having five billion farm workers in a jar."

Prior to planting, the soil is prepared with the same solution of EM-EX used to ferment the bokashi. The EM-enriched soil is full of antioxidants, which will be transferred into the plants themselves, and eventually into the human bodies of those who eat them. The EM introduced into the soil also acts as a catalyst for other dormant strains of effective bacteria already naturally present in the humus. Much of the soil is made from the composted organic waste from the restaurant, whose structure is full of EM as well from the composting process. Due to the high nutrient and low oxygen content of the soil, there is no need to till the soil before planting.

The crops are planted and fed a solution of liquid EM mixed with water at a ratio of 1:1000 through a controlled drip system. Flannery uses a "droid" to control the accurate mixture of EM in the water supply. (This is another life-saving device, which Flannery says he cannot live without. It enables him to carry his EM solution in a 1-gallon bucket to any part of the ranch, and hook it into the irrigation system wherever he wants to.) The planted crops are also covered with the fermented EM-bokashi grain, to further enhance the quality of the drier topsoil. Since Flannery began using EM a year ago, he has noticed that virtually all of the plants are free of the destruction caused by pesky cucumber beetles, which once plagued his crops. He attributes this success to the beetles' preference to thrive in oxygenated soils. The use of EM bokashi has drastically reduced the oxygen content of the soil, allowing the plants to thrive and the bugs to die. The eggs laid by beetles and flies on antioxygenated soils tend to remain at the egg stage and never hatch. According to Dr. Higa, maggots, beetles, and other pests "treated with EM never progress beyond their larval stage, and therefore never mature into [pests]. The reason is that maggots thrive on certain substances found in contaminated and putrefied matter which enable them to produce the hormones needed to pass from the pupal stage and for maturity into adults. The antioxidants present in EM block formation of these special hormones thereby curtailing metamorphosis (Higa, p. 78)."

Thus, after a successful growing season, Brian Flannery is able to produce organically grown fruits and vegetables of the finest quality, without the use of a single drop of chemical fertilizer, pesticide, or tilling machinery. The food is harvested and served in the restaurant of Lucasfilm, LucasArts, and Skywalker Sound.

To complete the biological cycle, Flannery collects the organic food waste from the kitchens in 90-gallon trash buckets. The waste is then mixed with just two gallons of EM-bokashi bran on the bottom of the bucket, and two on top. The buckets are sealed and the anaerobic decomposition process begins. Under optimal warm-weather conditions, the entire 90 gallons of food waste are converted into a useable soil product in just two weeks! The EM-rich compost is then turned back into the existing soil and used to grow new crops. For larger amounts of organic waste, Flannery coats the bottom of three-foot deep trenches with bokashi, and spreads organic waste out on top, covers with more bokashi and topsoil, and lets it sit for a while. In a short time, he has produced exceptional compost; capable of growing the finest tangerine trees he has ever produced, sprouting right out of the compost heap.

Skywalker Ranch is a small-scale example of the many solutions EM generate for agriculturists and composters on a global scale. In Japan, and across the globe, the EM Research Organization has begun to work with cities and municipalities to implement citywide home composting operations, using small five-gallon anaerobic decomposition buckets, which fit right under the kitchen sink.

New Horizons for Municipal Waste Management

Kani City, Japan has become a model city for the effective widespread use of EM on a municipal level. In 1992, the suburban city was at its wits end over trash disposal issues, and turned to the EM Research Organization for help. Incinerators were running at full capacity, spewing toxic fumes across the entire town. To begin the EM treatment process, all households were given EM home composting buckets to use in their kitchens. People simply mix five gallons of food waste with EM-bokashi, seal the lid to ensure an

anaerobic environment, and in four weeks time, the food has decomposed into an odorless fermented fertilizer. The EM-rich liquid that results from the fermentation process is drained off the bottom of the bucket through a spicket. "Poured down drains and outlets like those found in the kitchen, bathroom, and toilet, it not only completely dissolves away the contaminated build-up inside drainage and waste water pipes, it also acts as a deodorant, banishing unpleasant odors and keeping the pipes and general area sweet-smelling (Higa, p. 128)." Furthermore, as the EM-effluent makes its way through the sewage system, "it has the effect of purifying the liquid sewage it mixes with as well as the sewers as it passes through. It then goes on to play a similar role in helping to clean up pollution in rivers when it empties into them (Higa, p. 128)." The implementation of kitchen composting systems have helped to divert over 20% of the waste stream out of the city's incinerators, and generated rich fertilizer for the town's rice fields, eliminating the need for chemical fertilizers (Higa, p. 135).

Kani City has also begun to use EM in its treatment of incinerator fly ash residue. First, garbage piles and walls of the pulverizing chamber are coated with an EM spray to eliminate the noxious odor of the facility. During the scrubbing phase, EM ceramic powder is injected into the fly ash, (replacing a dangerous ozonation device), and immediately goes to work on the breakdown of dioxin particles generated as a result of the burning process. By the time the purified smoke clears the stack, dioxin levels are virtually undetectable, and there are no foul odors remaining (Higa, p. 121).

In Manteca, California, Martin Harris, owner of Cen-Cal Septic Services has been using EM-1 rather than poisonous chemicals to treat the pathogenic bacteria and odors which grow in his septic tanks. The EM acts to purify the wastewater by devouring all of the toxins, and the stench of the solid waste is eliminated almost immediately. Furthermore, studies have shown that the wastewater, which leaches out the bottom of the septic tank into the groundwater aquifer, contains no harmful chemicals, bacteria, or pollutants (Harris, 2000).

Studies have shown that "one of the important advantages of anaerobic processes over aerobic processes [in wastewater treatment] is a high percentage conversion of organic matter to gasses and liquid and a low percentage of conversion to biological cells (Cheremisinoff, p. 50)." The EM introduced to anaerobic wastewater treatment facilities help to reduce the unpleasant by products of anaerobic decomposition, leaving very little residual sludge (Cheremisinoff, p. 129).

Recently, the EM Research Organization (EMRO) of Tucson, Arizona has introduced the use of EM to large scale agricultural and livestock operations across the USA. Examples include the deodorization of Tyson Chicken's vast poultry and pork farms in Missouri. Not only has the EM helped to devour the malodors associated with intense livestock operations, in has also been used to compost vast amounts of animal waste into high-grade fertilizer sold to local markets (Wood, 2000).

In another cooperative venture, the Main Squeeze Juice Bar of Columbia, Missouri has been trading EM-grown fruits from a local organic farmer for the raw food waste generated by the bar. The farmer then ferments the waste with EM-bokashi and turns it back into useable plant fertilizer. This cooperative cycle is possible due to the added value of the waste aggregate as potential fertilizer. Furthermore, it keeps all of the organic waste out of the landfill (Wood, 2000).

Challenges to the Global Use of EM

For the most part, it seems as if many applications of EM technology are simply too good to be true. Dr. Higa contends that they are, however he admits that most people, including farmers and municipal waste disposal officials from around the globe are highly skeptical until they see the strikingly positive results of EM treatments for themselves. One of the largest obstacles to the widespread diffusion of EM use in Japan is the government's opposition to disturbing the huge chemical and industrial manufacturing economy, which supports with the agricultural industry. In the future, however, the United States government may take a more active role in promoting the use of EM in agricultural operations, due to the more "pragmatic" and "rational" qualities of its farmers. Like any other capitalistic system, American farmers are interested in the bottom line. If US farmers begin to realize that the use of EM costs less in overhead and labor, increases quality, and reduces pollution, then the government will take notice. This could eventually lead to national standards for higher quantities of organic food production (Higa, p. 111).

Another argument raised by scientific purists is the fact that the introduction of EM into soils alters the natural chemical composition of the soils, displacing native microorganisms and nutrients, which may be harmful to the survival of native plant species (Smith, 1999). This may be true, and more research must be conducted on soil structure at local levels. Western science is in need of large amounts of quantifiable data as proof of EM's long-term beneficial qualities if it is going to back any long-term changes to the current food distribution and waste-collection systems beyond the experimental phase.

Finally, the largest obstacle in generating public support in America for home composting projects is the fact that most Americans

want nothing to do with their garbage. It is hard enough to get people to separate their recyclables. There is a prevailing psychological perception that composting is a dirty, bacteria-infested process. Thus, Americans would rather pay higher taxes for waste management officials to take away their garbage rather than deal with it themselves. In reality, most people who actually begin to work with EM in home composting find it to be a very clean, easy, and rewarding experience, which eventually becomes habitual. Hands on education programs are key to the successful implementation of kitchen composting projects. Furthermore, community cooperative EM-bokashi fermenting and distribution centers could also double as fermented kitchen waste collection centers in urban areas. The waste could then be marketed to local farmers as fertilizer. A program of this type already exists in Tucson, Arizona.

In general, it is evident that each community on the planet must decide upon the best way to resolve their own environmental problems. However, all of us must make a concerted effort to pay attention to emerging technologies designed to help us reach higher levels of sustainability at minimal cost. The use of Effective Microorganisms is certainly a technology that deserves considerable and serious attention. It's beneficial potential for creating a sustainable world is too promising to be ignored.

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