SOIL AND SUSTAINABILITY
Effective Microorganisms as Regenerative Systems in Earth Healing

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Preface : Sustainable Agricultural Practice and the Life of the Soil

With global populations expected to climb into the tens of billions within the next century, never before in history has the issue of food supply and waste disposal been more pressing. Our current mainstream approaches to these two interconnected fundamental human requirements require radical revision if humanity is to curb its devastating effects upon global ecology and climate. Our society must find new ways not only to grow food without destroying surrounding ecologies and toxifying watercourses and organisms, but also means to reduce, reuse, and recycle the food waste, our effluent. We need to change our linear consumption patterns into 'cycles' where the waste from one process becomes the energetic input for another process.

The answer may lie in the widespread use of Effective Microorganisms (EM) to promote highly sustainable, closed-cycle agricultural and organic waste treatment methods. EM is a balanced culture of over 80 natural microorganisms including populations of lactic acid bacteria and yeasts and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms that are mutually compatible and can coexist in balance in liquid culture. Effective Microorganisms can be applied to turn our organic and food waste and even our effluent into beneficial microbe and nutrient rich compost that has the capacity to assert a powerful regenerative effect on soil (Higa 1994), helping to re-establish a balanced soil ecology, raise yeilds in organic agriculture, and to combat oxidative stress in plants and humans (Deiana, et al 2002).

Microorganisms and Soil

"The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture"
Sir Albert Howard, 1940

The Earth-Saving vision includes the deep ecology understanding that beneficial microbes are absolutely fundamental to life on Earth. The fermenting, photosynthetic, nitrogen fixing and gas-exchanging properties of microbes early on in Earths history composed complex feedback systems that slowly modulated the atmosphere, water and soil and today make possible the existence of more complex forms of life. "We are both surrounded by them and composed of them. [We have to] think of ourselves and our environment as an evolutionary mosaic of microcosmic life" (Margulis 1992). Microorganisms are the originators of soil and constitute the life of the soil just as they constitute much of the fabric and health of our own bodies. "Beneath our superficial differences we are all of us walking communities of bacteria. The world shimmers, a pointillist landscape made of tiny living beings." (Margulis 1992).

Considering the function of microbes within biospheric processes points us towards ways of changing our methods of agriculture and waste treatment. Both issues bring us to the nature of soil. Soil is a dynamic living system that works in concert with plants and the atmosphere to create the web of life in which humans are but a strand. Microorganisms are the originators of soil. Long ago, they created vast colonies of 'microbial mats' for photosynthesis. The top layers were scorched by the sun but protected the lower layers with their dead bodies. Over a hundreds of millions of years, microorganisms converted mineral substratum to organic compounds, and through accumulated layering of their dead bodies a living soil of humus was created in which the earliest plants (lichens) established themselves. A healthy soil ecology protects plants from diseases and parasites via a balanced food web between pathogenic and beneficial bacteria. Soil is a living organism and needs to be appreciated as such, as a dynamic system that works in concert with plants. In living soil around 100 elements and billions of microorganisms work together in synergy. microorganisms are precisely what differentiates a living soil from a dead soil. Microorganisms decompose and ferment organic matter into humus, containing nutrients and hormones that facilitate plant growth. Typically, microorganisms are responsible for providing hormones, nutrients and minerals in a useable form to the plants via the root ecology. Microorganisms cohere soil particles and soil structure, retaining nitrogen and other fertilizing compounds. They are also responsible for the sequestration of greenhouse gas. Methane is an important greenhouse gas, which contributes about 15% to global warming (Rodhe, 1990). Soil microorganisms, which oxidise atmospheric Methane are responsible for an estimated 5-10% of the total removal of atmospheric methane (Cicerone and Oremland, 1988).

This ancient primordial foundation is being undone by intensive modern agriculture, an unsustainable, inefficient system requiring high energy and chemical inputs. 7.5% of arable land is abandoned every 10 years, because intensive farming kills the microorganisms that enrich soil. The chemicals involved in fighting crop blights contaminate groundwater and damage the immediate health and the genetic structure of organisms including humans.

We need to move away from the point of view that soil is just a mass of brown, inert mineral particles that merely serve as a substrate for plants which can be supplied with artificial fertilisers, and where symptoms of plant deficiency such as diseases and parasites can be countered with fungicides and pesticides. Such an approach is very destructive and unsustainable. Rather, soil is a living organism and needs to be appreciated as such, as a dynamic system that works in concert with plants. In living soil around 100 elements and billions of microorganisms work together in synergy. microorganisms are precisely what differentiates a living soil from a dead soil. Therefore, maintaining soil health, that is, the life of the soil, is the truly rational place to begin in healthy sustainable farming practice.

Pesticides, Fungicides and Fertilisers Are Toxic to Life

DDT (dichloro diphenyl trichloroethane) was discovered by chemist Paul Herman Mueller in 1939. Mueller was awarded a Nobel Prize in 1948 for his discovery. Since then, more than 600 different chemicals have been tested and registered for use in agriculture. The Environmental Protection Agency estimates that worldwide, the total amount spent on pesticides that year is an estimated 25 billion dollars. Monsanto alone reports sales of over a billion dollars for the 'Roundup' herbicide. The worldwide consumption of pesticides has reached 2.6 million metric tons (Aspelin 1997). Of this, 85% is used in agriculture.

Here are some of the currently understood consequences for soil ecology, biodiversity, groundwater and health :

- **Death to microorganisms leading to agricultural pests and a soil lacking nutritive qualities**
  The destruction of beneficial predators removes the homeostatic mechanisms for keeping virulent agricultural pests in check, leading to increasing not decreasing use of pesticides (Menz 1984). In 50 years the US has, with intensive pesticide use, doubled the amount of crops lost to pests.
- **Death to Birdlife**
  The United States Environmental Protection Agency (US EPA, 1989) estimated that Carbofuran (an insecticide) results in the death of 1-2 million birds each year in the United States alone. This is only considering the impact of one agrochemical of the hundreds in use.
- **Death to Aquatic Wildlife**
  Contamination of watercourses leading to death of aquatic organisms. 1977 to 1987 the number of fish kills due to all factors (including fertilisers) has been 141 million fish per year, out of which pesticides are responsible for the death of 6-14

million (Pimentel and Greiner 1997). Pimentel and Greiner stress these figures can be considered highly conservative due to difficulty in determining accurately the primary cause.

- **Climate change - global warming**
  Agricultural practices drastically decrease the oxidation rates of atmospheric methane in arable soils compared to forest soils (Dobbie et al., 1996). The inhibition of methane oxidation lasts for many decades or even centuries (Priemé et al., 1997). Methane monooxygenase bacteria is sensitive to pesticide application. The long term effects of pesticide application on methane oxidation in soils has not been studied in detail and we cannot predict consequences of regular pesticide application on the global methane budget.
- **Increased costs, diminished returns**
  Firstly in the linear consumption of xenobiotics by farms, from crop losses due to proliferation of pests, and effects on agricultural soils from pesticide pollution (Wilson and Tisdell 2001). In addition there are costs implicit in the energy requirements of intensive agriculture : fuel for combine harvesters, energy to produce and transport pesticides and fertilizers, fuel to refrigerate and transport produce around the world. These all contribute to ozone pollution and global warming, which has a real potential to exact inestimatable irrepairable damage to human civilisation through violent natural disasters. Such factors, along with human health costs and damaged fisheries, are currently unaccounted for. A truly rational and economic cost estimate would include the long term costs of damaged coastal fisheries, ruined arable land, health costs etc
- **Endocrine Distruption in wildlife and humans**
  The sparse research that has been undertaken to trace the fate of pesticides, fungicides, fertilisers and other xenobiotics in mammals and humans has tended to be reductionist, analysing one at a time. Recent research points to the damaging influence of very low amounts of agricultural chemicals in combination (Cummins, J, Mae-Wan Ho. 2002). There is significant mutagenic, immune system and endocrine system distruption potential (Bolognesi and Morasso, 2000, Wilson and Tisdell 2001). Warren Porter, a UW-Madison professor of environmental toxicology has said "The single most important finding of the study is that common mixtures, not the standard one-chemical-at-a-time experiments, can show biological effects at current concentrations in groundwater." According to the Food and Drug Administration (FDA) approximately 35% of the foods purchased by consumers have detectable levels of pesticide residues and 1-3% of the foods have pesticide residue levels above the legal tolerance levels. Endocrine disruption has multiple consequences including sterility, hermaphroditism, effects on brain development, and altered immune function.
- **Genotoxicity**
  When genetic-level mutations occur, this is a problem that transcends the individual and impacts future generations. "A large number of studies on cytogenetic effects on human

populations exposed to pesticides have been published. Three major types of cytogenetic changes have been measured as biological indicators of genotoxic damage: chromosomal aberrations, micronuclei frequency and sister chromatid exchange... the majority of these studies gave positive results, mainly as chromosomal damage... the dose-response effect in genotoxic damage evidenced in the majority of biomonitoring studies suggests a need to further reduce the limit of pesticide residues in foods by proper application of pesticides and good agricultural practice." (Bolognesi and Morasso. 2000)

- **Loss of nutrients and antioxidants**
  See the section "EM, Anti-oxidation and Nutrition".

All these problems need solutions to stabilise and regenerate the quality of the environment and provision of food for humankind and also all forms of life on Earth (HRH The Prince of Wales, 1998).

The Agricultural Use of Effective Microorganisms

In May 31, 2002, the journal Science published its first article on organic agriculture. It reported the findings of the worlds first long-term study on organic crop production. The trial showed that although expenditure on fertilizers and energy was 50% lower and pesticide use was 97% lower, yields of organic crops over a 21-year period were only 20% lower on average. It also demonstrated that organic agriculture builds healthy soil, maintains high levels of biodiversity, preserved diverse communities of microorganisms. Such research hints at the irrationality and market driven nature of agrobusiness. One of the main benefits of modern agriculture is a healthy Petro-Chemical industry. Yet this state of affairs is far from sustainable. So what can make the case for organic agriculture even stronger ?

EM stands for effective microorganisms and specifically refers to a cocktail of beneficial bacteria that is used as a soil remediation and health measure in many organic farms in Japan. EM was discovered and developed by the Japanese horticulturalist and agriculturalist Dr Higa, Professor at the University of Okinawa. EM contains over 80 microorganisms including populations of lactic acid bacteria and yeasts and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms that are mutually compatible and can coexist in balance in liquid culture. These microorganisms are capable of generating minerals such as tocopherol, lycopene, ubiquinone, saponin, and powerful anti-oxidant flavonoids, such as quercetin, quercetin-3-O-glucopyranoside, and quercetin-3-O-rhamnopyranoside.

EM can be used in agriculture via a number of methods. EM is innoculated into the rhizosphere with the intention to regenerate soil, raise yields, and improve the nutrient content of foods. EM can be drip fed or sprayed in dilution onto crops and soil. Alternatively EM can be used as a means of processing organic waste to create a rich compost to facilitate crop growth. EM Bokashi is starter made from a mix of fermented organic waste, molasses and wheat bran. It contains large populations of EM which are dormant. When Bokashi is mixed with organic food waste or manure, it activates, and the beneficial microbes proliferate, fermenting the waste into nutrient and antioxidant rich compost that competitively excludes pathogenic bacteria and fungi. 1 litre of EM which costs approximately £10 can produce 204 kg of Bokashi, that can process 7530kg/7.5 tons of organic food waste. In other words one litre of EM can create 7.5 tons of organic Bokashi compost, rich in beneficial microbes.

EM is reported to assert a powerful regenerative effect on soil (Higa 1994), helping to re-establish a balanced soil ecology and to combat oxidative corrosion in plants and humans (Deiana, Dessi, Ke, Liang, Higa, Gilmour, Jen, Rahman, Aruom, 2002). According to Dr Higa, a combination of microorganisms applied to the soil has a much higher chance of establishing itself that the innoculation of a single strain. "If the microorganisms comprising the mixed culture can coexist and are physiologically compatible and mutually complementary, and if the initial inoculum density is sufficiently high, there is a high probability that these microorganisms will become established in the soil and will be effective as an associative group, whereby such positive interactions would continue."

The question may be raised as to the wisdom of innoculating soil microbe cultures derived from Japan into different ecosystems. However EM is a dynamic technology adaptable to different bioregions. It is made in over 40 countries in all continents, from beneficial species isolated from the different bioregions, therefore its negative impact is negligible (Sangakkara 2002), as it is serving to reintroduce beneficials that have been lost through pollution. Disease-inducing soil can be transformed into disease-suppressing, zymogenic and synthetic soils by inoculating the problem soil with EM (Higa, 1991; 1994; Parr et al., 1994). A zymogenic soil has the following characteristics, pleasant fermentative odors especially after tillage, favorable soil physical properties - increased aggregate stability, permeability, aeration and decreased resistance to tillage, large amounts of inorganic nutrients, amino acids, carbohydrates, vitamins and other bioactive substances which can directly or indirectly enhance the growth, yield and quality of crops, low occupancy of the hostile Fusarium fungi, and low production of greenhouse gases. A synthetic soil is one that has a significant population of microorganisms able to fix atmospheric nitrogen and carbon dioxide into complex molecules such as amino acids, proteins and carbohydrates, with photosynthetic bacteria which perform incomplete photosynthesis anaerobically, and both green algae and blue-green algae which function aerobically. Such a soil is naturally disease suppressive therefore minimising the use of expensive and destructive pesticides and fungicides.

The potential values of EM is becoming accepted internationally as shown by the development of separate sessions on EM at the annual International Federation of Organic Agriculture Movements conference in New Zealand. There exists in the literature many reports from many different bioregions that present the success of EM in crop production.

Yield improvements are reported in a maize, lettuce and onion farm in South Africa. "A significant difference existed between EM treated and the chemically fertilized flood irrigated plots with EM treated plots producing significantly higher yields." (Prinsloo 2002). In Japan, infertile soil on the Shoichiro Tabata rice farms in Sakai-machi in Fukui Prefecture was capable of yielding 6 bales/1,000 m2 of rice, but began to yield up to 11 bales/1000 m2 after applying EM technique, surpassing conventional standards without use of harmful agro-chemicals. Research on papaya in Brazil (Chagas et al, 2001), herbage grasses in Holland and Austria (Bruggenwert, 2001, Hader, 2001), vegetables in New Zealand and Sri Lanka (Daly and Stewart, 1999, Sangakkara and Higa, 2000) and apples in Japan (Fujita, 2000) all demonstrate that the correct use of EM and Bokashi increase yields of traditional organic systems over a period of time.

EM, Anti-oxidation and Nutrition

"There has been growing evidence over the past three decades showing that malnutrition (e.g., dietary deficiencies of protein, selenium, and zinc) or excess of certain nutrients (e.g., iron and vitamin C) gives rise to the oxidation of biomolecules and cell injury. A large body of the literature supports the notion that dietary antioxidants... play an important role in preventing many human diseases."
- Yun-Zhong Fanga, Sheng Yangb and Guoyao Wu PhD. 2000

The term 'oxidation' comes from the observation that almost all elements react with oxygen to form compounds called oxides. Examples include the rusting of metals, the process involved in photography, the operation of a car battery, and the way living systems produce and utilize energy - all are "electron-transfer" or oxidation-reduction reactions. The form of oxidation with which we are concerned here involves the endogenous production of 'reactive oxygen species' or ROS. ROS can be created via many pathways in the normal metabolism of aerobic organisms, through mitochondrial metabolism and neutrophil activation. ROS include free radicals such as superoxide anion, and hydroxyl radicals, and nonradical oxygen species such as ozone, hydrogen peroxide, peroxynitrite, reactive lipids and carbohydrates e.g., malondialdehyde, ketoaldehydes and hydroxynonenal (Gracy, R.W. Talent, J. Kong, Y. Conrad, C.1999).

Free radicals are defined as molecules having an unpaired electron in the outer orbit (D.L Gilbert 2000). Free radicals 'steal' electrons from surrounding biomolecules causing a cascade of oxidative corrosion in protein, amino acids, lipid, and DNA, which leads to cell injury and death. Several chronic diseases typically associated with aging have been associated with ROS free radical processes. These include atherosclerosis, stroke, rheumatoid arthritis, neurodegeneration, diabetes, and cancer ; "...oxidative stresses may contribute to half of all human cancers." (K.B. Beckman and B.N. Ames 1997). Oxidative damage to DNA can occur by many routes including the oxidative modification of the nucleotide bases, sugars, and crosslinks. Such modifications can lead to mutations, pathologies, cellular aging and death.

In the industrially developed nations we are exposed to new pollutants through emissions from industrial activity, cars, and synthetic materials in our homes. Free radicals are more prevailent in our environment than ever before, in the form of hydrocarbons, aerosols, sulphur dioxides and nitrogen oxides. In sunlight, mixtures of nitrogen oxides and reactive organic compounds create ozone and peroxyacetyl and other photochemicals that damage organisms through free radical oxidation. According to the Intergovernmental Panel on Climate Change, a global warming of 4°C will increase photochemical oxidants in some parts of the U.S and Europe by up to 20%.

Anti-oxidant nutrients in foods are fundamental to removing free radicals thus preventing many diseases (Decker, 1995, Y.Z. Fang, 2002, Sheng Yang and Guoyao Wu PhD. 2000). Among them, phenolic and polyphenolic compounds, such as flavonoids and catechin in edible plants, exhibit potent antioxidant activity. "The principal defense systems against oxygen free radicals are anti-oxidant nutrients." (Yun-Zhong Fang, Sheng Yang and Guoyao Wu PhD. 2000). If soil lacks a healthy rhizosphere, this prevents the creation and transport of nutrients into plants, thus the nutritional value of the plant is compromised. Less anti-oxidants reach the consumer. Increased malnutrition with lowered resistence to oxidation is a major factor in industrial agriculture's impact upon human health. This is a result of the chemicals used by intensive agriculture, which kill anti-oxidising soil microorganisms. Plants get most of their nutrients, hormones, and minerals in a useable from the interactions of soil microorganisms. If the soil is dead, there is no creation and transport of nutrients into plants, so the plants nutritional content is compromised and less anti-oxidants reach the consumer. Loss of nutrients and antioxidants leads to malnutrition (e.g., dietary deficiencies of protein, selenium, and zinc). This gives rise to oxidation of biomolecules and cell injury. When EM is present in soil, plants are spoon-fed anti-oxidising nutrients through the root hairs and problems of malnutrition are reduced.

According to agricultural scientist Don Dysart, plants get most of their nutrients from the interactions of soil microorganisms. When beneficial microorganisms are present in the rhizosphere, plants can aquire anti-oxidising nutrients much easier via soil microorganisms than through direct uptake from fertilizers. This is because through microorganisms metabolic activities they create nutrients that exist in plant-available forms and are 'spoon-fed' to the root hairs which they live within and around. Therefore rather than providing fertilisers to plants through a dead, inert soil substrate, the new perspective respects the need to nurture soil health, from which the plants derive strong immune systems and nutrients.

EM contains powerful anti-oxidants such as flavonoids, Inositol, Ubiquinone, Saponin, low molecular polysaccharides, polyphenols and Chelates of minerals. These anti-oxidant substances are proven to develop disease suppression in humans (Higa 1993). Antioxidants also help to naturally preserve the freshness of foods grown in it, and unlike artifical preserves this quality is transmitted to the consumer. In a banana farm in Costa Rica it was reported that "...the absence of premature ripening is an indication that the black sigatoka toxin had not proliferated and had not been transported to the fruits. This is an important development and could have been an effect of anti-oxidation of the EM." (Tabora, 2001)

Against the backdrop of onslaught on our health and environment by pollution, effective microorganisms offer us a microcosmic army of earth savers who can potentially turn the situation around. According to Dr Higa, the anti-oxidant substances formed by EM have the capacity to decompose certain harmful substances. "They suppress harmful reactions by deionization of hazardous substances and also promote the chelation of heavy metals such as iron and induce microbes to secrete decomposing enzymes such as lignin peroxidase. Such enzymes have the capacity to decompose residual agrochemicals and even dioxin in soils." (Higa 1993).

Conclusion : Bioregional Agriculture and the Cyclic Renewal of Soil Fertility

Maintaining soil fertility, the microbial life of the soil, is fundamental to a sustainable agricultural practice. In nature plants and animals discard leaves or droppings directly into the soil ; food returns to its place of origin, fertilising the soil thus completing the cycle. Organic waste is a valuble form of energy for soil and plants that humanity has yet to harness en masse.

We waste our waste. Domestically, we tend to mix food waste with non-organic food waste, putting the mixture into plastic bags that are transported and buried in landfill sites. With our effluent, we use around 7 litres of clean water in conventional toilets to flush our urine, droppings and bleached paper into underground pipes where the solution putrifies.

When processed properly, organic waste and effluent can be a beneficial substance for soil and plant health. When processed improperly, organic waste is a serious problem, causing pollution and climate change. When organic waste decays without air (anaerobically), it putrifies and creates Methane as well as pathogenic microbes.

Effective microorganism composting provides a solution to this problem. EM fermentation composting systems and EM toilets and septic tanks can create from waste a soil that is anti-oxidising and beneficial microorganism rich, with the capacity to remediate soil that has been compromised through human activity. EM composting systems are safe to handle and be in proximity to because beneficial microbes competitively exclude disease forming microbes. Adopting waste fermentation systems completes the loop, bringing us back to nature through honoring the principle of cyclic renewal. Additionally, waste treatment via composting systems can be carried out locally thus remove the pollution associated with transport to landfill and putrifaction of waste.

The use of EM compost made from a free resource, our organic waste, has many benefits for soil health and agriculture, whether carried out domestically or as large scale systems. Effective microorganisms can become established in soil as an associative group of positive interactions. The benefits are immense, including :

- greater resistance to water stress (Xu 2000, Hussein et al 2000),
- greater mineralization of carbon (Daly and Stewart, 1999),
- decomposition of residual agrochemicals in soils (Higa 1993),
- better penetration of roots (In Ho and Ji Hwan, 2001),
- more efficient release of nutrients from organic matter (Sangakkara and Weerasekera, 2001),
- enhanced photosynthetic capacity of plants (Xu et al, 2001),
- enhanced protein activity (Konoplya and Higa, 2001),
- improved resistent to adverse weather, including typoons (Higa 1993),
- increased yields (including maize, lettuce, onion, rice papaya, herbage grasses, vegetablies and apples) over a period of time. (Prinsloo 2002, Chagas et al 2001, Bruggenwert 2001, Hader 2001, Daly and Stewart 1999, Sangakkara and Higa 2000, Fujita 2000)
- and resistance of plants to pests and diseases such as Fusarium fungi (Higa, 1994), Sclerotinia. (Kremer 2001), Phytopthora (Guest 1999, Wang et al 2000), pickleworm (Wood 1999) and black Sigatoka (Tabora, 2001).

With community compost systems, bioregional agriculture would have a continual supply of microorganism rich compost with which to grow the food to supply back to that community. Such an approach would mean there would be no need for using 2.6 million metric tons (Aspelin 1997) of pesticide a year, no need to loose 7.5% of arable land every 10 years because of agro-chemical approaches, no need for consumers to suffer genotoxic damage through pesticide residues on their food, and no need for the disruption of essential food webs.

We have no choice but to change our current approach, it simply is not sustainable. Pesticides pose a significant health risk to all living organisms, including genotoxicity. The planet has no means to metabolise them. The long term 'health costs' are beyond any estimation or quantification in economic terms. More wisdom in our interaction with the earth, including maintaining soil health and diversity of crops significantly reduces plants suceptibility to blights and parasites. Rather than sterilising everything with chemicals that are unfamiliar to the planets metabolic process, the method of competitive exclusion using beneficial soil microbes is much more sustainable.

Beneficial, anti-oxidising microorganisms constitute the health of the soil and are conductive to the health of the consumer. Our exposure to ambient levels of free-radicals has increased in recent years through pollution, and our consumption of anti-oxidants to combat free radicals has decreased. Increased antioxidant nutrient content in foods could help people remain healthy.

EM follows the philosophy of sustainable industrial ecologies by transforming the 'end product' of one human activity (organic food waste) into a useful resource for growing food and remediating soil. Soil remediation is a global project. Unfortunately intransient power-bases have much staked on the production and distribution of agro-chemicals. Increasingly, corporations attempt to gain control on the food-chain via patents on life forms and genetically modified food staple. Like renewable energy, EM agriculture threatens to decentralise the production and supply of human essentials, thus rendering existing power-bases obsolete. Therefore major economic powers are not helping to develop such a promising tool for growing food sustainably. Movements toward the creation of sustainable agriculture may have to come from the bottom up, at least initially, through education, consumer choices, and the introduction of technology to communities and farms looking to convert from agrochemical to organic methods.

Increased awareness of the viability of intensive organic agricultural alternatives is necessary to facilitate a shift toward sustainability. The EM method may supplant the need for damaging chemicals in food cultivation, and could improve human health considerably by increasing antioxidants and nutrients to the human diet. It will also lessen the damage to fisheries and marine wildlife, birdlife and farm workers, whilst reducing farmings impact upon climate change. Application of EM in intensive organic agriculture offers us promising means to supplant current destructive unsustainable approaches, providing healthy organic food, and furthermore may function as a Regenerative System, a system of Earth healing.

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