Writers' Supplement to *EDN* 110

We often come across interesting material related to articles in *EDN* that could not fit into the available space in the issue. We share the most relevant of those here. For more information on the following, click on the article name:

How to Multiply Indigenous Microorganisms (IMO 1)

Indigenous microorganisms (IMO) are harvested and produced in various ways for natural farming. Out of five types of NF IMOs, IMO 1 refers to the group of indigenous microorganisms that are produced from microbes collected from forest settings (IMO 1 method 1), from around the stubble of harvested rice (IMO 1 method 2) and directly from forest leaves (IMO 1 method 3).

To collect IMOs from the forest, fill a wooden box (or split bamboo internode) up to 7 cm long with steamed rice. Do not compact the rice, as you need to accommodate both anaerobic and aerobic microorganisms. Cover the box with porous paper (to allow air to move in and out) tied snugly with string or a rubber band. Place the covered container into a shallow hole located in the soil of an area where forest leaves are falling and decomposing with the presence of fungus. The weight of the leaves accumulating on top of the covered box should **not** be allowed to press the paper down to touch the rice surface. During the rainy season, protect the box by covering the layer of fallen leaves with a plastic sheet. Leave out for two to 10 days depending on the temperature (two days in hotter climates and 10 days in colder ones). When collecting IMO from the forest, results are better when there is adequate soil moisture, such as during the rainy season.

When you retrieve the rice from the forest, you should see a white mold growing on it. This harvested IMO 1 material (including the old rice) can be mixed with molasses (at a 1:1 rate) and fermented in clay crocks for at least one month. The resulting fermented IMO material can be used to make various IMO solutions and products. For instance, the fermented IMO product can be diluted in water (0.1-0.2%) and sprayed onto transplanted seedlings to help them with their establishment.

Another IMO 1 product is called **IMO soil.** It is produced by first mixing the fermented material with water and then applying the solution to new batches of compost. The solution helps to increase microbial activity in compost piles, thereby shortening the composting period. The finished IMO 1 compost can then be applied as a culture to activate a larger batch of IMO soil. Such IMO soil is recommended for application to areas that were previously farmed with chemicals but still have soil organic matter rates higher than 4%. The amendment will help restore microbial balance and improve soil structure.

In addition to a similar method of producing IMO 1 from around the stubble of harvested rice fields (method 2), Dr. Arnat's book contains a slightly different method for collecting IMO from leaf mold (the third method of producing IMO 1). From the forest, collect leaf molds that contain white hypha. Deciduous trees have more microorganisms than evergreen forests. Mix up a solution of FPJ (fermented plant juice; see later in this document for details) diluted 1000 times in water, and boil. Allow to cool and then add enough steamed rice to create a porridge-like consistency. Mix the rice mixture with four to five cups of leaves covered with white mold and allow to sit for one night. Mix this compound into rice bran to propagate more microbes. Mix with enough rice bran to obtain a mixture with approximately 65 to 70 percent moisture (i.e. if a handful of material is squeezed tightly, little if any water will drip out, but the material will remain in a clump after squeezing). Heap the moist rice bran mixture to a height of 30 to 40 cm. Add FPF (fermented plant juice) and/or FAA (fish amino acid) to promote microbial activity. Cover the rice bran pile with rice straw to incubate IMO growth and conserve moisture. Keep covered in this state for five to seven days. Afterward, store in a shady area outdoors or indoors. Similar to IMO soil, this IMO product can be broadcast onto soil that is otherwise good (having organic matter levels higher than four percent) but that has been exposed to a lot of agricultural chemicals, in order to increase the population of microbes in the soil. It can be added to compost as well.

Bokashi

Keith O. Mikkelson, executive director of an orphanage and children's home called Aloha House in the Philippines, shares some of the ways EM is used on their farm in his book *A Natural Farming System for Sustainable Agriculture in the Tropics*. On his farm, EM is used in the form of bokashi (fermented plant matter). According to Mikkelson, anaerobic composting, or fermentation, results in material that is fermented but not yet decayed (as would happen with aerobic composting).

Mikkelson describes the process of making bokashi: "We mix one sack of copra meal to three sacks of low-grade rice bran and three sacks of charcoal. We charcoalize rice hull in a specialized process ahead of time. These ingredients are mixed dry with shovels on a cement floor.

"Then we pour an EM solution into the mixed grains and waste material. We use 200 ml of EME and 200 ml of molasses diluted in ten liters of water to make the solution. We add additional water depending on how dry the materials are. If we substitute manure for copra meal, the moisture is higher and we don't need as much water. However, the target is 40 to 50% moisture content. You get a feel for it after a while. We do the squeeze test. Just take a handful of your moist bokashi and squeeze it. If it crumbles in your hand after you release it, add more water. It should stick together without dripping when squeezed. This moisture will help fuel the fermentation process and prepare the ingredients for fertilizer use. [The bokashi] doesn't change form till it is buried in the soil." Mikkelson commented that the 'recipe' for bokashi can be changed based on what organic wastes are available in your area (e.g. eggshells from a bakery; copra from a coconut oil factory; hulls from a grain mill).

Bokashi can be added to kitchen waste. At Mikkelson's farm, they "use one kilo of bokashi per 20-liter pail. We add the bokashi to the bottom of the pail to insure smooth fermentation. Then we add our kitchen wastes; things like peelings, bones, cooked food and old rice, layer by layer with the bokashi. We mix each layer of food waste with a stick. The key is to recycle at source. Set it up right in your kitchen. This allows the whole family to participate in the fun of creating your own fertilizers for producing your own vegetables or fruits. The results are worth the effort.

"We pack it tight to keep out the oxygen. Anaerobic composting is always without air. This permits the lactic acid forming bacteria to go to work eliminating diseases. When the plastic container is full, just seal it up. It will remain airtight! We place it in the shade for two weeks. A label with the date is helpful.

"This container will not discharge liquids or cause odors because it is leak proof and air proof. This is the first stage in anaerobic composting and it takes two weeks. Then bury the fermented kitchen garbage in the soil. Mix some of the soil that was removed from the hole with the waste. This will [ensure] decomposition within two weeks."

Fermented Plant Juice (FPJ; information from Cho Han Kyu's book *Natural Farming*)

Fermented Plant Juice (FPJ) is another oft-used Natural Farming input. It can be made in the following way: Collect plants that have defenses against the cold and that grow well in the spring. Other good plants to use are ones that are fast-growing and vigorous (these contain very active growth hormones). Bamboo shoots can be used; collect them while small, and remove the soil but not the outer skin. Other good plants to use for FPJ are strawberry, kiwi or cucumber (use lateral buds of cucumber; it grows quickly, though it is not very tolerant of cold and disease). For cucumber, cut "50 cm above…roots during last part of harvest season, then hang cucumber's stem upside down in a bottle." Juice will seep out. It is said to last for three years. Banana sprouts/shoots and morning glory (*Ipomea aquatica*) are also good ones to use.

Collect plants when they are in season, but make enough FPJ for use through the year. Often it works well to give FPJ made from a plant back to the same type of plant. Cho Han Kyu directs, "Give back to the plant what it has produced."

When collecting plants for making FPJ, avoid very hot sunshine (which might mean a low moisture level in plants, so that juice might not be extracted) and excessive rainfall (which will wash lactic acid bacteria and yeasts from leaves). Plants will have higher levels of useful plant microbes and hormones just before sunrise. Cho Han Kyu recommends that men get their wives involved, since women tend to be more careful while collecting! Quickly snap the growing points. Use the harvested material to make FPJ right away, so that the maximum amount of juice is available.

Notes on Materials. Container. Use a clay pot or wooden container made with Japanese cedar. Glass can be used, but the quality of the FPJ will be less. Glass containers should be shaded with dark cloth or paper to block the sun's rays. Avoid stainless steel, iron and plastics. The container should have a small opening, to limit air contact but also so that the liquid will rise above the ingredients.

Brown sugar. Use 1/3 to ½ the weight of the original ingredients (use the larger amount if the ingredient has high moisture content). Using refined white sugar will result in lower quality FPJ. Crude sugar is best. Depending on price and availability, molasses or other types of sugar are used in Thailand and other locations in Asia. Some sea salt can also be added, but should be kept to less than 1/3 the amount of sugar.

Use a weight on top of the jar (such as a stone) to extract air. Cover the lid, for example with porous paper. Write the date and ingredient on the lid.

Making FPJ. Collect ingredients. Shake off dirt and cut in 5 to 10 cm pieces. Use only one kind of ingredient in one container. Weigh the ingredient and crude brown sugar (for 7 kg of leaves/shoots, add 3 kg sugar). Mix in a large bowl using hands. Cover with newspaper and leave for 1 or 2 hours. Then transfer to a clay pot. The pot should be filled ¾ in order for the proper amount of air to react with ingredients. Place a weight on top of ingredients (e.g. a stone) and tie porous paper onto the jar. After one or two days, remove the weight and recover the jar. Put the jar in a cool, shaded place, undisturbed during fermentation. Leave it for 8 to 10 days.

To use, dilute FPJs with water to 1:800 or 1:1000. Use a stronger dilution rate in wet weather. As an example, 1 tablespoon of FPJ in 10 liters of water would be a 1:640 dilution.

Highlights from Higa and Parr's Document

Higa, Teruo and James F. Parr. 1994. "Beneficial and Effective Microorganisms for a Sustainable Agriculture and Environment." International Nature Farming Research Center, Atami, Japan.

Because the approach outlined by Higa and Parr in this paper is so different from what I (DRB) have previously read on the subject of soil microorganisms, I thought I would summarize some key points. If you would like more details, I encourage you to read the paper.

The Case for Beneficial Microorganisms. Moving from conventional to organic agriculture can be risky for the first several years, with potential for lower yields and increased pest problems. Beneficial microorganisms can help ease the transition. Microbial methods can also help address environmental problems resulting from agriculture (e.g. fertilizer and pesticide runoff; animal wastes; erosion), which are often targeted using chemical and physical methods.

The organisms in Higa's EM-1 solution are mutually compatible. "The ultimate goal is to select microorganisms that are physiologically and ecologically compatible with each other and that can be introduced as mixed cultures into soil where their beneficial effects can be realized."

You need high initial populations of microorganisms for inoculating. "The most reliable approach is to inoculate the beneficial microorganism into soil as part of a mixed culture, and at a sufficiently high inoculum density to maximize the probability of its adaptation to environmental and ecological conditions."

Plants generally use less than 5% of available solar energy! Lots of visible light and infrared radiation are unused.

In agriculture, "the farmer attempts to integrate certain agroecological factors and production inputs for optimum crop and livestock production."

Application of single-culture microbial inoculants is problematic. "…there is a greater likelihood of controlling the soil microflora by introducing mixed, compatible cultures rather than single pure cultures." In a natural ecosystem, "the greater the diversity and number of the inhabitants, the higher the order of their interaction and the more stable the ecosystem."

The majority of microorganisms in any particular soil are harmless to plants. But harmful microorganisms can quickly multiply under certain conditions (e.g. monoculture; lots of chemical fertilizers and pesticides). Conventional (chemical-based) farming tends to treat symptoms.

Changes in farming practices may be required along with use of EMs.

Classification of Soils. One interesting suggestion made in the paper is to classify soils based on activities and functions of the predominant microorganisms. Higa and Parr wrote, "Most soils are classified on the basis of their chemical and physical properties; little has been done to classify soils according to their physicochemical and microbiological properties. The reason for this is that a soil's chemical and physical properties are more readily defined and measured than their microbiological properties. Improved soil quality is usually characterized by increased infiltration; aeration, aggregation and organic matter content and by decreased bulk density, compaction, erosion and crusting. While these are important indicators of potential soil productivity, we must give more attention to soil biological properties because of their important relationship (though poorly understood) to crop production, plant and animal health, environmental quality, and food safety and quality….

"The basic concept here is not to classify soils for the study of microorganisms but for farmers to be able to control the soil microflora so that biologically-mediated processes can improve the growth, yield, and quality of crops as well as the tilth, fertility, and productivity of soils. The ultimate objective is to reduce the need for chemical fertilizers and pesticides."

Higa and Parr suggest four classifications:

1). Disease-inducing soils. "In this type of soil, plant pathogenic microorganisms such as *Fusarium* fungi can comprise 5 to 20 percent of the total microflora. If fresh organic matter with a high nitrogen content is applied to such a soil, incompletely oxidized products can arise that are malodorous and toxic to growing plants. Such soils tend to cause frequent infestations of disease organisms, and harmful insects. Thus, **the application of fresh organic matter to these soils is often harmful to crops. Probably more than 90 percent of the agricultural land devoted to crop production worldwide can be classified as having disease-inducing soil**. Such soils generally have poor physical properties, and large amounts of energy are lost as "greenhouse" gases, particularly in the case of rice fields. Plant nutrients are also subject to immobilization into unavailable forms."

2) Disease-suppressive soils. These soils contain many beneficial microorganisms that produce antibiotics. Plants tend to experience few diseases or pests. The soil has excellent physical properties.

3) Zymogenic soils. Beneficial microorganisms in these soils carry out useful fermentations. Soil has a pleasant odor and good properties; lots of inorganic nutrients are available; there is low incidence (<5%) of *Fusarium*; and low production of greenhouse gases, even from flooded rice.

4) Synthetic soils. Fix N and C. These soils need little extra organic matter. They have low levels of *Fusarium*; are often disease-suppressive; and produce few greenhouse gases.

Higa and Parr concede that the types of soils will not always be so clearly defined. A mix of 2, 3 and 4 is most desirable.

Mechanisms of Action of EM Solutions

The *EDN* soil microorganism article stated, "the many positive observations made by hundreds of farmers are an indication that something helpful is (sometimes) happening, in some situations and with some preparations." Matthew Bakker read a draft and commented, "Yes, but by what mechanism? It is entirely possible that the effect is due to something other than the microorganisms! What if there is some fish emulsion or something in the EM solution, and direct provision of plant nutrients causes the effect? In a low-fertility situation, this seems like a plausible scenario."

Ongoing Experimentation at ECHO

Andy Cotarelo shared, "Recently we obtained some recipes of EM and IMO from network members in Thailand and in the US, all of whom are using the soil organisms and have seen positive results in their gardens and farms. Some network members are using EM, a purchased product, while others are creating their own versions of IMO. We are now experimenting with these recipes of IMO and testing them against the EM purchased product to see if they perform worse, as well or better. We have been able to set up a protocol for making EME and having it available to interns to use in their garden. The Activated EM will last for up to four months, so it can be used as needed. The other problem we have solved is how to apply the EM. We recently purchased a mist blower that will blow a fine liquid mist onto plants [EM can be applied to soil or leaves; as a foliar application, the benefit to plants is said to come from plant photosynthetic bacteria in EM that produce sugars/substances beneficial to plant health]. This allows interns to cover a large area quickly. We are in the process of setting up a 35-gallon sprayer that interns can use to spray larger amounts of EM in their areas with fewer refills, thus saving time. [In addition,] a donor offered to supply us with an inline dosing pump that would allow us to use EM in our drip tape. This would be a very simple process that would allow us to drench large amounts of soil with EM, with very little effort.

"Intern Brandon Lingbeek has been instrumental in the introduction of EM here at ECHO due to his research and application of it. Right now he and Brian Dant are conducting an experiment testing the effectiveness of EM vs. FPJ vs. Control. Brandon and Brian have also made the process and recipes much easier for staff to utilize.

“How EM is used at ECHO varies from intern to intern. Some use the EM very faithfully on certain plants to see if there is any difference in growth or health. Some will use it to remediate soil when pathogens or pests are dominating and [the soil needs] to be brought back into balance. Some will use it as a pre-planting and post-planting drench for new plants. Right now, [ECHO is seeking to further our knowledge and experience with EM and IMO through more focused research.] Joel Wildasin has been experimenting with… a fermented feed for animals….Joel’s experiments have focused on silage for our ruminants. I have experimented with making bokashi (wheat bran, molasses, EM) at home and pickling my compost scraps so that I can bury them in my garden and have accelerated compost. This may be something useful to our network members that cannot deal with scraps in a timely manner. We are just starting to get data in on how to make the feed successfully. We are trying to find recipes that work for us and our food sources.

In December we made a fermented feed with pounded rice hull, moringa, wheat bran, molasses and EM. [This is a modified recipe from Keith Mikkelson's book *A Natural Farming System for Sustainable Agriculture in the Tropics*] After the first of the year we will crack it open and see how the chickens like it. We have two different sets of ratios [for ingredients] to see which works best.

“We have some fermented feed made from napier and are seeing if the goats will eat it. This spring we will bury some of the fermented kitchen compost and see how it does as a soil amendment and fertilizer. The experimentation is in the infant stages and will probably slow down as Joel leaves in April.

“[Our experience at ECHO with] the propagation of soil organisms is at an infant stage, but is quickly maturing as we gain more experience and because we have staff and interns that want to learn and experiment with EM/IMO. Most of this research and experience has happened within the last year. As this topic becomes more widely discussed and more information becomes available, EM/IMO will become easier to research at ECHO.”

More on Reasons for Multiplying Microbes

Matthew Bakker commented, “In some of the literature that I am familiar with (having to do predominantly with the use of microbes to prevent plant disease), there has been a shift from inoculative approaches toward what is often called ‘microbial community management.’ Rather than applying organisms, these approaches investigate the relative effectiveness of different management strategies (particular green manure crops, cropping sequences, etc) at fostering beneficial (for example, strongly pathogen-inhibitory) soil microbial communities. This is a little bit of a different emphasis.”

A quote from Higa and Parr’s paper (see above) addressed this topic: “Agriculture, in a broad sense, is not an enterprise which leaves everything to nature without intervention. Rather it is a human activity in which the farmer attempts to integrate certain agroecological factors and production inputs for optimum crop and livestock production. Thus, it is reasonable to assume that farmers should be interested in ways and means of controlling beneficial soil microorganisms as an important component of the agricultural environment. Nevertheless, this idea has often been rejected by naturalists and proponents of nature farming and organic agriculture. They argue that beneficial soil microorganisms will increase naturally when organic amendments are applied to soils as carbon, energy and nutrient sources. This indeed may be true where an abundance of organic materials are readily available for recycling which often occurs in small-scale farming. However, in most cases, soil microorganisms, beneficial or harmful, have often been controlled advantageously when crops in various agroecological zones are grown and cultivated in proper sequence (i.e., crop rotations) and without the use of pesticides. This would explain why scientists have long been interested in the use of beneficial microorganisms as soil and plant inoculants to shift the microbiological equilibrium in a way that enhances soil quality and the yield and quality of crops.”

Chia Nutrition Information

Table 2. Chia nutritional data summarized by the Nutritional Science Research Institute (http://www.nsrinews.com/nsriChia_research.html)	
Amount per 15-gram serving (≈2 Tbsp)	(% Daily Values)*
Calories 50; Calories from fat 44	2.5
Total Fat 4.9 g	8
Saturated Fat <0.5g	1
Trans Fat 0g	
Omega-3 (Alpha-Linolenic Acid) 3g	
Omega-6 (Linoleic Acid) 1g	
Cholesterol 0g	0
Sodium <0.5mg	0
Carbohydrates Available 0.1g	0
Dietary Fiber 6.1g	24
Sugars 0g	
Protein 3.1g	6
Calcium 107mg	11
Iron 2.4mg	13
Zinc 0.5 mg	3
Potassium 105mg	3
Magnesium 59mg	15
Phosphorus 160mg	16
*Based on a 2000 calorie diet For a more complete nutritional analysis, see http://www.nsrinews.com/abstracts/Chia_Technical_Sheet.pdf, which mentions that chia has no toxic or anti-nutritional factors.	

Table: Nutrient Content of a 5.6 oz (157g) Serving of White Rice, With or Without 4% Chia (from NSRI)

	Daily Reference Intake (DRI)	Chia, 6.3g or 0.23oz (%DRI)	White rice, 5.6oz or 157g serving (%DRI)	White rice and chia combined (%DRI)
Protein	50,000+	1309 (3)	4204 (8)	5512 (11)
Dietary Fiber	25,000	2601 (10)	0.7 (3)	2602 (13)
Omega-3 fatty acids	1600	1344 (84)	0 (0)	1430 (84)
Calcium	1000	45 (5)	16 (2)	61 (6)
Magnesium	400	24 (6)	19 (5)	43 (11)
Antioxidant units#	NE*	600^	0	600

*Not established
^Equivalent to 0.26 oz blueberries
#Expressed in ORAC units (Trolox equivalents)
+Expressed in milligrams