EM Technology Network

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# EM Teacher's Manual

## TRANSFORMING WASTE
## . . . TO WONDERFUL !!

**COMPOSTING FOOD WASTE AT SCHOOL WITH EFFECTIVE MICROORGANISMS™**

A PRACTICAL GUIDE AND CURRICULUM FOR TEACHERS

# SPECIAL ACKNOWLEDGEMENTS

This publication was made possible in part by a Waste Reduction Initiative Through Education (WRITE) Grant received from the Arizona Department of Environmental Quality - Recycling Program. WRITE Grants provide funding assistance to educate Arizona's citizens on issues related to reducing, re-using, recycling, composting, and buying recycled content products - with the ultimate goal of diverting waste from landfills, reducing the number of landfills needed, and preserving our natural environment. This program is funded by landfill disposal fees collected from solid waste landfills located throughout the state.

We also wish to express our sincere gratitude to the members of the EM Bokashi Network in Arizona who participated in and currently support this environmental recycling program.

# TRANSFORMING WASTE TO WONDERFUL

## RECYCLING AT SCHOOL USING EFFECTIVE MICROORGANISMS™

### A PRACTICAL GUIDE AND CLASSROOM ACTIVITIES

1ST EDITION - May, 2000
2ND EDITION - March, 2005

PUBLISHED BY EM BOKASHI NETWORK-U.S.A.
A PROGRAM SPONSORED BY:
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# TABLE OF CONTENTS



# INTRODUCTION

Dear Teacher:

The EM Bokashi Network-USA is pleased to present this manual to you and your colleagues as part of our continuing environmental education program to promote food waste as a valuable resource that can be recycled back into the soil. It is our sincere hope that the manual will serve as a useful resource for educators, students, and parents who are concerned about their environment and who wish to participate in school and community efforts to divert waste from landfills and beautify their communities.

**What is the EM Bokashi Network?**

The EM Bokashi Network is a world-wide grassroots movement aimed at promoting community recycling and gardening through the use of EM (Effective Microorganisms™). Inspired by Dr. Teruo Higa, discoverer of EM, this network has its roots in Japan, where over one million people are involved. The Network's primary mission is to reduce the amount of waste going into landfills and to encourage the recycling of organic waste. The Network promotes the use of EM Bokashi as a tool to transform food waste into a nutrient rich compost that can be used for gardening and landscaping. The program is unique in that it provides all individuals, regardless of their ability or disability, a chance to contribute to their communities and to become environmental advocates. The EM Bokashi Network presents children with a valuable opportunity to establish a connection between the soil and the ecosystem, and to understand their own role in improving the quality of our environment.

In 1996, the Tucson-based company EM Technologies, Inc. launched the EM Bokashi Network-USA to introduce EM Bokashi recycling to schools and communities in the United States. In 2002, the name of the company changed to EM Technology Network. Pilot projects at Miles Exploratory Learning Center and the Arizona Schools for the Deaf and Blind (ASDB) in Tucson have led these schools to be recognized as national models for their innovative composting and gardening projects. The Miles Exploratory Learning Center received the 1996 NEAT REAP environmental award for diverting 5 tons of food waste from county landfills. In 2000, the Center won top prize for Outstanding School Garden at the 3rd Annual Southwest Region School and Community Gardening Conference sponsored by Maricopa County Cooperative Extension of the University of Arizona.

In addition to its extensive EM gardening projects, ASDB is the first school in America to implement an EM vocational program, in which students produce their own bokashi and high-quality EM-composted soil. The school has also received School to Work grants in 1999 and 2000. Following the success of these pilot programs, over forty schools and organizations in Arizona have implemented EM Bokashi recycling and gardening programs.The EM Bokashi Network-USA has shared its program with numerous schools in North America, and many grassroots movements have recognized the educational value of this program.

**What is EM and EM Bokashi?**

EM Bokashi is a fermented compost starter made from wheat bran and EM (Effective Microorganisms™), a mixed culture of naturally-occurring beneficial microorganisms. EM contains food-grade microbials such as those used to make cheese, bread, yogurt, miso, and other foods. The microbes in EM are non-harmful, non-pathogenic, not genetically-energized or modified, and not chemically synthesized. When the correct conditions are provided, EM sets in motion a fermentation process to transform food waste and other organic materials into a nutrient-rich compost. EM Bokashi (Bokashi=a Japanese agricultural term meaning fermented organic matter) can decompose food waste in less than half the time of conventional composting methods, without any unpleasant odors. This system can be easily implemented in an indoor environment, making it a simple and pleasant task for schools, households, restaurants, and businesses to compost their food waste.

We hope you find this manual useful and informative, and that the information and activities inspire you and your students to become actively involved in helping our environment through the innovative EM food waste recycling program.

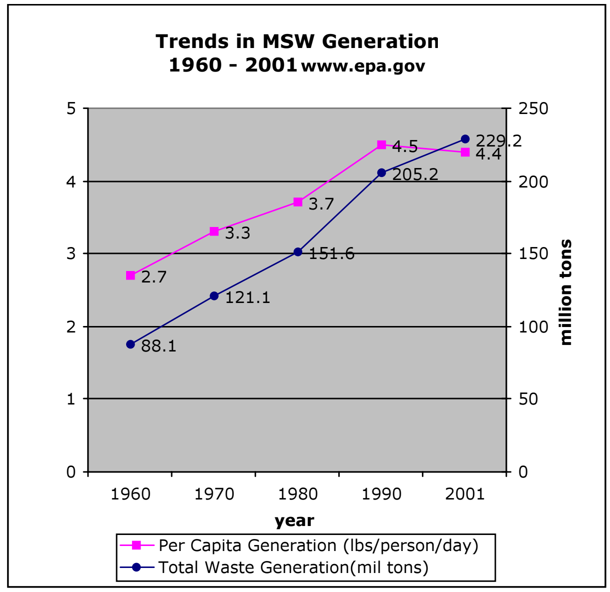
Thank you for your interest and support!

Gardening class at Miles Exploratory Learning Center
Tucson, Arizona

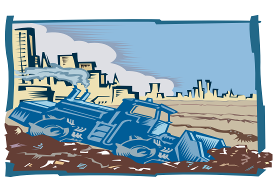
# MUCH TO DO ABOUT GARBAGE

According to U.S. EPA (Environmental Protection Agency) estimates, on average, we each produce 4.4 lbs. of waste every single day. In 2001, this added up to 229 million tons of municipal solid waste. As the population grows - along with the amount and variety of commercial product - so does the amount of solid waste. The EPA projects an annual increase in MSW of 1.2%. If this trend holds, our cities will be dealing with 262 million tons in 2010.

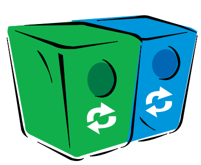
The cost of handling garbage is the fourth largest expense - after education, police and fire protection - in many city budgets. Although we can put solid waste out of mind, and even out of sight, it has to go somewhere. So, where does our 4.4 lbs. of solid waste per day go? Some of it gets recycled, some incinerated, but the bulk of it is laid to rest in more than 3000 landfills in operation throughout the United States.




SOURCE: EPA 2001 http://www.epa.gov



LANDFILLED
55%



RECYCLED
30%

INCINERATED
15%

SOURCE: EPA 2001 http://www.epa.gov

In 2001, 15% of solid waste was incinerated, 30% was recycled, but over half (55%) was discarded into landfills. The idea of burning waste to create energy seemed initially to make a lot of sense. But, in practice, it has not turned out that way because of the very high cost and problems related to production of dioxin and toxic flash ash. Some landfills that are not properly lined produce leachate, which is runoff that can contaminate our drinking ground water. Once our groundwater is contaminated, it is extremely expensive and difficult to clean it up. Furthermore, many landfills are nearing capacity and the cost of siting and maintaining new landfills is extremely expensive. Communities have an almost universal resistance to having a landfill nearby because they take up valuable land space and are unpleasant sights. The solution to our waste problem lies not only on perfecting disposal methods, but in finding ways to avoid making it in the first place. There are sustainable options that will allow us to meet our current needs and provide for future generations as well. The most promising alternatives to manage waste and protect our environments are to reduce, re-use and recycle **(3R's)**.

# ORGANIC MATTERS!!

Organic waste, such as yard and food waste, accounts for 23% of the waste stream in the United States. Food waste includes leftover portions of meals and food scraps from food preparation activities in kitchens in restaurants, fast food chains, and cafeterias. Food waste is the third largest component of generated waste (after paper and yard trimmings) and the second component of discarded waste. This means that most food waste generated does not get recycled in comparison to other items such as newspapers, cans, glass, and plastics. Dumping organic waste into landfills is highly inefficient .The lack of oxygen inside the landfills cause decomposition to occur slowly. This produces methane gas and acidic leachate. In addition to contributing to the environmental problem created by landfills, organic waste takes up valuable space that could be used for other waste products. While composting is not nearly as widespread in the United States as other forms of recycling, it represents a viable and productive addition to traditional means of municipal solid waste disposal. The standard means of disposal for most yard, food, sewage and paper mill sludge include landfilling and incineration. These practices are not as environmentally or economically sound as composting.

Composting is the decomposition of plant remains and other once-living materials into a nutrient-packed substance useful in enriching house plants, garden and farm soils. It is a form of recycling which occurs naturally, and has successfully been adopted by humans, who usually enlist the help of insects, earth worms, and microorganisms. Today, more and more people are beginning to compost their yard and/or kitchen scraps either individually or through their municipality. These efforts improve plant production while reducing the volume of garbage going into already overburdened landfills. By addressing the solid waste issue, composting provides a way of instilling in children a sense of environmental stewardship.

Many educational programs focus on reducing, reusing, and recycling our solid waste. Composting fits in with this idea but takes it a step beyond. With composting, children can do more than just send cans or newspaper off for recycling-- they can see the entire cycle of food scraps or other organic waste turn into something that is pleasant to handle and is good for the soil. Contrary to the “out of sight, out of mind” philosophy, children who compost become aware of organic wastes as potential resources rather than just as something to be thrown away and forgotten. They learn through direct experience that they personally can make a difference and have a positive effect on the environment.

# EM: AN AMAZING DISCOVERY

Microorganisms are tiny units of life too small to be seen with the naked eye, They exist everywhere in nature, in the air, soil, ocean, rivers, animals and in the human body. We usually tend to associate these microorganisms only with uncomfortable infections, sickness, or such inconveniences as spoiled food, foul smells, mold and mildew. However, the vast majority of microorganisms are crucial for maintaining ecological balance on Earth, and carry out chemical processes that make it possible for all other organisms, including humans, to live. These "friendly guys" of the microbial world are known as beneficial microorganisms. Only a minority of microorganisms are harmful and capable of producing disease, decay, and pollution. This not so friendly group is known as pathogens.

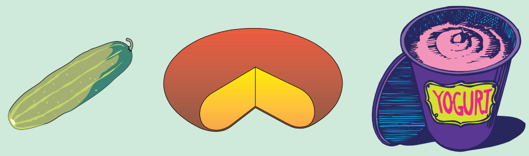
In 1982, Dr. Teruo Higa, professor of Agriculture at the University of the Ryukyus in Okinawa Japan, introduced to the world a breakthrough in the field of microbiology. After more than 20 years researching beneficial microorganisms for use in agriculture, Dr. Higa discovered a specific group of naturally-occurring beneficial microorganisms with powerful antioxidant and anti-putrefactive properties. In other words, microorganisms with an amazing ability to revive, restore and preserve. He named this group " **EM"**, an abbreviation for **EFFECTIVE MICROORGANISMS™**. EM is a combined culture of aerobic microorganisms (requiring oxygen to survive) and anaerobic (do not require oxygen to survive) microorganisms that co-exist symbiotically in one liquid solution. Prior to Dr. Higa's discovery, it was presumed these two groups of microorganisms, requiring opposite conditions to survive, were not compatible.

Microorganisms control and determine which course Nature will follow, that of regeneration (a state of life, health & vitality) or that of degeneration (a state of degradation, decay, disease, pollution, oxidation). Dr. Higa's findings demonstrated the power of EM to influence which of these two forces will prevail in a specific environment. Soil conditions are a good indicator of how these two forces work in nature. A soil where regenerative or beneficial types of microorganisms predominate exhibits remarkable growth, yield and is also disease and pest free. Soil quality continues to improve without the need for agricultural chemicals. The opposite holds true in soils controlled by degenerative or pathogenic type of microorganisms. In this case, the balance of normal microflora has been upset and disease inducing organisms take over. Soils that have been intensely farmed with agro-chemicals fall under this category and therefore growth tends to be poor and crops are weak and afflicted with pests and pathogens. By introducing EM into these types of soils, it is possible to shift the microbial equilibrium in order to ensure that beneficial microorganisms become the dominant force. The organisms in EM combine with the beneficial microorganisms already present in the soil and help them proliferate. Together, they work to build a healthy, living soil.

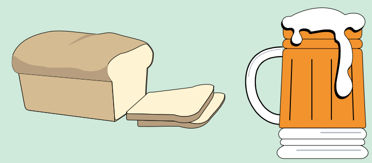
EM contains naturally-occurring beneficial microorganisms found in soils worldwide. The three main groups of microorganisms found in EM are Phototrophic Bacteria, Lactic Acid Bacteria, and Yeast. Many of these cultures are used for processing cheese, yogurt, bread, soy sauce, pickles, miso, sauerkraut, beer and other common fermented foods and distilled spirits. EM•1® is listed on the OMRI list (Organic Material Review Institute). EM is not toxic or pathogenic and is safe to humans, animals and the environment.

# MEET THE EFFECTIVE MICROORGANISMS

**LACTIC ACID BACTERIA**




**YEAST**



## EFFECTIVE MICROORGANISMS FOR SOIL & PLANTS

EM is a practical and “down to earth” bio-technology, easy for children to learn and use. EM•1® comes as a liquid concentrate, and, in this form, the microorganisms are alive but dormant. To activate them, you simply dilute the concentrated solution with water according to the application. An equal amount of molasses, a food source, may be added to further activate EM•1®. The following are some applications and benefits of EM•1® .

### APPLICATIONS:


* As a pre-planting treatment
* As a foliar spray for growing plants
* As an inoculant for seeds and transplants
* As an inoculant for nursery crops, container-grown plants, and in hydroponic systems
* As an inoculant for accelerating the decomposition of crop residues, cover crops, green manures, and other organic wastes from municipal and agricultural sources

### BENEFITS:

* Enhances soil fertility
* Promotes germination, growth, flowering, fruiting, and ripening in crop plants
* Increases crop yield and improves crop quality
* Accelerates the decomposition of organic waste from crop residues
* Increases the population of beneficial microorganisms in the soil, leading to the control of pathogens through competitive exclusion

# COMPOSTING WITH EM•1® & EM•1® BOKASHI

EM•1® can be used to compost both **aerobically** and **anaerobically**. This manual focuses on composting food waste through anaerobic fermentation, however a brief explanation on the how to use EM•1® in aerobic systems is presented below. You can incorporate both methods in your school gardening projects.

## AEROBIC: USING EM•1® - CONCENTRATED LIQUID SOLUTION

**Aerobic** compost can be made in the usual manner of layering organic materials. Inoculate the materials with a solution of EM•1® and molasses at a dilution of 1:1000 as they are added to the pile. Use 3 gallons of this diluted solution per cubic yard of materials in the pile. This is equivalent to 3 teaspoons of EM•1® , 3 teaspoons of molasses to 3 gallons of water. Apply with sufficient water to be wringing wet. The pile will heat up quickly to a high temperature. The pile may need to be turned. The compost may be mature in 3 to 4 weeks with this method.

## ANAEROBIC: USING EM BOKASHI (COMPOST STARTER)

The most effective method of composting food waste is through **anaerobic fermentation.** This process is done in airtight environment and using **EM Bokashi** as an inoculant or compost starter. **Bokashi** is a Japanese term that means "fermented organic matter". This method results in the fermentation or "pickling" of the materials, as opposed to the decaying process that occurs in traditional composting. **EM Bokashi** is wheat bran that has been fermented with EM•1® and then dried for storage. The wheat bran, a carbon source, acts as a housing or medium for the microorganisms to live. When the correct conditions are provided, EM Bokashi guides the decomposition of organic matter into a fermentation rather than a putrefaction pathway. This unique method can produce a nutrient rich compost in less than half the usual time of conventional methods, without the unpleasantness associated with putrefaction. This system can be easily implemented in an indoor environment, making it practical for schools, households, restaurants, and businesses to compost food waste. When compared to traditional composting systems, you can produce an incredibly healthy soil in just 4 to 6 weeks compared to the 6 to 8 months that it takes in traditional composting process.

### TRADITIONAL COMPOSTING

- Aerobic process
- Putrefactive decomposition pathway
- Requires turning
- May produce foul odors
- May attract flies and unpleasant insects
- Nutrients are turned to elements (unsoluble) and are not readily available for plant intake
- Loss of energy - up to 80% of original nutrient content is lost through leaching and volatilization
- Requires large amounts to meet plant nutrient needs
- Requires 2 to 3 months to complete
- No control of microflora

### EM•1® COMPOSTING

- Anaerobic process
- Fermentation pathway
- Not labor intensive - does not require turning
- Produces no foul odors
- Attracts beneficial insects
- Nutrients are readily available in soluble form for plant intake
- Increase of energy- beneficial substances are created and shared between aerobic & anaerobic organisms, retaining nutrients in the compost
- Requires smaller amounts to meet plant nutrient needs
- Requires only 1 month to be ready for use
- Controlled inoculation of specific beneficial microflora

# FROM PLATE TO PLANTING

This section presents an overview of the entire composting process, from collection, fermentation, to the transfer of the food waste into the soil. Before introducing this activity to your classroom, we recommend you try it first at home. This will allow you an opportunity to learn from any mistakes and give you confidence to teach this bio-technology. Additional information and issues to consider when composting in a school cafeteria setting can be found on pages 17-20.

## LIST OF MATERIALS


**1. EM Kitchen Fermenter Bucket or any 3 to 5 gallon capacity plastic buckets that can be adapted to provide the following features**:

- An airtight lid to ensure an anaerobic environment (no exposure to air).
- A strainer/ divider to separate the food waste from liquid that may collect at the bottom of the bucket.
- A spigot or stopper to drain out the liquid.

The size and number of the composters will depend on how much waste you are planning to collect. You may purchase special buckets from EM Technology Network, or build your own as a classroom project. For instructions on how to build a bucket, refer to page 33.

**2. EM Bokashi:** Making Bokashi allows children a hands-on opportunity to work with microorganisms and be part of the entire EM fermenting cycle. It is also a fun and eye-opening activity!!! For instructions on how to make EM Bokashi, refer to page 31.

**3. Fresh leftovers and kitchen scraps:** Do not include spoiled or moldy items. To ensure an effective fermentation process break large pieces of food items into smaller fragments and drain any excess liquid prior to placing the waste in the bucket. Use only organic materials suitable for turning into compost. Note: Paper products, although organic, should be excluded.

### ITEMS YOU COMPOST WITH EM

- **Fresh fruits & vegetables**
- **Prepared foods**
- **Cooked or uncooked meats & fish**
- **Cheese & eggs**
- **Bones - chopped into small pieces**
- **Coffee & tea without the filter paper or bags**
- **Dry leaves and wilted flowers**

## DO NOT ADD TO COMPOST WITH EM

- **Plastic**
- **Styrofoam**
- **Glass**
- **Paper**
- **Aluminum foil**
- **Soda cans**


# THE COLLECTION PROCESS

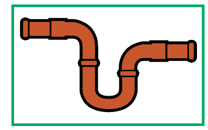
**1.** Begin by sprinkling Bokashi in the bucket. Place your fresh kitchen scraps or meal leftovers inside the bucket and coat them evenly with a layer of Bokashi. Remember, do not include any moldy or spoiled food items. Use approximately one handful of Bokashi for every one inch layer of food waste. Use more Bokashi during the summer or in hotter climates and when treating high protein foods such as meat, fish, cheese and eggs.

**2.** Repeat this layering process until the bucket is filled to capacity. Add a generous coat of Bokashi to the final layer of food waste and seal the lid tightly. In a school cafeteria setting, you will fill-up at least one bucket per lunch period. At home, it may take you a week to a month to fill up a bucket depending on the number of people in your household. Make sure to close the lid tightly every time you add waste into the bucket. Remember, EM needs an air-tight environment (anaerobic) to do its job!! Not doing so could result in putrefaction rather than fermentation of the food waste!

**3.** Date and store the bucket(s) away from direct sunlight in a cool place. At school, store it in a closet or any avaiable space away from the cafeteria's kitchen and high traffic areas. At home, store the bucket under the kitchen sink, closet, or garage. Buckets can also be stored outside in a shed or any shaded area. Let the waste ferment for a perod of two weeks in warm weather and up to one month in coler climates.

**4** Prior to and during the final two-week fermentation period, liquid may collect at the bottom of the bucket. Use the spigot to periodically drain this liquid commonly called "EM Garbage Juice". The amount and color of the liquid drained will depend on the type of foods you dicard. Fruits and vegetables tend to release more moisture than other foods. Do not be concerned if little or no liquid is produced. Do not discard this valuable liquid as it can be used to:

**a.)** Apply to the Soil: This liquid fertilizer is rich in nutrients from the food waste and alive with EM.To fertilize an existing garden or house plants use a 1:1000 - 2:000 dilution rate and apply directly to the soil. Do not apply directl to plant foliage. For trees and shrubs you may use a stronger dilution rate, such as 1:500.



**b.)** Clean and Control Odors in Drain Systems: Pour the concentrated soltion directly into your kitchen and bathroom drains, toilet or septic system. EM will help maintain the population of beneficial microorganisms in check, prevening slime build-up and curtailing malodors.

**Please note this liquid is not equivalent to and should not be used in place of the original EM•1® concentrate. The EM Garbage Juice cannot be stored and must be used within 24 hours after drainage or it could spoil.**

## THE SWEET SMELL OF SUCCESS: SIGNS OF A GOOD FERMENTATION PROCESS

Once the two week fermentation period is over, open the container and check to see if your compost is ready for use. You will notice the food waste has not fully degraded but rather has preserved its physical properties, appearing and smelling like pickles. Remember that EM preserves rather than putrefies organic matter. The full breakdown of the material will occur once it's transferred into the soil. The following are signs that your compost has been a success:

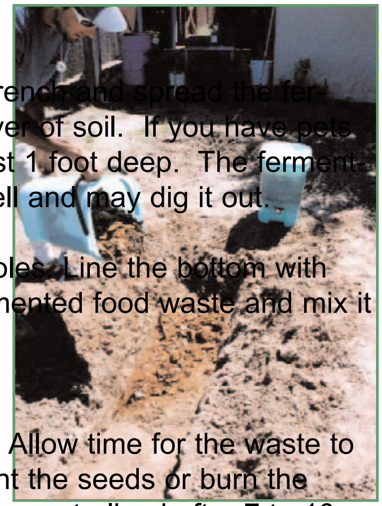
**1. SMELL**: Well fermented waste should have a sweet and sour smell, similar to that of pickles or apple cider. A strong, rancid or rotten smell indicates the process has failed.

**2. VISUAL:** Occasionally, a white cotton-like fungi growth may appear on the surface of the compost. This does not indicate failure, but rather that a good fermentation process has taken place. On the other hand the presence of maggots, or black or blue-green fungi indicates that contamination has occurred and the process has followed a putrefactive pathway.

To know why a fermenting batch could go bad and how to dispose of it, refer to page 16.

# HOW TO USE YOUR FINISHED EM COMPOST

## 1. TO PREPARE THE SOIL FOR PLANTING:



**A) Establishing a garden:** Dig approximately a 6 to 8 inches deep trench and spread the fermented waste. Mix with some soil and cover with at least a 3-inch layer of soil. If you have pets or live near a wild animal habitat, you may want to dig a trench at least 1 foot deep. The fermented food waste poses no danger to animals, however they like the smell and may dig it out.

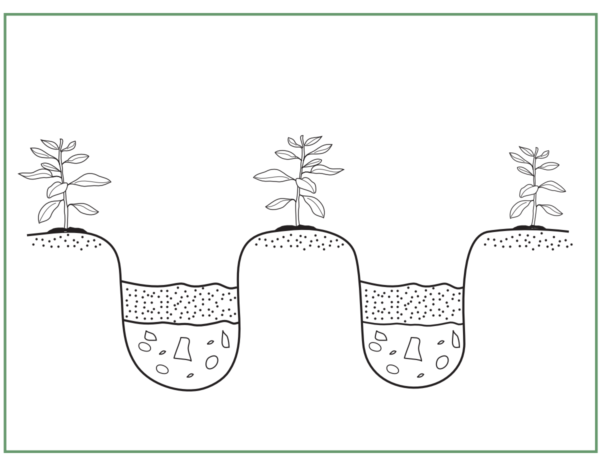
**B) For planters/container gardening**: Select a planter with drain holes. Line the bottom with gravel or other materials that drain well. Add 1/3 potting soil, 1/3 fermented food waste and mix it in with some soil, finally cover with 1/3 potting soil.

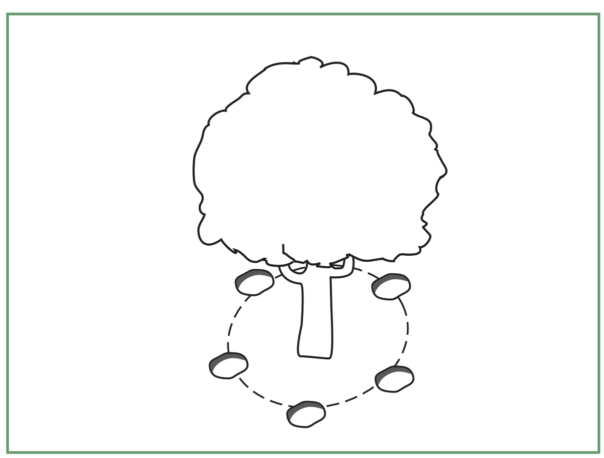
Whether transferring the fermented waste to a garden or planter, wait at least two more weeks before planting any seeds or seedlings. Allow time for the waste to ferment and breakdown in the soil. Planting immediately could ferment the seeds or burn the roots of the seedlings. The EM fermented compost is acidic and will be neutralized after 7 to 10 days.

## 2. TO FERTILIZE:

**A) Existing gardens:** Dig approximately 6 to 8 inches deep in between beds and spread the fermented food waste. Mix in with soil and cover with a 3-inch layer of soil. Be sure the roots do not touch the compost directly.

**B) Trees:** Dig 8 to 12 inch deep holes at two feet intervals around the tree's drip line. Bury the fermented food waste in the holes and cover with a 3-inch layer of soil.





**3. TO PRODUCE EM SUPER-SOIL:** Dig one or several trenches 3 to 5 feet deep and 1 to 2 feet wide. Transfer waste into the trench and cover with a thick layer of soil. Repeat this process until the trench is full. Wait at least a month to dig out this "super soil " and use it as a soil conditioner in your garden or planters. This trenching method is ideal for schools, restaurants, farms, and businesses that may generate large volumes of waste in excess of their gardening needs. The super soil produced can be marketed as a specialty soil. (See page 28 for educational activities.)

Trenching method at ASDB.

## AN IMPORTANT FINAL STEP:

Wash the buckets thoroughly with water after every transfer. Not doing so may contaminate your next batch of fermented food waste and be a cause for failure.

## THE FOUL SMELL OF FAILURE: WHY A FERMENTATION PROCESS GOES WRONG

**1.** Poor quality of the Bokashi.

**2.** Not adding enough Bokashi to the food waste.

**3.** Not replacing the container's lid tightly after every use.

**4.** Failure to frequently drain the "Garbage Juice" from the bucket.

**5.** Spoiled items were added to the compost.

**6.** Prolonged and direct exposure to sunlight and extreme temperatures (too hot or too cold).

## HOW TO DISPOSE OF A BAD BATCH OF COMPOST

**1.** Find a spot in your garden away from trees and plants and dig a 1 foot deep hole. You can also use a 10 gallon planter.

**2.** Place 1/2 lb. of Bokashi in the hole or if using a planter, first layer with soil and then add the 1/2 lb. of Bokashi.

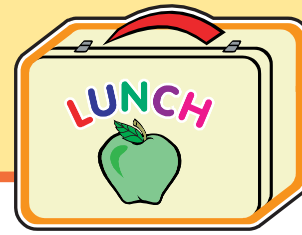
**3.** Pour the failed batch and mix with some soil. If maggots are present, add boiling water first.

**4.** Add another 1/2 lb. of Bokashi and cover with at least a 3-inch layer of soil.

**5.** Finish by spraying a 1:100 diluted EM solution over the soil.

**6.** You may plant in this area or plant after a month.

# LET'S DO LUNCH AT SCHOOL




Introducing an EM recycling activity at a school setting can be as simple as collecting one bucket of food waste in a classroom or setting up a daily food collection effort in the cafeteria. In fact, an EM composting project often starts in a classroom, evolves into a cafeteria program, and expands into the community. However, implementing an EM food waste recycling program at a large scale or on a permanent basis requires detailed planning, a coordinating team who will follow-through, and the enlisting of a strong core of volunteers. Keep in mind that the greater the volume of food waste collected, the wider the base of support and logistics required to manage it. The following are some issues to consider when proposing a program to your school's administration.

## LOBBYING FOR SUPPORT:

Composting in a school setting may not be a common practice in many urban areas. This may be due in part to limitations posed by conventional composting methods and the lack of public awareness on the need to divert organic waste from landfills. Space constraints, unsightliness of an outdoor pile, flies, odors, and other unpleasantness associated with putrefaction tend to discourage schools from composting food waste. Although the EM Bokashi method solves these inconveniences, you may run into some barriers when proposing an EM food waste recycling program to your school officials. The fact is that most of us view food waste as solely garbage and do not attach any value to it. Furthermore, microorganisms are mainly perceived as agents of disease and decay and many people do not realize that a vast number of them sustain life on this planet. Therefore, gain the support of the school administration, teachers, parents, and other staff by changing their perception on these issues. The key to win them over, is to educate them on the value of recycling food waste and the benefits of EM. This can be achieved by distributing information on the subjects, sharing EM curricular activities, inviting guest speakers to address topics, touring EM pilot school projects, and attending EM training workshops.

## BUILDING YOUR TEAM AND SETTING GOALS:

Once you have succeeded in gaining the school's attention and endorsement, assemble a coordinating team to help implement the program. The team should set the goals to guide the project, evaluate needs, and determine the logistics and budget required to implement this program. Get involvement from as many people you believe will be impacted by the project. Include not only the principal, teachers, parents, and students but also cafeteria staff, maintenance personnel, etc. If a gardening committee is already in place at your school, tie into their activities and work in conjunction with them. The coordinating team should determine what they would like to accomplish with this project and set goals to direct the volunteers. For example,determine the main goal: to raise environmental awareness and reduce waste, complement a gardening project, enhance a science curriculum, promote organic gardening and good nutrition, increase parent involvement in school activities, establish a community garden, etc. In general, determine how this program will benefit the school and the community. Without setting goals, you may end up collecting more food waste than you need or you can manage.

## LOGISTICS AND SCALE:

The scale and frequency of food collection will not only depend on your goals but also on the volume of waste the school generates per day. Although everyday collection is the ideal, it poses a logistical challenge for schools with very large student populations. Our recommendation is to start on a small scale and increase collection once you feel comfortable with the process and have the necessary logistics in place to handle larger volume. For example, a school of 300 on average collects two to three 5 gallon buckets per lunch hour (120 to 180 lbs) of food waste per day. That translates into 15 buckets a week. Before initiating daily collection, ask if there is room to store it and what will be done with all that fermented waste.

If gardening is your main goal, begin collecting food waste at least one month prior to planting season. Remember that the waste needs to ferment two weeks inside the composter and another two weeks in the soil. For example, if planning a spring garden, begin composting and preparing the soil during the winter or early spring. You may begin collecting and trenching food waste at any point in time if you are not planning to establish a garden immediately. In either case, make sure the logistics are in place to ensure the process runs smoothly. The following is a checklist of tasks and other items to include in your planning:

**1. Training:** Arrange for training of all key players and volunteers so they become familiar with the various steps in the composting process, such as Bokashi production, food collection, transfer, etc. If the volunteers are able to perform multi-tasks, they can then substitute in areas where needed. A thorough training program also helps to ensure the continuity of the project. In the case where coordinators and volunteers move on to other projects, there will be always be someone there to carry on the program.

**2. Assigning duties and responsibilities:** The coordinator(s) should prepare a sign-up sheet listing the different tasks and responsibilities for the volunteers to carry out. These include setting-up the collection station in the cafeteria during lunch time, monitoring the collection process, cleaning-up, labeling, and storing the buckets accordingly. In addition, volunteers must drain buckets when needed and use the “Garbage Juice” as instructed. Please remember that failure to drain this liquid could trigger putrefaction of the fermented waste. Volunteers must arrange for the timely transfer of the fermented waste into the garden or deep trenches. Also, buckets must be rinsed thoroughly before they can be used for a new batch. A log should be kept to record the amount of food waste your school is diverting. Post this information in the school cafeteria, newsletters, and publicize it in the community.

**3. Making Bokashi:** Make sure you have a good supply of Bokashi available before you begin collecting waste. If you are planning to make your own Bokashi, do so at least a month in advance to allow enough time for it to ferment and dry. Fermenting and drying may vary according to your local climate.

**4. Building Buckets:** When considering what buckets to use, consider volume, ease of transportation, drainage capacity, and costs. The bucket system is easy for students and volunteers to manage and move around. Have enough fermenting buckets on hand to meet your recycling goals. For example, to collect two buckets twice a week, have at least 8 -12 buckets on hand to begin the process. As the batches complete their fermentation period and are transferred into the soil, rinse the buckets thoroughly and put them back to use. An alternative to the bucket system is to convert a 30 to 50 gallon capacity barrel into a fermenter. The same criteria for building a composting bucket applies for building a fermenting barrel. The system must provide an anaerobic condition (airtight lid), it must have a screen to separate the waste from the liquid that accumulates and a method to drain it out. A full bucket can weigh an average of 40 lbs, while a fermenting barrel can hold more than 500 lbs.

**5. Setting-up a collection station:** Set up the station next to other recyclables and garbage receptacles. It is important to have someone monitoring the station at all times in order to guarantee an efficient collection. Have each student clear their own plate into the bucket using a spoon or utensil. Although the instructions recommend that large pieces of food be broken into smaller fragments, this may be possible at home but not in a fast paced cafeteria setting. Instruct volunteers to try their best to break large items and sprinkle Bokashi over each layer of food waste that goes into the bucket. The Bokashi is perfectly safe to handle, however, gloves can be worn if desired.

**6. Select storage site for food waste:** Select a site away from the food preparation area and high traffic. You may store waste outside as long as it is underneath a shade. Have a dolly or utility cart on hand to help transport the buckets to the storage place and later on to the garden.

**7. Preparing Transfer Site:** Make sure in advance that garden trenches are dug and ready for the fermented food waste to be transferred. Arrange for a backhoe if you plan to incorporate a deep trenching system. Place trenched soil adjacent to the trench to use as a soil cap to cover the fermented compost. Food waste may be stored for more than two weeks under the right conditions, but we recommend you avoid storing it for extensive periods of time. There is no point in collecting food waste for the purpose of storing it! You may want to consider transferring excess waste to a different site, such as a community garden, another school's garden, a farm, or a composting facility. Searching for a transfer site is a good exercise in resourcefulness and community networking for the students.

## BUDGET AND PROGRAM'S SUSTAINABILITY:

Composting with EM does not cost, it saves ... money and the environment. This program has been designed with minimal costs in order to make it affordable for schools to implement. Schools are giving the option to make their own Bokashi as well as to build their composting buckets out of recyclable materials. This brings the cost of the program down and also provides children a valuable lesson in sustainability. Budgeting for this program really depends on the scale of food collection the school will undertake. However, a budget of approximately $130.00 will get the program off to a start. This will cover the purchase of utensils needed to collect waste, build buckets and make Bokashi. It is also enough to buy ingredients to make your first 100 lbs. of Bokashi. The long-term savings realized in waste collection fees and purchases of gardening inputs more than offsets the total cost of running the program. Further, the program offers entrepreneurial and fundraising potentials that will ensure its sustainability.

### INITIAL COST: Utensils/Materials (Estimated cost, as an example)

| | | |
|---|---|---|
| 10 OR MORE MIXING TUBS<br>*Cheaper alternative: use old tubs, trays, buckets or a 10 x 8 tarp ($5.00) | | $ 50.00 |
| 2 SPATULA/SCRAPERS | | $ 5.00 |
| 2 OR MORE MEASURING CUPS | | $ 3.00 |
| 2 OR MORE MEASURING SPOONS | | $ 3.00 |
| DRILL (Borrow from school maintenance department) | | $ 0.00 |
| COMPOSTING BUCKETS (Recycled ) | | $ 0.00 |
| 12 GOOD QUALITY SPIGOTS<br>*Cheaper alternative: Rubber stoppers, cork | | $ 36.00 |
| BUCKETS TO MIX SOLUTIONS & STORE BOKASHI (Recycled) | | $ 0.00 |
| | **SUBTOTAL** | $ 97.00 |

### COST TO MAKE 100 LBS. OF BOKASHI (TREATS 50 BUCKETS OF 5-GALLON CAPACITY)

| | | |
|---|---|---|
| EM•1® SOLUTION (2 cups) | | $ 10.00 |
| MOLASSES (2 cups) | | $ 2.80 |
| WHEAT BRAN (2 50 lb. bags) | | $ 20.00 |
| | **SUBTOTAL** | $ 32.80 |
| | **TOTAL** | **$ 129.80** |

## SUSTAINING THE PROGRAM:

It really pays to recycle with EM•1®. Not only is the program inexpensive to implement, but the added benefits realized from the program ensures the program's sustainability and continuity.

**1. Savings on the purchase of gardening supplies:** The school can significantly cut down on the purchase of soil, compost, and other gardening supplies.

**2. Reduced Garbage Collection Fees:** By cutting down the volume of waste that goes into the dumpsters, the school will reduce garbage collection fees charged by waste management companies. For example, the Arizona Schools for the Deaf and Blind (ASDB) was able to cut down their garbage pickup from 4 to 3 times per week, realizing a savings of $500 in their first year of implementing the program.

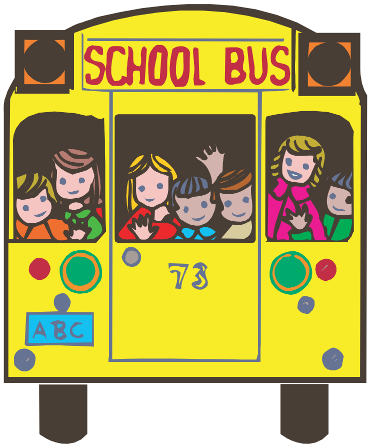
**3. Entrepreneurial Potential:** There are many entrepreneurial projects that your school can undertake. As a school fundraising project, for example, schools can sell Bokashi and EM-grown vegetables and herbs, and EM super soil.

**4. Community Appeal**: Businesses are always happy to support projects that have an environmental education component and that benefits the community.

**5. Grant opportunities:** The merits of this recycling program have been recognized by many educational, environmental, and gardening organizations who have awarded grants to some of our pilot schools so they can continue and expand this program. Funding for this type of educational program is available from both, the non-profit as well as corporate sectors.

**Notes:**

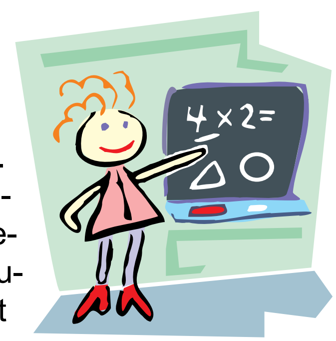
# INTRODUCTION TO EDUCATIONAL ACTIVITIES




Environmental conservation and sustainability are concepts that can be easily presented and demonstrated in schools through the use of the EM BOKASHI food waste fermenting system. The system can be used to establish a school garden, enhance science units, or as an ongoing project in food waste reduction and recycling.

The following section includes a variety of educational activities using the EM Bokashi food waste fermenting system. These activities present the concepts of landfill reduction, recycling processes for food waste and plant discards, and the reuse of recycled products. Each activity generally consists of the following format:

**1.** Purpose - Describes the intent of the activity
**2.** Key concepts - Describes major concepts presented
**3.** Skills - Lists skills the activity will enhance
**4.** Materials - Lists tools and materials needed and suggestions for obtaining them
**5.** Procedure - Provides a general description of the activity
**6.** Follow up activities - Suggests extension activities to enhance the concepts presented

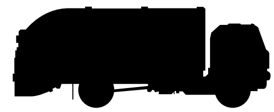



An additional component called "Tips for the Teacher" appears randomly throughout the activities. This component provides additional ideas to emphasize specific skill development in content areas (e.g. math, science, art, language, and social studies) during the lesson. Educators are encouraged to consider the age/grade levels of their students as they use these activities. It is suggested that lessons for elementary school students focus on the school environment. Young students are most aware of their immediate environments and learn best with concrete tangible activities. Students in middle schools will be ready to generalize concepts practiced in the school environment to their home environments. Hence, the emphasis in middle school should be reduction, recycling, and reuse of food waste collected in the home.

Finally, at the high school level, students are able to embark on projects involving (1) reduction, (2) reuse, and (3) recycling of food waste in their local communities. Projects can be developed using the EM Bokashi food waste fermenting system in restaurants, and community gathering places. Students can expand their experiences to compare and contrast the impact of recycling food waste in larger geographic areas and then consider the differences in disposal of food waste among a variety of countries and cultures.

Perhaps after introducing this innovative method of fermenting food waste to your classroom, you decide to go one one step further and propose an on-going school food waste recycling program at your school. The segment**, "Let's do Lunch at School",** (p. 17-20) contains guidelines and suggestions that will help you implement such a program.

# FOOD FOR THOUGHT
# *The Fate of Food Waste*



❒ **PURPOSE:** To learn what happens to our food leftovers.

❒ **KEY CONCEPT:** Food waste does not have to end up in landfills, it can be recycled through a natural process called composting.

❒ **SKILLS:** Science, Vocabulary development, Environment

❒ **AGE GROUP:** 5th Grade and above

❒ **MATERIALS:** Chalkboard, Dictionaries, pictures whenever possible

❒ **PROCEDURE:**

**1.** Instruct students to look up the words **compost** and **decompose** and observe that compost is part of the word decompose. Now, they are ready to begin a discussion on food waste.

**2.** Ask students what happens to the leftovers they do not eat at home or in the cafeteria. Write their response on the board. Where does all this waste go? Does it disappear? No, it ends up in our landfills or transfer stations.

**3**. Ask students to go back 50 to 100 years ago, before the existence of garbage trucks, dumps and modern landfills. What do they think people did then with their food waste? The waste would be buried in the soil or placed outside in piles to let nature **decompose or recycle** it into a soil-like dark substance called humus. Microorganisms, worms, and other organisms that live in the soil, eat and convert the food waste into a nutrient form that can be easily absorbed by plants.

**5.** Find out how many students compost at home and what method they use. There are various methods that can be used to compost organic matter faster than it occurs in nature.

**Aerobic (air required):** open piles, open bins, worm bins,
**Anaerobic (no air required):** Closed -air systems, underground composting (waste gets buried in the soil), EM Bokashi fermentation process

**6. What can you compost:** Food waste, leaves, grass clippings, manure, saw dust, and other organic matter
**Where can you compost:** Home, school, restaurants, community gardens, farms
**What can compost be used for:** Soil amendment, mulch, side dressing
**Benefits of composting**: Helps divert waste from landfills, improves soil quality and fertility, helps the environment, saves money

❒ **FOLLOW-UP:** Arrange for a field trip to a municipal or commercial composting facility, community garden, or farm to observe various kinds of composting operations.

# DON'T LET A GOOD THING GO TO WASTE

❒ **PURPOSE:** Raise awareness among teachers and students on the amount of food waste generated by the school on a daily basis.

❒ **KEY CONCEPTS:** By recycling food waste, schools can make a significant contribution to the environment,

❒ **SKILLS:** Science, Math, Social Science

❒ **AGE GROUP:** 3rd Grade and above

❒ **MATERIALS:**

1 EM Bokashi
2. EM food waste fermenting buckets **(Number will depend on the number of students at your school)
3. Spatula
4 Labels

Collecting food waste at Miles Exploratory Learning Center, Tucson, AZ. Photo by Mike M.

❒ **PROCEDURE:**

**1.** Discuss with students the problems created by garbage and landfills. Review the 3'R concept: **R**e-duce, **R**e-use, **R**e-cycle and where composting fits in.

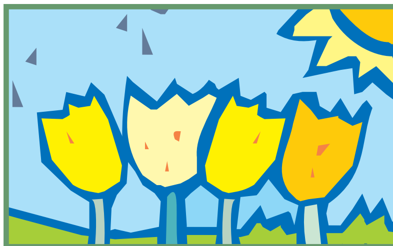
**2.** Have your class collect one lunch period of cafeteria food waste. Prior to collection, inform the principal and the rest of the school what will take place at the cafeteria. Place the composting buckets with a **FOOD WASTE ONLY** sign next to other collection receptacles i.e, soda cans, plastics, and regular garbage. Have two students at a time manning the collection process. Encourage students to explain the purpose of this activity to their curious peers. After the collection is done, weigh the buckets and record this number.

**3.** Date the buckets and store them in a dark place, away from direct sunlight for a two week period.

**4.** Calculate the total amount the school generates in one day, week, month, etc. Share this information with the rest of the school. Discuss the value of fermenting food waste in the reduction of landfills. Additionally, reinforce the concept of source reduction i.e. do not waste food, serve yourself only what you can eat.

> ***TIPS FOR THE TEACHER:*** *Discuss the implications of establishing a permanent food waste collection program at the school ( i.e establishing gardens, waste diversion, environmental sustainability, saving waste management fees for the school, entrepreneurial activities, etc. Refer to pg. 18-20).*

❒ **FOLLOW-UP:** After the two week period is over, transfer food waste into garden trenches or planters. During this period, make sure to drain liquid that may accumulate at the bottom of the bucket and use accordingly.



# PICK-UP PICNIC

PICK-UP PICNIC

❒ **PURPOSE :** Use a litter awareness activity to introduce the use of Effective Microorganisms as a method to decompose food waste.

❒ **KEY CONCEPTS:** Decomposition is a form of recycling that continuously occurs in nature. Microorganisms play a key role in decomposing organic matter.

❒ **SKILLS:** Science, Social Science, Environment

❒ **AGE GROUP:** Elementary school (all grades)

❒ **MATERIALS:**

**1.** EM Bokashi
**2.** EM food waste fermenting bucket(s)
**3.** Large size garbage bags
**4.** Picnic food and utensils
**5.** Five pairs of cloth, reusable gloves (optional)

❒ **PROCEDURE:**

**1.** This activity must be pre-planned as a field trip to help clean/beautify the environment. Students are asked to plan an outing to a local park or public recreation area in order to pick up litter. This activity can be adapted to age groups by the teacher's choice of setting (e.g. school playground, local park, national preserve, etc.).

**2.** In preparation for the outing, assign students food items to prepare at home and bring for a picnic lunch after the litter. The teacher should plan to bring the rest of the materials for this activity.

**3.** Take the class out for a walk around the park to collect litter. Students can place the items collected into two bags, one for recyclables and one for non-recyclables. Look for signs of decomposition on each type of litter found. Discover the different ways that decomposition takes place and look for the presence of microoganisms (tins can rust, bacterial action on paper, mold and fungus on food, insects and animals). If an item is not decomposing, why not? Have children observe organic matter, such as any plant or animal remains, naturally decomposing in the soil.

**4.** Lunch is served after the walk

**5.** After everyone is done eating, begin cleaning-up picnic area. Instruct students to place the recyclable items into the designated bag and all food waste inside the buckets. Begin sprinkling EM Bokashi over every layer of food waste as the students fill the composter. At this point, take time to explain what you are doing and introduce the use of EM Bokashi to decompose waste.

❒ **FOLLOW-UP:** Take all the recyclable items to your school's recycling bins or the nearest recycling center. Dispose of the non-recyclable items in the school dumpster.

# FROM SCRAPS TO SPLENDOR

❒ **PURPOSE:** Observe how EM•1® fermented food waste breaks down into soil.

❒ **KEY CONCEPT:** Composting - Mother Nature's answer to recycling.

❒ **SKILLS:** Science, Math, Writing

❒ **AGE GROUP:** All grades

❒ **MATERIALS:**

**1.** EM•1® Fermented Food Waste **(Refer to pgs. 13-15.)**

**2.** Clear plastic containers to better observe and record the decomposition process. Containers should between 8 to 12 inches deep. You can find them at restaurant supply stores. If not available, use regular planters.

**3.** 2 bags of potting soil, preferably organic. (Save one bag for activity on page)

**4**. Plastic lids or plastic wrap to seal the container.

❒ **PROCEDURE:**

**1.** Drill small holes in the plastic container, so as to resemble a planter. First place some gravel in the bottom to allow drainage. Add 1/3" soil, followed with 1/3" EM fermented food waste, and cover with 1/3" soil. Close container's lid tightly or cover with plastic. Allow food to continue fermenting in the soil and complete its decomposition (break down) process. This can take anywhere from 2 weeks up to a month depending on the weather.

**2.** Have students observe and record the decomposition process of the fermented food waste.

> ***TIPS FOR THE TEACHER:*** *To further develop conceptual understanding of composting processes, compare the EM Bokashi anaerobic method with conventional methods. Build an outdoor compost pile and /or worm bin. Students can track the decomposition of organic matter in aerobic vs. anaerobic composting processes. They can compare temperatures, time it takes to breakdown, smell, appearance, etc. Create a graph to show decomposition over time.*

❒ **FOLLOW-UP:** Do a comparison trial to see how EM works in an aerobic environment. Build two identical compost piles. Apply a solution of **EM•1**® & Molasses at a 1:1:1000 dilution rate to one of the piles. Have students compare the decomposition rates of both piles. They can measure temperatures, time it takes to breakdown, smell, appearance, etc. Create a graph to show decomposition over time.

# TO ROT OR NOT TO ROT ... THAT IS THE QUESTION

❒ **PURPOSE:** Learn the role that microorganisms play in decomposing organic matter, using scientific methodology (i.e. hypothesis, observation, recording, conclusion). Compare fermentation, a process guided by beneficial microorganisms vs. putrefaction, a process guided by harmful/pathogenic microorganisms.

❒ **KEY CONCEPT:** EM promotes fermentation (pickling) and not putrefaction rotting of food waste. Development of a hypothesis and observation techniques.

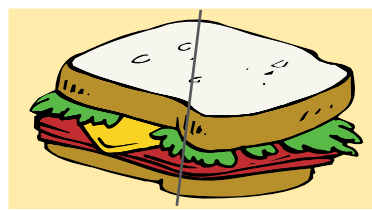
❒ **SKILLS:** Science, Writing, Vocabulary. Environment

❒ **AGE GROUP:** All grades

❒ **MATERIALS:**

**1.** Two small (sandwich size) plastic containers with tight lids. Use containers that are preferably transparent for better recording and observation. Do not use glass receptacles.

**2.** Ingredients to prepare a sandwich:
* Slices of bread
* Slices of cold cut i.e. turkey, ham, roast beef
* Slices of cheese
* Lettuce & tomato
* Mayonnaise



A sandwich has a good variety of food items, including meat and dairy, to better observe the difference between putrefaction and fermentation. You may replace any of these food items with your class's favorite food.

3. **EM Bokashi**

❒ **PROCEDURE:**

**1.** Place a slice of each ingredient inside containers. Add a generous amount of EM Bokashi (3 or more handfuls) only to one container, making sure to coat the entire surface of all the food items inside. Seal both containers tightly and label as **" EM BOKASHI"** and **"NO EM BOKASHI"** respectively. Date and store containers in a cool, dark environment. Have students write down a hypothesis as to what will happen to each container and why.

**2.** After two weeks, open containers to observe and compare changes in the food items. Unpleasant smells may be present when opening containers, so make sure to do so in a well ventilated area or outside First open the container with **EM Bokashi**, followed by the one with no **EM Bokashi.** Have students record what they see and smell, i.e. color of mold growing on food, which food item contains most of the growth, etc. Have them conclude what has determined the outcome in each case. The stage is set to begin a discussion on the role of microorganisms in determining fermentation or putrefaction of food waste and other organic matter.

❒ **FOLLOW-UP:** EM•1® contains lactic acid bacteria also present in pickle brine. Students can pickle cucumbers to compare pickling with the EM fermentation process.

# NAILS FOREVER!

❒ **PURPOSE:** Illustrate **oxidation** and **anti-oxidation** forces at work.

❒ **KEY CONCEPT:** EM•1® has the ability to reduce and prevent oxidation. EM•1®'s anti-oxidant abilities prevent putrefaction of food waste.

❒ **SKILL:** Science, Math, Writing, Vocabulary, Environmental

❒ **AGE GROUP:** 3rd Grade and above

❒ **MATERIALS:**

1. EM•1® Liquid Concentrate
2. Water
3. Two clean, identical jars with tight lids
4. Four nails. Use brand new nails that are not galvanized or have anti-rust coating. Rusty nails cannot be used.

❒ **PROCEDURE:**

**1.** Make a dilution of 1 part EM•1® to 100 parts water.

**Example:** 1 teaspoon (5 ml) of EM•1® to 2 cups (500 ml water) or
2 teaspoon (10 ml) of EM•1® to 1 liter (1000 ml water)

**2.** Fill up one jar with regular water and one with the EM•1® diluted solution. Label each jar appropriately.

**3.** Put two nails in each jar and close lids tightly. Place both containers under the same conditions, preferably in a cool and dark place.

**4.** Have students make observations every 48 hours for a period of two weeks and record changes in their science journal. **Important: Do do not open the caps or shake the jars.**

**5.** Compare nails in both jars and discuss results with students. Observe how EM•1® prevents rusting (oxidation) from occurring. Relate rusting in nails to what happens in the soil, environment, and our bodies due to pollution. Correlate EM•1®'s anti-oxidant properties to its ability to prevent putrefaction and decay of food waste and other organic matter.

EM•1® 1:100 No EM•1®
*3 Days Later*

❒ **FOLLOW-UP:** Place nails in other liquid solutions, such as carbonated water, vinegar, etc. to compare and contrast the oxidation rate of these substances. Students can also experiment with different EM•1® dilution rates (i.e. 1:500, 1:1000).

# EM SUPER POTTING SOIL

❒ **PURPOSE:** Make a specialty potting mix using EM Super Soil. Demonstrate the uses and added value of compost.

❒ **KEY CONCEPT:** Adding **EM** fermented food waste to the soil, produces a superior amendment that enhances soil properties - aeration, water infiltration, aggregation of soil particles, and provides a sources of plant nutrients.

❒ **SKILLS:** Science, Math, Business

❒ **AGE GROUP:** 4th Grade and above

❒ **MATERIALS:**

1) EM Super Soil (composted soil dug out from garden trenches), peat moss, vermiculite, bark fines/forest humus
2) EM•1® Solution and molasses
3) Several large mixing bins (2'x 4'x 6")
4) Air tight containers or black garbage bags with twist ties & cardboard storage boxes
5) Spray bottles

❒ **PROCEDURE:**

**1.** Dig out soil from deep trenches where the waste has been accumulated and fermented over time. Refer to page 17 for information on EM Super Soil.

**2.** Introduce students to common ingredients in potting soil mixtures. Discuss the properties of these components and their role in producing a good potting soil mixture (e.g. water absorption, aeration, nutrient value, etc.).

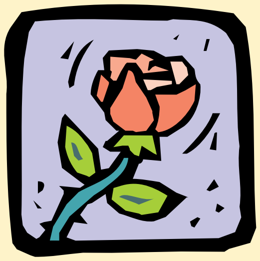
**2.** Start with a four component mixture: one part EM Super Soil, one part peat moss, one part vermiculite, and one part bark fines/forest humus. Adjust this mixture according to garden needs.

**3.** Measure and mix components. Spray a 1:1:1000 solution of EM•1® and molasses to the entire soil mixture until it is moist (not muddy).

**4.** Pour each bin full of soil into a large black (or dark colored) plastic bag or other airtight container. Make sure to squeeze out all the air from the bag. Close the bag securely with a twist tie. Place these bags of soil in a cardboard box and close the boxes. Store in a cool dry place.

**5.** Ferment the potting soil mix for a period of two weeks to culture and ensure the dominance of EM in it. This potting soil mix can be packaged and students can utilize marketing skills to earn money in order to sustain and expand their school gardening programs

❒ **FOLLOW-UP:** Students can also market the EM Super Soil (unmixed) as a soil amendment.



# COMPARING EM•1® TREATED SOIL VS. REGULAR POTTING SOIL

❒ **PURPOSE:** Compare plant growth in soil treated with EM•1® fermented food waste vs. untreated soil.

❒ **KEY CONCEPTS:** Plants grown in soil treated with EM•1® fermented waste have a better germination rate, growth, quality, yield, taste, etc. than plant grown in untreated soil.

❒ **SKILLS:** Science, Math

❒ **AGE GROUP:** 4th Grade and above

❒ **MATERIALS:**

- High quality red radish or carrot seeds
- Tomatoes or strawberry seedlings
- Labels

Without EM•1® With EM•1®

❒ **PROCEDURE:**

**1.** Prepare four 3 x 3 beds in a separate area of the school garden. Trench the fermented waste only in 2 of the beds. Let the waste ferment for a period of two weeks to a month depending on the climate.

> ***Tips for the teacher:*** *Prior to this activity conduct a soil analysis on the chosen site and follow up and test the EM plot every gardening season.*
>
> *This experiment can be done with planters. Use **EM•1**® treated soil and regular potting soil, preferably organic.*

**2.** Plant equal amount of seeds and seedlings on the control and EM plots respectively.

**3.** Water the EM plots daily with a solution of 1:1:1000 of EM•1® and molasses and the control side with water only.

**4.** Have students make daily observations and record any changes in seeds/seedlings. Have them also monitor for the presence of beneficial insects and worms in the soil, as well as any pest damage that could occur on leaves. An observation sheet is attached for this purpose. Students can present their conclusion using charts and graphs to represent scientific data.

❒ **FOLLOW-UP:** Replicate this experiment every planting season and compare different varieties of plants. Use soil analysis to compare over time the nutrient value and other characteristics of the EM site to the untreated area.

# OBSERVATION SHEET

**YOUR NAME: ___________**
**PLANT TYPES: ___________**
**DATE OF OBSERVATION:_____________**

| PARAMETERS: | WITH EM•1® | WITHOUT EM•1® |
|---|---|---|
| Date seed/seedling planted: | | |
| Number of seeds/seedling planted: | | |
| No. of seeds germinated: | | |
| Height of plant | | |
| Number of leaves | | |
| Size of the leaves | | |
| Color of leaves | | |
| Number of buds | | |
| Number of flowers | | |
| Number of fruits | | |
| Size of fruits | | |
| Length and structure of root system | | |
| Taste | | |

**OTHER OBSERVATIONS**

# RECIPE FOR MAKING EM BOKASHI COMPOST STARTER

❒ **PURPOSE**: Teach students how to make EM Bokashi for their school projects. Allow students a hands-on opportunity to work with Effective Microorganisms and partake in the entire EM•1® composting process.

❒ **KEY CONCEPT:** EM•1®, the key ingredient in Bokashi, is what prevents the putrefaction of food waste. EM is housed in the wheat bran and uses the molasses as a food source.

❒ **SKILLS:** Science, Math

❒ **MATERIALS NEEDED**

**1.** EM•1® - Concentrated Solution
**2.** Wheat Bran - Available at your local feed store. You may substitute rice bran for wheat bran.
**3.** Molasses - Available in feed stores or at your local supermarket
**4.** Water (Non-chlorinated preferred). Water may be left out overnight for the chlorine to evaporate
**5.** Plastic tubs or any large receptacles to mix the ingredients
**6**. Sealable 1 gallon plastic bags

❒ **PROCEDURE:**

**DILUTION RATE:** The standard dilution rate to make EM Bokashi is 1:1:100 or one part EM•1®, one part molasses, to 100 parts of water. Using this dilution rate will guarantee a good quality Bokashi.

**PROPORTIONS TO MAKE 50 LBS. OF BOKASHI**

This activity is designed for 25 students to make 2 pounds of Bokashi each. Pair students and distribute one tub and 4 lbs. of wheat bran per group. Fifty pounds of Bokashi can treat approximately 1000 pounds of food waste or 25 composting buckets of 5-gallons capacity.

50 lbs. of Wheat Bran
1-1.5 gallons of water
1/2-3/4 cup of EM•1® (Concentrated Solution)
1/2-3/4 cup of Molasses

Making Bokashi at Miles Exploratory Learning Center, Tucson, Arizona.

**1.** Pour the molasses into the water and stir thoroughly. If necessary, dissolve the molasses first with a small quantity of warm water.

**2.** Add the EM•1® concentrated solution into the water and mix well.

**3.** Distribute equal amounts of the EM•1® and molasses solution per group. Using a cup gradually pour the liquid over the wheat bran. Make sure the ingredients are thoroughly mixed and no dry spots are left. Once the wheat bran mixture reaches a 35%- 40% content level, stop. How is this determined? Grab a handful of the mixture and squeeze it into a ball. No liquid should be dripping through your fingers. When you open your hand, the Bokashi ball should keep its shape but crumble slowly to the touch. If excess water drips through your fingers that indicates that too much liquid has been added. To correct this, add more wheat bran and mix thoroughly to achieve the desired moisture level.

Making and drying Bokashi

**4.** Have each student fill a 1 gallon plastic bag (2 lbs)with the wet Bokashi. Press all air out prior to sealing the bags. The Bokashi needs to ferment for at least two weeks in the summer or in hot climates and up to a month in winter or colder climates. However, it may be fermented for more than a month. Have students date and name the bags before storing them away from direct sunlight in a cool place. An option can be for students to take the bags home for observation.

***NOTE TO THE TEACHERS:*** *Another alternative to ferment large quantities of Bokashi is to do so in air-tight container or thick trash bags with twist ties. (Double bagging will ensure good fermentation.)*

**5.** Have students monitor the smell and appearance of their bags. They may notice the smell of fermentation, similar to that of apple cider coming from the bags. Occasionally, a white growth will appear on the surface of the Bokashi. This is normal and indicates that a good fermentation has taken place. Discard bags with a foul smell or that have black mold. This failure occurs when bags are not properly sealed or the moisture content of the mix was higher than 40%.

**6.** After 2 to 4 weeks students can open their bags and dry the Bokashi. Use trays, tarp, or newspapers and spread it out to dry in the sun or in a covered area. Drying time will vary according to the weather. Once dried, store it in plastic bags or any other air-tight container to keep grain weavels out. Students can use the Bokashi to compost at home or to supply the school's cafeteria project. If you live in a humid climate, use paper instead of plastic bags. The Bokashi can be stored for up to a year.

**FOLLOW-UP:** Arrange for a family Bokashi making day. Invite parents, staff, volunteers, and the community to make Bokashi for the school's project.

**Notes:**

# DO IT YOURSELF! BUILD YOUR OWN COMPOSTER EM•1® FERMENTING BUCKETS


❒ **PURPOSE:** Building EM•1® Fermenting bucket to implement and sustain a school food waste recycling activity.

❒ **KEY CONCEPTS:** Reinforce the 3 R's concept. Recycle buckets to recycle food waste!

❒ **SKILLS:** Written, Oral Communication, Community Relations.

❒ **AGE GROUPS:** 5th Grade to Middle School

❒ **MATERIALS:**

**1. Three to five gallon capacity plastic buckets.** Two buckets are needed to build one composter unit. Buckets must be identical so they can perfectly fit one inside the other. They can be sourced from your school's cafeteria, restaurants, hotels, fast food chains and other community cafeterias. Prepared foods or condiments for the food service industry are usually packaged in these types of containers. Students can also bring some empty paint, detergent, or pool cleaning supplies buckets they may have at home. Any bucket is fine as long as it is clean and has an airtight lid.

**2. Spigots or stoppers:** Look for the leak-proof kind, similar to the ones installed in water dispensers. You can find these at neighborhood water stores. The stoppers can be purchased at any hardware store.

**3. Drill:** 2 different bit sizes are required: 1/4" and a 3/4" or 1" depending on the size of the spigots.

❒ **PROCEDURES:**

**1. Making the buckets is easy!!** Have students collect buckets from the school cafeteria or contact local businesses who may discard these types of buckets. Writing request letters and calling business to procure buckets, is also a good vehicle to promote to the community your school's composting and recycling efforts.

**2.** Use the small bit to drill holes to the bottom of bucket **No.** 1, as to resemble a strainer.

**3.** Take bucket No. 2 and drill a hole using the 3/4 or 1 inch bit, approximately one inch from the bottom. This is where you will place the spigot needed to drain the liquid or EM garbage juice from the bucket. You may want to practice drilling a couple of buckets prior to the classroom activity.

**4.** Insert bucket No. 1 inside bucket No. 2 and make sure the lid fits tightly.

❒ **FOLLOW-UP:** Students can use these fermenting buckets to introduce food waste recycling at home or as an entrepreneurial activity to raise funds for the school's gardening activities.

# EM MATH

❒ **Every day each of us makes 4.5 lbs. of trash.**

How many people are in your family?__________
How much garbage does your family produce per day? __________
per week, __________
per month, __________
per year, __________

❒ **A school of 300 students produces an average of 80 lbs. of cafeteria waste per day.**

How much waste could this school recycle in a week?___________
a month?__________
a school year (9 months)?__________

❒ **A typical fast food restaurant serving 2000 customers per day produces an estimated 238 lbs. of waste per day.**

How much food waste does it produce in a week?___________
a month?__________
a year?__________

❒ **Making EM•1® Dilutions** (Hint: to answer these questions, please check the EM Dilution Guide at the back of this manual.)

To make a basic 1:1000 EM•1® dilution, how many teaspoons of EM•1® would you use for 1 gallon of water?__________For 4 gallons?__________

For a 1:500 EM•1® dilution, how many teaspoons of EM•1® would you use for 1 gallon of water?___ For 4 gallons?__________

To make the same dilution, how many Tablespoons of EM•1® do we need for 4 gallons of water?__________

❒ **Bokashi Making**

To make 4 lbs. of Bokashi you need the following ingredients:
4 lbs. of wheat bran or rice bran
1-1.5 quarts of non-chlorinated water
1 teaspoon of EM•1®
4 teaspoons of molasses

What is the dilution rate used here?__________

To make 10 lbs. of Bokashi how many teaspoons of EM•1® do we need?__________

# KNOW YOUR "EM•1®" COMPOST

Food and yard waste can be turned into fermented food waste. It is Nature's way of recycling and turning your waste into a rich soil amendment. All types of food left overs can be fermented with **EM•1® BOKASHI**, including meats and fish, bones, dairy products, as well as cooked and oily foods.

**Circle all the items you can compost with EM•1®. Put an X over items you cannot compost with EM•1®.**

| | | |
|---|---|---|
| orange peels | plastic soda bottles | pizza |
| glass jar | sausage | donuts |
| apple core | eggs | plastic utensils |
| hamburger | chicken bones | leaves |
| cheese | foil wrappers | tuna salad sandwich |
| hot dogs | burrito | paper lunch bag |
| potato salad | weeds | french fries |
| tomatoes | milk cartons | steak |
| soda cans | spaghetti & meatballs | lettuce |
| macaroni & cheese | plastic bags | banana peels |

**TIPS FOR THE TEACHER:** See pages 12 and 13 for guidance. Compare and contrast other composting methods to the EM•1® anaerobic method (see pg. 11 "Composting with EM•1® and EM Bokashi" for guidance). Have students analyze school cafeteria menus and investigate which items in their lunchboxes, and family meals can be fermented using EM•1®. Food items identified should also be classified by food group to show that protein-based products can be composted with the EM method.

# WORD FIND

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | I | O | S | B | D | I | W | U | E | F | A | Y | T |
| A | F | T | H | J | Z | P | N | L | M | S | L | N | O |
| N | C | U | E | F | F | E | C | T | I | V | E | K | R |
| D | M | Q | G | T | S | Y | G | P | C | M | U | D | G |
| F | P | O | K | A | C | N | R | Q | R | W | B | V | A |
| I | X | I | D | E | R | A | Z | E | O | S | P | Q | N |
| L | U | B | R | K | S | D | F | B | O | F | U | B | I |
| L | E | T | O | V | B | J | E | H | R | A | T | W | C |
| M | W | A | S | K | L | G | Y | N | G | L | R | Z | M |
| A | D | B | I | T | A | D | T | I | A | K | I | B | A |
| S | L | E | P | B | W | S | J | M | N | E | F | K | T |
| T | U | S | R | U | N | C | H | G | I | Q | Y | I | T |
| R | F | A | H | O | J | G | X | I | S | F | D | L | E |
| N | G | G | N | I | T | S | O | P | M | O | C | D | R |
| Y | K | F | O | O | D | W | A | T | S | E | Y | P | A |

**FIND THE FOLLOWING WORDS. LOOK UP, DOWN, ACROSS, BACKWARDS AND DIAGONALLY.**

| | | |
|---|---|---|
| EFFECTIVE MICROORGANISMS | FERMENT | GARDEN |
| PUTRIFY | COMPOSTING | SOIL |
| ORGANIC MATTER | LANDFILL | RECYCLE |
| BOKASHI | FOOD WASTE | GARBAGE |

# EM DILUTION GUIDE

| | EM | TO | WATER |
|---|---|---|---|
| **1 : 50** | 1 tsp | | 1 Cup |
| | 4 tsp | | 1 Quart |
| | 3Tbsp & 1tsp | | 1 Gallon |
| **1 : 100** | 1 tsp | | 2 Cups |
| | 2 tsp | | 1 Quart |
| | 2.5 Tbsp | | 1 Gallon |
| **1 : 500** | 3/4 tsp | | 2 Quarts |
| | 1.5 tsp | | 1 Gallon |
| | 1 Tbsp | | 4 Gallons |
| **1 : 1000** | 3/4 tsp | | 1 Gallon |
| | 1 tsp | | 6 Quarts |
| | 2 tsp | | 2.5 Gallons |

# COMMON KITCHEN MEASUREMENTS

| **Units =** | **tsp** | **Tbsp** | **Cup** | **Quart** | **ml** |
|---|---|---|---|---|---|
| **tsp** | 1 | 1/3 | * | * | 5 |
| **Tbsp** | 3 | 1 | 1/16 | * | 15 |
| **Cup** | 48 | 16 | 1 | 1/4 | 240 |
| **Quart** | * | * | 4 | 1 | 950 |

**For more EM information, please visit the following web sites:**
**www.emtechnologynetwork.org**
**www.emrousa.com**
**www.emamerica.com**