KYUSEI NATURE FARMING AND THE TECHNOLOGY OF EFFECTIVE MICROORGANISMS

GUIDELINES FOR PRACTICAL USE

Authors

Takashi Kyan, Masaki Shintani, Shoji Kanda, Masanobu Sakurai, Hiroyasu Ohashi, Aki Fujisawa and Somlak Pongdit

Editor

Ravi Sangakkara

APNAN

INFRC

Asia Pacific Natural Agriculture Network, Bangkok, Thailand

Published by

International Nature Farming Research Center, Atami, Japan

and

Asia Pacific Natural Agriculture Network, Bangkok, Thailand

REVISED EDITION

1999

KYUSEI NATURE FARMING AND THE TECHNOLOGY OF EFFECTIVE MICROORGANISMS

GUIDELINES FOR PRACTICAL USE

This manual presents guidelines for the adoption of Kyusei Nature Farming and the Technology of Effective Microorganisms. The guidelines are not intended to be absolute instructions for the use of Effective Microorganisms in Kyusei Nature Farming.
In contrast, the guidelines stated herein need to be modified and utilized on the basis of environments, resources available and the rate of adoption.

The authors and publishers are happy to answer any queries of readers and users of the technology presented in this handbook to meet specific situations.

Please address queries to
APNAN,
A-304, Monririn Bldg, 60/1, Soi Sailom, Phaholyothin Road,
Bangkok 10400, Thailand
Fax + 66 2 272 7127
E mail emro@ksc.th.com

Please contact the following for further information:

ASIA PACIFIC NATURAL AGRICULTURE NETWORK,
A-304, Monririn Building, 60/1 Soil Sailom, Phaholyothin Road,
Bangkok 10400, Thailand.
Phone: + 66 2 272 7126
Fax: + 66 2 272 7127 or 272 7061
Email: emro@ksc.th.com

ACKNOWLEDGMENTS

The authors and editor express their gratitude to the sponsors of this handbook, the International Nature Farming Research Center, Atami, Japan and its President, Rev Setsunori Shinoda and Board of Directors for their support and encouragement.

A special note of thanks is made to the President of APNAN, Professor Dr. Teruo Higa, who invented the technology of Effective Microorganisms, for his advise and guidance in preparing this handbook. They also express their appreciation to Rev Kazuo Wakugami for practically demonstrating the benefits and success of the technology stated herein at a magnificent nature farm in Sara Buri and many other locations in Thailand, from where guidelines were procured to develop this handbook.

Gratitude is also expressed to the President and management of EM Research Organization, Okinawa, Japan for providing the technical services of two authors and for their support to the spread of EM technology in the world through APNAN.

To all others who helped make this handbook a reality, the authors and editor say

Thank you.

Bangkok, Thailand
May, 1999

KYUSEI NATURE FARMING AND THE TECHNOLOGY OF EFFECTIVE MICROORGANISMS

GUIDELINES FOR PRACTICAL USE

TABLE OF CONTENTS

1.0. INTRODUCTION TO KYUSEI NATURE FARMING AND THE TECHNOLOGY OF EFFECTIVE MICROORGANISMS

1.1. IDEAL AGRICULTURE

Kyusei Nature Farming is the practice of an ideal agriculture. The five principles of this concept of ideal agriculture as advocated by Mokichi Okada in Kyusei Nature Farming are -

1. Production of safe and nutritious food to enhance human health
2. Development of economic and spiritual benefits to both producers (farmers) and consumers
3. Sustainability and ease of practice by every person
4. Conservation of the environment
5. Production of sufficient food of high quality for the increasing populations

Kyusei Nature Farming is not traditional organic farming. As advocated by Mokichi Okada, Kyusei Nature Farming is a way of life that harmonizes with nature. Hence it is a living process that blends all components of agricultural ecosystems to provide healthy food to all living beings, while maintaining sustainability.

Conventional chemical farming is a process producing very high yields. However, the folly of this system of farming has been felt in all agricultural enviroments. In contrast, traditional organic farming is a system which produces low yields of good quality food. Hence, at the present times, this system is not very suitable to meet the ever growing needs of food by humankind and animals.

Kyusei Nature Farming using the technology of Effective Microorganisms is a system of agriculture that combines the benefits of both these extreme systems of farming. It does not use chemicals which pollute the ecosystems, but is capable of producing high yields on a sustainable basis, while preserving the environment.

The comparison of these three systems, as presented in Table 1 highlights the benefits of Kyusei Nature Farming with EM technology, in contrast to the other two methods advocated by most agriculturists of the world.

Table 1. Comparison of Kyusei Nature Farming with conventional systems of agriculture.

Parameter	Conventional Farming	Traditional Farming	Kyusei Nature Farming with EM
Yield	Medium-High	Low-Medium	Medium-High
Quality	Low-Medium	Medium-High	Medium-High
Cost	High	Low	Low
Toxicity	High	None	None
Environment	Damaged	Protected	Protected with Improvement
Sustainability	Not Sustainable	Sustainable	Sustainable

1.2. MICROORGANISMS IN AGRICULTURE

Agricultural production begins with the process of photosynthesis by plants, which requires solar energy, water and carbon dioxide, all of which are available freely. Therefore, it can be said that agriculture is the production of something from nothing.

Although this sounds promising, when viewed from an economic aspect, the current agricultural practices have very

low efficiencies. This is due to the low utilisation of solar energy and its transfer through the trophic levels.
The potential utilisation of solar energy by plants has been estimated to be between 10 - 20%. However, the actual utilisation rate is less than 1%. Even C_4 plants such as corn and sugar cane, which have higher rates of carbon fixation fix approximately 6 - 7% of solar energy during their maximum growth periods. However, in general, the utilisation rate of photosynthesis is lower than 3% even under conditions that produce optimal yields.
Research has shown that photosynthetic efficiency of chloroplasts of most crops cannot be enhanced much further. This indicates that the biomass productivity of these crops have reached a maximum. The best opportunity for increasing biomass production is to utilise the visible light which cannot be used by chloroplasts, and also the infra red radiation, which together account for approximately 80% of total solar energy. In addition, science should also explore methods of recycling organic energy contained in plant and animal residues through direct utilisation of organic molecules.
In the presence of organic matter, photosynthetic bacteria and algae can utilise wavelengths ranging from 700 - 1,200 nm. Green plants do not use these wavelengths. Fermenting microbes could also breakdown organic matter, thereby releasing complex compounds such as amino acids for utilisation by plants. This enhances the efficiency of organic matter in crop production. Therefore, a key factor for increasing crop production is the availability of organic matter, which has been developed by using solar energy, and the presence of efficient microbes to decompose the organic material. This increases the utilisation efficiency of solar energy.

1.3. EFFECTIVE MICROORGANISMS (EM) IN AGRICULTURE

Effective Microorganisms (EM) was developed at the University of the Ryukyus, Okinawa, Japan in the early 1980's by a distinguished professor of horticulture, Professor Dr Teruo Higa. He is a horticulturist by training, and had worked on the intensive use of agrochemicals, thereby realising the damage it causes to humankind and the environment. Thus, he developed a mixture of beneficial microorganisms, first by accident and thereafter by diligent research, to enhance productivity of conventional organic farming systems. The results were remarkable and the expansion process of this technology, which is now commonly referred to as EM, began in 1989, with the inception of the International Kyusei Nature Farming conferences.

Professor Dr Teruo Higa

At the first international conference on Kyusei Nature Farming held in Thailand, the need to scientifically validate the technology of Effective Microorganisms and enhance its use in the region was discussed. Thus, the Asia Pacific Natural Agriculture Network (APNAN) was formed. This network, which included 13 countries ranging from the west coast of the United States of America through Asia to Pakistan developed the mandate to establish an international program for promoting research, education and extension of Kyusei Nature Farming and EM Technology. Today, this network has extended its activities to over 20 countries within the region and made contacts in all continents of the world.

The use of EM in agriculture has many significant beneficial impacts. The most researched and stated are as follows -

1. EM promotes germination, growth, flowering, fruiting and ripening in crop plants
2. EM enhances the photosynthetic capacity of plants
3. EM increases the efficacy of organic matter as fertilisers.
4. EM develops resistance of plants to pests and diseases.
5. EM improves the physical, chemical and biological environments of the soil.
6. EM suppresses soil borne pathogens and pests.

Due to the above stated benefits, EM enhances crop yields in organic systems in most environments. It also develops the soil, to improve its ability to sustain crops. Therefore, the use of EM culminates in the following economic benefits to the user.

1. The requirement of EM declines with time, as the microbes are self propagating. Application of EM improves soil and when the conditions of the soil become conducive for microbial propagation, application of EM is required occasionally to maintain populations.

2. The use of EM requires lower quantities of organic matter. The organic matter derived from crop residues, weeds and the vegetation from the hinterland is sufficient to maintain a rich soil. The application of bokashi once a season would also suffice, and the crop residues could be added with the bokashi, rather than being burnt, as per current practice.

3. Use of EM reduces the labour requirements. Soils to which EM has been applied requires lower intensities of tillage and weeding. Tillage is practised to break up the soil and enhance nutrient and moisture availability from deeper layers. However, this also generates problems such as profuse weed growth.
   The use of EM enhances the soil biota, and develops the physical structure. This makes tillage easy. Addition of organic matter enhances the chemical and biological properties of soils, thereby releasing nutrients for crop growth. However, the use of EM causes a problem in the first few seasons. EM promotes active growth of weeds, and these could be used as organic matter. The depletion of the weed seed bank in the soil with time reduces weed problems within two to three seasons, when crops are cultivated with EM. In addition, the absence of normal tillage practices also reduces weed incidence.

4. EM produces greater quantities of better quality crops. These crops are more presentable, better tasting and have longer shelf lives. This enhances incomes to farmers using EM.

5. EM facilities continuous cropping. Fallow periods are no longer necessary as EM develops a rich soil. Multiple cropping could replace mono cropping in most instances with the use of EM.

6. EM eliminates the use of agrochemicals, which are expensive in most countries. The use of agrochemicals would only reverse the beneficial effects of EM. The soil would lose its rich diversity of fauna and flora, and destroy organic matter. Thus soils become barren and plants find a poor depleted environment. Diseases and pests thrive in such environments, which calls for greater use of agrochemicals, thereby reducing the incomes of farmers and polluting the environment.

7. EM ensures faster crop growth. Thus crops could be harvested earlier, thereby reducing the time available for pests and diseases to infest crops.

There are other benefits that could be derived from the use of EM. These are as follows;

1. EM ferments organic matter as opposed to deterioration. Therefore, any type of organic matter could be used for making compost with EM, as there is no development of offensive odours.
2. EM breaks down organic matter rapidly, once incorporated into the soil. This is in contrast to normal applications where it takes several months for decomposition.
3. EM facilitates the release of greater quantities of nutrients to plants.
4. EM destroys harmful insects and pests, but not beneficial organisms.
5. EM develops internal immunity of plants and animals, thus enhancing natural resistance.
6. EM has the capacity to convert wastes into useful non toxic products. This includes all types of wastes, ranging from sewage to industrial toxic affluents.
7. EM retards the process of rusting in metals, reducing the replacement costs of machinery.

These qualities of EM makes it a very useful product for the modern world. With EM, burning of organic wastes is not required, as these materials could become fertilisers, and thus could be recycled effectively.

1.4. PRINCIPAL MICRO-ORGANISMS IN EM AND THEIR ACTION

Photosynthetic bacteria (Rhodopseudomonas spp)

The photosynthetic or phototropic bacteria are a group of independent, self supporting microbes. These bacteria synthesise useful substances from secretions of roots, organic matter and / or harmful gases (e.g hydrogen sulphide), by using sunlight and the heat of soil as sources of energy. The useful substances developed by these microbes include amino acids, nucleic acids, bioactive substance and sugars, all of which promote plant growth and development.

The metabolites developed by these micro-organisms are absorbed directly into plants and act as substrates for increasing beneficial microbial populations. For example, Vesicular Arbuscular (VA) mycorrhizae in the rhizosphere are increased due to the availability of nitrogenous compounds (amino acids) which are secreted by the phototropic bacteria. The VA mycorrhizae in turn enhance the solubility of phosphates in soils, thereby supplying unavailable phosphorus to plants. VA mycorrhizae can also coexist with Azotobactor and Rhizobium, thereby increasing the capacity of plants to fix atmospheric nitrogen.

Lactic acid bacteria (Lactobacillus spp)

Lactic acid bacteria produce lactic acid from sugars and other carbohydrates, developed by photosynthetic bacteria and yeast. Therefore, food and drinks such as yoghurt and pickles have been made with Lactic acid bacteria from ancient times. However, Lactic acid is a strong sterilising compound, and suppresses harmful micro-organisms and enhances decomposition of organic matter. Moreover, Lactic acid bacteria promotes the fermentation and decomposition of material such as lignin and cellulose, thereby removing undesirable effects of undecomposed organic matter.

Lactic acid bacteria has the ability to suppress disease inducing micro-organisms such as Fusarium, which occur in continuous cropping programmes. Under normal circumstances, species such as Fusarium weakens crop plants, thereby exposing them to diseases and increased pest populations such as nematodes. The use of lactic acid bacteria reduces nematode populations and controls propagation and spread of Fusarium, thereby inducing a better environment for crop growth.

Yeast (Saccharomyces spp)

Yeasts synthesise antimicrobial and other useful substances required for plant growth from amino acids and sugars secreted by photosynthetic bacteria, organic matter and plant roots.

The bioactive substances such as hormones and enzymes produced by yeasts promote active cell and root division. These secretions are also useful substrates for Effective Micro-organisms such as Lactic acid bacteria and Actinomycetes.

The different species of Effective Micro-organisms (Photosynthetic and Lactic acid bacteria and Yeast) have their respective functions. However, Photosynthetic bacteria could be considered the pivot of EM activity.

Photosynthetic bacteria support the activities of other micro-organisms in EM. However, the Photosynthetic bacteria also utilises substances produced by other microbes. This phenomenon is termed "Co existence and Co prosperity".

The enhancement of populations of EM in soils by application promotes the development of existing beneficial soil micro-organisms. Thus, the microflora of the soil becomes abundant, thereby the soil develops a well balanced microbial system. In this process soil specific microbes (especially harmful species) are suppressed, thereby reducing microbial diseases that cause soil borne diseases. In contrast, in these developed soil, the Effective Micro-organisms maintain a symbiotic process with the roots of plants within the rhizosphere.

Plant roots also secrete substances such as carbohydrates, amino and organic acids and active enzymes. Effective Micro-organisms use these secretions for growth. During this process, they also secrete and provide amino and nucleic acids, a variety of vitamins and hormones to plants. Furthermore, EM in the rhizosphere co exist with plants.

Therefore, plants grow exceptionally well in soils which are dominated by Effective Micro-organisms.
The following figure clearly explains the functions of Effective Micro-organisms in the soil

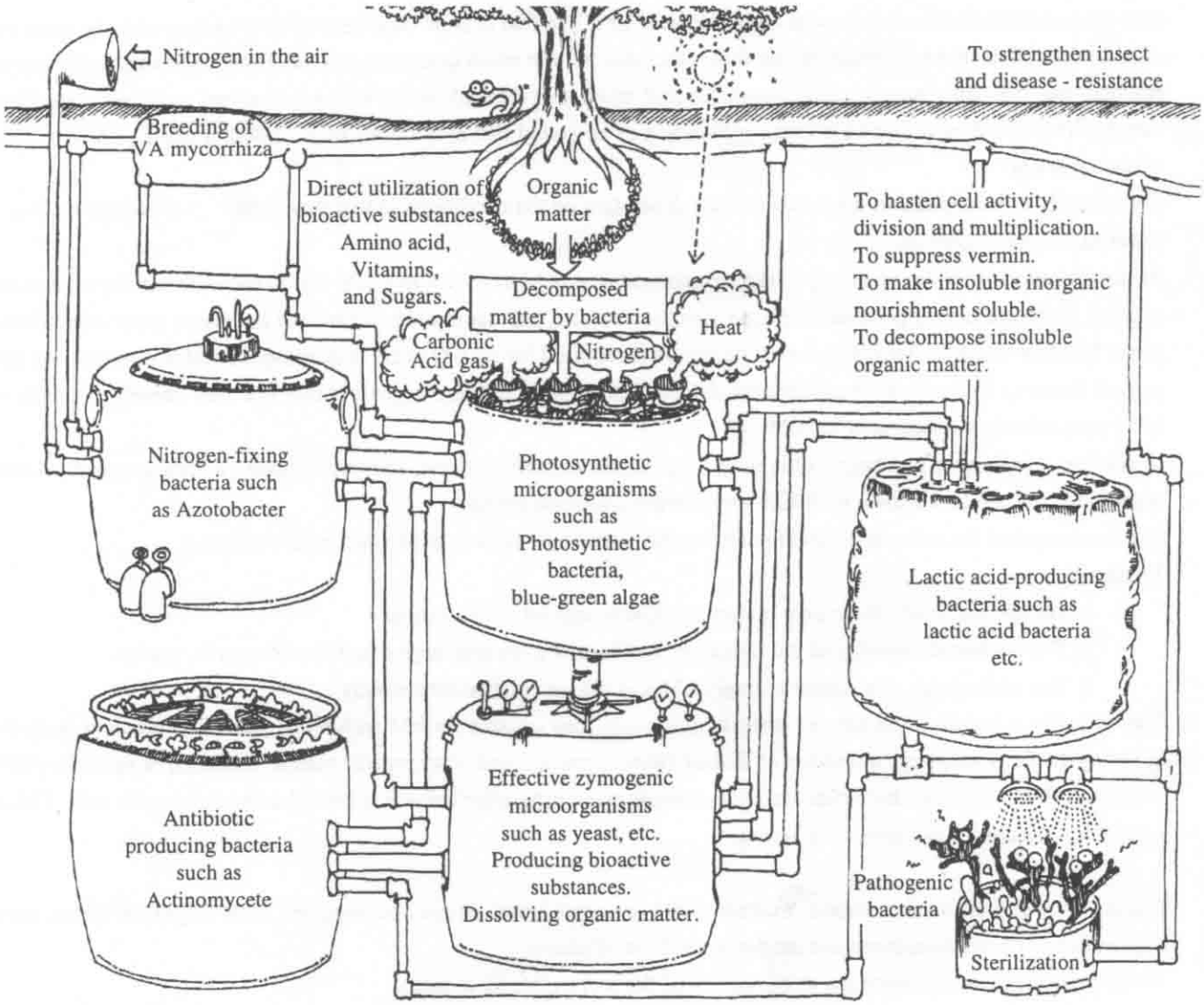


Figure 1 : "Microorganisms for Agriculture and Environmental Preservation", Teruo Higa (1991)

1.5. ECONOMIC VALUES OF EM

EM reduces the costs of farming over time. The rate of reduction is variable, based on several factors. At the onset, a farmer would have to use EM with irrigation, spray EM and add bokashi several times throughout the season. Large quantities may also be needed to observe benefits in a short period of time.

However, soil conditions change with the addition of EM. The EM in soils becomes self propagating and, the quantity of EM required declines. Eventually, the farm may only require small quantities of EM. Thus, once an equilibrium is reached, one may only have to add bokashi treated manure to the soil along with post harvest residues, soon after harvest, This could be followed with an application of extended EM at dilutions of 1 : 2,000 or even 1 : 5,000 with irrigation water.

The quantity to be applied in the future will be dependant on the conditions at that time, although it would be much lower than at the inception.

At the inception, a farmer routinely using agrochemicals would have to apply EM and agrochemicals, for economic reasons. If the soil is very poor and depleted of organic matter, a direct transfer to EM will not give a profitable harvest in the first few seasons. Thus a period of transition is required for such farmers to develop a suitable environment for organic farming. Under these conditions consistent application of EM and organic matter is a very important aspect to build up a suitable environment for EM.

In contrast, if a farmer had been cultivating crops under organic systems, thereby ensuring a high quantum of soil organic matter, the first season with EM would bring enhanced profits.

The time required for a degraded soil to enhance its productive value is dependant on three factors.

These are -

1. The degree to which organic matter and EM is applied by the farmer.
2. The economic capacity of the farmer to purchase or even add large quantities of organic matter.
3. The willingness of a farmer to apply EM and organic matter consistently.

Theoretically, a highly degraded soil could be made into one suitable for EM within one year. This could be done by covering the field with large quantities of Bokashi treated manure and other organic matter. Extended or secondary EM is used to flood the field thereafter, and plant debris remaining after harvest is ploughed back into the soil. These operations are carried out prior to planting.

During crop growth in the season, extended EM is sprayed onto crops and supplied with irrigation water, with applications of bokashi and organic matter to the base of plants.

These processes would ensure the development of the soil within 12 months.

One must also understand that EM is not an agrochemical, and thus it must not be treated as such. In contrast, EM is a mixture of microbial inoculants found in all ecosystems. It is living substance, and does not contain any genetically engineered organisms. If it was so, EM could not be made at different locations, using native micro-organisms, as being done in over 20 countries at present.

EM is used for initiating beneficial biological functions such as composting, degradation of organic matter, cleansing the environment and controlling pests and diseases. This is done by the introduction of beneficial micro-organisms to the plant environment. Therefore, pests and pathogens are controlled or suppressed through natural processes by the competitive or antagonistic behaviour of the Effective Micro-organisms.

2.0. BASIC INFORMATION ON EM

2.1. IMPORTANT ASPECTS OF EM

2.1.1. EM is a living entity

EM is a living entity containing active microbes. Therefore, solutions of EM are completely different from all agrochemicals. The activity of EM is different to that of agrochemicals, and does not work in a similar manner. The most important aspect of EM is that it enhances beneficial microbes in the soil, thereby developing a conducive environment for the crop.

2.1.2. EM requires good quality water

The use of EM necessitates the use of clean water. Good quality water free of pollutants or chemicals need to be used when diluting EM solutions or preparing bokashi (fermented compost). The use of polluted water (with high BOD) induces the development of pests and diseases in plants and reduces yield and quality of crops.

However, if good quality water (such as that from a well or an underground source) cannot be found, the available water needs to be filtered through charcoal or EM ceramics.

2.1.3. Storage of EM

EM could be stored in a closed container for a period upto 6 months if kept in a dark cool place (Refrigeration is not required). If there is some doubt of the quality of EM after storage, one could check the smell. EM always has a sweet - sour smell. If there is a foul odour (such as that of hydrogen sulphide), please do not use that EM. One may notice a white film on the surface of EM, when it is stored. This is yeast. and does not cause any harm to the EM.

2.2. SOIL CLASSIFICATION ON THE BASIS OF MICROFLORA

In the use of EM, soil is classified into 4 classes on the basis of microbial characteristics.

Disease inducing soil

These soils have a high population of disease causing microbes (e.g. Fusarium). The addition of raw organic matter having a high nitrogen content to this soil produces a foul odour. In addition larvae of pests develop in these soils. The application of raw organic matter creates problems in these soils.

Disease inducing soils are generally hard, and the physical characteristics are not conducive for crop growth. In rice fields, gases are generated from these soils. These soils are generally developed with the continued application of high quantities of agrochemicals.

Disease suppressive soils

Disease causing organisms do not survive in these soils, as organisms such a Penicillium, Tricoderma and Streptomyces which produce antibiotics, exist in disease suppressive soils.

The application of raw organic wastes with high quantities of nitrogen does not produce foul odours in these soils. The organic matter is decomposed rapidly, and the soil has a fresh sweet smell, similar to that of virgin mountain soils.

These soils have very good physical characteristics. Disease and pest incidence of crops is low. However, crop yields are not optimal.

Zymogenic soils

These soil contain zymogenic organisms such as Lactic acid bacteria and yeast. When raw organic matter with high nitrogen contents is applied, the soil develops an aromatic smell. The populations of fermenting fungi such as Aspergillus and Rhizopus increases, while those of disease causing organisms such as Fusarium declines.

These soils have very good physical characteristics, with a high water holding capacity. Thus nutrient solubility and

availability is high in these soils.

The beneficial microbes in these soils produce amino acids, sugars, vitamins and other bioactive substances, which promote the growth of crops.

Synthetic soils

These soils contain beneficial microbes such as photosynthetic and nitrogen fixing bacteria. Under stable soil moisture conditions, soil quality is enhanced by the addition of small quantities of organic matter. Thus, these soils are considered good for crop growth and often links up with disease suppressive soils.

**** Zymogenic - Synthetic soils***

These are a blend of zymogenic and synthetic soils, and are ideal for crop production.

3.0. BASIC CONCEPTS IN THE APPLICATION OF EM

3.1. APPLICATION OF EM AS A LIQUID

3.1.1. EM Stock solution (Kyusei EM1)

The EM stock solution is a yellowish - brown liquid, with a pleasant odour and a sweet - sour taste. The pH of this solution should always be below 3.5.

If the solution has a foul smell or if the pH is over 4.0, the EM is not suitable for use.

The EM stock solution could be applied as follows;

1. Application to soil after dilution - manually, using sprinklers or in drip irrigation systems
2. Spray onto plants as a foliar application

3.1.2. Multiplied EM solution (Secondary / Extended EM solution)

If one cannot obtain required quantities of EM stock solutions, the available EM could be multiplied. However, this secondary / extended EM is of inferior quality to that of EM stock solutions. Therefore, the storage life of the secondary / extended solution is less than that of EM. The process of multiplication of EM is as follows:

Material	For Agriculture	For Environment
Water (good quality)	100 litres	100 litres
EM	5 litres	1 litre
Molasses	5 litres	1 litre
	(or 5kg brown sugar)	(or 1kg brown sugar)

Process of preparation

1. Mix molasses and EM in water.
2. Pour the mixture into a clean plastic container or drum, close tightly and store at ambient temperature.
   One need not use a glass container for this purpose.
3. This solution is ready for use when the pH drops below 4.0, which take approximately 5 - 10 days.

Use of Secondary EM

The secondary EM should be used as soon as possible. However, if required, it could be stored for a maximum of 7 days in an air tight container in a shady place.

Precautions

EM Secondary solution must never be multiplied as one cannot prevent contamination. Once the secondary solution is extended, the microbial balance is altered and thus the efficacy of EM is lost.

3.1.3. EM Fermented Plant Extracts (EM FPE)

EM fermented plant extract is made from fresh weeds and EM. Therefore, EM FPE contains organic acids, bioactive substances, minerals and other useful organic compounds. The production cost of EM FPE is very low as weeds are used for this process.

Preparation of EM FPE

The recipe given below is for making standard EM FPE;

Material		
	Fresh weeds (chopped) *1	14 litres (2-3 Kg)
	Water*2	14 litres
	Molasses*3	420 ml
	EM*4	420 ml

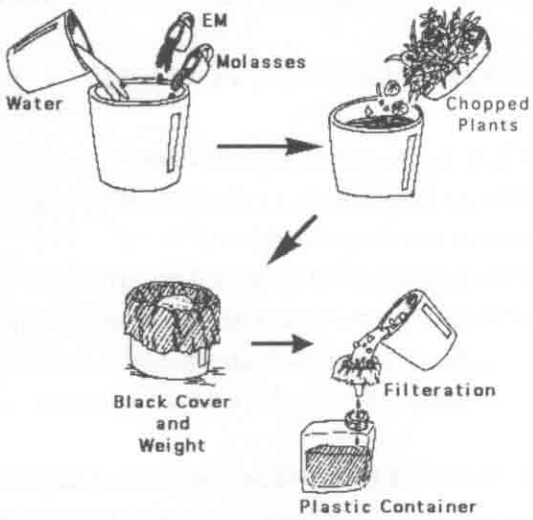
*1 Weeds having strong flavours - such as mugwort, mint and grasses having medicinal values are considered to be more effective. Prunings, both young shoots and immature fruit could also be used. However, it is advisable to use a mixture of weeds in order to increase the bioactive substances and microbial diversity. Weeds and other materials to be used in making EM FPE are best cut in the mornings.

*2 Use good quality water. The addition of a small quantity of sea water (salt water) in a ratio of 0.1% supplies minerals to crops.

*3 The molasses account for 3% of the total volume of water.

*4 EM accounts for 3% of the volume of water.

Material required for making EM FPE are a large plastic drum or bucket and a weight to press the chopped weeds.



Process of preparation

1. Chop freshly harvested weeds into small (2 - 5 cm) pieces and place in container.
2. Mix EM and molasses in water and add to weeds in container.
3. Cover container with black polythene or vinyl.
4. Place lid of container on top of the black cover and place some weights on it.
   Avoid having space between the liquid and cover (i.e. the container must be full).
5. Store the container in a warm (25 - 30℃) place, away from direct sunlight.
6. Fermentation is initiated and gas is generated within 5 - 10 days. This depends on the ambient temperatures.
7. Stir the liquid in container regularly to release gases.

The EM FPE is ready for use when the pH drops below 3.5. Pour the prepared EM FPE into plastic bottles after removing weeds by filtration, using cloth.

Storage of EM FPE

EM FPE should be placed in a dark, cool place, that has relatively uniform temperatures. It should not be stored under refrigeration or exposed to direct sunlight.

EM FPE should used within 90 days of preparation.

Application of EM FPE

There are many ways of applying EM FPE -

1. Watering into soil at a dilution of 1 : 1,000 by manual, sprinkler or drip irrigation methods.
2. Spraying to crops at a dilution of 1 : 500 to wet the plants.

The application should begin after crop emergence, but before the incidence of pests and diseases, as a prophylactic measure. The spraying is done in the mornings or after rains, at regular intervals. The efficacy of EM FPE can be enhanced if mixed with EM5 in equal proportions (*Details of EM5 are given in the next section).

EM FPE is not a pesticide or a harmful chemical, and hence its method of application is different to that of the normal agrochemicals. Agrochemicals are generally applied to overcome a specific problem forcefully and rapidly, after it has emerged. In contrast, EM FPE should be applied from the time of crop emergence, before the incidence of any pest and disease problems. If this practice is not carried out and problems appear, EM FPE needs to be applied daily until the problem is overcome.

EM FPE can be applied once or twice weekly, directly onto plants. A thorough spraying each time would ensure healthy plant growth. Direct sprayings onto pest populations will reduce the populations, eventually leading to their disappearance.

EM FPE works over time through biological processes and hence regular applications are required. It is not harmful to the plant or soil. In contrast, although agrochemicals have the capacity to indicate immediate benefits, their long term effects are harmful to the environment and the economic status of farmers, as these chemical products are expensive. EM FPE does not have such an effect, and even with excessive applications, the vigour of plants is enhanced, by the absorption of EM derivatives and developing antioxidants within the plant. This enhances the ability of plants to resist the influence of pests and diseases. Although EM FPE takes some time to develop beneficial effects, its use will certainly enhance the quality of the crop, the environment and most importantly the economic status of the farmer.
EM FPE is easily made by individual farmers at a very low cost. More importantly, the use of EM FPE over a long period of time improves the environment, which does not need repeated applications thereafter. It also facilitates the maintenance of healthy sanitary conditions for subsequent crops, especially if the crop residue is incorporated back into the soil, as in most organic systems. This also removes the demand for agrochemicals, thereby saving costs to the farmer, while ensuring bountiful harvests.

3.1.4. EM5 (EM fermented solutions)

EM5 is a non toxic chemical free insect repellent. It can also be used to prevent pest and disease problems in crops.
EM5 is usually sprayed onto crops to prevent pest and disease problems. The rate of dilution is 1 : 500 or 1 : 1,000, in clean water.
EM5 acts by creating a barrier around the plant, thereby protecting it from insect pests. In addition, contamination of stored food of insects by EM initiates a fermentation process in this feed, which makes it inedible to the insect populations. This too reduces insect populations.
The ingredients used to make EM5 vary. However, a standard list of ingredients is given below. One could enhance the efficacy of EM5 by the addition of organic materials having high quantities of antioxidants. These include garlic, hot peppers, Aloe vera, Neem leaf, prunings of fruit trees and herbs and grasses having medicinal value. These are chopped or mashed prior to addition.

Preparation of EM5

The following list contains the ingredients for standard EM5

Material	Water*[1]	600 ml
	Molasses	100 ml
	Vinegar*[2]	100 ml
	Distilled spirits*[3]	100 ml
	EM	100 ml

*[1] Clean water, preferably from an underground source, free of chlorine.
*[2] Natural vinegar is preferred over artificial acids
*[3] Whiskey or ethyl alcohol could be used.

Equipment needed include a large container for mixing ingredients, plastic bottles for storage and a funnel.

Methodology

1. Blend the molasses with water, ensuring complete dilution. If required warm water could be used to hasten the process of dilution.
2. Add vinegar and spirits, followed by EM.
3. Pour the mixed solution into a container, which can be closed tightly. Close the lid tightly, removing excess air, to develop anaerobic conditions. The chopped vegetative material could be added to this container.
   (**Please note** - Glass containers should not be used in the tropics.)
4. Store in a warm (20 - 30℃) place, away from direct sunlight.

5. Release gas at regular intervals by partially opening the container and closing it again within a short time.

EM5 is ready for use when the production of gas has subsided. Well prepared EM5 has a sweet fruity smell, similar to that of an ester.

Storage

EM5 should be stored in plastic containers in a dark cool place, which has a uniform temperature. If plant material was used, these could be filtered out at this stage. EM5 should not be stored in refrigerators or exposed to sunlight.

Most importantly, EM5 should be used within 3 months of preparation.

Application of EM5

EM5 is sprayed at dilutions of 1 : 500 or 1 : 1,000 to wet the crop. Spraying could be initiated after seed germination or crop establishment, before the incidence of pests and diseases, at regular intervals. It is best that EM5 is sprayed in the morning or after heavy rains.

3.1.5. Bokashi Extract

Bokashi* is organic matter fermented with EM and is equivalent to compost in traditional organic farming. An extract of this material could also be used for pest control.

This extract is made by soaking 100 g of bokashi in 10 litres of water overnight. The solution could be used for spraying crop plants.

There are many methods of making this extract. For example, 100 g of fresh kitchen garbage could be soaked in extended EM overnight, and the liquid sprayed onto plants. However, this solution must be used within a very short period of time, as it could spoil very easily.

One could also treat collected animal urine with EM and once the foul smell disappears, this could be sprayed onto plants at a dilution of 1 : 1,000.

(* Bokashi is explained in the next section)

3.2. BOKASHI

Bokashi is equivalent to compost in traditional organic farming. However, it is prepared by fermenting organic matter with EM. Bokashi is ready for use in 4 - 10 days, although the organic matter is not well decomposed as in traditional compost.

The application of bokashi to soils provides a medium for EM to develop. It also provides nutrients to crops.

3.2.1. Standard Bokashi

The bokashi made under normal circumstances can be classified as "Aerobic" or "Anaerobic" on the basis of the process of manufacturing. The advantages and disadvantages of the two types are as follows;

Aerobic Bokashi

This can be produced on a large scale, and due to the open conditions, temperatures during the process of composting are higher. However, if the temperatures are not controlled during the process of composting with EM, the energy of the organic matter is lost. Aerobic bokashi maintains the nutritive value of organic matter as in silage. However, mismanagement leads to rapid spoilage.

Anaerobic Bokashi

Due to the requirements of anaerobic conditions, making this bokashi is difficult. However, it has a superior quality if well made, which enhances plant growth.

Ingredients for making bokashi

Bokashi can be made with most organic materials. A few examples of material that could be obtained from plants and animals are as follows;

Plant material-

Rice, corn or wheat bran, maize flour, rice or bean husks, rice, wheat or corn straw, oil cake, cotton seed cake, pressmud, begasse, chopped crop residues and weeds, saw dust, dried sea weed, coconut fibre and husks, post harvest residues such as peel of fruit in food industries and empty fruit bunches of oil palm

Animal residues-

Fish or bone meal, animal dung, crab shell, wastes from meat industries and dead livestock

Another material that could be used is kitchen garbage.

Generally in bokashi making, it is best to have a balance between plant and animal material in the ratio of 1 - 3 : 1. However, some form of bran obtained from grain is an important ingredient as it contains high quantities of nutrients for micro-organisms. It is also desirable to combine organic matter having high and low C : N ratios, As a general rule, it is best to mix at least three types of organic material in making bokashi to maintain microbial diversity.

In making bokashi, one could use wood or rice husk charcoal, zealot, kelp, grass and wood ash. These materials help improve soil physical characteristics and nutrient holding capacities. They also act as points of anchorage for Effective Microorganisms.

Preparation of Bokashi

Bokashi can be classified according to the ingredients. However, a typical bokashi contains the following;

Ingredients	Rice bran	100 litres*
	Oil cake	25 litres*
	Fish meal	25 litres*
	*by volume	
	EM	150 ml
	Molasses*[1]	150 ml
	Water*[2]	15 litres

*[1] If molasses is not available, one could use sugar. Many use raw cane sugar, juice of ripe fruits and waste water of alcohol industries.

*[2] The quantity of water given is a guideline. The quantum of water that is required depends on the moisture content of the material used. The ideal quantity required is that needed to moisten the material without drainage.

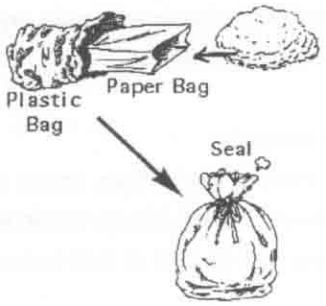
Methodology - Anaerobic bokashi

Mix rice bran, oil cake and fish meal. Dissolve molasses in water (dilution 1 : 100). The use of warm water eases this process. Add EM to the solution of molasses.

Pour the EM mixture gradually onto the dry ingredients and mix well, while checking the moisture content. to avoid draining of water.

The moisture content of the final mixture needs to be approximately 30 - 40%. This can be checked by squeezing a handful. The handful of the mixture should remain intact, but crumble when touched.

Place this mixture in a bag that does not permit air movement (e.g. paper or polythene). Place this bag within another polythene bag (black is preferred) to further prevent air movement. Close bags tightly to maintain an anaerobic condition, and store in a dark place.



The period of fermentation is dependant on the climate. In the temperate countries, during summer, bokashi is ready in 3 - 4 days, while in winter, it takes approximately 7 - 8 days. However, in winter, the process could be enhanced by storing the material in a warm place.

In the tropics, bokashi is ready within 3 - 4 days.

The bokashi is ready when it has a sweet fermented smell. A foul odour indicates that the process of fermentation has been disrupted, and the bokashi is not fit for use.

Anaerobic bokashi should be used soon after preparation. If storage is required, the bokashi should be spread on a concrete floor for drying under shade. After drying, it could be placed in a polythene bag and stored, avoiding damage by rodents and other pests.

Methodology - Aerobic bokashi

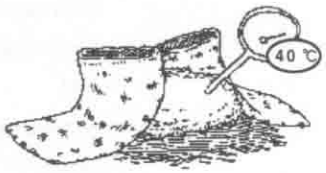
The process of mixing is similar to that of anaerobic bokashi. Thereafter, place the mixture on a concrete floor and cover with gunny (Jute) bag, straw mat or similar material. The mixture needs to be protected from rain.


Cover by Gunny Bags

Under aerobic conditions bokashi ferments rapidly. The temperature increases, and ideally the temperature needs to be kept between 25 - 35℃. This could be achieved by regular checking of the mixture and mixing the material if the temperature exceeds 40 -45℃, which is the upper limit. The excessive rise of temperatures releases energy, and the bokashi thus made is of a poor quality than that made at the prescribed temperatures.


On Straw Mat

The fermentation period for aerobic bokashi is also dependant on the location. In the temperate winters, it takes 7 - 8 days, while in summer, the time required is 3 - 4 days. In the tropics, aerobic bokashi could easily be made in 2 - 3 days.



Temp. is below 40 - 45 °C

As in anaerobic bokashi, the mixture is ready for use when it has a sweet fermented smell, and white fungi is observed on the surface. If it has a foul odour, the process of making bokashi has failed.

This bokashi should also be used soon after preparation. However, if storage is required, bokashi is spread on concrete floors and dried under shade, prior to storage in polythene bags. The material should also be protected from rodents and other pests.


Sweet Fermented Smell

The preparation of good bokashi is not easy, and one should practice it several times. The key to make good bokashi lies in maintaining the required moisture content and temperatures.

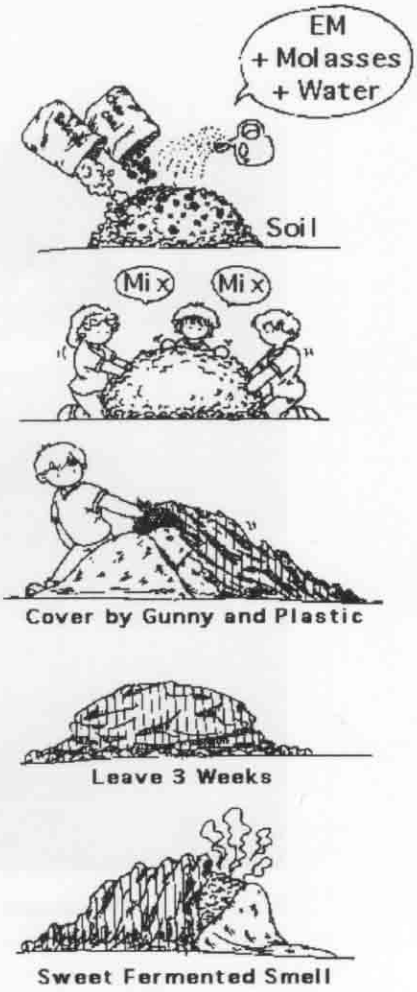
Plate 1. *Preparation of Bokashi in rice fields*

Plate 2. *Bokashi made with rice straw (White fungi appears in well prepared Bokashi)*

3.2.2. Bokashi from animal wastes

This bokashi uses wastes from animal husbandry units.

Ingredients	Animal manure	2 parts
	Rice bran	1 part
	Rice husk	1 part
	EM and Molasses	As for standard bokashi



Preparation

Mix the dry ingredients well . Dissolve EM and molasses in water (dilution of 1 : 1 : 100) as described for standard bokashi and spray the solution onto the dry ingredients with a watering can.

Mix well until the moisture content lies within 30 - 40%, which can be tested as described earlier.

Heap the mixture on a dry floor to a height of 15 - 20 cm and cover with a gunny (jute) bag.

During fermentation, the temperature needs to be maintained between 35 - 45℃. Hence regular checking of temperatures and mixing for aeration, if required, is recommended.

The bokashi is ready for use when it has a sweet fermented smell and white filamentous fungi on the surface. If it has a sour or foul odour, the material is not fit for use.

3.2.3. Bokashi from soil for raising seedlings

Ingredients	Soil	20 parts by volume
	Bokashi (aerobic or anaerobic)	1 part
	Rice husk charcoal	1 part
	EM and Molasses	As for standard bokashi

Methodology

The soil, bokashi and charcoal are mixed well. EM, molasses and water are mixed (dilution 1 : 1 : 100) and sprinkled onto the solids to ensure a uniform moisture content of 30 - 40%, which can be tested as described earlier. The final mixture is covered with a gunny (jute) and a plastic sheet. Mix the fermenting bokashi several times to maintain temperatures between 35 - 40℃. The fermentation process takes approximately 3 weeks, during which period, the mixture should be covered with a polythene sheet to prevent drying. The bokashi is ready for use when it has a sweet fermented smell and white fungi is observed. As in earlier instances, a sour or foul smell indicates a failure of the process.

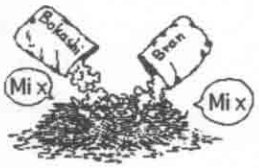
Application

This bokashi - soil mixture could be used when raising vegetables and fruit crops, especially in nurseries.

3.2.4. Bokashi from rice straw

This material can be prepared easily under most field conditions.

Soak Straw



Ingredients	Rice straw (chopped)	200 kg
	Straw from weeds	50 kg
	Rice Bran	5 kg
	Chicken manure	10 kg
	EM and Molasses	As for standard bokashi

Methodology

Cover with Gunny Bag

Dissolve EM and molasses in water at a dilution of 1 : 1 : 100.

Soak a part of the rice straw in the EM solution, drain the water and place on clean dry floor. Tread on this straw to remove trapped air and heap to a height of 30 cm.

Soak a part of the dry weeds in the diluted EM solution and place on the heaped wet straw . Trample heap to remove trapped air and heap to a height of 10 - 15 cm.

Mix a part of the rice bran and the chicken manure and sprinkle on the surface of heap to a thickness of 1 - 1.5 cm. Mix well with a hand fork or similar implement.

Repeat this process until the height of the heap becomes 1 - 1.5 meters.


Spread Bokashi

Cover the heap with a gunny and thereafter with a plastic sheet to obtain anaerobic conditions and prevent the infiltration of rainwater.

The fermentation process takes 5 - 7 days, and when the temperature drops, turn the heap, cover and leave for another 5 - 7 days. Thereafter, it is ready for use. White fungi will be seen on the surface.

3.2.5. Bokashi made in 24 hours

Ingredients	Straw (Any type)	10 parts (chopped)
	Bokashi (Aerobic or Anaerobic)	1 part
	Rice bran	1 part
	EM and molasses	As for other types at a dilution of 1:1:100

Methodology

Soak the straw in the EM solution and mix well with rice bran and bokashi. Place on clean dry floor to a height of 15 - 20 cm and cover with gunny (jute).

Mix well after 18 hours and continue fermentation for another 6 hours. It is ready for application thereafter. If the temperature of the bokashi is high, uncover and spread it for aeration.

3.2.6. Bokashi as an animal feed

This is a very effective feed additive for livestock. It is made as per standard bokashi, using only rice bran as the dry ingredient.

3.2.7. Bokashi for the environment

This bokashi also uses only rice bran as the dry ingredient. The process is as for the standard bokashi.

3.2.8. Bokashi of Nepal

This bokashi is made under conditions of Nepal, where EM technology is being adopted rapidly and successfully. However, the same techniques could be used in other countries as well.

Ingredients	Rice bran	100 kg
	Rice husk	50 kg (this could be substituted with dried leaves or weeds)
	Goat or Chicken manure (dried)	25 kg
	Kitchen garbage	25 kg
	EM	300 ml
	Molasses	300 ml (Could be substituted by 300 g brown sugar)*[1]
	Water	30 litres

*[1] If molasses or brown sugar is not available or too costly, one could use 30 litres of water in which rice has been washed prior to cooking. Most households could easily collect this water which is generally discarded.

Methodology

Mix all dry ingredients and add water in which molasses / sugar and EM is dissolved. If water from rice washing is used, add this to the dry ingredients.

Check moisture content, which should be approximately 30%, and place the mixture in a container. The best container under conditions of Nepal is a large flower pot. The drainage hole at the bottom needs to be covered with mud, made with soil and a weak solution of EM (Dilution 1 : 500 or 1,000). Plastic bags should not be used, as they could easily be damaged by rodents and insects.

Close the container with a layer of mud, made with soil and a weak solution (dilution 1 : 1,000) of EM. Leave under shade for 7 - 10 days. If the mud layer cracks, exposing the mixture, please place another layer, made with the same material.

The development of white fungi on the surface and the smell of fermented bokashi is an indication of the completion of the process, and the bokashi is ready for use. If storage is required for a long time, it is best that another layer of mud made with EM is placed, and the container kept under shade.

Once this bokashi is well prepared, it could be used as an additive to animal feed, that brings many benefits.

If the bokashi has a foul odour and is infested with worms and insects, it indicates spoilage. This material should not be used.

3.2.9. Bokashi from Myanmar

The EM project in Myanmar, carried out under the auspices of the Myanma Agriculture Service uses EM over a very large extent of land. The bokashi described below is widely used by resource poor farmers with very good results.

Ingredients	Straw (rice, wheat or corn)	10 parts
	Animal manure (Any type)	3 parts
	Rice bran	1 part
	EM and molasses	

Methodology

Dissolve EM and molasses in water to at dilution of 1 : 1 : 100. Soak rice straw in this solution and spread a part of it on a clean dry floor. Sprinkle a part of the rice bran over the straw, along with some animal manure. Place another layer of straw on this heap and repeat the process until 80 - 100 cm high. Cover with gunny (jute) or polythene.

The fermentation process is completed in 5 - 7 days, when the bokashi is ready for use.

Plate 3. *Bokashi piles on rice fields in Myanmar*

Plate 4. *Bokashi made with organic wastes of cities and industries*

3.2.10. Bokashi from weeds

Ingredients	Weeds (fresh)*[1]	1,000 litres or 1,000 Kg
	Goat or chicken manure (dried)	50 kg
	Rice bran	20 kg
	Kitchen garbage	25 kg
	EM	1 litre
	Molasses	1 litre (could be substituted by 1 kg brown sugar)
	Water	100 litres

*[1] Broad leaved weeds make very good bokashi. If leaves with high contents of lignin - such as pine leaves are used, one has to increase the quantity of manure and kitchen garbage by 25% to facilitate fermentation

Methodology

Make a container with bamboo, branches of trees or wood and place the chopped weeds or leaves in it. Do not dig a pit as in traditional compost making. Spray EM onto this heap and mix well. Cover with plastic sheet, especially during rainy weather. The fermentation is completed in 30 - 50 days, and the bokashi could be used for crop production or as an ingredient in animal feeding.

3.3. EM TREATED RICE WATER

In remote areas, where molasses or sugar is not available freely, water used for washing rice could be used for extending EM. In this method of extending EM, collect the water remaining after washing rice. One should use the water of the first 2 - 3 washings only.

Mix EM with this water (temperature of the water should be over 20℃). The rate of dilution is 10% EM. Pour into plastic containers and close tightly. If atmospheric conditions are cold, one could use a thermos flask to maintain temperatures.

The fermentation process takes 10 - 12 days, when the sweet fermented smell develops. At this time, the fermented solution could be used as extended EM.

This liquid can be used for making bokashi by diluting to a ratio of 1 : 100, or be given in the water for livestock at a dilution of 1 : 1,000.

The process of fermentation could be hastened by the addition of 100 g of sugar, diluted in the water used for making this extended EM.

4.0. CROP PRODUCTION WITH EM

Agriculture in most developing and also developed countries is based on crop production. Even in countries which produce large quantities of milk and meats, pastures, which comprise of plants are a key factor. Hence EM becomes important in the agricultural sectors of all countries, which strive to enhance productivity while maintaining environmental quality.

The sections below present the use of EM in selected environments producing crops. These guidelines could be modified to suit specific conditions, although the principles do not change.

4.1. RICE

Rice is an important crop all over the world, and is produced in summer in the temperate zones, and throughout the year in the tropics. Hence this section presents important operations that need to be carried out in all rice growing situations, irrespective of the seasonal variations of the tropics and temperate regions.

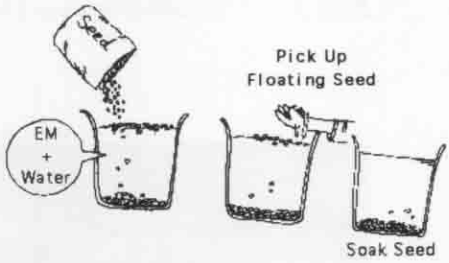
1. After the harvest of the previous season.....

   Add all crop residue (straw and husk) to the field and apply 100 - 150 kg of bokashi and 5 - 10 litres of EM at a dilution of 1 : 500 to 0.1 ha

2. At the onset of the current season.....

   a. Raising of healthy seedlings - Soak rice seeds in a EM solution (dilution 1 : 1,000), until enlarged. This will hasten germination and prevent the development of seed borne diseases. However, it is preferable to change the EM solution daily.

   Once the germinated seeds are sown, apply EM at a dilution of 1 : 1,000 at regular intervals to the seedlings, and 4 - 5 applications are recommended. In addition, spraying of EM FPE at a dilution of 1 : 1000 during the nursery stage prevents pest and disease incidence.



   b. Land preparation - Apply 5 - 10 litres of EM solution (either stock or extended, undiluted) per 0.1 ha. The rate of dilution is 1 : 50 or 100 to the flooded field, at the time of land preparation.

   c. Crop husbandry - Within 10 - 15 days of transplanting, apply 750 - 1,000 litres of diluted EM (dilution 1 : 500) per ha (7.5 - 10 litres of stock solution) prior to weeding.

   In addition, apply bokashi (30 - 50 kg per 100 square meters) as supplementary fertilizer once or twice, at times of application of conventional chemical fertilisers.

   It is recommended that 5 - 10 litres of EM extended or FPE solution be sprayed at a dilution of 1 : 500 or 1 : 1,000 once in a month per every 0.1 ha. This adds upto 3 - 4 applications based on the duration of the crop.

Weed control in rice fields

Microorganisms such as lactic acid bacteria, which is a primary organism in EM produce organic acids and bioactive substances, when EM is applied to the soil with organic matter. These substances break the dormancy of seeds. They also prevents callus formation in perennial weeds, enhance fermentation and subsequent decomposition of the perennial weed bank in the soil. The seeds of annual weeds sprout after the first tillage, and can be suppressed at the final puddling of soil. This reduces the number of weedings in the rice crop.

In the temperate regions where temperatures are lower during autumn and winter, it should be noted that Lactic acid bacteria is activated only at ground temperatures above 5℃. With increasing temperatures, activity is enhanced. Weed seeds germinate at temperatures around 10 - 15℃. Thus timing of EM application becomes important in these regions.

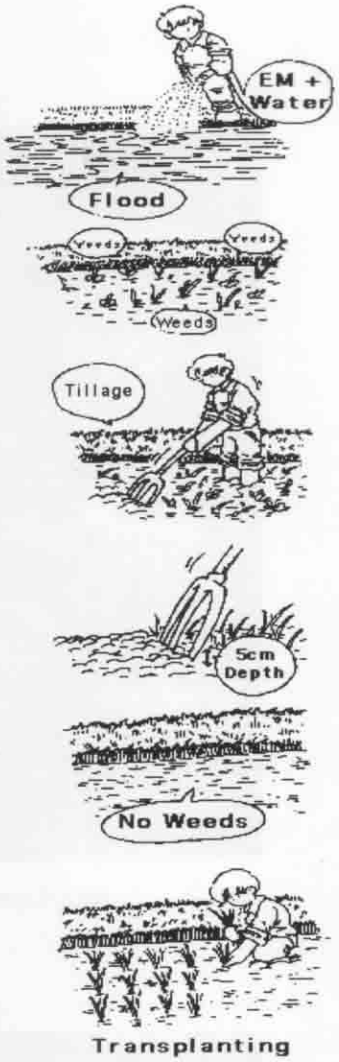
Plate 5. *A farmer applies EM to rice fields*

Plate 6. *Contrasting growth of rice plants growth with (right) and without (left) EM*

In Autumn, 5 - 10 litres of EM stock solution per 0.1 ha should be sprayed to the field at a dilution of 1 : 500 soon after harvest. This ensures a longer period of high soil temperatures, to induce the germination of weed seeds before winter. Once these seeds germinate, the plants die during winter. The beneficial effects of EM are further enhanced if the rice fields could be flooded in winter.

In spring, 5 - 10 litres of EM per 0.1 ha is sprayed to the field at a dilution of 1 : 500, along with molasses, at the first land preparation. This is done by flooding the field as soon as ground temperatures rise above 10℃. Thereafter, the soil is kept saturated for approximately 20 days, to increase soil temperatures and induce the germination of weed seeds. The second puddling is carried out after weeds have sprouted. Flood the field again and one could either remove the floating weeds to prevent contamination of other rice fields or be left to ferment and decompose.

However, one must realise that germination of weed seeds vary with species. Therefore, farmers should be aware of weeds and their growth characteristics in the rice fields



4.2. UPLAND FOOD AND CASH CROPS

General guidelines

In the tropical regions, apply 200 - 300 g of bokashi per 1 square meter, 2 - 3 weeks before crop establishment. This application should be accompanied by a spray of diluted EM solution (dilution 1 : 1,000) at a rate of 1 litre per square meter. The field can then be cultivated. In the temperate zones, this should be done a month before crop establishment. After land preparation, mulch the field with straw, hay or weeds to a thickness of 3 - 5 cm. These material should not contain any seeds. If these materials are not available, a plastic mulch could be applied. The mulch will help retain soil moisture, which in turn activates EM, and also control weeds.

If this pre preparation cannot be done, bokashi and EM could be applied at the time of crop establishment. However, the seeds or seedlings should not come into direct contact with bokashi. The bokashi should be spread evenly around the seed or seedling and the dilute EM solution applied. This will induce better seedling establishment and root development.

Nursery management

A good seed bed is prepared using soil bokashi (Section 3).

Soak seeds in a EM solution (dilution 1 : 1,000) as an inoculation. The periods of soaking are as follows;

Small seed	(e.g. mustard)	20 - 30 minutes
Medium seed	(e.g. Cucumber)	30 - 60 minutes
Large seed	(e.g. Pumpkin)	2 - 3 hours

If vegetative propagules such a cut pieces of potato, sugar cane setts and ginger are used, the soaking time is 5 minutes. After seeding or planting spray an EM solution (dilution1 : 500). Thereafter, spray an EM FPE solution (dilution 1 : 1,000) at a rate of 1 litre per square meter once in 3 days to facilitate healthy growth. For seedlings purchased from commercial nurseries and are planted in pots, transplanting is recommended after sprinkling a EM solution (dilution 1 : 1,000) 2 - 3 times during the nursery period. Flooding is not recommended for upland crops.

Field establishment

At 5 - 7 days before transplanting, apply a dilute solution of EM (dilution 1 : 1,000) at a rate of 1 litre per square meter

Plate 7. *Radish grown with EM and Bokashi*

Plate 8. *Intensive vegetable production in Kyusei Nature Farming with EM*

Field establishment

At 5 - 7 days before transplanting, apply a dilute solution of EM (dilution 1 : 1,000) at a rate of 1 litre per square meter of the field. After transplanting, you could flood irrigate the field using a dilute EM solution (dilution 1 : 4,000 or 5,000). The volume of EM stock solution would depend upon the area of the field and the volume of water required for flood irrigation.

If bokashi is to be applied to the planting site, one should do this 10 - 14 days before planting to avoid toxicity problems.

Crop Management

The application of EM is dependant upon the crop. However, one could apply 1 litre of diluted solution of EM (dilution 1 : 1,000) per square meter every week for a period of one month after crop establishment. An increase in application would not cause problems. The number of applications could be reduced once healthy crop growth is observed.

EM FPE helps healthy growth of plants. Hence regular sprays onto leaves at 14 day intervals are recommended. The addition of molasses or the juice of Aloe leaves (0.1%) as a sticker into the EM FPE enhances efficacy. The dilution of EM FPE should not be less than 1 : 500 (i.e. 1 : 500 or above - e.g. 1 : 600 etc.).

Bokashi could be applied as an additional manure at times of normal fertilizer application. This could be applied around the crop. In the absence of bokashi, kitchen garbage or animal urine treated with EM could also be applied. Excess bokashi or EM treated manures could cause problems of toxicity.

In all instances, solutions of EM should exceed dilutions of 1 : 500. (i.e. 1 : 600 etc.). A lower dilution would cause problems such as yellowing of leaves due to the low pH of the EM solution. If organic matter is available or weeding is carried out, these materials could be used as mulches.

The use of agrochemicals, especially pesticides reduces the efficacy of EM by 50 - 60%. If these chemicals are used, they should be followed by sprays of EM FPE.

Harvest

At harvesting, remove only the economical parts, and return all crop residues to the field. All damaged or diseased plants could also be added to the field. EM is applied to the crop residue at a dilution of 1 : 1,000, along with bokashi. The rate of application is 1 litre of the diluted solution to one square meter. Mulch the field with straw or organic debris.

Return All Crop Residues to the Field

The field would be ready for replanting within 20 - 30 days.

A spray of EM at a dilution of 1 : 1,000 would help prolong the shelf life of fresh vegetable crops.

4.3. MIXED CROPPING SYSTEMS

Mixed cropping of vegetables is a common practice, which could also be carried out very successfully with EM. However, the crops should be selected to reduce competitive effects between crops.

Planting of the two crops could be done together or at different times. If the planting of one crop is carried out while the other is growing, remove all weeds in the inter row spacing to facilitate sufficient light during germination and early growth. After germination, mulch around the growing plant with grass or weeds to a thickness of 5 cm or more. Thereafter, spray diluted EM (1 : 1,000) at a rate of 1 litre per square meter. Fermented compost could also be used at a rate of 1 kg per square meter. Do not use unfermented organic matter at any time.

Plate 9. *Grapes on a Kyusei Nature Farm*

Plate 10. *A proud farmer exhibits bananas growth with EM Bokashi*

Plate 11. *EM enhances productivity of citrus*

4.4. ZERO TILLAGE CULTIVATION WITH EM

Once the quality of soils is enhanced with EM, the organic matter of soils increase. Populations of earthworms and beneficial insects also grow, which improves the physical characteristics of the soil. This facilitates the use of zero tillage.

In such instances, the planting points are prepared by spot tillage. Weeds, grass and the crop residues in the field are cut at a height of 5 cm, and placed as a mulch. EM is sprayed on the mulch at a dilution of 1 : 1,000 at regular intervals. Bokashi and compost (treated with EM) could also be used at this time. Direct seeding is preferred in this system to facilitate root development.

The protection of walkways, by wooden planks, bamboo or even grass is recommended in this system. Disturbances to soil by excessive trampling adversely affects the soil ecology.

Insecticides and pesticides are not used in this technique. Similarly, crops of the same family are not cultivated on the same land continuously.

If the leaves of the growing crop are excessively green, please reduce the application of bokashi and compost. However solutions of EM and EM FPE could be sprayed at dilutions of 1 : 1,000.

4.5. SEED PRODUCTION WITH EM

Most smallholder farmers obtain seeds for planting from commercial sources or neighbours. Some do store seed from previous seasons. However, the procurement of good seed is a constant problem to most farmers.

EM technology enables farmers to use their own seed due to the high quality of the produce. Farmers could leave a part of their crops for setting seed and ripening. These seeds could be harvested at full maturity, sprayed with very dilute solution of EM (dilution 1 : 4,000) and air dried. Thereafter, these seeds could be stored in airtight conditions under refrigeration or in a dry cool place for future use.

This makes farmers independent and crops grown from these seeds germinate early to produce a healthy vigorous crop capable of producing high yields through EM technology.

4.6. ORCHARD CROPS

Orchard crops are perennial species and hence require special attention. Furthermore, one should select the species and varieties suitable for a given climatic regime. EM technology offers the potential of developing very good orchards of fruit trees. The guidelines for establishing and maintaining orchards with EM are given below.

Nursery management

Nursery management is a very important concept in rearing plants for orchards, as these are perennial species. Strong and vigorous seedlings ensure the success and a bountiful harvest for a long period of time.

In nursery management, the first step is the preparation of a good medium for establishment. Soil bokashi is an ideal medium (Section 3), especially if forest or virgin soil is used.

Once the bokashi is made, soak seeds, cuttings or grafts in a dilute solution (1 : 1,000) of EM. The time of soaking would depend on the size of seed, where the larger seeds require longer times of immersion (Section on vegetables gives guidelines). If cuttings are used, place the cuttings on charcoal, and cover with bokashi. Pour the diluted EM solution onto this material to moisten the cutting

and charcoal. The time of treatment depends on the size of the propagule. Large cuttings are generally left overnight. The treated seeds or propagules are planted in soil bokashi. Once a week, diluted (1 : 1,000) EM is sprayed at the rate of 1 litre per square meter to the soil. EM FPE is also sprayed at the same dilution at 7 - 10 day intervals. The growth of the propagules could be further enhanced by spraying extracts from bokashi or kitchen garbage, or even EM treated animal urine, at a dilution of 1 : 1,000 at regular intervals. Clean weeding is not recommended in the nursery, and only the shoots of weeds are removed.

Planting and crop management

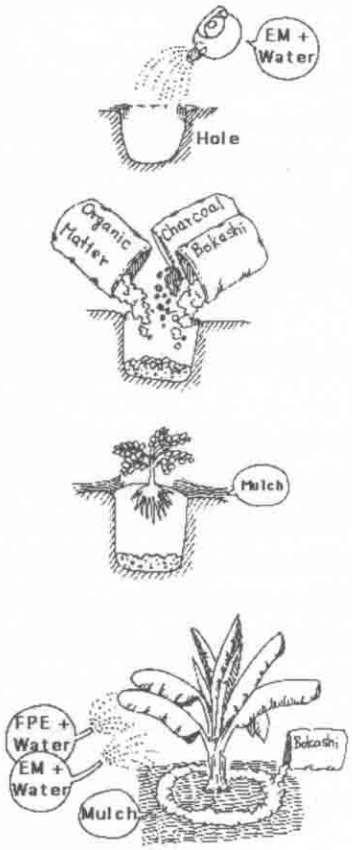
Prepare the site and spray a diluted solution of EM (1 : 1,000) into the planting hole to moisten soil. Add bokashi, organic matter and charcoal at a rate of 300 g of each component to 1 kg soil per planting hole. If organic matter is not available, add 500 g of bokashi and charcoal per kg of soil. Mix well to avoid contact of propagules with the bokashi. If the crop to be transplanted prefers an acidic soil (such as tea), you could add some top soil, which is also acidic, to create a conducive environment for the plant.

After planting, spray diluted EM solution (dilution 1 : 1,000) at a rate of 1 litre per square meter and cover the soil with a mulch of straw, grass, husk, fibre, leaves or weeds to a thickness of 5 cm.

Once the crop is established, spray diluted EM (1 : 1,000) at a rate of 1 litre per square meter. Bokashi could be added at a rate of 250 - 500 g per square meter and the soil surface mulched regularly with organic debris. EM FPE should also be sprayed at a dilution of 1 : 1,000 at regular intervals to maintain healthy growth.

At the time of flowering, bokashi should not be applied. However, EM could be sprayed at regular intervals after flowering.

After harvest, continue the application of EM spray at the same rate (1 litre per square meter) and bokashi (300 - 500 g per square meter). and mulch with organic matter.



Note - In special crops such as mango, which are prone to scorching due to sunlight, the provision of shade is important, especially at early growth stages. In such crops, pruning is required after harvesting to facilitate vegetative growth for the next harvest.

POINTS TO REMEMBER .....

1. Mulching with EM

The provision of a grass mulch is an important criterion. It prevents erosion, maintains soil moisture and temperature and a good environment for EM. It suppresses weeds and enhances soil quality by the provision of organic matter. It also provides important nutrients (such as nitrogen and potassium) to crops. In mulching with grass, bokashi or EM diluted with molasses should be applied onto the mulch to enhance its value.

2. Sod culture

This is the provision of cover crops. Establish mixtures of leguminous and graminaceous cover crops in orchards. The cover crops are mowed several times per year and the cuttings used as a mulch with EM and bokashi. This also prevents erosion, increases organic matter and aggregate formation. The use of alternate rows of cover crops in orchards is recommended in EM culture, as it brings excellent results.

3. Irrigation with an open fermenter

The research projects in Pakistan have developed a very appropriate system to distribute water with EM. This technique is called an open fermenter. It has proven to be very successful.

The fermenter is a concrete tank, made at the entrance of the water channel to the field. The recommended dimensions of an fermenter for 5 hectares are -

Depth	1.5 m
Width	3.0 m
Length	6.0 m - This length is based on using of 1.2 meters per hectare.

If the channel is lined with concrete, the fermenter can be located at one site. In the case of earth lined channels, it would be advisable to have one fermenter to one hectare. The top of the fermenter should on the same level as the channel.

In making the fermenter, two gates are made at the point of entry and exit of water. The base of the gates should be 25 cm above the base of the water channel, to have a space for holding organic matter.

Fill the fermenter with farmyard or poultry manure or sugarcane press mud (filter cake) to a depth of 1 meter. This enables the provision of 50 cm of water above the organic mater. Fill the fermenter with water from the channel.

Add 60 litres of extended EM to the fermenter and mix well. After 5 - 7 days, the water in the fermenter is applied to the field along with the irrigation water. The gates of the fermenter are so manipulated to enable 80 - 90% of the water in the channel to flow directly along the waterway, while 10 - 20% moves via the fermenter.

The organic matter in the fermenter is agitated regularly during irrigation. The water flowing out of the fermenter will be black in colour and contains metabolites such as amino acids, polysaccharides, organic acid and antioxidants, along with plant nutrients.

Plate 12. The open fermenter in Pakistan

5.0. CULTIVATION OF MUSHROOMS WITH EFFECTIVE MICROORGANISMS

Mushrooms are a delicacy in most countries. They are grown under special conditions that favor microbial growth. EM thrives in such environments. Therefore, EM can be effectively used to enhance productivity of mushroom cultivations.

The use of EM in mushroom cultivation requires several stages. These are as follows;

Preparation

EM is sprayed to all parts of the shed when cleaning at a dilution of 1 : 1,000. No chemicals are used. If agrochemicals have been used, EM needs to be sprayed a few days later.

EM is not sprayed on the day of cultivation, as it can damage the mushroom seed.

Cultivation process

The sawdust used as the medium can be effectively treated with EM. Add approximately 60 liters of extended EM (Section 3.1.2) to 1,000 kg of sawdust and mix well. One could also add some lime and Magnesium sulphate as per routine practice at a rate of 1 - 2 kg of each material per 1,000 kg of sawdust.

Cover treated sawdust with plastic sheet or cloth overnight.

Thereafter add rice bran if required and sterilize by steaming.

Compost could also be used for growing mushrooms. Treat compost with dilute EM in the ratio of 1 : 1 : 100 EM : Molasses : Water. Lime and magnesium sulphate could also be added in the same quantities as for saw dust. Cover and keep overnight.

After sterilization, fill bags and place mushroom seed.

Once the mushrooms begin germination, never spray EM onto buttons. However, the shed could be sprayed with EM and EM5 every morning and evening. The solution for spraying is made up in the following manner -

EM : Molasses : Water mixed in the ratio of 1 : 1 : 1,000; This is kept for fermentation for 6 - 12 hours.

Prior to spraying in an airtight container. Dilute this solution 500 times and spray. Do not keep the fermented solution for longer than 3 days.

If EM 5 is used, please spray once in 3 - 5 days, diluted in the following manner -

EM5 : Molasses : Water 1 : 0.25 : 500.

Prophylactic treatment

Spray EM5 around the shed to a distance of about 50 meters, to prevent entry of insects. The same solutions of EM could be used, once in 3 days at a dilution of 1 : 500. EM5 is not an insecticide, but prevents the entry of insect pests.

Cleaning shed

After harvest, spray EM (dilution 1 : 1 : 100 EM : molasses : Water) to the shed. One could also spray this solution lightly to the freshly harvested mushroom to prolong shelf life.

Plate 13. *A farmer inspects a mushroom unit after spraying EM*

Plate 14. *EM increases productivity of mushroom farms*

6.0. ANIMAL PRODUCTION WITH EFFECTIVE MICROORGANISMS

6.1. INTRODUCTION.

Animal husbandry is an area of agriculture that causes problems of pollution, diseases and pests. In addition, this aspect of food production is associated with religious and cultural concepts. Hence, animal enterprises need to be carried out under hygienic conditions, ensuring a high productivity per unit of investment.

EM Technology offers much scope in this aspect, with proven results in many countries and locations. The benefits arise from the fact that EM not only increases productivity, but also animal health and overcomes problems of smell and pollution.

In using EM in animal production enterprises, there are some basic guidelines. These are as follows;

1. EM should not be used as a chemical, medicine or disinfectant.
2. EM is a living entity and thus conditions must be conducive for its activation.
3. Animals being given EM should not be reared under stress conditions.
4. The activity of EM is distinct and thus a whole shed needs to be utilised for EM. It is not advisable to use a part of the animal shed for testing EM as the beneficial influence of EM will be negated.

EM has a multitude of beneficial effects in animal production. These could be listed as follows;

1. EM suppresses foul odour in livestock sheds and septic tanks.
2. EM decreases flies, ticks and other harmful insect populations.
3. EM enhances animal health.
4. EM reduces the stress factor in animals and enhances immunity against diseases.
5. EM increases the quality of animal products and enhances shelf life.
6. EM improves animal fecundity.
7. EM when fed to animals produces manure of high quality.
8. EM lowers the requirements of regular medicines, antibiotics and disinfectants in animal husbandry.

6.2. GENERAL FEATURES OF USING EM IN ANIMAL PRODUCTION

The general features listed below act as standards for all aspects of animal husbandry. The specific activities for the enhancement of the productivity of different animal units are stated later in this section.

The general features of EM that ensure success in animal husbandry are as follows;

1. EM bokashi could be fed as an additive to the feed.
2. EM could be mixed into drinking water.
3. EM extended solution could be sprayed within the animal shed.
4. EM Bokashi should be spread on the bedding used for animals.
5. EM in septic tanks collecting animal wastes reduces odours and flies.

Bokashi as a feed ingredient

Bokashi made with feed ingredients such as rice bran is a good additive to animal feed. This improves the intestinal microflora. Hence the digestive process is stimulated and the health of animals is improved. The foul odour of faecal matter is suppressed.

The rate of addition of bokashi into feed is 1 - 5%. Bokashi could also be sprinkled onto the feed daily.

Some guidelines of the addition of bokashi to animal feed are as follows:

Type of product	Stage of growth	Percentage bokashi in feed
Chicken - Egg production	Chick	1 - 3%
	Layer	1%
Chicken - Meat production	Early growth	2 - 3%
	Final growth stage	1%
Swine	Breeding	1%
	Piglets	1 - 3%
	Piglets for meat	1%
	Adults for meat	0.5 - 1%
Beef cattle	Calf	10 - 20 g per day with milk
	Heifer	30 - 50 g per day
	Adult	30 - 50 g per day
Milk cattle	Calf	10 - 20 g per day with milk
	Adult	50 - 100 g per day

If EM solution is used, a dilute solution (1:100) could be sprayed onto feed prior to feeding.

Please note : These rates are guidelines for feeding and not absolute recommendations.

EM in water

The rate of application of EM into drinking water is a dilution ranging from 1 : 1,000 to 1 : 5,000. The higher dilution is for very young animals. However, do not introduce EM directly to adult animals as it may cause stress problems. Hence begin the program of supplementing EM in water from early stages of the life cycle.

Furthermore, the EM should be added to water daily, after changing the water in drinking troughs. Never supply EM to water that is been in the trough for a long period of time.

Spraying of EM

The foul odours associated with the animal faecal matter are due to harmful microbes. These produce substances such as ammonia and hydrogen sulphide.

The spraying of EM suppresses the development of these harmful microbes, and thereby enhances the hygienic conditions of the livestock barns and also that of animals.

The spraying of EM to barns could be carried out with extended EM. This EM is prepared as follows;

Ingredients	Water*[1]	100 litres
	Molasses	1 litres (5 kg of brown sugar could also be used)
	EM	1 litres

*[1] Well water is preferred as chlorine could affect the development of EM.

Preparation

Blend the molasses with water until completely dissolved. Warm water (40℃) could be used to accelerate dilution. Add the EM and pour into a plastic container that could be closed firmly. Never use a glass container.

Close tightly, and store in a warm place (25 - 30℃) away from sunlight. Release gas occasionally. The EM is ready for use in 10 - 14 days, when the pH drops below 4.0.

THIS EXTENDED EM MUST BE USED WITHIN 30 DAYS.

Application

Dilute the extended EM solution to a ratio of 1 : 100 and spray the entire barn or animal house. Splashing animals with the EM solution, even poultry does not cause problems. However, in the temperate zones, do not spray animals in winter.

The spraying rate is 1 - 2 litres of the diluted solution per square meter once a week. Once the foul odour declines, the frequency of application could be reduced.

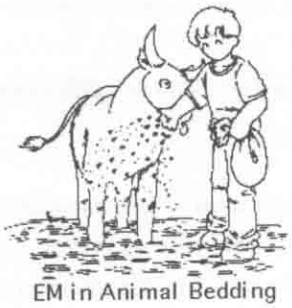
Please note the following points in this operation -

1. If a motorised sprayer is used, please increase the dilution to 1 : 1,000.
2. Clean the sprayer including the nozzle, as it could be blocked.
3. In swine units, please clean the floors prior to the application of EM.
4. In very wet seasons, spraying of EM could cause problems. Under such circumstances, sprinkle bokashi on animal bedding in the manner described below.

EM in animal bedding

In instances of very wet or cold weather, EM bokashi could be used to suppress the foul odours of animal bedding. This could be carried out by preparing bokashi with the following ingredients;

Ingredients	Rice bran	100 litres
	Saw dust	100 litres
	Molasses	200 ml
	EM	200 ml
	Water	20 - 30 litres



EM in Animal Bedding

The method of preparation is similar to that of bokashi (Section 3).

Application

Sprinkle a handful (50 g) per square meter on animal bedding once in 3 - 5 days. Once the foul odour is suppressed, the time interval between sprinkling could be extended to once in 3 - 4 weeks.

Animals may tend to consume the bedding with bokashi. This does not cause problems. However, the moisture content of the bedding should be kept low. If required, one could add rice husk to ensure moisture control.

EM in septic tanks

The use of EM in animal feeding, supplying through drinking water and application to barns, sheds and onto bedding enables the EM to be taken in by animals. Thus the faecal matter contains EM and the foul odours are suppressed. This in turn reduces the smell of septic tanks which collects the wastes. However, by pouring extended EM into septic tanks, one could reduce the smell further.

To ensure the control of bad odour, pour extended EM into the septic tanks at a rate of 1% of the total tank capacity. Thus if the tank has the capacity of 1,000 litres, please add 10 litres of extended EM.

If biogas is produced, do not add EM to the generating tank, as EM reduces the production of methane. In such instances, EM could be applied to the sludge and waste water from the biogas plants.

6.3. ANIMAL MANAGEMENT WITH EM

Poultry

Free range management

Under free range conditions, it is advisable to maintain the chicken in batches of 1,000. A part time farmer could raise 300 - 500 chicken easily. The important aspect of free range chicken is to not to stress the birds. Hence the density of birds per square meter should be 3 - 5 under open conditions and 10 - 12 per 1,000 square meters when kept in fruit orchards. Under free range conditions, a farmer would require another 2,000 square meters to produce green feed for the birds.

An adult bird requires 50 kg of feed per year. Approximately 50% of this feed is corn, wheat, rice bran and similar products. The balance contains products such as fish meal, oil cake, bones, egg shells and kitchen refuse. A chick requires 50 g of feed per day along with fresh green vegetation. This feed is always given in the morning.

In most instances, disease incidence in free ranges occur in 4 - 5 years, if the shed is not kept clean. Therefore, EM plays an important role in this process of sanitation. and the pens should be sprayed regularly with a dilute solution of EM (dilution 1 : 100 of extended EM).

The chicken shed should always be dry. The floor does not need concrete at all times. One could develop a floor containing wood, bamboo or rice husk charcoal, which is soaked in EM solution for three days. This layer could be 5 - 10 cm deep. If concrete is used, extended EM could be added (dilution 1 : 100) in mixing the cement.

Once the floor is ready, spray EM (dilution 1 : 100) at a rate of 1 litre per square meter. Thereafter, develop the litter using dry husk, sawdust, chopped straw and dry weeds. You could mix bokashi to this material to account for 10% of the total volume. However, one should never mix chicken manure in making bokashi for poultry litter. The litter is 15 - 20 cm thick and should always be dry. After one year, this litter, which is very good compost, should be changed.

The shed should be well protected and if a second floor is made, attention must be given to protect the birds from rodents. The house should also contain some perches for the birds. The feed and water troughs must be kept clean and EM (dilution 1 : 1,000) could be lightly sprayed, avoiding the dampening of the litter.

Once day old chicks are hatched or introduced, they need much care. The temperatures must be maintained at 33 - 35℃ in the first 7 - 10 days, and lowered by 1 degree per every two days to ambient conditions.

The humidity should also be high in the first few days and lowered thereafter.

In the first three days, the chicks are fed with broken brown rice. EM is supplied in the drinking water at a dilution of 1 : 5,000. The drinking water must be changed daily. From the fourth day, chopped fresh green leaves could be given, and it is advisable to wash this feed with a EM solution (dilution 1 : 1,000). From the 6th day chick feed could be provided along with the chopped green leaves. Bokashi could also be mixed at a ratio of 1 - 5% of the feed. Generally the feed troughs should be empty 1 - 2 hours before the next feeding.

Generally layers should not be transferred or transported. If they need to be transported, it is best done in the morning. Thereafter, stress could be reduced by supplying EM FPE (dilution 1 : 1,000) or a garlic paste with the water.

Layers require artificial lighting to increase production. Hence 15 hours of lighting should be provided to ensure regular laying.

Chicken in battery cages

These are intensive systems, although management is similar to the free range systems. Bamboo is a suitable material for making these cages in the developing countries. If possible the cages should be made above fish ponds or open fermenters.

EM should be provided with the drinking water at dilutions of 1 : 4,000 or 5,000. This water should be changed daily. Bokashi could be mixed with the meal at a ratio of 1 - 5%. Any green vegetation fed could also be washed in dilute EM (1 : 1,000). All other management features follow that of the free range systems.

Swine production.

Swine production is a controversial operation due to the odour developed in these farms. However, EM plays a very important role in overcoming this problem. The guidelines to achieve this are as follows;

The animals should be reared under stress free conditions. They should be provided with clean ample space. Concrete floors which are sloped are preferred, as the animals could be trained to use the higher levels for sleeping and the lower locations for placement of faeces and urine. There should be adequate aeration and ventilation.

EM could be used in mixing the concrete at a dilution of 1 : 100. If concrete is not used, dig a pit (1 meter depth) in the pen and place dry organic matter such as leaves, bark of trees, saw dust, rice husk, straw or charcoal. This material would become compost in 8 - 10 months and need to be replaced.

The feed of swine could be mixed with bokashi and kitchen garbage treated with EM (dilution 1 : 100) to overcome the foul smell. The green leaf provided could also be washed in diluted (1 : 1,000) EM solutions. However, excess feeding of bokashi may lead to the development of excessive layers of fat, which needs careful scrutiny.

In cleaning the pens, try to separate faeces and urine. Do not use water to collect the solid wastes. Once this waste is collected, wash shed with EM diluted (1 : 1,000) water. If the urine is used for liquid fertiliser, add EM to remove the smell and mix with water (dilution 1 : 500 - 1,000) prior to application.

The faecal matter could also be mixed with dry organic matter and sprayed with EM (dilution 1 : 100). The moisture content of this compost should be below 30%. If the smell remains in the compost, spray EM again.

Cattle

Cattle should always be reared under open conditions. The cattle barns should not have many walls, and need good light and ventilation. If concrete is used for the floor, EM could be used in the mixing of the cement (dilution 1 : 100). If concrete is not used, the floor needs to be sprayed with a dilute solution of EM (1 : 100) and dry organic matter such as straw placed on the floor. These materials make ideal compost and hence needs cleaning at regular intervals.

EM could be diluted (1 : 1,000) and sprayed on the floor, roof and walls of the barns and also on the animals on a daily basis.

The dung and urine needs to be separated. The urine could be mixed with 0.1% of undiluted EM until the smell disappears and be used as a liquid spray at a dilution of 1 : 1,000 (urine : water) to crops. The dung could be mixed with organic matter such as leaves and diluted EM (1 : 100) sprayed and mixed to maintain a moisture content below 30%. This becomes good manure when the smell disappears. If the smell is retained, spray EM again to the heap.

Cattle can be provided with drinking water mixed with EM at a dilution of 1 : 4,000 or 5,000 on a daily basis. EM bokashi made with rice straw and bran could be mixed with feed as in swine. EM could also be sprayed onto the green fodder (1 : 1,000) or be applied to silage at the same dilution.

Plate 15. *Fattener swine fed with EM fermented meal*

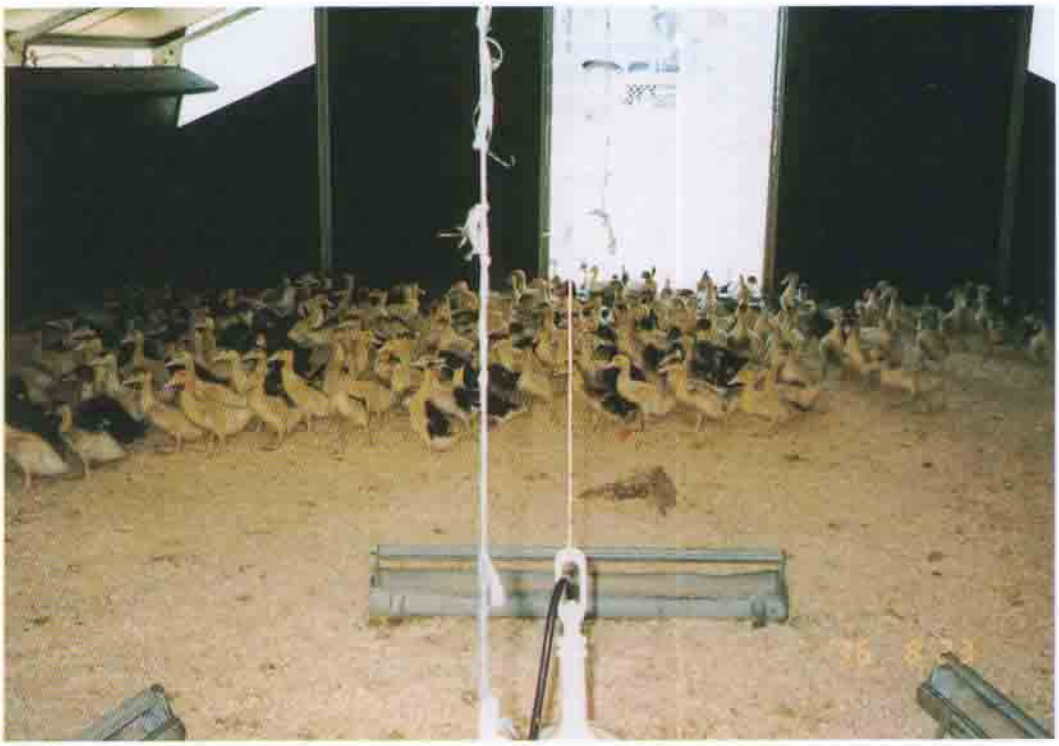


Plate 16. *A free range poultry unit managed with EM Technology*

7.0. INTEGRATED FARMING WITH EM

This concept, which is well developed in Thailand and Indonesia integrates crops and livestock. The basic principle is that the faecal matter and urine of some animals is used to feed others and fertilise crops. For example, 1 - 5% of poultry manure could be mixed with swine feed and 1 - 5% of dried and crushed pig manure could be fed to chicken, using EM Technology.

In making feed from animal manures, the material is fermented anaerobically, in a manner similar to bokashi making. The pH should be below 4.0, and if processed carefully, the EM bokashi would have a sweet fermented smell. If there is a foul smell, please do not use such material for animal feeding.

If swine and fish are integrated, please separate the urine from faecal matter. Add the urine to the fish pond. This principle holds true for combinations of cattle and fish. However, when applying urine to fish ponds, please check quality of water in the pond regularly. If there is pollution and eutrophication, stop the application of urine.

The urine that is applied to fish ponds must be treated with EM (ratio of 0.1 - 1.0%) to remove the smell and the liquid aerated. If there is no unpleasant smell, this material could be used for fish ponds. The same liquid could be used to spray cattle and swine at a dilution of 1 : 1,000. In the event of a unpleasant smell developing, please do not use this material.

The dung could also be treated with EM (dilution 1 : 100) and the moisture kept below 30%. This makes very good compost for field application.

Plate 17. An integrated poultry - fish unit in a Kyusei Nature Farm

8.0. EM IN AQUACULTURE

8.1. BACKGROUND

EM is a very versatile product, that can be used in many facets. A principal requirement for the successful utilisation of EM is the availability of moisture or water. Due to its hydrophilic nature, EM could also be used very successfully in the rearing of fish and Crustacean life for consumption and ornamental purposes.

8.2. EM IN THE CULTURE OF PRAWNS

EM has been very successfully used in the culture of prawns in many countries. However, the most successful enterprises are seen in Thailand, where the yields of prawns have been enhanced significantly.
The usefulness of EM in prawn culture are derived from many benefits.
These could be cited as follows;

1. EM reduces the capital outlay by 50%.
2. The use of EM facilitates the culture of prawns without chemicals. The produce fetches higher prices due to the lack of accumulated chemicals.
3. Prawns are healthy with a shining shell.
4. It reduces the quantity of sludge produced.
5. EM eliminates ammonia, methane and hydrogen sulphide, which are common in normal prawn cultures.
6. The prawns are disease free and this saves costs of antibiotics.
7. The water is clean and hence does not require repeated changing.
8. It conserves the environment.

The culturing of prawns has four important stages, and EM could be used in all these activities.

Preparation of the pond.
After the harvest of prawns, the ponds need cleaning and the sludge treated. Thereafter, bokashi is spread on the sludge at a rate equivalent to 175 - 200 kg per ha , and left for 2 - 3 weeks. Thereafter, 1,000 - 1,500 litres of extended EM is sprayed and left for another 2 weeks.
Finally the clean water is pumped back into the pond. While the water is being pumped, extended EM is added into the pond. The rate of addition is 100-150 litres of extended EM per day for 10 days to add upto total of 1,000 - 1,500 litres per ha. The water is then left for 7 - 10 days.
However during these 10 days, the water is aerated daily. At the end of this period, the water in the tanks become green, indicating the presence of adequate algae for the small prawns to be added.

Launching
Launching is the introduction of the seed prawns into the pond. This is done either early in the morning or late in the afternoon. The density of prawns added is 40 - 50 per square meter. Higher densities would increase mortality rates and feeding costs, while lowering the weights at harvest. Hence maintaining the densities is a very important aspect in launching the small prawns.
When adding small prawns into the pond, the bag containing the seed should be dipped in the water of the pond for 30 - 40 minutes. This is to acclimatise the prawns to the water. Thereafter, the bag is opened, and the water of the pond allowed to flow in. The prawns are released thereafter.

Growth period

In Thailand, there are two methods of adding EM to the ponds.

Method A (This is the preferred method)

Age of prawns (Months)	Quantity of EM* (Litres/ha)	Interval of addition
1	125 - 150	Daily
2	300 - 350	Daily
3	375 - 400	Daily

Method B

Age of prawns (Months)	Quantity of EM* (Litres/ha)	Interval of addition
1	900 - 1000	Every 7 days
2	As above	Every 5 days
3	As above	Every 3 days

* Extended EM is used for this purpose. This reduces costs.

A farmer could decide on the method to be used. In the method B, one can divide the quantity of EM to be applied into 1 - 2 applications per week. However, one should apply the total quantities stated above.

Water

The pH of water must be checked every morning and afternoon. The differences between the pH values in the morning and afternoon should not exceed 0.5. If different, extended EM needs to be added.

The colour of water should also be monitored in order to regulate the application of EM.

Feeding

The feed supplied could be from a commercial source.

However, a general guideline of the feeding regime is as follows;

Upto one month	28 kg / day per hectare added in four instalments.
2 - 4 months	Adequate feed provided in five instalments. The quantity is dependant upon the growth rates.

Feed is added in close proximity to the banks of the pond.

The feed could be treated with EM. Mix 10 kg of feed with one litre of extended EM and leave for 4 hours before feeding. If frequent molting is observed, feed the EM treated material once a day. The normal feed could be provided at other times.

The pond should not be aerated while feeding. For one month old prawns, aeration needs to be stopped for 2 1/2 hours at feeding time. The length of stopping aeration for older prawns while feeding is one hour.

Feeding patterns need to be monitored at all times. This could be done by placing small quantities of feed in small nets and monitoring its consumption. The quantity used for monitoring feed consumption is approximately 3 g per kilogram of feed. Generally there are four nets to monitor feed consumption in a pond of 0.8 ha.

The feed in the net is checked after 2 hours in one month old prawns. If there is feed left, the total quantity of feed added is reduced. If all the feed is consumed, the quantity added could be increased. In two month and older prawns the time of testing is one hour.

Extreme care should be taken not to add excessive feed. The incorporation of excessive feed develops stress conditions due to the pollution of water, foul smell and the development of sludge. Thus the weight gain is lowered and the prawns are prone to diseases.

Aeration

Aeration is required at all times, except during feeding. The numbers of required aerators are lower with the use of EM. If the development of algae is high, aeration is stopped during the day for 7 days. The algae will die and could be removed.

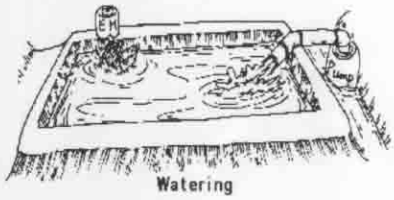
Harvesting

Prior to harvesting of prawns, extended EM is added to the water used for making ice at a rate of 1 : 1,000. This enhances the quality of prawns and extends the shelf life.

Common problems in prawn culture

The culture of prawns is cumbersome, although profits are high. Most farms have some common problems which are listed below, along with possible remedies with EM.

Preparation of the Land

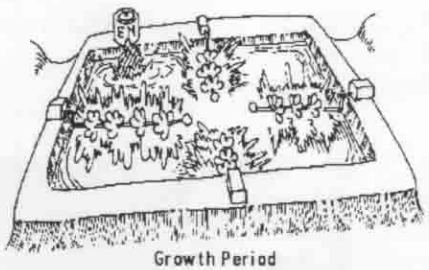


Watering

1. The lowering of water levels in ponds - Add 1,250 litres of multiplied EM or 95 kg bokashi per ha and check after a few days.
2. Luminous water - Add 1,250 litres of extended EM per ha and check after a few days.
3. Some types of algae affect molting, due the binding of these organisms in the gills and around the bodies. Add 60 litres of EM5 per ha and the prawns will generally molt within 24 hours.

General considerations

There are some general guidelines in the use of EM in prawn culture. These will enhance the profitability of the enterprise.



Growth Period

1. It is always advisable to use extended EM daily, rather than at intervals.
2. Prawns could be reared in open or closed systems. In the open system, farmers use water from canals or the sea and there are no storage ponds. In the closed system, storage ponds are a requirement. However both systems pollute the environment and the extent of this problem can be reduced significantly with the use of EM.
3. The advantage of using EM in prawn culture is that all problems could be solved with derivatives of EM. No additional costs are incurred for medicines or antibiotics.

8.3 FISH CULTURE WITH EM

The use of EM in fish culture is similar to that of prawn culture. The guidelines are as follows;

Add EM to obtain a dilution of 1 : 1,000-10,000 in the water of the pond at 7-14 day intervals. If there is a foul odour, add EM at more frequent intervals.

Mixing of bokashi (bokashi for animals) in the feed (1 - 5%) is very effective in increasing growth rates and productivity of the fish.

Plate 18. *A shrimp harvest from a Kyusei Nature Farm*

Plate 19. *Fish aplenty in ponds containing EM in a Kyusei Nature Farm*

9.0. ENVIRONMENTAL MANAGEMENT WITH EM

EM is a very useful and easy method of managing the environment. This is due to the use of naturally occurring microorganisms. The application of EM to the environment, including garbage and sewage reduces and virtually eliminates smells and also the populations of flies. This makes the environment a better place for all living organisms. Extended EM is always used in environmental management. Thus the first step is to make extended EM as described earlier (Section 3. 1. 2.).

Spray the EM at a dilution of 1:100 to wet the garbage (10 - 30% moisture on a volume basis), at regular intervals until the smell disappears. In sewage treatment, add undiluted EM to the tank to achieve a final dilution of 1:1,000 in the waste water.

After the smell is eliminated, spray EM at regular intervals to the new garbage that is added daily. The ratio of spray could be adjusted to obtain the best results. If the smell appears again, please apply a greater concentration of EM or begin the process again.

Continued or regular sprayings ensures the elimination of smell and flies.

This system makes the environment a more healthy place and produces good organic manure from the waste materials.

Plate 20. EM sprayed on a city garbage site in Thailand

10.0. CONCLUSIONS

EM is a versatile product, that uses microorganisms found in all ecosystems. It does not attempt to introduce microbes from Japan or any other country to another. It always uses the microbes of the location. It respects nature and does not contain genetically engineered species.

The principle of EM is the conversion of a degraded ecosystem full of harmful microbes to one that is productive and contains useful microorganisms. This simple principle is the foundation of EM Technology in agriculture and environmental management. Hence the use of EM will ensure a very productive agricultural enterprise, a clean environment and increased profits to the farmer. This is vision of every human being, which can easily be achieved through the adoption of EM Technology, as advocated by Kyusei Nature Farming.

Plate 21. Kyusei Nature Farming with EM Technology
- Sustainable productivity with harmony and beauty