APPENDIX 6

NATURE FARMING MANUAL

A handbook of preparations, techniques and organic amendments inspired by Nature Farming and adapted to locally available materials and needs in the Western Visayas region of the Philippines

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Table of Contents

Section 1: General Introduction

1.1. Background

Organic agriculture in The Philippines is developing rapidly and farmers have adopted and adapted an array of techniques inspired by a number of different philosophies including biodynamic farming, permaculture and Nature Farming. Of particular interest to organic agriculture practitioners in The Philippines is the Nature Farming approach which was first advocated by the Japanese philosopher Mokichi Okada in 1935. This system promotes a holistic and sustainable approach to agriculture, with the aim of protecting life and the integrity of the natural world. The basic principles of Nature Farming are akin to those advocated by Rudolf Steiner in 1924 when he laid the foundations of biodynamic agriculture. Both systems of thought arose in response to problems that were, even then, associated with industrial agriculture, inorganic fertilizer use and monocultures. A fundamental principle that has evolved with these alternative agricultural systems is that a farm should form a basic unit of self-sustainability. The use of native materials can restore and enhance the fertility and vitality of the farm. The presence of a fundamental philosophy of sustainability and biodiversity will allow organic agriculture to transcend current trends to define it simply as a system of farming that restricts the use of certain chemical fertilizers and pesticides.

A key component of sustainable organic farming in the developing world is the use of locally produced and low cost biomass resources to rebuild and maintain soil productivity. Organic fertilizers and soil amendments can be produced in a number of different ways. This manual focuses on the preparation of organic soil and plant amendments using microbiological processes, as inspired by Nature Farming. Although biodynamic farming also uses preparations that may potentially stimulate microbial activity of the soil, these have not yet been fully adapted to the indigenous plant materials in the Philippines. An increased diversity and activity of beneficial microorganisms in the soil can stimulate decomposition processes, providing a constant supply of nutrients from soil organic matter, enhancing nutrient uptake by plants and increasing plant resistance to pathogens and herbivorous insects. There are two basic sources of microorganisms for use in Nature Farming. The first of these consists of indigenous microorganisms (IMOs) collected from the immediate environment surrounding the farm. The second consists of commercial preparations of effective microorganisms (EM) that contain a mixture of phototropic bacteria, lactic acid bacteria, fermenting yeasts, actinomycetes and other types of organisms.

In The Philippines, there are numerous small-scale farming endeavors occupying a mosaic of environments spanning a broad gradient of biotic and abiotic conditions. In this context it is preferable to avoid inputs of commercial EM preparations in favor of locally produced IMO preparations. The EM could potentially overwhelm local microbial communities and reduce their biodiversity or, alternatively, EM preparations may not be adapted to the new environment and will only have minimal effectiveness. Since IMOs are collected in the environment surrounding the cultivated area it is reasonable to postulate that they are adapted to the local plants and soil conditions and are therefore likely to be more effective. An additional advantage of indigenous IMOs over commercial EM preparations in a development context is that they can be harvested from the local environment for a minimal cost.

There is a limited amount of scientific research which has directly investigated the impacts of bokashi fertilizer or indigenous microorganisms on crops (Yan, 2002). There is, however, a significant body of literature published in journals associated with the disciplines of agronomy, phytopathology and evolutionary biology which investigates the interactions between crop plants, crop pests and diseases, and beneficial microorganisms in the soil. There are a number of potentially beneficial interactions between soil microorganisms and crop plants which can be enhanced by the use of IMO.

In biocontrol applications, a number of microorganisms have been identified which are referred to as "antagonists". These are generally fungi which have the ability to hinder the growth of a number of fungal and bacterial pathogens of crop plants (Weeden et al). This can be accomplished directly through parasitism of a fungal pathogen, competition for limited resources or the production of enzymes such as chitinases which inhibit the growth of the pathogen (Harman, 2006). There is also an indirect mode of action of beneficial microorganisms, whereby they suppress disease and insect attacks by stimulating increased production of the plants' natural defenses (Woo, 2006). Some beneficial fungal species also colonize plant roots and stimulate increased nutrient uptake which, in turn, improves size and yield. A number of species of the genus Trichoderma are fungal antagonists of particular interest in biocontrol because they are mycoparasitic on a number of crop pathogens (Woo, 2006). On a biochemical and molecular level, some Trichoderma species also stimulate plant production of natural defenses (secondary metabolites, defensive proteins, signal molecules) which can increase the host plant resistance to a broad spectrum of both pathogens and insects (Marra, 2006; Woo, 2006).

The success of soil microorganisms in improving crop health and crop yields is linked to overall agroecosystem management. In general, beneficial microorganisms require a stable environment in terms of moisture, nutrient supply, and pH (Weeden et al.). As such, the best area for applying beneficial microorganisms is the soil, although a sufficient and consistent supply of nutrients needs to be ensured. Managing soils so as to ensure high soil organic matter can help meet this criterion. In support of this, organically managed soils grown to wheat and barley crops have higher microbial activity coupled with lower impacts of the "Take All" pathogen, Gaeumannomyces graminis var. tritici (Hiddink et al., 2006). The choice of microbial inoculum is important, since any inoculum applied to an agricultural soil will be required to compete with existing microbial populations before it can become established provide benefits to the crop. It has been observed that biological control of weeds and other agricultural pests using microorganisms is met with limited success when using exogenous microorganisms due to a failure of the initial inoculation to generate a lasting population (Chee-Sanford, 2006). In general, the use of naturally occurring and indigenous strains of microorganisms is more successful for purposes of biocontrol. The use of beneficial indigenous microorganisms can also take the form of providing conditions for enhancing the growth conditions for the naturally occurring soil biota or taking measures to restore the microbial community in degraded agroecosystems.

There are strong biological interactions between all levels of the agroecosystem, which includes beneficial microorganisms, pathogenic microorganisms, crop plants, insect herbivores and predatory insects. An improved soil and an increased pool of beneficial microorganisms can have beneficial impacts throughout the system. However, the other components of the agroecosystem must also be managed to achieve optimal results. Maintaining diversity of crop genotypes and using cultivars with some resistance to pathogens is an essential component of any system with seeks to derive maximum benefit from the use soil microorganisms. Experimental work has shown that beneficial microorganisms can significantly suppress the activity of fungal pathogens in crops of mildly susceptible Rhododendron cultivars (Hoitink, 2006). Highly susceptible cultivars, on the other hand, derived no benefit from beneficial microorganisms. In fact, in wheat, susceptible cultivars appear to enhance selection for increased pathogen virulence, which can lead to an overall increase in the virulence of pathogen strains over time (Ahmed, 1996). The use of crop cultivars with some resistance to local pathogen strains is therefore essential to enhance the effectiveness of beneficial soil microorganisms and to slow the evolution of pathogen virulence. Beyond the use of the right cultivars, it can be advisable to diversity of cultivars in a given field since this can provide environmental niches for a greater number of beneficial microorganisms. Cultivar mixtures have been shown to greatly reduce disease and insect pressure, even in the absence of treatments with beneficial microorganisms (Zhu, 2000; Kousik, 1996; Johnson, 2006)

Taken together, this literature suggests a number of benefits that can be derived from the use of beneficial microorganisms found in IMO. These include: increased rates of decomposition of soil organic matter and associated increases in nutrient availability, improved plant nutrient status and yield, a decrease in the prevalence of pathogenic microorganisms and an increase in levels of natural inducible plant defenses. In order to derive a benefit from IMO, a number of aspects of farm management need to be considered.

Organic farming methods which favor the enrichment of the soil organic matter pool can help create an agroecological environment which will favor the growth of a community of beneficial soil microorganisms. Selection of crop cultivars or mixtures of cultivars with some existing resistance to disease and insects will synergize the ability of the microorganisms to stimulate plant defenses. An increase in the diversity of the cultivars used can increase the number of strains of beneficial microorganisms which can thrive in the soil, by increasing the number of available environmental niches. Efficient water management is also required to maintain an optimal environment for beneficial microorganisms.

In agroecosystems where soil organic matter has been depleted following years of intensive farming using highly soluble inorganic fertilizer, there may be a depleted pool of beneficial soil microorganisms. Furthermore, in fields which have only recently converted to organic agriculture, the past use of insecticides, fungicides and herbicides may also have had detrimental impacts on the community of soil microorganisms. Applications of IMO coupled with an increase in soil organic matter may allow a significant increase in beneficial microbial activity and reduce the time required for soil restoration following the cessation of agrochemical applications. This can help buffer against the initial yield loss common to the first crops following the conversion to organic agriculture and may represent the most important benefit of IMO for resource-poor farmers who lack the financial resources to risk a failed or suboptimal crop.

A number of organic soil amendments and foliar sprays are described in this document, accompanied by instructions for their preparation and application. These include directions for culturing indigenous microorganisms and for making the various preparations catalyzed by IMO such as fermented fruit juice, fermented plant juice and kohol amino acid. Instructions are also given for the production of carbonized rice hull and bokashi fermented organic fertilizer. Bokashi is used for restoring both soil fertility and soil structure during the conversion of a conventional farm to an organic agriculture system. All the preparations have been successfully produced according to the methodologies described in this document. However, in the spirit of creativity that is essential for developing sustainable agroecological systems, new users are encouraged to use their own ingenuity and instincts to experiment with the preparations in order to optimize and/or improve them.

1.2. Abbreviations and terms used in this document

CRH	Carbonized Rice Hull
FAA	Fish Amino Acids
FFJ	Fermented Fruit Juice
FPJ	Fermented Plant Juice
FRB	Fermented Rice Bran
IMO	Indigenous Microorganisms
KAA	Kohol Amino Acids
OHN	Oriental Herbal Nutrients
Tuba	Semi-fermented coconut tree sap

1.3. Units

Converting imperial units to metric units:

1 inch = 2.5 cm
1 pound = 0.45 Kg
1 gallon = 3.8 L

Sacks: Unless otherwise mentioned, a “sack” refers to a standard feedsack and is assumed to weigh 45 Kg.

Section 2: The Fermented Preparations

2.1. Indigenous Microorganisms (IMO)

Background (IMO)

Indigenous microorganisms are beneficial members of the soil biota (including filamentous fungi, yeasts and bacteria) collected from non-cultivated soil near the area where they will be applied. An IMO preparation can be used alone as a soil amendment but it is also the fundamental catalytic ingredient of other Nature Farming preparations such as bokashi fermented organic fertilizer. The critical element in the production of high quality IMO is to collect and culture the most appropriate population of soil microorganisms. The IMO should be collected from healthy soil that is not currently under cultivation but is situated relatively near to the area where the preparation will eventually be applied. One of the best indications of soil with a high content of beneficial organisms is the presence of earthworm castings, which are often found under bamboo trees.

Materials (IMO)

- 1 Kg forest soil from an area with worm castings (under a bamboo tree is a good place to look).
- ½ Kg powdered rice bran
- water
- 2 Kg brown sugar or molasses
- Water

Procedure (IMO)

1. Collect soil containing worm castings from beneath bamboo trees (figure 2.1-a). Other types of soil may also be used.[1]

2. Using your hands, break all the lumps in the soil to make a fine powder.

3. Mix the forest soil together with the rice bran.

4. Add enough water to the mixture to achieve 60% moisture content. This is when the mixture is wet enough to form a ball that will crumble easily. The mixture will still appear to be quite dry.

5. Wrap the mixture in a dark cloth and place it in a cool dark place (e.g. in the branches of a mango tree), for 3 days.

6. After this time open the cloth and inspect the molds formed (figure 2.1-b). Desirable molds are white although orange and blue molds are also acceptable. Black moulds are not desired although a few are acceptable as long as they are not predominant.[2]

7. Break the ball into pieces approximately 1 inch in diameter using a clean stick. This stimulates the development of the IMO.

8. If the mixture has dried out, sprinkle a small amount of water on the surface.

9. Tie the cloth back up around the IMO culture.
10. Mix together 7 L water and 2 Kg brown sugar or molasses in a large container.

11. Hang the cloth above the water and sugar solution with about ¾ of the bundle submerged in the solution.

12. Cover the entire preparation with a cloth. This will help protect it from bees and other insect that may be attracted to the high sugar content of the solution.

13. Stir the solution for 10 minutes, 2 times per day, for 10-15 days.[3,4,5]

14. Strain the solution through a fine cloth and retain the liquid fraction which contains the IMO.

15. The liquid IMO can be stored in a glass bottle for up to 6 months. It is important not to tighten the cap completely on the bottle to allow aeration. Shake the bottle once a week to provide air to the microorganisms.

16. Once a month feed the IMO with 20 % of its volume of sugar.

17. The solution should be discarded when it begins to give off a foul odor.

Notes (IMO)

[1] IMO can be cultured from non-cultivated soil collected close to the area where the crop to be treated with the IMO is grown. It is also possible to culture "mixed IMO" for use on the entire farm. This is achieved by collecting and combining soil from several non-cultivated areas on the farm including forest soil, soil from near a river or stream, soil from a bamboo stand, soil found under rocks and soil present near the cultivation areas of several different crops.

[2] Once the molds have formed the preparation should no longer be touched with human hands to avoid contamination by HMO (human micro-organisms)!

[3] When stirring, emulate the technique used for activating biodynamic preparations. Stir steadily in one direction until a vortex is formed in the liquid and then reverse directions to form a new vortex.

[4] Never remove the bundle from the sugar solution, just move it to the side of the container while stirring.

[5] In areas where bees are a major problem the best solution is to remove the worm casting ball from the bucket and seal the lid completely during this time.

Figure 2.1: Photographs of IMO production: Worm castings collected beneath a stand of bamboo trees (Tapi, Negros) for the manufacture of IMO (a) and white mold forming on the solid IMO culture after 3 days in a cool dark place (b).

<u>Application guidelines (IMO)</u>

For the control of the golden apple snail and weeds in rice paddies:

Concentration: 1 Tbsp/L
Application rate: 1L/Ha

Instructions:
Spray the IMO on wet soil before the first plowing. Do not apply IMO to the soil during the dry season. The application should be a light spray only. If no sprayer is available it is possible to mix the IMO with rice bran and ferment it to create fermented rice bran (see instructions for FRB in section 2.2). This preparation can then be hand-broadcast on the field.

For the control of nematodes on eggplants and tomatoes:

Concentration (liquid IMO): 1 Tbsp/L
Application rate (liquid IMO): 1L/Ha
Application rate (FRB): 10 Kg/Ha

Instructions:
Apply liquid IMO 1X to the soil (during soil preparation) and FRB 2X to the soil 1 week after transplanting.

Other reported beneficial effects of IMO:

- No more damping off of tomato plants
- No more bacterial wilt
- No more cucumber mosaic virus on ampalaya (bitter gourd) and squash

2.2. Fermented Rice Bran (FRB)

Background (FRB)

Fermented rice bran is a solid preparation of IMO that can be applied to the soil without requiring the use of a sprayer as is necessary for liquid IMO. Because the rice bran provides the IMOs with a stable substrate they have increased viability and are more effective. Furthermore, the addition of rice bran to the IMO increases the amount of organic matter that is added to the soil.

Materials (FRB)

- 1 Tbsp KAA
- 1 Tbsp IMO
- 1 L water
- 1 Kg rice bran
- Clay pot

Procedure (FRB)

1. Combine the KAA + IMO, alcohol and water and stir for 5 minutes.

2. Add gradually to the rice bran[1] while mixing. Continue until the moisture content of the rice bran is 60%. This is when the mixture is wet enough to be formed into a ball that will crumble easily.

3. Place the mixture in the clay pot and cover with a piece of paper or cloth. It is important to leave an airspace in the top ⅓ to ¼ of the pot.

4. Ferment for 7-10 days in the clay pot, stirring 1X per day.

5. When the mixture begins to dry out, add water to maintain the proper moisture level.

6. Use the FRB immediately, OR, store in the clay pot, maintaining the air circulation and moisture.

7. If the FRB is to be used as an animal feed ingredient, ferment for 3-4 days instead of 7-10 days. Air dry and stop the fermentation process before feeding to the animals.

Notes (FRB)

[1] The rice bran can be replaced with powdered corn, powdered soy, or any other biomass material that is readily available and inexpensive.

Application guidelines (FRB)

For soil application:

Application rate: 1Kg/1000m^2 or 10 Kg per Ha.

Instructions:
Spread the FRB on wet soil prior to tilling.

For use as chicken or livestock feed:

The dried FRB preparation can be incorporated in chicken feed to improve digestibility and increase nutrient availability.

2.3. Fermented Plant Juice (FPJ)

Background (FPJ)
Fermented plant juice (FPJ) is an ingredient in bokashi production and can also be used applied directly to soil and plants. FPJ is produced by the fermentation of plant leaves, grasses, thinned crop plants, auxillary buds and/or young fruits. It contains plant growth hormones and micronutrients that stimulate the growth of beneficial microorganisms.

Materials (FPJ)
- Plant materials: leaves, grass, buds, young fruits, etc.
- Crude sugar (½ to ⅓ of the weight of the plant material)

Procedure (FPJ)
1. Without washing, mix the picked plants with the crude sugar.
2. Pack them in a pot until the pot is full.
3. Put a stone on top of the material for 1 day to lose remove air.
4. Upon removing the stone, materials should fill about ⅔ of the pot.
5. Cover the pot with paper and string.
6. Keep in a cool dark place for 5-10 days. The plant juice will be extracted and fermentation will occur in the pot.
7. The color of the juice will change from green to yellow or brown.
8. The smell should be sweet and alcoholic.
9. At this time, filter out and discard the plant residues and retain the juice.
10. The FPJ can be stored in a glass bottle in a cool, dark place for up to 6 months. It is important not to tighten the cap completely on the bottle to allow aeration. Shake the bottle once a week to provide air to the microorganisms.

11. Once a month feed the IMO with 20 % of its volume of sugar.

12. The solution should be discarded when it begins to give off a foul odor.

Application guidelines (FPJ)

Concentration: 2 tsp/5L water

Instructions:
Spray on soil and plants.

2.4. Fermented Fruit Juice (FFJ)

Background (FFJ)
Fermented fruit juice (FFJ) is prepared in a similar manner to fermented plant juice (FPJ). It is used as a foliar spray to enhance fruit quality, as a feed supplement for animals, and as a food supplement for humans. In general FFJ is not used in the production of bokashi. FPJ is preferred in this case because it contains plant growth hormones that stimulate microbial activity during the fermentation process.

Materials (FFJ)
- Ripe sweet fruits (bananas, etc.)
- Crude sugar
- optional: starchy root crops (cassava, potatoes, etc.)

Procedure (FFJ)
1. Mix the fruit with an equal weight of sugar.

2. Follow the same fermentation procedure as for FPJ.

3. Collect and store following the same procedure as for FPJ.

Application guidelines (FFJ)

Concentration: 1 tsp/5L water (minimum application rate for plants in healthy soil)
1-2 tsp/L water (for plants in soil that is being rehabilitated)

Instructions:
Apply to plants as a foliar spray.

2.5. Fish Amino Acid (FAA)

Background (FAA)
Fish amino acids are a good source of nitrogen for crop plants and may be used to supplement compost and manures in coastal regions which have a good supply of inexpensive fish by-products. Fish trash may be purchased from fish vendors at the market.

Materials (FAA)

- 1 Kg uncooked fish trash (bones, head, guts). Avoid using fish that has been in cold storage
- 1 Kg crude sugar

Procedure (FAA)

1. Mix the fish trash with the sugar.

2. As with the FPJ and FFJ, allow the fish juice to extract and fermentation to occur.

3. Filter out the solids and retain the liquid fish amino acids.

4. Store in glass bottles or empty mineral water bottles. Do not completely close the cap on the bottle.

5. Shake the solution weekly and add sugar to it every month (20% of the volume) as is done for IMO.

Application guidelines (FAA)

Concentration: 1 tbsp/L water

Instructions:
Apply to the soil as a source of nitrogen and amino acids.

2.6. Kohol Amino Acid (KAA)

Background (KAA)

The golden apple snail, *Pomacea canaliculata* Lamarck or "Kohol" is an introduced pest in The Philippines that proliferates in rice paddies and consumes young rice seedlings. Proper water management and transplanting the rice seedlings at a more mature growth stage can mitigate the harmful effects of the kohol. Transplanted rice is generally preferred by organic farmers and is less vulnerable to Kohol damage than direct seeded rice.

Due to the high protein content (12%) of the Kohol, it may be used to manufacture a crop amendment referred to as Kohol Amino Acid (KAA). This is a particularly interesting alternative to the use of Fish Amino Acid (FAA) for farmers established in inland regions who do not have access to an affordable supply of fish materials for the manufacture of FAA. Furthermore, it couples the physical management of the Kohol (by removing it from the rice paddy) with the manufacture of a crop amendment, thereby increasing labor efficiency.

Materials (KAA)

- Kohol snails collected from a rice paddy.[1]
- Boiling water
- IMO
- 1 Kg crude sugar OR ½ Kg molasses, dissolved in ½ L of water

Procedure (KAA)

1. Submerge the snails briefly in boiling water (1-2 minutes). They should still be quite raw. Boiling will facilitate the removal of the snail bodies from the shells but should be kept to a minimum or else the proteins will be lost to the water.

2. Remove snail bodies from the shells using a sharp implement.

3. Mix 1 Kg of the whole snail bodies with IMO, water and sugar in a clay pot and cover with paper or cloth.

4. Allow fermentation to occur while mixing 1X daily.

5. After 7-10 days the snail bodies should have yielded their protein to the liquid.

6. Filter out the solids and store the liquid KAA in a glass bottle. Do not completely close the cap on the bottle.

7. Shake the solution weekly and add sugar to it every month (20% of the volume) as is done for IMO.

Notes (KAA)

[1] Kohol eggs can also be included in this preparation

Application guidelines (KAA)

Concentration: 1 tbsp/L water

Instructions:
Apply to the soil as a source of nitrogen and amino acids

2.7. Calcium carbonate ($CaCO_3$) preparation from kohol shells

Background ($CaCO_3$)

Mollusc shells are composed of calcium carbonate ($CaCO_3$) embedded in a protein matrix. The shells of the golden apple snail (kohol) are therefore a good source of calcium and other micronutrients. This soil amendment can easily be made from the kohol shells after the bodies have been used for the manufacture of KAA.

Currently, PABINHI farmers are using calcium carbonate as a foliar/flower spray. Commercially sold agricultural lime is also composed of calcium carbonate and is prepared from ground limestone. Lime is used to treat acidic soils in order to increase soil pH and decrease acidity. This stimulates soil microbial activities and increases the bioavailability of nitrogen (N) and phosphorus (P). Likewise, the calcium carbonate amendment prepared from kohol shells can potentially assist in the rehabilitation of mildly acidic soils and provide a source of micronutrients to crops.

Materials ($CaCO_3$)

- Kohol shells (enough to give 400 g after powdering them)
- 1 sheet of tin
- Fire
- 1 gallon (3.8 L) of tuba

Procedure ($CaCO_3$)

1. Start a fire and place the tin sheet over it.

2. Put the kohol shells on the tin sheet and roast them. Roasting is complete when the color of the shells becomes darker and they can be broken easily using your fingers.

3. Pound the shells to a powder using a heavy iron object on a concrete floor.

4. Sift the shells through a fine mesh (e.g. a folded mosquito net) and retain the fine powder. Continue crushing the remaining large fragments and sift through the mesh again.

5. Add 400 g of the fine, sifted powder to the bottle of tuba.

6. Allow the solution to ferment for 1 month. For the first week do not completely close the cap on the bottle. After the first week, test the amount of gasses being generated by the preparation by completely closing bottle cap for 20 minutes and then reopening it. If there is no "pssst" sound when reopening (made by escaping CO_2), then it is time to completely seal the bottle.

7. Filter the preparation and put it in a new container (a glass jar).

8. $CaCO_3$ has a long shelf life and can be stored for up to a year. Do not shake or add sugar to the $CaCO_3$ solution during storage.

Application guidelines ($CaCO_3$)

For soil application
Concentration: 1 Tbsp/L of water
Application rate: 1L/Ha

Instructions:
Apply to soil prior to tilling.

For use as a foliar/flower spray
Concentration: 1 Tbsp/L of water

Instructions:
Rice: Spray on rice plants during the booting stage when a bulge appears at the base of the leaf sheath (about 2-3 weeks before the flowering stage). For lowland rice drain the water from the paddy and spray $CaCO_3$ on the soil during this stage. $CaCO_3$ may also be applied to rice plants during the milking stage (when the panicle starts to droop as the grains fill).

Fruits and vegetables: Apply as a foliar spray at the first sign of flowering.

Cucurbits: Spray the plants every two weeks. Cucurbits have a long flowering stage and exhibit a continuous cycle of the flowering and fruiting stages of growth. They should therefore be sprayed with either KAA of FPJ one week and with $CaCO_3$ the next week.

2.8. Oriental Herbal Nutrients (OHN)

Background (OHN)

Oriental herbal nutrients are used as a medicinal food supplement for both people and animals.

Materials (OHN)

- Beer
- Gin
- Plant material (ginger, garlic, oregano, etc.)
- 1/8 Kg sugar (for each L of OHN to be produced)
- Glass jar (1L capacity)

Procedure (OHN)

1. Fill 1/3 of the glass jar with the plant material.

2. Fill 1/3 of the glass jar with beer (to the same level as the plant material).

3. Close the cap loosely and leave the mixture for 12 hours.

4. Fill the rest of the container with gin.

5. Add the sugar to the solution. Sugar improves the taste and prolongs the life of the concoction. It is better not to substitute the sugar with molasses in this case because the OHN will not be as palatable when made with molasses.

6. Store in a glass bottle with a loose cap for 2 weeks, then tighten the cap.

7. Do not add sugar to the OHN after tightening the cap.

8. The OHN can be stored for 6-12 months.

Application guidelines (OHN)

Use as a dietary supplement for people and livestock.

2.9. Storage guidelines for the fermented preparations

Some of the fermented preparations are living cultures of microorganisms and special storage measures must be taken to keep them healthy. The most important measure is to keep the cap loose on the bottle to allow some air circulation. Leaving the cap loose also prevents the liquid from exploding out of the bottle when removing the cap since there may be a buildup of gases formed as a by-product of microbial metabolic activities. Shaking the bottles provides oxygen to the microorganisms. The preparations can all be stored in glass bottles and should be protected from excessive heat and direct sunlight. See table 2.1 for detailed instructions

Table 2.1: Instructions for storing and preserving the liquid fermented preparations.

Preparation	Bottle cap	Shaking	Sugar	Shelf life
IMO	Keep the cap loose	Shake once a week.	Add sugar every month (about 20% of the volume of the solution).	6 months, or until it starts to smell bad.
FPJ	Keep the cap loose and loosen it even more after 2 weeks.	Shake once a week.	Add sugar every month (about 20% of the volume of the solution).	6 months, or until it starts to smell bad.
FFJ	Keep the cap loose and loosen it even more after 2 weeks.	Shake once a week.	Add sugar every month (about 20% of the volume of the solution).	6 months, or until it starts to smell bad.
FAA	Keep the cap loose	Shake once a week.	Add sugar every month (about 20% of the volume of the solution).	6 months, or until it starts to smell bad.
KAA	Keep the cap loose	Shake once a week.	Add sugar every month (about 20% of the volume of the solution).	6 months, or until it starts to smell bad.
$CaCO_3$	Leave the cap loose for the 1st 2 weeks. At this time tighten the cap for 20 minutes and then re-open. If gas escapes the bottle upon reopening, leave it loose, if not, tighten the cap.	Do not shake.	Do not add sugar to the solution.	6-12 months
OHN	Leave the cap loose for the 1st 2 weeks. At this time tighten the cap for 20 minutes and then re-open. If gas escapes the bottle upon reopening, leave it loose, if not, tighten the cap.	Do not shake.	Do not add sugar after tightening the cap.	6-12 months

Section 3: Carbonized Rice Hull (CRH)

3.1. Background

Rice hulls are composed of 20% inorganic materials and 80% organic materials. The organic fraction of the rice hull includes cellulose and hemicellulose (50%), lignin (26%) and other compounds such as oil and proteins (4%) (de Souza *et al.*, 2002). The high concentration of lignin in rice hulls impedes decomposition processes and reduces the bioavailability of the remaining organic components of the rice hull. Biological lignin decomposition is primarily an aerobic process carried out by fungi. Under anaerobic conditions, such as can occur in compost piles or in rice paddy soil, the rice hulls will not decompose.

The production of carbonized rice hull (CRH) has been identified as an appropriate method for circumventing this problem. Carbonized rice hull is a crucial ingredient of bokashi organic fertilizer and can also be used in composting toilets and animal bedding. CRH results from the incomplete combustion of rice hulls under high heat and low oxygen conditions (pyrolysis). Pyrolysis causes the decomposition of organic materials such as lignin and cellulose, leaving a residue of carbon and mineral nutrients. Breaking down the lignin accelerates decomposition of the rice hulls and the subsequent release of nutrients. When CRH is incorporated in bokashi organic fertilizer it provides a carbon source for microorganisms to balance the high nitrogen content of the manure. Carbonization conserves the physical structure of the rice hull which provides a colonization site for beneficial microorganisms, contributes to soil permeability and water retention, and improves aeration of the soil. Carbonized rice hulls also contain nutrients such as potassium, phosphorous, calcium, magnesium and other microelements.

Rice hull ash, which is also formed during the carbonization process, is mainly composed of silica. **Care should be taken not to inhale this ash by protecting the face with a mask or bandana**. The carbonization processes described below produce varying proportions of carbonized rice hull to ash depending on the conditions of the carbonization. Since rice crops deplete silica from the soil the use of this amendment can help restore soil silica. Figure 3.1 illustrates the process of carbonization. The two open-type rice hull carbonizer models described below can easily be constructed from recycled materials. They both consist of an ignition chamber with a chimney that provides the heat source for carbonizing the rice hull pile.

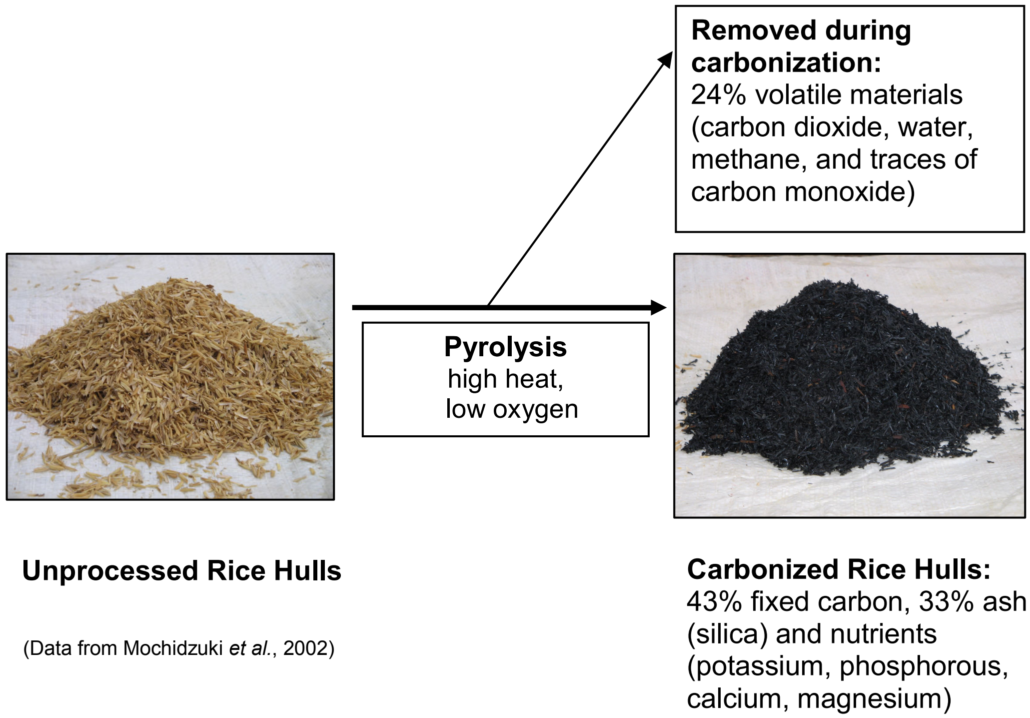

Figure 3.1: The physico-chemical transformation of rice hull through pyrolysis.

3.2. Rice hull carbonizer model for small-scale production (1-3 sacks)

Base

- 1 metal can (about 2-4 L)
- Remove the bottom of the can and cut a hole in the top for inserting the chimney.
- Make holes in the sides using a nail or other sharp tool.
- Holes should be about 1 inch (2-3 cm) apart.

Chimney

- Long tube made of bamboo or a G.I. sheet designed to fit hole in top of can
- Should be long enough to be above the heads of the users.

Tripod

- Made using bamboo sticks or other materials tied to the chimney to hold it in place.

Technical notes

- This carbonizer is good for carbonizing 1-3 sacks of rice hull at a time for use on an individual farm basis.
- This amount of rice hull requires approximately 4 hours to carbonize.

3.3. Rice hull carbonizer models for large-scale production (4-130 sacks)

3.3.1. For 4-50 sacks of rice hull

Base

Instructions:

1. Use an 18 L can (18 L), a kerosene can works well. The can used may be square or round. The instructions in this document refer to a square can.

2. Remove the bottom of the can.

3. Cut a hole for the chimney in the top using a knife (a 4" diameter for the hole is good).

4. Use a hammer and nail to make holes in the sides.

5. The holes shouldn't be too big or hulls may fall in and smother the fire.

Dimensions:

- Can volume: 18 L
- Can measurements: 23.5 x 23.5 cm (base) x 34.5 cm (height)
- Chimney hole: 10 cm
- Holes per side: 120 (12 rows of 10 holes each)
- Hole diameter: 3 mm
- Distance between each hole: 2-3 cm

Chimney

Instructions:

1. Make the chimney with a No. 24 galvanized iron (GI) sheet or other type of sheet metal.

2. The sheet may be rolled up to achieve the desired chimney size and held in shape using wires.

3. Chimney should be at least 1.5 m tall. It should be taller than the people present so that smoke will be carried away from the users.

4. If the chimney and the hole in the top of the base have different diameters (i.e. if the chimney is smaller) it is possible to place a skirt of sheet metal on the base of the chimney to adapt them to each other.

5. A toxic creosote residue can build up at the bottom of the chimney so it is important not to make the chimney too narrow or the residue will block the flow of air. The chimney will need to be scraped clean of this residue periodically.

6. A narrow chimney (7 cm) is good for up to 10 sacks of RH since the small pile is quite porous. For carbonizing more than 10 sacks use a wider chimney (10 cm) which will allow more air flow and increase the speed of combustion.

<u>Dimensions:</u>

- Height: 1.8-2 m
- Diameter: 7-10 cm
- The chimney should only extend a few inches down into the can, just enough for it to be stable, otherwise the fire won't burn well.

Technical notes

- Do not increase the size of the can to carbonize a larger volume of rice hulls. This is a waste of space, it is better to combine several carbonizers to increase the power of the process (section 3.3.2.).
- The carbonizer apparatus described here will last about 2 years before it wears out.

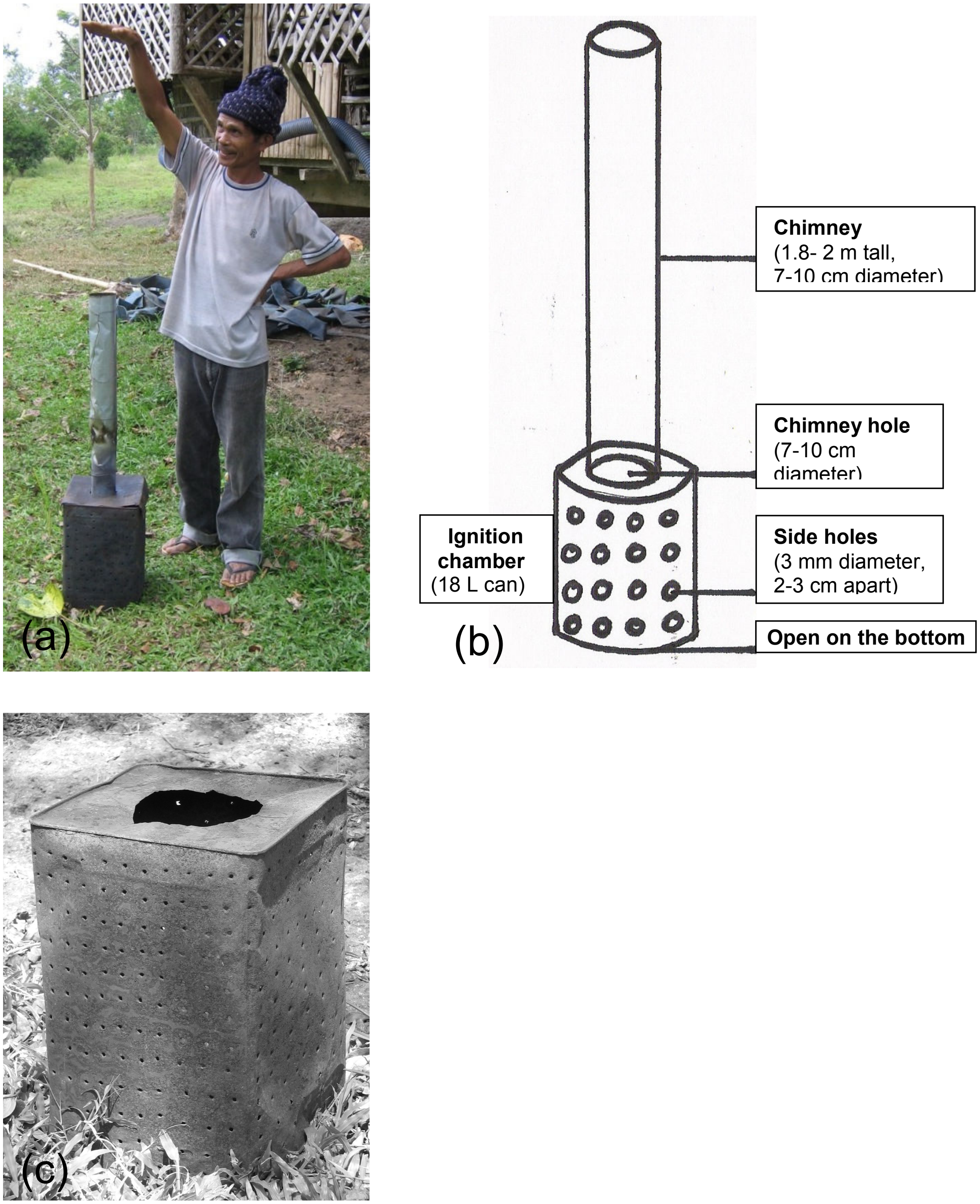

Figure 3.2: Photograph (a) and diagram (b) of a large-scale rice hull carbonizer and detail of the ignition chamber (c). Note that the chimney on the model shown in (a) is too short; Leopoldo is indicating the appropriate height with his hand.

<u>3.3.2. For 50-130 sacks of rice hull</u>

If more than 50 sacks of rice hull are to be carbonized it is best to combine 3 carbonizers (as described in section 3.3.1.) in a triangle. They should be 1 m apart from each other. Make one big pile of rice hulls covering all 3 carbonizers and proceed with the carbonization. Combining 3 carbonizers can significantly reduce the carbonization time. For example, it will take 24 hours to carbonize 130 sacks using 1 carbonizer compared to only 12 hours to carbonize 130 sacks using 3 carbonizers.

3.4. Rice hull carbonization process

Materials

- Carbonizer
- Rice hull or other materials for carbonizing
- Lit coals
- Firewood and newspaper
- Stirring stick
- Shovel
- Rake
- Water sprinklers

Procedure

1. Starting the fire

- Start the fire using a small amount of coals (equivalent to the content of ½ a coconut hull) and wood. Always use the same size of fire, regardless of the number of sacks to be carbonized.
- Place the carbonizer can on top of the fire.

2. Adding the rice hulls to the carbonizer

- Dry the rice hulls in the sun prior to use. This will reduce their moisture content and increase the speed of carbonization.
- The base of the carbonizer needs to be entirely covered with hulls. The minimum quantity of rice hulls is 4 sacks because the size of the pile decreases with combustion. With less than 4 sacks the base will be exposed by the end of the carbonization process.
- The side of the pile that is facing the source of the wind will burn faster; the pile should be thicker on this side.
- When the hulls start to burn the smoke will become denser and whiter.

3. Early stage of carbonization

- It is easy to tell which parts of the pile are burning faster because smoke will start coming out of these areas and the hulls will begin to turn black.
- When the hulls around the base of the chimney start to blacken cover them with rice hulls from the base.
- When black spots of carbonized hulls appear on the outside of the pile, push the spot inwards by applying gentle pressure and then cover it with hulls from the base of the pile.
- The bottom of the pile burns more slowly, this is why the hulls from the base are always moved upward to cover carbonized areas.
- Always keep the sides of the pile as steep as possible.
- Do not mix the pile during this initial stage of carbonization, just cover carbonized areas with non-carbonized hulls.
- If it is necessary to speed up the carbonization process it is possible to remove the outer, non-carbonized layer of the pile at this stage for later carbonization.

4. Late stage of carbonization

- At this point most of the center of the pile is black and large portions of the outer layer are also black.
- Stirring the pile begins now. When one area on the outside looks mostly black insert a stick into the middle of the pile (at the base) in that area and lift the stick up and sideways at the top. Go methodically around the pile doing this, making sure to remake the steep-sided cone shape of the pile while stirring. Do not stir too much, this will cause the carbonization to take longer and the fire may go out. Once the pile has been mixed, wait for the outside to turn mostly black before mixing again.
- Because the fire is stronger on the side of the source of the wind the pile can be rearranged to add more hulls to this side.
- WARNING: A lot of dust (rice ash, mostly silica) comes out of the pile when stirring. This is a potential health hazard. Participants should wear dust masks/bandanas to cover mouth and nose during this stage and should ensure that they are upwind from the pile.

5. Halting the carbonization

- The can in the center needs to be removed. Use a shovel to remove the can as well as the remaining charred wood from the pile of CRH.
- Do not remove the can until the outside of the pile is AT LEAST 90% black.
- Remake the cone shaped pile and wait for the remaining non-carbonized rice hulls to turn black.
- Spread the carbonized hulls in a long flat oval pile about 15-20 cm high (if the pile is round it is hard to pour water on the center part).
- Sprinkle water on the rice hulls and work it through the pile using a rake.
- Use about 4 gallons of water for every 2 sacks of rice hull that were carbonized.
- Make sure the fire is completely extinguished or else the combustion will continue.
- Do not bag the rice hulls until the excess water has drained out.

6. Storage of the CRH

- The yield of CRH is about 60% of the original volume of rice hull. During the dry months this climbs to 70% because there is less moisture in the hulls.
- It is better not to store the CRH in feedsacks because experience has shown that it will destroy the sacks after one month. Plastic fertilizer bags will work for storage.
- The best storage option for the CRH is to keep it in a pile under a shelter.
- After the CRH has been in a pile for at least 1 month it can be stored in feedsacks without destroying them.

7. Troubleshooting and notes

- If the fire seems to go out and no more smoke is coming from the chimney it may have become blocked with creosote. Use a long stick to unblock it. Otherwise, hulls may be falling in and smothering the fire, in this case use a can with smaller holes.
- Even if the carbonization is interrupted by rain the fire can keep going. Just wait until the rain stops and then the fire will rekindle and dry out the hulls. This will take longer because the moisture content of the hulls will be very high. It is best to carbonize during the dry season.
- A cement surface is the best option for carbonizing and makes it possible to achieve 100% carbonization.

Figure 3.3: The steps of rice hull carbonization. Starting the fire and installing the carbonizer (a), adding hulls to the carbonizer (b), the appearance of carbonized areas on the rice hull pile (arrow) (c), the progression of carbonization (d), the appearance of the pile when approximately 90% of the carbonization has occurred (e), stirring the rice hulls during the final stage of carbonization (f) and spreading out the carbonized rice hulls and halting the carbonization (g).

3.5. Suggestions for adapting the carbonization procedure to alternative biomaterials

Depending on local agricultural production and the type of biomass that is readily and inexpensively available it may be desirable to carbonize materials other than rice hulls. Possible substitutes include peanut shells, millet husks, cacao husks, and coconut husks, among others. Expeiments in The Gambia using millet husks containing straw and chaff trash have been successful, giving a 50-60% yield of carbonized material (fig.3.4-a). Differences in the composition and structure of these materials may necessitate slight modifications of the procedure. These include:

1. The structure and size of rice hulls restricts airflow through the pile and allows pyrolysis to occur. Materials such as peanut shells will probably require processing prior to carbonizing. Try to grind such materials to achieve a reasonably fine texture that still has enough air spaces to allow for some circulation of heat and air through the pile. If the material is too porous complete combustion and ash formation may occur, causing a loss of the nutrients and destroying the structure of the biomaterial.
2. If it is difficult to achieve the right texture for appropriate air flow and there is a small supply of rice hulls available it may be possible to make a layered pile. Cover the carbonizer can with a layer of rice hull, then make the main part of the pile with the alternate material and finally cover the pile with another thin layer of rice hulls. This will help regulate the air flow.
3. If there is insufficient airflow to maintain the fire due to high density of the selected material it may be helpful to construct a small air inlet through the base of the pile. This technique was successfully used for millet husk carbonization. The inlet was used during the first 10 minutes after starting the fire to ensure good ignition and was subsequently removed (fig. 3.4-b).

Figure 3.4: Carbonized millet husk production in the Gambia (a) and detail of the air inlet used to ensure good combustion of the millet husk mixture (b)

3.6. Carbonized rice hull from biomass stoves

The increasing cost of LPG fuel and the rapid depletion of forest resources in the Philippines are spurring an initiative to develop alternate cooking fuels. Waste biomass materials such as rice hulls have the potential to provide an abundant and inexpensive fuel supply. The Mayon Turbo Stove (MTS, designed by REAP-Canada) and the Belonio rice husk top-lit updraft (T-LUD) gasifier (Belonio, 2005) (figure 3.5) are both powered by rice hulls. The MTS is a small stove designed for household cooking applications whereas the Belonio rice husk gasifier is designed for large-scale cooking operations. The operation of these stoves produces high quality carbonized rice hull as a by-product which can be recuperated for use in the production of bokashi fermented organic fertilizer. Between 35-40% of the rice hull consumed by the stoves remains as a blend of carbonized rice hull and rice hull ash (table 3.1).

In order to recover carbonized rice hull from the cooking stoves the fuel must be removed from the stove immediately after operation and extinguished with water. Otherwise, combustion will continue and the rice hulls will become ash. If we assume the lowest possible yield of CRH from the stove (557 g of CRH recovered per hour of stove operation) and that an average household spends 1 hour a day cooking we can conclude that approximately 1.4 metric tonnes of CRH can be produced per household per year. The volume of carbonized rice hull produced from cooking applications should therefore be ample for subsequent use in the production of bokashi. Integrating biomass stove technologies with bokashi production can save the time and labor associated with the production of carbonized rice hull and provides a means for disposing of combustion by-products.

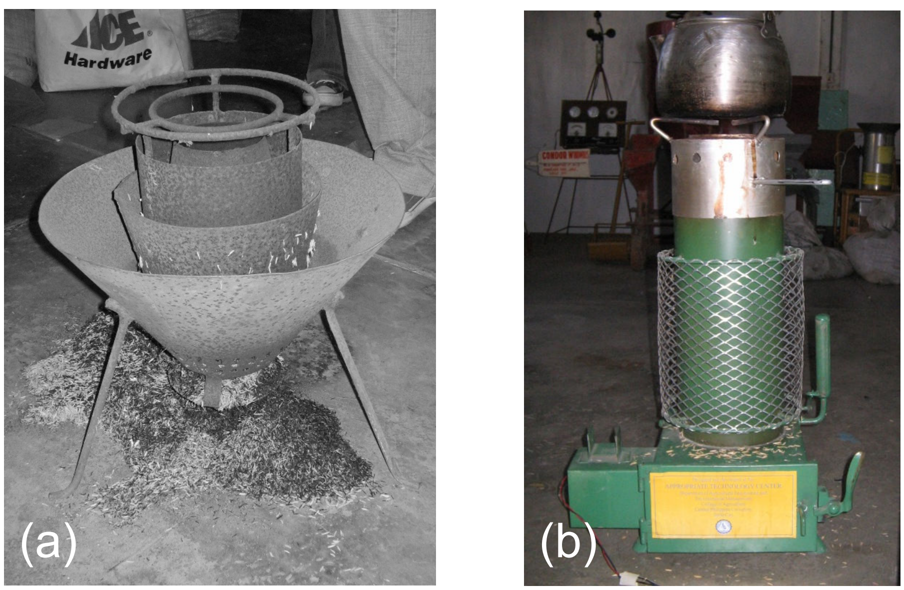

Figure 3.5: The Mayon Turbo Stove (a) and the Belonio rice husk T-LUD gasifier (b).

Table 3.1: Rice hull consumption and carbonization data for the rice hull gasifier compared to a rice hull carbonizer.

Stove type	Model	Yield of carbonized rice hull (%)[1]	Rice hull consumed/hour (g)	Yield of carbonized rice hull/hour (g)
Mayon Turbo Stove (MTS)	--	29.3	--	--
Belonio rice husk T-LUD gasifier[2]	1-burner	35-40	1590-2000	557-800
Rice hull carbonizer[3]	--	60-62[2]	--	--

[1] Also includes ash
[2] Data from Belonio (2005)
[3] Data reported by PhilRice on www.oryza.com

Section 4: Organic compost

Background

Organic compost is easily made using waste biomass material and small amounts of manure available on the farm. The benefits of making compost include returning waste organic mater and nutrients to the soil. Compost can replace the use of pure animal manure in the production of bokashi if manure is not available in sufficient quantities. Compost is produced by layering different organic materials in a pile and allowing them to decompose. Brief composting instructions are provided in this section.

Layer sequence:

1. 4 Kg rice straw or dried grasses[1,2]
2. Small branches of trees[3]
3. 1 Kg fresh leaves of N-fixing trees
4. Garden soil (20% of the weight of the rice straw)
5. 4 Kg rice straw or dried grasses
6. 1 sack of animal manure
7. Garden soil (20% of the weight of the rice straw)

Notes:

[1] This layer can be mixed with dried leaves, this diversifies the carbon source so that it is not coming only from rice.

[2] When layering the pile, straw and grass layers can be alternated. (i.e., if rice straw is used in the first layer sequence, then use dried grasses in the second layer sequence).

[3] It is good to use bamboo in the compost, it has a high silica content and is good for restoring soil that has been planted to silica-depleting crops such as rice and sugarcane.

Building the pile and layering

1. Put a layer of rotting wood at the bottom of the pile for aeration.
2. Repeat the layer sequence 4 times
3. After adding each layer, sprinkle it with water and IMO (dilute 4 Tbsp of IMO in the water).
4. Sprinkle water on top of the pile
5. Cover the pile with plastic or old sacks
6. The pile should be approximately 3m x 6m (base) x 1.5 m (height)

Mixing the compost

1. Mix the pile after 2 months
2. Mix the pile 2 weeks after the first mixing.
3. Wait another 2 weeks before using the compost.

Section 5: Bokashi fermented organic fertilizer

5.1. Background

Bokashi is an organic soil amendment originally formulated in Japan, where it is widely used. It is a fermented organic fertilizer containing indigenous microorganisms and nutrients which are beneficial to soil and plants. Practical advantages associated with the use of bokashi include the rapid preparation time (only 2-4 weeks) relative to traditional compost (6 months) and the reduced cost compared to commercial fertilizers because it is manufactured from low-cost, locally available materials. Moreover, it is easily substituted for chemical fertilizers without requiring much additional training. As such, it is an appropriate tool for farmers who are in the process of making the transition from conventional to organic agriculture. The use of bokashi fertilizer can become a stepping stone from which to explore other organic agriculture practices and techniques. Bokashi can be used as a basic fertilizer during soil preparation and also as a supplementary fertilizer during the fruiting stage. Research with peanut crops has shown that crops treated with bokashi fertilizer had higher growth rates, increased nodulation and higher yield than crops treated with chemical fertilizer (Yan and Xu, 2002).

PABINHI farmers have found bokashi to be particularly effective in rehabilitating degraded soils and restoring soil organic matter. The use of bokashi has also been noted to improve drought tolerance in crops such as corn. On-farm experimentation has determined that in rich soils it is not always necessary to reapply bokashi prior to planting the second rice crop. In the long term, when soil fertility and organic matter have been restored it may be preferable to reduce the application rate of bokashi and combine it with other organic amendments such as compost.

This manual describes four different variations on the bokashi recipe. These recipes evolved through the adaptation of the basic bokashi technology to the locally available materials in different regions. A further variation that has been introduced is "no-mixing" bokashi which greatly reduces the labor requirement for bokashi production but lengthens the decomposition process. Recent experiments by REAP partners in the Gambia have demonstrated that bokashi production can be successfully adapted to the West African natural ressource base using materials such as millet husk rather than the rice by-products that are used in Southeast Asia.

5.2. Bokashi recipes

5.2.1. Bokashi recipes from Negros

Bokashi I: For areas where sugar mills can provide a source of mudpress[1]

Materials
- 1 tonne of mudpress (dry:20-30% moisture content)
- 500 Kg carabao or cow manure (20-30% moisture content)
- 3 sacks of rice bran (120 Kg)
- 6 Tbsp. of IMO or 100 g of FRB
- 2 Kg sugar of 1 Kg of molasses
- 300 Kg of garden soil
- 12 Tbsp. of FPJ (the amount of FPJ is always double the amount of IMO)
- 4 sacks of CRH
- 2 gallons water
- Sprinkler

<u>Procedure</u>

1. Crush the mudpress and animal manures into smaller pieces using a spade and wooden mortar.

2. If these materials are too dry sprinkle enough water to soften them before crushing.

3. Add garden soil and mix the three materials together in a space shaped like a garden bed (1¼ m X 6 m).

4. Mix the IMO, FPJ and crude sugar or molasses in 2 gallons water.

5. Add some water to raise the moisture content to 60-70% using a sprinkler.

6. Sprinkle 1 gallon of the water diluted with IMO, FPJ and sugar.

7. Spread the rice bran on top of the pile and mix again.

8. Sprinkle the remaining gallon of water diluted with IMO, FPJ and sugar on the pile.

9. Add the 4 sacks of CRH and mix twice.

10. Cover with plastic sacks or other material.[3]

11. Mix once a day for 3 days.

12. Mix twice a day from day 4 to day 10 or until the pile has a lower temperature.[2]

13. Mix once a day until day 21 or until the pile has cooled down.

14. Harvest and store in a cool dry place.

15. Store at least 2 weeks before use (nutrients become more readily available).

Bokashi II: For areas with no sugar mills

This is basically the same recipe as *bokashi I* with a few minor variations. These are:

1. Double the amount of sugar used and replace the mudpress volume with compost and/or manure.

2. Add the rice hull at the end of the fermentation process instead of at the beginning.

3. It is OK to use only compost if there is no manure available.

Notes:
[1] The process of making bokashi using mudpress takes 1-2 weeks longer than when using animal manure or compost alone and the temperature is higher (up to 70°C or more) compared to only 50-60°C.

[2] Usually on the 10th-12th day the temperature of the pile goes down to ½ of the peak temperature.

[3]During the fermentation/decomposition process add water whenever necessary to maintain the appropriate moisture content of the pile

5.2.2. Bokashi recipes from Guimaras

Bokashi III: Original bokashi recipe

Materials for small-scale bokashi production
- 3 sacks chicken dung or other animal manure
- 2 sacks carbonized rice hull
- 2 sacks garden soil, forest soil or soil collected from under a bamboo tree
- 1.5 sacks rice bran
- 1 kg sugar
- 1/2 gallon Tuba OR 5 Tbsp. FFJ or FPJ
- 5 tbsp. indigenous micro-organisms (IMO)

Materials for large-scale bokashi production
(Gives a yield of 78 sacks, approximately 3.5 tonnes)
- 32 sacks chicken dung or other animal manure
- 30 sacks carbonized rice hull
- 20 sacks garden soil, forest soil or soil collected from under a bamboo tree
- 10 sacks rice bran
- 10 Kg sugar
- 8 1/2 L tuba OR 1/3 L FFJ or FPJ
- 1/3 L indigenous micro-organisms (IMO)

Procedure
1. Select a good site for bokashi production (e.g. under a tree). The site should have a roof to protect the bokashi from sunlight and the surrounding area should have good drainage to protect the bokashi from heavy rains.

2. It is much better if the area is cemented and located near the house so that it is safe from heavy rains and easy to monitor. During the dry season, the bokashi can be produced under a tree. In this case it is important to ensure that the area does not have any stray animals.

3. Prepare all materials needed. Chicken dung should be dried.

4. Slowly mix the materials together one at a time and add water (for every 1 sprinkler can of water mix 1 glass of tuba) until the mixture is saturated but not too wet. Estimate the moisture content; it should not be more than 60% (mixture can be formed into a ball that crumbles easily, if you squeeze the ball you shouldn't see any water come out). Avoid adding too much water because moisture content above 60% can result in a foul odor being produced which means that the bokashi is not good.

5. Mix the materials thoroughly, form the mixture like a pyramid and cover with sacks.

6. Check and mix everyday. Temperature should be less than 70 centigrade. Record the temperature before mixing. Mixing should be done in the morning and afternoon for 1 week. If it is not possible to measure temperature with a thermometer, check temperature by burying your hand in the pile. In general, if you can't resist the heat after a few seconds, then your pile needs to be mixed twice a day. After 1 week, if the bokashi is too dry, add 1 sprinkler of water.

7. From 8-14 days, mix the bokashi once a day, in either the morning or afternoon. As well, record the temperature. If the temperature is below 30 centigrade (i.e., feels cool to lukewarm on the hand), there is no need to mix. Starting on the 8^{th} day, if the form is not pyramiding, just level it on the ground flat and cover with sacks. After 14 days, it is ready to use and should have a smell similar to silage.

8. After 2 weeks of fermentation, leave the sacks on the bokashi and store it in a dry place away from direct sunlight.

9. Mix with an equal volume of local soil and apply to fields during soil preparation.

Bokashi IV: Anaerobic Bokashi (no mixing)

<u>Materials (the same as for *Bokashi III*)</u>
(Gives a yield of 78 sacks, approximately 3.5 tonnes)

- 32 sacks chicken dung or other animal manure
- 30 sacks carbonized rice hull
- 20 sacks garden soil, forest soil or soil collected from under a bamboo tree
- 10 sacks rice bran
- 10 Kg sugar
- 8 1/2 L tuba <u>OR</u> 1/3 L FFJ or FPJ
- 1/3 L indigenous micro-organisms (IMO)

<u>Procedure</u>

1. Repeat steps 1-4 from the previous recipe (*Bokashi III*).

2. Mix the materials thoroughly, form into an oval-shaped pile, and cover it with plastic sheets or a tarpaulin. Ensure that the pile is thoroughly covered so that moisture will not be lost through evaporation.

3. After 3-7 days the temperature will rise to 70°C.

4. Do not touch the pile during this time except to ensure that no portions of it are exposed.

5. By the 30th day, check the moisture level of the pile. If it is too dry sprinkle the top of the pile with water and cover again with the plastic sheets or tarpaulin.

6. After 60 days, the temperature will be lukewarm. The bokashi is now ready for use and can be stored in bags. Waiting an additional 2 weeks before using the bokashi will increase its' potency.

Notes

1. Advantages to the "no-mixing" technique include: (1) A significant reduction of labor. Daily mixing is very labor-intensive, particularly for large-scale production of quantities exceeding 1 tonne of bokashi. (2) A reduction of disputes over labor. The mixing task sometimes creates tensions among participants due to the difficulties of allocating the labor and ensuring that everyone fulfils their commitment in a timely manner.

2. By removing the mixing step from the bokashi production the decomposition process becomes anaerobic, rather than aerobic. This is similar to EM bokashi which is produced in plastic bags, but different from the traditional Japanese bokashi, which is made using cycles of heating, mixing, and cooling. Good results have been reported from both the aerobic and anaerobic techniques.

3. This "no-mixing" innovation was first used in Nueva Valencia, Guimaras and is now being applied in large scale bokashi production in Bayawan, Oriental Negros where members of Hubon Himal-Usanon have been recruited as consultants on organic farming systems for the September 2005-March 2006 Sustainable Agriculture Program sponsored by the Local Government Unit (LGU).

5.3. General bokashi production notes

1. Materials for bokashi can be reduced or increased by ratio and proportion.

2. It is possible to add the carbonized rice hull at the end of the fermentation process instead of at the beginning.

3. If the manure to be used in bokashi production contains a high proportion of organic matter such as grass, straw or leaves, then the amount of rice bran added to the mixture can be reduced in consequence.

4. Alternate organic materials may be used to substitute for products that are not locally available (table 5.1). The fundamental rule for substitutions is to maintain the overall composition of the preparation: organic matter with high nitrogen content (chicken dung), a sugar source, beneficial microorganisms, fermented alcohol, organic matter with a high carbon content (rice bran), carbonized organic matter (CRH) and soil.

Table 5.1: Possible substitutions for certain ingredients used in bokashi production.

Ingredient	Substitution	Changes in the procedure	Rationale	Notes
Sugar	Mudpress (residues from sugarcane milling)	1. Reduce the amount of rice bran by ½ . 2.Reduce the amount of manure by ½ .	The mudpress has a high content of sugars as well as non-decomposed organic matter and nutrients. This can replace the entire sugar requirement of the recipe as well as a proportion of the manure and rice bran.	Because mudpress is finely ground it appears composted but in fact the organic matter it contains is still fresh. Bokashi made with mudpress requires 1 month to cool off (rather than 14 days) due to the time required for complete breakdown of the organic matter.
Sugar	Molasses	Replace the sugar with molasses by reducing the quantity by ½.	These ingredients are equivalent, use whichever is easier to obtain.	
FFJ or FPJ	Tuba (semi-fermented coconut tree sap)	Replace FFJ or FPJ with a 4.5X greater volume of tuba.	Tuba is produced by letting coconut sap partially ferment in the sun as it runs out of the tree. It contains beneficial indigenous bacteria and yeasts as well potassium and other plant-derived nutrients and sugars that can replace the FFJ or FPJ preparation.	A larger volume (4.5X greater) of tuba is required to replace FFJ or FPJ due to the less concentrated nature of tuba.

5.4. General bokashi application guidelines

Background

The reported application rates for bokashi vary from farm to farm and from region to region depending on soil type and fertility (table 5.2). In general, the data indicates that application rates can be greatly reduced on soils that have been under organic cultivation for many years. In particular, the farms that had been under organic cultivation for 8 or 10 years reported using only 4 and 10 sacks of bokashi per hectare, respectively. This is a significant reduction from the 30 sacks applied to soil during the first year of organic cultivation. A judicious reduction of the application rate of bokashi after soil fertility has been restored will entail both economic and environmental benefits. Bokashi fertilizer can provide many benefits to the agroecosystem but it should not be applied in excessive amounts in order to avoid nutrient leaching to neighboring aquatic ecosystems and other negative ecological impacts.

Table 5.2: Reported application rates of bokashi fertilizer for rice fields on Guimaras and Negros. The application rate is measured as the number of feedsacks of bokashi that were applied to a given surface area.

Application rates reported[1, 2]	Times per year	Soil status	Crop	Location
4 sacks/Ha	1	Healthy soil, in organic cultivation for 8 years	Irrigated lowland rice	Tapi, Negros
10 sacks/Ha	1-2	Healthy soil, in organic cultivation for more than 10 years.	Rainfed lowland rice	Tapi, Negros
20 sacks/Ha	1-2	Healthy soil, in organic cultivation for 5 years.	Irrigated lowland rice	Cabano, Guimaras
25-30 sacks/Ha	2	Soil in the transition process to organic agriculture	Rainfed lowland rice	Calaya, Guimaras

[1] 1 sac = 50 kg of bokashi, 20 sacs = 1 tonne bokashi
[2] 3 sacs of bokashi are equivalent to 1 sac of chemical fertilizer

There is no set rule for the appropriate amount of bokashi to be applied. For areas where chemical fertilizers have previously been used the initial application rate of bokashi can be determined by applying 3 units of bokashi to replace each unit of chemical fertilizer. Personal experience and judgment should be used to determine the best yearly application rate in subsequent years. Guidelines for applying bokashi organic fertilizers on grain and vegetable crops are provided in table 5.3. The amounts mentioned are suggestions rather than set rules. They are based on practices that have been successful under specific conditions and should be modified according to the local soil conditions.

Table 5.3: Guidelines for applying bokashi organic fertilizer to different crops.

Crop	**Application type**	**Application rate**[1]	**Method**
Vegetables & rice	Basal application	20-30 sacks/Ha	Mix with the soil by spreading on the topsoil before plowing. In the case of lowland rice drain the water first. Follow up by spraying IMO or spreading FRB.
Corn, millet & upland rice	Basal application	30 sacks/Ha	Apply on furrows before planting the seeds.
Lowland rice	Top dress (only if basal application was inadequate)	1 Kg/m^2	Drain water and spread bokashi
Corn, millet & upland rice	Top dress (only if basal application was inadequate)	20 sacks/Ha	Apply before on-bearing or hillling up.
Cucurbitaceae (squash, bitter gourd, etc.)	Top dress (only if basal application was inadequate)	2 Kg/plant	Dig a trench around the plant (5-10 cm from the base), put bokashi in it and cover with topsoil.
Solanaceae (tomatoes, eggplants, etc.)	Top dress (only if basal application was inadequate)	1 Kg/plant	Dig a trench around the plant (5-10 cm from the base), put bokashi in it and cover with topsoil.

[1] 1 sac = 50 kg of bokashi

Section 6: Conclusion

The organic soil amendments described in this document have proved extremely useful for jumpstarting the soil rehabilitation process on farms that are initiating the conversion to organic agriculture. The long term use of inorganic fertilizers results in a soil that is impoverished in terms of organic matter content, microbial activities and structure. The first years of organic cultivation are frequently characterized by lower yields and reduced farm income until the soil has been restored. This is a particularly serious concern on small-scale farms whose primary function is to provide for the nutritional needs of a family. Funds are not always available to supplement nutritional shortfalls engendered by short term yield decreases. It is therefore important to accelerate the restoration of the soil so as to render the conversion to organic agriculture feasible for small landowners by reducing the associated risk.

Bokashi fermented organic fertilizer has been a particularly important tool for recruiting and energizing new members in organic farming organizations. Many farmers are interested in adopting organic agriculture practices but have concerns about decreased crop yields and profits. Annual reports from PABINHI-affiliated People's Organizations in a number of regions throughout The Philippines have shown equal or higher yield levels on farms that used bokashi organic fertilizer compared to neighboring conventional farms. This is probably due to a number of factors including inoculation of the soil with beneficial microorganisms, the high organic matter content of the bokashi, and the use of carbonized rice hulls to improve soil structure, water retention and microbial activity.

Farmers who have successfully rehabilitated their soil using bokashi and other amendments over a number of years report that they are now favoring the use of compost and decreasing the application rate of bokashi. Bokashi provides a powerful combination of beneficial microorganisms, abundant organic matter and essential nutrients and micronutrients to degraded soil. This stimulates the development of a healthy soil biota and good soil structure. It may no longer be necessary to reapply bokashi as frequently once this has been accomplished. The most important component to add to the soil at this point is composted organic matter to feed and maintain the existing soil biota.

Economic developments in The Philippines in recent years have provided impetus for reducing the use of commercial agricultural inputs and, as a result, there is now an increased interest in closed-loop farming where agricultural residues are recycled into the farm ecosystem. The rapid increase in the cost of fossil fuels has increased the price of synthetic fertilizers and chemicals. Inflation and depreciation of the Philippine peso has also led to increased prices for imported agrochemical products. Organic crop amendments produced from native materials now have a much lower cost than commercial amendments. This is especially true when farmer's organizations undertake large-scale production of some amendments which can be distributed to participants. During these activities group members donate materials and labor in return for an allotment of the output. This practice has the additional positive impact of increasing cooperation and communication between farmer-members of the organizations. The most important long-term impact of these organic agriculture practices is the reinforcement of self-reliance and creativity among farmers.

Section 7: References

The majority of the recipes and techniques listed in this manual were contributed by the members of Peoples Organizations affiliated with PABINHI-Pilipinas. The recipes and methodologies inspired by nature farming and other organic agriculture techniques have been adapted and improved upon so as to suit the locally available materials and conditions. Other sources of information used in the preparation of this document are listed below.

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