A
Report
On
Better Compost Management at Kathmandu Valley Using Fermentation Technique

Kazuya Shinagawa
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Intern/ICIMOD

Contents

Introduction

The soil consists of a lot of living organism and microorganism. They play an important role in the soil. When the soil fertility improves, their activity must have a corresponding improvement. In my opinion, the improvement in their activity is caused by the kind and the number increase in the living organism and the microorganism. In other words, it is based on the living organism and the microorganism diversifying. Soil biodiversity makes food chain rich. Nutriment and water will transfer well in a food chain rather than no living organisms. At least they can keep nutriment and water in their body. Therefore, how compost can enrich soil biodiversity is a focus in the fermented compost.

What is quality composting?

Just heaping compost materials is enough to make compost if we think mainly that to obtain material things from compost. **Time changes any organisms into compost.** Quality compost means to make better compost from the same material. In high quality compost the loss of nutrient is less in the composting process. And quality compost has large number and numerous kinds of living organisms than other one.

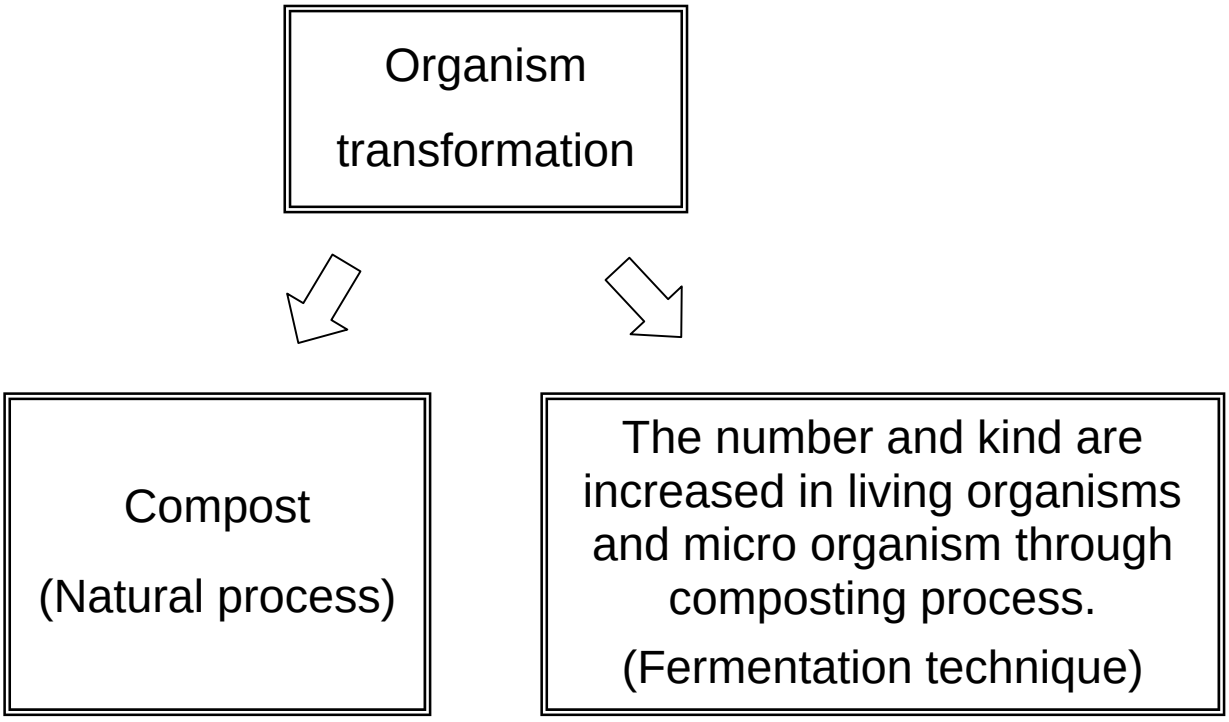


Figure 1: Compost as source of living things

What does this compost focus on?

To grow healthy vegetable and crops, soil has to be healthy. The key to healthy soil is biodiversity, which can be measured by the kind and number of living organisms and microorganisms. If diversity is maintained, soil is less vulnerable to pest. Lack of balance and low adaptability of soil make soil sickness. Sickness is a state where certain specific living organism or microorganism is increased above normal number. Soil biodiversity contributes to obstruct the extreme activity of specific living organism.

Healthy soil can strengthen itself:

- Soil biodiversity enhances a biotic symbiosis in the soil.
- Biotic symbiosis provides a stable balance of biota (flora and fauna) in the soil.
- The stable balance manages soil health.
- Healthy soil can hold abundant soil biodiversity.

Thus, the healthy soil supplies sufficient condition for soil biodiversity to soil itself. Self-healing capacity is the final aim in using fermented compost.

Importance of quality compost

Microorganism is difficult to control. But it is fact that they have a favorable environment for surviving. If we provide microorganism with the favorable environment, we can keep microorganism. Thus, we can control microorganism indirectly. And smell is an important indicator. It is possible to know from smell what kind of fermentation is going on.
The most important thing in the fermentation technique is how we can set up the favorable environment for breeding microorganism in the compost.

Forest

We all know that most of the genetic resources are found within forest. Forest is rich in the living organisms. We can not call a place where many trees just stand forest. Forest has a system as a whole. There is a young tree, an old tree, a low tree, and a high tree. They connect each other with time sequence and spatially. Forest has functions rather than a place where trees are just standing together.

Microorganisms and Creatures

Hence we take living organisms which attaches to leaf mould from forest. Forest is the best source to obtain large number and numerous kinds of living organism and microorganism. Rice bran and rice straw have its own microorganisms, like lactic acid bacterium, yeast and bacillus.

Moisture

Moisture should be kept at 50-60% at the initial stage. When you grasp compost material in your hand, it is an ideal moisture if water ooze from the root of finger. If a drop of water comes, moisture is much. This can be used as an indicator of ideal moisture. Add dry materials to a

wet material, and add water to a dry material for it to be the ideal moisture. Pit keeps moisture well, but moisture adjustment is difficult.

Heaping above the ground

In pit it is difficult to control moisture. To obtain high quality compost, controlling is required. The heap cannot keep moisture well. It will become dry. Hence compost should be set up at the shade. We need to avoid exposing direct sunlight. Then we need to avoid heaping too high (lower than 2.0 m). Weight pushes bottom layer, and condition becomes bad at that part.

Cover of compost

In order to retain adequate moisture and heat, the heap is always **tightly covered**. Forests are abundant in the living things because forest has favorable conditions for living things. Forest shelters the ground from direct sunlight and rain, and extreme changes of temperature. The conditions are mostly steady. The heap should be keeping with condition like ground in the forest.

Space in the compost heap

Adequate space in the compost is very important for keeping air and water within compost. The space is due to hardness and size of compost material. The mass is useless for compost material. Homogeneity is connected with the high quality.

Adequate space should be adjusted in the compost. The space will change by combination of material or way of piling. And moisture links with containing air in the compost. Water eject air from the space. Hence the space in the compost changes by moisture, and with passing of time. Moreover, oxygen in the compost is consumed by the activities of the living organisms, and carbon dioxide increases. Turning compost heap supplies much more air to the compost. In order to retain adequate heat in the compost, piling loose is also not available.

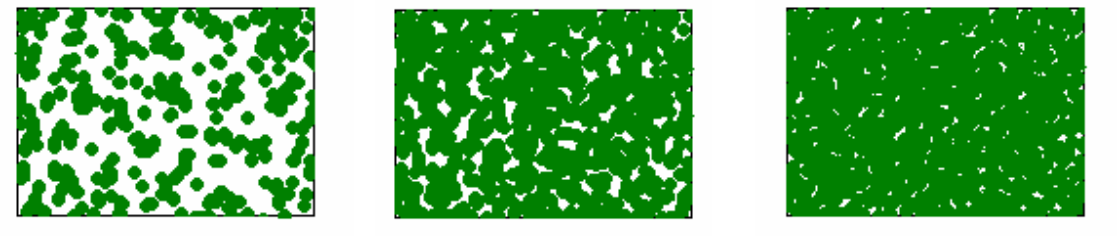


Figure 2: Space in the compost heap

Temperature

Require minimum 60kg of raw compost material in order to retain adequate heat. Heat will come from within the compost, if we start compost proper way. It is caused by microorganism activity.

Nutrients

For nutrient content, the C/N ration is 30-35 to 1. It is assumed that when microorganism consumes 1 carbon, 1/25 or 1/40 of nitrogen is taken by them.

What to be done?

There are three steps:

- Experiment fermented compost making in Kathmandu Valley
- Examine effectiveness of fermented compost in vegetable growing
- Apply fermentation techniques to village.

In the first six months, the object was to see if quality compost can be made in the Kathmandu valley (Godavari) by fermentation techniques. And it was experimented. Next six months, the object was to ensure quality compost using fermentation technique can raise productivity.

Methods of quality compost

Ingredients

- 60kg Rice bran
- 20kg Leaf mould **from forest**
- 2 buckets water (case by case)
- One bundle of Rice straw (3kg)
- Cover (e.g. plastic, sheet, newspaper, straw, mat, old blanket etc.)

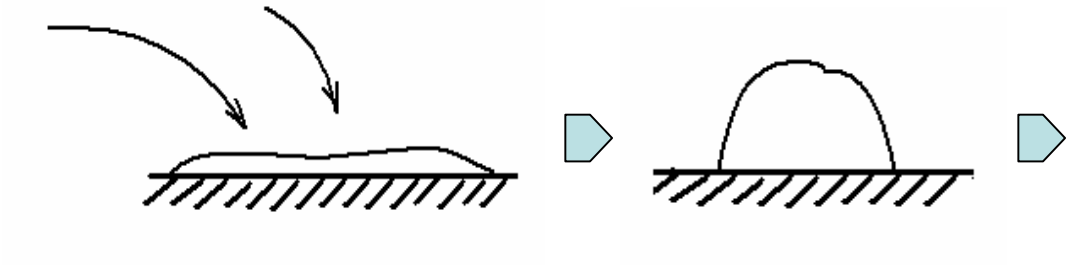
Step 1 *Making a compost heap*

1. Mix up rice bran, leaf mould and water. Stir up with your hands. Continue pouring water in small quantities and stir until the rice bran becomes moist. **Moisture is important.** Adjust the moisture of compost material to 50-60%
2. Heap the mixture
3. Cover the mixture with rice straw
4. Cover the heap with plastic

1. Add rice bran and leaf mould 2. Heap the mixture

Rice bran

Leaf mould *water*



3. Cover with straw 4. Cover with plastic

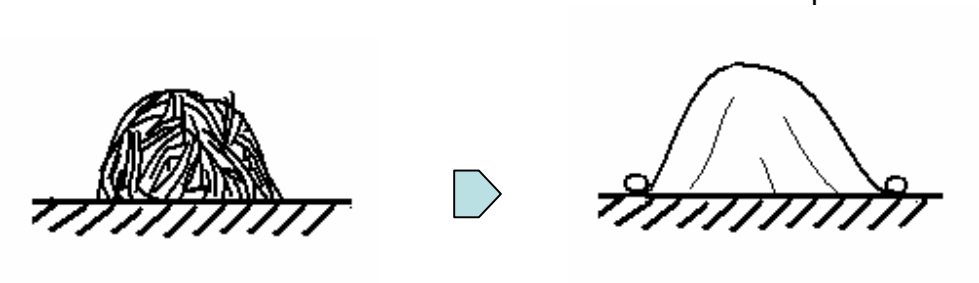


Figure 3: Making compost heap

Step 2 ***After care***

1. The compost will be heated in 1-2 days
2. Turn over the compost once in 7-10 days in order to ventilate the compost. Take out cover and rice straw. Stir the compost, and heap it again. Cover it with rice straw and plastic
3. Turning should be repeated 5-6 times over the 2 months maturing period

Step 3 ***Using compost***

Apply compost to soil 50kg per 250 m^2 (half Ropani) generally. Don't expose to the direct sun at that time. It should not be exposed to the direct sunlight in all processes.

Effectiveness of fermented compost

Effectiveness of fermented compost in vegetable growing examined at Godawari Traial and Demonstration site (ICIMOD). Three composts: 63-day old compost, 41-day old compost and local manure from Puful Village in Godawari are applied to the field.

Nutrient balance of compost

63-day old compost and 41-day old compost were made by fermentation technique. They are different compost though almost same procedure. In 63-day old compost 1kg Ash and 10kg rice husk were added in the beginning. 41-day old compost started 22day late than 63-day old compost. These two composts contain higher nutrient than local manure. Another unit (Kg/ha) of total phosphorus and total potassium are calculation (Table1).

Table 1: Compost analysis (Godawari 1)

	pH	OC (%)	N (%)	P2O5		K2O	
				(%)	(Kg/ha)	(%)	(Kg/ha)
63-day old compost	6.80	23.68	2.59	1.07	479.1	4.65	2082.1
41-day old compost	6.35	22.35	2.38	1.69	704.2	3.64	1516.7
Local manure	6.20	12.83	0.89	0.24	145.8	0.57	346.2

Test plant

Broad leaf mustard was planted, but it was seedling. At that time there was no proper plant because of winter season. But there were small seedlings at next field. 24 seedlings were collected, and they were planted to four areas. 1) 63-day old compost area, 2) 41-day old compost area, 3) Local manure area, and 4) Control area (no compost) in 30 Nov 2004.

Leaf size

Leaf size was measured during plant growing. The biggest leaf in 63-day old compost area is 38cm wide and 72cm long. The biggest leaf in Control area is 24cm wide and 45cm long. The difference of leaf area is about 2.5 times. In Local manure area the biggest leaf is 21cm wide and 50cm long. These photos were taken in 4 March 2005.

63-day old compost area *No manure area*

Figure 4: Comparison of leaf size between 63-day old compost area and Local manure area in 4 March 2004 (Height: 120 cm)

Seed product

Seed product from 63-day old compost area is about four times more than local compost area. And 41-day old compost area is twice as much as local compost area. The seeds were harvested in 12 May 2005. Another mustard seed which planted proper term at next field was harvested before one month. The test plant was missed proper term from beginning to end. Therefore products would be a less amount than usual one. However the differences are clear.

1) 63-day old compost area…….34g
2) 41-day old compost area…….17g
3) Local manure area…….9g
4) Control area (no compost)……7g

Soil analysis (after harvesting)

Compared with Control area, nutrients still remain in the soil at 63-day old compost and 41-day old compost areas (Table2). It can be said that there are advantages to both products and soil.

Table 2: Soil analysis of test area (after harvesting)

	pH	OC (%)	N (%)	Available P2O5 (Kg/ha)	Available K2O (Kg/ha)
63-day old compost area	5.80	6.62	0.57	210.0	1334.4
41-day old compost area	5.00	6.51	0.56	205.3	1180.8
Local manure area	5.40	2.52	0.22	40.1	825.6
Control area (no compost)	5.35	2.43	0.21	68.2	552.0

Nitrogen (N) and Organic Carbon (OC) are over 2.5 times higher at 63-day old compost and 41-day old compost areas, compared with Local area and Control area. When these are compared in the state of the compost, 63-day and 41-day old compost are over 2.5 times higher in nitrogen. And it was over 1.5-2.0 times higher in organic carbon.

The value of 2.5 times corresponds to the ratio which compared with the maximum area of the leaf. Moreover, when mean value of the amount of the harvest of 63-day old compost area and 41-day old compost area (25.5g) is divided by 9g (Local compost area), the value of 2.83 is obtained. According to the correlation of ratio, it is found that the nutrients in fermented compost affected leaf and seed products, and soil nutrients.

Two points can be said though the change of Phosphorus (P2O5) and Potassium (K2O) are complex. The highest seed production was at 63-day old compost area. It is potassium that only 63-day old compost shows a high value compared in compost analysis. Potassium might have worked effectively to the seed production. It seems that the potassium came from 1kg Ash and

10kg rice husk which was added to only 63-day old compost. To make the procedure brief as much as possible, the kind of the material has been decreased in 41 day old compost.

Another is a balance of phosphorus and potassium. The ratio of phosphorus to potassium is under 10, except at Local compost area. At Local compost area it is over 20. The difference is twice as high as other areas. When Local compost area is compared with control area, the value of phosphorus has fallen more than control area. It is thought that the balance of the nutrient has collapsed in Local compost area.

Case study 1 (Dhulikhl)

Fermentation technique applied to farmer at Bhattedanda village, Dhulikhel Municipality 1, in People and Resource Dynamics in Mountain Watershed Project (PARDYP). Dhulikhel is about 30km from Kathmandu. Bhattedanda Woman's group participated in this programme. The main subject was three points: First, to obtain villagers experience of fermentation technique. Secondly, to make compost by another ratio of compost material. Third, to know the effectiveness of turning compost heap.

There was a communication problem, but it was not allowed to go to Dhulikhel in February 2005 in a difficult situation in Nepal. There was a lack of common understanding even though we contacted by telephone. Bhattedanda Woman's group has set up fermented compost in 9 February 2005.

Figure 5: Bhattedanda Woman's group

Ingredients

- 50kg Rice bran
- 600kg Leaves from community forest and other organic matter
- Water
- Five bundle of Rice straw (15kg)
- Plastic (cover)

Making a compost heap

1. Mix up leaves and organic matter and water. Adjust the moisture of compost material to 50-60%
2. Sprinkle rice bran on the mixture
3. Make two heaps from the mixture.
4. Cover each mixture with rice straw
5. Cover the heaps with plastic

"After care" and "Using compost" are same as before. However one heap (Compost A) never turned from beginning to end for comparison.

Problems observed in Dhulikhel

There are two big problems due to miscommunication. The first, moisture adjustment. They did not add water whether the heap is dry or not. Second, the cover of the heap was not tight. It caused the heap dry especially first 20 days. Microorganism activity was obstructed by lack of moisture especially at the initial stage. Some microorganisms had to be killed.

Nutrient balance of compost

The compost samples were taken in 29 April 2005. It means 79-day old compost. The local compost was collected from Bhattedanda village. Compost B has a better result than Compost A. Hence it can be said that turning is effective. The value of Organic Matter in Compost B is lower than Compost A. One reason may be that it consumed by microorganism activity.

Table 3: Compost analysis (Dhulikhel)

	pH	OC (%)	N (%)	P2O5 (%)	K2O (%)	C/N
Compost A (No turning)	5.20	24.89	0.90	0.50	0.84	28
Compost B	4.90	23.22	0.98	0.55	0.92	24
Local compost (Dhulikhel)	6.70	15.12	0.58	0.35	0.52	26

Case study 2 (Godawari)

In case study 2, the main subject was to make compost with high quality from the same material. There was a demonstration to the villagers who had used EM technique by "Educate The Children (ETC)" at Godawari Traial and Demonstration site (ICIMOD) in 12 April 2005.

EM compost is also using fermentation technique. First, making a medium. It is called “Bocashi”. Bocashi is made from 25kg rice bran, 2.5kg bone mill, 2.5kg oil cake, 2.5kg goat dung and 100ml EM. It wrapped by plastic and keeps for one week for fermentation. After one week, another compost material weed is added. ETC uses a pit.

In the same way, making a medium in method of fermented compost. The main material for medium is the same 25kg rice bran. EM and EM additives like bone mill, oil cake, and goat dung were not used. We do not use EM, but mature fermented compost as alternative. Moreover Leaf mold is added.

Ingredients

- 25kg Rice bran
- 20kg Leaf mould **from forest**
- 3kg Mature compost
- 2 buckets water (case by case)
- One bundle of Rice straw (3kg)
- 70kg Weed
- Plastic

Making a compost heap

The first, make a medium (process 1-5). After one week, fermentation will be started. Then add weed which was cut. And make heap (process 6-10). “After care” and “Using compost” are same as before.

1. Mix up rice bran, leaf mould and water. Adjust the moisture of compost material to 50-60%
2. Add mature compost
3. Heap the mixture
4. Cover the mixture with rice straw
5. Cover the heap with plastic

   (*After one week*)

6. Cut the weed about 20cm. Piling 10-15cm in height
7. Add medium 3cm.
8. Repeat process 6) and 7)
9. Cover the mixture with rice straw
10. Cover the heap with plastic

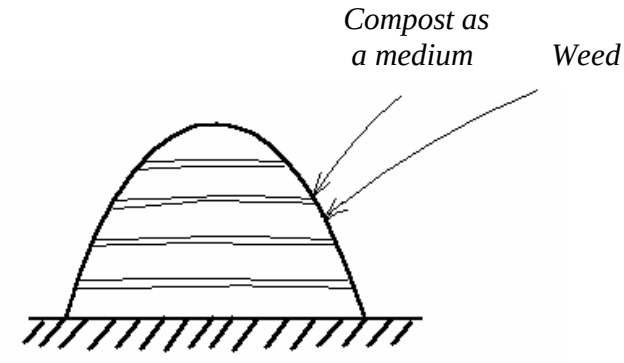


Figure 6: Process 6) and 7)

Nutrient balance of compost

The compost samples were taken in 11 August 2005. It means 121-day old compost. Weed rice bran fermented composts contain higher nutrient than EM compost . Therefore it can be said that fermentation technique makes quality compost from same material (Table 4).

Moisture adjustment

Moisture had better to be 45-50% at the final stage in the compost. Fermentation process goes on in much moisture. In order to bring living organism and microorganism to the soil, their activity should not be finished before using compost. 40% in Weed-rice bran fermented compost is less moisture, and 60% in EM compost is much moisture. These states are brought by the character of Pit and Heap.

Consumed Organic Carbon

In EM compost, the value of OC is low. It is assumed that microorganism activity consumed OC. It might consider that it passed the appropriate time to use, because of low value of OC.

Table 4: Compost analysis (Godawari 2)

	pH	OC (%)	N (%)	P2O5 (%)	K2O (%)	C/N	Moisture (%)
Weed-rice bran compost	7.00	20.01	1.32	0.95	3.83	15	40.16
Weed-EM compost	6.15	8.87	0.95	0.22	2.78	12	60.25

Conclusions

The present study and experience reveals the following:

1) The climate and environmental condition of Kathmandu valley is favorable for fermented compost making with local available material.
2) Quality compost using fermentation technique can raise productivity.
3) To apply fermentation techniques to field, clear understanding about concept of this technique is required.

Issues to be further explored

About methods of quality compost

- Time when we start making compost should be counted backward from the period of using it.
- There is a possibility that the compost material makes compost in the field if there is a fallow period enough (Input compost material to the field directly)
- Many kinds of material should be used for compost preparation.
- The chemical fertilizer is added to compost as a compost material.

Make sure guidance of fermentation technique to farmers.

Fermentation technique is based on different concept from traditional method. The concept of fermentation technique should be given attention first. Mixing both techniques doesn't work.

There is a benefit of exposing compost to the direct sunlight. However, only when compost has the problem, it works effective. If there is no problem in the compost, it just would obstruct activities of living thing and microorganisms.

The majority of compost could be made by a traditional method as usual, and Fermented compost makes only the amount that can be made. Then the quality is firmly managed for it. That would be the best way.

Examine effectiveness of fermented compost in making seedling

If it utilizes fermented compost as breeding ground, there is a possibility that the seedling bring living organism and microorganism to their field by transplant. The plant will be defended by those living things if plant roots and those living thing are state of symbiosis.

Continuous using Fermented Compost

Continuous using Fermented Compost results in several benefits to soil, farmers, and environment.

- Self-healing capacity in the soil would be cultivated.
- With increased knowledge of the laws of nature, farmers will be able to stop obstructing supports nature has itself.
- Awareness for forests which support soil productivity will be raised.

References

Miyawaki Akira. 1997. Midori kankyo to syokuseigaku (Green environment and Vegetation study). NTT Publishing

Shimamoto kunihiko. 2001. Shimamoto biseibutsu nouhou (Microorganism farming by Shimamoto method). Nou bun kyou (Rural Culture Association)

Usugami hideo. 2001. Hakkouhiryou no tsukurikata tsukaikata (How to make and utilize the fermentation compost). Nou bun kyou (Rural Culture Association)

Kijima toshio. 1995. Kikkou biseibutsu ni yoru byougai boujyo (Disease control by rivalry microorganism). Nou bun kyou (Rural Culture Association)

Yamane Ichiro. 1997. Dojyougaku no kiso to ouyou (Base and application of soil study). Nou bun kyou (Rural Culture Association)

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