Briefing text for the visiting excursion to the

# 1. Compost producing facility in Sarabetsu village, Tokachi district, Hokkaido, JAPAN

Translated from the pamphlet of JA Sarabetsu

# 2. Laboratory manual for testing the maturity of compost

for JICA Country Forced Course for Malawi
Capacity Building for Extention Trainers for Small Scale Livestock Farming

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## 1. Outline of agriculture in Sarabetsu village

In Sarabetsu village, located in the southern part of Tokachi plain, an average farmer possesses 43 ha of farm land and 3.4 tractors, which is deemed to be the largest scale agriculture in Japan. A large scale upland management including potato, sugar beet, wheat, and pulses, are mainly conducted in this village. Cropping of heavy vegetables carrot and Japanese radish is also increasing. On the other hand, dairy farming has a tendency to increase the number of cattle per a unit farmer but it is gradually decreasing as a whole due to the change to upland agriculture and also to the abandonment of agricultural management.

For the promotion of agriculture, our village displays the following goals:

1) Promotion of upland agriculture by establishing a rotational cropping system and increasing soil fertility and build-up of a production center of vegetables.
2) Promotion of "clean agriculture" by the application of organic matter (fully matured compost) and by growing green manure.
3) Soil improvement program by promotion of drainage, fertilizer planning based on soil diagnosis.
4) Training and securing of breadwinner and successor of agriculture.
5) Measure for the promotion of dairy farming by introduction of dairy labor helpers and securing grasses and crude forage with good quality.

## 2. Build-up of good soil and the measure for environmental protection

In accordance with the enlargement of the size of dairy farming management, the load to environment by the dairy excrement is increasing. If the each farm should take measure for the treatment of excrement or production of compost, an enormous cost and labor will be required. Therefore, the measure for environment and build-up of good soil has become a common goal for the community. The agricultural co-operative of Sarabetsu village has introduced the soil diagnosis program, green manure crops, enlargement and reinforcement of mature compost production facility.

The village administration also cooperates with the agricultural cooperative and has set up an integrated project, which includes the establishment of agricultural system with organic matter recycling, and the promotion of soil diagnosis using the agricultural information network. The goal of the project, as shown to villagers, is the rational soil fertility management and education of agriculturists to promote active tactics.

Thus, build-up of good soil and the measure for environmental protection has become a very important goal for the bright future of the agriculture in Sarabetsu.

3. Present state of compost production in Sarabetsu village

Formerly, as upland crop farmers also raised small numbers of dairy cattles and horses for cultivating power, supplying compost to small area of upland fields was manageable by each farmer. However, as the size of agricultural management grew larger, tractors were introduced and dairy farming was changed to upland field farming. Under such intensive agriculture, chemical fertilizers and agricultural chemicals were started to be used in large amounts, which caused the decrease in soil fertility and the spreading of soil borne plant disease. Tokachi area suffers from weather calamity due to too severe coldness or too much rain almost every five years. However, in the field which received compost annually the damage due to such calamity was shown to be minimized. Therefore, buildup of soil fertility by the application of organic matter has become the most important goal in our village.

Sarabetsu village, the leading community engaging in the buildup of soil, started the production of compost since 1989. Annually 30,000 t of compost has been produced in the composting yard of 4.9 ha managed by the agricultural cooperative of Sarabetsu town. The barnyard manure as a mixture of feces and bark excreted from two beef cattle farmers and from the beef cattle raising facility owned by the agricultural cooperative was used as raw material. The soil liberated from the beet during the cleaning procedure, waste from the potato starch company, and chicken droppings were mixed with the barnyard manure and converted to compost, which was graded as a special grade compost by the association of bark compost industries in Japan.

This compost has contributed to the buildup of soil in Sarabetsu village. However, the compost had some problem of mixing with gravels from the composting bed, which sometimes caused damage to the manure spreading machine. This problem has been overcome by improving the pavement of the composting yard.

Since compost application was started in the whole village level, the yield and quality of the agricultural products from Sarabetsu village has increased remarkably. The yield of beet, which was ranked at the lowest level in the Tokachi area about 10 years ago increased to the top level in Tokachi. Therefore, the construction of the composting plant which can produce the compost with higher quality is expected to push and support the specialization of the agricultural products by building up the soil.

4. The outline of the new compost producing facility.

The new composting facility was constructed as one of the project which comprises an integrated farmland area development project sponsored by the government which was carried out in the two areas in Sarabetsu town.

The outline of the whole project is shown in Table 1..

The new composting facility was constructed on the same place where former facility was located. It is located in the central border of the eastern and western districts of the village.

The new facility introduced the durable half bending pavement, which has the both merits of asphalt and concrete pavements. This pavement prevents the ground seepage of dirty water and the mixing of gravels into the compost.

Stock room for the raw materials for adjusting the moisture content was constructed, and the lagoon ponds were installed to collect and clean the leaked water from the compost. Thus, the problems found in the former composting facility have been overcome and is expected to contribute to the realization of recycling agriculture.

The area of the composting field is 47,300 $m^2$ (8 lanes), in which 17,800 $m^2$ (3 lanes) are reserved for the western district and 29,500 $m^2$ (5 lanes) are reserved for the eastern district. Two non-penetrating type lagoon ponds were constructed to treat the waste water from the composting plant. The flow of compost production is shown in the attached figure.

Wastes from potato starch company and the soil liberated from the beet are stored in the stock house for the raw material. The mixture and cattle manure and bark is stored in the composting house. The chicken dropping in the transportation bag is placed on the open field. These raw materials are mixed in the composting house using a manure spreader and water content in the raw material is homogenized. After mixing, the mixture is transported to the composting yard, and turned 1 – 2 times per month until it is brought to the upland field for spreading.

On the other hand, the waste water coming out from the pile of compost is collected into the lagoon pond, aerated to remove the smell three times (to minimum extent to prevent the loss of ammonium), then returned to the field (grassland). The drained rain water from the lane without compost is led to the river through the drainage channel.

For the smooth operation of compost producing works, two wheel-loaders, one automatic compost-turning machine, one manure-spreader, and one slurry tank truck were introduced.

Table 1. Outline of the integrated upland field area development project in Sarabetsu village.

| | West & south area | East & Seiyu area |
|---|---|---|
| Starting year | 1998 | 2000 |
| Irrigation | 772.3 ha | 725.5 ha |
| Open drain channel | 6,520 m | 4,991 m |
| Under-drain channel | 66.8 ha | 155.0 ha |
| Soil layer improvement | 581.7 ha | 575.7 ha |
| Re-arrangement of fields | 119.6 ha | 43.6 ha |
| Composting facility | One common facility | |

5. Beneficial effects expected from the application of good quality compost.
   1) Chemical fertilizer can be reduced because the soil from the beet and the chicken manure contains large amounts of fertilizer constituents.
   2) The compost is rich in trace elements.
   3) The compost is rich in calcium and can be used for ameliorating the soil acidity.
   4) Degree of calcium saturation can be increased.
   5) Formation of soil aggregate structure can be expected.
   6) Percolation of water and aeration through the soil can be improved due to the contribution of the bark which is the dominant raw material.
   7) The compost is very rich in organic matter, and it helps increase soil temperature.

6. Maintenance of the compost producing facility

The facility is maintained by the JA Sarabetsu (Agricultural Cooperative of Sarabetsu). The compost is sold to the farmers for the price of 1,700 yen / ton. At the same time 500 yen from the Sarabetsu village and 600 yen from the JA Sarabetsu are subsidized for the every ton of the sold compost. Almost whole the compost produced here (30,000 ton annually) is sold to village farmers every year.

The ability of this facility to produce compost will be increased to 46,000 ton/ year. Liquid manure produced in this facility is also requested by the farmers. These materials will contribute further to the build-up of the soil in our village. The method of compost production has also become environmentally friendly and the compost with better quality can be supplied to the farmers due to the introduction of paved composting yard and composting housing and lagoons. The agricultural products from our village can be differentiated from the products of other places thanks to our practice for building up the good soil.

7. Outlines of the compost producing facility

Table 2. Outline of the composting facility in Satabetsu village

| No. | Facility | | Size |
|---|---|---|---|
| 1 | Composting house | | 4,950 $m^2$ |
| | | Storing of raw material | 210 $m^2$ |
| | | For mixing | 690 $m^2$ |
| | | For curing | 4,000 $m^2$ |
| 2 | Office | | 30 $m^2$ |
| 3 | Composting yard with semi flexible pavement | | 47,300 $m^2$ |
| 4 | Drainage channel within the facility | | 266 m |
| | Drainage channel outside of the facility | | 327 m |
| 5 | Lagoons 2 ponds | | 5,892 $m^2$ |
| | Trees | | |
| | Attached instruments | | |
| | | Wheel loader (4.1 $m^3$ class) | 2 |
| | | Manure spreader (10 ton class) | 1 |
| | | Automatic compost turning machine | 1 |
| | | Slurry tank truck | 1 |

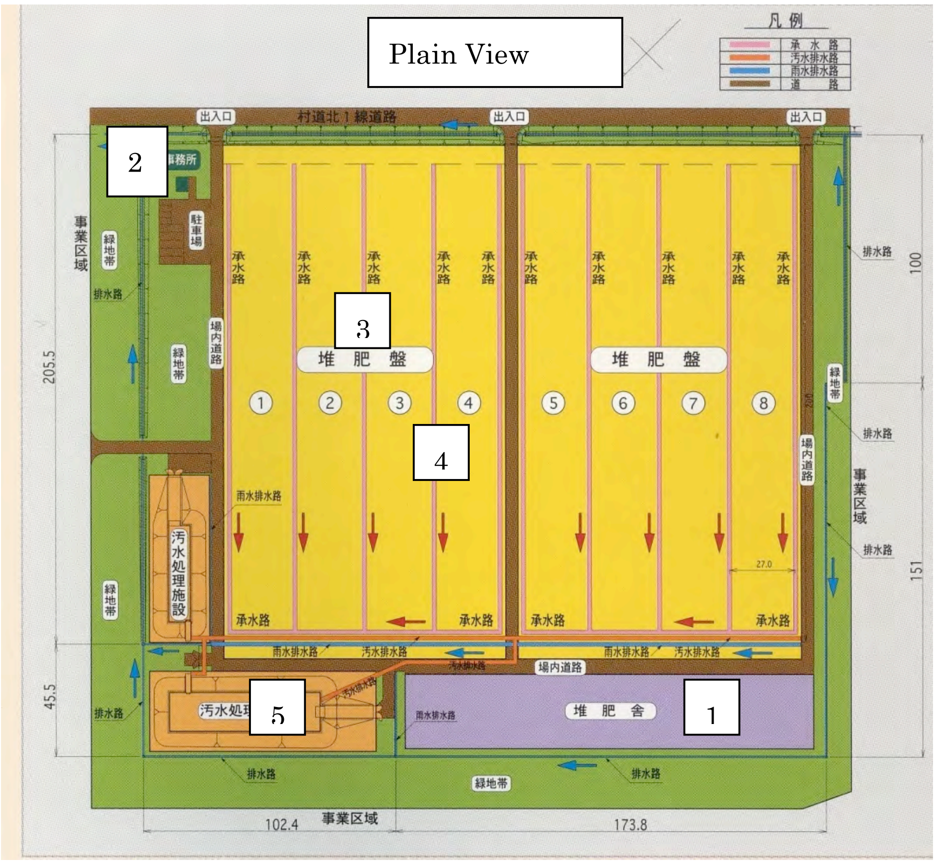


Figure 1. Plain view of the compostint yard.

(Numbers in the figure shows each facility given in Table 2. )


Figure 2. Location of compost facility

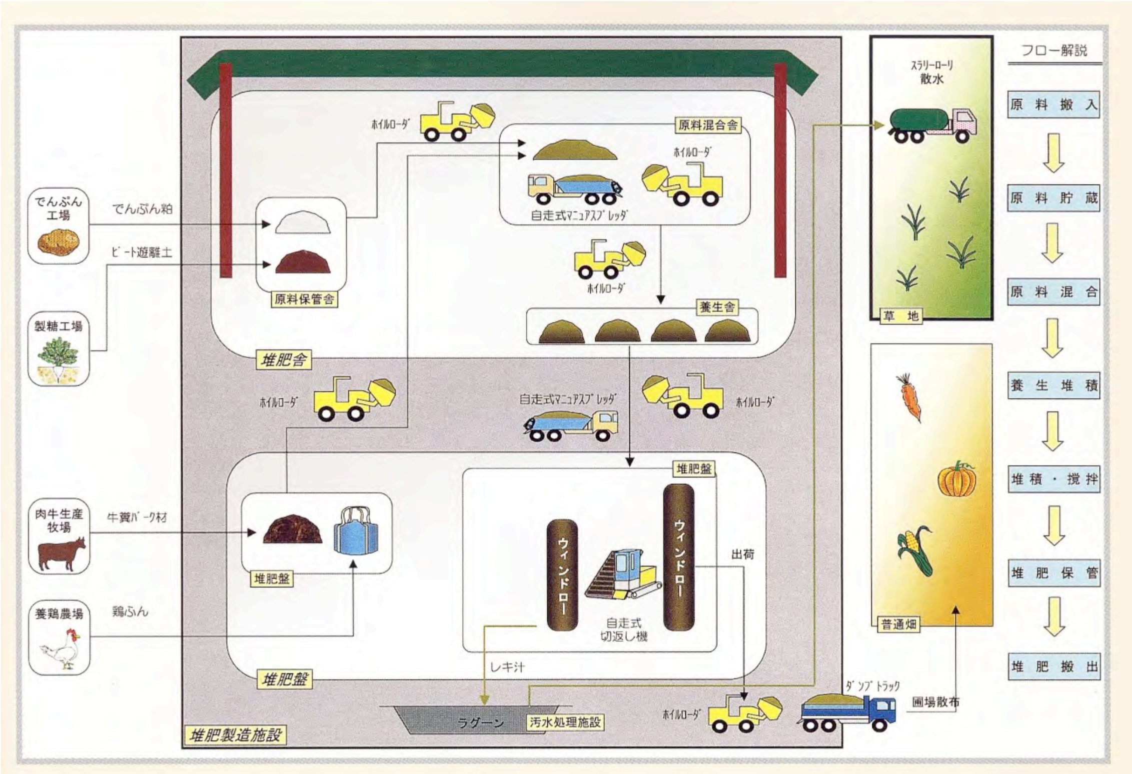


Figure 3. Diaram of compost preparation

Photo 1. Farmers field in Sarabetsu village

Photo 2. Whole view of the composting facility

Photo 3. Compost turning machine

Photo 4. Drain channels.

Photo 5. Semi-flexible pavement.

Photo 6. Wheat in harvest season

Photo. 7 Manure spreader.

Photo 8. Dairy farming.

8. Further information which I (K. Tsutsuki) learned from Mr. H. Kawahara of JA Sarabetsu at the site

1) Background for the composting project

Sarabetsu village is located in hill side. Climate is cool. The yields of crops have been low.

Numbers of farmers have been decreasing, and the acreage per one farmer family has been increasing.

In the large scale farming, the fertility of soil has also decreased.

Soils in Sarabetsu village include black volcanic ash soil, brown volcanic ash soil and alluvial soil. Black volcanic ash soil has a problem of bad drainage and volcanic ash soils are generally deficient in phosphate. Therefore, these soils should be improved to increase their fertility.

In Sarabetsu village, four major upland crops are grown in rotation agriculture. These crops are winter wheat, sugar beet, beans, and potato. Among these crops, sugar beet requires especially high soil fertility due to its long growing period. The order of crops in the rotation is rational with respect to growing period of the crops as well as to the recycling of organic matter. All harvested rests are recycled in the field to benefit the following crops. Beet tops serve as nutrition for beans, bean husks for potato, and potato is harvested early enabling the seed sawing of wheat in September (around 9/20).

In Sarabetsu village, a large quantity of agricultural wastes has been produced, such as soil liberated from beet during washing, potato pulp from a potato starch company, and feces of beef cattle and cow cattle. These wastes should be treated in the village. Bark is also available from lumber mills in the village.

Village farmers decided to start the composting project by preparing compost from these agricultural wastes and apply it to the field to increase soil fertility in 1989.

Recently, growing of green manure is also promoted.

2) How compost is prepared

As raw materials for compost, they mix 7.5% beet soil, 7.5% potato pulp, 10% chicken dropping, and 75% bark. Initial moisture content of the raw material is decreased to 70% before piling.

Chicken dropping is bought from a chicken farm in Iwate prefecture. It is not so expensive. To increase the fermentation temperature, chicken dropping is indispensable.

These raw materials are mixed on a fine day and piled up in an open barnyard with half penetrating pavement.

On a rainy day, they are not mixed.

The temperature of the compost pile increase to higher than 70 degree Celsius, and this high temperature lasts longer than three weeks.

For turning the compost, a power-shovel machine and a compost turning machine are used. No forced aeration is done because the scale of composting pile is too large.

After every turning, the temperature increases again.

While the temperature of compost is still high, it cannot be used in the field. Thanks to the high temperature, seeds of weeds and plant pathogenic germs are killed.

Initial C/N ratio of the compost is 30-40 in the initial stage, but it decrease to 20 when the composting process is completed.

Best season for compost preparation is from May to October, but composting is started three times in a year. The composting is started in

April, July, and November. The pile of compost is turned 8 times before it is forwarded to farmers. The duration of the composting is longer than one year. 30,000 tons of compost is prepared per year, though ability of the facility is actually 50,000 tons in maximum.

3) How compost is used

About 80-90 % of the whole compost produced in this facility is taken out to the field in August. In August, wheat is harvested, and the compost is plowed into the field on this timing. After the wheat, farmers usually grow sugar beet, to which compost is especially effective.

There are 240 farmer households in Sarabetsu village. Among them, 180 are upland farmers. One hundred upland farmers among 180 farmers use the compost produced in this facility. The average application rate is 30 tons per hectare.

Other 80 upland farmers exchange wheat straw with cattle manure from dairy farmers directly.

Due to the long term application of compost, soil fertility of the agricultural field in Sarabetsu village has been increased. It shows no more difference compared with that in the central part of Tokachi plain.

The composting project using the agricultural wastes from upland farming was a pioneer project and it is evaluated as a long lasting successful project.

Soil fertility with respect to N, P, K has been improved, but Mg status is still low. They are now seeking for the method to supplement magnesium to the upland field.

Seepage water from the compost is stored in a lagoon pond, where it is aerated every 2-3 weeks. After the nitrogen level in the water decreases to 0.1%, it is used as a liquid fertilizer to the field (pasture).

# Maturity Test of Compost

Samples will be collected at Sarabetsu composting facility on the occasion of site excursion.

For example: Compost samples started in different timings.
Different raw materials

Hot Water Extraction
20 g raw compost
200 mL distilled water
Extract 30 min at 60 C.
Cool down to room temperature.
Filter through a 0.45 μm membrane filter.

1) Determination of pH
Calibration of pH meter at pH 7 and pH 4..
Measurement of sample solution

2) Determination of EC （Electrical conductivity）
Calibration of EC meter
Measurement of sample solution
Used for quality control of compost.

3) Determination of ammonium ion (Sign of immaturity)
Pack test for $NH_4^+$ ion
Suck a portion of sample solution into a tube.
Compare the developed color with the color chart.

4) Determination of nitrate ion (Sign of maturity)
Pack test for $NO_3^-$ ion
Suck a portion of sample solution into a tube.
Compare the developed color with the color chart.

5) Determination of optical density at different wavelengths

Optical densities at 280, 400, 600 nm will be determined.

Ratio of optical density is calculated.

These ratio will increase with maturity.

OD600/OD400    OD400/OD280

6) Germination test by the seeds of Brassica campestris

10 mL aliquote of the water extract is transferred into a laboratory dish.

Two filter papers are dipped into the solution.

30 – 50 seeds will be sowed on the filter paper.

The dish is covered and left at room temperature for 3-6 days.

Germination rate and the length of root is measured.

7) Growth test of the seedling of Brassica campestris

700 g of soil, 300 g of compost, 0.5 g of ammonium sulfate, 0.5 g of potassium sulfate, and 0.5 g of phosphate fertilizer are measured and mixed and put into a pot.

For control, only one kg of soil and fertilizers are mixed.

Twentyfive seeds of Brassica campestris were sowed on July xx.

Results

| | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 |
|---|---|---|---|---|---|
| pH | | | | | |
| EC | | | | | |
| $NH_4^+$ | | | | | |
| $NO_3^-$ | | | | | |
| E280 | | | | | |
| E400 | | | | | |
| E600 | | | | | |
| E600/E400 | | | | | |
| Germination | | | | | |
| Growth of seedlings | | | | | |