Verification Survey with the Private Sector for Disseminating Japanese Technologies for Recycling Project of Organic Garbage and Agricultural Waste by Screw Type Composting Plant

Sri Lanka

March 2017

Kawashima Co., Ltd.

I. BACKGROUND

Domestic garbage is increasing in Sri Lanka due to economic growth and diversification of lifestyles. The garbage is normally disposed by open dumping at a garbage landfill site, however the effective lifetime of garbage landfill site is decreasing because of rapidly increasing the amount of garbage and it is difficult to secure new adequate sites for landfilling.

The waste-related problem has caused many environmental issues, such as water contamination, bad odor from hydrogen sulfide and ammonia, vermination and the emergence of flies due to decomposition of organic garbage. These problems are worsening the local environment and have negative effects on the health and sanitation of inhabitants. Furthermore, an aerobic fermentation of organic garbage releases methane, which is one of the Green House Gases, into the atmosphere and affects climate change.

Although composting of organic garbage on a trial basis has been tried, the challenge of recycling organic garbage has made little progress. The major reason of this limited progress is that appropriate mechanized composting technology has not yet been introduced in Sri Lanka. Since the subsidy increases the fiscal burden of the government, composting of organic garbage is an effective measure in terms of the national finance. On top of that, it is also advantageous to popularize organic fertilizer and compost plants that can make good-quality organic fertilizer.

If the appropriate mechanized composting technology which enables sanitary and environmentally thoughtful treatment of organic gavage, such as screw type composting machine developed by KAWASHIMA Co., Ltd. (KAWASHIMA) is introduced, it would contribute to improve living environment at a garbage landfill site for inhabitants and to supply good-quality organic fertilizer for farmers.

II. OUTLINE OF THE SURVEY

1. Title

Verification Survey with The Private Sector for Disseminating Japanese Technologies for Recycling Project of Organic Garbage and Agricultural Waste by Screw Type Composting Plant

2. Purpose

A screw type composting plant is introduced in a rural area of Sri Lanka in order to produce good quality organic fertilizer and create a value chain of organic fertilizer distribution. Major raw material to make compost is

organic domestic garbage collected by separate collection. Agricultural waste can be utilized as a material for water content adjustment and livestock excreta can be also utilized as a raw material. It is also planned to establish a recommended recycle model of organic waste. This will contribute to reducing local government's expense for garbage disposal, expanding job opportunities and increasing their income and making the garbage collection and treatment sustainable.

Furthermore, the scheme will reduce large amount of garbage at dumping sites and prolong the life of the sites as well as improve water environment issues and human health issues. It also contributes to reducing methane emissions from garbage disposal sites and to improve climate change issues.

3. Activities

1) Activity 1: Construction of composting plant and production of organic fertilizer

1-1. To gather information associated with construction of the composting plant and implement field investigation

- KAWASHIMA investigated the occurrence situation of household garbage, processing situation of the garbage, generation amount of agricultural waste and demands of compost etc., in Pathadumbara district, Kundasale district and surrounding area in cooperation with Pathadumbara Pradeshiya Sabhwa (PDPS) and Kundasale Pradeshiya Sabhwa (KUPS). A project implementation plan was also prepared. It was confirmed that the amount of household garbage generated, including the surrounding area, matches the throughput of the composting plant.

1-2. To hold stakeholder meeting

- KAWASHIMA and the consortium held a stakeholder meeting on January 28, 2015. 94 stakeholders such as regional residents including housewives and others participated in the meeting.
- The compost factory construction site is a landfill disposal site of household garbage in Kundasale district. There was a request from local residents to build a compost factory in order to solve the odor problem.

1-3. To design composting facility and plant

- KAWASHIMA designed the facility to treat 17 tons of organic waste (household garbage and agricultural waste) and produce 6 tons of compost in

a day.

1-4. To construct the composting plant at Gangapitiya, Aluthwaththa, Kundasale, Kandy District, Central Province.

- KAWASHIMA and SAKURABA completed the RA-X installation work from October 12 to 16, 2015. After doing electrical work from November 22, the commissioning of the plant was carried out on November 26, 2015, and then the compost plant was completed.

1-5. To demonstrate compost production at the composting plant

- The completion ceremony was held on April 29, 2016 and demonstration activities were started. In order to allow the consortium to manage and operate the compost plant, KAWASHIMA provided the consortium with technology transfer of composting plant operation, facility management and maintenance, quality control of raw organic waste, composting production and quality control.

2) Activity 2：Confirmation of composting project model

2-1. To design a plan and structure for organic garbage collection

- PDPS and KUPS which are members of the consortium collect organic waste (household garbage and agricultural waste), produce and sell compost jointly. The government of Central Province supports and oversees projects from administrative and financial aspects.

2-2. To design a plan and structure for the composting plant operation

- KAWASHIMA and the consortium formulated an operation and structure plan of the compost plant, and held the completion ceremony on April 29, 2016. The operation of the plant has been started from April 30, 2016.
- The consortium plans to cover approximately 15,900 SLR/day of operating costs (electricity, labor, fuel, etc) and maintenance costs. As its financial resources, compost sales income, garbage collection fee and recycled item sales revenue will be devoted. If full operation is realized, 32,200 SLR/day of revenue is expected.

2-3. To design a plan and structure for compost selling

- The consortium commenced to produce compost from April 30, 2016 and to sell compost from October 2016. Compost products is sold to farmers and households (vegetable gardens) in Pathadumbara district, Kundasale district, Wategama county, Gagawatakorale district, Poojapitiya district, Panvilla district, Harispaththuwa district, Medadumbara district.

2-4. To design a plan and structure for environmental monitoring

- The consortium formulated a monitoring plan and structure based on ER (Environmental Recommendation) issued by CEA of Central Province. The Environmental Monitoring Committee to confirm monitoring results was established in April 2016.
- Monitoring items are amount of input organic waste and compost production, drainage volume, odor and noise. During the verification survey activity, technical guidance for monitoring of odor is provided by KAWASHIMA.

2-5. To make evaluation method for outcome of the survey project

- Evaluation is based on input, output, outcome and evaluation index as follows.

Input	Output	Outcome	Evaluation Index
Introduction of screw-type composting plant	Household garbage is collected separately and treated to compost	Household garbage is collected separately	Amount of household garbage collected (ton)
		Disposal volume to waste dumping site and illegal dumping decrease	Amount of household garbage collected (ton) (= amount of garbage treated)
		Compost is produced and used as compost	Amount of compost sold (ton)
		Greenhouse gas emissions from waste disposal sites decrease.	Amount of CH_4 emissions

2-6. To implement a training program for composting plant operation and study tour for separate garbage collection in Japan

- In the schedule of May 9 to 15, 2015, KAWASHIMA conducted training in Japan on the operation and management of composting plants for five people involved in the government of Central Province, PDPS and KUPS. In addition to conducting technical training at facilities in Miyagi prefecture where RA-X was introduced in Japan, they visited Kawasaki city to observe garbage administration such as sorting collection of household garbage.

2-7. To conduct organic waste collection

- The consortium is planning to collect 17 tons of household garbage and agricultural waste in Pathadumbara district, Kundasale district, Wategama county, Gagawatakorale district, Poojapitiya district, Panvilla district,

Harispaththuwa district, Medadumbara district in a day. 3,371.5 tons of household garbage was collected and processed from April 31, 2016 to May 31, 2017.

2-8. To operate the composting plant

- KAWASHIMA and the consortium held completion ceremony on April 29, 2016 and operation of the plant has been started from April 30, 2016.

2-9. To sell compost produced at the plant

- Compost sales began in October 2016. The name of compost products is NPK, taking the initials of NIPPON, Pathadumbara Pradeshiya Sabha and Kundasale Pradeshiya Sabha. Compost has been sold through local government networks and dealers who handle household garbage. 38,000 kg of compost was produced and sold by the end of March 2017.

2-10. To conduct environmental monitoring

- KAWASHIMA carried out technology transfer of environmental monitoring related to the composting plant. Based on the ER, the consortium established a monitoring committee for the monitoring in April 2016 and has conducted monitoring based on the monitoring plan. Monitoring items are input volume of organic waste, compost production volume, drainage volume, odor and noise.
- The consortium and KAWASHIMA conducted odor monitoring at the plant gate, however no bad odor was detected. Therefore, the odor problem was improved.

2-11. To collect and analyze data on the amount of organic garbage collection, compost production and compost sales

- The average of the running cost (labor cost, power bill and water bill) and operation and maintenance expenses of the project was 8,778 SLR/month by the end of May 2017. If full operation of the plant begins, revenue of 32,200 SLR/day is expected. A part of the revenue is planned to be used for running and maintenance cost.

2-12. To evaluate the project outcome based on the evaluating method

- Input, output, outcome and evaluation index until March 2017 are as follows.

Input	Output	Outcome	Evaluation Index
Introduction of screw-type composting plant	Household garbage is collected separately and treated to compost	Household garbage is collected separately	Amount of household garbage collected 2,736 ton
		Disposal volume to waste dumping site and	Amount of household garbage collected

		illegal dumping decrease	2,736 ton
		Compost is produced and used as compost	Amount of compost sold 38 ton
		Greenhouse gas emissions from waste disposal sites decrease.	Amount of CO_2 emissions 12,751 tCO_2e/10years

3) Activity 3: Design of plan for promoting composting plant

3-1. To disclose information of the project activities through website

- KAWASHIMA created the website introducing the project activities on November 30, 2016. As activities in Sri Lanka are widely known even in Japan, there are orders for new RA-X system, and it is currently under negotiation.

3-2. To conduct visiting tour of the composting plant

- After the plant operation, KAWASHIMA held study tours for local residents, local governments, enterprises, mass media, etc., with the cooperation of the consortium. Recognizing the superiority of RA-X to local governments, it is currently negotiated with the Sri Lankan government to introduce RA-X with the budget of the government.

3-3. To hold seminars and debriefing sessions on project outcome

- KAWASHIMA and the consortium held a debriefing session on dissemination and demonstration activities at the government of Central Province on February 28, 2017. There were orders from compost wholesale companies. Contracts have been signed with four companies and compost products are selling to them.

3-4. To formulate of business development plan of KAWASHIMA in Sri Lanka

- As Ministry of Provincial Councils and Local Government (MPCLG), which is responsible for management of wastes in Sri Lanka, has high interest in the composting plant introduced by the verification survey, it is planned to demonstrate producing compost by the plant and to realize plant sales to Sri Lankan government.
- KAWASHIMA produces RA-X system in Japan and export the system to Sri Lanka. KAWASHIMA makes business tie-ups with a Sri Lankan company by providing technical guidance. The partner company will assemble and install RA-X and carry out maintenance work.

4. Product/Technology provided

The Survey was implemented through composting plant which consists of following components:

a) A screw type composting machine "RA-X" with screws, 5.3kW motor and pails;
b) Bucket loader to transport organic garbage and agricultural waste into fermenting chamber;
c) Three air blowers (2.2kW) to supply air into composting material from under the floor, and
d) A fermenting chamber with roof to protect rain fall.

The major specifications of the composting plant are shown in Table 1.

Table 1 Major specifications of the composting system

Article	Specification
Size of Fermenting Chamber	756 m^3 (W×L×H=12m×35m×1.8m)
Churn Ability	300m^3/hour
Treatment Capacity of Garbage	17 ton/day[1]
Producing Capacity of Compost	6 ton/day[1]
Churn Frequency by RA-X	Once per day
Operation Time of RA-X for Churn	3 hours/day
Fermentation Duration	40 days
Water Content of Domestic Garbage	80 %
Water Content of Garbage added by Agricultural Waste	60~70 %

Composting technology is classified as mechanical method which treats large amount of organic garbage by churning mechanically and manual method by hand working. Screw type composting machine "RA-X" (Patent No. 3607252) is classified as mechanical method and able to treat organic garbage up to 50 ton per day. Operation of "RA-X" can be operated by one operator. Furthermore, easy maintenance and low

[1] Treating capacity of organic garbage and production amount of organic fertilizer are described as 25 ton/day and 8tons/day respectively in the Annex 1 of "the Minutes of Meeting". However, those values are corrected after the meeting.

power consumption are the features of the system.

Since “RA-X” churns the garbage only up and down by screw type agitating equipment and can spread air into every part of the garbage, the environment in which anaerobes cannot be activate and keep fermentation by aerobes in high temperature. As only the top portion contact with air, a little decrease of temperature is occurred (approximately 5 ºC drop after churn). The high temperature allows early maturing of the compost. It also wipes out noxious insect and disease germ, and reduces emission of bad odor by anaerobic fermentation.

The composting system discharges no effluent, because water included in the organic garbage is evaporated by the high temperature. It means that solid material and liquid filth can be treated simultaneously. As an example, manure from some pig farm is treated by “RA-X” system at the same time in Japan. Composting method by the screw type churn machine “RA-X” also has the patent No. 5442325.

Picture 1 Screw type composting machine “RX-1” and fermenting chamber with roof

Bucket

Screw Unit

Picture 2　Bucket and screw unit

Air blowers installed at the sidewall of primary fermenter

Channels in the floor and aeration pipes

Picture 3　Aeration by air blowers

5. Implementing Organizations

Japanese side:　KAWASHIMA Co., Ltd.

Sri Lanka side:　Ministry of Local Government And Provincial Councils,
Central Provincial Council,
Pathadumbara Pradeshiya Sabhwa
Kundasale Pradeshiya Sabhwa,

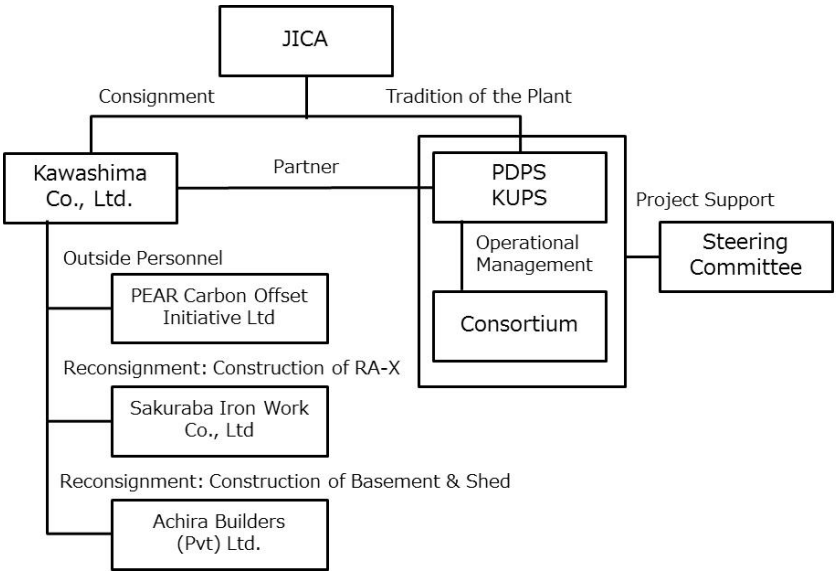

Figure 3 Implementation Structure

6. <u>Target Area and Beneficiaries</u>

Target Area: Pathadumbara and Kundasale, Kandy District, Central Province and ambient area

Beneficiaries: Community resident

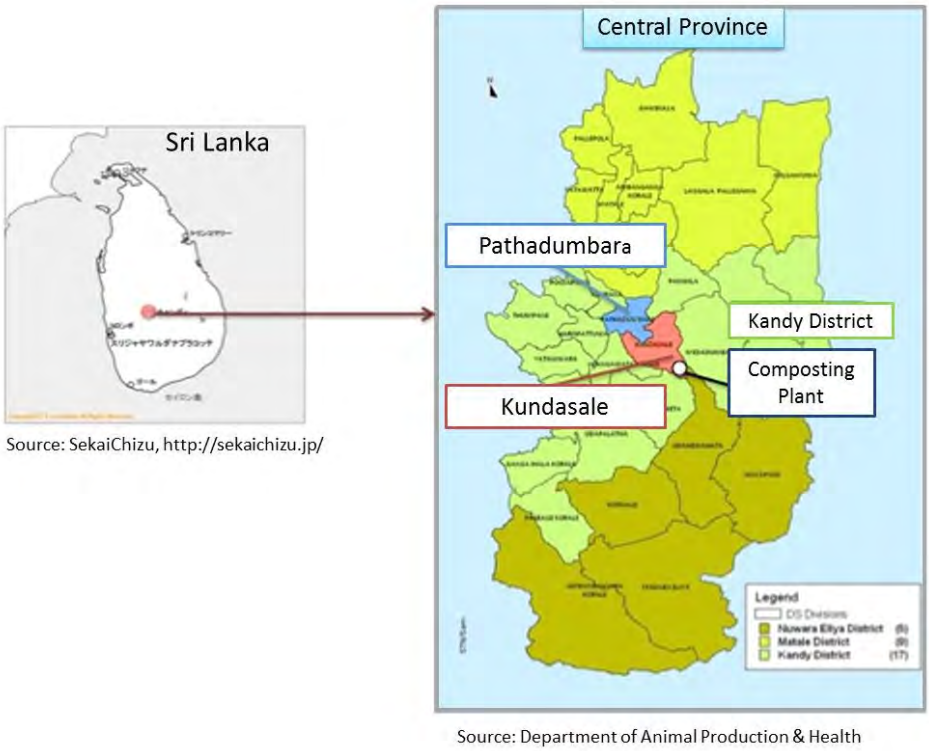

Figure 4 Map of the Target Area

7. Duration

From January 2015 to April 2017 (One year and eleven months)

III. ACHIEVEMENT OF THE SURVEY

The Survey implemented through composting plant in which organic waste is fermented into compost with probiotics to enhance aerobic fermentation process and inhibit emission of bad odor.

The composting plant installed by Japanese ODA consists of following components:

a) A screw type composting machine "RA-X" with 20.3kW motor, two buckets, railway system and various types of motors to drive system.
b) Eight air blowers (2.2kW) to supply air into composting material from under the floor,
c) A fermenting chamber with roof to protect rain fall.

The major specifications of the composting plant are shown in Table2.

Table 2 Major specifications of the composting system

Article	Specification
Size of Primary Fermenter	756 m^3 (W×L×H=12m×35m×1.8m)
Churn Ability	300 m^3/hour
Treatment Capacity of Garbage	17 ton/day
Producing Capacity of Compost	6 ton/day
Stirring Frequency by RA-X	Once per day
Operation Time of RA-X for stirring	3 hours/day
Fermentation Duration	40 days
Water Content of Domestic Garbage	80 %
Water Content of Garbage after adding of Agricultural Waste	60~70 %

The project period is from January 2015 to April 2017. "RA-X" was assembled by KAWASHIMA, the Primary fermenter and roof of the composting plant were constructed by Sri Lankan companies (see Picture 4 and Picture 5). On April 29, 2016, the governor of Central Province took part in the completion ceremony (see Picture6) and started operations on April 30, 2016.


Picture 4　Construction of primary fermentation

•


Picture 5　RA-X assembly work


Overall view of the composting plant　　Governor dumping household garbage to bucket by driving shovel loader

Picture 6　Completion Ceremony

The operational personnel framework of the composting plant is a total of seven persons, who consist of a chief, a “RA-X” engineer, and five workers.

As of December 19, 2016, household garbage in the Pathadumbara, Kundasare, Gangawatakorale and Poojapitiya districts have been collected and processed.

Table 3 shows the plan and actual results of household waste collection, and Table 4 shows the results of household garbage input and amount of compost production. It was planned to collect household garbage in all districts during December. Amount of household garbage collected and processed by October 30, 2016 was 1,539 ton.

Table 3 Plan and actual results of household waste collection (Unit: ton)

Month	Kundasale	Pathadumbara	Gangawatakorale	Poojapitiya	Panvila	Watteg ama	Medadumbara	Harispathtuwa	Total
Result									
May to Aug.	532.0	233.4	159.9	13.0	-	-	-	-	938.3
Sep.	118.5	16.5	52.4	12.6	-	-	-	-	200.0
Oct.	110.1	27.7	47.7	5.8	-	-	-	-	191.3
Nov.	108.2	33.8	44.6	22.8	-	-	-	-	209.4
Total	**868.8**	**311.4**	**304.6**	**54.2**	-	-	-	-	**1,539.0**
Plan									
Dec. 2016	110.0	35.0	45.0	25.0	15.0	15.0	30.0	30.0	
2017									
Jan.	115.0	35.0	50.0	25.0	15.0	15.0	35.0	35.0	
Feb	120.0	40.0	50.0	30.0	20.0	20.0	40.0	40.0	
Mar	125.0	45.0	55.0	30.0	20.0	20.0	45.0	45.0	
Apr	130.0	45.0	55.0	30.0	25.0	20.0	50.0	50.0	
May	135.0	45.0	55.0	30.0	25.0	25.0	55.0	55.0	
Jun	140.0	50.0	60.0	30.0	25.0	25.0	60.0	60.0	
Jul	150.0	50.0	60.0	30.0	30.0	25.0	60.0	60.0	
Aug	150.0	55.0	60.0	35.0	30.0	30.0	60.0	60.0	
Sep	150.0	55.0	60.0	35.0	30.0	30.0	60.0	60.0	
Oct	155.0	60.0	60.0	35.0	30.0	30.0	60.0	60.0	
Nov	160.0	60.0	60.0	35.0	30.0	30.0	60.0	60.0	
Dec	160.0	60.0	60.0	35.0	30.0	30.0	60.0	60.0	

Table 4　Results of household garbage input and amount of compost production

Month	Input Waste (ton)	"RA-X" operation time (mini)	PRODUCED COMPOST (Kg)	SAMPLE SALE (Kg)
May to Aug.	938.3	40.30 (AUG)	-	
Sep.	200.0	65.40	-	
Oct.	191.3	58.15	1,800	1,400
Nov.	209.4	50.20	8,300	1,440
Total	1,539		10,100	2,840

Household garbage being input is separated very well as shown in Picture7, and it is good organic waste. There are very few foreign bodies other than plastic bags in the waste. Also, the waste contains a lot of cellulose and sugar content such as fruits and branches of banana. There is less animal protein such as meat, but it contains more than 80% of moisture.

Picture 7　Input situation of organic waste

The place facing the aisle becomes whitish owing to the generation of aerobic microbe. On the other hand, water vapor is generated at the part being stirred, and it can be seen that high temperature aerobic fermentation occurs (see Picture 8 and Picture 9).

Picture 8　Aerobic fermentation condition

Household garbage input place

High temperature aerobic fermentation plase

Picture 9 “RA-X” stirring condition

Production of compost was started from October 2016. (see Picture10). As shown in Table 4, 10,100 kg and 2,840 kg of the compost manufactured in October and November respectively were shipped as samples, and the rest were utilized in the project of “Using compost for home vegetable garden” promoted by the Kundasale District Government and the segment office of Ministry of Agriculture, Irrigation, Animal Production and Health, Agrarian Development, Fisheries, & Environmental Affairs. There is a vegetable garden using compost for demonstration on the premises of the government office building in the Kundasare district, where use of the compost produced by the JICA project has begun (see Picture 11).

Picture 10 Production of compost products

Picture 11 Compost use promotion in home vegetable garden and Kundasale District Government building

Quality of the compost is as follow. The Ministry of Agriculture, Forestry and Fisheries of Japan has adopted the criteria for determining maturity using the product color, shape, odor, moisture, fermentation temperature, deposition period, number of turning back, presence or absence of forced aeration, for soil reduction after detoxifying and agricultural use. It is recommended to use it as a material for judgment (see Table 5). In other countries, products are scientifically analyzed and comprehensive judgment is made using nitrogen content, phosphoric acid content, potassium content, ash content, EC value, C/N value, pH, etc.

Table5　Criteria for matured judgment of compost (indication of aging)

Color	Yellow～Brownish yellow (2),　Brown (5), Blackish brown (10)
Shape	Keep original shape (2), Crumble considerably (5), Do not keep almost shape (10)
Odor	Strong material odor (2), Material odor (5), Compost smell (10)
Moisture	>70% (2), 70~60% (5), < 50% (10)
Maximum fermentation temperature	>50 ºC (2), 50～60 ºC (10), 60～70 ºC (15), >70 ºC (20)
Deposition duration	Raw materials almost from livestock manure --------- < 20days (2), 20～60days (10), > 60days (20) Mixing with crop harvest residue -------- < 20days (2), 20～90days (10), > 90days (20) Mixing with wooden materials ----------- < 20days (2), 20～120days (10), > 120days (20)
Number of turning back	< = 2 (2), 3～6 (5), > = 7(10)
Forced aeration	Absence (0), Presence (10)

The score in parentheses are added, then if the total point is 30 points or less, from 31 to 80 points or 81 points or more, the compost situation is estimated "immature", "moderate mature" or "mature" respectively.

Table 8 shows the judgment results for the products of JICA Sri Lanka Project, which was produced from organic waste and under final maturing. Despite the product was under final maturing, it was a very well-made product in accordance with the average product standards, and it was almost "mature" with a total of 90 points.

Table 8 Matured judgment of compost products

Color	Yellow～Blackish brown (10)
Shape	Almost no shape is recognized as being free-flowing powder (10)
Odor	No material odor and compost smell (10)
Moisture	< 20% (10)
Maximum fermentation temperature	>= 80 ^{o}C (20)
Deposition duration	>= 60 days (10)
Number of turning back	1 time /day (>= 60 times totally) (10)
Forced aeration	Presence (10)

The compost produced by JICA project was analyzed before final maturing. The main figures of the analysis data are as follows (all data are within the reference values):

a) pH：	6.7	(Reference value 6.5-8.5)
b) EC Value：	9.45	(0.5-3.0)
c) Moisture：	19 %	(20-30 %)
d) Carbon content：	24.23 %	(20-35 %)
e) Nitrogen content：	1.82 %	(0.8-3.0%)
f) Phosphoric acid content：	4.0 %	(0.5-4.0%)
g) Potassium content：	1.7 %	(0.5-3.0%)
h) C/N ratio：	13.3	(20-50)

The product is almost within the reference value and the C/N ratio which is the criterion for maturing is 13.3 and can be judged as "mature". The C/N ratio is the ratio of the carbon (C) content (%) and the nitrogen (N) content (%) contained in the organic matter. This value is an important index for evaluating the difficulty of decomposition of organic matter by microbe, the ease of manifestation of fertilizer effect, the degree of maturation of compost, and the like.

The action of microbe on organic matter (decomposition, release of inorganic nitrogen, etc.) is generally governed by the C/N ratio of organic matter. In other words, organic matter with a low C/N ratio (less than or equal 20) generally decomposes quickly. Furthermore, fertilizer effect on crops appears quickly, because it releases inorganic nitrogen in the decomposition process. On the other hand, decomposition is slow in organic matter with a high C/N ratio (30 or more), and the inorganic nitrogen produced in the decomposition process is taken up as a nutrient of the microbe, so the onset of the fertilizer effect is delayed.

The only "EC value" indicating electric conductivity is about 3 times the standard of

Sri Lanka. However, because household garbage is used as a raw material, it can be said that there is no way to increase the amount of ionic substances such as salt. This value is not a problem when used for rice cultivation in paddy fields, and it is considered that the value decreases by adding other organic matter such as saw dust and rice husk in order to control the moisture conditioning of raw material at the time of processing. On the contrary, as it can be judged that the compost contains many fertilizer components, it is considered that it is effective as "fertilizer" in Sri Lanka, which soil is not eutrophic like in Japan.

Prices of nitrogen raw materials are stable or declining in current chemical fertilizer raw material market, but phosphoric acid and potash raw materials tend to rise. Although this project produces compost product, it contains relatively high phosphoric acid and potassium content, so it can be confirmed the effectiveness as a fertilizer.

Furthermore, since high temperature aerobic fermentation treatment is continuously performed, effects such as suppression of the generation of pathogenic bacteria, prevention of pest occurrence, suppression of germination of weeds due to death of various plant species can be expected. In addition, since it is a compost product containing a large amount of effective microbe, it can be evaluated that it is good compost that can be expected to have effects of soil improvement and plant immunity enhancement.

Odor monitoring was carried out with Kitagawa type detection tube (see Picture 12). Hydrogen sulfide and methyl mercaptan were not detected. Although ammonia was detected, it was extremely small amount of 10 ppm. In compost manufacturing, the floor got wet by moisture of household garbage, because the input of moisture conditioning material was insufficient. Since some parts were not aerobic fermented, there was an odor near the fermenter. However, no odor was felt in the vicinity of the main gate of the plant (see Picture 13).

Picture 12 Measurement with Kitagawa type detection tube

Picture 13　Main gate of the composting plant

Malodor was a major problem for the residents around the garbage disposal site in the Kundasale district. Implementation of the project improved the malodor problem and the health and sanitation problem (see Picture 14).

Before the project　　After the project

Picture 14　Waste dumping site in Kundasale

If the proper amount of moisture controlled material such as sawdust and rice husk ash is introduced, the problem of odor is solved perfectly. The countermeasures to increase such materials are implemented (see Picture 15).

Furthermore, two workers of the seven staff in the plant are female　. The project also contributes to the expansion of women's employment.

Picture 15　Spreading rice husk

In Sri Lanka, efforts have been made to produce compost from organic waste manually. This type of composting involves forming organic waste into rows of piles called “windrows” and aerating them periodically by manually turning the piles.

Organic waste was fermented by mechanical stirring in “RA-X” system. The operation system was fully automated with only one operator. Input raw material into the buckets of primary fermenter and displacement compost produced from the first fermenter to the secondary fermenter were carried by shovel loader. Therefore, workers at the compost factory were released from hard labor. Also, as odors in the workplace were improved, it was not necessary to wear a mask. Hygiene environment was also improved because flies and mosquitoes die. Since the work of workers was only light work such as cleaning and packing of compost, it became a working environment where women can work. It contributed to employment creation for women (see Picture16).

On the other hand, "RA - X" is an automatic driving machine and requires engineers who are educated on driving and maintenance (one senior engineer and two deputies).

Workers making compos manually

Women working at composting plant of JICA project

Picture 16　Comparison between manual work and RA-X working environment