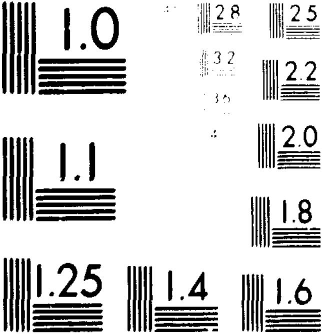

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PRELIMINARY ASSISTANCE FOR COMPOSTING OF MUNICIPAL SOLID WASTES

SI/INS/80/801

INDONESIA.

Technical report*

Prepared for the Government of Indonesia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

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Summary

The Government of Indonesia attributes high priority to the introduction of a programme for the recycling of organic wastes with the aim of improving environmental hygiene and promoting energy production from biomass. At present, Indonesia participates in a FAO regional project RAS/75/004 - Improving Soil Fertility through Organic Recycling - which is mainly concerned with on-farm techniques for organic recycling. However, an important aspect of organic recycling is the production of fertilizer from urban solid wastes (composting). The Government has, therefore, confirmed its interest to set up a National Composting Programme.

In the following report, an assessment and evaluation of costs and benefits of a National Composting Programme is made. For this purpose, a general survey of collection and treatment methods of household refuse currently practiced in Indonesia is carried out. In addition, data has been collected on the composition of Indonesian household refuse. The results of this evaluation indicate that

a. waste disposal and collection facilities in Indonesia need considerable improvement,

b. the high content of organic matter in Indonesian household waste makes it very suitable for composting.

A quick survey of Indonesian soil characteristics furnished the result - in agreement with the Indonesian governmental and agricultural authorities - that soils are only partly of fertile character and that there is a general lack of organic material for most of Indonesia's cultivated soils.

For the assessment of establishing a National Composting Programme in Indonesia, recommendations are submitted, which include

a. design and cost estimate for two different types of compost plants (industrial and pilot plant: selection of site, list of equipment, maintenance and repair procedures, training of personnel);

b. marketing activities for compost sales and application in agriculture;

c. financial and administrative arrangements for waste collection and compost plant management;

d. investment cost appraisal for the National Composting Programme covering two five-year periods.

The last part of the report deals with the completion of the Jakarta compost plant and with the trouble-shooting of the plants at Surabaya and Medan.

For the plant at Jakarta which has been waiting for 17 years to be put into operation, an arrangement with the manufacturer of the plant for its completion is suggested. In addition, a solution for the legal status of the plant regarding ownership and administration has to be found.

At the compost plants of Surabaya and Medan, it was found that yeild and quality of compost was far too low. Also, frequent breakdowns were caused due to lack of maintenance and spare parts. Therefore the plants were running at a loss. However, minor modifications should improve the compost quality and yield. With moderate investments the compost production rate could be increased two or three times.

CONTENTS

1. Introduction

1.1. Objectives

The following report is a summary of the findings of a two-month assignment of a UNIDO expert in Indonesia in 1980. The objectives of the mission were :

a) to elaborate a detailed scheme, in several phases, for city wastes composting that can be adopted at the major cities of the country, by determining the best standard plant design and process, capacities, locations, arrangements for local fabrication of equipment, repair and maintenance procedures, training of plant operators, distribution and marketing of compost, and financial and administrative arrangements for waste collection and compost plant operation; and to assess the costs and benefits of a national composting programme;

b) to participate in a national seminar on organic recycling and city wastes composting;

c) to advise Indonesian authorities on the completion of the Jakarta composting plant;

d) to advise Indonesian authorities on the trouble shooting of the plants at Surabaya and Medan.

1.2. History

Considerable effort has been made in the past on national and international levels for the improvement of urban solid waste management in Indonesia.

For example, the local Government of Jakarta had a survey for solid waste management carried out by the Environmental Institute of Jakarta

(P.P.M.P.L.) which recommended Jakarta sanitary landfilling and an incineration plant in the centre of the city.

Studies were also prepared for Surabaya, Medan, Bandung and Semarang by engineering companies such as Camp Dresser& McKee International, Boston, USA, and Burn And McDonnel Engineering Co. together with Trans Asia Engineering Associates Inc., under the auspices of the Ministry of Public Works. Results of this work provided after 15 months by six engineers in 1976 were to recommend sanitary landfill and refuse collection by lorries with compacting devices. The cost for this research had been partially paid by a loan given to Indonesia by the USA.

The World Bank, within the framework of the Kampung Improvement Programme (a programme for the improvement of slums) covering 20 cities in Indonesia, assigned a loan of US $54 million to Indonesia's Third Urban Development Project. US $10 million of this loan should have been allocated for the purchase of garbage collection vehicles and tools for Jakarta and Surabaya by the end of 1979. At present, most of the World Bank loan is still not utilized due to lack of appropriate technical assistance.

Other loans came from the Dutch Government (2.5 million guilders for Ujung-Padang, 2.5 million guilders for Medan), while the city of Bandung received US$ 3 to 4 million from the Asian Development Bank for the improvement of solid waste management.

2. <u>Foundations for a national programme for urban solid waste composting in Indonesia.</u>

In order to receive information in a fast and economic way on household refuse management, questionnaires were sent by the expert to the Municipalities and to the Ministry of Agriculture's Provincial Extension Services in the following cities : Jakarta, Medan, Bandung, Solo, Semarang, Jogyakarta, Denpasar, Ujung,Badung. Data collected in this way and during visits and meetings, and also taken from earlier surveys, form the basis for this report.

2.1. Urban solid waste management and solid waste characteristics in Indonesia

2.1.1. Urban solid waste collection and disposal practices currently applied in Indonesia.

The most common method of waste handling and removal in the main cities in Indonesia is still the storage of refuse along the street or on specially assigned intermediate dumping sites resulting in a random piling up and spreading of refuse over the area. Rarely are containers used for the storage of waste, like in Denpasar, Solo, Semarang. In very few cases have these containers a metal door or cover. The intermediate dumping sites or transfer stations are usually large enough to allow unloading from carts, becaks (a three wheeled bicycle with a large basket in the front) ox-carts, and trucks. But before these transfer stations are emptied by the collection service of the Municipality they usually get overloaded and therefore cause environmental problems such as creating a public eyesore, omitting bad odours and providing a breeding place for flies and rats.

The equipment with which household refuse is normally collected in Indonesia consists of:

1. Carts ; e.g. in Jakarta 2,790 of these carts are in use under Municipal or private ownership.
2. Open trucks and trailers with capacities ranging from 6 to 12 m^3.
3. Collection lorries with compacting devices having capacities of upto 18m^3; only a few old and outdated models of these lorries are in use.

The collected solid waste is deposited on dumping places outside the cities, but sometimes on dumping sites in the centre of a city (Jakarta). The general problem now is to find new space for dumping. Although bulldozers or machines with compacting devices operate on some large dumping sites, sanitary landfill is practically never practiced in Indonesia and only two compost plants (Surabaya, Medan) exist.

2.1.2 Municipal refuse characteristics in Indonesia.

The composition of solid waste - mainly determined by its origin (residential, administrative, industrial, market, slums) - is an important factor for waste disposal and processing. The high proportion of organic matter present in the refuse of tropical countries such as Indonesia makes such refuse most suitable for composting (Tabs. 1 and 2).

	Paris Winter	Summer	Rabat	Conakry	Jakarta
Daily production of garbage per capita kg	1.00	1.10	0.550	0.400	0.650
Density	0.08	0.11	0.35	0.30	0.30
Humidity %	29	34	66	65	61
Thermal value Kcal/kg	2,000	1,750	980	-	962
C/N ratio	38	35	21	23	23
Fermentible components%	32	35	70	80	82

Tab.1 Characteristics of household refuse in various cities

	Jakarta	Denpasar	Surabaya
Glasses, china etc	0.24	1.00	0.50
Paper, cardboard	3.33	3.00	2.00
Rubber, leather	-	2.00	-
Plastics	4.40	4.00	2.00
Metals	4.71	3.00	0.50
Earth, rubble, etc.	0.85	-	-
Textiles, rags	1.24	1.00	1.00
Wood	3.27	-	-
Animal and vegetable wastes	81.95	78.00	94.00
	100.00	100.00	100.00

Tab.2 Average composition of urban refuse in Indonesia

	Markets	Commerce	High Income Dwellers	Medium Income Dwellers	Slums (Kampung)
Organic material	86.77	81.74	88.68	77.21	81.79
Paper and cardboard	1.84	2.67	1.57	2.52	1.86
Textiles	0.16	0.84	0.48	3.87	1.02
Plastics	3.64	4.55	1.54	3.23	2.22
Glass	0.16	0.11	0.41	0.39	0.61
Metals	0.87	2.92	2.27	4.48	6.41
Rock, soil	0.67	2.95	3.19	3.32	3.13
Miscellaneous	5.89	4.22	1.83	4.98	2.95
Total	100.00	100.00	100.00	100.00	100.00

Tab. 3 Jakarta refuse composition (According to Jakarta Market Authority)

Only minor changes in refuse composition, for example, in paper and plastics content, can be expected in the coming years.

Since humidity tests for household refuse samples in Indonesia have not yet been carried out, the following figures for water content and thermal value are computed by referring to figures published in the literature and applying them to the respective refuse compositions. For Jakarta the following results are obtained : average water-content 61.38%, thermal value 962 kcal/kg dry weight. If the water content in refuse exceeds 65%-70%, mainly during the rainy season, there will be problems with the composting process.

Due to low paper and plastic content, the average density of Indonesian refuse is relatively high:

- household 0.3 - 0.32
- markets 0.27 - 0.29

(For comparison, the density of refuse of western industrialized countries is about 0.1)

At present the quantity of waste produced daily and collected daily in the major cities of Indonesia (Tab.5) is sufficient to provide a continuous supply for a pilot or even an industrial plant for composting in order

Table 4 Composition of refuse at Semarang (from Burns and McDonnel 1976)

	1976		
	Domestic refuse	Market refuse	Combined refuse
Food	41.3	51.5	44.3
Yard waste	41.6	31.6	38.6
Paper	9.0	9.1	9.0
Cardboard	0.1	0.0	0.1
Textiles	0.8	1.0	0.9
Rubber and plastics	2.0	0.4	1.5
Wood	2.4	1.0	2.0
Glass	0.0	0.0	0.0
Metals	0.1	0.0	0.0
Rock and soil	2.9	5.4	3.6
Total	100.0	100.0	100.0

Projection 1980		
Domestic refuse	Market refuse	Combined refuse
38	49	41
35	28	33
15	12	14
1	1	1
1	1	1
2	1	2
2	1	2
1	1	1
1	1	1
3	5	4
100	100	100

Tab.5 Quantities of daily refuse generation at different cities in Indonesia*

	Jakarta	Jogya--karta	Den--pasar	Surabaya	Semarang	Solo	Medan	Bandung
	1980	1980	1980	1975	1976	1980	1980	1980
Population	6,081,963	380,000	320,000	2,500,000	737,000	450,000	630,000	1,300,000
Amounts generated								
- in cu.m.	13,311	742	546	5,000	894	700	2,490	3,200
- in tons	3,994	270	191	1,750	298	224	797	1,024
Amounts collected								
- in cu.m.	10,795	435	273	1,029		260		2,100
- in tons	3,238	157	96	360		83		672
Average density	0.30	0.36	0.35	0.35	0.30	0.32	0.32	0.32
Amount refuse generated per capita								
- in cu.m.	2.19	1.95	1.71	2.00	1.33	1.73	2.46	2.46
- in tons	0.65	0.70	0.60	0.70	0.40	0.55	0.79	0.79

* data were provided by municipalities; for Surabaya data taken from Camp, Dresser and Mc.Kee and for Semarang from Burns and McDonnel

to start up the National Composting Programme in different cities. If waste generation should be faster than what composting facilities can cope with, the excess refuse can be discharged on sanitary landfill sites. The low thermal value of the Indonesian wastes however does not favour the adoption of any incineration process.

2.2 Organic material supply and soil conditioning in Indonesia.

2.2.1. General data

During the expert's mission to Indonesia only Java, North Sumatra and Bali were visited. Necessary data was collected partly from literature but mostly with the help of questionnaires handed over to the Ministry of Agriculture's Provincial Extension Services, who forwarded them, amongst others, to the Agricultural Services of Jakarta, North Sumatra, Bandung, Solo, Semarang, Jogyakarta and Bali.

Although Indonesia belongs to an area of high volcanic activity soils are only partly of fertile character. For example, in West Java with the large plain of Jakarta and in North Sumatra, the prevailing acid results in poor soils. The reasons are that volcanic ashes barely reach these areas; climate also has a negative influence on soil quality in that severe erosion is caused by heavy rains and rivers which carry away large quantities of humus soils into the Java Sea.

2.2.2 Problems of organic material supply for Indonesia's soils.

a) All institutions for agriculture (Food Crops and Estate Crops Division of the Central Government, Provincial Extension Services of the Ministry of Agriculture, Soil Research Institute in Bogor, Agronomy Research Institute, Bogor, etc.,) interviewed during this preliminary assistance mission agreed that there is a general lack of organic material for most of Indonesia's cultivated soils and that urgent action must be taken to develop new sources of organic material all over the country.

This was the immediate objective of the National Seminar on Biogas and City Waste Composting, Jakarta, 1 to 4 July 1980, in the course of which the problem of finding new resources of organic material for soil conditioning was extensively discussed by the most competent authorities in the country.

During the first 15 years following the Independence of Indonesia, the agricultural sector was developed by utilizing all available fertilizing or soil conditioning facilities. From 1949 to 1973, the food production development programme was carried out with an intensive use of inorganic fertilizers.

The result of this unbalanced practice was a disturbing decrease of organic material in soils. It then became generally accepted that measures for conservation and regeneration of soils were an absolute necessity. Therefore, from 1973 onwards, a new initiative was taken to promote the use of a balanced chemical and inorganic fertilizer.

b) Present availability of organic fertilizer.

1) Burning

A very old practice of burning the soil to improve its fertility is still used in some areas for rice and tobacco cultivation.

2) Intercropping

Intercropping is the farming practice that consists of planting a subsidiary crop between rows of the main crop. For instance, rice is grown between rows of corn (maize), 4 metres apart. After harvesting the crop residues remain on the land as a contribution of organic matter. Such a practice is of common use with maize, cassava, soybeans, upland rice and peanuts.

3) Green manure

i - Among the atmospheric nitrogen fixing crops, we should emphasize "crotelleria juncea", a very quick-growing crop that brings to soil 20 tons per hectare green manure if cut within 70 to 80 days before flowering.

ii - Azolla - especially "asolla pinnata" which is the most prevalent species in Asiatic countries - free floating cryptogamic ferns used in China many years ago, is a very active nitrogen fixator and a remarkable means of improving rice lands' fertility. For Azolla two cultivation practices are commonly used: either the ferns are grown in small nurseries and then "sown" onto the ricefields for further reproduction; or they are grown over relatively large areas as green manure crop in their own right. As stressed at Bogor Agronomy Research Insitute, 1 hectare fertilized with azolla brings 100 kg. nitrogen to the land within 110 days.

There is a practice of fertilizing azolla by means of compost prepared from vegetal matter such as straw mixed in due course into the azolla nursery. (See also FAO Soils Bulletin, No. 41, pages 1 to 20).

Also green manure is applied in the form of "Guatemala grass" to some estate crops such as rubber, tea, etc.

4) Crop residues

Rice, straw and other crop wastes are very commonly used. Mulch prepared with rice straw and other residues is applied to rice fields at the rate of 1 ton/ha.

5) Forest earth

Forest earth with good humus content is applied to tea nurseries.

6) Slaughter-house wastes

7) Animal manure

According to 1976 statistics (Asia Bulletin, 30.06.79) livestock farming includes 6 to 7 million cattle, 3.2 million sheep, 4.4 million pigs, and 7.5 million goats. It is not too much for such an overpopulated country. Animal manure and dung are in great demand all over the country, and the supply falls far short of demand. On the other hand, manure or dung application is difficult due to transportation problems.

With regard to the prices of animal manure on the market, Tab.6 gives some average figures. Sale price is generally in the range of Rp. 4,000 to Rp. 5,000 per m^3 and sometimes reach Rp. 7,000 or even Rp. 10,000 at some places (Medan, Surabaya) where demand is excessively high.

8) Raw urban solid wastes

As is the case in most tropical developing countries, a relevant part of urban collected garbage never reaches the respective dumping site. Unofficial commerce especially between market gardeners and garbage truck drivers are of common practice in all Indonesian cities, so that there is an unofficial market price which corresponds to an unofficial payment of transportation service. According to the place and demand, raw garbage market sale price ranges from Rp. 1,000 to Rp. 2,500 per m^3. (See Tab.6)

Table 6

Organic Soil Conditioners average Sale Prices at different places of Indonesia

	Java, Sumatra and Bali							
	Jakarta	Surabaya	Bandung	Semarang	Medan	Solo	Jogyakarta	Bali
Animal manure	Rp. 10.-/Ko at farm or Rp. 30,000 per truck 3-5 cu.m.	Rp. 10,000 per cu.m. at the farm		per cu.m. Rp. 1,000 (lowlands) Rp. 2,500 (mounts)	per cu.m. Rp. 5,000 or 7,000 up to Rp. 10,000	per cu.m. from Rp. 2,000 to Rp. 4,000	per cu.m. from Rp. 2,000 to Rp. 5,000	average per cu.m. Rp. 5,000
Urban household Refuse bulky bargained	Rp. 3,000 per truck 2 to 3 m.t. (papaya, etc.)	Rp. 3,000 per truck 3 to 5 m.t.			Rp. 1,500 per m.t.	Rp. 2,000 per truck 5 cu.m.		Rp. 36,000 per 15 cu.m. (Nosadua)
Slaughter residues								Rp. 5,000 per truck 8 cu.m. or Rp. 1,000 per cu.m.
Anaerobic Compost					Rp. 25.- to 30.-/Ko depend. on quantity (Jayatani)			Rp. 22.- to 25.-/Ko. B.T.D.C. (Nosaduaa)
Aerobic Industrial Compost		Rp. 17,500 per m.t. (Kurnia Pelita to Gov. est.)			Rp. 35.- to 40.-/Ko. Kur.Pelita to mark. gardeners (bagged)		Rp. 16.60 bagged/Ko Rp. 2,500 per cu.m. bulky	up to Rp. 75.-/Ko (from Surabaya) to ornementals and hotels

Chemical fertilizers sale prices (Government 60% subsidized prices)

Urea : Rp. 70.- TSP : Rp. 70.- ZK : Rp. 120.- Compound NPK : Rp. 80.-

2.3 Present state of Compost Production in Indonesia - Amounts available and Sale Prices.

2.3.1. Traditional compost production

Several traditional installations are operating at present. The following examples are worth describing:

a) The Ministry of Agriculture Extension Service Jogyakarta (Kakanwil Deptan Jogyakarta)

Experimental small scale installation operates on the outskirts of Jogyakarta City on an area site of 6,000 sq.m. for market garbage processing.

The process is carried out under two 12 m x 45 m open sheds. Raw garbage is built up in heaps and fermented for two months. The process is aerobic. Fermenting material is turned over twice by means of hand shovels. Otherwise, fermenting heaps are sprayed with wastewater from a nearby small stream.

After fermenting, compost is manually screened through simple screening frames fitted with a 10 mm iron mesh and under-riddle material is manually put into bags (30 Kg.) for sale. Sale price is Rp. 16,66 per kilo, but bulky material wholesale price is Rp. 2,500 per cubic meter delivered at the composting site. Overall yield is about 500 cu.m. per year.

Personnel required consists of only one foreman and 3 non-skilled labourers. Compost sales cover the operation cost.

Part of compost is used at the Kanwil Deptan orchard for citrus cultivation. Also it is demanded by neighbourhood market gardeners for vegetables.

b) NOSADUA or Bali Tourism Development Corporation B.T.D.C. (PT. Pengembangan Pariwisata Bali)

The B.T.D.C. farm is located at the Denpasar South Peninsula, a very beautiful site selected for development of new tourist hotels. The farm includes a nursery where ornamentals are grown.

Anaerobic compost is prepared with garden and crops wastes as raw materials, with household garbage added. Garbage from nearby kampungs is preferred, because it is deemed more suitable for compost processing. Animal manure, if available, is also used. The process is carried out in rows of 5 m x 2 m and 1.5 m deep under shelter.

Raw material is arranged in the form of successive layers. The mass is turned over every 2 months and anaerobic compost is ready for use after 6 months. Compost density is about 0.75.

An estimate of the operation cost was given: garbage from Kampung is paid Rp. 31,000 each 15 cu.m. and 15 cu.m. garbage yield 5 cu.m. compost. Stable manure cost is Rp. 5,000 per cu.m. so that, according to 1979 evaluation, the operation cost corresponding to 4 tons compost yield is:

–	manpower	Rp. 18,000
–	garbage and manure	Rp. 18,000
	Total:	Rp. 36,000

Above cost price corresponds to Rp. 9,000 - for 1 ton compost ready for use.

In comparison with usual sale prices Bali Beach Hotel pays Rp. 25.— per kilo (Rp. 22.— B.T.D.C. delivered, Rp. 3.— for transportation) valid May/June 1980. Since crops like citrus, cloves and ornamental are of good profitability, NOSADUA manager's opinion is that Rp. 22.— per kilo is a reasonable sale price for compost.

c) PT. Jaya-Tani, Medan (North Sumatra)

"Kompos Jaya" is very traditionally prepared by mixing garbage with all available agriculture and animal waste. (See also chapter 5).

Jaya-Tani workshop is installed nearby the Medan main dumping site: several years old anaerobically fermented refuse is extracted from the dump and then manually blended to other animal or vegetable wastes. Small quantity of appropriate chemical fertilizer is added. Upgrading process is carried out at the attached workshop where very simple equipment is implemented.

Jaya-Tani overall production is about 400 tons per month. We must emphasize the Company's owner - and manager - outstanding cleverness. Although the plant's operating facilities be reduced to its simplest terms, regular and uniform quality bagged product is supplied that fulfils the following analytic data:

- N Total	3.4%
- P_2O_5	2.0%

- K_2O 1.6%
- C Organic 9.5%
- Over riddle ∅ 100 14.0%

Since Jaya-Tani compost sale price, Rp. 25.— to 30.— per kilo is less than the price of industrial aerobic compost produced by PT Kurnia Pelita at the same place (for Rp. 35.— to Rp. 40.— per kilo) it is very well accepted and even preferred sometimes.

2.3.2. Industrial Compost Production

As regards industrial production of compost by aerobic process, refer to Chapter 5 : Medan and Surabaya composting plants.

Surabaya composting plant average yield is 1,000 to 1,200 tons per month and compost sale price to the Ministry of Agriculture estates is Rp. 15,500 per ton.

Medan composting plant capacity is - theoretically - the same. However, amounts available to area farmers are smaller, and sale price is in the range of Rp. 35.— to Rp. 40.— per kilo.

2.4. Recommendations for selection of the type, equipment and site for compost plants in Indonesia.

a) Two types of compost plants should be considered for Indonesia (see also Fig. 1 and Fig. 2).

The Industrial Composting Unit

The "industrial type" relates to composting plants with capacity appropriate for the largest Indonesian cities. Such a unit will include one, two, or more identical processing lines arranged in such a way that further extension could be easily carried out in due time. However, certain sections must be implemented right from the beginning. All existing, and also all extension of processing lines must be designed in such a way that they could be fed from suitably sized reception pits fitted with appropriate handling equipment. The same recommendation also applies to power transformer or power plant, if any. Conversely, the upgrading section may be shared by two or more main processing lines.

The Pilot Composting Plant

The"Pilot composting unit" does not need to process all of the City's generated or collected refuse, because it is designed for experimental purpose.

Such a type of plant - with a 10 tons/hour refuse capacity - is quite suitable to smaller cities such as Denpasar, Jogyakarta, Bogor, etc... The processing priniciple is the same but, since the refuse volume to be processed is smaller, mechanization is not brought to the same perfection as for the industrial type unit.

Some composting plant suppliers advocate no mechanical shredding of refuse prior to the composting operation. However, we do not agree with this opinion. No scheme which has to treat substantial quantity of refuse would be satisfactory without it. It must be noted that modern composting schemes start the operation with the shredding of refuse.

All shredding equipment that is designed for specific capacity has to be arranged in such a way that shredding operation is performed steadily, without any clogging or blocking. Slat conveyor is recommended for a regular feeding of the crusher, and the unit is to be adjusted

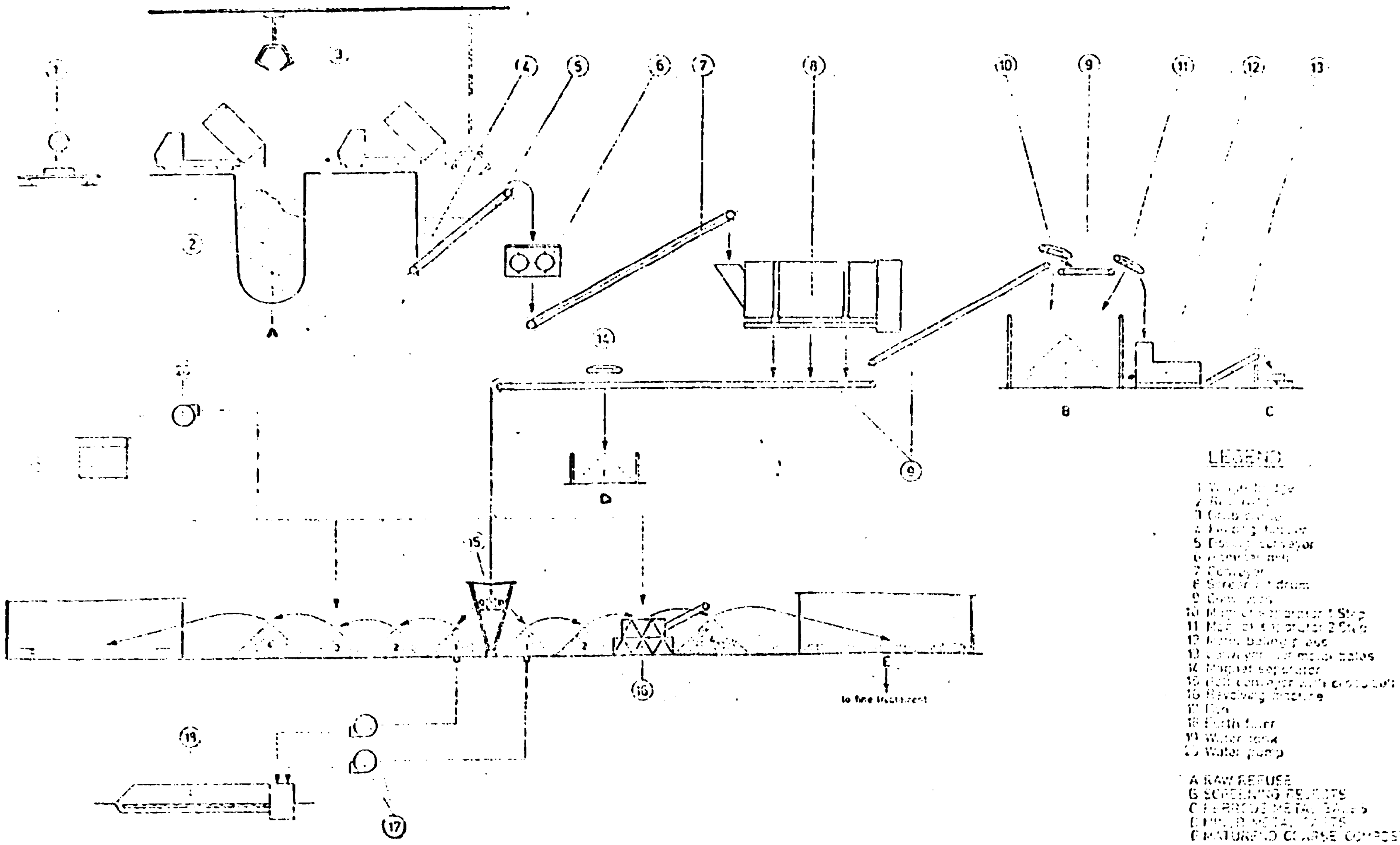


Figure 1a **Industrial Compost Plant, 500 tons refuse per day in one 8-hour shift, coarse treatment and fermentation**

Capacity : 500 tons garbage per day in one 8-hour stift
1,000 tons garbage per day in two 8-hour shifts

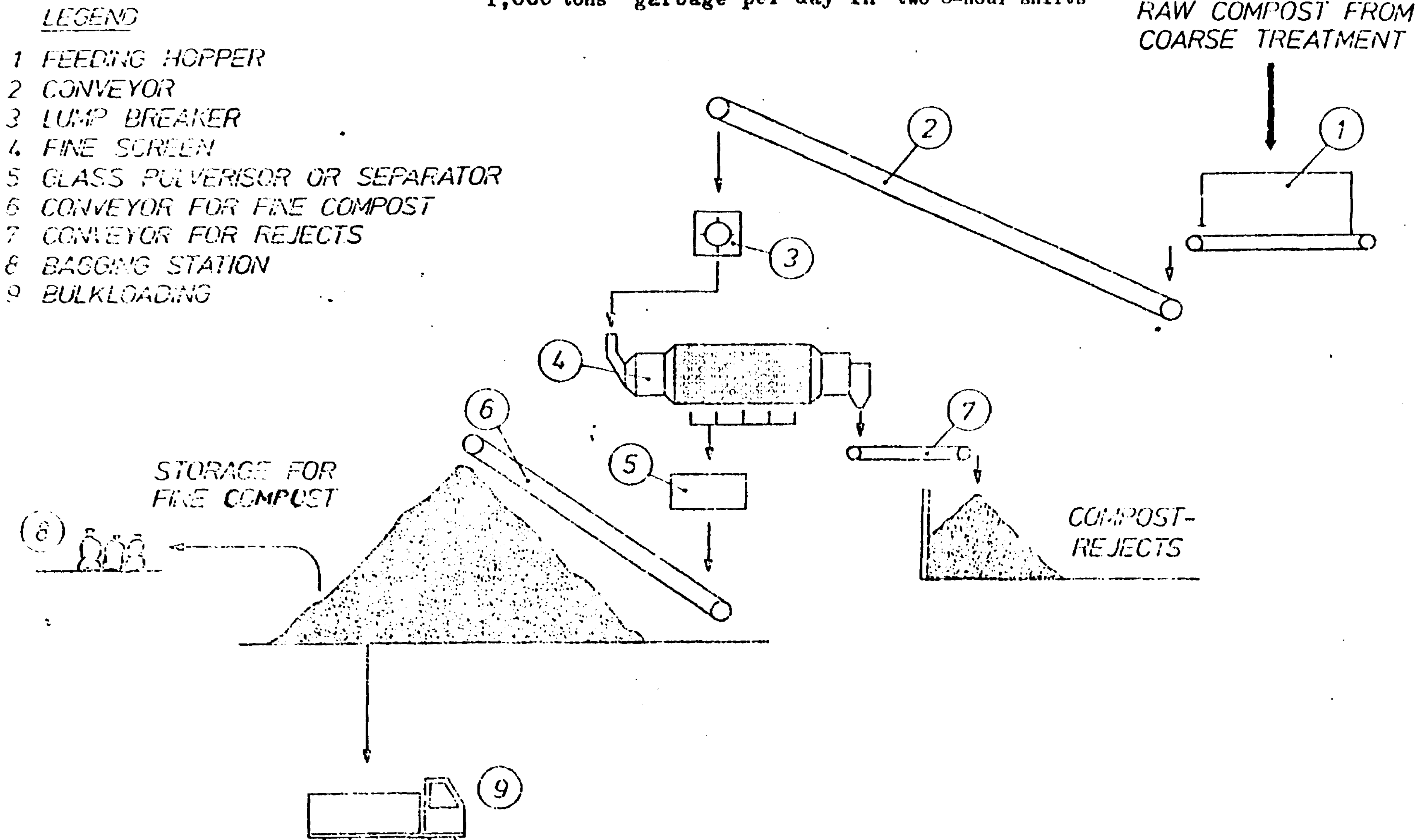


Figure 1b Industrial Compost Plant, Compost Refining Section

I. Garbage delivery and coarse crushing
1 – reception hopper
2 – slat conveyor
3 – hammer mill
4 – coarse crushed garbage
5 – wheeled loader

II. Prefermentation
6 – shed of iron frame
7 – windrows for fermentation

III. Refining
8 – hopper for prefermented compost
9 – conveyor
10 – revolving sieve
11 – rejects container
12 – fine crushing hammer mill
13 – conveyor
14 – magnet separator
15 – metal rejects

IV. Maturation and storage
16 – fine compost
17 – wheeled loader
18 – piles of compost for maturation and sale

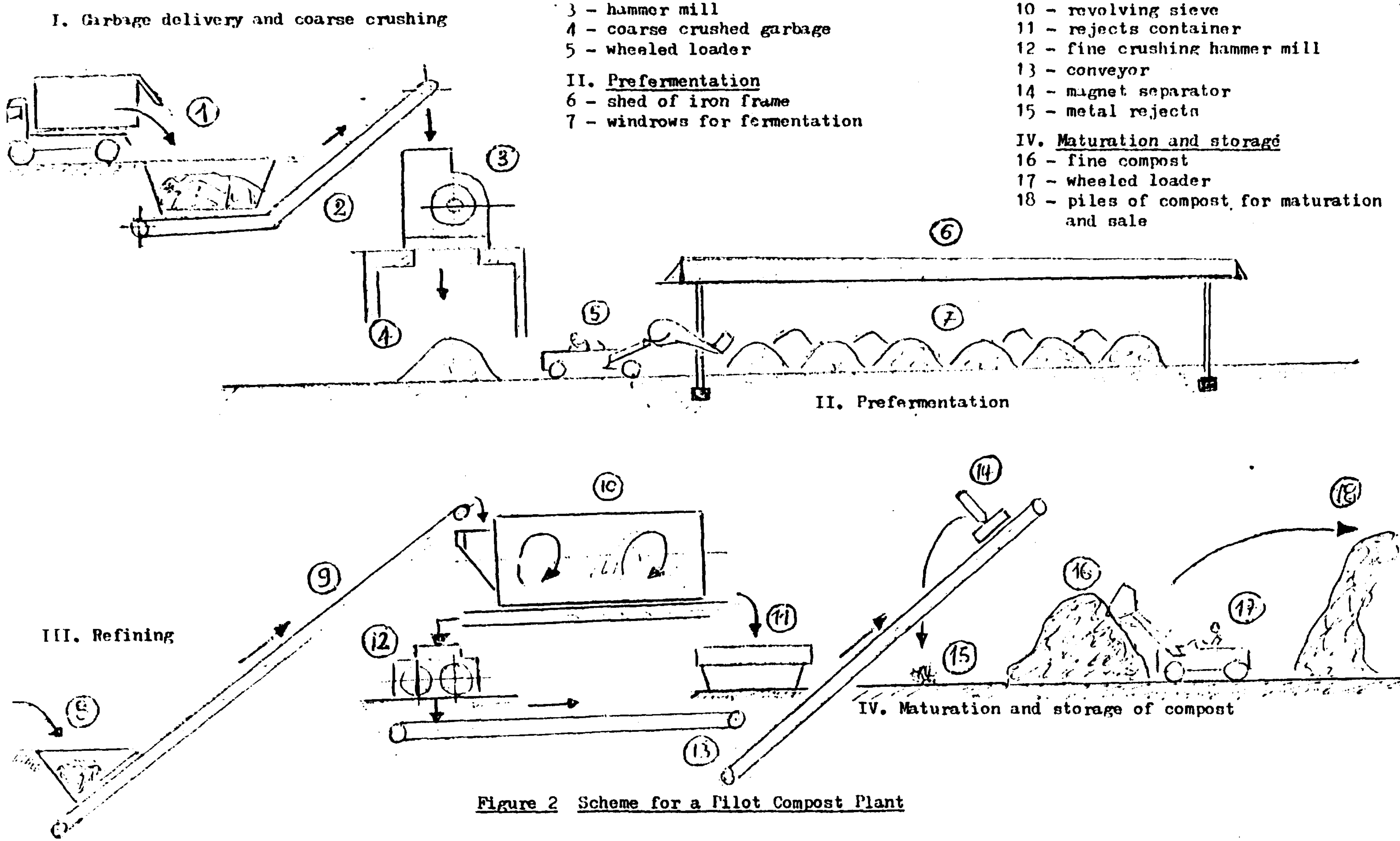


Figure 2 Scheme for a Pilot Compost Plant

in such a way that slat conveyor's speed and crusher's rotation speed are synchronized .

Thus, the shredding unit - which includes both slat conveyor and crusher - is the basic element for all composting plants. It is also the most expensive equipment part - at least at the pilot plant where all remainder equipment such as : conveyors, sieves, etc... is standard. (See also Tab.7).

A compost plant should not have too sophisticated a design. Heavy duty shredders and other equipment must be easily run, maintained and repaired. Consumed parts must be replaced in a simple way and always available. Therefore an appropriate stock of spare parts for a 2 to 3 years operation period is essential right away from the beginning. To avoid stopping of the plant and subsequent breakdown due to lack of suitable spare parts, replenishment of stock should therefore be foreseen early enough.

At huge industrial composting units windrows turning-over should be carried out under shed by means of special windrows turning-over machines.

At all pilot composting units - to be implemented with lowest cost and operated at lowest expenses - turning over operation should be carried out by means of wheeled shovel diesel engine.

After the plant's extension is decided - after several years of successful operation and of satisfactory compost sales - new turning over mechanical devices should be introduced.

Turning over is a job that must be carefully and logically carried out - and performed until a suitable temperature is reached. A set of bi-metal plunging thermometers is used for temperature checking.

Sieving equipment - revolving or vibrating type - must be fitted with appropriate screen sheets with correct size of mesh. Discarded material over riddle - and also separated metal if there is no outlet for it - should be collectedby appropriate containers or lorries for transfer to sanitary dumping sites.

Table 7 General Characteristics for Different Types of Crushers

Manufacturers	Bühler-Miag	Bühler-Miag	Gondard	Gondard	Hazemag	Hazemag	M.F.I.	Tollemache
Model and type	ZHK 4 hammer mill	ZHS 4 hammer mill	HOSST hammer mill	BONST hammer mill	AP.4/BOM percussion	HM 1000/1250 hammer mill	B [illegible] hammer mill	[illegible] D hammer mill
Inlet size								
- length, mm.	1,000	495	600	1,000	2,000	1,250	710	1,220
- width, mm.	970	800	600	1,000	1,500	850	700	762
Rotor								
- rotors number	1	2	1	1	1	1	2	1
- length, mm.	870	430	600	1,100	2,000	1,200	617	1,700
- revolution speed, rpm.	1,200	2,900	1,000	1,000	1,500	1,800	1,500	1,000
- positioning	horizontal	horizontal	horizontal	horizontal	horizontal	horizontal	horizontal	vertical
- diameter, mm.	/	/	/	/	/	/	/	/
- number of teeth	/	/	/	/	26	/	/	/
- diameter of disks, mm.	490	375	690	690	/	1,000	_	600/800/1,000
- number of disks	18	9	5	9	/	17	/	13
- number of hammers/rotor	16	24	24	48	/	32/64	24x2	4 + 10 + 21 + 35
Cards								
- number of lines	none	none	none	none	2	1	none	none
- number of cards per line	none	none	none	none	13	17	none	none
Grates	6 bars	none	adaptable bars	adaptable bars	none	none	adaptable gap from 20 to 100 mm.	none
Transmission	V-belts	V-belts	direct coupling	direct coupling	V-belt + hydraulic coupling	V-belt + hydraulic coupling	direct coupling	belt
Capacity	20/40 cu.m./h	50/100 cu.m./h	1.5/4 m.t./h w. grate 55 mm.	3/10 m.t./h.	20/30 m.t./h. or 100 cu.m./h	10/15 m.t./h.	9/10 m.t./h.	10/12 m.t./h.
Drive motor(s)								
- number	1	2	1	1	1	1	2	1
- type	electr.	electr.	electr.	electr.	electr.	electr.	electr.	electr.
- output, HP	120	62/27	100	150	150 to 220	180	2 x 125	150

Due to maintenance and delicate operational problems, we do not support the necessity of installing a rejects incinerator.

With the aim of meeting compost buyers' demands regarding separation of plastics and other inert material, the upgrading section must be treated with attention. The recommended process has the advantage of allowing easier upgrading operations, since the material to be upgraded is prefermented so that part of its water content is previously lost. Excellent results should be obtained using such equipment as : fine mesh sieves, fine crushing hammer mills and ballistic separators. Compost upgrading process must be planned thoroughly, even at the stage of the pilot plant.

b) Arrangements for local fabrication of equipment

A rapid survey of industrial facilities existing in the country indicates that a part of standard equipment like : conveyor belts revolving sieves, etc... as well as hoppers, intermediate parts, and sheet metal hardware, could be manufactured by Indonesian sub-contractors. Standard drive motors up to 20 or 25 HP are available. Nevertheless, gear motor and also drive motors of special design must be imported. Specialized equipment such as : heavy duty crushers or hammer mills, magnetic separators, slat conveyors, etc... as well as windrow turning-over machines and all sophisticated equipment must be imported.

c) Recommendations related to Civil Works

All buildings should be sized according to their respective destination and ground characteristics.

The capacity of the reception pit should be sufficient for two days storage of refuse. The pit must be constructed of reinforced concrete with all corners suitably curved, bottom minimum slope and drainage system. Reception platform should be wide enough to allow an appropriate number of lorries to discharge and manoeuvreeasily at the same time. Platform and access road should be heavily coated and suitably drained.

Apart from the supporting elements for crushing equipment which are to be designed for severe operational stress, all other sections of the plant may be built with light material such as metal sheets or asbestos-cement plates mounted on concrete or iron frame.

Complete crushing units fitted with respective hopper, feed slat conveyor and supporting iron frame are sometimes supplied by some specialized manufacturers. If not so, concrete antivibration platforms that resist mechanical stress during operation must be built by local contractor upon data provided by the manufacturer.

Fermentation and storage areas must be duly coated and designed to ensure easy turning traffic. Surface material to be used at compost fermentation and storage areas must be able to resist tempertatures of upto 70°C. Asphaltic revestment must also withstand severe treatment by shovel loader buckets and granular material must offer high abrasion and shock resistance. Suitable slopes and drainage commodities must be provided to allow satisfactory surface water drainage.

Fermentation area should be installed under an appropriate shed consisting of asbestos-cement or similar material with a roof supported by a modular iron frame. Supporting pillars are spaced in such a way allowing easy manoeuvrability for the loaders.

Power plant - if any - transformer and electrical control buildings should meet the usual safety requirement.

d) Since the composting process is carried out in the open air, special environmental considerations must be taken into account when selecting the site for the plant:

- Isolation from residential areas, dwellings, schools, etc. Composting plant could be located at industrial areas. Even a very well operated compost plant cannot avoid emissions of characteristic odour and dust, plastics and paper scattered by wind. The material is heavily infested with flies and insects.

- Its location must not adversely affect the logistics of the cleansing service.

- The plant should be located within an economic distance for the potential users.

- The site should be generally levelled and have an adequate area. Required surface area average :

15,000 sq.m.	for plant	capacity	160 tons/day
60,000 sq.m.	"	"	500 tons/day
85,000 sq.m.	"	"	1000 tons/day

- It must have an adequate electricity and water supply.
- It must have readily accessible and adequate facilities for the disposal of the non-compostable material.

An accurate and comprehensive survey is to be carried out for the selection of a suitable site that takes also further extension of the plant into account.

2.5. Cost estimation

2.5.1. Investment costs for an industrial composting plant.

A typical plant of this type should process 500 tons per day with one 8 hour shift. The plant's equipment has a lay-out of 1000 tons per day with two shifts.

I. Equipment

a) Reception, crushing and fermentation equipment comprising :

- 1 road vehicle weighbridge
- 1 equipment for reception pit including 2 grab-buckets mounted on respective bridge-cranes.
- 2 heavy duty hammer mills fitted with respective slat conveyors and geared-drive system
- 2 sifting revolving drums
- complete conveyer system allowing fresh compost distribution to the pre-fermentation section
- 2 sheds (fermentation section)
- 2 magnetic separators and 2 scrap presses
- 1 set of bi-metal thermometers
- 4 automatic compost windrow turning machines
- 4 wheeled loading shovels
- 2 92-93% sludge blending and metering devices (for processing sludges from nearby sewage treatment plant)
- 1 3-phase oil transformer 1,200 KVA
- electrical control panel

CIF cost price US $ 5,868,000

b) Upgrading line

comprising :

- 2 hoppers and respective conveyors

- 2 compost loosening machines
- 2 sifting revolving drums
- 2 ballistic separators
- 1 bagging section and respective handling facilities
- 2 fine crushing hammer mills with the complete compost and rejects distribution system
- electrical control panel
- main cabling

CIF cost price US $1,900,000

c) - <u>Vehicles</u>

- 4 wheeled loading shovels
- 1 auxiliary 8 cu.m. dump body truck
- 1 service truck for miscellaneous duties
- 1 small service van
- 1 multibucket system
- Refuse collection vehicles are not included

CIF cost price US $ 532,000

d) - <u>Other facilities</u>

- cranes, shovels, etc.
- workshop equipment and individual kits
- complete laboratory equipment

CIF cost price US $ 120,000

e) - <u>Installation of equipment - Technical assistance Indonesian staff training and fellowships, etc.</u>

- installation of equipment, about 5 months (not including the local manpower 40/50 workers)
- the technical assistance 36 m/m
- individual fellowships and Indonesian staff training

CIF cost price US $ 2,000,000

f) - <u>Wear and spare parts</u>

- Stock for 2-year operation and maintenance

CIF cost price US $ 550,000

CIF overall cost price CIF cost price US $10,970,000

II. <u>Buildings, civil work, roads and networks</u>

As a rough estimate, civil works costs are usually about 50% to 60% of equipment cost in the US and European countries. Since manpower cost is significantly less expensive in Indonesia, the respective civil works costs - that includes buildings, roads and networks - is estimated at 35% of the equipment cost, or :

- <u>for a 500 tons/day composting unit :</u>
  <u>the equivalent of US $3,840,000</u> in Indonesian currency

Should an extension of the plant up to 1000 tons per day be considered, 25% must be added to the above civil work costs :

- for a 1000 tons/day composting unit the equivalent of US $4,800.00 in Indonesian currency (≘Rp.3,000,000.000, - with an exchange rate of 1 US $ ≘ 625 Rp)

III. Refuse collection facilities

Should the plant be provided with their own collection facilities, we strongly recommend 12 compacting trucks with a capacity of 15 cu.m., which would then have the same collection capacity as 35 or 40 15 cu.m. open lorries. Such equipment is available at an average cost price of about US$ 75,000. Thus, the respective investment would be :

- 12 refuse collection trucks at unit cost price US $75,000		900,000
- 10% spare parts		90,000
Total	US $	990,000

2.5.2. Investment for a pilot plant

a) Mechanical and electrical equipment (foreign supply)

Post No.	Unit Nr.	Description	US $ FOB price
1	1	road vehicle weighbridge weighing range : 30 tons platform : 8m x 3m for weighing the incoming refuse collection trucks or outgoing compost delivery trucks	34,600
2	1	monorail mounted grab bucket hoist run length 14 m bucket lifting height 12 m bucket capacity : 1 cu.m.	55,000
3	1	slat conveyor length : 7 m. - wide : 1 m variable speed gear motor speed range 1.7 to 7.5 rpm for delivery to the hammer mill	73,500
			173,100

			173,100
4	1	<u>heavy duty hammer mill</u> capacity 10 tons/hour drive motor 150 HP, 1500 rpm w. starting device and driving v-belt with components and set of special parts and ancillaries	101,500
5	1	<u>Elevating conveyor belt</u> length 6 m. width 0.80 m with feed-hopper and feed-worm drive motor 2 HP - 1500 rpm v-belt driven	9,200
6.	1	<u>Sifting unit</u> revolving trommel type, ext. 2.10 m.- length 5 m. fitted with inlet hopper and discharge worm 0.90 drive motor 5.5 HP, 1500 rpm V-belt driven	39,900
7.	1	<u>Elevating belt conveyor</u> length 15 m., width 0.80 m. with feed-hopper and feed-worm drive motor 5 HP - 1500 rpm V-belt driven	21,200
8.	1	<u>Overband magnetic separator</u> fixed to the head of above belt conveyor, w. suspension magnet, discharge equipment, with 2HP gear motor with selenium rectifier for iron elements separation. Scrap press should be provided on request only.	8,200
9.	1	<u>Bi-roter hammer-mill</u> for compost fine crushing with 2 drive motors 60 and 30 HP, 1500 rpm V-belt driven with components and set of special parts and ancillaries.	42,500
10.	1	<u>Vibrating sieve</u> for fine screening Drilled sieving plates with holes 0.20 mm drive motor 12 HP, 950 rpm	44,000
11.	6	<u>Bi-metal plunging thermometers</u> temperature range 0 - 85°C with 100 mm reading dial Stainless steel stem and stirrup handle, length 1 m. 0 12mm	900
12.		<u>Complete electrical equipment for the plant</u> comprising of : <u>1 three phase oil transformer 250 KVA</u> (with possibility of further extension by adding additional cell) <u>1 complete electric control panel</u> <u>the main cabling and earthing equipment</u>	<u>67,000</u>
		Sub-total FOB	507,500
13.		<u>Contingency item 5%</u>	25,375
		<u>FOB fixed equipment total</u>	<u>532,875</u>

		FOB fixed equipment total (report)	532,875
		+ Oversea transportation 14% on FOB price	72,600
		+ Assembly on the site 18% on FOB price	95,917
		Overall cost price of assembled mechanical and electrical equipment *	701,392

* Since this investment is of general interest, it is assumed to be customs duty free

b) Rolling and transport equipment

14.	1	Wheeled loading shovel Diesel engine 140 HP 4-wheel drive, hi-tip bucket, quick release, 3 cu.m. bucket with refuse clamp + 1 refuse dozer blade	83,000
15.	2	Diesel engine lorries payload 10 m.t. for rejects removal	50,000
		Sub-total FOB	133,000
		+ Oversea transportation 8% of FOB price	10,640
		Rolling equipment overall CIF price	143,640

c) Spare parts

16. The Spare parts are of foreign supply that include all normal used parts to be periodically replaced (hammers, segments, grates, protection rings, slats for conveyors, etc.) as well as spare parts designed to most common repairs (moto-rotors, relés, pulleys, rollers, V-belts, transmission chains, etc.) are required to process about 35,000 or 40,000 m.t. refuse, ie. 2 or 3 years plant's operation

CIF package price US$ 50,000

d) Workshop tools and commodities
consisting of:

17. The lifting equipment (hoists, jacks, etc.)
Workshop equipment (welding equipment, workshop tools and kits, etc.)
CIF package price US$ 15,000

e) Buildings, civil works and networks (local supply) consisting of the following civil works and buildings implementation:

18. Site clearing up and preparation
surface area about 15,000 sq.m.

19. Excavation works and earth banking
for reception pit and platform and building foundations.

20. Execution of the reinforced concrete reception pit
10 m x 4.50 m x 3.50 m

21. Execution of the main processing block:
industrial type building with reinforced concrete antivibration basements. Reinforced concrete or steel frame structure and platforms. Building structure is filled with hollow bricks or asbestos-cement sheets. Corrugated asbestos-cement roofing.

22. Office and weighbridge building
2 office rooms, changing room, showers and lavatories.

23. Electrical equipment and oil transformer room that meet all safety requirements.

24. Heavy duty coated and drained areas
at: vehicles access and service roads, reception platform area, windrowing area: about 12,000 sq.m.

25. Main water supply

26. High voltage power supply

Package cost raw estimate Pos. Nr. 18 to 26:
35% of a) + b) equipment value,
i.e. the equivalent in Rp. of US$ 315,500
or - at exchange rate \$ 1 = Rp 625 Rp. 197,470,000

27. Prefermentation shelter

open steel frame supporting corrugated asbestos-cement - or similar material - roofing, modular structure allowing further extension, 2,200 sq.m. and 5.50 height under roof at Rp. 50,000 per sq.m. (approximate price provided by the Ministry of Agriculture) or (equivalent to US$ 177,000) Rp. 110,000,000

The investment estimate for a pilot compost plant processing ten tons of refuse per hour, located at any city of Indonesia, is as follows:

a)	Mechanical and electrical equipment	US$	701,392
b)	Rolling equipment		143,640
c)	Spare parts for 2 years operation		50,000
d)	Workshop tools and commodities		15,000
	Total	US$	910,032
e)	Buildings and civil works	Rp.	307,470,000

2.5.3. Calculation of the composting plants amortization

see Table 8

The calculation has been done for both industrial and pilot composting plants.

2.6. Costs for compost plant operation and maintenance

The following cost assessment had been done for two types of compost plant (see chapter 2.4.)

- industrial composting plant
- pilot plant.

A composting plant could generally operate 310 days per year if the rainy season is not too heavy. In Indonesia, however, due to the high water content of the urban refuse, which exceeds 70% during the rainy season, the composting process can become very difficult or even unpredictable. For this reason we assume only 270 days of operation per year.

For the yield of compost an average of 55% is assumed which would result in 550 kg of compost from 1000 kg of Indonesian urban refuse, with a characteristic described in 2.1.2.

Table 8

Calculation of Indonesian Composting Plants Amortization

1 - Mechanical and Electrical Equipment

(rolling equipment and spares not included)

15 years at World Bank interest rate 8% :

Amount US$ ....

Gross annuity US$ ....

Yearly interest US$ (rounded) ....

Annuity US$ ....

Equivalent Rupiahs (rate $ 1 = Rp 625) ....

2 - Rolling Equipment

5 years at World Bank interest rate 8% :

Amount US$ ....

Gross annuity US$ ....

Yearly interest US$ ....

Annuity US$ ....

Equivalent Rupiahs (rate $ 1 = Rp 625) ....

3 - Buildings and Civil Works

20 years at 12% (Indonesian interest rate) :

Amount Rupiahs ....

Gross annuity Rupiahs ....

Yearly interest Rupiahs ....

Annuity Rupiahs ....

4 - Total annuity Rupiahs ....

Note - Above interest rates and amortization time are in accordance with data collected from BAPPENAS on 20 August, 1980

	Industrial Plant 1,000tons /16 h.	Pilot Plant 160tons /16 h.
..	9,888,000	716,400
..	659,200	47,760
..	52,736	3,821
..	$\frac{9,888,000 + 52,736 \times Sn(1 - 15)}{15}$	$\frac{716,400 + 3,821 \times Sn(1 - 15)}{15}$
	= 1,081,088	= 78,328
..	Rp. 675,680,000	Rp. 48,955,000
..	532,000	143,640
..	106,400	28,728
..	8,512	2,298
..	$\frac{532,000 + 8,512 \times Sn(1 - 5)}{5}$	$\frac{143,640 + 2,298 \times S(1 - 5)}{5}$
	= 131,936	= 35,622
..	Rp. 82,460,000	Rp. 22,263,750
..	$3,000,000 \times 10^3$	$307,470 \times 10^3$
..	$150,000 \times 10^3$	$15,373.5 \times 10^2$
..	$18,000 \times 10^3$	$1,845 \times 10^3$ (rounded)
..	$\frac{(3,000,000 + 18,000 \times Sn(1 - 20)) \times 10^3}{20}$	$\frac{(307,470 + 1,845 \times Sn(1 - 20)) \times 1}{20}$
	Rp. 339,000,000	Rp. 34,746,000
..	Rp. 1,097,140,000	Rp. 105,964,750

2.6.1. Personnel requirements

The personnel expenses estimate is based on the figures provided by the Jakarta Composting Plant Manager, 26 June 1980.

On the level of an industrial composting plant a plant manager is needed, who meets all qualifications required for a director of a company with a comparable size. He is assisted by one technical manager who deals with the general plant's operation, one administrative manager in charge of all finance, personnel and legal affairs, and one chemical-agricultural engineer with the duty to closely cooperate with the Soil Research Institutes, Agronomy Institutes, and the Ministry of Agriculture Provincial Extension Services with the aim to finalize joint programmes for the application of chemical fertilizers and compost to specific crops cultivation.

On the other hand a pilot plant needs a manager with a very flexible ability and allround knowledge, since he does not have at his disposal the same technical staff as the manager of an industrial compost plant.

The number of workers for composting plants are usually only half the number given in Table 9 and Table 10. In this study the unemployment problems of Indonesia were taken into consideration. Since the salaries of unskilled labourers are low, additional workers for cleaning, washing and general daily maintenance are suggested.

In the following the personnel expenditures per ton refuse processed for both types of composting plants are summarized (see also Tables 9 and 10):

1. Industrial plant

   270,000 tons refuse processed per year, Rp. 79,061,400 personnel costs per year. Personnel costs per ton Rp. 293

2. Pilot plant

   43,200 tons refuse processed per year Rp. 28,110,720 personnel expenses per year. Personnel costs per ton Rp. 650

2.6.2. Utilities

a) Electricity

Price of electricity for industrial use is assumed at Rp. 59.50 per KWH (information provided by P.T. Kompos Jakarta)

Industrial compost plant

Refuse processed per hour: 62.5 tons

installed electrical power: about 1,120 KW

Table 9 Personnel required for the Industrial type Composting Plant - Refuse capacity 1,000 t /16 h.

	Ins.Rp./month
1 General Manager	350,000
Management and Administration Staff	
1 Administrative manager	250,000
1 Technical manager	250,000
1 Accountant assistant	150,000
1 Chemical and Agricultural Engineer, head of the Compost Development Service	250,000
2 Laboratory assistants : 2 x 75,000	150,000
1 Secretary Chief-assistant	150,000
3 Trained Administrative Clerks : 3 x 75,000	225,000
2 Clerk-typists : 2 x 50,000	100,000
1 Storekeeper	60,000
2 Storekeeper-assistants : 2 x 50,000	100,000
3 Weighbridge operators : 3 x 50,000	150,000
18 staff employees	2,185,000
Operation staff	
2 Technical senior foremen : 2 x 150,000	300,000
2 Technical junior foremen : 2 x 100,000	200,000
2 Electricists : 2 x 125,000	250,000
6 Mechanical or electricist assistants 6 x 50,000	300,000
4 Grab-bucket operators : 4 x 50,000	200,000
4 Loader operators : 4 x 50,000	200,000
4 Revolving machine operators : 4 x 50,000	200,000
6 Lorry drivers : 6 x 50,000	300,000
30 Operartion staff members	1,950,000
Maintenance staff	
1 Workshop master : 1 x 100,000	100,000
3 Workshop assistants : 3 x 50,000	150,000
2 Painters : 2 x 60,000	120,000
2 Rolling equipment maintenance workers 2 x 50,000	100,000
8 Maintenance staff labourers	470,000
Non skilled labourers	
25 Non-skilled labourers (with the duty to help, wash, sweep, clean, etc...) at the average salary : 25 x 28,000 = 700,000	470,000
Safety and Security Team	
1 Security head	50,000
3 Security guards : 3 x 30,000	90,000
4 Security team	140,000
86 Personnel members : Total salary per month	5,445,000

Salary year :

- 5,445,000 x 12	Rp.	65,340,000
- more : social charges (health insurance, incentive, social welfare) 21%	Rp.	13,721,400
Total annual wages :	Rp.	79,061,400

or :

Salary rate per 1 ton refuse processed : Rp. 29[illegible].-

Table 10 — Personnel required at the Pilot Composting Plant - Capacity : 160 tons refuse/16 hours

	Rupiahs/month
1 Plant manager	300,000
2 Senior mechanic or electricist foremen 2 x 200,000	400,000
2 Mechanic assistants 2 x 50,000	100,000
2 Electricist assistants 2 x 50,000	100,000
2 Grab-bucket operators ... 2 x 50,000	100,000
3 Engine drivers 3 x 50,000	150,000
2 Weighbridge operators 2 x 50,000	100,000
1 Workshop master	100,000
2 Workshop assistants 2 x 50,000	100,000
1 Painter	60,000
2 Lorry drivers 2 x 50,000	100,000
2 Security guards 2 x 30,000	60,000
1 Clerk-typist	50,000
8 Non-skilled labourers 8 x 27,000	216,000
30 Personnel members with Total Salary per month	1,936,000

Salary year :

- 1,936,000 x 12	Rp.	23,232,000
- more : social charges (health insurance, incentive, social welfare) 21%	Rp.	4,878,720
Total annual wages :	Rp.	28,110,720

or :

Salary rate per 1 ton refuse processed : Rp. 651.-

consumed power: about 860 KW

consumed power per ton refuse processed 14 KW

costs for electricity per ton: Rp. 833

Pilot plant

Refuse processed per hour:	10 tons
installed power:	about 220 KW
consumed power:	about 140 KW
consumed power per ton:	14 KW
cost for electricity per ton:	Rp. 833

b) Fuel consumption

The basis for the calculation is a fuel price of Rp. 250 per gallon (P.T. Kompos Jakarta); 10 % of fuel costs must be added for lubricants

Industrial compost plant

- Fuel for power shovel operation:
  64 hours per day operation is assumed, if all diesel loaders are operating at the same time with a consumption of 16 l per loader. Then the total consumption per day is 1,024 l.
- Fuel for the removal of rejects:
  It is assumed that the removal of rejects to appropriate dumping sites is performed by the plants own transportation facilities. With one trip one truck removes 5 m.t. of reject during one hour with an average fuel consumption of 15 l per hour, consumption per day 360 l.

Total fuel consumption per day 1,384 l

Total fuel costs + 10 %: Rp. 83.71 per m.t. of refuse

Pilot plant

- Fuel for power shovel operation:
  14 hours per day of operation with a fuel consumption of 16 l/hour, total consumption 224 l/day.
- Fuel for the removal of rejects:
  19.2 tons of rejects are assumed, which lead to a fuel consumption per day of 57.5 l

The total fuel consumptic- is 282 l per day.

The total fuel costs + 10 % per ton of refuse: Rp. 106.75

c) Water consumption

Due to the high water content of Indonesian refuse no additional water has to be added to the refuse before processing. Therefore, water is only needed for general maintenance.

Price of water: Rp. 75 per m3
Water consumption per ton refuse: 100l
Total costs for water per ton refuse: Rp. 7.50

d) Spare parts

In the following it is assumed that spare parts are to be imported. However, local industries could provide part of the replacement parts at lower costs.

Cost for spare parts per ton refuse: Rp. 1,000

e) Maintenance

- Plant equipment: 1 % of the investment costs:
  Industrial plant: Rp. 229 per ton refuse
  Pilot plant: Rp. 112 per ton refuse

- Mobile equipment:
  These costs are calculated assuming 70 % of the respective investment costs over a period of 10,000 hours:
  US$ 6.10 per hour for each loader
  US$ 2.00 per hour for each truck

Industrial plant

Maintenance costs for trucks and loaders: Rp. 325/ton

Pilot plant

Costs for loaders and trucks: Rp. 441/ton

f) Buildings etc.

Raw estimate is 1 % of investment for buildings, civil work, roads etc.

Industrial plant: Rp. 111 per ton refuse
Pilot plant Rp. 71 per ton refuse

g) Overhead

(see Table 11) 20 % overhead should be added to the total costs for operation and maintenance:

Industrial plant: Rp. 779 per ton refuse
Pilot plant: Rp. 647 per ton refuse

2.7. Compost production price

2.7.1. Compost price without amortization.

Costs for processing one ton of refuse are summarized in Table 11.

Table 11

Indonesian Household Refuse Processing Costs
and Compost Cost Price (Summary)

	Industrial plant 1,000 tons /16 h.		Pilot plant 160 tons/16 h.	
Personnel	Rp.	293.-	Rp.	651.-
Utilities				
- Electricity	-	844.-	-	844.-
- Fuel + ingredients	-	84.-	-	107.-
- Water	-	8.-	-	8.-
Spare parts and wear parts				
for fixed equipment	-	1,000.-	-	1,000.-
Maintenance				
- Fixed equipment	-	229.-	-	112.-
- Rolling equipment	-	325.-	-	441.-
- Buildings and civil works .	-	111.-	-	71.-
		2,894.-		3,234.-
+ Overheads 20%		579.-		647.-
Total : Operation cost for 1 ton refuse processed	Rp.	3,473.-	Rp.	3,881.-
1 ton compost cost price with yield 55% (without amortization)	Rp.	6,315.-	Rp.	7,056.-
- Amortization rate per 1 ton compost generated ..	Rp.	7,388.-	Rp.	4,460.-
1 ton compost cost price including amortization	Rp.	13,703.-	Rp.	11,516.-

Industrial plant: Rp. 3,473
Pilot plant: Rp. 3,881

For calculation of the production price of compost one has to consider that the yield of compost generated by household refuse is about 55 %. Therefore, compost production price for the two different types of plants will be:

Industrial plant Rp. 6,315 per ton compost
Pilot plant Rp. 7,056 per ton compost

Here, amortization costs are not included.

At this point, one should compare these results of production costs with those reported from India at the National Seminar on "Biogas and City Waste Composting" at Jakarta, Indonesia, 1 - 4 July 1980.

For one ton of compost:

Bombay:	Indian Rp.	60	(≙ Indonesian Rp.	5,400)
New Delhi:	" Rp.	77	(≙ " "	7,030)
Ahmedabad:	" Rp.	60	(≙ " "	5,400)

The production costs for Indonesia are in the same range as those reported for India.

2.7.2. Compost price with amortization

In Table 8 the costs for amortization of the plants are calculated. The amount of costs for compost production is easily obtained dividing costs of amortization by the yearly compost production rate and adding this to the compost production costs obtained under 2.7.1.

The production costs per ton of compost including amortization are:

Industrial plant: Rp. 13,700
Pilot plant: Rp. 11,516

The pilot plant treats a smaller total amount of refuse and is, therefore, equipped in the most simple way that cannot be done for an industrial plant. Therefore, the costs for amortization are significantly lower for a pilot plant than for an industrial plant.

2.8. Compost marketing

It has already been mentioned before that the demand for organic material in Indonesia is remarkable and that compost is demanded all over the country as a valuable soil conditioner. The agricultural sector is able to absorb a large quantity of compost, even considerably higher than forecasted.

Successful compost marketing is subject to the following necessary requirements:

- the availability of a good and regular quality of compost that meets standards of quality that are to be defined;
- the complete understanding of farmers to compost application as a soil conditioner;
- the availability of different types of compost which meet the requirements for application to different specific crops;
- the distribution of the product at prices oriented towards market conditions.

2.8.1. Quality standards for compost

In spite of the heterogeneous character of municipal refuse, quality standards for compost can be defined and should be established by governmental regulations.

Our definition of compost is the following:
"Municipal Refuse Compost" or "Household Refuse Compost" is the product obtained through aerobic controlled fermentation of municipal household and/or market refuse with an appropriate physical treatment such as: sorting, crushing, screening, metals removal, etc., and that contains colloidal humus complex which is the result of microbiological reactions. Only products which fulfil all following minimal requirements are allowed to be called "Municipal Refuse Compost" or "Household Refuse Compost".

These minimal requisits are as follows:

- particle size: 90 % of the product passes through riddle with ∅ 35 mm holes;
- water content: less than 35 % in weight;
- carbon content: over 5 % C in weight of dry material;
- nitrogen content: over 1.3 % N in weight of dry material;
- carbon to nitrogen ratio: C/N ratio in the range of 15 to 25;
- free of pathogenic germs
- free of seeds

Should the above definition be established by law it is recommended that compost deliveries are accompanied with a voucher that testifies the conformity of the product with above standards. With above standards introduced, other definitions must be found for other products that are generally sold under "compost" in Indonesia at present. We suggest the following:

- fresh garbage: household and market garbage that has not been subjected to any mechanical or fermenting process;

- screened - crushed garbage: the result of mechanical treatment of household refuse with crushed product passing through riddle Ø 75 mm.
- riddled dump garbage: the product obtained by screening household refuse from more or less old dumps. Organic material content of old garbage has decreased due to either intensive combustion or progressive mineralization to such an extent that C/N ratio dropped below 10, so that such a product cannot be called compost.

It is advisable that physical and chemical analysis is frequently carried out in order to make sure that the above standards are fulfilled. The pilot plant should operate with the control of a specialized laboratory, officially entitled by the Ministry of Agriculture such as the Soils Research Institute of Bogor, or others, depending on the location of the first plant. For an industrial plant, a laboratory and testing team are also considered.

2.8.2. <u>Dissemination of information to farmers</u>

Promoting and advertising of compost is the responsibility of the Ministry of Agriculture. This aspect of the problem was also discussed at the National Seminar, Jakarta, 1 to 4 July 1980.

The services of the Ministry of Agriculture are provided with an efficient and adequate organization to carry information on compost to Indonesian provinces. Each Province Extension Service (Kanwil Deptan) has staff with specialists on fertilizer application whose opinion is very well considered among farmers of their extension area.

Also, the Ministry of Agriculture has a Research and Development Section for the popularization of new techniques and is engaged - via the Province Extension Services - in all agricultural and marketing activities as the supervisor of all Government estates.

2.8.3. <u>Application of different types of compost to different crops</u>

Composting plants of both types are equipped to supply different types of compost for specific agricultural uses.

a) <u>Coarse compost (3rd quality)</u>

The minimal requisites as defined in 2.8.1. relate to coarse product that could be called 3rd quality compost. Upper Ø 35 mm riddle large bodies of plastics, leather, glass and other inert material were removed. Such material can be applied to the soils as basic conditioner for arboreal crops, such as citrus, papaya etc.

b) Standard quality compost (2nd quality)

The upgrading process was more carefully carried out. Pieces larger than 2 or 3 mm were removed and a more carefully performed riddling ensures a satisfactory uniform texture. Standard quality compost may be applied to most food crops: maize, cassava, arboreal and outdoor market gardening crops as well as to estate crops: tea, coffee, rubber, cloves. It should be used for the distribution of organic matter in the surface layer.

c) Fine compost (1st quality)

An upgrading process that allows the obtaining of such a refined 1st quality product requires further riddling operation through fine riddle (∅ 20 mm) as well as further fine crushing for complete pulverization of smaller pieces. Upgrading process is completed by ballistic separation to achieve small plastic particles removal. Such type of compost is specially designed to market gardening.

d) Special top quality compost

It is possible to produce perfectly upgraded and deodorized compost types in limited quantities for hotel lawn grounds and ornamental applications. Small quantities of chemical fertilizer may be added to improve nutrient properties and justify sale price at the same time. Blending compost and chemical fertilizer with 5 - 10 kilos superphosphate per 1 cu.m. compost is a profitable practice that allows the charging of attractive sale prices. It is obvious that such a special top quality compost would be bagged in 5 or 10 kilo parcels labelled with analytic data information.

2.8.4. Suggestions for an average compost sale price

The compost sale price must be the result of a fair compromise between the usual organic conditioner sale price and compost production costs. Sale prices for organic material from different sources that are of common use in Indonesia have been reviewed and summarized in Table 6. These prices, however, cannot be compared to each other because the different types of soil conditioners have quite different fertilizing quality. Thus, one ton of animal manure with 70 to 80 per cent of water content cannot be compared to one ton of compost with 30 to 32 per cent of water content only; or raw garbage with a low density of 0.25 to 0.3 is not comparable to compost of a density three times higher.

According to the opinion of most of the officers within Province Agriculture Extension Services the average compost price of about Rp. 15,000 per ton is considered reasonable and feasible. For example, in the area of Surabaya a compost market price of Rp. 17,500 per ton prevails. These figures are in agreement with the findings in chapt. 2.7.

We suggest the following figures for compost delivered at the factory in bulk:

a) Coarse compost (3rd quality)
   Rp. 12,500 per ton

b) Standard quality compost (2nd quality)
   Rp. 15,000 per ton

c) Fine compost (1st quality)
   Rp. 17,500 per ton

d) Special top quality compost
   Minimum Rp. 35 per kilo packed in bags.

A lot of crop growing areas are distant - or very distant - from the composting plant and since compost is a voluminous bulky material transport charges are a big handicap to compost sales.

According to data collected from PT. Kompos Jakarta, road transport prices are as follows:

- inside city: Rp. 0.5 to Rp. 1 per 10 km
- outside city: Rp. 2 to Rp. 3 per 10 km

or an average value Rp. 150 per km ton.

It is suggested that a warehouse be installed close to the main areas and used for sales distribution of compost in the same way as is practiced for chemical fertilizers and other farm utilities.

2.8.5. Is Government support needed for compost sales?

a) Chemical fertilizers

Government support given to chemical fertilizers in Indonesia is a common and incentive practice, and also of significance to thechemical industry. As can be seen from Table 6, chemical fertilizers are sold to farmers at Rp. 70 per kilo, while the average cost is about Rp. 150 to 160. In other words, chemical fertilizers are subsidized by about 50 per cent.

b) Compost

If the compost sale price is kept at Rp. 15,000 per ton, it seems that no Government support is needed. However, high transport costs turn compost too expensive for lower income farmers.

For this reason, Government support is suggested, at least in the form of transportation subsidy. It is advisable to make the compost plant owner responsible for the transport of compost to several distribution warehouses and to grant him a lump subsidy for transport costs in proportion to the total delivery and calculated according to the average distance to different warehouses.

It is not easy at this stage of preliminary assistance - to establish an appropriate subsidy rate. This is a matter for the Ministry of Agriculture. But it is important that the same prices for compost are applied everywhere in Indonesia. Of course, special top quality compost for ornamental plants does not require any support. Government support is suggested only for application in agriculture because of its importance to the national economy.

2.8.6. Management of the composting programme

If the Indonesian composting programme is implemented, the Government has to decide on the programme's organization, operation and management.

- The municipality, responsible for the waste management of the city, delivers the collected garbage to the compost plant free of charge. If the collection service, however, is carried out by the plant with its own collection equipment, a respective contract should be awarded by the municipality to the compost plant owner.
- It seems advisable that the Ministry of Agriculture be the responsible authority for compost marketing and distribution and related issues as is currently practiced for chemical fertilizers. In this way, a suitable technical support for compost application could also be ensured. Within the framework of the National Composting Programme the distribution of different types of compost will be subject to special technical and commercial activities organized by the Ministry of Agriculture.

2.8.7. Public or private responsibility for composting activities?

At present, private companies are involved in composting activities in Indonesia. Should a state-controlled composting sector be set up in the framework of the Indonesian National Composting Programme, it is important that equal support - especially in the form of subsidies - be given to the private and public sector, in order to ensure that standards of compost as specified in 2.8.1 are satisfactorily fulfilled. Also a fixed compost sale price must be established to avoid eventual speculations.

According to the findings of chapters 4 and 5 significant investment is required from the private sector in order to restore the existing composting plants and to put them on an equal basis with future state-controlled composting plants. Government support for the private sector would be fruitful for this purpose.

2.9. Budget estimate for a National Composting Programme

This estimate covering two 5-year periods - 1983/1987 and 1988/1992 - was set up in Jakarta on 21 August 1980 and submitted to BAPPENAS (National Planning and Developing Board)

2.9.1. Jakarta

Population 1980 : 6,081,963
" 1985 : 7,762,297
" 1990 : 9.906,876

Amount of solid waste generated per capita (1980) :
1.96 liter/day or 0.56 kg/day

Refuse growing rate per capita/year: 2 %

Forecast 1983/1987

a) Pasar Mingu composting plant implementation

i.	Inventory and assembly of the equipment	US$	2,000,000
ii.	Buildings and civil works		2,000,000
		US$	4,000,000
iii.	Plants own collection facilities (compacting trucks)	US$	750,000

The capacity of this plant is 1,100 cu.m./day refuse or 315/350 tons/day

b) One additional composting unit of the industrial type

Consisting of 2 or 3 lines with processing capacity:

500 tons refuse in 8 h. working time/day
750 tons refuse in 12 h. working time /day
1,000 tons refuse in 16 h. working time/day

Investment costs:

i. equipment	US$ 11,000,000
ii. civil works	35 to 40 % of equipment in Rupiahs
iii. plant's own collection facilities (compacting trucks)	US$ 1,000,000

Forecast 1988/1992

a) Two additional composting units of the industrial type of the same type and cost as above, with overall processing capacity:

1,000 tons refuse in 8 h. working time/day
1,500 tons refuse in 12 h. working time/day
2,000 tons refuse in 16 h. working time/day

Investment costs

i. equipment	US$ 22,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$ 2,000,000

b) Alternative issue:
Pasar Mingu plant extension (cost not assessed)
+ one additional composting unit of the industrial type.

2.9.2. Bandung

Population 1980 : 1,400,000
" 1985 : 1,700,000
" 1990 : 2,000,000

Forecast 1983/1987

One composting unit of the industrial type

240 tons refuse in 8 h. working time/day
360 tons refuse in 12 h. working time/day
480 tons refuse in 16 h. working time/day

Investment cost

i. equipment	US$ 6,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$ 500,000

Forecast 1988/1992

One additional composting unit of the recommended type

500 tons refuse in 8 h. working time/day
750 tons refuse in 12 h. working time/day
1,000 tons refuse in 16 h. working time/day

Investment costs

i. equipment	US$ 11,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$ 1,000,000

The remainder of municipal refuse has to be discharged in sanitary landfill.

2.9.3. Surabaya

Population 1980 : 2,300,000
" 1985 : 3,120,000
" 1990 : 3,660,000

Refuse generated per capita: 0.5 kg/day (1980)
Amount growing rate per year: 2 %

Forecast 1983/1987

One composting unit of the industrial type with capacity:

500 tons refuse in 8 h. working time/day
750 tons refuse in 12 h. working time/day
1,000 tons refuse in 16 h. working time/day

Investment costs

i equipment	US$ 11,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$ 1,000,000

Forecast 1988/1992

One additional composting plant of the industrial type with capacity :

500 tons refuse in 8 h. working time/day
750 tons refuse in 12 h. working time/day
1,000 tons refuse in 16 h. working time/day

Investment costs

i. equipment	US$ 11,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$1,000,000

PT Kurnia Pelita is able to process 120 tons/day refuse. Should recommended improvements be carried out by a private company and the extension completed, the overall refuse processing capacity passes to 240 tons/day.

The remainder of municipal refuse must be tipped into sanitary dumps.

2.9.4. Medan

Population 1980 : 630,000
" 1985 : 843,000
" 1990 : 1,128,000

Forecast 1983/1987

One composting unit of the industrial type but with half overall capacity :

240 tons refuse in 8 h. working time/day
360 tons refuse in 12 h. working time/day
480 tons refuse in 16 h. working time/day

Investment costs

i. equipment	US$ 6,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection means	US$ 500,000

Forecast 1988/1992

One additional composting unit of the industrial type

240 tons refuse in 8 h. working time/day
360 tons refuse in 12 h. working time/day
480 tons refuse in 16 h. working time/day

Investment costs

i. equipment	US$ 6,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$ 500,000

PT. Kurnia Pelita is able to process 120 tons/day. Should recommended improvements and further extension be carried out, overall refuse processing capacity passes to 240 tons/day.

At both stages, the remainder of municipal refuse must be tipped at the sanitary landfill.

2.9.5. Semarang (750,000 inh. in 1980)

2.9.6 Ujung Pandang (600,000 inh. in 1980)

2.9.7. Solo (550,000 inh.)

2.9.8. Jogyakarta (383,000 inh.)

2.9.9. Bogor (220,000 inh.)

2.9.10. Denpasar (206,000 inh.)

Forecast 1983/1987

One pilot plant consisting of 1 line with 10 tons/hour refuse capacity

Investment costs

i. equipment	US$ 1,500,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection facilities	US$ 250,000

Forecast 1988/1992

Extension of the respective pilot plant by adding one or two additional lines:

i. equipment	US$ 1,500,000 to 3,000,000
ii. civil works	35 to 40 % in Rps.
iii. plant's own collection means	US$ 250,000 to 500,000

Above cost forecast of equipment includes:

- all mechanical and electrical equipment for main and upgrading lines;
- the installation of equipment as well as starting up, commissioning and 1 year technical assistance;
- the service vehicles according to the capacity of the respective plant;
- assistance for staff training and individual fellowships;
- wear and spare parts for two years of operation.

Inflation rate is not taken into account. Price appraisal valid as per 1 August 1980.

3. Summary of recommendations

Present prevailing conditions for solid waste treatment in Indonesia necessitate immediate action being taken for the setting up of a National Composting Programme. However, its implementation requires extensive financial resources as well as technical assistance over several years

3.1. Government's input

If the Government of Indonesia embarks on a National Composting Programme the following steps have to be undertaken:

a. Legislative and other measures to set up the necessary institutional framework for the National Composting Programme.

b. Allocation of appropriate funds and administrative support for the provision of

- adequate waste collection facilities as recommended for delivery of refuse to the projected plants,
- compost plants in different cities, including land, utilities, equipment and construction and maintenance expenditures.

c. Selection, preparation and specialized training of staff for the compost plants, if possible under a UNIDO assistance project.

d. Provision of financial and organizational support for the promotion of compost sales and application in agriculture.

3.2. UNIDO inputs

Further UNIDO assistance may be considered with the following aims:

a. To complete the elaboration of a detailed scheme for solid waste composting management in major cities of Indonesia, to be implemented in several phases, according to section 2.9.

b. To finalize a preliminary survey and complete accurate data collection regarding the composition of refuse at different cities, indicated for a possible future composting plant within the framework of the National Composting Programme.

c. To complete and/or coordinate previous surveys in order to ensure the establishment of an efficient collection service to deliver on a regular basis enough refuse to the projected composting plants.

d. A first objective should be the establishment of a pilot plant with characteristics as recommended under 2.6; to provide a location for the site, local arrangements, preparation of a specification book etc.

e. To prepare an outlet for compost that would be produced at different areas, and to deal with all marketing, distribution and application problems, jointly with the Indonesian Central and Provincial authorities.

Since the agricultural sector is largely involved, this aspect of the programme may be carried out under FAO/UNIDO cooperation.

It is recommended that UNIDO assistance or, eventually, UNIDO/FAO assistance, is provided through the appointment of 36 m/m engineering staff that includes at least one refuse collection and disposal specialist, one expert in garbage processing and composting plant operation, and one agronomist with extensive experience in organic fertilizers marketing and application. However, it must be pointed out that depending on the extent and duration of the National Composting Programme, one year assistance may not be enough and that one or two further extensions should be foreseen.

4. The Completion of the Jakarta Composting Plant

4.1. History of the Jakarta Composting Plant

On September 13, 1961 a contract was signed between the Municipality of Jakarta - supported by the Central Government - and John Thompson Compost Plant Ltd., London, UK, for a refuse composting disposal plant in Jakarta with a capacity of 1,100 m^3 per day.

The plant, delivered cif Jakarta in 1963, had a value of £595,000,- (Rp. 595,000,000,-) at that time with 40 collection vehicles, assistance during erection and testing included. By the end of 1964 construction of buildings was completed only up to 20% of the total on the plant's site at Pulo Mas/Pulo Gadung which appeared very suitable. Unfortunately, due to political events and a significant lack of funds, the plant went under the authority of the Municipality of Jakarta.

In addition, according to a new city master plan, Pulo Mas was declared as a residential area and the plant had to be transferred to Pasar Minggu, 25 km south of Jakarta. All the equipment was stored on land owned by Mercu Buana, a Holding Company. After several attempts failed to find financial aid for the completion of the plant, which by now had increased up to 726,000,000,- Rp., the Municipality and Mercu Buana signed an agreement in 1973 according to which the Municipality turned over the ownership of the equipment to P.T. Kurnia Pelita, a subsidiary of Mercu Buana, and also the right and responsibility for completion, operation and maintenance of the plant.

In 1975 an expert from Bangkok, where John Thompson composting plants were also operating and which in 1979 had been visited by the expert, was invited to advise on the erection of the plant. Results of this visit were that with the help of the Municipality of Bangkok the completion of the plant was going to be undertaken. Missing drawings were asked from J. Thompson but were not supplied, although John Thompson, now part of the Clarke Chapman Ltd. group, proposed establishing an inventory (like in 1970) prior to the completion of the plant and promised to send his representative. But nothing happened.

Siemens-Indonesia checked in 1976 the electrical equipment and in 1979 a private company P.T. Boma-Bisma-India wasinvited to do another survey, the result of which was that the whole plant's erection and completion costs were estimated at 1,649,642,00,- Rp.. As to the expert's information this company has not so far receivedany payment for its service.

Within the framework of the FAO project "Recycling of organic wastes" FAO Regional Co-ordinator Mr. P.R. Hesse in 1979 contacted the Indonesian Authorities and a UNIDO proposal was submitted to the Government. After this, UNIDO preliminary assistance was requested to advise on the completion of the Jakarta composting plant.

4.2. General Survey of the Jakarta Composting Plant

The plant's operation principle is based on aerobic digestion crushed refuse. The operational scheme can be subdivided into the following 3 sections:

1. Reception, shredding and separation of rejects

   This part is standard equipment with a reception pit, two crushing and separating lines, one upgrading section.

2. Fermentation

   This is a specific John Thompson design. A collection and distribution conveyor system furnishes the fermentation house with the refuse, where it is discharged into perforated steel troughs on the top level of a series of 6 levels of troughs. Every 24 hours

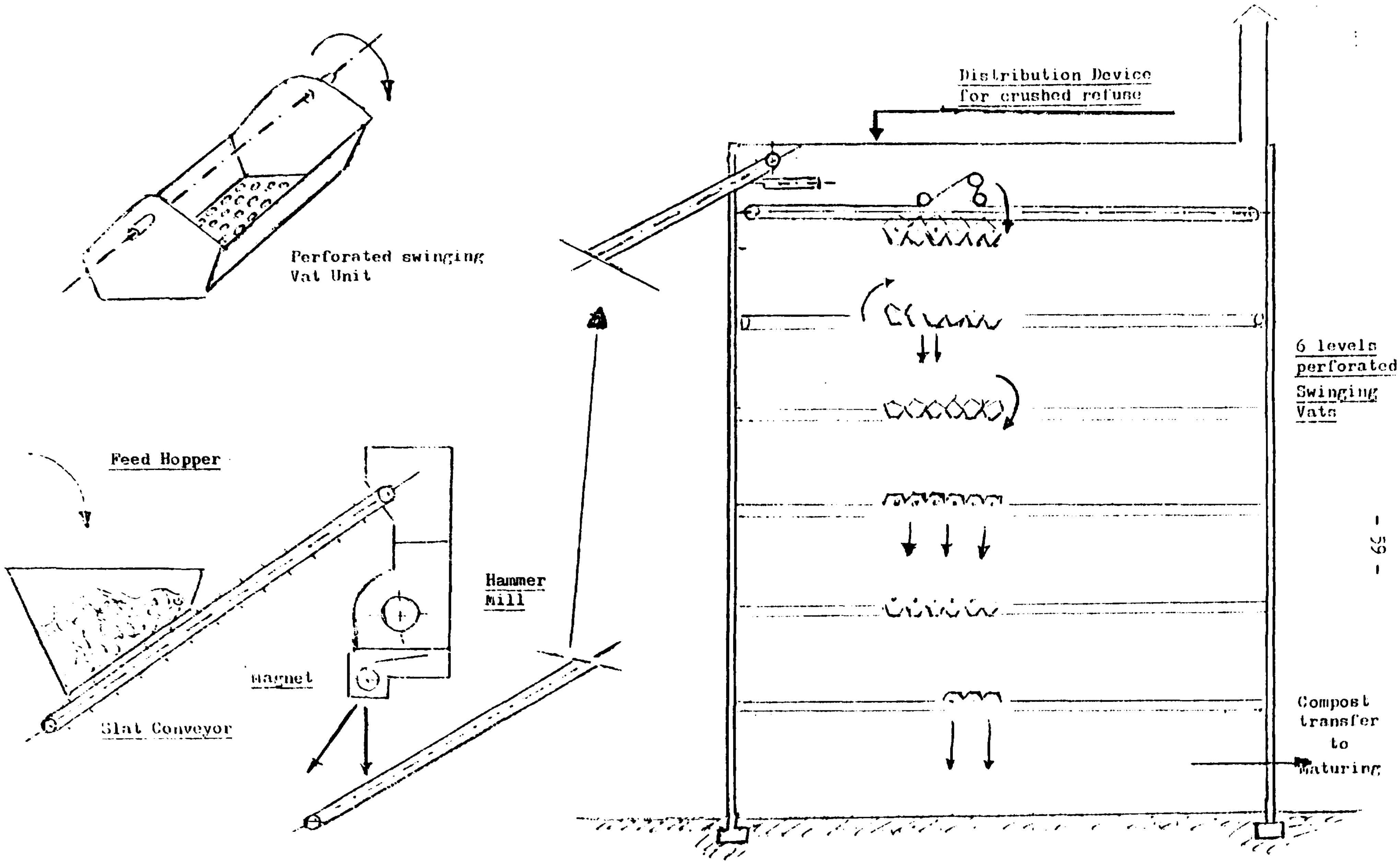


Figure 3 Composting Process of John Thompson Method

material is transferred from an upper to a lower level trough until the fermented product arriving at the ground level is transported to the maturing section. The whole process is controlled and steered automatically and represents quite sophisticated and costly equipment.

3. Maturing

Three maturing houses (80 x 16 m), two tractors (Massey Ferguson 35x), two bulldozers (Massey Ferguson 205) are the units for the maturing section.

The plant is equipped with three 270 KVA Diesel generators (Lister Blackstone) for 380/420 Volt, one of which at present is only used. For the maintenance of the plant a workshop with the usual tools is provided.

4.3. <u>The actual value of existing equipment</u>

The equipment overall weight is 1,268 metric tons. The contract's value was £595,000 in 1961 or - at the exchange rate £1 = Rp.1,000 at this time - Rp.595,000,000,-. Evidently, this figure does not cope with the reality of the present time.

Value assessment was carried out in 1979, with an average increase of 76%.

On the basis of the above price and in comparison with other costs for composting plants with the same capacity, should the Jakarta plant be purchased today, the price would be in the range of 9-12 million uS $.

On the other hand, sale possibilities are more than limited since 60% of the equipment could be used only for composing plants operating a John Thompson system. Therefore the completion of the plant still appears to be the most economic solution although a significant investment is required.

In the following, the value of different sections relative to the total, which has not changed since 1961, is presented:

- Reception, crushing, separation 13.38%
- Fermentation.......................... 59.04%
- Power plant 7.46%
- Heavy duty rolling equipment........... 5.50%
- Weighing 0.07%
- Workshop tools 0.38%
- Collecting trucks (lost equipment) .... 14.[illegible]0%.

It is interesting to observe that the fermentation section with 60% of the total costs has only a capacity of 320 tons day while reception, crushing etc. section with a capacity of 900 tons/day represents only 13.4% of the total cost. Therefore, if an extension of the fermentation section to the full capacity of 900 tons/day is considered, such costs would be up to 120% of the actual overall value of the plant, assuming a linear relationship between increase of price and increase of capacity.

4.4. <u>Present conditions of the Jakarta composting plant</u>

4.4.1. <u>Technical aspects</u>

At present one of the three maturing houses is used as an office, the two others as warehouses for the equipment. A large part of the steel construction is repainted or under repainting.

Most of the machinery remained untouched for 17 years under tropical conditions. Without an inventory the construction of the plant cannot be undertaken.

The power supply is satisfactory, although two of the three generators are run manually. Construction and assembling drawings are available. The forty collection trucks, however, have been assigned to other purposes many years ago.

The new Pasar Minggu site, prepared for the erection of the plant, is not easily accessible, since one has to travel over the level crossing of the heavily frequented Jakarta-Bogor railroad before arriving at the entrance of the plant. The road conditions are also rather difficult.

4.4.2. Legal aspects

Responsibility and ownership circumstances of the Jakarta composting plant appear quite unclear. Land belongs to the private company Mercu Buana, but the expenses of the staff and maintenance is paid by the Municipality of Jakarta. It now seems that Mercu Buana is losing interest in managing the plant in the future.

A ten-man team of 20 staff personnel is in charge of safeguarding and maintenance of the stored equipment.

Colonel Marsono, the present manager and director of P.T. Jakarta, with many years of experience in composting will take part in a one-month training in New Delhi, India, within the FAO-project TCP/INS/8904.

4.5. Problems to be solved in order to complete and operate the Jakarta Composting Plant

4.5.1. Technical problems to be solved in order to complete the plant

For the assembly of the equipment, several proposals were made, but not one so far has been fully satisfactory. A particular problem is the fact that 60% of the equipment is of John Thompson Ltd. (U.K.) origin. Furthermore, the design of the fermentation house operating system requires extensive accuracy and specific skills.

Therefore, as a first step, the supplier of the plant should be contacted first before any other decision is made. A list of missing or replacement parts should be submitted to the supplier in case he shows interest in further collaboration.

However it seems appropriate to assign the civil engineering work to a consulting company which will be responsible for calculation of costs and the execution of the work, done by Indonesian contractors.

Prospects for future extension: Since the crushing section's capacity is nearly three times the capacity of the fermentation section, it is reasonable to consider further extension now in order to give the plant its full capacity. Such extension would allow the processing of about 20 to 25% of Jakarta generated garbage whereas presently designed capacity is hardly sufficient for processing 8 to 10%.

However, it is too early to advise the Government on the best design and process to be selected for the extension of the fermentation section. Available space as well as investment and operation cost according to local conditions should first be considered.

4.5.2. Technical problems to be solved in order to operate the plant

(a) Refuse supply by road

To improve the junction of the national road to Jakarta with the dirty road leading to the plant: e.g. traffic lights and widening of the left lane of the road; to coat the dirty road and equip the railroad gate with traffic lights, acoustic signals and automatic blocking. The guard's shelter at the railroad gate is already constructed but not used at present.

At the same time suitable measures are to be taken to avoid high transport frequencies of the refuse collection trucks, which could be reduced to 30% by the use of high capacity compact trucks.

(b) Refuse supply by rail

It is most advisable to take advantage of the existing railroad for the plant's refuse supply with the help of a suitable branching-off upstream. This now seems feasible after Colonel Marsono contacted the Railroad Directorate. This would also allow compost transportation by rail downstream, and facilitate communication with distant dumping sites for the Jakarta refuse in an economic way. Since the composting plant is not equipped with an incineration plant, a suitable dumping site for waste rejected by the composting plant must still be found.

(c) Collection facilities

A suitable agreement must be reached between the Municipality and the plant's management according to which adequate city areas for waste collection and removal are defined and the payments to be effected by the Municipality for this service of the refuse composting plant are established. This co-operation is already practiced in Surabaya and Medan.

(d) In addition the acquisition of 15 compact lorries with 14 to 16 m^3 capacity instead of the 40 Thames Trader refuse collection trucks is recommended to cope with the needs of the Jakarta household refuse collection service, which at present is not in full operation.

4.6. <u>Financial, Administrative and Legal Aspects</u>

The National Planning Development Board (BAPPENAS) is responsible for the preparation of Indonesia's Five Year Development Plan. BAPPENAS thus plays a key role for the Jakarta Composting Plant completion and development project.

Dr. Herman Heruman, Director for Environment of BAPPENAS, with whom the UNIDO expert had two meetings, is dealing with the National Composting Development Programme and specifically with the Jakarta composting plant project, which has in the meantime been given high priority.

4.6.1. Financial aspects

BAPPENAS is going to make, as soon as possible, a project proposal for financing the Jakarta composting plant completion under World Bank loan. A large World Bank loan, previously granted in the framework of Slums Improvement Programme (Kampung Improvement Programme), is largely not used because of lack of technical assistance, and is thus partially available. The UNIDO expert was asked about the amount required, but could not give any reasonable figure for the Jakarta composting plant completion and starting-up,a problem which in 1973 had been studied already by Mr. Marsono.

The costs for equipment are generally up to 15-18% of the equipment updated value. Buildings and civil works costs are to be added, and cost assessment has to be made on the basis of John Thompson estimates and drawings. Therefore, Clarke Chapman Ltd. has to be contacted urgently. However, an estimated US $4,000,000,- is needed and included in the proposal for the National Composting Programme (see 2.9.).

4.6.2. Administrative aspects

(a) It is obvious that a new organization is required, not only to complete the plant, but also to run the plant and to organize the compost sales and marketing. Thus, two aspects must be contemplated: ownership and operation.

One has to keep in mind that a municipality activity is normaly limited to urban refuse collection, removal and dumping at the lowest cost (sanitary landfill), and composting is not the cheapest way to get rid of garbage. Compost production is justified by agricultural and economical purposes which are within the scope of the Central Government Development Programme, as indicated by the plan for a National Composting Programme.

The above criteria have to be taken into account for the decision on the plant's ownership and administration scheme.

(b) As regards the plant's operation, BAPPENAS considers 3 possibilities:

- 1st alternative - The plant may be run by the Local Government, with aid from the Central Government through the Ministry of Public Works, or Ministry of Industry, or Ministry of Agriculture;
- 2nd alternative - The plant may be run by the Central Government under the scheme of the Kampung Improvement Programme, i.e. the Government's financing in the framework of the Urban Development Programme headed by the Ministry of Public Works;
- 3rd alternative - The plant may be run by the Central Government under the Ministry of Agriculture in association with the Agriculture Production Programme. This alternative corresponds to a new project that would be created by the Department of Agriculture.

For the 2nd alternative, there has been a programme under World Bank loan for activities of garbage collection that could be extended to composting activities (in the World Bank programme for garbage collection and disposal 40 cities are involved).

For the 3rd alternative, the programme may get higher priority, since it involves the Agriculture Production Programme.

(c) The expert was asked about the possiblity of operating the plant by a private company. This form of management may be recommended if the appointed contractor is an experienced compost production and management professional, and as long as the contractor's rights and duties are well established.

4.7. Findings and recommendations

The following immediate actions are recommended:

UNIDO

To approach Clarke Chapman Ltd. in Wolverhampton, U.K. for discussions on assembly and plant's starting up and operation costs.

UNIDO offered to transfer results to the Government through UNDP/SIDFA Jakarta. BAPPENAS is expecting a report before the end of October 1980.

Government

Subject to the Government's agreement on Clarke Chapman's proposal:

- To use all possible efforts for making the World Bank loan available before 31 December 1980;
- To decide on the plant's ownership and to set up new administrative and operational status;
- To launch tender invitation to Indonesian contractors for buildings and civil works implementation;
- UNIDO assistance may be requested for the plant's completion consisting of: preparing tender specification book, assisting the Government in selection and assembly of equipment, in co-ordination of civil works implementation, assistance in delivery and testings, as well as in providing necessary training and fellowships for key personnel.

A project document outlining the above activities should be prepared within the Framework of the National Composting Programme for Indonesia.

5. The trouble-shooting of the compost plants at Medan and Surabaya

5.1. General survey

Both Medan and Surabaya factories have been installed in 197? with equal operation lay-out and are owned and run by the same private commercial company:

P.T. Kurnia Pelita
Oikini Raya, 48 - Jakarta

P.T. Kurnia Pelita itself is owned by the holding company:

P.T. Mercu Buana
Rayam Luruk Building - 14th floor - Jakarta

Mercu Buana deals with agro-activities and the production and exportation of estate crops, chemical and organic fertilizers etc. The company is also involved in the Jakarta Composting Plant (see 4.1.)

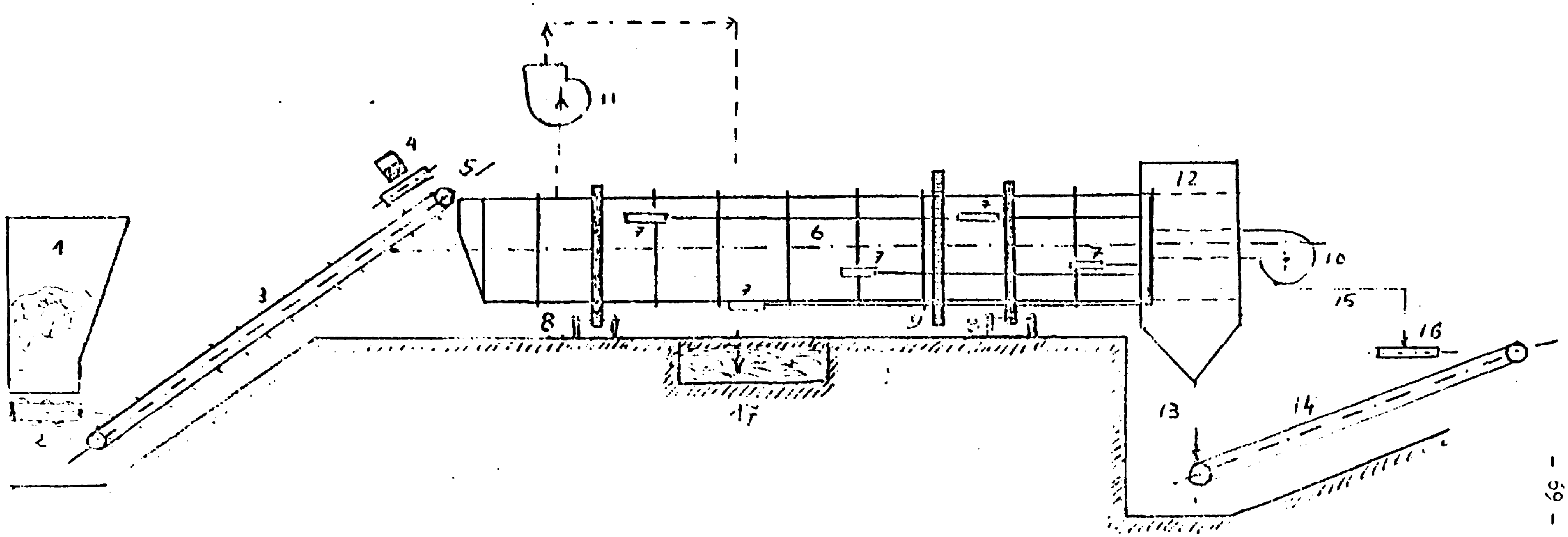
5.1.1. Operation scheme

The plant's reception building is designed for 2 lines, each of them with a capacity of 400 m3/day (or 100 tons/day assuming average density 2.5).

Each line consists of:

- One concrete reception pit
- one sloped belt conveyor
- one DANO-Bio-stabilizator
- one Siebteknik Vibrating-Sieve through which material is separated into 2 fractions: under-riddle 2 is led to the plant's outlet while over-riddle is conveyed to:
- one 40 HP and 60 HP Bi-rotor Fine Crusher (from BIAS, Denmark supplied by Ernst Koromsky, Hamburg, West Germany)

The end product is transferred to the maturing area where it is piled in windrows by means of appropriate wheel-loader-engine. Compost remains at open air 2 months and fermentation continues at the same time. Temperature rises to 78°C and drops progressively down to 46°C after 2 months. Windrow turning-over is performed every 2 weeks.



1. Reception pit
2. Slat conveyor
3. Slat conveyor
4. Magnetic separator
5. Biostabilizer hopper
6. Biostabilizer revolving body
7. Air inlets
8. Cast steel rings and rollers
9. Drive gear
10. Ventilating fan
11. Fouled air exhaust fan to earth filter
12. Revolving screen
13. Coarse screened compost
14. Compost conveyor
15. Rejects over riddle
16. Rejects conveyor
17. Earth filter

Figure 4 Dano Stabilizer Composting Process

5.1.2. Ancillary equipment

Both factories are equipped with their own power plant consisting of two diesel power units, one under operation, the other standing by: Medan factory two 262 KVA caterpillar units, Surabaya two 313 KVA units. Diesel wheeled loaders and dumping trucks are available for garbage and compost handling.

Surabaya plant has 7 open refuse collection trucks. The fee for removal of garbage is Rp. 450/m3 paid by the Municipality. Medan plant being at a distance of 13 km from the city centre, has no collection trucks and therefore garbage, mainly coming from markets is delivered at the plant free of charge. But the plant maintains 4 HINO open lorries for compost delivery to distant places. Both plants are equipped with a weightbridge.

5.2. Composting capacity and yield

a) Medan

Although the plant's capacity is 80-100 tons/day, the present capacity is as low as 30 tons/day. If the city's refuse collection exceeds this limit, the excess amount of garbage is transported to a dumping site and extra costs are charged to the Municipality.

According to the plant manager the compost yield is estimated at 30 % compost, 60 % rejects, 10 % loss due to water evaporation.

b) Surabaya

The plant's full capacity is 125 tons/day of refuse. At present compost production per month is between 1000 and 1200 tons.

The percentage of compost yield is nearly the same as in Medan: 30 % compost, 50 % rejects and 20 % loss due to water evaporation.

In both plants the compost yield is abnormally low.

5.3. Operational conditions and compost price

5.3.1. Operation costs

a) Personnel

One hundred workers are employed at the Surabaya plant, most of them unskilled; working hours are 16 hours per day, Sundays included (DANO-stablizer operates day and night). Skilled personnel, besides the plant's manager, comprises of a mechanic, an electrician foreman and one laboratory assistant working at the local government office. The medan plant on the other hand has only 28 workers. The average wages are in the range of Rp. 750 - 1000 per day with transportation, health insurance etc. included.

b) Technical operation input

Consumption of fuel by power generators and vehicles is about 1.2 tons/day with a fuel price of Rp. 52.50 per liter. Rp. 10,000,000 is allocated per month for spare parts and maintenance. The double rotor hammers are recharged electrically and other parts are repaired or produced in the plant's own workshop.

5.3.2. Compost production cost

According to a study, the Surabaya plant processed up to 12,906 tons of refuse in 12 months during 1976 and had a compost production of only 3.5 tons at the same time. Since the operational cost over the year was up to 115,437,413 Rps. (amortization included), the average compost production cost per kg was Rp. 33,05.

These abnormally high operation costs can be explained as follows:

- the plant's capacity had been used up to only 35 %, while overhead and labour costs are of course not cut down at the same rate;
- a compost yield of 31 % is extremely low and reveals severe technical problems during the composting stage;
- compost yield of 31 % is unusually weak and reveals trouble shooting at the composting stage.

5.4. Possible factors causing low compost yields

a) Water content

Household and market refuse in tropical countries usually have a high percentage of water (about 60 % during dry season, up to 90 % during rainy season), which is not adequate for treatment in the Biostabilizer. Drying of the garbage in these cases is done by the sun while the material remains in the reception area, a process quite uncontrolled.

b) Garbage composition

In developing countries like Indonesia municipal waste control is not subject to regulations like in developed countries. Therefore, household refuse arriving at the plant contains a lot of large, for the DANO-Biostabilizer, indigestable components.

c) Fermentation

Residence time in the DANO-Biostabilizer should be about 5 days, while in reality at the Medan plant it is about 3 days at maximal 55°C and at the Surabaya plant only 2 days at 45° to 50°C. Under such conditions one could operate as well without a Biostabilizer. Obviously a satisfactory fermentation process cannot be achieved.

d) Sieving

A "Siebtechnik" vibrating sieve set up immediately after the exit of the biostabilizer, fed with incompletely fermented material with high water content is the reason for a substantial loss of organic matter. In other words, the concept applied to Medan and Surabaya composting plants is practically the same as applied to countries with a moderate climate (Denmark, New Zealand etc.) without taking into account Indonesian tropical conditions.

e. Operational breakdown

Due to a general lack of maintenance the plant has to stop operation frequently.

5.5. Market Situation

a. Most of the Medan plant compost is sold to it's owner Mercu Buana Co. who maintains three huge estates located at a distance of 100 km from the plant.

Other clients are the North Sumatra market gardeners, who are supplied by three distribution storehouses. Compost price is in the range of Rp. 30 to 40 per kg which is far too high compared with the price for animal manure (up to Rp. 8 per kg). North Sumatra is supplied by another compost producer: P.T. Jaya Tani, Medan, with a compost capacity of 400 tons/month. This compost is produced in a different way and the price for the final product is about Rp. 30 per kg.

b. East Java estates within the Surabaya compost area are generally Government owned. In this area the compost market price is about Rp. 17 per kg, a price established by the Ministry of Agriculture Extension Services.

Some of the compost is exported to Bali and sold for a price higher than the price for fertilizers.

5.6. Recommendations for the improvement of Medan and Surabaya composting plants

a. The drying procedure for the refuse practiced at the present time must be abandoned.

b. Daily testing of the water content for rejects and fresh garbage should easily be performed and a mixing rate as a function of the water content must be established in such a way that the humidity of the whole mixture does not exceed 60 to 65 % at the inlet of the processing line.

c. Sieving

It is recommended to convey the material from the DANO stabilizer immediately to the maturing area and to perform sieving after fermentation is completed (about 10 days). Over-riddle should be recycled and under-riddle be subjected to the bi-rotor hammer mill for fine crushing.

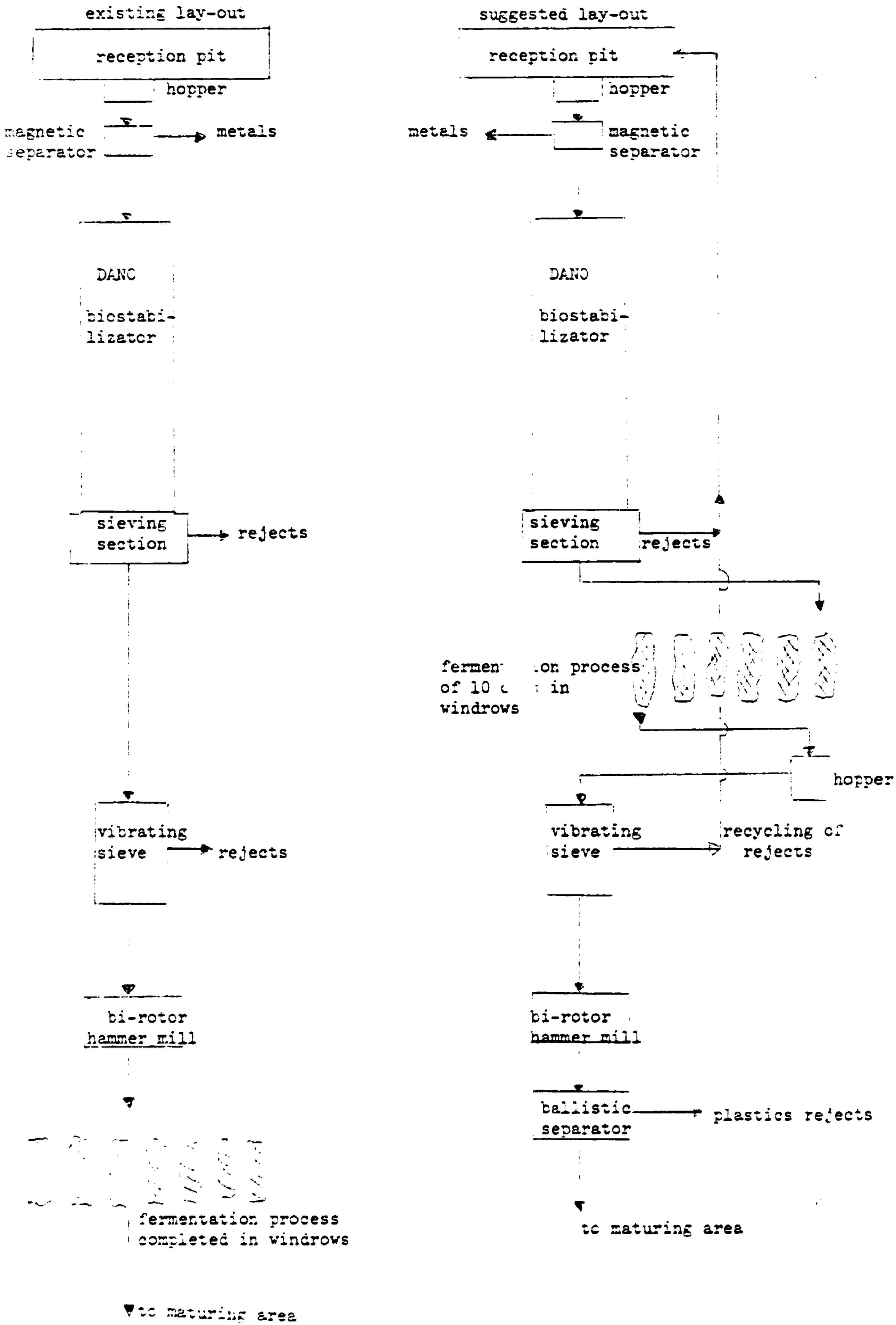


Figure 5 Proposed modification for the compost plants at Surabaya and Medan.

d. Crushing of large components

A heavy-duty hammer mill crusher should be installed and the crushed material could be combined with the DANO-Biostabilizator product for maturing.

e. General restoration and maintenance

A complete repainting and cleaning, replacing of all corroded or consumed parts is badly needed. Also the workshop must be completed, a team for exterior and interior cleaning and a maintenance team with a skilled foreman should be created. In case of an operational breakdown, collection trucks should not be given permission to deliver more garbage than the plant's capacity allows.

f. Part of the suggested transformation can be executed with minor changes. However, aquisition of a heavy-duty hammer mill would lead to double or triple the actual capacity (Fig. 5) and to a yield improvement of up to 50%.

At the same time, compost production price will decrease to a normal level (Rp. 10 per kg). It was noticed that Thyssen Energie GmbH, West Germany, submitted a proposal in 1976 for a composting plant with a Rheinstahl drum stabilizer at a price of DM. 8,380,000 cif including assistance during erection. This procedure is not very different from DANO-Biostabilizator and also does not include a heavy-duty crusher, which, at present, is the equipment mostly needed.

6. "Compost from household refuse and aerobic composting process in tropical environment".

Presented at the seminar on "Biogas and City Waste Composting", Jakarta, 1 to 4 July 1980 (32 pages), by Robert F. Gillet, Geneva, Switzerland.

Abstract

Compost is a fertilizer - better a soil conditioner - obtained from aerobic fermentation of municipal solid wastes. Composting, in comparison with sanitary land filling, as a method for refuse disposal, requires considerable investment but has the advantage of satisfying some agricultural needs by selling compost and thus contributing to ease, through organic recycling, the environmental impact caused by city wastes.

Among the many types of composting techniques existing, three are shortly described: the collected municipal refuse - generally crushed before treatment - is exposed in rows under open air sheds, which are turned over according to the temperature evolution during fermentation process. By another method, the John Thompson process, the crushed refuse is evenly distributed into a system of perforated steel containers which are automatically emptied one into another, while the DANO-Biostabilizator technique is a rotating steel drum, filled with the waste. In both cases fermentation is completed under open air sheds.

An excellent compost with a higher nitrogen content is obtained when at the beginning of the composting process a certain amount of sludge from sewage plants is added.

A cost estimation reveals that investment for a compost plant on a pilot plant scale will be around US$ 800,000 for equipment and US$ 550,000 for civil works. However, for a composting plant with a capacity of about 500 tons/day, approximately US$ 20 million is needed of which 35 to 40 % are requested for civil works.

7. **Persons Interviewed**

Jakarta

Ministry of Agriculture (Departmen Pertanian)

- Dr. Birowo A.T., Head of the Planning Commission (Biro Perencanaan)
- Ing. Tchokroperdoto, Planning Bureau
- Dr. Husin Anang, Planning Bureau
- Dr. Suharyo Husen, Chief Subdivision for the Multilateral Cooperation
- Mr. Hidayat Ganda Atmadja, Planning Bureau
- Mr. Saefoeddin Achmad, Planning Búreau
- Mr. Philman, Planning Bureau
- Mr. Saubari, Head of the Fertilizer Bureau (Bina Sarana Usaha)
- Mr. Samad Siam, Fertilizer Bureau
- Mr. Soedjarno, Evaluation and Controlling Division, Regional Office, Jakarta
- Ing. Hadiono, Agronomist, Crops Production Directorate, Pasar Mingu

Ministry of Home Affairs

- Ing. Soegiarso Padmopranoto, Director for Urban Development
- Mr. J. Rumagit B.A., Urban Development Division
- Mr. Hermansyah, Urban Development Division

Ministry of Works

- Ing. Soeratmo Notodipoero, P.U. Dept. (Cipta Karya)

BAPPENAS (National Development Planning Agency)

- Dr. Herman Haeruman, Director for Environment
- Mr. A. Rosli, Bureau of Environment and National Resources

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Jakarta Local Government (D.K.I. Jakarta)

- Mr. Wahyu Santoso, Manager of the Municipal Cleansing Service (Dinas Kebersihan)
- Mr. E. Djuhara, Municipal Cleansing Service
- Mrs. Yunnani Kartawiria, Chief of the Environment Division
- Miss Ruth Ariani, Assistant Environmental Division

The Jakarta Composting Plant (P.T. Kompos Jakarta)

- Colonel Marsono, Director

Private companies

- Mr. François Denis, Director for S.O.D.E.T.E.G. Indonesia
- Mr. Yves Aubert, Director P.T. Alun (Citroën and Renault Vehicules Industriels)

The United Nations staff in Indonesia

- Mr. Rana, Resident Representative, U.N.D.P.
- Mr. Faquir M. Iqbal, Senior Industrial Development Field Advisor
- Mrs. Victoria Grevemeyer Korb, U.N.I.D.O. Junior Professional Officer
- Dr. Jacques G. Rumeau, F.A.O. Representative in Indonesia
- Mr. W. I. Khan, Assistant of the F.A.O. Representative
- Mr. Bambang, F.A.O.
- Mr. Peter R. Hesse, F.A.O. Regional Coordinator
- Mr. D. Joshy, F.A.O. Consultant for Biogas

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Bali (Denpasar)

- Dr. Gede Jukaca, Director of the Agriculture Extension Service (Kakanwil Deptan Bali, Denpasar)
- Mr. W. Maras, Agriculture Service (Dinas Pertanian)
- Ing. Kt. Ardha, Assistant Agriculture Extension Service)
- Dr. Igusti Ngurah Wardana, the Mayor of Denpasar (Wali Kota Denpasar)
- Mr. Ali Tenaya, BAPPEDA (Provincial Development Planning Agency), Bali
- Mr. Artha, Dept. Public Works, Province of Bali (P.U. Kabupaten Badung)
- Mr. Agung Suteja, Public Works
- Dr. Wayan Muja, Denpasar City Secretary
- Dr. Ida Bagus Widia, The Bali Tourism Development Corporation (P.T. Pengembangan Pariwisata Bali), Cabang Denpasar
- Mr. Oka, Governorate of Camat Village (Kecamatan Baturiti)
- Mr. Jerbekil Wija, Governorate of Camat Village
- Mr.   , Manager Pupuk Kompos, Denpasar

Bandung

- Dr. Husen Wangsaatmadja, the Mayor of Bandung
- Mr. Djembar, Head of thr City Cleansing Service (Dinas Kebersihan)
- Mr. Dipokoesoemo, Manager of the "Dewi Sartika" Project
- Dr. Tutin Sukartini, Horticulture Dept. Wet Java
- Dr. Sutama Wiramihardja, Food Crops Dept.
- Mr. Kosasih, Estate Crops Dept.
- Miss Ir. Yaya, Estate Crops and Plants Protection
- Mr. Anhar, Staff Consulting, Agriculture Regional Div.

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- Mr. Djarja, Agriculture Regional Division

- Dr. Filino Harahap, Director of the Development Technology Centre, Institute of Technology, Bandung

- Dr. Wibowo Suryo, Chemistry Division, Institute of Technology, Bandung

Bogor

Soil Research Institute, Bogor (L.P. Tanah)

- Dr. D. Muljadi, Director of the Soil Research Institute

- Dr. M. Sudjadi, Head of the Soil Fertility Division, Soil Research Institute

- Mr. Istiqlal Amien, Soil Fertility Division, Soil Research Institute

Institute of Agronomy, Bogor (L.P.3)

- Dr. Soetjipto Partohardjono, Agronomist

Jogyakarta

- Dr. Achmad, the Mayor of Jogyakarta

- Mr. Jacob Mardjadi, Chairman of the Agricultural Department Agency of Jogyakarta Province

- Ing. H. Susanto, Agriculture Extension Service

- Mr. Sunkono, Agriculture Extension Service

- Dr. Kridoyato, Head of Agriculture and Fisheries Services

- Mr. Probokusumo, Chairman of the Provincial Development Planning Agency (BAPPEDA) of Jogyakarta Province

- Mr. Soesanto, Subdirectorate of Development of the Municipality of Jogyakarta

- Mr. Soepadi, Head of the Sub-directorate of Finance of the Municipality of Jogyakarta

- Mr. Hardjomuryono, Head of the Sub-directorate of Economical Affairs, Municipality of Jogyakarta

- Mr. Boediarto, Head of the Public Works Service of the Municipality of Jogyakarta

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Medan

- Dr. P. Panggabean, General Secretary of the Municipality on behalf of Dr. A.M. Rangkuty, the Mayor (Wali kota Medan)
- Ing. A. Nasution, Head of the Landscape Department
- Mr. Dawamuddin Nasution, Head of the Cleansing Department (Dinas Kebersihan Medan)
- Mr. Yahya Harahap, Power Department, Medan
- Ing. Faemruddin, Provincial Development Planning Agency (BAPPEDA) of Medan Province
- Ing. Zulfikar Idriss, Agriculture Extension Service
- Mr. Soejarto Ronosoehardjo, Agriculture Department Medan
- Mr. S.H. Harahap, Agriculture Extension Service
- Mr. H. Hutagaol, Agriculture Extension Service
- Ing. J. Aller Situmorang, Agriculture Extension Service
- Ing. Sutana, Agriculture Extension Service, Food Crops Division
- Mr. [illegible], Responsible for Kurnia Pelita Composting Plant, Medan
- Mr. Jayatani, Manager of Kompos Jaya Co. Medan

Semarang

- Dr. H. Iman Luparto Tjokrojolda S.H., the Mayor of Semarang
- Dr. Ir. Wasono, Chairman of the Area Planning of the City
- Dr. Hassan Suleman, Head of the Health Department
- Mr. Sudjatmoho, Head of the Municipal Cleansing Service (Dinas Kebersihan)
- Mr. Sutarso, Agriculture Extension Service (Province level)
- Mr. Moeljono H.P., Agriculture Extension Service

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- Mr. Tasrip, Assistant Municipality of Semarang
- Mr. Benjamin, Interpreter Municipality of Semarang

Solo (Surakarta)

- Dr. Soekatmo Prawirohadisebroto, the Mayor of Solo
- Dr. Djoko Santoso, the Secretary
- Ing. Soedjarwo, Public Works Department
- Dr. Soedarsono, Chief of Project Division Surakarta
- Dr. Salimin, Head of the Kampung (slums) Improvement Programme, Third Urban Development Project, Surakarta
- Dr. Emmanuel Prasetyo, Agriculture Extension Service, Province of Surakarta
- Dr. Herman Soetari, Department of Agriculture, Central Java Province
- Mrs. Tjokrosaputro , Batik Keris owner
- Mr. Handoko Tjokrosaputro , President of Batik Keris
- Mr. Handiman Tjokrosaputro , Director of Batik Keris
- Ing. Hy Green, Batik Keris Technical Adviser

Surabaya

- Dr. Martono, Director of the Agriculture Extension Service (Hakanwil Deptan Surabaya)
- Mr. Imam Soeroeri Ngisoatmodjo, Agriculture Extension Service
- Mr. Drh. Soemitro, Agriculture Extension Service
- Ing. H.M.O.B. Moechtadi, Assistant Secretary for Development
- Colonel Czi Soekardjo, Chairman of the Surabaya City Planning Board
- Ing. Zairudin Djapri, Public Works Dept.

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- Mr. Karwi, City Cleaning Division
- Mr. I.D.F. Sukarda, City Cleaning Division
- Mr. Renny Da Costa, P.T. Kurnia Pelita Surabaya Composting Plant
- Mr. Wijono Koesoemowidjojo, P.T. Kurnia Pelita

8. Documents consulted

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  Les Presses Universitaires de France, Paris 1967

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  Bulletin Nr. 3 - Soil Research Institute, Bogor 1976

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  Massachusets, U.S.A. 1976

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  Jogyakarta - Jogyakarta Municipality Document

- Ringkasan Dan Kesimpulan Peninjauan Pabrik Kompos
  Surabaya - P.T. Kurnia Pelita, by Colonel Marsono, 1977

- All P.T. Kompos Jakarta documentation and reports (including John Thompson documents) gently communicated by
  Colonel Marsono, Director of Fabrik Kompos Jakarta, Pasar
  Mingu

U.N.I.D.O. Project SI/INS/80/801/11-01

Preliminary assistance for composting of Municipal Solid Waste - Indonesia and U.N.I.D.O. further assistance for a National Composting Programme that can be adopted at all major cities of the country

DATA CONNECTED WITH THE CITY GARBAGE COLLECTION SERVICES

CITY OF

1. STATISTICAL DATA (at present time July, 1980)

1.1 Population

	Areas sq.km.	Number inhabitants
District		
District		
District		
District		
District		
Total		

Average density per sq.km. :

Evaluation of the population growing rate :

Population at 1960
- 1965
- 1970
- 1975
- 1980
- 1985 (forecast)
- 1990 -
- 1995 -
- 2000 -

Population average growing rate per annum :

Notes -

.../...

1.2 AMOUNT GARBAGE TO BE MANAGED

	Generated garbage		collected garbage	
	cu.m.	m.t.	cu.m.	m.t.
Household				
Markets				
Industries				
Other				
Total				

Average amount garbage per capita
(industrial not included)
Houshold + Market only

Garbage average growing rate per capita/year :

1.3 COMPOSITION OF GARBAGE (Physical analysis)

Note – Kindly specify the authority having ordered garbage analysis, as well as all useful details about weighting or manual sorting (date, places, duration of the sorting campaign, season, etc.)

	% of dry material	% of raw material
Water		
Glasses, china, etc. .		
Paper, cardboard		
Rubber, leather		
Plastics		
Metals		
Earth, rubbles, etc.		
Textiles, rags		
Wood		
Animal or vegetal wastes ...		
Total		

Notes -

.../...

2. SURVEY OF THE GARBAGE COLLECTION SERVICE AS OPERATING AT PRESENT TIME (July, 1980)

2.1. Draw overall picture of the Garbage Collection Service, specifying :

- How is it organized at the different levels ?
- How is it linked to the other Governmental or Municipal authorities and services ?
- How is organized the Garbage Collection Service itself on the following rungs down (districts, sub-districts, etc.)

Kindly explain the operating scheme with the help of Organization Chart .

Join annexed note, if necessary .

2.2. How is the Garbage Collection Service operating ?

- Directly operated by the Municipality's own means ?

  Specify the names of the General Manager, his Deputy and chief-assistants :

- Through private contractor(s) ?

  If so, specify all useful informations about these private contractors : corporate name and address, etc.

2.3. Address of the Garbage Collection Service

Head Office — Phone

Branches — Phones

Garage(s)

Workshop(s)

Notes -

2.4. In short : To draw an estimate at present time of the overall organization of the service and annexes .

3. THE GARBAGE COLLECTION FACILITIES

3.1. At the level of the dwellings (Pre-collection)

- Explain on separate paper the course of garbage at the different stages from the generation places to the several places where it is delivered or put down in awaiting to be picked up by the garbage collection vehicles, for removal

- How is this task carried out at the different following cases :

Household ? explain the mode of practice for :

- upper income dwellers ?
- lower income dwellers ?
- slums ?

- Inventory of the different types of receptacles or similar means for pre-collection purposes :

  - cans or dust-bins ?
  - plastic bags ?
  - baskets ?
  - metal or plastic containers ?
  - cemented fixed containers ?
  - cemented or not cemented tipping areas ?

Notes -

.../...

3.2. Survey of the Rolling Collecting Facilities

Inventory of the collecting equipment owned by the Garbage Collection Service, according to its operational conditions at present time :

	Good	Fair	Poor	Out of use
Compacting lorries				
- mini (less than 6 cu.m.)				
- medium (6 to 12 cu.m.)				
- maxi (more than 12 cu.m.)				
Specify - in annexed note, if necessary - the makes, types, diesel or gasoline, garbage compaction rate, etc.				
Opened lorries				
- mini (less than 6 cu.m.)				
- medium (6 to 12 cu.m.)				
- maxi (more than 12 cu.m.)				
Specify - in annexed note, if necessary - the makes, type, diesel or gasoline, etc.				
Tractors and trailers				
- medium (6 to 10 cu.m.)				
- maxi (more than 10 cu.m.)				
Specify the number of tractors required for towing trailers, as well as makes, types, etc.				
Multibuckets				
- mini (3 to 6 cu.m.)				
- maxi (12 cu.m. and more)				
Specify the number of lifting lorries required for the multibucket removal, as well as makes, types, etc.				
Carts and other animal drawn facilities				
Railroad trucks				
Specify trucks capacities and types (if any) and specify if dumping or no dumping trucks				

Note - Kindly provide similar data for contractor(s) owned collecting facilities .

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3.3 Housing and Maintenance/Repair Facilities

- Draw a short review of housing and maintenance facilities for the garbage collection rolling equipment :
  - garages (number, location, capacity)
  - washing, lubricating, tyres and filling stations owned by the Garbage collection service .
  - Are the repairs carried out by the own Municipality means or through private workshops ?
  - Workshops owned by the Municipality : number, location, capability and equipment ?

3.4. In short :

To draw an estimate - at present time - of the removal overall cubic meter capacity per day of the Municipality owned rolling stock that is normally in condition to operate (overall capacity for one trip only) in the different categories :

	compacted	non compacted
Compacting lorries		
Open lorries		
Trailers		
Multibuckets		
Carts and animal drawn		
Railroad trucks		
Total		

Notes -

4. THE GARBAGE COLLECTION OPERATION

4.1. Collecting areas

Kindly provide a map of the city, and report the main following data at the map :

- Demarcation of the different garbage collection sectors
- Location of the transfer stations, if any
- Main provisional tipping places for pre-collected garbage
- Final dumping sites
- Location of the processing plants, if any (if not, please check possible location for composting plant)
- Collecting lorries garage location
- Maintenance and repair workshop location

4.2. Are definite specific routes assigned to garbage collection lorries ?

Explain how is scheduled the rotation of vehicles and specify how many trips according to respective capacities .

4.3. Could you give an estimate of the served network overall length, in miles or kilometers ?

The overall mileage covered by the lorries as a whole, per annum ?

Or the average mileage per lorry and per annum ?

4.4 The total fuel consumption by the lorries as a whole, per annum in

- diesel ?
- gasoline ?

Or the average consumption per lorry and per annum in

- diesel ?
- gasoline ?

Notes -

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5. THE GARBAGE DISPOSAL OR PROCESSING

5.1. Final dumping site(s)

Respective locations and capacities (estimate in cubic meters and number of years operation) ?

Operating systems ?

- Sanitary landfilling (i.e. the controlled dumping with inert covering material intermediate layers as per the usual rule) ?

- Half-controlled dumping (garbage is compacted, but inert covering material is not used) ?

- Dumping at open air ?

- In both last alternatives, what provided for environmental protection ?

- Is the picking up of common use at dumping site ?

5.2. Compacting equipment available at dumping site(s)

- Bulldozers and other tracked compacting engines
  Specify, number, makes, types, etc.

- Shovel wheeled equipment for garbage and covering material handling
  Specify number, makes, types, capacities, etc.

- Transport lorries
  Specify number, makes, types, capacities, etc.

Is earth covering material available at reasonable distance ?

5.3 Other means for getting rid of garbage

- Composting plant ?
- Incineration plant ?
- Direct sale to farmers ? If so specify average sale price according to the common use ?

- Tipping to river or sea ?

Could you specify garbage that is got rid as per above respective means ?

.../...

6. GARBAGE MANAGEMENT OPERATION COST APPRAISAL

(Specify per month/year/etc.)

6.1 Expenses

a/ - Collection service and dumping site personnel

Personnel employed	Number of persons	Wages incl. charges
- Head office and administration staff		
- Collection supervisors		
- Lorry drivers		
- Garbage collectors		
- Workshop and maintenance personnel		
- Engine drivers		
- Other personnel at dumping site(s)		
Total		

b/ - Utilities

- Fuel and ingredients (lump amount)		
- Power, water, etc.		
- Maintenance		
- Repairs		
- Running cost fixed expenses (insurances, fixed installations, etc.)		
- Rodent control, Insecticid, etc.		
- Earth covering		
Total		

c/ - Overheads ....

d/ - Amortizations ....

Overall running cost

6.2 Receipts

Fees and taxes paid by dwellers

- - - market traders

- - - industrialists

Municipality's contribution

Note - Should contractor(s) service be used, kindly specify :

- the terms of the agreement : contractor's and Municipality's respective duties and charges, duration of the agreement, contractor's remuneration, etc.

7. THE MUNICIPALITY'S FINDINGS AND RECOMMENDATIONS IN ORDER TO IMPROVE THE GARBAGE COLLECTION SERVICE

Date :

Please, convey this document to the U.N.I.D.O. Consultant in charge of the project SI/INS/80/801/11-01 - c/o Ministry of Agriculture
Planning Division
Jl. Imam Bonjol, 29
Jakarta

Thank you in advance

The transmission of any document relating to the garbage collection and disposal should be gratefully appreciated

 Questionnaire II

U.N.I.D.O. Project SI/INS/80/801/11-01

Preliminary assistance for composting of Municipal Solid Waste - Indonesia and U.N.I.D.O. further assistance for a National Composting Programme that can be adopted at all major cities of the country

DATA CONNECTED WITH THE MARKET RESEARCH AND MARKETING STUDY FOR COMPOST PRODUCED IN THE CITY OF

Note - Since compost is bulky product and transport costs expensive, the outlet for compost is to be found within a radius that does not exceed reasonable distance from the processing plant, that could be estimated 40 to 60 km. maximum

The purpose of the present inquiry is to set up a rapid survey of the potential market for compost within the limits of the above considered area .

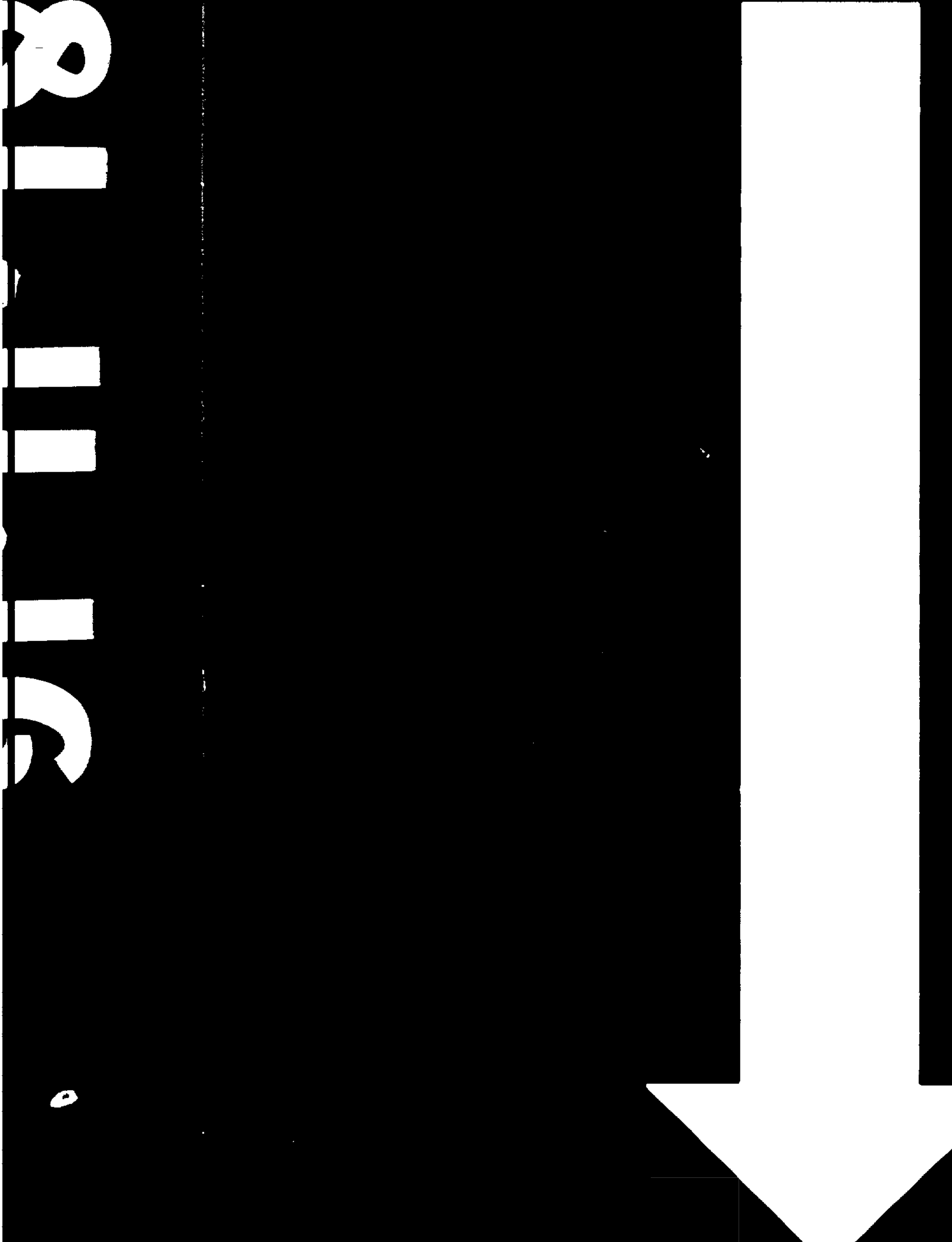
1. ENVIRONMENTAL CONDITIONS

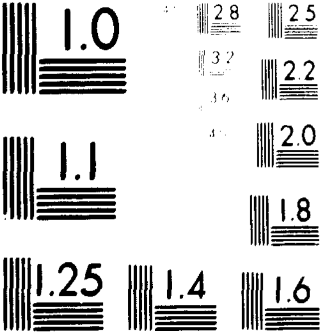
Kindly provide available data about :

- Specific climatic conditions
- Rainfall : mm. per annum and mm. per month (graph)
- Geological characteristics and mother rock (substratum)
- Pedological characteristics of the soils and their potential for agriculture
- Average P_H of the soils and other physical and chemical characteristics
- Effects of erosion and its extent at the considered area

Note - All analytic data or other that could be provided are gratefully appreciated .

Notes -





MICROCOPY RESOLUTION TEST CHART

2. THE AREA'S AGRARIAN STRUCTURE AND AGRICULTURAL CHARACTERISTICS

2.1 Explain how the considered agricultural sector is distributed among private/Government estate holdings or cooperatives and small land-holders

and how the mainscrops growing is carried out through the respective types of farming .

2.2 Local technical assistance to the farmers, in form of :

- top agricultural institutes (University) and secondary agricultural schools
- basic research institutes, especially dealing with the fertility and plants' nutrition problems

Notes -

.../...

3. THE AGRICULTURAL PRODUCTION WITHIN THE LIMITS OF THE CONSIDERED AREA

Areas under cultivation and common yields for the vegetable crops (Please, use the chart below)

	Areas covered at present time	Areas targets 1985/9)	Common yields at present time
Food Crops			
Rice (for information only)			
Corn (maiz)			
Sorghum			
Cassava			
Soya beans			
Ground nuts			
Fruits (citrus)			
Papaya			
Fruits (other)			
Market gardening crops (vegetables or horticulture)			
Estate crops			
Tobacco			
Coffee			
Tea			
Cane sugar			
Coco nuts			
Oil palms			
Rubber			

(Please tick off crops that, at your opinion, could take advantage of compost application)

Notes -

.../...

4. FERTILIZERS AVAILABLE FOR THE AGRICULTURAL PRODUCTION

4.1 Chemical fertilizers

a/ - NPK amounts applied on average to the main vegetable crops

	Urea	TSP	ZK	Compound
Food crops				
Rice (for information only)				
Corn (maiz)				
Sorghum				
Cassava				
Soya beans				
Ground nuts				
Fruits (citrus)				
Papaya				
Fruits (other)				
Market gardening crops (vegetables or horticulture)				
Estate crops				
Tobacco				
Coffee				
Tea				
Cane sugar				
Coco nuts				
Oil palms				
Rubber				

b/ Chemical fertilizers common cost prices

Maximum retail sale prices to farmersfor chemical fertilizers delivered at the distribution shop

- Urea
- TSP
- ZK
- Compound NPK

Notes -

.../...

4.2 Organic fertilizers (Soil conditioners)

a/ - How is the organic matter provided to the soils of this area at present time ?

- Burning
- Intercropping and crops residues (straw, mulch, etc.)
- Green manure (crotellaria, azolla, etc.)
- Animal manure (cows, pigs, poultry, etc.)

  Specify : availability
  sale prices
  To which crops are they applied and quantities
- Raw garbage (city waste) as delivered by truck drivers :

  Specify : availability
  common prices
  To which crops is raw garbage applied ? quantities ?
  Is raw garbage previously sorted or not on the farm ?
  Is the raw garbage fermented or not on the farm ?
- Compost (from composting plant)

  Specify : availability
  cost price for delivery at the plant
  To which crops is it applied ? quantities used ?
  Average transportation cost price

4.3 Chemical and organic fertilizers joint application

Please, provide some usual blendings

Notes -

.../...

5. PROSPECTS ON POSSIBLE USE OF COMPOST WITHIN THE LIMITS OF THE CONSIDERED AREA

5.1 Requirements

Specify the requirement for year in the different crops below : (and 1985 and 1990 forecast)

	arboreal	industrial	market gardening crops
1980 (or 1982)			
1985			
1990			

5.2 Quality

Specify the degree of sorting and riddling required for the different crops ?

Specify the degree of fermentation ?

for the different types of crops : arboreal, industrial, market gardening crops ?

5.3 Price

Estimate of the sale price that could be paid by the farmers according to the crops and compost upgrading and quality ?

5.4 Distribution

What are the measures suggested in the field of the distribution ? Distribution network ? Sales points ?

Loose product or bagged mixed or not mixed product ?

5.5 Government support

At your opinion, is compost to be supported by the Government ?

Notes

.../...

6. WHAT ARE YOUR FINDINGS AND RECOMMENDATIONS IN ORDER TO PROMOTE COMPOST'S POPULARIZATION AND USE ?

Date :

- Please, convey this document to the U.N.I.D.O. Consultant in charge of the project SI/INS/80/801/11-01 c/o Ministry of Agriculture
Planning Division
Jl. Imam Bonjol, 29
Jakarta

- Thank you in advance

The transmission of any document relating to the subject should be gratefully appreciated .

Some examples of temporary refuse storage

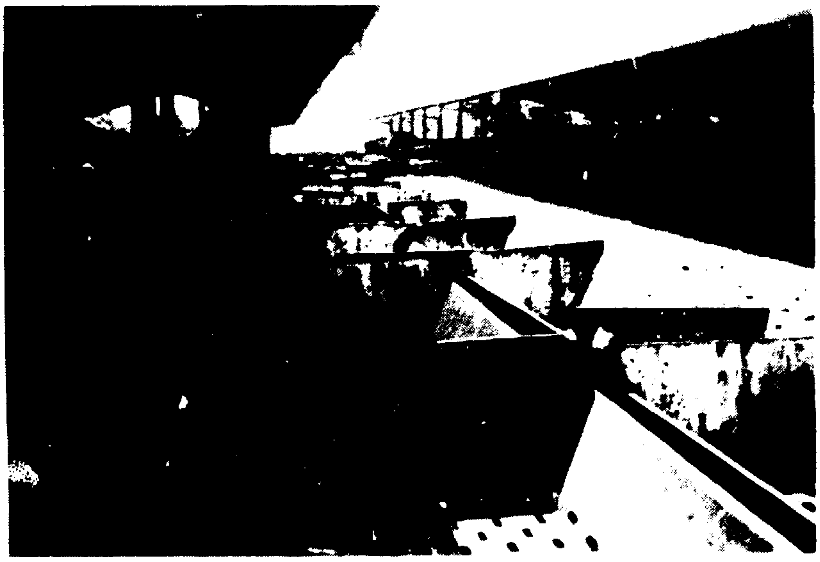
Semarang

Solo

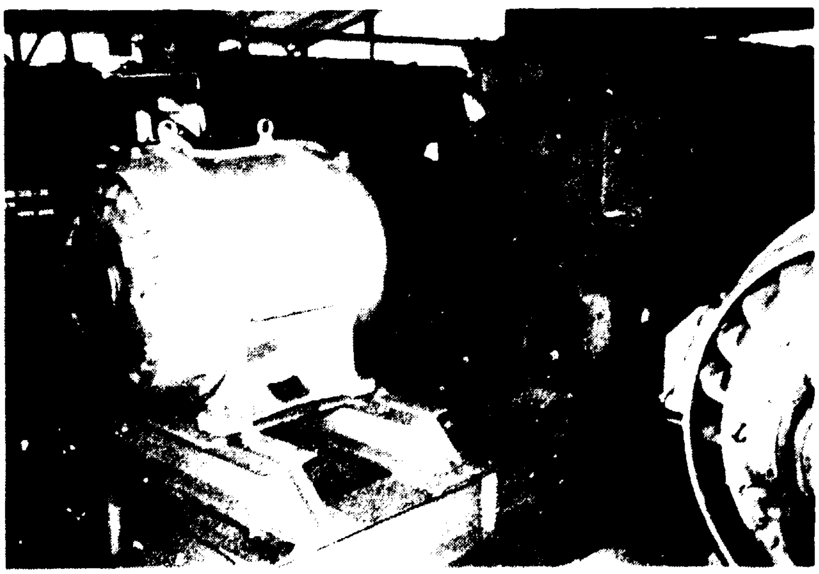
Solo

Compost plant at <u>Jakarta</u>

equipment stored in a building originally assigned for maturing of compost; in the front a model of the plant.

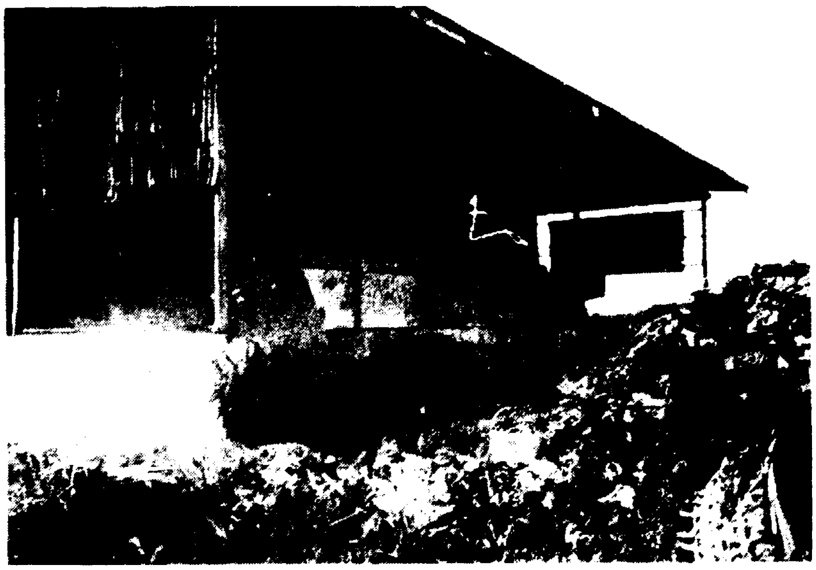


864 JOHN THOMPSON fermentation vats stored at the plant site for 17 years



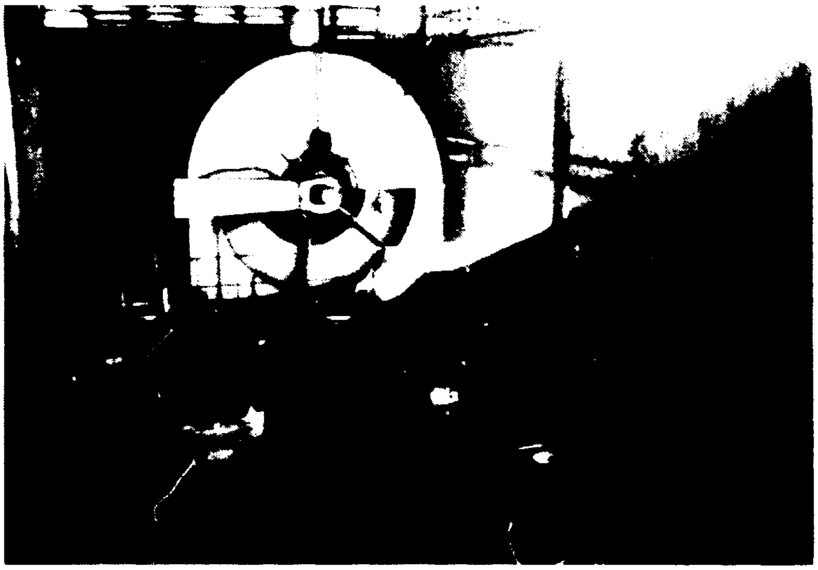
JEFFREY DIAMOND 200 HP hammer mill

Compost plant
at Medan



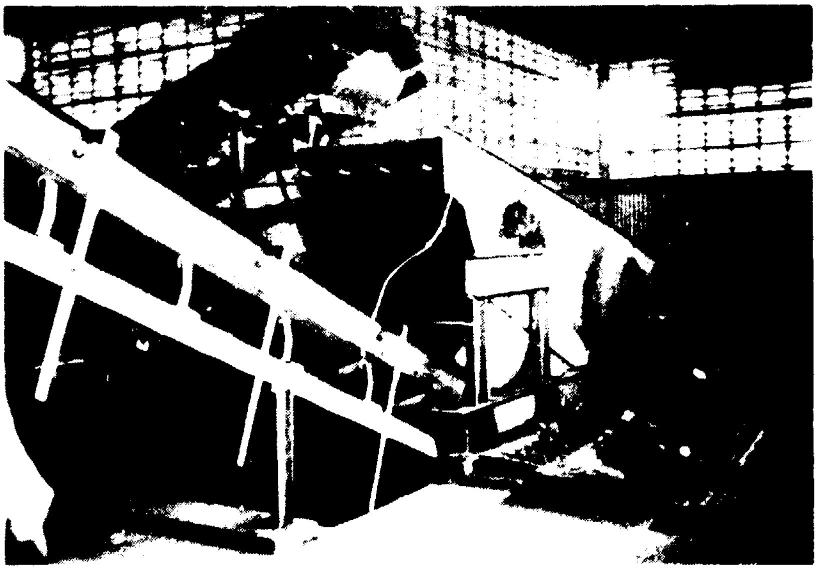
Medan :
reception plat-
form, accumulated
refuse is covered
by weeds

Compost plant
at Surabaya



Surabaya

DANO stabilize
outlet with fa
and belt
conveyor



Surabaya

SIEBTECHNIK
vibrating sieve

Surabaya

manual removal
of plastics at
the fermentatio